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CONTENTS

(Contents continued on outside back cover)

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NEW PALYNOLOGICAL DATA ON THE UPPER PRECAMBRIAN AGE OF THE SIBIŞEL LITHOGROUP (CENTRAL SOUTH CARPATHIANS)

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Key words: Sibişel Lithogroup. Central South Carpathians. Medium Grade Metamorphism. Acritarchs. Upper Proterozoic. Cadomian Orogenesis.

Abstract: The researches carried out confirm that the acritarchs can also be preserved under conditions imposed by medium-grade metamorphism. The determined palynomorphs enable us to refer the Sibişel Lithogroup to the Upper Proterozoic. The age determination allows the conclusion that the metamorphosis of the formations took place during the Cadomian Orogenesis. The metamorphics from the Sibişel Lithogroup can be correlated with the ones from the Suru Lithozone (Făgăraş Lithogroup), because of the similar lithologic associations, of the paralel metamorphic history and especially on the basis of the palynological content.

1. Introduction

The Sibişel Lithogroup is exposed in the Central South Carpathians west of the Olt Valley.

The crystalline schists of this lithogroup have constituted, during the last years, the object of several petrographical and structural investigations (Hann, Szàsz, 1984: Mânecan, 1984, 1989; Hann, Balintoni, 1988; Hann, 1992) to which we add recent palynological investigations.

The results of these investigations led to new data on the acritarchs which are preserved in these metamorphic formations.

The polymetamorphic character of the schists generally hindered the acritarchs preservation in great number.

Most samples were barren and for other acritarchs the presence was sporadic, but certain.

This fact confirms Vidal's statement (1981), which demonstrated that these microfossils could preserve themselves also under conditions of a medium grade metamorphism.

First palynological investigations on the metamorphics of the Sibişel Lithogroup were done by Naumova et al. (1964), who attributed the formations of the Sibişel Lithogroup to the Riphean. This age was argued by the following association of palynomorphs: *Leiominuscula minuta* NAUM., *Lophominuscula prima* NAUM. *Margominuscula tenela* NAUM. *Margominuscula antiqua* NAUM., to which Riphenideae are added.

Investigations were resumed by Codarcea Dessila and Iliescu (1969), on samples collected also from a restricted area (Răşinari region - Fig.).

The determined palynomorphs permitted us to attribute this lithogroup to the Upper Proterozoic. Here they are: *Protoleiosphaeridium* sp., *Leiosphaeridium* sp., *Trachyoligotriletum obsoletum* (NAUM.) TIM., *Stenozonoligotriletum sokolovi* TIM., *Stenozonoligotriletum validum* TIM., *Leiosphaeridium* T. TYP. (S–71) PHLUG, *Millaria* sp. PHLUG, *Mycteroligotriletum marmoratum* TIM., *Lopholigotriletum* sp.

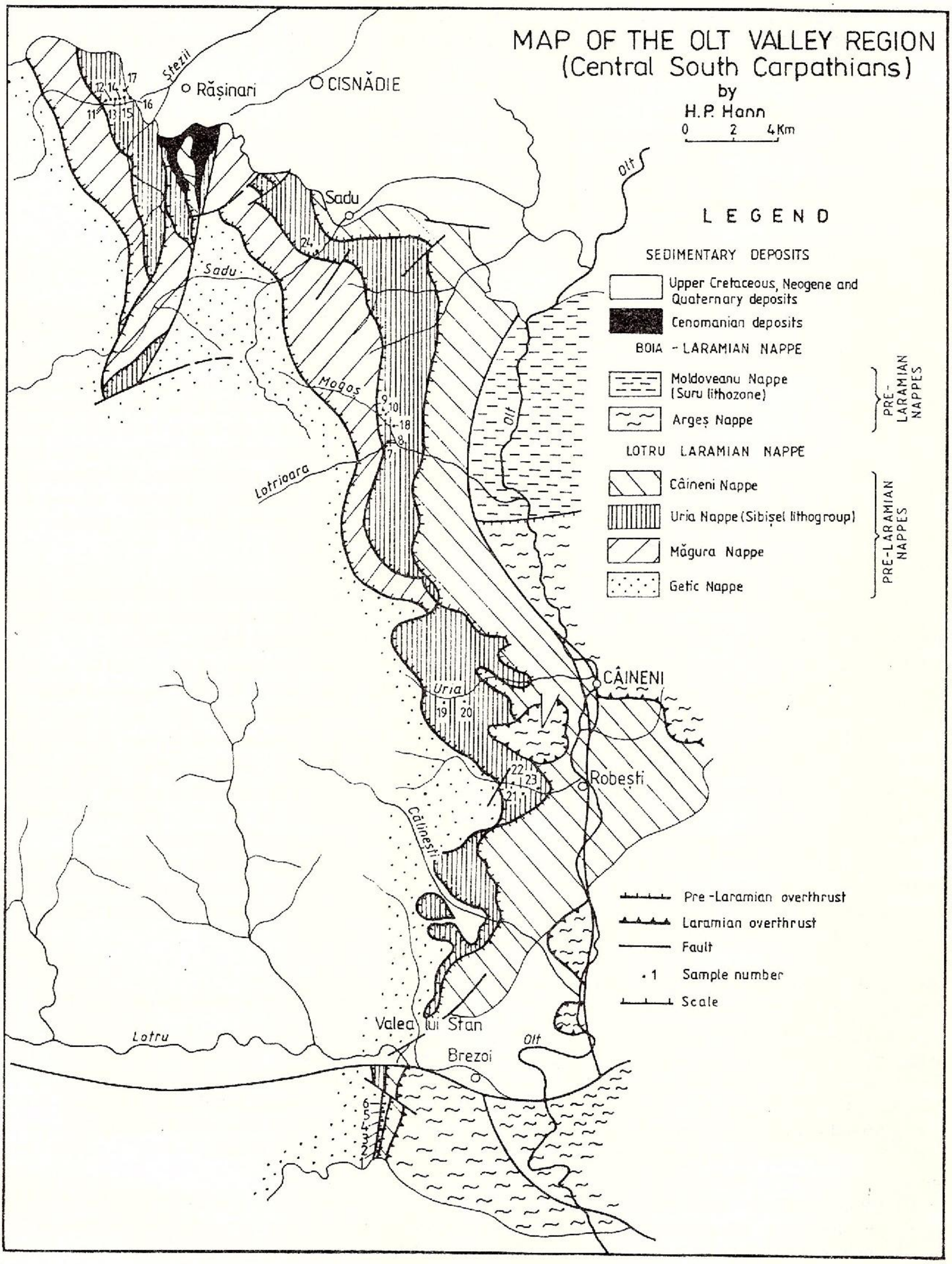
In this paper, the sampling was extended to the whole area of the Sibişel Lithogroup, between Răşinari-Sadu to the north and Brezoi-Valea lui Stan to the south.

2. Structural and petrographical data

The central part of the South Carpathians, which is crossed by the Olt Valley, is characterised by the fact that on a relatively small area, there are several tectonic units which differ one from another by the extent and the age, all of them belonging to the Getic-Supragetic Domain.

Within this structural domains, the Uria Nappe develops too and contains metamorphic formations of the Sibişel Lithogroup (Fig.)

Looking from west to east, we notice that different tectonic units geometrically overlap one another.


MAP OF THE OLT VALLEY REGION
(Central South Carpathians)
by
H.P. Hann
0 2 4Km
LEGEND
SEDIMENTARY DEPOSITS
Upper Cretaceous, Neogene and Quaternary deposits
Cenomanian deposits
BOIA - LARAMIAN NAPPE
Moldoveanu Nappe (Suru lithozone)
Argeș Nappe
PRE-LARAMIAN NAPPES
LOTRU LARAMIAN NAPPE
Căineni Nappe
Uria Nappe (Sibișel lithogroup)
Măgura Nappe
Getic Nappe
PRE-LARAMIAN NAPPES
Pre-Laramian overthrust
Laramian overthrust
Fault
• 1 Sample number
Scale
Rășinari
CISNĂDIE
Ștezii
Sadu
Sadu
Olt
Moșoș
Lotrioara
Olt
Uria
CĂINENI
Robești
Călinești
Valea lui Stan
Lotru
Brezoi
Olt
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2
3
4
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22
23
24

Table 1

Table with samples which constituted the object of the palynological study

No.	Number of sample	Type of rock	Place of samples
1.	5833/P.1	carbonatic schist	Valea lui Stan
2.	5834/P.2	grey crystalline limestone	”
3.	5835/P.3	”	”
4.	5836/P.4	banded grey crystalline limestone	”
5.	5837/P.5	banded crystalline limestone	”
6.	5838/P.6	”	”
7.	5842/P.10	”	Valea Mogoş
8.	5843/P.11	”	”
9.	5844/P.12	”	”
10.	5845/P.13	”	”
11.	5847/P.15	retromorphic sericite-chlorite schist	Răşinari, V. Stezii
12.	5848/P.16	”	”
13.	5849/P.17^x	grey crystalline limestone	”
14.	5850/P.18^x	”	”
15.	5851/P.19^x	mylonitic schist	”
16.	5852/P.20	”	”
17.	5853/P.21	retromorphic sericite-chlorite schist	”
18.	5743/5024 A.3^x	plagiogneiss	Valea Mogoş
19.	5746/5074^x	quartz-sericite schist	Valea Uria
20.	5751/5071^x	quartz-feldspathic schist	”
21.	5744/5038^x	quartzitic-sericite schist	Valea Robeşti
22.	5745/5044^x	quartz-chlorite-sericite schist	”
23.	5747/5039^x	quartz-sericite schist	”
24.	5779/2	banded crystalline limestone	Valea Sadului

* 1, 2, 3...current number of sample/5833/P.1...barren samples,
5744/5038^x-samples with palynological content.

Following the internal structure of the alpine nappe pile from the Olt right slope, we notice that the lower and the western position is occupied by the Getic Nappe, which is constituted of medium metamorphics of the Sebeş-Lotru Lithogroup (metalithofacies). On this nappe the Măgura Nappe is thrust (which contains ocular gneisses of Cumpăna-Cozia type, Sebeş-Lotru Group) and south of Căineni, it disappears under the overlying Uria Nappe. The Uria Nappe thrusts both over the Măgura Nappe (north of Căineni) and over the Getic Nappe. On the Uria Nappe the Căineni Nappe is thrust, which is constituted of mesometamorphic schists of Cumpăna type. The Uria Nappe has a variable thickness and in a few places it is tectonically interrupted.

The intensity of the tectonic phenomena explains the great number of retrograde transformations caused by a dynamic metamorphism underwent by the medium grade schists of the Sibişel Lithogroup.

This is also the reason why the schists have been initially considered to be epimetamorphic (Codarcea-Dessila, 1965; Mânecan, 1984). Kräutner (1980), relying on the same idea, attributed the rocks of the Sibişel Lithogroup to the Cibin Group, which is constituted of Upper Precambrian-Lower Paleozoic formations, and considered that the schists lay transgressively and discordantly over medium-grade metamorphics of the Sebeş-Lotru Lithogroup.

The schists of the Sibişel Lithogroup belong to two distinct formations: Leptino-amphibolitic Formation at the lower part of the metamorphic pile and Gneissic Formation at the upper part (eastern part) (Fig.). The Leptino-amphibolitic Formation is characterised by a background of paragneisses ± garnet in which numerous intercalations of amphibolites, white quartz-feldspar gneisses, discontinuous levels of lenses of crystalline limestones and intercalations of microblastic gneisses of blastomilonitic origin are found. The Gneissic Formation is represented by paragneisses with garnet ± staurolite, which also contain amphibolitic or quartz-feldspar layers. Visible deformations suffered by the whole rock pile generated typically low-grade aspects, for instance changing paragneisses into chlorite-sericite schists, in which garnet or staurolite, as relict minerals are still preserved.

So sometimes it was possible to keep palynomorphs, as well as relict minerals, in the so-called zones of "pressure shadow". Where milonitisation have been extremely intense, there were not kept any relict minerals, or palynomorphs, respectively. In this way, it is

Table 2
Palynological association of samples from Sibişel Lithogroup

Number of samples									Acritarchs	Stratigraphic range		
										Upper Precambrian		Lower Cambrian
5743/5024 A$_3$	5744/5038	5745/5044	5746/5074	5747/5039	5751/5071	5849/P. 17	5850/P. 18	5851/P. 19		Riphean	Vendian	
		x		x	x			x	*Protosphaeridium* sp.			
				x				x	*P. densum* TIM.			
	x				x				*P. tuberculiferum* TIM.			
x									*P. flexuosum* TIM.			
			x						*Zonosphaeridium* sp.			
					x				*Symplassosphaeridium* sp.			
							x		*Granomarginata squamacea* VOLV.			
					x		x		*Kildinella hyperboreica* TIM.			
								x	*K. exculpta* TIM.			
						x			*Synsphaeridium* sp.			
								x	*Leiosphaeridia* sp.			
						x			*L. volynica* TIM.			

not accidentaly that in Valea lui Stan, situated in the south of the studied perimeter, where tectonic units are strongly compressed, in the Uria Unit (with the Sibişel Lithogroup) reaching a few meters in width, none of the six samples had a palynological content.

The formations of the Sibişel Lithogroup have initially underwent a medium-grade metamorphism, which took place during two phases (two generations of muscovite and garnet). Subsequently, during the generation of the overthrust nappes structures, in the Alpine orogenesis, a prevailing dynamic metamorphism overprinted. Developed in several stages, it was leading to extensive mylonitisation and retrograde transformations, which often changed completely the initial aspect of the rocks.

3. Geological significance of the palynological data

The samples for palynological study are represented by carbonate schists, banded crystalline limestone, sericite-chlorite-schists (with relicts of garnet ± staurolite) and dark grey mylonitic schists.

These samples have been taken from both component formations of the Sibişel Lithogroup, and the sampling points represent the whole area of the series development (Fig.).

Twenty-four samples have been palynologically investigated from the crystalline formations of the Sibişel Lithogroup (Table 1).

The association of acritarchs obtained is the following: *Protosphaeridium* sp., *Protosphaeridium densum* TIM., *Protosphaeridium tuberculiferum* TIM.

Protosphaeridium flexuosum TIM., *Zonosphaeridium* sp., *Symplassosphaeridium* sp., *Granomarginata squamacea* VOLK., *Kildinella hyperboreica* TIM., *Kildinella exculpta* TIM., *Synsphaeridium* sp., *Leiosphaeridia* sp., *Leiosphaeridia volynica* TIM. (Table 2).

Although the above association also includes the acritarchs whose distribution interval surpassed the Precambrian/Cambrian boundary, it is typical of the Upper Precambrian.

The Upper Precambrian age of the crystalline schists from the Sibişel Lithogroup permite to conclude that their metamorphism took place during the Cadomian orogenesis, also developing during the Upper Precambrian.

According to Hann and Balintoni (1988), the metamorphics of the Sibişel Lithogroup can be correlated to those of the Suru lithozone (Formation) Negoi metalithofacies in the Moldoveanu Nappe (Pl. I), from the lithological point of view. Similar lithological associations suppose a common sedimentation regime. Moreover, one may state that the metamorphic history of respective schists was very similar (two main stages of metamorphism, under condition of almandine-amphibolites facies and in both piles there are not migmatites). It can be deducted that the Suru Lithozone was also metamorphosed during the Cadomian orogenesis and together with the Sibişel Lithogroup it comes from a geotectonic domain different as regards the age and evolution, from that in which were born crystalline schists of the Sebeş-Lotru Lithogroup, which are considered to have been metamorphosed during the Greenvillian orogenesis.

This statement can also be supported by the fact that the metamorphics of the Sibişel Lithogroup can be correlated with the ones from the Suru Lithozone, with respect to their palynological content. Twenty palynological samples from the Suru Lithozone (graphite schists), have been taken from Valea Sibişel, Valea Moaşei, Valea Lupului, Valea Capra and studied for the first time. From these samples, six have given results. Although the palynological association obtained was poor, it allows us (on the actual knowledge level) to conclude that it belongs to the Upper Precambrian like the one determined in the metamorphics of the Sibişel Lithogroup. Besides palynomorphs such as *Protosphaeridium* sp. *Protosphaeridium tuberculiferum* TIM., which can be also encountered in the palynological association determined on metamorphics of Sibişel Lithogroup, *Protosphaeridium papyraceum* TIM., *Protosphaeridium rigidulum* TIM., *Favososphaeridium favosum* TIM. occur as well.

For these reasons we consider that both the metamorphics of the Sibişel Lithogroup and the ones from the Suru Lithozone belong to the Upper Proterozoic and they are palynologically correlatable.

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Plate

Fig. 1 — *Leiosphaeridia* sp. 87μ.

Fig. 2 — *Kildinella exculpta* TIM. 60μ.

Fig. 3 — *Granomarginata squamacea* VOLK. 55μ.

Fig. 4 — *Kildinella hyperboreica* TIM. 45μ.

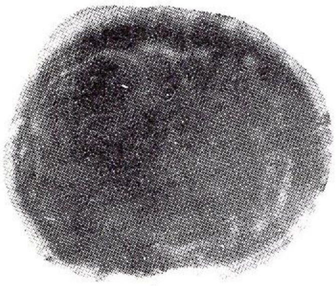
Fig. 5 — *Synsphacridium* sp.

Fig. 6 — *Protosphaeridium flexuosum* TIM. 25μ.

Fig. 7 — *Protosphaeridium densum* TIM. 62μ.

Fig. 8 — *Protosphaeridium tuberculiferum* TIM. 25μ.

M. VAIDA, H.P. HANN – PALYNOLOGICAL DATA ON THE UPPER PRECAMBRIAN OF THE SIBIŞEL LITHOGROUP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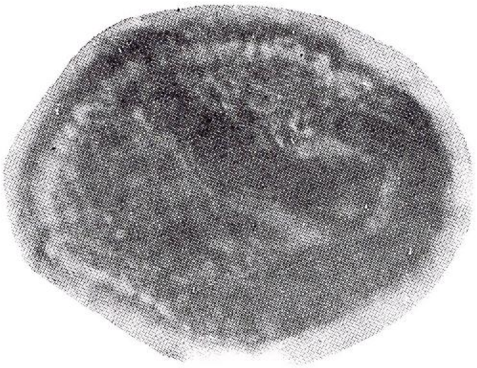
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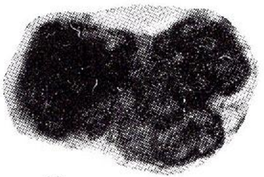
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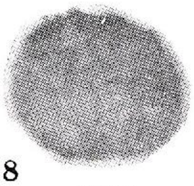
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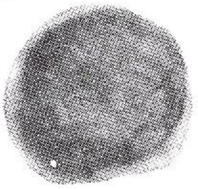
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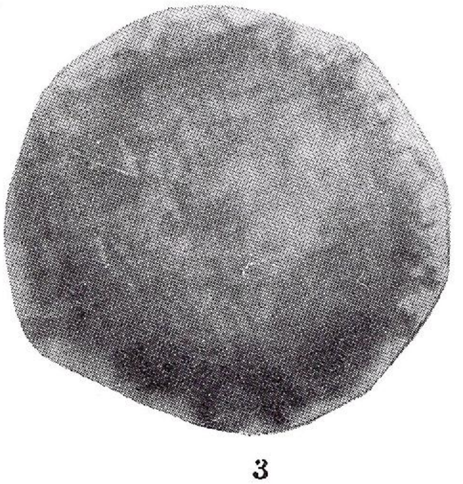
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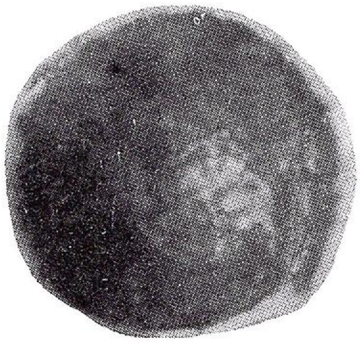
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Rom. J. Paleontology, 76, 1995, p. 7–12, Bucharest

SUR QUELQUES SCLÉRITES D'HOLOTHURIDES DES CALCAIRES TRIASIQUES DE LA DOBROGEA SEPTENTRIONALE

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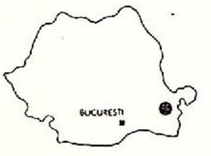

Key words: Triassic. Holothurian sclerites. New taxa. Biostratigraphy. North Dobrogea. Romania.

Abstract: *Some Holothurian Sclerites from Triassic Limestones of North Dobrogea (Romania).* In the Triassic limestones of North Dobrogea some holothurian sclerites species have been recognized, 5 of them are new ones. From the limestones assigned to the Anisian, four new species have been defined, namely *Acanthotheelia elenae* n. sp., *A. agighiolensis* n. sp., *Fissobractites persanensis* n. sp., *Eocaudina dobrogensis* n. sp. From the Carnian limestones one new species named *Theelia stellatiformis* n. sp. has been described.

Les études entreprises dernièrement sur les dépôts triasiques de la Dobrogea septentrionale ont permis l'élaboration d'un schéma lithologique (Baltreş, Mirăuţă, 1987) dont la chronostratigraphie a été précisée à l'aide des conodontes par Mirăuţă.

Les nombreux échantillons de calcaires prélevés ont fourni outre les Conodontes et les Foraminifères (Mirăuţă, Gheorghian, sous presse) aussi des sclérites d'holothurides. Généralement, ils sont fréquents et dans un bon état de conservation, surtout dans le faciès de Hallstatt développé à Agighiol. Des sclérites d'holothurides ont été rencontrés aussi dans les calcaires triasiques des Monts Perşani (Patrulius et al., sous presse), des Monts Apuseni (Patrulius et al., 1976), de Banat (à Sasca, Gheorghian, Mirăuţă, 1993).

Une tentative de zonation à base de sclérites s'avère difficile vu l'état actuel de nos connaissances. Même les 11 zones d'association établies par Mostler (1972) dans une aire très vaste, à partir de l'Allemagne jusqu'au Népal, ne sont pas applicables dans les formations triasiques de Roumanie.

On a identifié quelques espèces (*Acanthotheelia agighiolensis, A.elenae, Eocaudina dobrogensis* et *Fissobractites persanensis*) toujours présentes à côté des Conodontes attribués par Mirăuţă à l'Anisien inférieur et moyen tant en Dobrogea que dans les Monts Perşani (Gheorghian, 1978; Gheorghian in Patrulius et al., sous presse). Il y a aussi une *Theelia* (=*Th.stellatiformis*) rencontrée seulement dans le Carnien inférieur et moyen (fig.). On a identifié aussi d'autres espèces dont la distribution est significative toujours pour le Carnien. Le tableau de distribution met en évidence l'existence de deux associations bien différentes: celle qui caractèrise l'intervalle spathien-illyrien et l'autre attribuée au Carnien (Cordévolien-Tuvalien).

Tous les exemplaires figurés ont été photographiés au REM sur des supports (numéros P 105611 et P 105612) déposés dans la collection de l'Institut Géologique de la Roumanie, Bucarest.

Acanthotheelia elenae n.sp.
Pl. I, figs. 1–3

Derivatio nominis: dédiée à ma collègue Elena Mirăuţă.

Holotypus: Collection de l'Institut Géologique de la Roumanie, no. P 105612, pl. I, fig. 1.

Provenance: Dobrogea septentrionale: Dealul Cairace, D. Nucarilor, Agighiol, Dealul lui Platon, Dălbocul Tancului, Stânca Mare.

Age: Anisien inférieur et moyen.

Diagnose: Sclérite rotiforme, plat, à 6 jusqu'á 8 ou 9 rayons bifurqués vers la jante à contour festonné, rarement plus régulier.

Dimensions: diamètre 0,14–0,25 mm; diamètre du mayeu 0,04–0,06 mm.

Observations: Cette forme diffère de *A. spinosa* par l'absence des épines et les dimensions plus petites.

Zawidzka (1971) décrit de calcaires probablement illyriens des Monts Tatra, un exemplaire à 8 rayons de petites dimensions avec les deux faces similaires, qui pourrait appartenir à cette espèce.

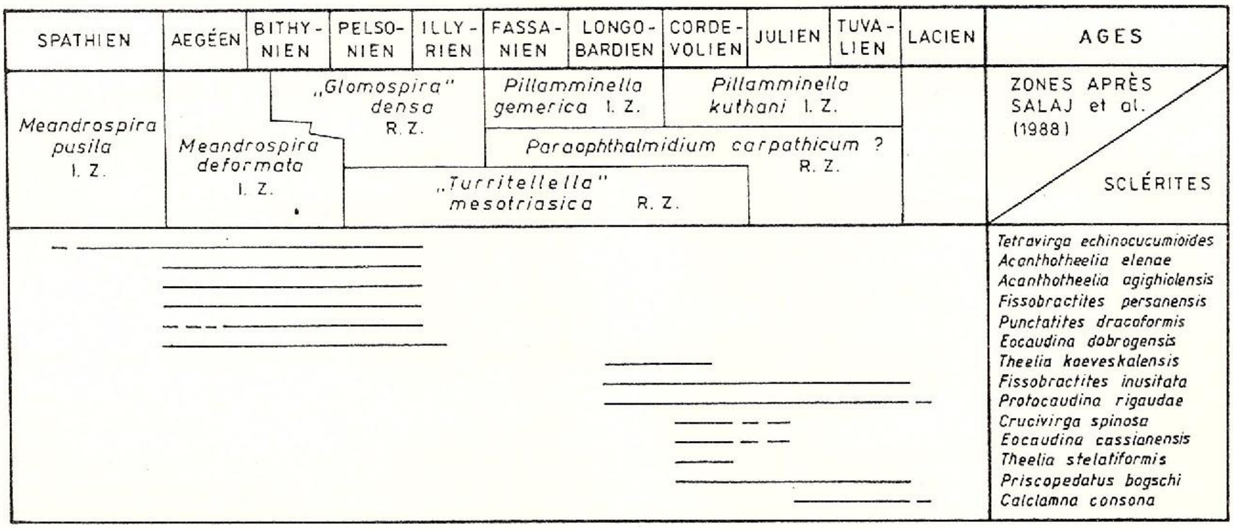

Fig. – Tableau de la distribution des sclérites caractéristiques dans les formations triasiques du Dobrogea du Nord.

Acanthotheelia agighiolensis n.sp.
Pl. I, figs. 5–7

Derivatio nominis: d'après la localité Agighiol, département de Tulcea où sont développés les calcaires triasiques qui ont fourni beaucoup d'exemplaires de sclérites.

Holotypus: Collection de l'Institut Géologique de la Roumanie, no. P 105612, pl. I, fig. 5.

Provenance: Dealul Cairace, Agighiol (Dealul Pietros et le ravin entre Dealul Lung et D. Mare), localité Parcheş.

Diagnose: Sclérite rotiforme avec un grand noyau central plat (mayeu) duquel partent 8–13 rayons arqués vers la jante qui en repose. Sa partie supérieure est plate et trouée par des pores situés devant chaque rayon et même un ou deux dans les intervalles des rayons ce qui lui donne un aspect de dantelle. La jante est pourvue d'épines situées devant et entre les rayons.

Dimensions: diamètre 0,31–0,43 mm; diamètre du mayeu 0,10–0,14 mm; largeur de la jante 0,05–0,10 mm.

Observations: Quelques exemplaires ressemblent à *A.spinosa* FRIZZELL et EXLINE dont ils diffèrent par l'irrégularité des épines, la présence d'une plus longue épine située devant le rayon (pl. I, fig. 6) aussi que par la courbure des rayons. L'exemplaire attribué à cette espèce et figuré par Kristan-Tollmann (1963, pl. 7, fig. 7) a plus d'affinités avec notre espèce qu'avec l'holotype figuré par Frizzell et Exline (1955).

Eocaudina dobrogensis n.sp.
Pl. I, figs. 9, 10

Derivatio nominis: de Dobrogea, région située dans la partie SE de la Roumanie.

Holotypus: Collection de l'Institut Géologique de la Roumanie, no. P 105612, pl. I, fig. 10.

Provenance: Agighiol (Dealul Pietros et D. Mare), Dealul Cairace, Dealul lui Platon, Heraclea, Stânca Mare, Dealul cu Piatră.

Age: Anisien inférieur-supérieur.

Diagnose : Petit sclérite en plaque perforée, plane, de forme subcirculaire à circulaire et contour ondulé; nombreuses perforations dont 6–7 plus grandes et peu ovales, situées au centre en rosette (ce qui rappelle *Priscopedatus mostleri*) et 1–2 rangées de petites perforations circulaires, vers la zone marginale.

Dimensions: 0,14–0,26 mm.

Observations: Les exemplaires décrits sont beaucoup plus petits que chez n'importe quelle des espèces du genre *Eocaudina* mentionnées dans la littérature.

Fissobractites persanensis n.sp.
Pl. I, fig. 8

Fissobractites sp., Gheorghian (1978), p. 61, pl. I, figs. 13–15.

Fissobractites sp.a., Gheorghian in Patrulius et al. (sous presse), pl. III, figs. 12–13.

Derivatio nominis: de Monts Perşani où ont été identifiés les premiers exemplaires.

Holotypus: Collection de l'Institut Géologique de la Roumanie, no. P 105612 , pl. I, fig. 8.

Provenance: Monts Perşani (Pleaşa Lupşei) et Dobrogea (Dealul Cairace, Agighiol, Orta Bair, Stânca Mare, Movila lui Uţu).

Age: Anisien inférieur-moyen.

Observations: Le petit sclérite décrit et esquissé en 1978 apparaît plus dense dans les photos exécutées au microscope électronique. Nos exemplaires ressemblent à ceux figurés par Gramann et al. (1972, pl. 4, figs. 9–11) qui sont d'ailleurs plus grands que les nôtres. Plus semblables s'avèrent ceux figurés (pl. 4, figs. 12 et 13) par les mêmes auteurs sous le nom *Acanthotheelia spinosa* FRIZZELL et EXLINE, mais c'est bien difficile de faire une comparaison entre les photos.

Dimensions: diamètre 0,10–0,29 mm, habituellement 0,14–0,15 mm.

Tetravirga echinocucumioides MOSTLER

Tetravirga echinocucumioides MOSTLER, Mostler (1968), p. 9, pl. I, fig. 5; Gheorghian in Patrulius et al. (sous presse), pl. III, figs. 1–4.

Plusieurs exemplaires de cette espèce montrant des transitions vers *T. fordelensis* FRIZZELL et EXLINE ont été fournis par les calcaires d'âge spathien jusqu'au pelsonien qui affleurent à Agighiol, Dealul Roşu, Uzum Bair, aussi que dans les calcaires pelsoniens des Monts Perşani. La même espèce a été mentionnée dans l'Anisien des Alpes (Mostler, 1968).

Punctatites dracoformis (MOSTLER)

Calclamnella dracoformis MOSTLER (1969), p. 23, text fig. 8/4.

Punctatites dracoformis (MOSTLER), Gheorghian in Mirăuţă et Gheorghian (1975), pl. I, fig. 10; A. Tollmann (1976), p. 92, fig. 10; Mostler et Rahimi- Yazd (1976), p. 3, fig. 16.

Cette espèce fait son apparition assez rarement et seulement dans les calcaires anisien inférieurs–moyens de Dobrogea (Dealul lui Platon, Agighiol, Stânca Mare) et des Monts Perşani, quoique dans les Alpes elle a été signalée dans le Norien (Mostler, 1972; A. Tollmann, 1976).

Theelia koeveskalensis KOZUR et MOSTLER
Pl. I, fig. 12, pl. II, fig. 5.

Theelia koeveskalensis KOZUR et MOSTLER, Kozur et Mostler (1971), p. 30, pl. 2, figs. 2–4; Kozur et Mock (1974), pl. VIII, fig. 7; Gazdzicki et al. (1978), p. 363, pl. 52, figs. 2–9.

L'apparition des exemplaires attribués à cette espèce est limitée à l'intervalle ladinien supérieur-carnien inférieur précisé dans les successions calcaires d'Agighiol (Dealul Lung, D. Pietros, Lutul Roşu, Dealul cu Piatră, forage Kogălniceanu 159/90). Une zone d'association correspondante à l'intervalle délimité par l'apparition et la disparition de cette espèce- index a été proposée par Mostler, qui la considère d'âge cordévolien quoique l'espèce peut monter jusque dans la base du Julien. D'après Mostler et Scheuring (1974), l'apparition des espèces *Th.koeveskalensis* et *Fissobractites inusitata* préciserait la limite Ladinien/Carnien, située plus haut que celle marquée par les Conodontes, ce qui permet la séparation d'un domaine de limite.

Fissobractites inusitata KOZUR et MOSTLER
Pl. II, figs. 10, 11.

Fissobractites inusitata KOZUR et MOSTLER, Kozur et Mostler (1971), p. 25, pl. I, figs. 5–7.

Cette espèce, présente dans l'association de la Zone à Theelia koeveskalensis, caractèrise strictement le Cordévolien de l'Hongrie (Kozur et Mostler, 1971) et de l'Autriche (Mostler et Parwin, 1973).

L'espèce a été identifiée aussi en Dobrogea dans le Ladinien supérieur (à côté de *Th. koeveskalensis*) (Agighiol, au N de Congaz, Dealul cu Piatră), mais aussi dans le Tuvalien d'Agighiol.

Protocaudina rigaudae MOSTLER
Pl. II, figs. 7, 8.

Protocaudina rigaudae MOSTLER, Mostler (1970), p. 352, pl. 3, figs. 5, 6.

L'espèce, dont le holotype provient des dépôts carniens de Salzkammergut (Mostler, 1970), est mentionnée dans l'association de la Zone à Theelia thallatocanthoides caractéristique pour le Julien (Mostler, 1972) d'Autriche, Hongrie, Italie, Grèce et Nepal. D'après Mostler et Parwin (1973) cette espèce est connue à partir du Carnien moyen jusque dans le Norien supérieur de Slovakie.

En Dobrogea, cette espèce caractèrise seulement le Carnien (Agighiol, Dealul cu Piatră, Collines Trei Movile), tandis que dans les Monts Perşani elle fût identifiée dans des calcaires attribués au Norien moyen développés dans la crête qui sépare les ruisseaux Hăghimaş et Surmanu.

Eocaudina cassianensis FRIZZELL et EXLINE

Eocaudina cassianensis FRIZZELL et EXLINE, Frizzell et Exline (1955), p. 84, pl. 2, fig. 20; Kozur et Mostler (1971), p. 24, pl. I, fig. 1; Gazdzicki et al. (1978),p. 360,pl. 51, figs. 1–4.

L'espèce apparaît en association avec *Crucivirga spinosa* Mostler et *Theelia stellatiformis* n.sp. dans les calcaires d'âge carnien inférieur et moyen de Dobrogea (Agighiol et Dealul Ogurului).

Eocaudina cassianensis a été mentionnée, dans la littérature, dans le Trias des Alpes méridionales (Frizzell et Exline, 1955), dans la Zone à Theelia koeveskalensis d'âge cordévolien (Mostler, 1972) et dans le Longobardien-Julien d'Hongrie (Kozur et Mostler, 1971) et des Carpates d'ouest en Slovakie (Gazdzicki et al., 1978).

Priscopedatus bogschi KOZUR et MOCK
Pl. II, fig. 9

Priscopedatus bogschi KOZUR et MOCK, Kozur et Mock (1972), p. 12, pl. VI, figs. 10, 11; Kozur et Mock (1974), pl. VI, figs. 15, 16.

L'espèce a été identifiée dans des dépôts attribués au Norien inférieur-moyen de Slovakie, tandis qu'en Dobrogea elle caractèrise le Carnien (Agighiol et N Congaz).

Calclamna consona (MOSTLER et PARWIN)
Pl. II, fig. 12.

Calclamnella consona MOSTLER et PARWIN, Mostler et Parwin (1973), p. 38, pl. I, figs. 9, 10, 13, 14–16; Mirăuţă, Gheorghian (1978), pl. I, figs. 8, 9.

Les auteurs de cette espèce l'ont attribuée au Carnien moyen-supérieur de Slovakie. Elle a été fournie par les calcaires noriens des Monts Perşani (Meghieş), mais aussi par ceux carniens de Dobrogea (Agighiol: Dealul Pietros et D. Lung) et norien supérieurs (Muchea Verde).

Theelia stellatiformis n.sp.
Pl.II, figs. 1–4.

Derivatio nominis; latin stella, d'après l'aspect d'étoile de la partie centrale (moyeu).

Holotypus: Collection de l'Institut Géologique de la Roumanie, no. P 105612, pl. II, fig. 1.

Provenance: Dobrogea: Agighiol, Zebil, Dealul cu Piatră, D. Trei Movile.

Âge: Carnien inférieur-moyen.

Diagnose: Sclérite rotiforme faiblement plan-concave à 6 – 9 rayons qui s'amincissent vers la jante et se rejoignent vers le centre en formant une étoile. La jante est légèrement festonnée sur son bord extérieur.

Dimensions:
diamètre extérieur 0,15 – 0,22 mm;
diamètre intérieur 0,11 – 0,19 mm;
diamètre du noyau central 0,05 – 0,08 mm.

Observations: Les exemplaires décrits diffèrent de *Theelia guembeli* KRISTAN-TOLLMANN, 1963, par l'aire centrale beaucoup plus grande et l'aspect général plus irrégulier quoique les tailles soient semblables.

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Planche I

Figs. 1–3 — *Acanthothelia elenae* n.sp. – Fig. 1, Dealul Cairace, Anisien; diamètre 0,21 mm; fig. 2, Dealul Cairacul Mic, Anisien; diamètre 0,18 mm; fig. 3, Dealul Cairacul Mic, Anisien inférieur; diamètre 0,22 mm, diamètre du noyau central 0,05 mm.

Fig. 4 — *? Acanthotheelia elenae* n. sp. - Somova, Anisien; diamètre 0,15 mm.

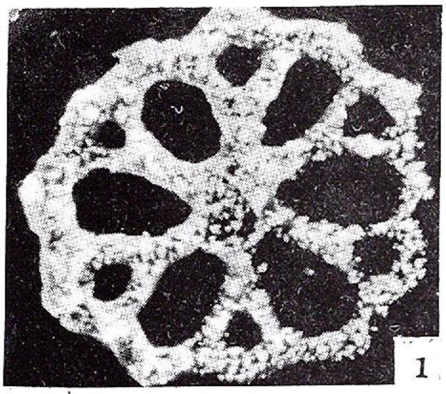
Figs. 5–7 — *Acanthotheelia agighiolensis* n. sp.- Fig. 5, Agighiol, D. Pietros, Anisien moyen; diamètre 0,35 mm, diamètre du noyau central 0,08 mm, largeur max. de la jante 0,08 mm; fig. 6, idem; diamètre 0,42 mm, diamètre du noyau central 0,10 mm, largeur de la jante 0,08 mm; fig. 7, Agighiol-Deluşorul, Anisien, diamètre 0,34 mm.

Fig. 8 — *Fissobractites persanensis* n.sp.- Dealul Cairace, Anisien; diamètre 0,17 mm.

Figs.9, 10 — *Eocaudina dobrogensis* n.sp.- Fig. 9, Agighiol, Dealul Pietros, Anisien; diamètre 0,17/0,22 mm; fig. 10, forage 69804/11, Anisien; diamètre 0,20 mm.

Fig.11 — *Theelia stellatiformis* n.sp.- Dealul cu Piatră, Carnien; diamètre 0,14 mm.

Fig.12 — *Theelia koeveskalensis* KOZUR et MOSTLER- Agighiol, Dealul Lung; diamètre 0,26 mm.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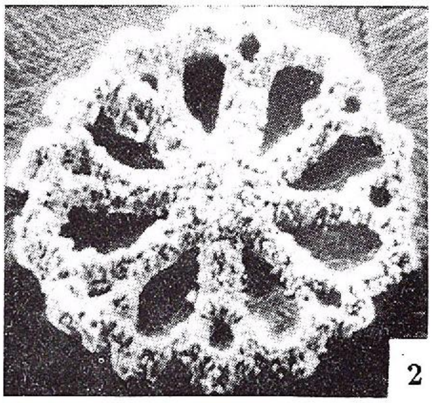
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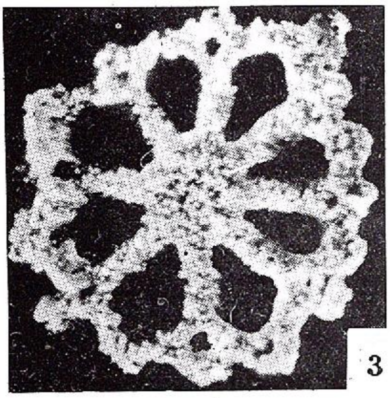
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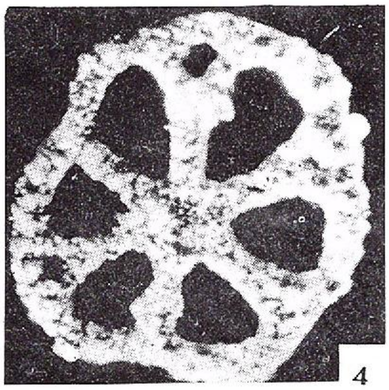
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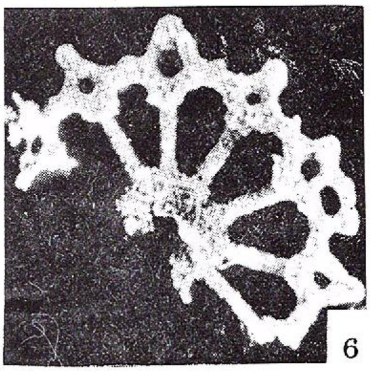
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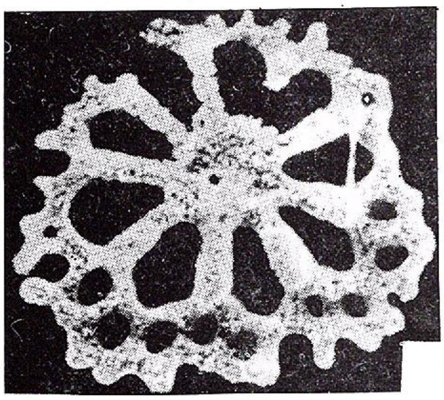

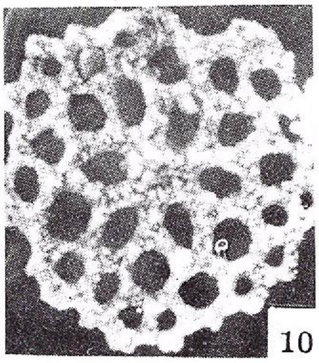
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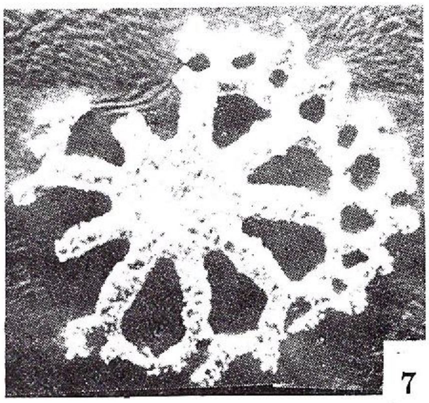
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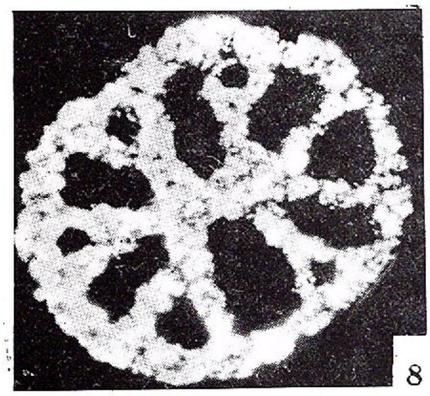
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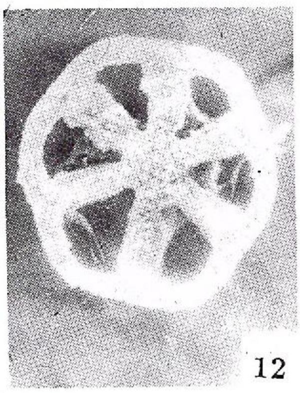
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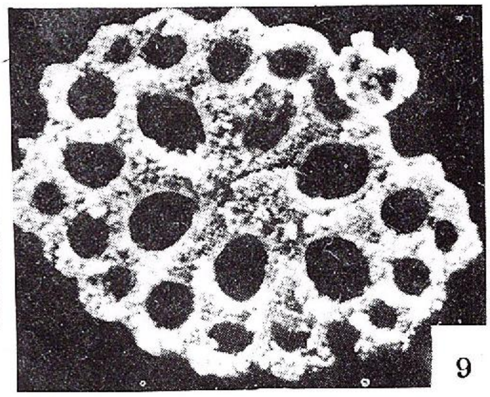
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Planche II

Figs. 1–4 — *Theelia stellatiformis* n.sp.- Dealul cu Piatră, Carnien inférieur; fig. 1, holotypus; fig. 2, diamètre 0,26 mm; fig. 3, diamètre extèrieur 0,19 mm, diamètre intérieur 0,15 mm, diamètre du noyau central 0,06 mm; fig. 4, diamètre extérieur 0,17 mm, diamètre intérieur 0,12 mm, diamètre du noyau central 0,05 mm. Coll. I.G.R., P 105612.

Fig. 5 — *Theelia koeveskalensis* KOZUR et MOSTLER -Agighiol-Dealul Lung, Carnien inférieur; diamètre 0,22 mm. Coll. I.G.R., P 105612.

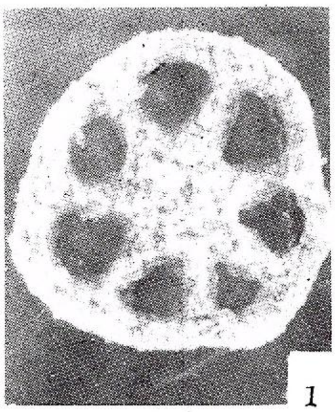
Fig. 6 — ? *Stueria multiradiata* MOSTLER - Agighiol- Dealul Lung, Carnien; diamètre 0,21 mm. Coll. I.G.R., P 105612.

Figs. 7, 8 — *Protocaudina rigaudae* MOSTLER - Fig. 7, Agighiol-Dealul Pietros, Carnien supérieur; diamètre 0,17 mm. Coll. I.G.R., P 105611; fig. 8,Dealul cu Piatră, Carnien; diamètre 0,31 mm, Coll. I.G.R., P 105612.

Fig. 9 — *Priscopedatus bogschi* KOZUR et MOCK - Dealul cu Piatră, Carnien inférieur; diamètre 0,33 mm.

Figs. 10, 11 — *Fissobractites inusitata* KOZUR et MOSTLER - Fig. 10, Agighiol-Dealul Pietros, Carnien supérieur; diamètre 0,24 mm Coll. I.G.R., P 105611; fig. 11, Dealul cu Piatră, Carnien inférieur-moyen; diamètre 0,21/0,26 mm.

Fig.12 — *Calclamna consona* MOSTLER et PARWIN - Agighiol- Dealul Pietros, Carnien supérieur; longueur 0,28 mm. Coll. I.G.R., P 105611.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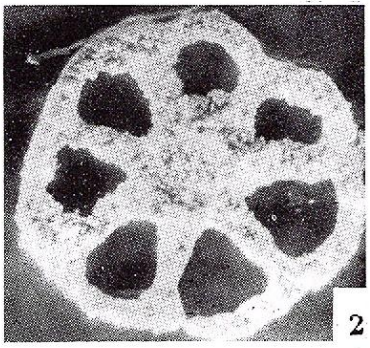
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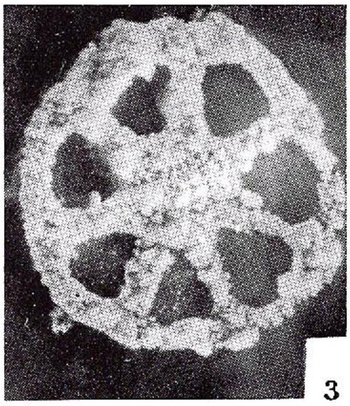
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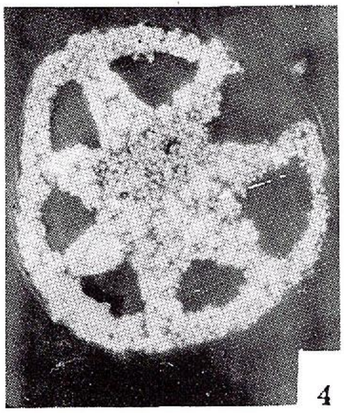
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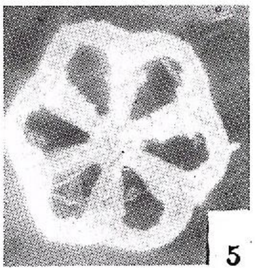
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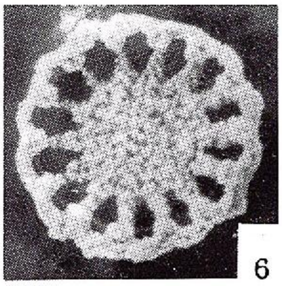
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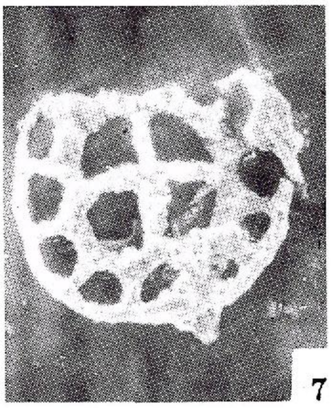
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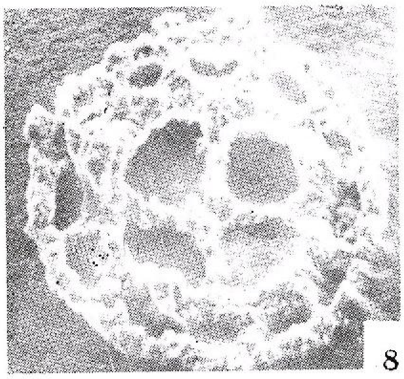
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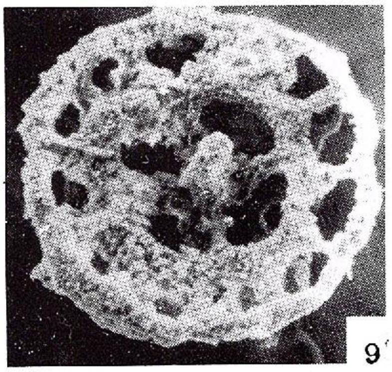
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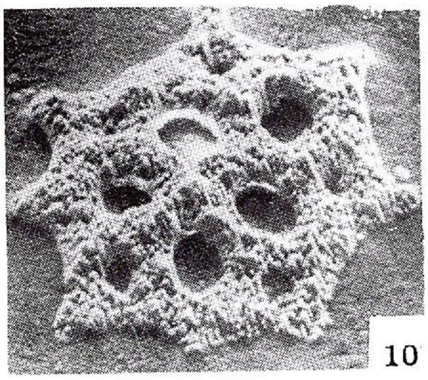
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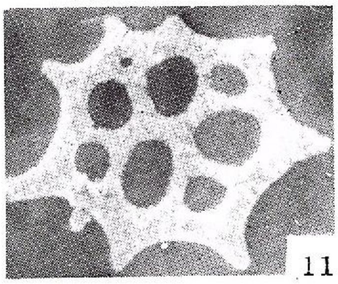
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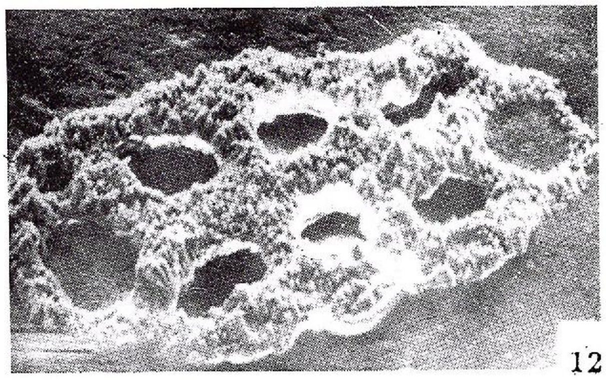
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Rom. J. Paleontology, 76, 1995, p. 13–20; Bucharest

SOME BRACHIOPODS AT THE KIMMERIDGIAN/TITHONIAN BOUNDARY (EASTERN CARPATHIANS, ROMANIA)

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Key words: Brachiopods. Jurassic. Carpathians. Taxonomy.

Abstract: This paper deals with several brachiopod species at the Kimmeridgian/Tithonian boundary in the East Carpathians area, namely, in the Hăgimaş Mountains and Bucegi Massif. They are attributed to the orders Rhychonellida and Terebratulida; three new species are also presented: *Rhynchonella avrami* sp. nov., *Belbekela lebatschovae* sp. nov. and *Fortunella sibliki* sp. nov.. Major changes in the brachiopod faunas at the limit here discussed are pointed out. Two assemblages for the brachiopods are established, the former below and the latter above the Kimmeridgian/Tithonian boundary.

Introduction

The general picture of the brachiopod fauna shows us that, at this level, the Romanian brachiopods do not differ much from those previously reported from Czechoslovakia, Poland and Austria. However, there are affinities with the northwestern and Tethysian faunas.

Rhynchonellida is the main group, and within it, genera as *Fortunella* CALZADA and *Lacunosella* WISNIEWSKA are the main components. Terebratulida is not so well represented as the previous group. Several new taxa are presented, and they seem to represent local offshots (more material from the adjacent areas is expected). We mention that the family *Pygopidae* MUIR WOOD is not analysed here; because of the great importance of this group, it will be the subject of a detailed study in the near future.

This study is the first attempt to reveal the changes of the Brachiopoda assemblages at the Kimmeridgian/Tithonian boundary in Romania.

The author wants to express his gratitute to Dr. Doc. Neagu Th. (University of Bucharest), Dr. Iordan M. and Dr. Avram E. (Geological Institute of Bucharest) and to Dr. Doc. Preda I. (University of Bucharest) for their help in preparing this paper.

Previous researches

Very few things are known about the brachiopods at the Kimmeridgian/Tithonian boundary in the East Carpathians area. At the end of the last century Neumayr (1873) studied the Upper Jurassic faunas of the East Carpathians. Later, Preda (1973) revised the fauna from the Hăghimaş Mountains. Southwards, the Bucegi Mountains faunas had been analysed by Patrulius (1969). In his magnificent work concerning the geology of the Bucegi Massif, this author had inventaried numerous brachiopod species. His material is deposited at the Geological Institute of Bucharest, and it will be the subject of a study in the near future.

Stratigraphical part

The Hăghimaş Mountains

There are a few sections where the brachiopods had been identified.

At the Ghilcoş Rock the Kimmeridgian/Tithonian boundary is located in the detrital horizon. Below this limit, in a bed consisting of grey sandy limestones *Pygope diphya* (COLONNA) had been identified.

On the Fagul Oltului Valley, the Kimmeridgian consists of red nodular limestones. At different levels there are present: *Septaliphoria* sp., *Lacunosella trilobata* (ZIETEN), *L. arolica* (OPPEL) *Fortunella sibliki* sp. nov., *Nucleata nucleata* QUENSTEDT and *"Terebratula"* sp. The Stamberg limestones which overlie these deposits do not contain brachiopods.

Recently, the Tithonian limestones from the Bicazului Gorges offered several specimens of *Echinirhynchia senticola* (SCHLOTHEIM).

The Bucegi Mountains

At the Horoaba Valley, in the lower part of the

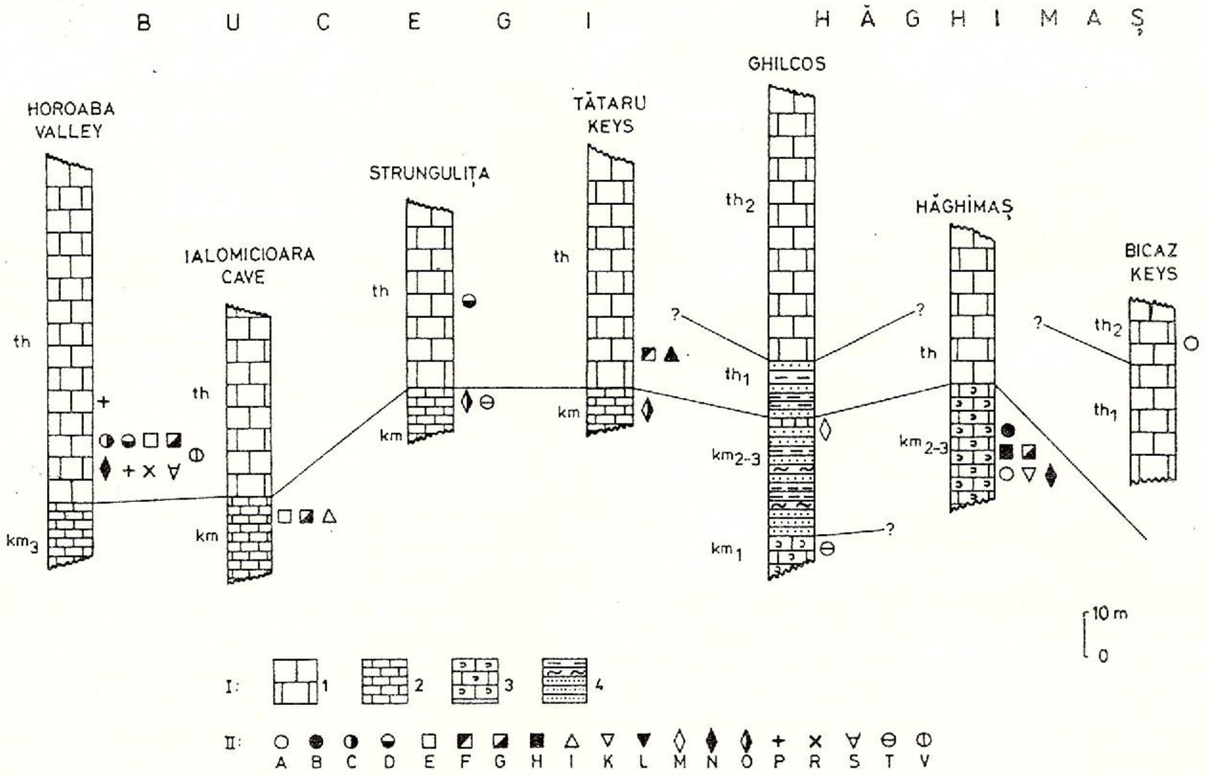

Fig. 1 – The brachiopods at the Kimmeridgian/Tithonian boundary in the East Carpathians area. I - Lithology: 1 - white reefal Stramberg limestones, 2 - pink limestones, 3 - red nodular limestones, 4 - detrital horizon (sandstones, clays, marls). II - Brachiopoda: A - *Echinirhynchia senticosa* (SCHLOTHEIM), B - *Fortunella sibliki* sp. nov., C- *F.* sp. (nov.?), D - *Rhynchonella avrami* sp. nov., E - *Lacunosella hoheneggeri* (SUESS), F - *L. visulica* (SCHLOTHEIM), G - *L. arolica* (OPPEL), H - *L. trilobata* (ZIETEN), I - *Belbekella lobatschevae* sp. nov., K - *Septaliphoria* sp., L - "*Rhynchonella*" sp., M - *Pygope diphya* (COLONNA), N - *Nucleata nucleata* (QUENSTEDT), O - *Nucleata* div. sp., P - *Loboidothyris undosa* (SCHMIDT), R - *Svaljavithyris carpathica* (ZITTEL), S - *Argovithyris* cf. *baugieri* (d'ORBIGNY), T - " *Terebratula*" sp., V - "*Terebratula*" *bissuffarcinata* SCHLOTHEIM.

Stramberg limestones, a brachiopod assemblage is recorded, consisting of: *Lacunosella visulica* (SCHLOTHEIM), *Septaliphoria* sp., *Fortunella* sp. (nov.(?), *Rhynchonella avrami* sp. nov., *Belbekella lobatschevae* sp. nov., *Svaljavithyris carpathica* (ZITTEL), *Loboidothyris undosa* (SCHMIDT), *Nucleata nucleata* (QUENSTEDT), *Argovithyris* cf. *baugieri* (d'ORBIGNY).

At the Ialomicioara Cave, a rich assemblage (with numerous specimens) is known in pink limestones, Upper Kimmeridgian in age. It is constituted of *Lacunosella arolica* (OPPEL), *L. hoheneggeri* (SUESS) and *Belbekella lobatschevae* sp. nov..

At Vama Strunga - Strungulița the Kimmeridgian pink, sandy or oolithic limestones contain fragments of *Nucleta* sp. and "*Terebratula*" sp.. The reefal Stramberg limestones had offered very few brachiopods: *Rhynchonella avrami* sp. nov..

The very scarce data concerning the ammonite "populations" in the studied areas made very difficult the correlation of the described species ranges with the standard scale of the Upper Kimmeridgian and Lower Tithonian. Consequently, these ranges were established taking into consideration the previous ages attributed to the brachiopod fossiliferous levels.

Taxonomic part

Superfamily *Rhynchonellacea* GRAY, 1848
Family *Wellerellidae* LIKHAROV, 1965
Subfamily *Lacunosellinae* SMIRNOVA, 1963
Genus *Lacunosella* WISNIEWSKA, 1932

Lacunosella hoheneggeri (SUESS, 1858)
(Pl. I, figs. 1–3)

Rhynchonella hoheneggeri nov. - SUESS, 1858, p. 56, pl. 6, figs. 13–19.

Rhynchonella hoheneggeri SUESS - REMES, 1899, p. 229, pl. 8, figs. 1–2.

Lacunosella hoheneggeri (SUESS) - NEKVASILOVA, 1977, p. 60, pl. 4, figs. 1–9, p. 5, figs. 1–5, 8–11, pl. 7, fig. 3; BARCZYK, 1979 a, p. 55, pl. 2, figs. 4–5; Lobatscheva, 1983, pl. 3, fig. 7.

Material. Six specimens, two of them well preserved (L.P.B. III b 0236).

Dimensions.[1] Dimensions of the illustrated specimens: L_p = 17.4 mm; W= 20.1 mm; t = 13.1 mm; D = 13.3 mm; H = 6.8 mm; W/L_p = 0.143; t/L_p = 0.752.

Description. Small-sized shells with transverse outline. The lateral commissures are ventrally deflected and the frontal one is uniplicate. Beak small and narrow. The shell surface is ornated with about thirteen costae on each valve, five of them being confined on fold and four on sinus.

Occurrence. Lower Tithonian in the Horoaba Valley, Bucegi Mountains.

Family *Rhynchonellidae* GRAY, 1848
Subfamily *Rhynchonellinae* GRAY, 1848
Genus *Rhynchonella* FISCHER DE WALDHEIM, 1809

Rhynchonella avrami sp. nov.
(Pl. II, figs. 7–8, Text-fig. 2)

Holotype. Specimen L.P.B. III b 0232.

Dimensions of the holotype. L_p = 30.2 mm; W = 20.6; t = 26.1 (dimensions given in millimeters). W/L_p = 0.645; t/L_p = 0.864; H/D = 1.147.

Derivatio nominis. Dedicated to Dr. E. Avram.

Stratum typicum. The middle part of the Stramberg limestones, at Vama Strunga - Strungulița, Bucegi Mountains.

Material. Other three poorly preserved specimens (L.P.B. III b 0233), one of them being transversally sectioned.

Dimensions. The ranges of variability for the main external features are: L_p = 22.2– 30.2 mm; W = 14.3–20.6 mm;, t = 14.6–26.1 mm; H = 13.8–20.3 mm; D = 13.7–17.7 mm. The main ratios: W/L_p = 0.645–0.711; t/L_p = 0.778–0.864; H/D = 1.014–1.147.

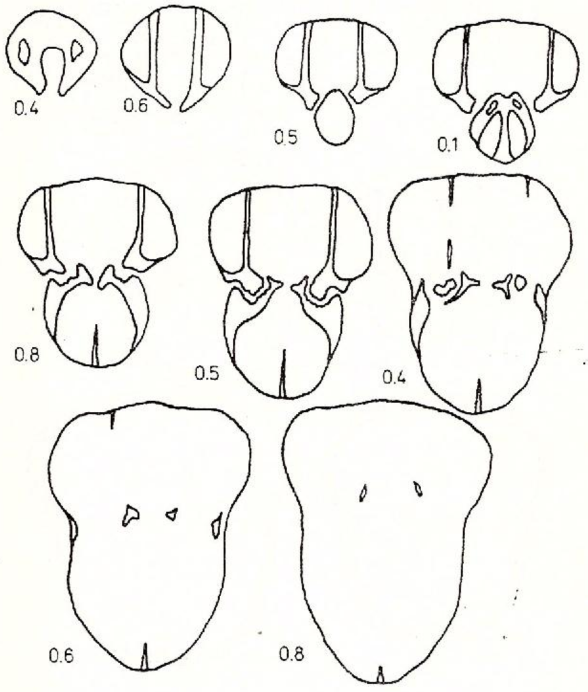

Fig. 2 – A series of ten serial transverse sections through a specimen of *Rhynchonella avrami* sp. nov. from the Lower Tithonian of the Bucegi Mountains (L_p = 24.3 mm).

Description. External features. Shells with very well pronounced cynocephalous aspect; lateral commissures are indented. Uniplicate, the uniplication is very sharp. There are two lateral costae on each side, on both valves; these are angular and weak. Beak small with rounded beak ridges. Foramen very small, subcircular. Internal features. As for the genus.

Remarks. By the very cynocephalous aspect of the shells and the sharp angular costae, our species differs from any other ones attributed to the genus.

Stratigraphical and geographical distribution. Lower and Middle Tithonian of Romania.

Subfamily *Cyclothyridinae* MAKRIDIN, 1955
Genus *Belbekella* MOISEEV, 1939

Belbekella lobatschevae sp. nov.
(Pl. I, figs. 4–9, 11–13, Text-fig. 3)

Holotype. Specimen L.P.B. III b 0237.

Dimensions of the holotype. L_p = 16.9 mm; W = 15.9 mm; t = 13.5 mm; W/L_p = 0.940; t/L_p = 0.798; H = 7.7 mm; D = 15.0 mm; H/D = 0.513.

Derivatio nominis. Dedicated to Dr. S. V. Lobatscheva.

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[1] L_p length of the pedicle valve, W - width, t - thickness, D - length of the fold, H - height of the fold.

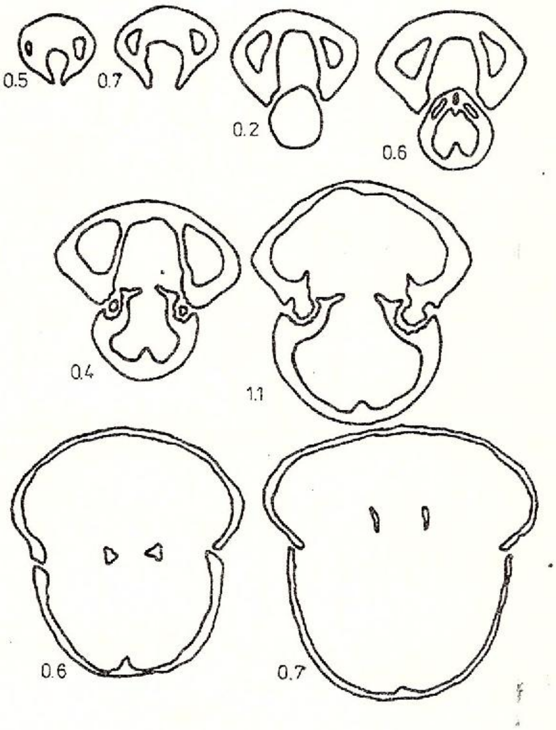

Fig. 3 – A series of serial transverse sections through a specimen of *Belbekella lobatschevae* sp. nov. from the Upper Kimmeridgian of the Ialomicioara Cave, Bucegi Mountains. (L_p = 12.6 mm).

Stratum typicum. The pink limestones (Upper Kimmeridgian) from the Ialomicioara Cave.

Material. Other ten well-preserved specimens (L.P.B. III b 0238), one of them being transversally sectioned (L.P.B. III b 0239). Many other poorly preserved specimens.

Dimensions. The limits for the main external measurements are: L_p = 12.2–17.1 mm; W = 10.1–16.0 mm; t = 9.7–13.5 mm; H = 5.3– 8.0 mm; D = 12.6–15.0 mm; the main ratios are: W/L_p = 0.922–0.986; t/L_p = 0.737 – 0.810; H/D = 0.319–0.520.

Description. External features. Rather small-sized shells, with pentagonal outline. The maximum width is attained slightly anteriorly at midlength. The shells are relatively inflated, biconvex; the brachial valve is more convex than the pedicle one. The frontal commissure is uniplicate, the uniplication being medium to high. The beak is small and erect; foramen small, permosothyrid is circular in outline. The beak ridges are very slightly pronounced. The brachial valve bears thirteen rounded costae, and the pedicle one, usually fourteen; well pronounced smooth stage. There are small variations around the number of costae (one or two more ore less). Five to six of them are confined on fold and four to five on sinus. *Internal features.* As for the genus.

Remarks. Our species closely resembles *B. airgulensis* MOISEEV.. It differs by a more rounded aspect, against the more "quadrate" – in lateral view – from the Russian species. The reduced number of costae of *B. airgulensis* MOISEEV is a distinctive feature, too.

Stratigraphical and geographical distribution. Upper Kimmeridgian and Lower Tithonian of the Bucegi Mountains.

Family *Acanthothyrididae* SCHUCHERT, 1913
Genus *Echinirhynchia* CHILDS, 1969

Echinirhynchia senticosa (SCHLOTHEIM, 1820)

Acanthorhynchia (Echinirhynchia) senticosa (SCHLOTHEIM) – CHILDS, 1969, p. 73, pl. 7, figs. 1–3, Text-fig. 26 (cum. syn).

Material. A well-preserved and two damaged specimens L.P.B. III b 0235, coll. Huza.

Dimensions. The dimensions of the well-preserved specimen: L_p = 1.1 mm; W = 1.3 mm; t = 0.8 mm; W/L_p = 1.181; t/L_p = 0.718.

Remarks. This small-sized species is clearly defined in spite of the poor material available.

Stratigraphical and geographical distribution. The white-grey Stramberg limestones from the Cheile Bicazului assigned to the Middle Tithonian, Hăghimaş Mountains.

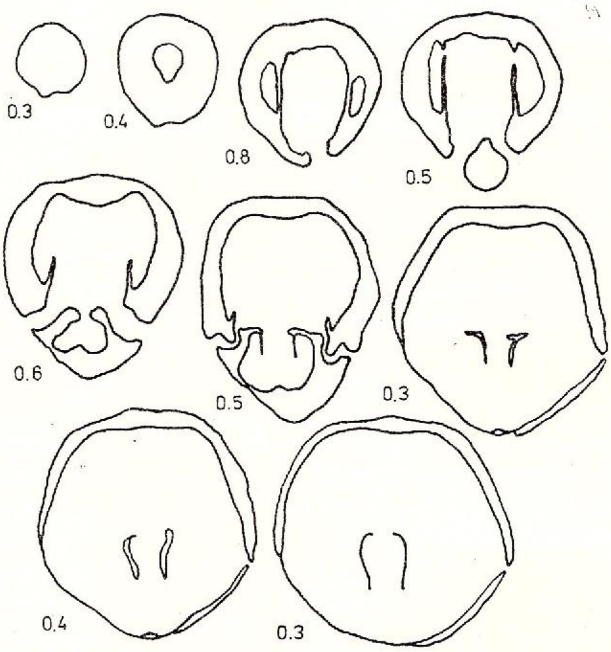

Fig. 4 – A series of nine serial transverse sections through a specimen of *Fortunella sibliki* sp. nov. (L_p = 14.6 mm).

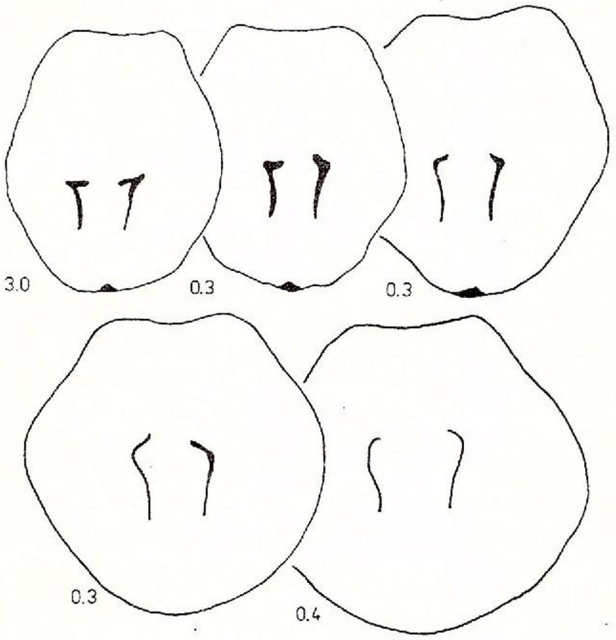

Fig. 5 – Five serial transverse sections through a specimen of *Fortunella sibliki* sp. nov. to show very well developed falcifer crura (L_p = 15.4 mm).

Family Uncertain
Genus *Fortunella* CALZADA, 1985

Fortunella sibliki sp. nov.
(Pl. II, figs. 1–3, 9–11, Text-figs. 4–6)
Rhynchonella strambergensis REMES - PREDA, 1973, Pl. I, figs. 12–14.

Holotype. Specimen L.P.B. III b 0226 (coll. Preda).

Dimensions of the holotype. L_p = 19.8 mm; W = 19.6 mm; t = 15.6 mm; W/L_p = 0.984; t/L_p = 0.788; H = 14.3 mm; D = 17.0 mm; H/D = 0.841.

Derivatio nominis. Species named after Dr. Siblik M.

Stratum typicum. The red nodular limestones (Upper Kimmeridgian in age) from Lacu Roşu, Hăghimaş Mountains.

Material. Over twenty well-preserved specimens, P.L.B. III b 0227. Other two specimens were transversally sectioned (L.P.B. III b 0228). Over thirty poorly preserved specimens had not been inventaried.

Dimensions. The ranges of variability for the main external features are: L_p = 13.8–20.7 mm; W = 13.4–21.8 mm: t = 10.2–19.0 mm; H = 6.3–16.7 mm; D = 10.6–21.2 mm; the main ratios are: W/L_p = 0.913–1.217; t/L_p = 0.635–0.946; H/D = 0.434–0.992. The regression lines for two correlated parameters are: W = 1.012 L_p + 1.26; t = 1.176 L_p – 2.98; H = 2.271; D = 6.33.

Description. External features. Medium-sized shells, with transverse outline and cynocephalous aspect. The lateral commissures are strongly ventrally deflected. Noncostate, uniplicate; the uniplication is subangular and rarely rounded. Beak well developed, erect, with long and slightly pronounced beak ridges. Foramen small, circular, mesothyrid, circular. Dental plates exposed. *Internal features.* As for the genus.

Remarks. The species is well defined by the features of the uniplication. By this it differs from *F. strambergensis* (REMES). From *F. fortunae* CALZADA in the Spanish Hauterivian, the Romanian species differs by a less pronounced cynocephalous aspect. From *F. makridini* (TCHOUMATCHENCO) (see Tchoumatchenco, 1987, p. 50) our species differs by more flattened shells and less convex dorsal umbonal region.

Stratigraphical and geographical distribution. Upper Kimmeridgian of Romania.

Fortunella sp.
(Pl. III, figs. 4–6)

Material. A single specimen, partly destroyed (L.P.B. III b 0225).

Dimensions. L_p = 22.7 mm; W = 26.3 (?) mm; t = 12.5 mm; W/L_p = 1.157 (?); t/L_p = 0.550; H = 10.6 mm; D = 19.9 mm; H/D = 0.532.

Remarks. The flattened shell and the rounded shape of the uniplication differentiate this specimen from any other ones attributed to the genus.

Stratigraphical and geographical distribution. The Lower Tithonian of the Bucegi Mountains (Horoaba Valley).

Order *Terebratulida* WAAGEN, 1883
Suborder *Terebratulidina* WAAGEN, 1883
Superfamily *Terebratulacea* GRAY, 1840
Family *Terebratulidae* GRAY, 1840
Subfamily *Lobothyrinae* MAKRIDIN, 1955
Genus *Loboidothyris* BUCKMAN, 1918

Loboidothyris undosa (SCHMIDT, 1905)
(Pl. III, figs. 1–3, 10–12)
Loboidothyris undosa (SCHMIDT) – BARCZYK, 1969, pl. 8, figs. 2, 4, 5.

Material. A relatively well-preserved mature specimen and two juvenile ones (L.P.B. III b 0230).

Dimensions.[2] L_p = 12.6–25.4 mm; L_b = 11.7–21.1 mm; W = 11.2–21.8 mm; t = 7.8–15.0 mm;

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[2] L_p - length of the pedicle valve, L_b - length of the brachial valve, W - width, t - thickness, LFS - length of the folded part of the shell, P - length from the posterior edge to the maximum width, d - legth of the sinus, D - length of the fold, p - depth of the sinus, H - height of the fold.

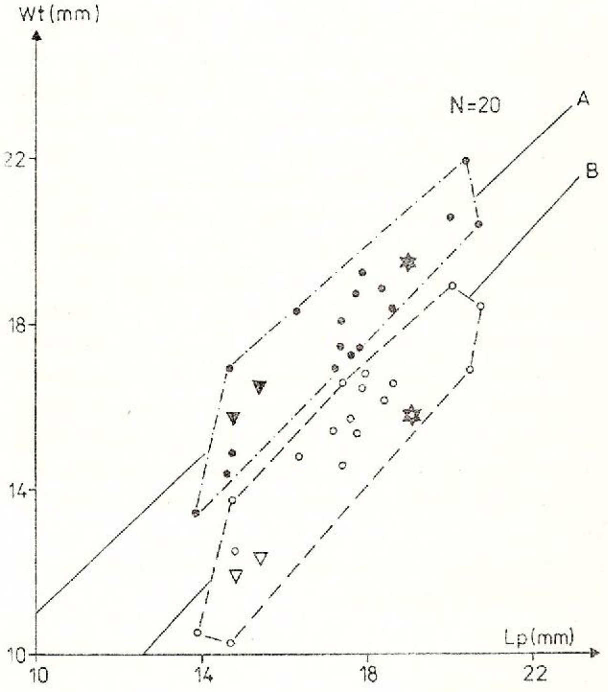

Fig. 6 – Bivariate analyses of the "population" of *Fortunella sibliki* sp. nov. from the Upper Kimmeridgian of the Hăghimaş Mountains. (L_p, W) - black signs, (L_p, t) - white signs. Triangles - sectioned specimens; stars - holotype. The equations of the regression lines are given in text.

$L_b/L_p = 0.839–0.927$; $W/L_p = 0.858–0.888$; $t/L_p = 0.590–0.619$.

Remarks. The specimens at our disposal are quite similar to those previously reported by Barczyk (1969) apart from the relatively greater thickness. We considered this difference insignificant.

Stratigraphical range and geographical distribution. Lower Tithonian from the Horoaba Valley, Bucegi Mountains.

Subfamily *Karadagithyrinae* TOHORSZHEVSKY, 1974
Genus *Svaljavithyris* TCHORSZHEVSKY, 1989

Svaljavithyris carpathica (ZITTEL, 1870)
(Pl. III, figs. 7–9)

Karadagithyris carpathica (ZITTEL) - BARCZYK, 1979 b, p. 210, Pl. I, figs. 5–7.

Svaljavithyris carpathica (ZITTEL) - TCHORSZEVSKY, 1989, p. 77, Pl. I, fig. 1.

Material. Three relatively poorly preserved specimens, L.P.B. III b 0229.

Dimensions of the figured specimen. $L_p = 20.2$ mm, $L_b = 18.7$ mm; $W = 16.0$ mm; $t = 9.6$ mm; $W/L_p = 0.787$; $t/L_p = 0.475$.

Remarks. Species very well defined by this outline, with the maximum width attained slightly anteriorly at midlength; the commissures are rectimarginate.

Stratigraphical range and geographical distribution. Lower Tithonian from the Horoaba Valley, Bucegi Mountains.

Subfamily *Lophrothyridinae* COOPER, 1983
Genus *Argovithyris* ROLLET, 1972

Argovithyris cf. *baugieri* (d'ORBIGNY, 1847)
(Pl. I, fig. 10)

Material. A poorly preserved specimen (L.P.B. III b 0231).

Remarks. Our specimen is quite similar to those figured by Rollet (1972) in pl. C, figs. 16–23 as *Argovithyris baugieri* (d'ORBIGNY). We maintained a reserve because the state of preservation of our specimen and a great time span separating the French and Romanian specimens. The age of this species in France is Middle Oxfordian; in Romania the only specimen at our disposal is attributed to the Lower Tithonian.

Subfamily Uncertain
Genus *Terebratula* MULLER, 1776 s.l.

"*Terebratula*" *bissuffarcinata* SCHLOTHEIM, 1820

Terebratula bissuffarcinata SCHLOTHEIM – SUESS, 1858). pl. I, figs. 1–3.

Material. A single well-preserved specimen (L.P.B. III b 0234).

Dimensions. $L_p = 17.5$ mm; $L_b = 16.4$ mm; $W = 12.7$ mm; $t = 9.7$ mm; $P = 12.1$ mm; $LFS = 13.6$ mm; $d = 9.6$ mm; $p = 1.9$ mm; $D = 10.2$ mm; $H = 4.3$ mm; $L_b/L_p = 0.938$; $W/L_p = 0.725$; $t/L_p = 0.554$; $LFS/L_p = 0.777$; $P/L_p = 0.691$; $p/d = 0.197$; $H/D = 0.421$.

Remarks. Apart from the rounded features of the anterior outline our specimen is similar to those figured by Suess in 1858, mainly with that in tab. I, fig. 3.

Stratigraphical and geographical distribution. Lower Tithonian from the Horoaba Valley, Bucegi Mountains.

Conclusions

The paleontological and stratigraphical study on several sections permitted us to establish two groups of species. The former group consists of species restricted, or crossing up the upper boundary of the stage, to Kimmeridgian deposits. The latter group is formed of species restricted to the Tithonian stage: these species occur above the Kimmeridgian/Tithonian limit. These groups are:

I. *Lacunosella hoheneggeri* (SUESS)
L. arolica (OPPEL)
Belbekella lobatschevae sp. nov.
Fortunella sibliki sp. nov.
Nucleata nucleata (QUENSTEDT)

Pygope diphyia (COLONNA)
II: *Lacunosella visulica* (SCHLOTHEIM)
Rhynchonella avrami sp. nov.
Echinirhynchia senticosa (SCHLOTHEIM)
Loboidothyris undosa (SCHMIDT)
Svaljavithyris carpathica (ZITTEL)
"*Terebratula*" *bissuffarcinata* SCHLOTHEIM

Certainly, the stratigraphical range of these species are those recorded in the studied area. These confirm the concept of provinciality of the brachiopod faunas.

There are not spectacular changes in brachiopod faunas at the Kimmeridgian/Tithonian boundary within the investigated area. It is of note a dominance of the *Rhynchonellida* against the *Terebratulida* at the Kimmeridgian level; in fact, the last ones are very, very poorly represented. In the Tithonian sequences an increasing in the number of Terebratulida taxa is observed, but the *Rhynchonellida* is still the major group (it dominates as number of individuals and area of spreading).

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Plate I

Figs. 1–3 — *Lacunosella hoheneggeri* SUESS. Upper Kimmeridgian from the Ialomicioara Cave (x 2). Hypotype, coll. Neagu & Georgescu, L.P.B. III b 0236.

Figs. 4–6 — *Belbekella lobatschevae* sp. nov. Upper Kimmeridgian from the Ialomicioara Cave. (x 2) Holotype, coll. Neagu & Georgescu, L.P.B. III b 0237.

Figs. 7–9 — *Belbekella lobatschevae* sp. nov. Upper Kimmeridgian from the Ialomicioara Cave, (x 2) Lectotype. coll. Neagu & Georgescu, L.P.B. III b 0238.

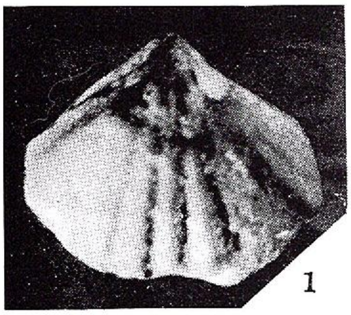
Fig. 10 — *Argovithyris* cf. *baugieri* (d'ORBIGNY. Lower Tithonian from the Horoaba Valley. (x 2.5). Hypotype. coll. Neagu, L.P.B. III b 0231.

Figs. 11–13 — *Belbekella lobatschevae* sp. nov. Upper Kimmeridgian from the Ialomicioara Cave, Bucegi Mountains. (x 2). Lectotype. coll. Neagu & Georgescu. L.P.B. III b 0238.

Photos: Bostan V. (University of Bucharest).

Plate I

D.M. GEORGESCU – BRACHIOPODS AT THE KIMMERIDGIAN/TITHONIAN BOUNDARY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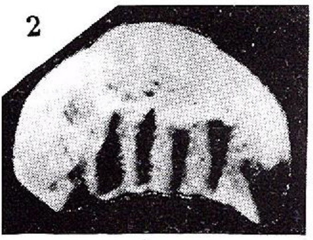
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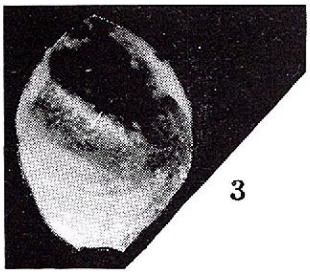
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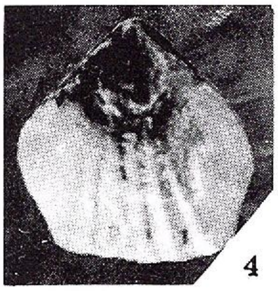
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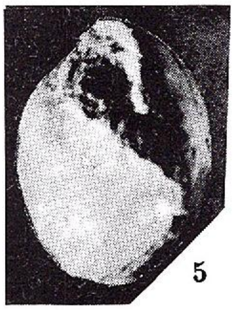
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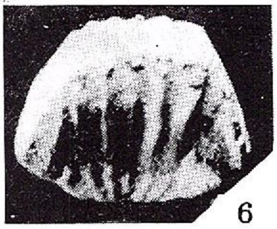
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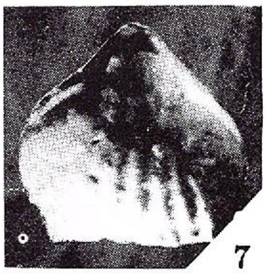
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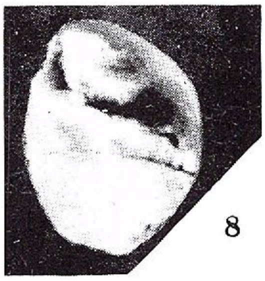
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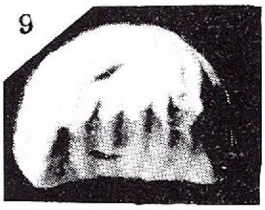
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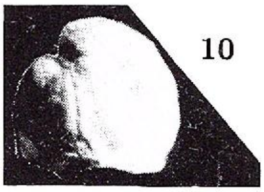
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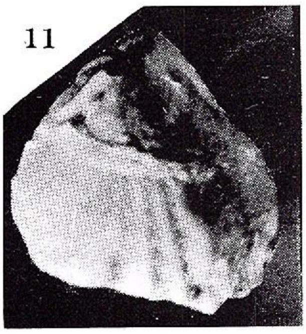
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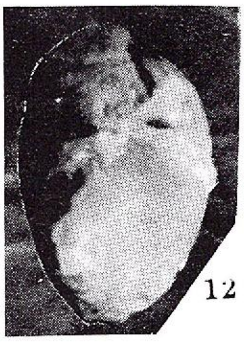
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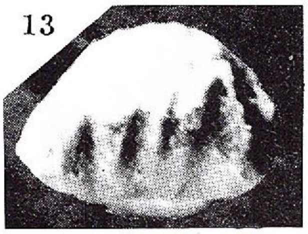
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Plate II

Figs. 1–3 — *Fortunella sibliki* sp. nov. Upper Kimmeridgian from Lacul Roşu. (x 2) Lectotype. coll. Preda. L.P.B. III b 0227.

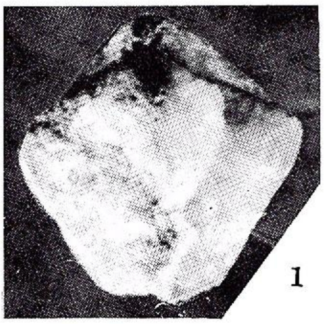
Figs. 4–6 — *Fortunella* sp. (nov. ?). Lower Tithonian from the Horoaba Valley. (x 2) coll. Neagu. L.P.B. III b 0225.

Figs. 7–8 — Middle (?) Tithonian from Strunguliţa. (x 1.5) Holotype. coll. Georgescu. L.P.B. III b 0232.

Figs. 9–11 — *Fortunella sibliki* sp. nov. Upper Kimmeridgian from Lacul Roşu. (x 2). Holotype. coll. Preda. L.P.B. III b 0226.

Photos: Bostan V. (University of Bucharest).

Plate II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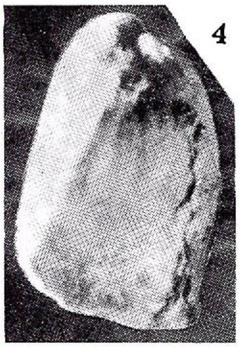
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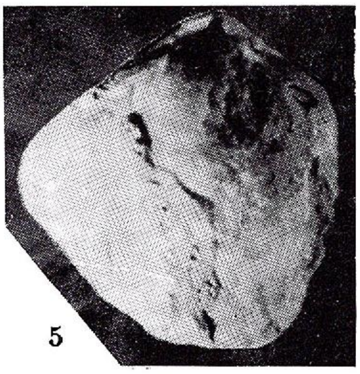
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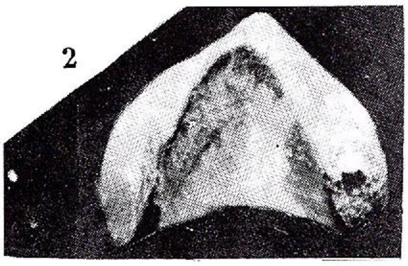
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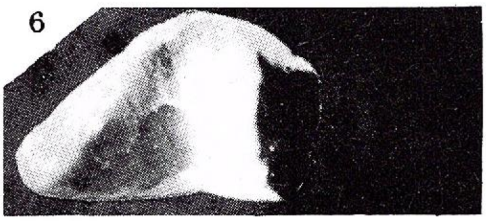
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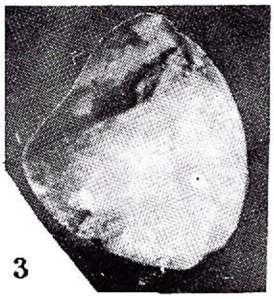
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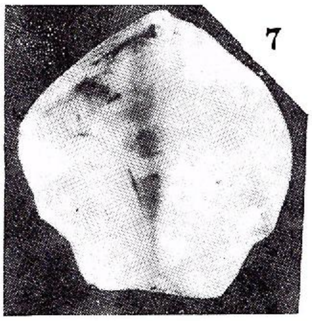
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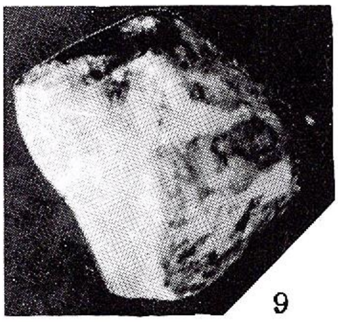
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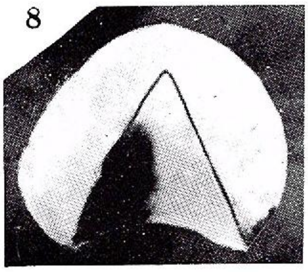
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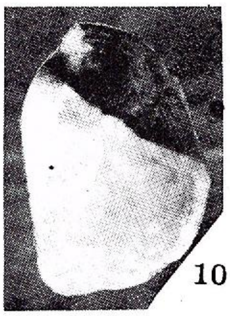
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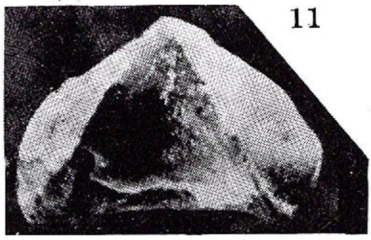
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Plate III

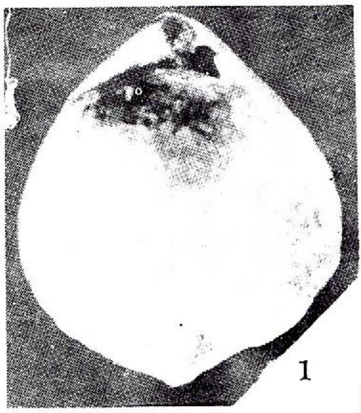
Figs. 1–3 — *Loboidothyris undosa* (SCHMIDT). Lower Tithonian from the Horoaba Valley. (x 2). Hypotype. coll. Neagu. L.P.B. III b 0230.

Figs. 4–6 — "*Terebratula*" *bissuffarcinata* SCHLOTHEIM. Lower Tithonian from the Horoaba Valley. (x 2.5). Hypotype coll. Neagu. L.P.B. III b 0234.

Figs. 7–9 — *Svaljavithyris carpathica* (ZITTEL). Lower Tithonian from the Horoaba Valley. (x 2.5) coll. Neagu. L.P.B. III b 0229.

Figs. 10–12 — *Loboidothyris undosa* (SCHMIDT). Lower Tithonian from the Horoaba Valley. (x 3). coll. Neagu. L.P.B. III b 0230.

Photos: Bostan V. (University of Bucharest).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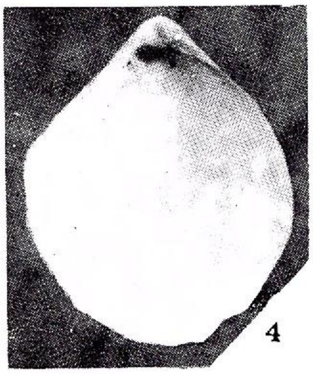
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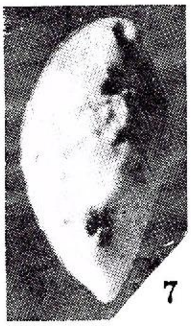
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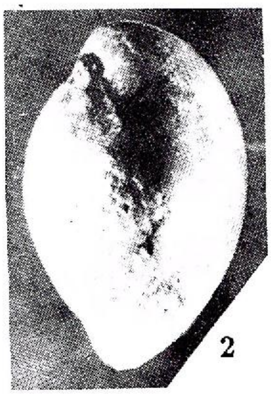
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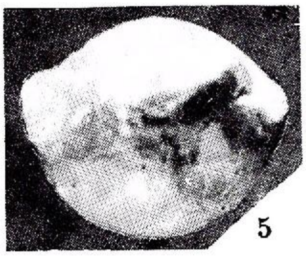
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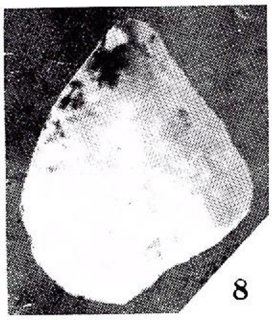
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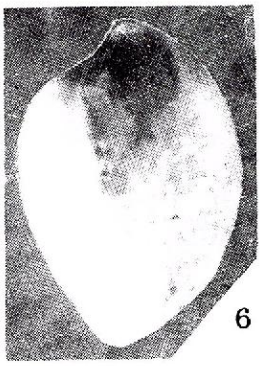
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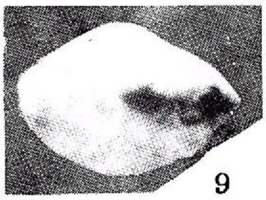
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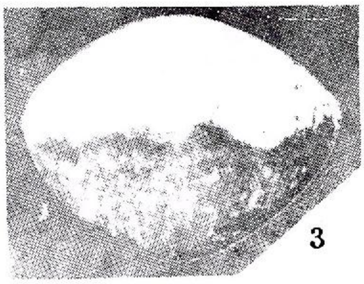
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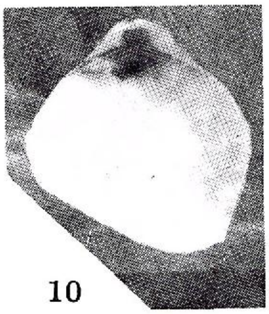
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Rom. J. Paleontology, 76, 1995, p. 21–30, Bucharest

STRATIGRAPHY OF THE LATE MAASTRICHTIAN-PALEOCENE DEPOSITS OF THE VRANCEA HALFWINDOW (MARGINAL FOLDS NAPPE, EAST CARPATHIANS - ROMANIA) ACCORDING TO FORAMINIFERA

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Key words: Biostratigraphy. Planktonic and agglutinated foraminifera. Stratigraphy. Lepşa Beds. Caşin Beds *s. l.*. Late Maastrichtian-Paleocene. Vrancea Halfwindow-Marginal Folds Nappe-East Carpathians.

Abstract: One of the most complete biozonations based on planktonic foraminifera from the Upper Maastrichtian-Paleocene of the Romanian Carpathian Domain was achieved in the Lepşa Beds and Caşin Beds *s. l.* of the Vrancea Halfwindow. This is the only place of the Romanian Carpathian area in which the level with "petites globigerines" (represented here by the "G" eugubina Zone) was intercepted from the base of the Lower Paleocene (Danian) as well as one of the first places in which it was proved that the extinction of the species *Ab. mayaroensis* took place before the Maastrichtian. The biostratigraphy on the basis of planktonic foraminifera for the Upper Maastrichtian is the one at Kef (Northern Tunisia), for the Paleocene is that of the latest zonal scales proposed for the Tethyan Domain but it is to note that the planktonic foraminiferal fauna in the upper part of the Upper Paleocene contains both species specific for the high latitude domain and some of those of the tropical/subtropical domain. The biostratigraphy based on the agglutinated foraminifera – intercorrelated with that based on planktonics – confirms/supports the biozonation recently proposed by the author for the Outer Flysch Zone of the East Carpathians. The data from 1971, according to which the boundary between the Lepşa Beds and the Caşin Beds *s. l.* lies in the lower part of the Lower Paleocene, is reconfirmed; the Lower Caşin Beds belong to the median part of the Lower Paleocene; the Middle Caşin Beds belong to the upper part of the Lower Paleocene-lower part of the Upper Paleocene; the Upper Caşin Beds belong only to the upper part of the Upper Paleocene – an opinion accepted also by the author – or reach the base of the Eocene if the stratigraphic scale with the M. velascoensis Zone at the Eocene base is used.

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Project 362 – Tethyan Boreal Cretaceous

1. Introduction

In the period 1970–1971 I carried out microbiostratigraphic researches based on foraminifera within the team led by Prof. I. Dumitrescu for the elaboration of the Outer Flysch monograph in order to establish the age of the Lepşa Beds and Caşin Beds *s. l.* from the Marginal Folds Nappe which appears in the Vrancea Halfwindow. The micropaleontological samples were collected (together with Prof. Dumitrescu, Alexandrescu, M. Săndulescu) from the deposits of the Pârâul Streiului anticline, which belong to the outer (Buciaş) facies of the Marginal Folds Nappe from this area. The micropaleontologically studied section through the Lepşa and Lower Caşin Beds lies on the Lepşa Valley (- 45 m downstream the first left tributary, Cojeni Brook) in the deposits on the western flank of the anticline. The section through the Middle and Upper Caşin Beds is situated on the Putna Valley (it begins at about 25 m upstream the confluence with the Tişiţa Valley and extends up to 200 m upstream the confluence with the Ciulei Brook) on the eastern flank of the anticline.

At that time, without direct paleontological arguments but only based on correlations, it was thought (Dumitrescu, 1963) that the Lepşa Beds from the Vrancea Halfwindow were Turonian in age, the Lower and Middle Caşin Beds belonged to the Senonian (which included also the Danian) and the Upper Caşin Beds were probably Paleocene in age. The Caşin Beds *s. l.* had been previously assigned (Dumitrescu, 1948) to the Eocene (which included also the Paleocene). Based on microfauna the Caşin Beds *s. l.* had been also assigned (Costea & Baltreş, 1962) to the Upper Senonian-Lower Eocene or (Costea, Saraiman, Comşa, 1969) to the Upper Maastrichtian-Paleocene.

My microbiostratigraphic researches from 1970–1971 (J. Săndulescu in Dumitrescu et al., 1970, 1971, tables 9, 22, 23, unpublished) led to the following conclusions as regads the age of these beds (using Luterbacher's, 1964, planktonic foraminiferal biostratigraphic scale):

– *The Lepşa Beds* from the Vrancea Halfwindow begin from the Coniacian and extend to the lower part of the Danian or of the Lower Paleocene because their terminal part contains an assemblage with "petites globigerines" and *Heterohelix* spp. (plus reworked *Abathomphalus mayaroensis, Rugoglobigerina* spp., etc.) belonging to the Globigerina eugubina Zone, followed by an assemblage with "petites globigerines", *Heterohelix* spp., *Globigerina pseudobulloides* (plus reworked Upper Cretaceous planktonic foraminifera) belonging to the Globigerina pseudobulloides Zone.

– *The Caşin Beds s. l.* belong to the Paleocene including the Lower Caşin Beds which are assigned to the Lower Paleocene *pro parte*, the Middle Caşin Beds to the Middle Paleocene *pro parte*, while the Upper Caşin Beds Middle Paleocene *pro parte* – to the Upper Paleocene *pro parte*. The basal part of the Lower Caşin Beds includes an assemblage of the G. pseudobulloides Zone, with "petites globigerines", *G. pseudobulloides, G. triloculinoides, Heterohelicidae* (and reworked Cretaceous species), followed by another one with *G.* cf. *pseudobulloides, G. triloculinoides, Globorotalia compressa, Heterohelicidae*. The upper part of the Middle Caşin Beds contains the Middle Paleocene assemblage with *G. pseudobulloides, G. triloculinoides, Globorotalia* cf. *pseudotopilensis*[1], *G.* cf. *convexa, Matanzia varians, Nodellum velascoense, Hormosina ovulum ovulum* etc.. The Upper Caşin Beds contain a Middle Paleocene assemblage in the lower part, with *Globigerina* spp., *G. triloculinoides, Globorotalia pseudotopilensis*[2], *Hormosina ovulum gigantea, H. ovulum ovulum, Nodellum velascoense, Matanzia varians* etc., and an Upper Paleocene assemblage (?) in the upper part including *Globorotalia* gr. *aequa - angulata, G. pseudotopilensis*[3], *Globigerina* spp. (and reworked Upper Crataceous species).

The above-mentioned data on the Lepşa and Lower Caşin Beds are presented in detail only in the reports concerning the monograph of the Outer Flysch (J. Săndulescu in Dumitrescu et al., 1970, 1971, unpublished) and briefly in a published paper (J. Ion, 1975). Those regarding the Middle and Upper Caşin Beds were presented by me only in the mentioned reports and lately have been used in a published paper (M. Săndulescu et al., 1987, Plate I).

Recently the study of the foraminiferal faunas has been resumed (J. Ion in Antonescu et al., 1988) based on the samples collected in 1970–1971 from the Lepşa and Caşin Beds *s. l.* from the Vrancea Halfwindow as they are still interesting both biostratigraphically and stratigraphically. This paper attempts to present the final results of these studies.

2. Lepşa Beds

The Lepşa Beds (Dumitrescu, 1958, 1963) from the Vrancea Halfwindow overlie the Upper Tisaru Beds and consist of grey-greenish centimetric marly to detrital limestones (with frequent inoceramus fragments) as well as rare centimetric sandstone interbeds. The lower part of the succession is marked by the presence of platy limestones which are silicified in places. The Lepşa Beds on the western flank of the Pârâul Streiului anticline, which have microbiostratigraphically been examined, have red marl interbeds in the base. On the eastern and south-western pericline they consist of detrital limestones that are rich in greenschist fragments, while towards the upper part they contain conglomerates with greenschist fragments.

These beds have been estimated to reach 250–300 m in thickness. Their upper part has microbiostratigraphically been examined (in the Lepşa Valley section) over a 100 m thickness only, a segment of about 60 m in thickness up to the first outcrops with the Lower Caşin Beds being, however, uninvestigated as it is not cropping out. The investigated segments of deposits are assigned to the Upper Maastrichtian-lower part of the Lower Paleocene (or lower part of the Danian *sensu stricto*) containing from bottom to top (see Pl. I):

– The first 15 m segment of deposits are marked by the presence of an agglutinated foraminiferal assemblage with *Haplophragmoides suborbicularis, Rzehakina inclusa, Hormosina ovulum ovulum, H. ovulum gigantea, Goesella rugosa* together with *Nutallides truempyi, Globotruncanita stuarti, Gt. elevata*. The agglutinated foraminiferal assemblage belongs to the upper part (H. suborbicularis Subzone) of the Rzehakina inclusa Zone.

– There follows the assemblage of Abathomphalus mayaroensis Subzone in the 60 m thick deposits containing *Ab. mayaroensis, Globotruncanita falsocalcarata, Plummerita hantkeninoides, Contusotruncana contusa, Gansserina gansseri, Rugotruncana subcircumnodifer, Globotruncanita elevata, Gt. stuartiformis, Globotruncana arca, G. rosetta, G. lapparenti, Heterohelix* spp.. The benthonic foraminifera are identical with those from the lower segment.

[1–3] *Acarinina primitiva* as a result of the researches from 1987–88)

– The Plummerita hantkenninoides Subzone (="non nommée Subzone) covers a 20 m thick segment of deposits and contains two assemblages. The former, which is the more extended, includes *Globotruncanita falsocalcarata, Plummerita hantkeninoides, Contusotruncana contusa, Ct. fornicata, Gansserina gansseri, Globotruncanita conica, Gt. stuarti, Gt. stuartiformis, Globotruncanella pschadae, Rugoglobigerina* spp., *Guembelitria* and other *Heterohelicidae, Globigerinelloides* spp., *Hedbergella*. The latter, which is situated in the terminal part, contains a lot of *Heterolicidae* and *Hedbergella*, rare *Globotruncanidae* among which also *Gansserina gansseri*.

– The "Globigerina" eugubina Zone, characteristic of the base of the Danian or of the Lower Paleocene, is hosted by a 2–3 m thick packet of beds. It contains specimens of "petites globigerines" such as *"G". eugubina, "G". minutula, "G". trifolia, "G".fringa* as well as some other undeterminable ones, *Guembelitria* and other *Heterohelicidae, Globanomalina* spp. At these levels I found in situ also benthonic foraminifera such as *Pararotalia, Spiroplectammina spectabilis, Rzehakina inclusa* and reworked Upper Cretaceous planktonic foraminifera (e.g. *Gt. stuarti, Pl. hantkeninoides, Ab. mayaroensis*).

– The basal part of the Morozovella pseudobulloides Zone is present in deposits covering a 1–2 m thickness and is characterized by the appearance of the index species, *Globigerina triloculinoides, Globoconusa daubjergensis* and containing also "petites globigerines" (such as *minutula, fringa, trifolia*). It also includes *Globigerina trivialis, G. edita, Globanomalina* spp., biseriate *Heterolicidae*. In this interval I found also *in situ* benthonic foraminifera which are not, however, significant from the stratigraphic point of view, as well as reworked *Calcarina, Siderolites, Rugoglobigerina* spp..

3. Lower Caşin Beds

The Lower Caşin Beds (Dumitrescu, 1952, 1963) show two facies, a marly one and a marly one with conglomerates including greenschist fragments (Piatra Streiului Conglomerates). The marly facies is present on the western flank of the Pârâul Streiului anticline, where it is represented by a succession (100 m) consisting of greyish marly-limstones (with numerous diaclases filled with calcite) with calcareous sandstone interbeds. Only a 10 m thick segment of beds, situated in the median part of the succession in marly facies (the section on the Lepşa Valley, Pl. I) has been microbiostratigraphically investigated. This packet belongs to the median part of the Lower Paleocene (the upper part of the Danian *sensu stricto* - lower part of the Montian *sensu stricto* respectively) containing:

– A first assemblage observed in 2–3 m thick deposits, represents the upper part of the Morozovella trinidadensis Zone, including *Morozovella* gr. *inconstans-trinidadensis, M. pseudobulloides, Planorotalites compressa, Globoconusa daubjergensis*, (the *koslowskii* morphotype inclusive), *Globigerina triloculinoides, G. trivialis, Woodrigina, Guembelitria, Globanomalina* spp.. Some of the present benthonic foraminifera worth mentioning such as *Goesella rugosa, Dorothia crassa, Hormosina ovulum ovulum, Pararotalia, Gansserina gansseri, Globotruncana arca, Rugoglobigerina* are present as reworked.

– There follows the assemblage of the lower part of the Morozovella uncinata Zone, made up of about 3 m thick beds, containing the first occurrence of *M. uncinata, M. perclara* and the last *Globoconusa daubjengensis*, represented only by the *koslowskii* morphotype. Within it *Morosovella* gr. *inconstans-trinidadensis, M. pseudobulloides, Planorotalites compressa, Globigerina triloculinoides, G. edita, G. varianta, Guembelitria, Woodrigina, Chiloguembelina, Globanomalina* spp. persist. Of the benthonics *Glomospira diffundens, Hormosina ovulum ovulum, H. ovulum gigantea* are present *in situ*, representing the assemblage of the lower part of the Glomospira diffundens Zone. The planktonics *Ab. mayaroensis* and *Gs. gansseri* are present as reworked.

There are no biostratigraphic data available for the age of the Lower Caşin Beds in their basal and terminal segments. But as the assemblage of the basal part of the M. pseudobulloides Zone exists in the upper part of the Lepşa Beds, and the transition assemblage from the Morozovella angulata Zone to the Planorotalites pusilla pusilla Zone is the lowest one known in the Middle Caşin Beds, it can be stated that the lower boundary of the Lower Caşin Beds lies in the lower part of the Lower Paleocene (namely within the Danian *sensu stricto*, probably within the interval covered by M. pseudobulloides Zone), while the upper boundary lies in the upper part of the Lower Paleocene (within the Montian *sensu stricto*). Therefore they belong to the approximately median part of the Lower Paleocene.

4. Middle Caşin Beds

The Middle Caşin Beds (Dumitrescu, 1952, 1963) are about 150 m thick, consisting of greyish, schistose argillaceous marls with calcareous sandstone interbeds. On Valea Putnei, in a 90 m thick segment of deposits from their upper part extending to the boundary with the Upper Caşin Beds, they contain the following foraminiferal assemblages (Pl. II):

– The first layers contain an assemblage marked by the co-occurrence of *Morozovella uncinata, M.* gr.

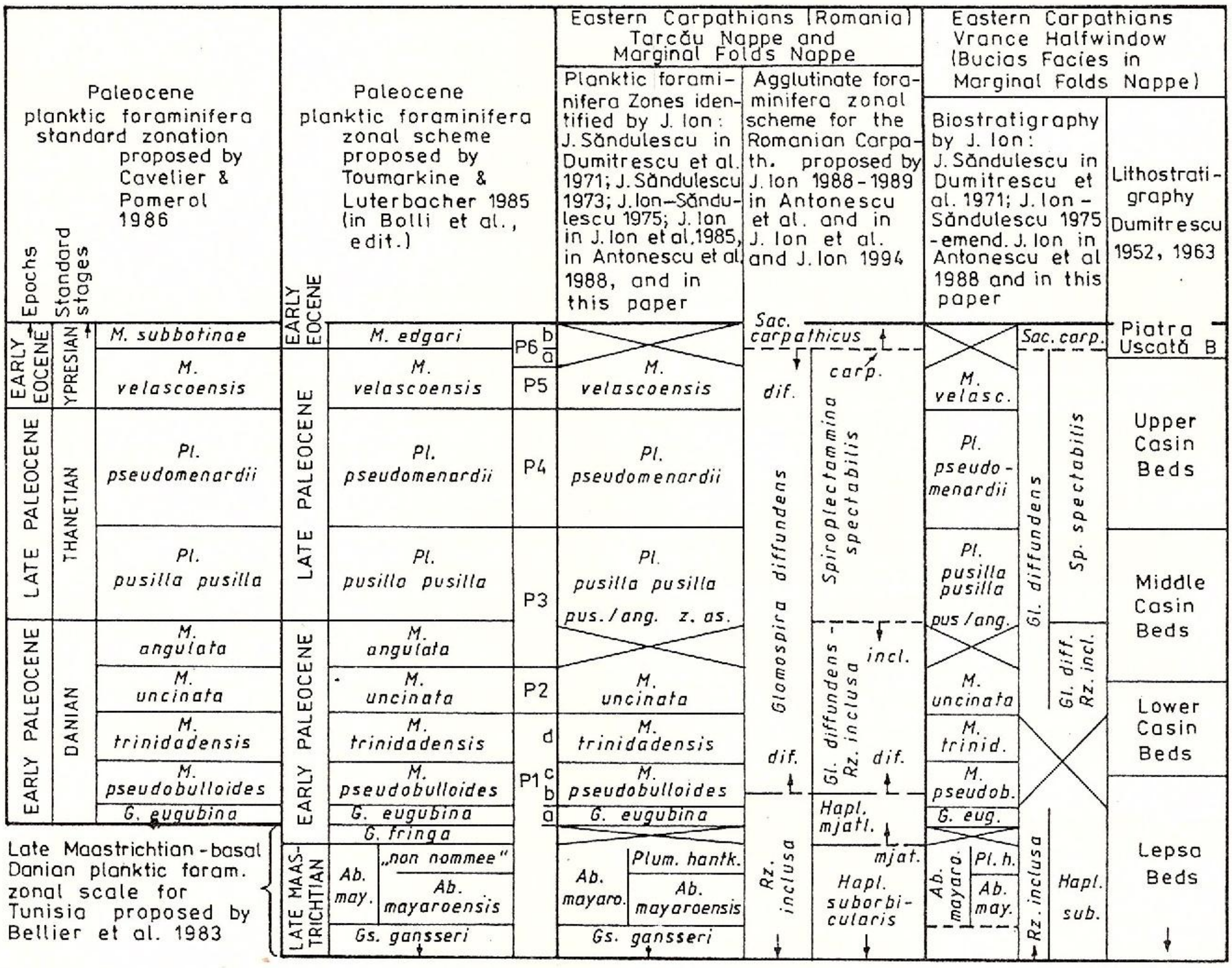

Fig. 1 - Correlation of the planktonic and agglutinated foraminiferal zones/subzones identified in the Late Maastrichtian-Paleocene of the Vrancea Halfwindow (Marginal Folds Nappe) with biozonal scheme proposed for the Romanian East Carpathians domain and with the others proposed for the Tethyan domain.

uncinata-praecursoria, M. conicotruncata, M. pseudobulloides with the first appearance of *Planorotalites pusilla pusilla, Pl. chapmani, Globigerina velascoensis*. It would be a transition assemblage from the Morozovella angulata Zone to the Planorotalites pusilla pusilla Zone, therefore on the Lower Paleocene-Upper Paleocene boundary. A lot of fragments of melobesids and bryozoans were also encountered in these layers.

– The rest of the deposits to the boundary with the Upper Caşin Beds show the microfauna of the lower part of the Upper Paleocene, namely the Planorotalites pusilla pusilla Zone, with the co-occurrence of the species *Pl. pusilla pusilla, Pl. chapmani, M. conicotruncata, Acarinina mckannai, A. primitiva, Globigerina velascoensis*, and towards the upper part also with *Globoconusa (?) chascanona* and *Acarinina aquiensis*. The planktonic foraminiferal assemblage also includes: *M. acuta, M. perclara, M. apathesma, G. triloculinoides, G. spiralis, G. trivialis, G. varianta, Globanomalina* spp.. However, the benthonic foraminifera prevail, including in two levels also *Asterigerina* sp. and *Discocyclina* sp.. The agglutinated foraminiferal assemblage contains *Glomospira diffundens, Hormosina ovulum ovulum, Nodellum velascoense, Rzehakina epigona*, and belongs to the upper part of the Glomospira diffundens Zone, the Spiroplectammina spectabilis Subzone respectively.

In conclusion, the Middle Caşin Beds are assigned to the upper part of the Lower Paleocene-lower part of the Upper Paleocene (they begin in the Montian *sensu stricto* and extend to the first levels with *Pl. pseudomenardii* of the Thanetian) (Fig. 1). This age is supported both by the microfauna they contain and the fact that towards the upper part of the Lower Caşin

Beds there is the microfauna of the lower part of the Morozovella uncinata Zone, and in the basal part of the Upper Caşin Beds the microfauna of the Planorotalites pseudomenardii Zone begins.

5. Upper Caşin Beds

The Upper Caşin Beds (Dumitrescu 1952, 1963) are estimated to be 250-350 m thick and consist of bituminous limestones and bituminous schistose clays containg interbeds of conglomerates with greenschist fragments (Piatra Cornii Conglomerates) at the top, followed by fucoid marly limestones. The base of these beds is rich in sponge spicules, and the top, especially in conglomerates; the debris of melobesids, bryozoans, corals and bivalves are frequent. The geological section on the Putna Valley (Pl. II) provided foraminiferal assemblages for almost the whole succession of the Upper Caşin Beds (reaching 250 m in thickness here). Only for its final part, at its boundary with the Piatra Uscată Beds, biostratigraphic data are provided by the studies carried out by other research workers.

On Valea Putnei the Upper Caşin Beds include a lot of calcareous benthonic foraminifera, among which it is worth mentioning the presence of *Hanzawaia budensis karpathica* and *Cibicides mariae* as well as agglutinated benthonic foraminifera belonging to the upper part of the Glomospira diffundens Zone, of the Spiroplectammina spectabilis Subzone respectively, specific for the Upper Paleocene. The characteristic agglutinated foraminiferal assemblage is represented by the co-occurrence of *Glomospira diffundens, Hormosina ovulum ovulum, Nodellum velascoense* and *Rzehakina epigona* in the final stage of their range; the assemblage is devoid of *Rz. inclusa* and (?) *H. ovulum gigantea*, their extinction being at the Lower Paleocene-Upper Paleocene boundary.

The planktonic foraminifera are present by several associations which represent the Planorotalites pseudomenardii Zone and the lower part (P_5 Zone) of the Morozovella velascoensis Zone:

- The basal levels include the association with *Pl.* cf. *pseudomenardii, Acarinina nitida, A. mckannai, Globigerina velascoensis*, which belongs to Pl. pseudomenardii Zone.

- After an about 30 m thick sequence of deposits devoid of microfauna there follows a 200 m sequence with microfauna of the Pl. pseudomenarii Zone, characterized by the joint-occurrence of the species *Pl. pseudomenardii, Acarinina nitida, Morozovella angulata, M. conicotruncata* with the first occurrence of *Globigerina linaperta* and *Morozovella velascoensis*; the last occurrences of *M. conicotruncata* and *Pl. pusilla pusilla* are found in the terminal part of the zone. The assemblage also includes the species: *Morozovella simulatilis, M.* aff. *perclara* (*fide* Luterbacher, 1964) and/or *M. hispidocidaris, M. perclara, M. acuta, Pl. chapmani, Acarinina aquiensis, A. convexa, A. mckannai, Globigerina triloculinoides, G. spiralis.*

- The last 20 m thick sequence of deposits of the Upper Caşin Beds, studied in the Valea Putnei section, includes the assemblage of the lower part (P_5 Zone) of the Morozovella velascoensis Zone. This assemblage is characterized by the joint-occurrence of *Acarinina soldanensis, Morozovella velascoensis, M. acuta* and *Acarinina mckannai.* It also includes: *Planorotalutes chapmani, Morozovella aequa, M. occlusa, M (?) quadrata, Acarinina convexa, A. primitiva, A. nitida, A aquiensis, Globoconusa (?) chascanona, Globigerina linaperta, G. velascoensis, G. incisa, G. imitata.*

In the terminal levels of the Upper Caşin Beds and in the base of the Piatra Uscată Beds, also in Valea Putnei but in the west flank of the Coza anticlinorium, is mentioned (Bratu in Dumitrescu et al., 1979) the agglutinated foraminiferal assemblage of the Glomospira diffundens Zone, typical of the Paleocene and only in the terminal levels of the Upper Caşin Beds is found also a planktonic foraminiferal assemblage within which *A. mckannai* still exists.

In conclusion (Fig. 1), according to the microfaunal content and Toumarkine and Luterbacher's biostratigraphic scale (1985) based on planktonic foraminifera - on which M. velascoensis Zone occurs in the terminal part of the Paleocene -, the Upper Caşin Beds represent the middle and upper part of the Upper Paleocene (the Thanetian respectively). Their boundary with the Piatra Uscată Beds would be situated in the terminal part of the Upper Paleocene, within the M. velascoensis Zone (either at the boundary between P_5 Zone and P_6 Zone or within P_6 Zone). However, according to the stratigraphic scale proposed as a standard by Cavelier and Pomerol (1986) - where M. velascoensis Zone occurs in the base of the Eocene -, they belong to the interval including the upper part of the Upper Paleocene-the basal part of the Lower Eocene and its boundary with the Piatra Uscată Beds would be situated in the Lower Eocene.

6. Biostratigraphical Conclusions

6.1. Planktonic Foraminifera

The Upper Maastrichtian-Paleocene succession in the Buciaş facies from the Marginal Folds Nappe occurring in the Vrancea Halfwindow is relatively rich in planktonic. Unfortunately, they have been studied especially on the basis of thin sections, their detach from the rock being quite difficult. However, even in these circumstances these deposits have revealed the most complete biozonation from the Upper Maastrichtian-Paleocene of the Romanian Carpathian Realm based on planktonic foraminifera.

The Upper Maastrichtian planktonic foraminiferal biostratigraphy of the Lepşa Beds is the same as in the Upper Maastrichtian succession of the Kef area (northern Tunisia) proposed as reference series for the Mesogean realm. In the Upper Maastrichtian of the Lepşa Beds (Pl. I, Fig. 1) one could separate the Abathomphalus mayaroensis Zone sensu Bellier et al. (1983) that is an Interval Zone, with two subzones: Abathomphalus mayaroensis Total Range Subzone (acc. to def. Bronnimann, 1952) and "non nommée" Interval Subzone (acc. to def. Bellier et al., 1983, representing the interval from the extinction of the Ab. mayaroensis to the first occurrence of "petites globigerines" of the basal Danian). For the latter the name Plummerita hantkeninoides Subzone has been proposed (J. Ion in Antonescu et al., 1988, unpublished; J. Ion, 1993; J. Ion in J. Ion & Szasz, 1994, in J. Ion et al., in press). In our case for the upper boundary of the "non nommée" or Plummerita hentkeninoides Subzone the layers with "Globigerina" fringa Zone have not been intercepted as at Kef in Northern Tunisia, *locus typicus* of "non nommée" Subzone. Only the layers including "Globigerina" eugubina Zone have been intercepted, the zone which according to some researchers (Likewise et al. 1981, *fide* Toumarkine and Luterbacker, 1985) represents the second zone of the "petites globigerines" interval of the basal Danian, an opinion with which we agree (Fig. 1). "Globigerina" eugubina Zone is the first zone of the Danian or Lower Paleocene both to Toumarkine and Luterbacher's (1985) and to Cavelier and Pomerol's (1986) biostratigraphical scales.

It is to note that the Lepşa Beds in the Lepşa Valley is the only place in the Romanian Carpathian Realm where the layers (2–3 m thick) with "petites globigerines" of the basal Danian are known so far. Recently (J. Ion in J. Ion & Szasz, 1993) the possibility of their occurrence in the Glodu Basin, therefore in the Median Dacides of the East Carpathians, has also been stressed out. In the Romanian Carpathian Realm, and generally in the Carpathian Realm, the oldest Danian (Lower Paleocene) planktonic foraminiferal assemblage intercepted is that of the Morozovella pseudobulloides Zone. It is well known, on a global scale too, that the sequence including "petites globigerines" is difficult to find out because of its very small thickness (from some centimetres up to some metres) as well as the extremely small sizes of the "globigerines".

The extinction of the species *A. mayaroensis* before the Maastrichtian-Danian (Lower Paleocene) boundary and the two subzones of the Ab. mayaroensis Zone have also been identified (J. Ion in Antonescu et al., 1988; J. Ion in J. Ion et al, in press) in the Hangu Beds *sensu stricto* and in the Horgazu Beds of the Tarcău Nappe (East Carpathians). On a global scale, this point of view on the extinction of the species *Ab. mayaroensis* has been known for a long time (e.g. Dalbiez, 1955; Sigal, 1967; Kassab, 1975) but it has recently been made actual again (e.g. Bellier et al., 1983; Bellier, 1983, Lamolda, 1983; Sigal, 1987) being argued on an ever larger area.

For the Paleocene (terminal part of the Lepşa Beds and Caşin Beds *s. l.*) in the Marginal Folds Nappe of the Vrancea Halfwindow the following zones have been identified (Pl. I, II and Fig. 1): "Globigerina" eugubina Total Range Zone, Morozovella pseudobulloides Interval Zone, Morozovella trinidadensis Interval Zone, Morozovella uncinata Interval Zone, Planorotalites pusilla pusilla Interval Zone, Planorotalites pseudomenardii Total Range Zone, lower part ($=P_5$ Zone in the biostratigraphic scales of Blow, 1969, Bergreen & Couvering, 1979 - fide Toumarkine and Luterbacher, 1985) of the Morozovella velascoensis Interval Zone. For the Morozovella angulata Interval Zone there is only an assemblage but of transition to the Pl. pusilla pusilla Zone.

According to definition, content and age, these zones correspond to those on Toumarkine and Luterbacher's biostratigraphical scale (1985), as compared to those on Cavelier and Pomerol's scale (1986) they differ in one respect (fide Fig. 1). Because on the former zonal scale M. velascoensis Zone (P_5+base of P_6) ends the Paleocene, a point of view accepted by us, the extinction of this species and the first occurrence of the species *Pseudohastigerina wilcoxensis* mark the Paleocene-Eocene boundary; on the latter zonal scale the Lower Eocene (Ypresian) begins with this zone. There are also other opinions concerning this matter. For instance (Samuel, 1989), the Paleocene-Eocene boundary (Thanetian-Ypresian boundary) is situated within P_5 Zone.

It is to note that in the Vrancea Halfwindow the planktonic foraminiferal fauna of the upper part of the Upper Paleocene contains species typical of the high-latitude realm as well as some species of the tropical/subtropical realm.

6.2. Agglutinated Foraminifera

The biostratigraphic scale based on agglutinated foraminifera proposed by us recently (J. Ion in Antonescu et al., 1988, 1989; J. Ion in J. Ion et al., J. Ion, in press) for the Upper Maastrictian-Paleocene of the Romanian Carpathian Realm, based on evidence from the Tarcău Nappe and Marginal Folds Nappes, is intercorrelated with that based almost on planktonic foraminifera, except for the terminal part (fide Fig. 1). The biostratigraphic data from the Vrancea Halfwindow, presented also in this paper, contributed to the mentioned calibration, as well. In this respect, from the Upper Maastrichtian-Paleocene agglutinated foraminifera biostratigraphy of the Lepşa Beds and Caşin Beds *s. l.* of the Vrancea Halfwindow the following data have been mentioned:

– The Upper Maastrichtian - base of the Lower Paleocene includes the agglutinated foraminiferal assemblage of the upper part (with *Rzehakina inclusa* and *Haplophragmoides suborbicularis*) of the Rzehakina inclusa Range Zone (acc. to def. J. Ion in Antonescu et al., 1988 and in J. Ion et al., in press). In the Lepşa Beds this assemblage coexists first with a microfauna with *Globotruncanita stuarti* and *Nuttallides truempyi* and then with the microfauna belonging to the Abathomphalus mayaroensis Interval Zone and "Globigerina" eugubina Zone. It is known (J. Ion in Antonescu et al., 1988, 1989 and in J. Ion et al., in press; J. Ion, in press) that in the Outer Flysch of the Romanian East Carpathians it coexists also with the lower part of the Morozovella pseudobulloides Zone, a stratigraphic segment which in the Vrancea Halfwindow includes few agglutinated foraminifera of no stratigraphic significance. As a matter of fact, from the viewpoint of the planktonic foraminifera in the Lepşa Beds the basal part of the Lower Paleocene (Danian *s. l.* is well marked by the "Globigerina" eugubina Zone; from the benthonic foraminifera point of view, in general, and the agglutinated foraminifera, in particular, we have not found here the association specific to the Haplophragmoides mjatliukae Subzone of the Rz. inclusa Zone, or to the Valvulineria alpina Subzone zones which, in our opinion (J. Ion in Antonescu et al., 1988, 1989, in J. Ion et al., in press; J. Ion, in press), in the Tarcău Nappe characterize the basal, aplanktonic part, of the Lower Paleocene (the first planktonic foraminifera found here belonging to the Morozovella pseudobulloides Zone). The first appearance of *Haplophragmoides mjatliukae, Hyperammina nodata, Reophax subnodulosus, Recurvoides nucleolus* in case of the agglutinates, and the first occurrence of *Valvulineria alpina* for the calcareous benthonics, – all of them belonging to a microfauna with *Rz. inclusa* and *H. suborbicularis* –, mark the beginning of the above-mentioned subzones and they would point to the beginning of the Paleocene. The H. mjatliukae Subzone and the top of the Rz. inclusa Zone, respectively, would be correlatable with "Globigerina" fringa, "G." eugubina zones and the lower part of the M. pseudobulloides Zone (Fig. 1); the first occurrence of Glomospira diffundens, which marks the beginning of the zone with the same name, takes place in the upper part of the M. pseudobulloides Zone.

It is to note that in the Vrancea Halfwindow *Spiroplectammina spectabilis* is found in the deposits which include also "G." eugubina Zone. In other regions of the Romanian Carpathian Realm this species existed before the Thanetian (Upper Paleocene): in the terminal part of the Maastrichtian in the Hangu Beds *s. str.* (together with the assemblage of the Plummerita hantkeninoides Subzone), in the Lower Paleocene of the Cuejdiu Beds (together with the microfauna of the Morozovella trinidadensis Zone). This stratigraphic distribution constituted one of the arguments for the redefinition (J. Ion in Antonescu et al., 1988 unpublished, and in J. Ion et al., in press) of Spiroplectammina spectabilis Zone as a zone representing the interval with zonal marker from the last occurrence of *Rzehakina inclusa* up to the first occurrence of *Saccamminoides carpathicus*. Sp. spectabilis Zone of Geroch and Nowak (1984) represents the interval ranging between the first frequent occurrence of *Sp. spectabilis* (species considered to occur first a little before the Lower-Upper Paleocene boundary) and the first occurrence of *Sac. carpathicus*.

– Likewise, the segment of deposits with planktonic foraminifera of the Morozovella trinidadensis Zone does not contain an agglutinated foraminiferal microfauna of stratigraphic significance. Only the segment belonging to the Lower Caşin Beds) with the planktonic foraminifera of the Morozovella uncinata Zone contains the agglutinated foraminifera of the lower part of the Glomospira diffundens Total Range Zone (acc. to def. J. Ion in Antonescu et al., 1988, and in J. ion et al., in press), of the Glomospira diffundens-Rzehakina inclusa Concurrent Range Subzone, respectively (acc. to def. J. Ion in J. Ion et al., in press), specific to the Lower Paleocene. Here, it is represented partly by the typical assemblage namely with the co-occurrence of the species *Glomospira diffundens, Hormosina ovulum ovulum* and *Nodellum velascoense* with the last of *Rzehakina inclusa* and probably of the *H. ovulum gigantea*.

– The agglutinated foraminiferal assemblage specific to the Upper Paleocene, in which persist *Gl. diffundens, H. ovulum ovulum, Nodellum velascoense, Rz. epigona, Rz. fissistomata*, representing the upper part of the Gl. diffundens Zone or the Spiroplectammina spectabilis Partial Range Subzone (acc. to def. J. Ion in Antonescu et al., 1988, unpublished, and in J. Ion et al., in press), characterizes the beds including also the planktonic foraminifera of the Planorotalites pusilla pusilla Zone, Pl. pseudomenardii Zone and the lower part (P_5 Zone) of the Morozovella velascoensis Zone. It extends also in deposits devoid of planktonic foraminifera belonging to the final part of the Upper Caşin Beds and the lower part of the Piatra Uscată Beds.

The chronostratigraphic calibration of the level of the disappearance of *Gl. diffundens, H. ovulum ovulum, N. velascoense, Rz. epigona, Rz. fissistomata, Rz. complanata* as well as of the first occurrence of *Sac. carpathicus*, which according to some researchers would mark the Paleocene-Eocene boundary could not have been made up till now in the deposits of the

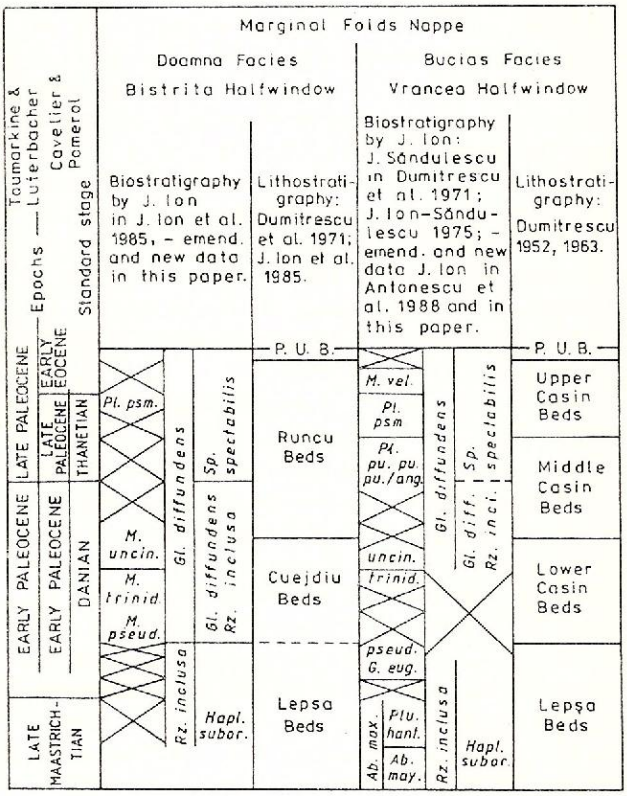

Fig. 2 – Bio- and stratigraphical correlations in the Marginal Folds Nappe.

Vrancea Halfwindow or in other places in the Romanian Carpathian Realm. However, by the present study a step has been made forward as we now know at least that these events take place above the lower part (=P_5 Zone) of the M. velascoensis Zone. Up till now the levels with planktonic foraminifera intercepted in the Paleocene of the Romanian Carpathian Outer Flysch belonged at most to the Pl. pseudomenardii Zone. Considering that M. velascoensis Zone ends the Paleocene, according to the biostratigraphic scale of Toumarkine and Luterbacher (1985), – a point of view adopted by us, as well –, then it is possible that the biomarker level given by these extinctions should be at the Paleocene-Eocene boundary or within the Lower Eocene. If the Eocene begins with the M. velascoensis Zone, according to Cavelier and Pomerol (1986), then it is situated within the Lower Eocene.

It is necessary to determine the age of the level with the extinction of the mentioned species and/or with the first occurrence of *Sac. carpathicus* within the East Carpathians Outer Flysch, because it is difficult to adopt a certain point of view accepted in the Carpathian Realm outside Romania, the conclusions on this subject being contradictory. Thus, in the Polish Carpathian Realm these events mark the Paleocene-Eocene boundary, but we are not informed where this limit is situated from the point of view of the planktonic foraminifera. In the Slovak Carpathians, the extinction of the species *H. ovulum ovulum, Rz. epigona, Rz. fissistomata, Rz. complanata* – but also of the species *Rz. inclusa* – is proved by co-occurrence with the planktonic foraminifera (Lesko and Samuel, 1968) to be at the Paleocene-Eocene boundary. But this boundary is located within the terminal part of the "Globorotalia subbotina marginodentata" Zone equivalent to the "Globorotalia rex" Zone of Bolli (1957), zones which according to Toumarkine and Luterbacher (1985) and Cavelier and Pomerol (1986) are located in the Lower Eocene.

It is to note all this because in the Romanian Carpathian Realm for the location of the Paleocene-Eocene boundary based on agglutinated foraminifera, Geroch and Nowak's (1984) point of view is accepted both when the M. velascoensis Zone is accepted in the Paleocene and when it is assigned to the Eocene.

7. Stratigraphical Conclusions

Different criteria for/and the age of the Lepşa Beds and Caşin Beds *s. l.*, with their subdivisions, are synthetically rendered in Figure 1.

The microbiostratigraphic evidence stressed out, according to our conclusions from 1971 and 1975, that the Lepşa Beds in the Buciaş facies of the Vrancea Halfwindow extend up to the lower part of the Lower Paleocene (or up to the lower part of the Danian *sensu stricto*, ranging within the M. pseudobulloides Zone = P_{1b} Zone).

The Caşin Beds *s. l.*, from the point of view of the stage stratotypes, correspond approximately to the upper part of the Danian plus the Montian and the Thanetian, they including in the final part the lower part (=P_5 Zone) of the Morozovella velascoensis Zone. Using Toumarkine and Luterbacher's biozonal scale (1985), – accepted by us –, the Caşin Beds *s. l.* are of Lower Paleocene *pro parte* (that is without the basal part) – Upper Paleocene *pro parte* age (according to our point of view 1971). Considering Cavelier and Pomerol's biostratigraphic scale, they are of Lower Paleocene *pro parte* – base of the Lower Eocene (or Danian *pro parte* – base of the Ypresian) age. In the former case their boundary with the Piatra Uscată Beds would be situated in the terminal part of the Upper Paleocene, and in the latter case it would be within the basal part of the Lower Eocene (Ypresian).

The Lower Caşin Beds belong to the middle part of the Lower Paleocene, the Middle Caşin Beds to the upper part of the Lower Paleocene-lower part of the

Upper Paleocene, and the Upper Caşin Beds pertain to the middle and upper part (*pro parte*) of the Upper Paleocene according to Toumarkine and Luterbacher's biozonal scale (1985) – a point of view accepted by us –, or they extend up to the base of the Lower Eocene – acc. to Cavelier and Pomerol's scale (1986).

The changes in the age dating of these biostratigraphic subdivisions, which occur in this paper as compared to the study made in 1971, come from the additional biostratigraphic data but especially from the interpretation of the whole biostratigraphic material based on the new chrono- and biostratigraphic schemes proposed for the Paleocene in the Tethys Realm.

The new biostratigraphic data brought in this paper have implications also in the stratigraphic correlations within the outer flysch zone, as already mentioned in a recent paper (J. Ion, in press). The correlation with the deposits of the Doamna facies zone of the Bistriţa Halfwindow is presented in Figure 2. On the occasion of this paper and of the paper by J. Ion (in press), for these deposits the zonation made based on foraminifera by J. Ion et al. (1985) has been revised according to the latest biozonal schemes adopted.

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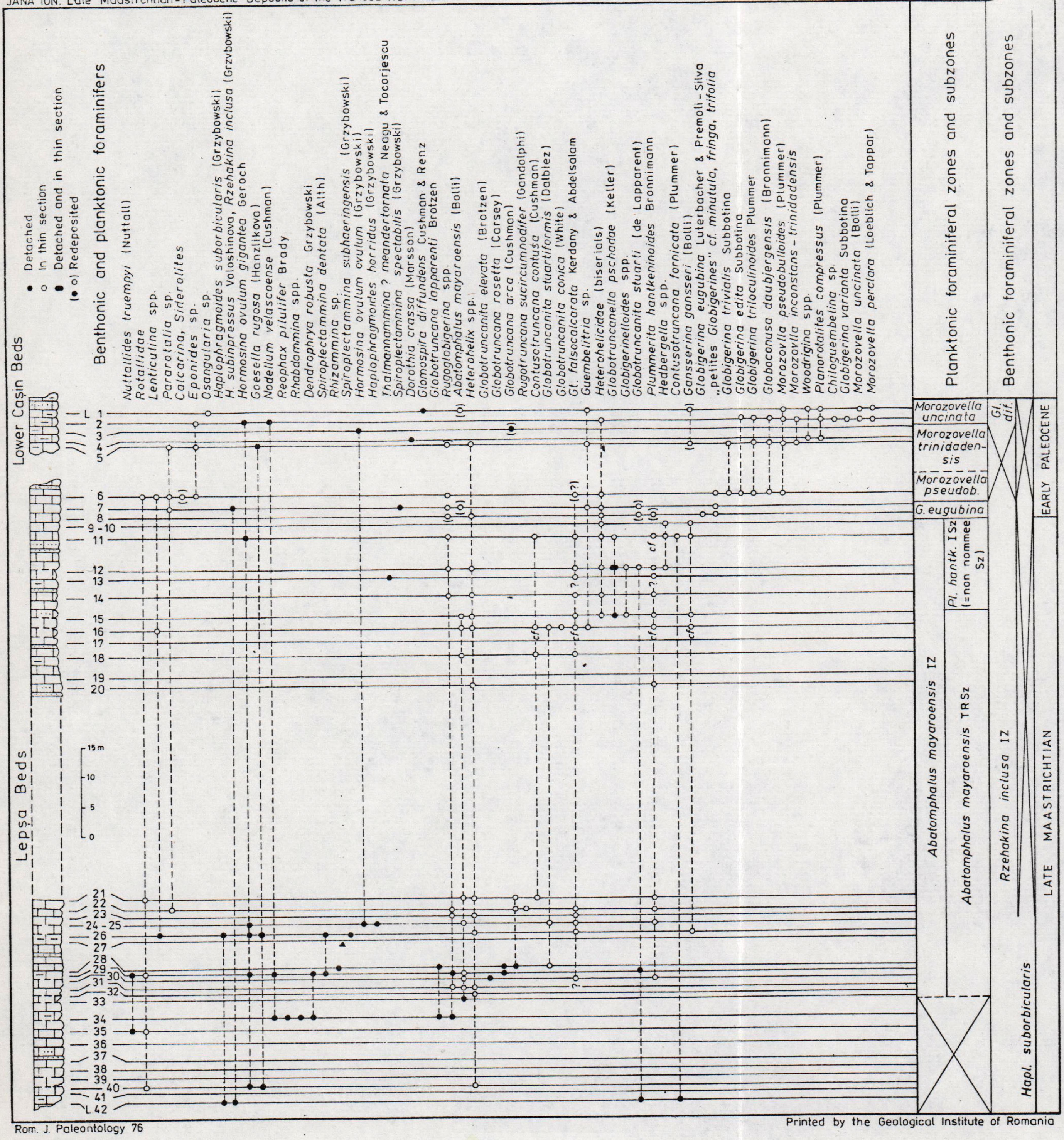
DISTRIBUTION AND BIOZONATION OF THE FORAMINIFERA IN THE LEPŞA BEDS AND LOWER CAŞIN BEDS - LEPŞA VALLEY SECTION

JANA ION. Late Maastrchtian - Paleocene Deposits cf the Vrancea Halfwindow



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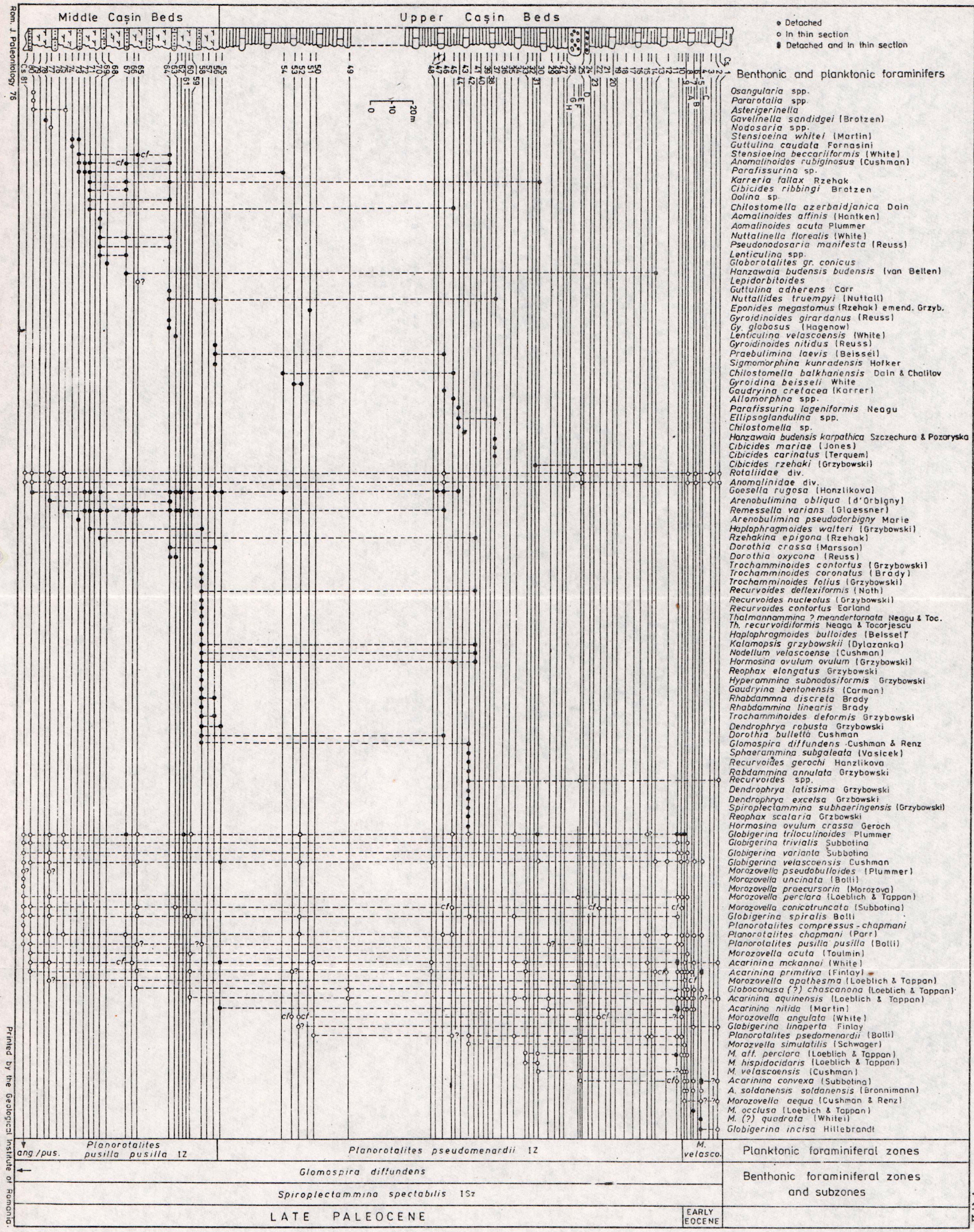
DISTRIBUTION AND BIOZONATION OF THE FORAMINIFERA IN THE MIDDLE CAŞIN BEDS AND UPPER CAŞIN BEDS - PUTNA VALLEY SECTION



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Rom. J. Paleontology, 76, 1995, p. 31–32, Bucharest

A NEW PLANKTONIC FORAMINIFER IN UPPER EOCENE DEPOSITS FROM NORTH TRANSYLVANIA

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Key words: Foraminifera. Upper Eocene. Transylvania. New taxa.

Abstract: The planktonic foraminiferal assemblages in some sections at the Eocene/Oligocene boundary in North Transylvania (Meseş area) contain numerous small hispid globigerinas. They have been described as new species that belongs to a new genus: *Dipsidripella hodisensis*. The taxon described and illustrated in this paper comes from the stratigraphic interval belonging to NP17 zone of foraminifera and to NP21 zone of nannoplankton.

Pelitic deposits from the north-western Transylvanian Basin, belonging lithostratigraphically to the Bryozoan Marls Formation (in west Meseş area) or to the Brebi Marls Formation (in east Meseş area) contain a rich planktonic foraminiferal assemblage.

The planktonic foraminiferal population consists especially of small hispid globigerinas which prevail over other species. It is of note that the species mentioned in this area (Iva & Rusu, 1982) are probably very rare; in fact, the species described and illustrated by the above authors were not found by us.

There were sampled four of the best sections: Valea Berecoaia, near the locality of Mera; Valea Peşterii, west of the village of Hodiş; Valea lui Jolj, near Creaca and Valea Petrindului, Petrind. Our collecting work was carried out with the kind assistence of our colleague Rusu. It was impossible to recognize the taxa and the biozonation proposed in North Transylvania by Iva & Rusu (1982).

Biostratigraphically, the strata containing the spinate globigerinas belong to NP21 Zone of nannoplankton (Martini & Moisescu, 1974) or to P17 Zone of foraminifera (Iva & Rusu, 1982) which chronostratigraphically belong to the Priabonian.

Hispid globigerinas recorded from the abovementioned region are difficult to be assigned to the one known genus. The morphologic features are far from the genera *Muriglobigerina* BLOW or *Testacarinata* JENKINS. With the last one there have been observed some similarities concerning the presence of hispid ornamentation of the test. It differs from *Testacarinata* in lacking the larger spines in equatorial area and by the rounded peripheral margin. For this type of globigerina a new genus is proposed.

Dipsidripella n.g.

Diagnosis. Test small- to medium-sized; chambers globular, inflated, trochospiral, arranged in a low to slightly high spire; suture deep, radial on both sides; peripheral margin rounded, peripheral outline lobated; wall calcareous, finely perforated; surface strongly hispid with regular distributed spines on surface; aperture a low arch, umbilical-extraumbilical.

Etymology. Arbitrary name containing the acronyme of Deep Sea Drilling Project in recognizing the great contribution to the development of paleontological sciences.

Type species. *Dipsidripella hodisensis* n.sp.

Dispidripella hodisensis n.sp.
(Pl. I, figs. 1–9)

Test small, low to slightly high trochopiral, 4–7 chambers on the last whorl; chambers inflated, globular; peripheral margin rounded, peripheral outline lobated; surface coarsely hispid with small irregulary distributed pores; suture deep, radially; aperture a very low umbilical-extraumbilical arch.

Range. The hispid globigerinas were recorded especially from the Paleogene and Eocene and considered as typical of Eocene deposits by some authors (Toumarkine & Bolli, 1975). This group was recorded also from the Oligocene (Stainforth & Lamb, 1981) and described as belonging to the genus *Globorotalia* (but mentioned as reworked material from the Eocene deposits).

In Transylvania, the material is coming from the early Oligocene or the uppermost Eocene, in the upper part of the Brebi Marls Formation.

Type section. Valea Peşterii section, Hodiş, Sălaj district, from the lithological sequence between *Nummulites fabiani* level (at the base) and *Pycnodonte gigantica* level (at the top; see Rusu, 1989).

Age. Late Eocene or earliest Oligocene.

Holotype deposited in Coll. I.G.R.

Remarks. The specimens assigned to this new species were found only in a short stratigraphic interval. The presence of specimens belonging to *Tenuitella gemma* (JENKINS) in the same sample restricted its range to Globorotalia brevis Zone (after Jenkins, 1985) or to Cassigerinella chiploensis-Pseudohastigerina micra Zone (after Bolli et al., 1985).

Some similar specimens were recorded from the South Pacific (Ross Sea) which were described and illustrated as *Globorotalia* sp. (Lecke & Well, 1986, p. 1135, pl. 16, figs. 10–15) from the site 270.

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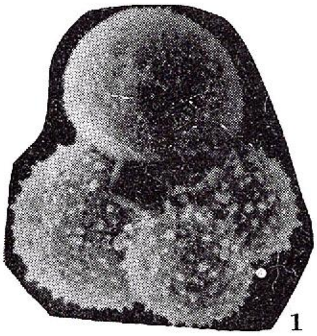
Plate

Figs. 1–12 — *Dipsidripella hodisensis* n. sp. Fig. 1, x 270; fig. 2, x 280; fig. 3, x 350; fig. 4, x 325; fig. 5, Holotype, x 280; fig. 6, x 325, fig. 7, x 290; figs. 8–12, x 380. Valea Peşterii, Hodiş, Cluj district.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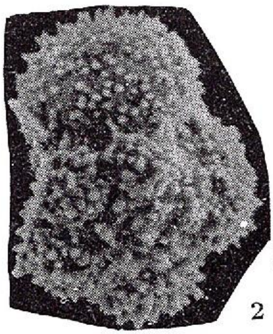
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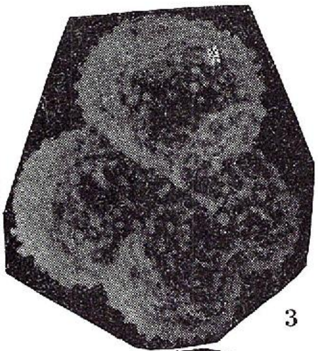
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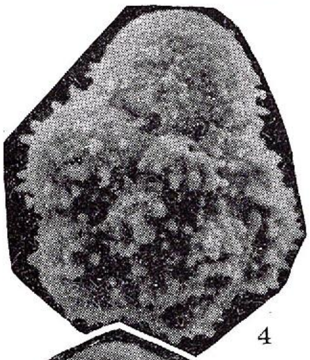
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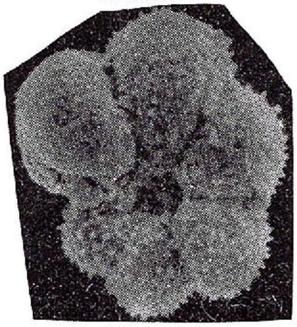
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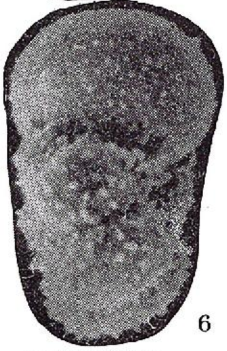
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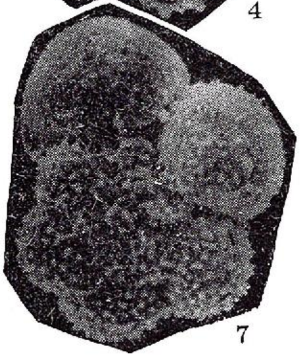
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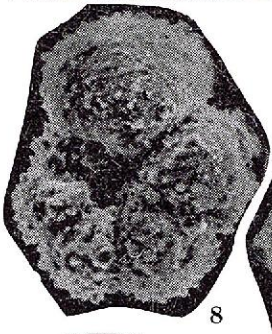
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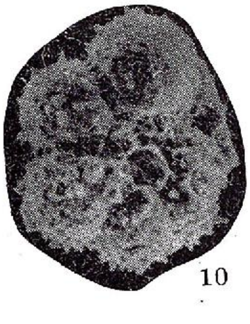
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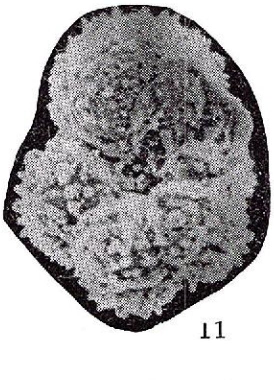
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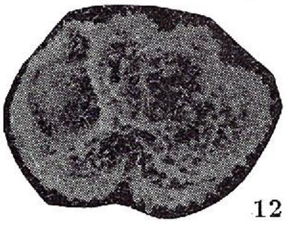
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Rom. J. Paleontology, 76, 1995, p. 33 36. Bucharest

AU SUJET D'UNE LUMACHELLE À MOLLUSQUES DE LA FORMATION DE BISERICANI (LE FLYSCH EXTERNE DES CARPATES ORIENTALES)

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Key words: Eocene. Priabonian. Tarcău Nappe. Bisericani Formation. Mollusques. Calcareous Nannoplankton. Lumachelle.

Abstract: *Consideration on a Molluscan Lumachelle of the Bisericani Formation (External Flysch of the East Carpathians).* A molluscan lumachelle is found in the Bisericani Formation (Larga syncline, Tarcău Nappe). The specimens analysed indicate the Upper Eocene (Priabonian) age. The calcareous nannoplankton content represents zone NP 19 – Isthmolithus recurvus zone – which always indicate the Priabonian.

A la partie supérieure de la formation de Bisericani, (le flanc Est du synclinal de Larga,la nappe de Tarcău), un de nous (Ionesi) a rencontré une lumachelle à mollusques. Cette lumachelle a été découverte à l'intérieur de l'ensemble des roches pélitiques-siltieuses, aux intércalations de grès, qui constituent le fond principal lithologique de la formation de Bisericani (figure).

Le liant des coquilles est pelito-siltique, a une couleur vert-grise, similaire à la formation de Bisericani. L'endroit d'échantillonage se trouve à 90 m épaisseur stratigraphique au-dessous du grès de Ferestrău (3m épaisseur), qui comporte une riche faune a mollusques, surtout des bivalves (Ionesi et Ionesi, 1971). A cette époque, le grès à mollusques a été attribué au grès de Lucăceşti, mais l'existence, sous ce banc, d'une intercalation de schistes dyssodyliques, avec l'épaisseur de 10 cm, nous a permis de faire la réctification nécessaire (Ionesi, 1989).

Le contenu bionomique et la signification biostratigraphique

De la lumachelle décrite ci dessus, on a réussi de dégager et déterminer (Moisescu) 15 taxons, dont la distribution biostratigraphique est mentionné ci-joint (Tableau I). De toute cette liste seulement cinq ont été déterminés avec certitude; pour le reste, à cause d'une mauvaise conservation des principaux caractères, la détermination reste problématique. On a réussi pourtant reconnaître: *Avicularium* sp., *Crenella* sp., *Corbula* sp., *Goniocardium* sp., *Cardita* sp., *Venericardia* sp., *Cardium* sp., *Arca* sp., *Teredo* sp., *Dentalium* sp., *Diplodonta* sp., *Marcia* (*Similivenus*) sp..A ce genres on doit ajouter la présence d'autres groupes de fossiles, déterminés spécifiquement, à savoir: *Atactoporidra brediana* MORREN, *Astreopora minima* d'ARCHIAC, *Calianassa* sp.et *Terebratulina nysti* BOSQUET.

En ce qui concerne la signification biostratigraphique, comme on peut observer du tableau I, les espèces *Arcoperna tenera* et *Cardita astieri* sont localisées dans l'Eocène supérieur; *Chlamys (Aequipecten) biarritzensis bellicostatus* dans l'Eocène supérieur et l'Oligocène inférieur et *Crassostrea cyathula* dans l'Eocène supérieur jusqu'a l'Oligocène supérieur. Il fait exception, et en même temps il contraste, l'espèce *Venus (Ventricoloidea) rhombica* connue de l'Oligocène supérieur. Il n'est pas exclus que l'espèce respective (*Venus rhombica*), commencât son évolution dès l'Eocène, possible dès l'Eocène supérieur. Avec cette observation, les taxons déterminés indiquent un indiscutable Eocène supérieur. Des autres espèces (avec une détermination incertaine), nous constatons que cinq, *Gari (Psammoica)* ex gr. *brevisinuata*, *Venericardia* ex gr.

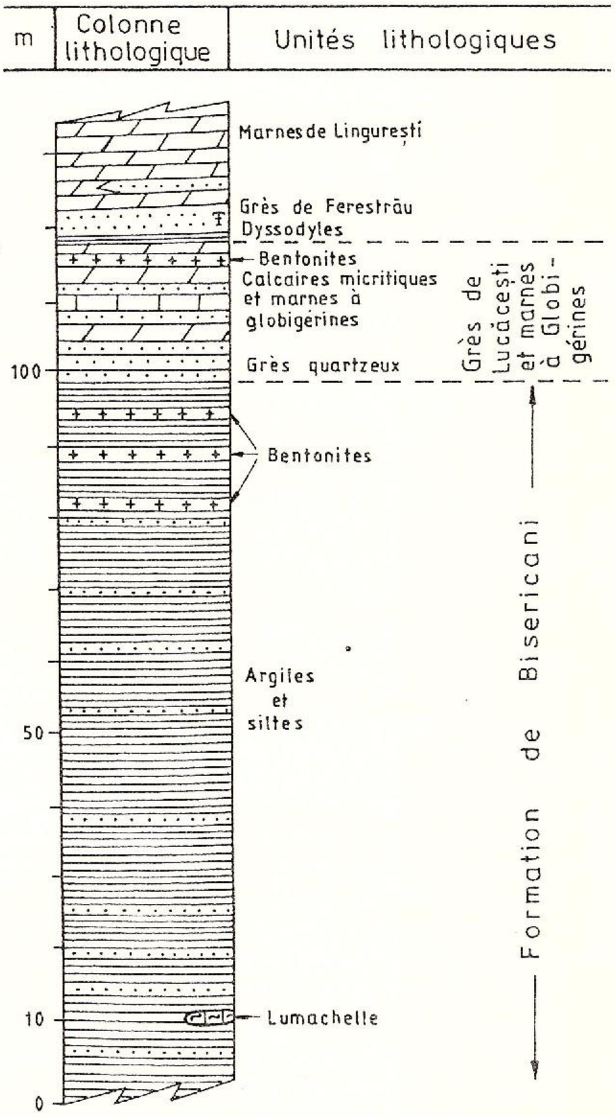

Fig. – La position de la lumachelle dans la formation de Bisericani.

hortensis, *Musculus* ex gr. *dilatatus*, *Fragum* ex gr. *reniforme* et *Vepricardium* ex gr. *hausmanni*, sont connues de l'Eocène supérieur; *Avicularium* ex gr. *aviculare* de tout l'Eocène et *Pholadomya* ex gr. *puchi* et *Ctenoides* ex gr. *eximia* de l'Eocène supèrieur jusqu'au Miocène.

On peut affirmer donc que toutes ces espèces confirment l'âge déjà mentioné ci-dessus. En contradiction sont: *Plicatula* ex gr. *cossmanni* (Eocène inférieur) et *Goniocardium* ex gr. *dubaleni* (Eocène moyen), qui suggèrent soit un remaniement des formations plus anciennes, soit qu'elles aient continué leur évolution jusqu'à l'Eocène supérieur. De tout ce que nous avons présenté, prenant en compte les taxons à détermination certaine, l'âge Eocène supérieur (Priabonien) est attesté pour toute la lumachelle.

On a analisé de surcroît le contenu du nannoplancton (Tab. II, Melinte) qui renferme les espèces: *Sphenolithus moriformis* BRAM. & WILC., *Markalius inversus* (DEFL.) BRAM. & MART., *Transversopontis pulcher* (DEFL.) HAY, MOHLER & WADE, *Zygrhablithus bijugatus* (DEFL.), *Retuculofenestra umbilica* (LEVIN) MART & RITZK., *R. hillae* BUKRY & PERC., *Lanternitus minutus* STRAD., *Cyclicargolithus floridanus* (ROTH & HAY) BUKRY, *Dictiococcites multipora* (KAMP.) MART. et *Cribrocentrum reticulatum* (GART.& SMITH) PERCH-NIELSEN.

L'association du nannoplancton dénote l'âge Eocène supérieur, la biozone NP 19. L'âge Eocène supérieur de la formation de Bisericani n'est pas, d'ailleurs, mis en doute. De la partie supérieure de cette formation ou des formations synchrones (de Plopu et de Podu Secu) on connaît des associations de nannoplancton placées toujours dans la zone de nannoplancton NP 19 ou NP 20 (Martini et Lebenson, 1971; Dicea et Dicea, 1980; Ionesi et Florea, 1982; Florea, 1982; Ionesi et Mészàros, 1989). Evidemment, il s'agit de la partie terminale (les derniers mètres).

De ce que nous avons présenté jusqu'à présent il résulte qu'autant la faune, qui constitue la lumachelle, aussi que le nannoplancton préservé dans cette lumachelle attestent l'âge Eocène supérieur (Priabonien).

La position stratigraphique

Quoique par son contenu bionomique le bloc en discussion revient à l'Eocène supérieur, le fait qu'il ne provient pas d'une couche *in situ*, mais est incorporé dans les roches pélitiques-silteuses, pose quelques questions, dans le sens s'il est ou non contemporain avec les dépôts respectifs.

On peut trouver les situations suivantes:

1. La lumachelle peut être remaniée des formations plus anciennes (Eocène inférieur ou moyen) et résédimentée. En faveur de cette interprétation plaident les espèces *Plicatula* ex gr. *cossmanni* et *Goniocardium* ex gr. *dubaleni*, mais l'incertitude de leur détermination et surtout la prédominance des taxons localisés dans l'Eocène supérieur excluent cette possibilité.

2. En tenant compte du fait que, 90 m en amont, est situé le grès de Ferestrău, dans lequel on a trouvé une riche faune de mollusques (Ionesi et Ionesi, 1966; Ionesi, 1971), on peut supposer que le ruisseau Larga(à l'occasion d'une grande crue) a détaché un grand bloc de lumachelle qu'il a transporté en aval. Cette possibilité est infirmée par la nature des roches respectives.

Tableau 1
Distribution biostratigraphique des espèces de
Mollusques dans les couches de Bisericani

No. crt.	Espèce	E_1	E_2	E_3	O_1	O_3	Mi
1.	*Plicatula* ex gr. *cossmanni* BOURRY in Cossmann, 1887	x					
2.	*Avicularium* ex gr. *aviculare* (LAMARCK, 1805)	x	x	x			
3.	*Goniocardium* ex gr. *dubaleni* VASSEUR in Cossmann, 1921		x				
4.	*Arcoperna tenera* DESHAYES in Cossmann & Pissarro, 1904			x			
5.	*Gari (Psammoica)* ex gr.*brevisinuatus* COSSMANN,1904			x			
6.	*Venericardia* ex gr. *hortensis* (VINASSA de REGNY,1897)			x			
7.	*Cardita (Cardita) astieri* d'ORBIGNY, 1850			x			
8.	*Musculus* ex gr. *dilatatus* (DESHAYES in Cossman & Pissarro, 1904)			x			
9.	*Vepricardium* ex gr. *hausmanni* (PHILIPPI, 1846)			x			
10.	*Fragum* ex gr. *reniforme* (KOENEN, 1893)			x			
11.	*Chlamys (Aequipecten) biarritzensis bellicostatus* (VOOD, 1861)			x	x		
12.	*Crassostrea cyathula* (LAMARCK, 1806)			x	x	x	
13.	*Pholadomya* ex gr. *puschi virgula* MICHELOTTI, 1847			x	x		x
14.	*Ctenoides* ex gr. *eximia* (GIEBEL, 1889)			x	x	x	x
15.	*Venus (Ventricoloidea) rhombicus* COSSMANN, 1921					x	

E_1 = Eocène inférieur
E_2 = Eocène moyen
E_3 = Eocène supérieur
O_1 = Oligocéne inférieur
O_3 = Oligocéne supérieur
Mi = Miocène

Tableau 2
Le Nannoplancton de la lumachelle et des dépôts
pélito-silteux dans lesquelles il est contenu

No. crt.	Nannoplancton Espèce	Echantillons no.			L	B	A
		8297	8296	8295			
1.	*Discoaster deflandrei* BRAMLETTE & RIEDEL	x					
2	*Discoaster barbadiensis* TAN SIN HOK		x				
3.	*Reticulofenestra insignita* ROTH & HAY		x				
4.	*Reticulofenestra hillae* BUCKRY & PERCIVAL	x	x	x	x		
5.	*Reticulofenestra umbilica* (LEVIN) MARTINI & RITZKOWSKI		x	x	x		
6.	*Reticulofenestra scissura* HAY, MOHLER & WADE	x	x	x			
7.	*Reticulofenestra coenura* (REINHARDT) ROTH		x				
8.	*Zygrhablithus bijugatus* (DEFLANDRE)	x	x	x	x		
9.	*Sphenolithus moriformis* (BRÖNIMANN & STRADNER) (BRAMLETTE & WILCOXON)	x		x	x		
10.	*Sphenolithus pseudoradians* BRAMLETTE & WILCOXON		x				
11.	*Sphenolithus predistentus* BRAMLETTE & WILCOXON	x	x				
12.	*Isthmolithus recurvus* DEFLANDRE		x	x	x		
13.	*Lanternitus minutus* STRADNER	x	x	x	x		
14.	*Cyclicargolithus floridanus* (ROTH & HAY) BUCKRY.	x		x	x		
15.	*Markalius inversus* (DEFLANDRE) BRAMLETTE & MARTINI			x	x		
16.	*Coccolithus pelagicus* (WALHICH) SCHILLER			x			
17.	*Transversopontis pulcher* (DEFLANDRE) HAY, MOHLER & WADE			x	x		
18.	*Orthozygus aureus* (STRADNER) BRAMLETTE & WILCOXON			x			
19.	*Helicosphaera reticulata* BRAMLETTE & WILCOXON			x			
20.	*Braarudosphaera bigelowi* (GRAN & BRAARUD) DEFLANDRE		x				
21.	*Blackites spinosus* (DEFLANDRE & FERT) HAY & TOWE	x					
22.	*Dictyococcites bisectus* ROTH				x		
23.	*Discolithina multipora* (KAMPTNER) MARTINI				x		
24.	*Cribrocentrum reticulatum* (GARTNER & SMITH) PERCH-NIELSEN				x		

L= Lumachelle
B= Biozone, NP_{19}
A= Âge, Eocène supérieur

Ainsi, la lumachelle a une matrice pélitique-silteuse, caractéristique de la formation de Bisericani, pendant que le grès de Ferestrău fût quartzeux. De plus, la lumachelle n'a pas été trouvée au niveau de l'eau, à 2 m en haut, contenue dans les dépôts pélito-silteux. La nature différente de la lithologie et cette localisation excluent le transport.

3. La troisième possibilité: la faune est contemporaine avec les dépôts qui la renferme, mais provient de deux domaines differents de sédimentation, leur association étant accidentelle. Les organismes, dont les coquilles constituent la lumachelle, ont eu la source dans la zone de shelf, où ils avaient les meilleurs conditions de vie, étant ensuite transportés par les courants de turbidité, dans le bassin plus profond,où s'est accumulée la formation de Bisericani. En tenant compte de ses caractères lithologiques de flysch distal, prédominants pélito- silteux, cette formation s'est accumulée en continuation du shelf, possible vers l'extrémité du piémont, atteint seulement accidentellement par les bioclastes.

Il surprend l'absence d'un flysch proximal, avec du matériel épiclastique grossier et de nombreux bioclastes, synchrone à celui distal. Un recouvrement tectonique, ou une consommation sont exclues.

En conclusion, nous considérons que la lumachelle est contemporaine avec le niveau pélito-silteux de la formation de Bisericani, niveau dans lequel elle a été identifiée. La faune de mollusques qui constitue la lumachelle aussi que le nannoplancton attèstent l'âge Eocène supérieur (Priabonien).

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CALCAREOUS NANNOPLANKTON IN THE EOCENE DEPOSITS OF THE TAZLĂUL SĂRAT VALLEY BASIN (OUTER FLYSCH OF THE EAST CARPATHIANS)

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Key words: Eocene. Ypresian. Lutetian. Outer Flysch. East Carpathians. Tarcău Nappe. Tazlău Facies. Leşunţ Facies. Calcareous. Nannoflora.

Abstract: In the present paper three profiles of the Tazăul Sărat Valley area with deposits of Lower and Middle Eocene age have been studied. The nannoplankton assemblages have pointed out a rich and very well-preserved nannoflora which indicates the presence of the NP_{12}–NP_{17} zones, representing the Lower Ypresian-Upper Lutetian interval.

There are a few studies based on the calcareous nannoplankton from the Eocene deposits of the East Carpathians flysch.

Thus, Bratu and Gheţa (1972) carried out a study of the Upper Paleocene-Upper Eocene formations in the Leurza Valley (Şotrile Facies) based both on the calcareous nannoplankton and on the planktonic foraminifera. Unfortunately, the outlining of the nannoplankton zones could not be achieved continuously because of the lack of nannoflora corresponding to the interval between the NP_{15} and NP_{19} zones, the Middle and Upper Eocene boundary, inclusive.

The present paper includes a study from the East Carpathians External Flysch based on nannoplankton in three profiles in the Tazlăul Sărat Valley Basin: Pârâul lui Manole, Tazlăul Sărat Brook (at the confluence with the Topliţa Brook) and Pârâul Sec.

The Eocene deposits cropping out in the mentioned three profiles belong both to the Tazlău Facies (Băncilă, 1940; Atanasiu, 1943) and to the Leşunţ Facies (Constantin et al., 1990, unpubl. data); they are the only ones in the study area with exposures good for an adequate sampling.

The study of the samples taken off from the mentioned profiles under the optical and electronic microscopes pointed out a rich nannoflora, with typical and well-preserved species.

The Straja Beds, cropping out at their upper part in the Tazlăul Sărat Brook (Fig. 3), are mainly represented by green, hard, fine-grained quartz sandstones, as beds of 0.10–0.15 cm, locally with many micaferous calcareous sandstones in alternation with decimetric banks represented by greenish, grey or bluish red clays. Sandstones are generally silicified, the whole formation displaying in the described profile obvious crushing marks as a result of a nearby fault.

The samples collected from the upper part of the Straja Beds indicated a nannoplankton assemblage specific to the NP_{12} zone – Tribrachiatus orthostylus zone, Brönimann et Stradner (1960) emend Bukry (1973 a) of Lower Eocene age (middle part of the Ypresian).

The zone was separated based on a rich nannoplankton assemblage with: *Tribrachiatus orthostylus* SHAMRAI, *Discoaster lodoensis* BRAMLETTE et RIEDEL, *D. barbadiensis* TAN SIN HOK, *D. binodosus* MARTINI, *D. saliburgensis* STRADNER, *D. kuepperi* STRADNER, *Zygrhablithus bijugatus* (DEFLANDRE), *Rhabdosphaera solus* PERCH-NIELSEN, *Lophodolithus nascens* BRAMLETTE et SULLIVAN, *L. reniformis* BRAMLETTE et SULLIVAN, *Reticulofenestra dictyoda* (DEFLANDRE in DEFLANDRE et PERT) STRADNER in STRADNER et EDWARDS, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Discoaster bifax* BUKRY.

It is of note the presence of *Discoaster bifax* BUKRY in the mentioned assemblage. The first appearance of this discoasterid was cited as starting from the bottom of NP_{16} zone, concomitantly with the first occurrence of the species *Reticulofenestra umbilica* LEVIN (PERCH-NIELSEN, 1985 b). Steurbaut (1989), in his studies of calcareous nannoplankton from the stratotype of d'Aalter sands (NW Belgium), pointed out that the occurrence of this species had preceded the occurrence of the species *R. umbilica* (probably NP_{15} zone). Köthe et al. (1988) mentioned the appearance of the species *D. bifax* at the lower part of the Ypresian (NP_{11} zone). The samples collected by us from the Straja

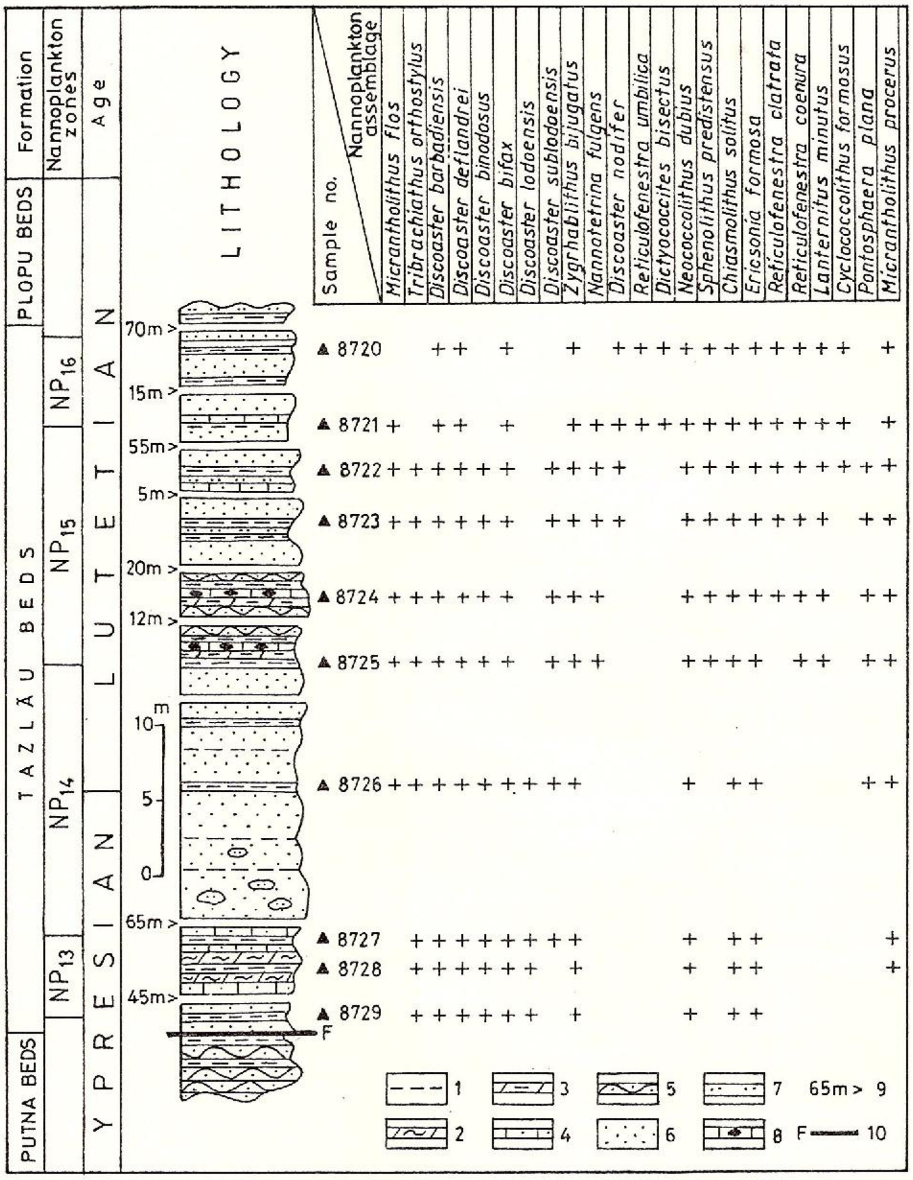

Fig. 1 – Middle-Lower Eocene deposits in the Pârâul lui Manole and the nannoplankton assemblage: 1, clays; 2, marly limestones; 3, marly limestones with fucoids; 4, sandy biosparites; 5, convolute sandy biosparites; 6, Tarcău-type micaferous sandstones with trace fossils; 8, argillaceous micrites with chaille; 9, observation gap; 10, fault.

Beds (their uppermost part) revealed the presence of the following species: *Discoaster bifax, Tribrachiatus orthostylus, Rhabdosphaera solus, Discoaster lodoensis*, which indicate the occurrence of the species in the middle part of the Ypresian in comparison with the upper part of the Lutetian where it was already known.

Among the numerous and diverse species of calcareous nannoplankton the discoasterids predominate, which display a great variety and morphology. The same diversity of the discoasterids at the Ypresian level is also found in the Polish Carpathians (Birkenmayer, Dudziak, 1988).

The Tazlău Beds, in the Părăul lui Manole and Toplița (Tazlăul Sărat) brooks, display a wide petrographic variety (Figs. 1, 3). The main lithological types are represented by: massive micaferous sandstones, as metric banks, more or less cemented, of Tarcău-type, in association with "hieroglyphic beds".

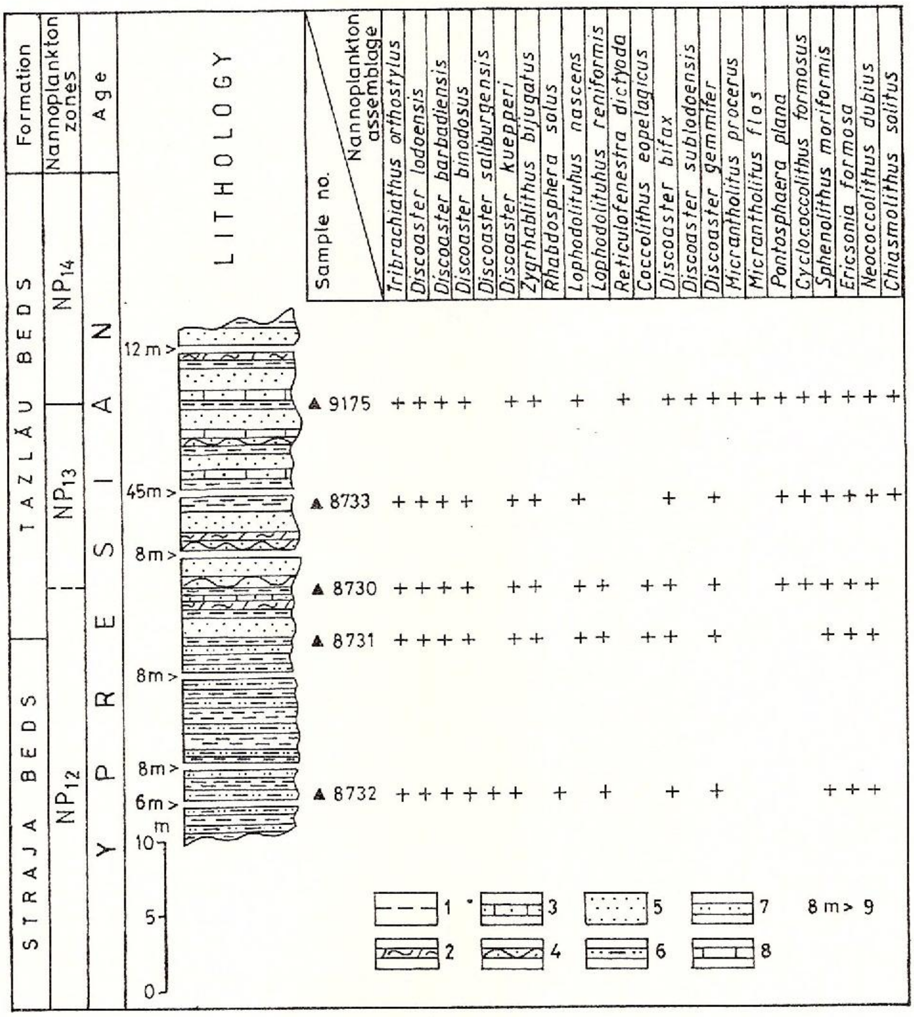

Fig. 2 – Lower Eocene deposits in the Tazlăul Sărat Brook (at the confluence with the Toplița Brook) and the nannoplankton assemblage: 1, clays; 2, marly limestones with fucoids; 3, sandy biosparites; 4, convolute sandy biosparites; 5, Tarcău-type micaferous sandstones; 6, green fine quartz sandstones; 7, calcareous micaferous sandstones; 8, argillaceous micrites; 9, observation gap.

Locally, the Tarcău-type sandstones are of 20–25 m thick and display harder spherical centimetrical zones, included in a friable sandstone resembling poorly cenented sands. The "hieroglyphic beds" are represented by thin, centimetric calcareous or subquartzous sandstones, in alternation with green clays. They occur in association with rhythms, more or less complete, consisting of sandy biosparites, very often with greenschists fragments in the base of "chaille" in the middle part which, towards the upper part, grade into clayey micrites and sandy marls or grey-greenish clays. Marly limestones with small fucoids, as centimetric beds, occur as well.

At the lower part of the Tazlăul Beds, at about 10 m above the boundary between these beds and the Straja Beds the samples gathered pointed out a nannoflora corresponding to the nannoplankton NP_{13} zone – Discoaster lodoensis Zone, Brönimann et Stradner (1960) emended Bukry (1973).

The nannoplankton assemblage is fairly rich, including beside the existing species new ones: *Discoaster gemmifer* STRADNER, *Cyclococcolithus formosus* KAMPTNER, *Pontosphaera plana* (BRAMLETTE et SULLIVAN) HAQ., *Micrantholithus procerus* BUKRY et BRAMLETTE, *M. flos* DEFLANDRE. Likewise, *Tribrachiatus orthostylus* is still present. It is of note the extinction of the species *Rhabdosphaera solus* and modifications as regards the number of arms of the species *Discoaster lodoensis* (from eight to seven or most frequently six).

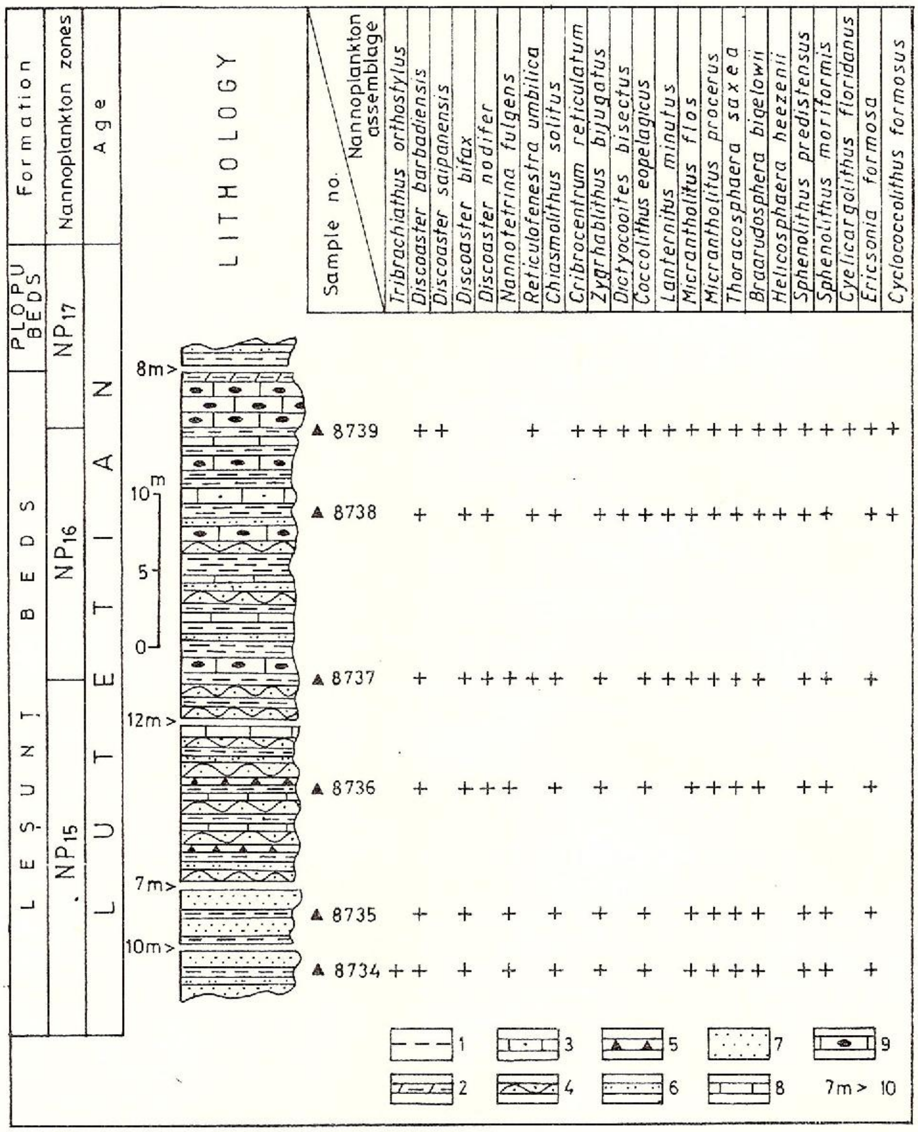

Fig. 3 - Middle Eocene deposits in the Pârâul Sec (left side) and the nannoplankton assemblage: 1, clays; 2, marly limestones with fucoids; 3, sandy biosparites; 4, convolute sandy biosparites; 5, microconglomerates with green schists; 6, calcareous sandstones with hieroglyphs; 7, Scorbura-type quartz sandstones; 8, argillaceous micrites; 9, micrites with chaille; 10, observation gap.

This assemblage is of Lower Eocene age (upper part of the Ypresian).

Above this nannoplankton zone within a restricted stratigraphic interval in the Părăul lui Manole, in the Tazlău Beds, the nannoplankton NP_{14} zone - Discoaster sublodoensis Zone (authors Hay, 1964; Bukry, 1973 a) could be identified. Within this nannoplankton zone the Ypresian/Lutetian boundary is located.

The coexistence in the nannoplankton assemblage of the species *Discoaster lodoensis* BRAMLETTE & RIEDEL and *Discoaster sublodoensis* BRAMLETTE & SULLIVAN is a certain proof of the presence of the NP_{14} Zone.

The occurrence of the species *Nannotetrina fulgens* (STRADNER) ACHUTAN & STRADNER, points out the existence of the NP_{15} zone, corresponding to the Middle Eocene (middle part of the Lutetian). The NP_{15} Zone - Nannotetrina fulgens, authors Hay in Hay et al. (1967) emend Martini (1970 a) et Bukry (1973 a), is well developed within the Tazlău Beds (Manole Brook).

Within the nannoplankton assemblage beside other taxa the species *Discoaster sublodoensis* and *Tribrachiatus orthostylus* are preserved, while the species *Discoaster lodoensis* disappeared.

Towards the upper part of the Tazlău Beds, the NP_{16} Zone – Discoaster tanii nodifer, authors Hay et al. (1967) emend Martini (1970 a), corresponding to the Middle Eocene (Lutetian) could be separated on the basis of the nannoplankton assemblage. Common species are: *Discoaster nodifer* (BRAMLETTE et RIEDEL) BUKRY, *D. barbadiensis* TAN SIN HOK, *D. bifax* BUKRY, *D. deflandrei* BRAMLETTE et RIEDEL, *Reticulofenestra umbilica* LEVIN, *Sphenolithus predistensus* BRAMLETTE et WILCOXON, *Zygrhabilithus bijugatus* (DEFLANDRE), *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Braarudosphaera bigelowii* (GRAN et BRAARUD) DEFLANDRE, *Thoracosphaera saxea* STRADNER, *Neococcolithus dubius* (DEFLANDRE) BLACK, *Coronocyclus nitescens* (KAMPTNER) BRAMLETTE et WILCOXON, *Cyclococcolithus formosus* KAMPTNER, *Sphenolithus moriformis* (BRÖNIMANN et STRADNER) BRAMLETTE et WILCOXON, *Lanternithus minutus* STRADNER, *Chiasmolithus solitus* (BRAMLETTE et SULLIVAN) LOCKER, *Reticulofenestra clatrata* (ROTH et HAY), *Reticulofenestra coenura* (REINHARDT) ROTH, *Ericsonia formosa* (KAMPTNER) HAQ.

The Leşunţ Beds are represented in the Pârâul Sec profile (Fig. 2) (the left side) by a schistous sandy flysch with Scorbura-type quartz sandstones included in a "hieroglyphic beds"-type flysch, with calcareous sandstones, marls and grey clays.

At the upper part of the profile occurs, on a thickness of about 40 m, a succession of more or less complete rhythms of convolute sandy biosparites (0.40-0.60 m thick) with greenschists microconglomerates at the bottom, which grade into fine, yellow micrites with siliceous accidents (0.10–0.15 m) and millimetrically bedded green clays, 0.30–0.40 m thick. Marly limestones with fucoids are locally present within these clays.

In places, the grey-yellowish micritic limestones reach 2-3 cm in thickness and present "chaille" (Pasieczna-type limestones).

The first samples taken off from the Leşunţ Beds (left side of Paraul Sec) indicated nannoplankton assemblages similar to those described in the Manole Brook (Tazlău Beds). On the basis of the assemblages determined the NP_{15} and NP_{16} zones were separated within the Leşunţ Beds.

At the uppermost part of the Leşunţ Beds, 10 m below the Plopu Beds, the nannoplankton assemblage determined is represented by the taxa: *Neococcolithus dubius* (DEFLANDRE) BLACK, *Discoaster barbadiensis* TAN SIN HOK, *D. saipanensis* BRAMLETTE et RIEDEL, *D. deflandrei* BRAMLETTE et RIEDEL, *D. nodifer* (BRAMLETTE et RIEDEL) BUKRY, *Zygrhablithus bijugatus* (DEFLANDRE), *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Reticulofenestra umbilica* LEVIN, *Lanternithus minutus* STRADNER, *Cribrocentrum reticulatum* (GARTNER et SMITH) PERCH-NIELSEN, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Coccolithus oclagicus* (WALLICH) SCHILLER, *Sphenolithus predistensus* BRAMLETTE et WILCOXON, *Micrantholithus flos* DEFLANDRE, *M. procerus* BUKRY et BRAMLETTE, *Sphenolithus moriformis* (BRÖNIMANN et STRADNER) BRAMLETTE et WILCOXON, *Braarudosphaera bigelowi* (GRAN et BRAARUD) DEFLANDRE, *Thoracosphera saxea* STRADNER, *Helicosphaera heezenii* BUKRY.

This nannoplankton assemblage is representative for the NP_{17} zone – Discoaster saipanensis Zone (Martini, 1970 a), corresponding to the upper part of the Middle Eocene.

Conclusion

The samples taken off from the three described profiles pointed out the nannoplankton NP_{12}–NP_{17} zones, lying within the stratigraphic interval between the Middle Ypresian and the Upper Lutetian.

A study of the data presented emphasized that the top of the Straja Beds is situated in the NP_{12} zone (Upper Ypresian).

These data are not in agreement with those obtained based on the planktonic foraminifera (Oituz Valley) concerning the boundary between the Straja Beds and the Tazlău Beds (Bratu, in Săndulescu et al., 1987) according to which this boundary occurs in the Lower Ypresian. Nevertheless, our data are in agreement with those provided by the study of foraminifera and spore-pollen (Bratu and Ionescu, in Săndulescu et al, 1988, unpubl. data) which situated the top of the Straja Beds in the Lower Ypresian.

The Tazlău Beds occupy a wide stratigraphic interval, ranging between the NP_{13} and NP_{16} zones (Upper Ypresian-Upper Lutetian). It is possible that, at the terminal part, below the Plopu Beds, the NP_{17} zone occurs, too (in the studied profile - Manole Brook, the last 65 m of the Tazlău Beds are not exposed).

In the Leşunţ Beds, NP_{15}, NP_{16} and NP_{17} zones (the last even at the uppermost part of the beds, immediately below the Plopu Beds) could be separated.

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Plate I

Fig. 1 — *Tribrachiatus orthosthylus* SHAMRAI; *Discoaster bifax* BUKRY; LT phase-contrast light x 2700.

Fig. 2 — *Micrantholithus procerus* BUKRY and BRAMLETTE; LT cross-polarized light x 2500.

Fig. 3 — *Nannotetrina fulgens* (STRADNER) ACHUTHAN and STRADNER; LT phase-contrast light x 2500.

Figs. 4–5 — *Discoaster lodoensis* BRAMLETTE and RIEDEL; LT phase-contrast light x 2500.

Fig. 6 — *Discoaster gemmifer* STRADNER; LT phase-contrast light x 2500.

Fig. 7 — *Pontosphaera plana* (BRAMLETTE and SULLIVAN) HAQ; LT cross-polarized light a) 45^0; b) 0^0 x 3000.

Fig. 8 — *Discoaster sublodoensis* BRAMLETTE and SULLIVAN; LT phase-contrast light x 2500.

Fig. 9 — *Micrantholithus flos* DEFLANDRE; LT a) cross-polarized light x 3000; b) phase-contrast light x 3000

Fig. 10 — *Zygrhablithus bijugatus* (DEFLANDRE) DEFLANDRE; LT cross-polarized light x 2500.


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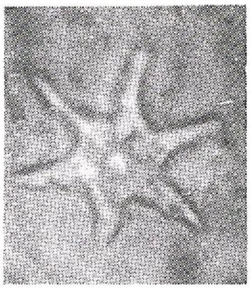
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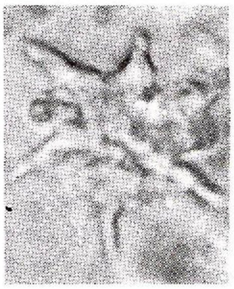
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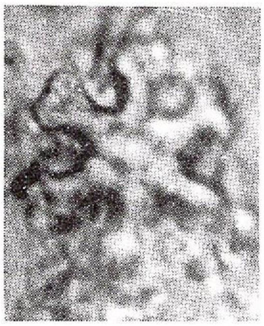
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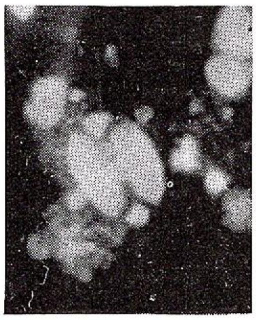
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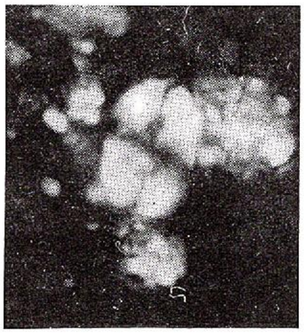
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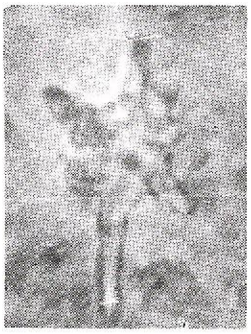
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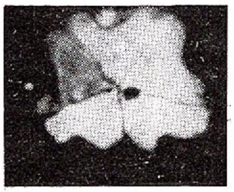
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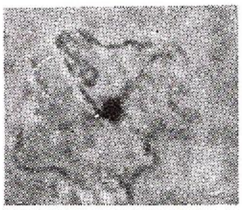
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Plate II

Fig. 1 — *Cyclococcolithus formosus* KAMPTNER; SEM x 6500.

Fig. 2 — *Discoaster binodosus* MARTINI; SEM x 10,000.

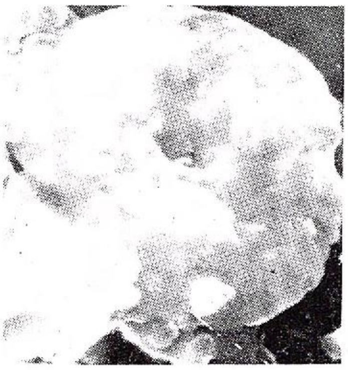
Fig. 3 — *Coccolithus pelagicus* (WALLICH) SCHILLER: SEM x 7500.

Fig. 4 — *Discoaster sublodoensis* BRAMLETTE and SULLIVAN; SEM x 9000.

Fig. 5 — *Rhabdosphaera solus* PERCH-NIELSEN; a) LT cross-polarized light x 3000; b) LT phase-contrast light x 3000.

Plate II

M. MELINTE, P. CONSTANTIN – CALCAREOUS NANNOPLANKTON IN EOCENE DEPOSITS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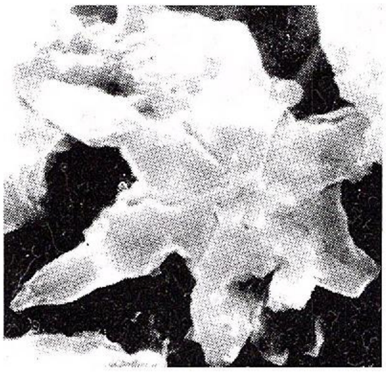
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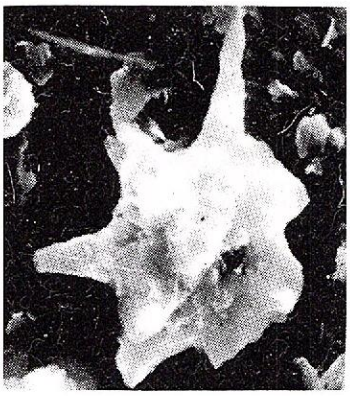
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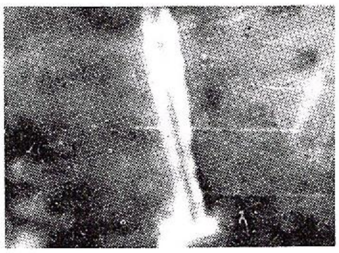
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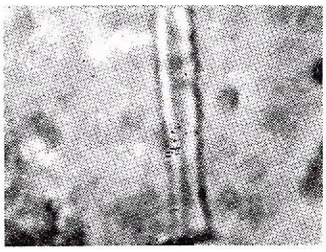
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CONTRIBUTIONS TO THE KNOWLEDGE OF THE MOLLUSCAN AND ECHINOID FAUNAS FROM THE IGHIU BEDS IN THE BILAG HILL (ALBA IULIA, SW TRANSYLVANIA)

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Key words: Paleogene. Merian. Mollusca. Echinodermata. Merian Zones of NW Transylvania.

Abstract: We have identified twenty-two taxa, among which three are similar to those determined previously and nineteen (17 molluscan and 2 echinoid species) are identified in the study area for the first time. Even the mentioned fauna does not include the two zonal markers (*Tympanotonos labyrinthum* and *Ampullinopsis crassatina*) of the Merian, it surely pertains to that interval, on the ground of the very similar faunal inventory reported by Mészáros (1969) from the Ighiu Beds at the type locality, where these markers have been identified.

The Alba Iulia area is the place where the southernmost occurrences of the Paleogene deposits of NW Transylvania are to be found.

In this area the Paleogene and Neogene deposits occurring in the Bărăbanţ-Sard-Ighiu-Sântimbru zone have been studied by relatively few researchers, among which Koch (1894, 1900), Roth v. Telegd (1906), Gherman (1943), Ilie (1943, 1953, 1955), Bombiţă (1963), Mészáros, Băluţă, Speck (1969), Băluţă (1974), and Suraru and Băluţă (1983).

Lists with molluscan species coming from Ighiu Beds have been drawn up by Roth v. Telegd (1906) (13 taxa), Gherman (1943) (20 taxa), and Mészáros et al. (1969) (14 taxa).

The paleontologic samples presented in this paper were kindly given to us by Popescu (the colleague from the Geological Institute of Romania to whom we address all our gratitude). These samples come from the Ighiu Beds in the Bilag Hill, located north of the Alba Iulia town, where the Eocene and Oligo-Miocene deposits, with a fairly rich fossiliferous content, occur in an almost continuous succession.

Even if this fauna is poorly preserved, twenty molluscan and two echinoid taxa have been identified. If we compare our inventory with the lists drawn up by the authors mentioned above, we observe that only three taxa are in common: *Natica* sp., *Terebellum fusiforme* and *Terebellum* sp. (see Table). The other nineteen (17 molluscs and 2 echinoids) taxa are identified in this area for the first time.

The molluscan specimens from the Ighiu Beds in the Bilag Hill indicate both the Eocene and the Oligocene. Taking into account that Mészáros et al. (1969, p. 315), reported from the Ighiu Beds, at the type-locality, specimens of *Polymesoda convexa* (BRONGNIART), *Tympanotonos labyrinthum* (NYST) and *Ampulinopsis crassatina* (LAMARCK), which define zone PSM_7 – T. labyrinthum – A. crassatina (Moisescu, 1989), typical of the Oligocene and Merian, we consider that the fauna in the Bilag Hill, although devoid of zonal markers, indicates the same time span.

The annexed table presents the local geographical distribution of the fauna described in this paper.

Table with molluscan and echinoid faunas from the Mera Beds
in the Bărăbanţ-Şard-Ighiu-Sântimbru area (Alba Iulia)

No.	Denomination of the species	Bărăbanţ	Şard	Bilag Hill	Ighiu
1	2	3	4	5	6
	I. Mollusca				
1.	*Nucula (Lamellinucula) comta* GOLDFUSS, 1837			x	
2.	*Pinna margaritacea* LAMARCK, 1806^{x}				x
3.	*Anomia ephippium* LINNE, 1766			x	
4.	*Crassostrea cyathula* (LAMARCK, 1806)	x			
5.	*Crassostrea* sp.			x	
6.	*Lucina lugeoni* BOUSSAC, 1911			x	
7.	*Fimbria* cf. *lamellosa* (LAMARCK, 1806)			x	
8.	*Laevicardium cingulatum* (GOLDFUSS, 1837)			x	
9	*Cardium sandbergeri* GUMBEL in WOLFF, 1897			x	
10.	*Cardium* n.sp.^{x}				x
11.	*Cardium* sp.^{x}				x
12.	*Tellina* aff. *tenuilamellosa* NYST, 1836			x	
13.	*Tellina paulini* DESHAYES, 1857	x			
14.	*Tellina* sp.^{x}				x
15.	*Polymesoda (Pseudocyrena) convexa* (BRONGNIART, 1811)			x	
16.	*Callista villanovae* (DESHAYES in STUDER, 1853)			x	
17.	*Venericardium suessi* (KOENEN, 1893)^{x}				x
18.	*Venericardia hortensis* (VINASSA DE REGNY, 1897)^{x}				x
19.	*Venericardia* sp.^{x}				x
20.	*Astarte* sp.			x	
21.	*Tapes* cf. *clandestinus* BAYAN, 1870			x	
22.	*Corbula (Caryocorbula)* ex. gr. *pixidicula* DESHAYES, 1857	x	x		
23.	*Panope angusta* NYST, 1836			x	
24.	*Panope* sp.			x	
25.	*Pholadomya puschi trigona* WOLFF, 1897			x	
26.	*Angaria* sp.			x	
27.	*Hydrobia* sp.			x	
28.	*Turritella* sp.			x	
29.	*Melanopsis* sp.			x	
30.	*Tympanotonos labyrinthum* (NYST, 1836)			x	
31.	*Cerithiella* sp.			x	
32.	*Campanile* cf. *lachesis* (BAYAN, 1870)			x	
33.	*Xenophora* cf. *agglutinans* LAMARCK, 1804			x	
34.	*Xenophora* cf. *gravesiana* d'ORBIGNY, 1850			x	
35.	*Rimella* cf. *fissurella labrosa* SOWERBY, 1823			x	
36.	*Rimella* sp.^{x}				x
37.	*Terebellum fusiforme* LAMARCK, 1804	x			x
38.	*Terebellum* sp.			x	x
39.	*Globularia patula brabantica* GLIBERT, 1933^{x}				x
40.	*Ampullinopsis crassatina* (LAMARCK, 1804)			x	
41.	*Amaurellina (Crommium) mutabilis* (SOLANDER in BRANDER, 1766)^{x}				x
42.	*Cepatia cepacea* (LAMARCK, 1804)^{x}				x

1	2	3	4	5	6
43.	*Euspira* cf. *helicina* (BROCCHI, 1814)			x	
44.	*Sigatica (Sigaretopsis) infundibula* WATELET, 1853)[x]				x
45.	*Natica millepunctata* LAMARCK, 1822			x	
46.	*Natica* sp.	x		x	x
47.	*Ficus* sp.			x	
48.	*Ancilla (Ancillaria) suturalis* (BONELLI, 1826)			x	
49.	*Vexillum (Uromitra)* cf. *cupressinus* BROCCHI, 1814)			x	
50.	*Athleta (Volutispina) ambigua* (SOLANDER in BRANDER, 1766)[x]				x
51.	*Athleta (Neoathleta) suturalis* (NYST, 1836)[x]				x
52.	*Athleta (Neoathleta) lineolata* (DESHAYES, 1853)[x]				x
53.	*Athleta (Neoathleta)* ex. gr. *depressa* (LAMARCK, 1803)[x]				x
54.	*Turbonilla edwardsi* GILBERT, 1938[x]				x
	II. Echinoids				
55.	*Pygorhynchus delbosi* DESOR in AGASSIZ, 1848[x]				x
56.	*Eupatagus* (?) sp.[x]				x

[x] specimens of mollusca and echinoids remarked in the Bilag Hill for the first time.

3, Bărăbanţ; 4, Şard; 5, Ighiu; 6, Bilag Hill

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Plate I

Fig. 1 — *Pinna margaritacea* LAMARCK, 1806 (x 1).

Fig. 2 — *Cardium* n.sp. (x 2).

Fig. 3 — *Cardium* sp. (x 3).

Figs. 4 — *Tellina* sp. (x 1,3).

Fig. 5 — *Venericardia hortensis* (VINASSA de REGNY, 1897) (x 3).

Fig. 6 — *Venericardia suessi* (KOENEN, 1893) (x 3).

Figs. 7, 12 — *Globularia patula brabantica* GLIBERT, 1933 (x 1).

Figs. 8 a, b; 9 — *Cepatia cepacea* (LAMARCK, 1804) (x 1,7).

Figs. 10, 11 — *Amaurellina (Crommium) mutabilis* (SOLANDER in BRANDER, 1766) (x 1,5).

Fig. 13 — *Sigatica (Sigaretopsis) infundibula* (WATELET, 1853) (x 2,5).

Figs. 14 a, b — *Athleta (Neoathleta)* ex. gr. *depressa* (LAMARCK, 1803) (x 1,6).

Figs. 15 a, b — *Athleta (Neoathleta) lineolata* (DESHAYES, 1853) (x 1).

Plate I

V. Moisescu, N. Mészàros – Molluscan and Echinoid Faunas from the Ighiu Beds


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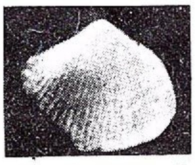
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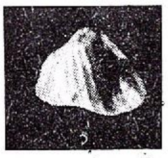
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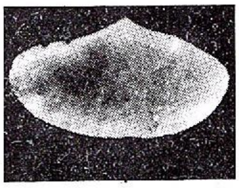
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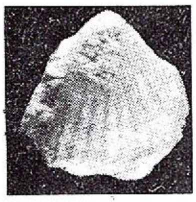
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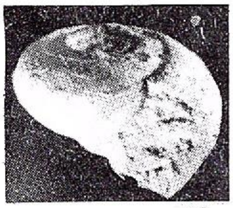
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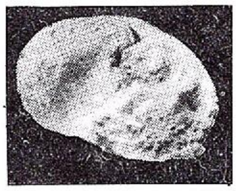
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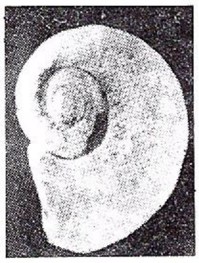
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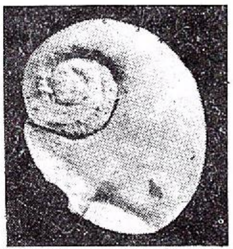
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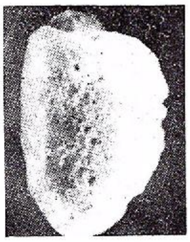
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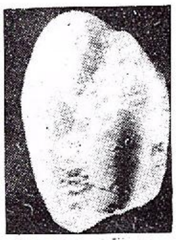
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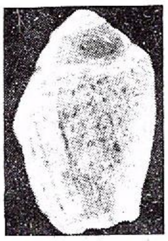

15a


15b

Plate II

Figs. 1 a, b — *Athleta (Neoathleta) suturalis* (NYST, 1836) (x 1).

Figs. 2 a, b — *Athleta (Neoathleta) lineolata* (DESHAYES, 1853) (x 1).

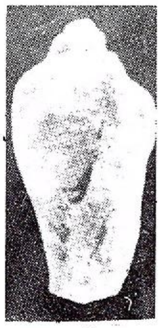
Figs. 3 a, b — *Terebellum fusiforme* LAMARCK, 1804 (x 1).

Fig. 4 — *Turbonilla edwardsi* GLIBERT, 1938 (x 1,3).

Figs. 5 a, b — *Athleta (Volutispina) ambigua* (SOLANDER in BRANDER, 1766) (x 1,5).

Figs. 6 a, b — *Pygorhynchus delbosi* DESOR in AGASSIZ, 1848 (x 1).

Fig. 7 — *Eupatagus* sp. (x 1).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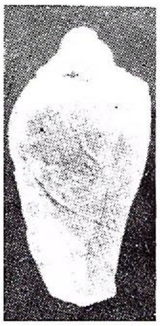
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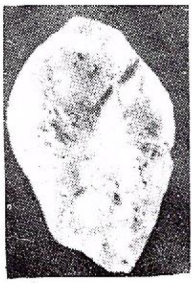

2a

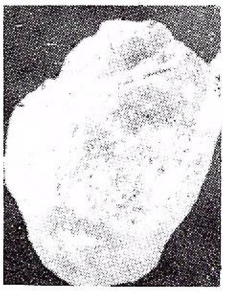

2b


3a


3b


4


5a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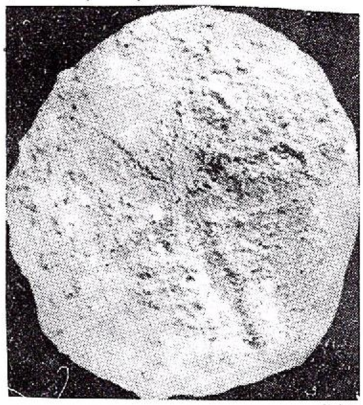
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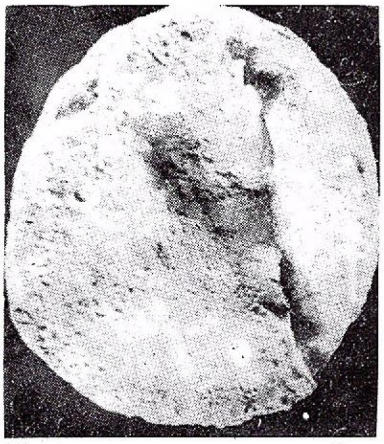
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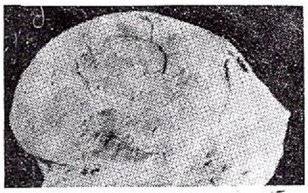
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PALEOCLIMATIC MEANING OF PALEOGENE MOLLUSCA IN NW TRANSYLVANIA (ROMANIA)

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Key words: Molluscs. Paleoclimate. Water temperature. Shelf domain. Paleogene. NW Transylvania.

Abstract: The analysis of the molluscan assemblages pointed out the existence of two climathemes: a warm climate phase in the Upper Lutetian-Priabonian, attested by the presence of the thermophile forms from the group of nautiloids, strombids, terebellids, neritids, xenophorids, vulsellids, crassatelids, chamids, spondylids etc., and a cold climate phase in the Rupelian-Chattian, marked by the appearance of the genera indicating cold waters, such as: *Glossus, Glycymeris, Nucula, Nuculana, Arctica, Cancellaria, Polinices* and others. The water temperatures of shallow shelf decreased from about 25° C in the Upper Lutetian, corresponding to the warm subtropical zone, to annual mean temperatures of below 15° C, 10 Ma later (after two temperature drops during the Early Rupelian), characteristic of the warm temperate zone, temperatures which presumably are maintained in the Late Rupelian and in most of the Chattian.

The changes in the composition of marine organisms assemblages in the course of time are due to numerous factors (salinity, depth, nature of the floor, sedimentary type, turbulence, basin configuration, marine currents, food abundance etc.), of which the climatic one, sometimes ignored, plays an important role.

This paleoclimatic study is based on the analysis of the molluscan faunas – the best known group of organisms from the Paleogene deposits of the Transylvania "basin". Many of them are known as eurythermal forms, which are able to adapt themselves to a very large climatic belt, while some species or even entire families are restricted either to cold (boreal or arctic) or warm (tropical-subtropical) waters, using them as climatic indicators. Therefore there were selected the taxa with paleoclimatic meaning from my collection, from the collection of the Museum of Paleontology-Stratigraphy (Babeş-Bolyai University of Cluj-Napoca) as well as from the published studies (Koch, 1894; Mészáros, 1957; Mészáros, Nicorici, 1962; Vlaicu-Tătărim, 1963; Mészáros et al. 1969, 1987, 1989; Moisescu, 1972; Rusu, 1977; Mészáros, Moga, 1987) that might give indications on the water temperature.

For such a selection the general data provided by the treatises of ecology and paleoecology are not sufficient, and there are few studies dealing with this subject. Some of them belong to Chavan, 1947; Palmer, 1967; Stauch, 1968, 1972; Piccoli, 1984; Golikov, 1985; Amitrov, 1986; Piccoli et al., 1987, and Popov, 1989, being used in the preparation of the present note.

The Paleogene marine sedimentation in NW Transylvania began about 43 Ma ago, towards the end of the Lutetian, with the Foidas Gypsum Formation (restrictive facies with supratidal evaporites) that includes a lumachelle with Anomia - bivalve characteristic of warm waters. There follow the Căpuş Beds, the first richly fossiliferous marine euhaline formation, marked by the presence of large-sized nummulits (constituting the Nummulites perforatus Level) of Biarritzian type. Here occurs a highly diversified molluscan fauna comprising numerous tropical and subtropical forms. Thus **Nautiloidea** are represented by the genera *Cimomia* and *Nautilus*; **Gastropoda** are represented by strombids (*Tibia* cf. *athleta, T. ampla* and *Rimella fissurella*), terebellids (*Terebellum fusiforme, T. sopitum*), neritids with *Velates perversus* GMELIN (= *V. schmidelianus* (CHEMNITZ)), harpids with *Harpa mutica*, xenophorids and melogenids, each with two species, and cerithids with *Clava striata* (Fig.). Some of the important thermophile **Bivalvia** are vulsellids, crassatelids, chamids, and the ostreid *Sokolowia eszterhazyi* (PÁVAY), a typical mesogean species forming real lumachelles. Global paleoclimatic studies (see Savin, 1977, Barron, 1985; Velitschko, 1987; Kennett, Barker, 1990 etc.) show that the Cainozoic climatic optimum took place 45–43 Ma ago, in the Upper Lutetian, a moment followed by a gradual decrease in temperature in the rest of the Eocene. The temperature investigations made by Berlin et al.

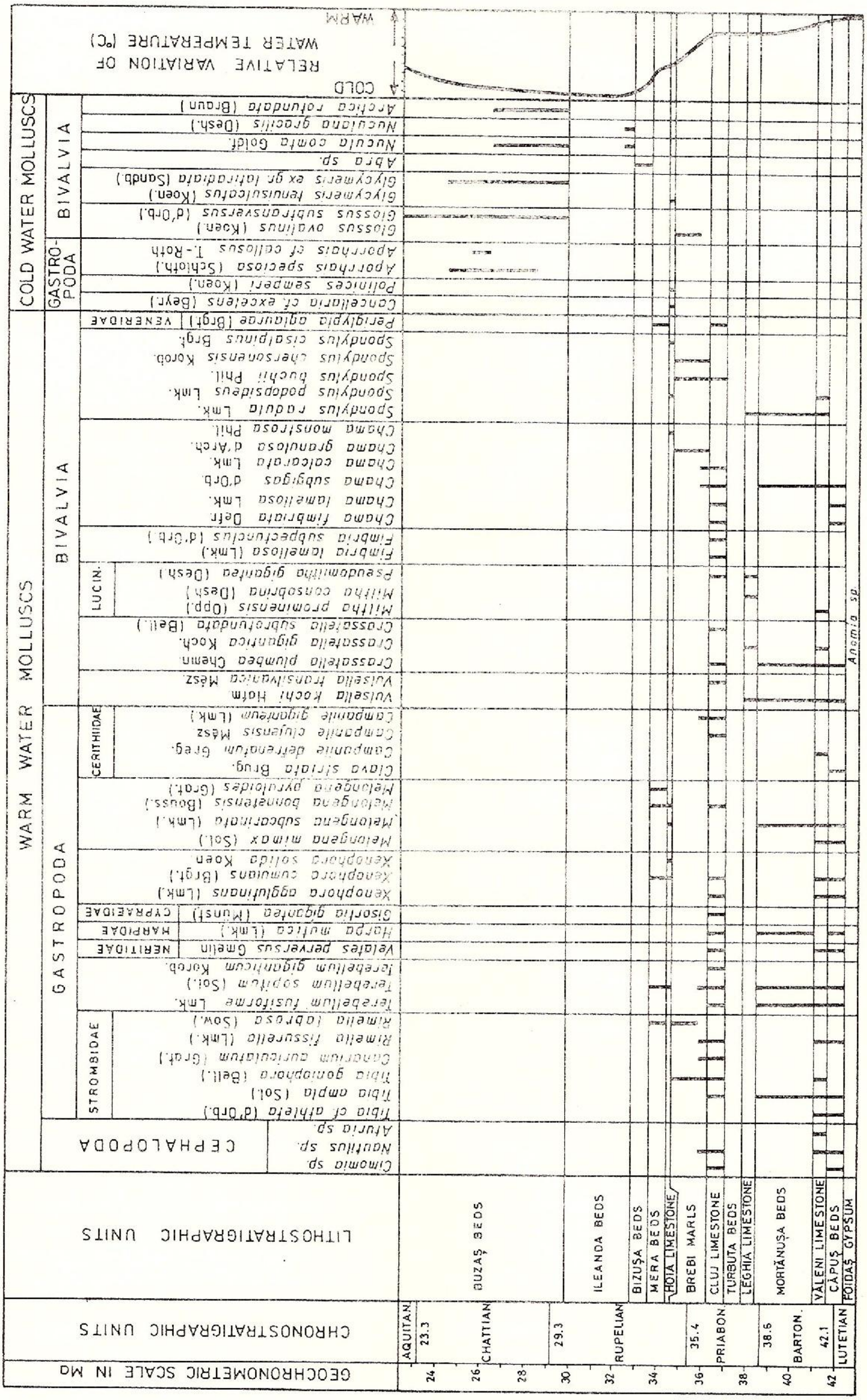

Fig. – Distribution of climatic-indicative Molluscs in Paleogene Formations from North-west Transylvania

(1976) through the Ca/Mg method on nummulit tests (of *Nummulites perforatus* MONTF. inclusively) from the Middle Eocene of Hungary indicated temperatures of 21.4–25^{0}C, considered valid by me also for the waters on the Transylvanian shelf. These values place the Carpatho-Pannonian area in a warm subtropical zone, at the boundary with the tropical one. The slow temperature decrease during the Bartonian and Priabonian from the Tethyan region is not evident based on molluscs in Transylvania, the exuberant development of some faunas at certain levels, due to the local paleoecological conditions, giving the impression of some warming moments. Thus, at the level of the Văleni Limestones from the Early Bartonian, the warm water assemblages are diversified (Fig.) through the first appearance of the genus *Aturia* within cephalopods, and spondylids among bivalves: *Spondylus radula* and *S. podopsideus* LMK. (=*S. bifrons* MÜNSTER). Strombids and crassatelids are better represented both as number of species and as individuals, and the *Velates perversus* populations proliferate in the littoral facies, a reason why this calcareous member was previously named the "Velates Limestone".

At the level of the Cluj Limestone from the Middle Priabonian, all the above presented thermophile groups from the basin are to be found beside some new ones (Fig.). It is to note also the occurrence of the species *Gisortia gigantea* belonging to the most thermophile genus of cypraeids, and of *Canarium auriculatum*, recorded from the Alba Iulia region (Mészáros et al., 1969), belonging to strombids. It is worth specifying that the genus *Strombus*, the most rigorous marker of high-temperature, is lacking from the Paleogene of Transylvania, the specimen labelled as "Strombus chersonensis Fuchs" from the museum of the Cluj University representing in fact a volutilid – *Athleta chersonensis* (FUCHS). The large-sized forms of cerithids (*Campanile giganteum* and *C. clujensis*) as well as of some species belonging to other families proliferate. Bivalves are represented by frequent chamids and vulsellids (*Vulsella* even constitute a lumachelle horizon), and another two warm-water genera occur: *Fimbria* and *Periglypta*.

Following the local distribution of the taxa, it is found that up to the basal part of the Brebi Marls (including also the Nummulites fabianii Level), the stenotherm forms of warm subtropical climate abound, the species indicating cold waters lacking altogether. They first appear within the Brebi Marls concomitantly with the global cooling recorded at the Eocene-Oligocene boundary (Savin, 1977; Poore, Matthews, 1984; Murphy, M., Kennett, J. P., 1985; Pomerol, Premoli-Silva, 1986). In the Brebi Marls-Mera Beds time-span (latest Priabonian-Early Rupelian) the most thermophile molluscs as well as other groups of organisms such as nummulits and hermatypic corals gradually disappear from the basin, while immigrants from northern Europe occur within an assemblage which still preserves its mesogean feature. It is worth mentioning as cold water molluscs the species: *Cancellaria* cf. *excelens*, *Polinices semperi*, *Glossus ovalinus*, *Glycymeris tenuisulcatus* and *Angulus nysti* (Fig.). The climate continues to deteriorate during the Upper Rupelian, when a glacioeustatic drop in the sea level led to the isolation on the territory of central and eastern Europe of the Solenovian Sea, marking the first separation of the Paratethys (Protoparatethys phase, Rusu, 1988). This isolation resulted in the decrease of the water salinity to 9–16.5 $^0/_{00}$ (pliohaline environment) which led to the appearance of some endemic faunas of brackish molluscs, difficult to estimate from the climatic point of view. Influxes of euhaline marine waters at certain levels within the Ileanda Beds (Upper Rupelian) attest the resumption of some episodic connections with the cold-water basins of northern Europe. The presence of such species as *Nucula comta* and *Nuculana gracilis* points to a cooling of the waters to annual mean temperatures below 15^{0}C, close to the present day ones from the temperate zones (at the boundary with the cold subtropical zones). The conditions achieved at the end of the Rupelian are preserved also in the Chattian, the northern influences being marked in the lower half of the Buzaş Beds by species such as *Apporhais speciosa*, *Glossus subtransversus*, *Glycymeris* ex gr. *latiradiata*, *Arctica rotundata* etc. (Fig.), some of which do not bear temperatures over 16–18^{0}C. Towards the end of the Chattian the climatic conditions were slightly improved, reaching the subtropical optimum at the level of the Coruş Beds (Aquitanian), with the well-known eggenburgian faunas (Large Pecten Horizon) of Indo-Pacific origin.

The bioprovincial distribution of the whole ensemble of molluscan faunas does not reflect with fidelity the climatic variations, depending on some other factors, too. However, this distribution appears significant throughout the interval, becoming very eloquent at a few levels. Thus in the Mortănuşa Beds (Bartonian) there are 42% Mediterranean species, 58% species common to the mesogean and northern domains (many of which are of mesogean origin) and no taxon exclusively located in the northern domain; in the Hoia Beds (Lower Rupelian) there are 45% Mediterranean species, 45% forms common to the two domains, and 10% northern species; in the Chattian sequence of the Buzaş Beds (except the fauna at the level of the Coruş Beds) only 13% Mediterranean species occur, 59% being common taxa and 28% strictly northern species.

It can be concluded that in the Upper Lutetian-Chattian time-span (approximately 20 Ma) the mollusc faunas point to two climathemes in Transylvania as follows: a warm climate phase (thermochron) in the Upper Lutetian-Priabonian, and a cold climate phase (kryochron) in the Rupelian-Chattian (which is followed by another improvement of the climate in the Aquitanian). Starting from temperatures of the shallow shelf waters of ca. 25^0C, corresponding to the warm subtropical zone (at the boundary with the tropical one), after two temperature drops during the Rupelian, annual mean temperatures below 15^0C were reached, characteristic of the warm-temperate zone (at the boundary with the cold subtropical zone). This climatic variation is due both to the cooling of the global climate and to the regional paleogeographic changes from Central Europe.

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ÉTUDE DE LA FAUNE DE TEREBRATULINES DES COUCHES DE BREBI DE PETRINZEL (NO DE LA TRANSYLVANIE)

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Key words: Paleogene. Priabonian.Brachiopoda. Terebratulina. Systematics.

Abstract: *The Study of Terebratulids from the Brebi Beds from Petrinzel (Cluj Region - NW Transylvania)* It was pointed out the existence of 9 taxa, among which some are new. It is the matter of *Terebratulina tenuilineata* (BAUDON in Deshayes, 1860), *T. putoni* (BAUDON in Deshayes, 1860), *T.* ex. gr. *striatula* SOWERBY, 1829, *T. petrinzelensae* n. sp. MOISESCU, *T. bayani transylvanica* n. ssp. MOISESCU, *T. bayani* n. ssp., *T.* n. sp. and *T.*sp.

L'étude des Terebratulines de la formation de Brebi du Bassin de la Transylvanie a été abordée par Trifan, 1970, qui a indiqué deux espèces: *Terebratulina squamulosa* et *T. tenuilineata.* Au cours du prélévement de mollusques des couches de Brebi de Petrinzel, nous avons identifié, à côté des nombreuses autres formes, 9 taxons de *Terebratulina*: *Terebratulina tenuilineata* (BAUDON in Deshayes, 1860), *T. squamulosa* (BAUDON in Deshayes, 1860), *T. putoni* (BAUDON in Deshayes, 1860), *T.* ex gr. *striatula* SOWERBY, 1829, *T. petrinzelensae* n.sp. MOISESCU, *T. bayani transylvanica* n. ssp. MOISESCU, *T. bayani* n. ssp., *T.* n. sp. et *T.* sp.

Description paléontologique

1. *Terebratulina tenuilineata* (BAUDON in Deshayes, 1860)

(Pl., figs. 1 a, b).

Terebratula tenuilineata BAUDON (Deshayes, 1860, pl. LXXXVII, figs. 28-31).

Terebratulina tenuilineata (BAUDON) (Cossmann, 1904,p. 249, pl. XX, figs. 25-26: Trifan, 1970, p. 109, fig. 3 texte).

Observations. C'est un spécimen de petite taille de *T. tenuilineata*, de moins 6 mm en hauteur, semblable à celui illustré par Deshayes (pl. LXXXVII, figs. 28-31). La ressemblance concerne la taille, le contour des deux valves, la forme et la position du foramen. Quant à la comissure frontale de la valve brachiale, elle est légèrement arrondie, et non aplatié comme chez Cossmann (pl. XX, figs. 25-26) et Trifan (fig. 3, texte).

2. *Terebratulina squamulosa* (BAUDON in Deshayes, 1860)

(Pl., figs. 2 a, b).

Terebratula squamulosa BAUDON (Deshayes, 1860, pl. LXXXVII, fig. 16-18).

Terebratulina squamulosa (BAUDON) (Cossmann, 1904, p. 349, pl. XX, figs. 22-24; Trifan, 1970, p. 108, fig. 2, texte).

Observations. Le spécimen que nous avons trouvé est mal conservé, sans ornementation. La taille est petite, avec moins de 5mm de hauteur, comparable aux illustrations presentées par Deshayes et Cossmann; il ressemble aussi aux les deux espèces de Koenen, *Terebratulina rudis* et *T. fasciculata* (1894), dont il diffère par le contour des valves.

3. *Terebratulina putoni* (BAUDON in Deshayes, 1860)

(Pl., figs. 3 a, b).

Terebratula putoni BAUDON (Deshayes,1860, pl. LXXXVI, figs. 16-21).

Observations. La valve brachiale de *Terebratulina*, avec l'appareil apophysaire visible et avec une ornementation extérieure identique avec celle des formes de *T. putoni* illustrées par Deshayes, nous l'avons attribuée à cette espèce, qui est un peu plus arrondie.

4. *Terebratulina* ex gr. *striatula* (SOWERBY, 1829)
(Pl., figs. 4 a, b).

Terebratula striatula SOWERBY (Oppenheim, 1901, p. 258, pl. XV, figs. 15, 15 a).

Observations. Deux exemplaires de *Terebratulina* de très petite taille nous les avons attribué au groupe de l'espèce *T. striatula*, étant donné le contour des valves.

5. *Terebratulina petrinzelensae* n.sp. MOISESCU
(Pl., figs. 5 a, b; 6 a, b).

Derivation nominis: selon le nom de la localité d'origine.

Locus typicus: Petrinzel (région de Cluj).

Stratum typicum: les couches de Brebi.

Holotypus: Pl., figs. 5 a, b, coll. I.G.R., 18578.

Paratypus: Pl., figs. 6 a, b, coll. I.G.R., 18579.

Matériel d'étude: 2 spécimens.

Diagnose. Formes biconvexes, de petite taille, à contour ovale-allongé, à comissure frontale de la valve brachiale rectibordée et celle pédonculaire légèrement sulquée. L'ornementation des valves est formée de nombreuses stries radiaires et de rares bandes concentriques, faiblement visibles.

Dimensions (mm):

	hauteur	largeur	angle apical
Holotype:	8	5	55^0
Paratype:	11	7	57^0

Description. Formes de petite taille, biconvexes, à contour ovale-allongé. La valve brachiale présente le bord frontal rectibordé et celui pédonculaire, faiblement sulqué. Le foramen, mésothyridide, de forme circulaire, est ouvert vers la pointe du crochet. L'ornementation est formée de nombreuses stries radiaires (50 environs sur chaque valve) et de bandes concentriques rares, plus fréquentes dans la zone frontale.

6. *Terebratulina bayani transylvanica* n. ssp.. MOISESCU
(Pl., figs. 7 a, b; 8 a, b; 9 a, b; 10 a, b; 11 a, b; 12 a, b).

Derivatio nominis: du nom du Bassin de la Transylvanie.

Locus typicus: Petrinzel (environs de Cluj).

Stratum typicum: les couches de Brebi.

Holotypus: pl., figs. 7 a, b, coll.I.G.R., 18574.

Paratypus: pl., figs. 8 a, b, 9 a, b, 10 a, b, 11 a, b, 12 a, b, coll. I.G.R., 18575.

Matériel d'étude: 7 exemplaires.

Diagnose: Formes biconvexes de taille petite et moyenne, à contour ovale-souspentagonal, faiblement bombées dans la région du crochet, aux valves couvertes par de nombreuses stries radiaires.

Dimensions (mm):

	hauteur	largeur	angle apical
Holotype:	9,5	7,0	59^0
Paratypes:	12,0	9.0	65^0
	10,0	8,0	62^0
	10,0	8,0	63^0
	10,0	7,5	64^0
	10,0	8,0	65^0
	9,0	7,0	62^0

Description. Formes biconvexes de taille petite et moyenne, à contour ovale-souspentagonal, faiblement bombées dans la zone du crochet. La comissure frontale de la valve pédonculaire est sulquée. Le crochet présente une pointe aiguë; celui de la valve brachiale est faiblement développé, avec une petite pointe. Le foramen permésothyridide, circulaire, est placé immédiatement à côté de la pointe du crochet de la valve brachiale. Les carènes latérales sont courtes et les plaques diltidiales (le symphytium) ne sont pas observables. Les valves sont couvertes par des nombreuses (70–80 environs) stries radiaires, sur chaque valve, intersectées par de rares bandes concentriques.

Observations. Selon la forme des valves et l'ornementation, les spécimens decrits de *Terebratulina* ressemblent à *T. bayani* OPENHEIM. Ils en diffèrent par la taille, qui ne dépasse pas 12 mm en hauteur (aux individus de *T. bayani* presentés par Openheim arrivant jusqu'à 15–16 mm). De l'autre côté, les formes de *T. bayani transylvanica* n. ssp. présentent un crochet plus aigu, et la comissure frontale de type sulqué. Finalement, les stries radiaires des valves sont plus serrées aux spécimens qui proviennent des marnes de Brebi.

7. *Terebratulina bayani* n. ssp.
(Pl., figs. 13 a, b).

Description. Forme biconvexe, de petite taille, à contour ovale-souspentagonal, avec la valve pédonculaire visiblement bombée au crochet. Le foramen permésothyridide, circulaire, situé tout près du crochet. Les valves sont couvertes par de nombreuses stries radiaires et de rares bandes concentriques. Le bord frontal de la valve pédonculaire est sulqué.

Dimensions (mm):

hauteur	largeur	angle apical
12	10	72^0

La différence de la forme nominative regarde la forme de la coquille, avec la moitié inférieure élargie et avec le fossé frontal développé sur la valve pédonculaire; le crochet est un peu plus aïgu qu'à *T. bayani* et l'angle apical est plus petit (70–72^0 au lieu de 80–85^0 à *T. bayani*).

8. Terebratulina n.sp.
(Pl., figs. 14 a, b).

Observations. Un exemplaire de térébratulide de très petite taille, mal conservé, au contour particulier, nous l'avons attribué au genre *Terebratulina.* Il présente une inflexion en extérieur à la moitié supérieure des valves, qui l'éloigne de l'aspect général, ovale des térébratulides. Les deux valves et le foramen permésothyridide, montrent qu'il s'agit d'un nouveau taxon de *Terebratulina.*

9. Terebratulina sp.
(Pl., fig. 15).

Observations. La valve pédonculaire faiblement convexe; nous n'avons qu'un moulage, comparable au genre.

Les térébratulides des couches de Brebi sont peu nombreuses; elles sont accompagnées par des anthozoaïres, vers, échinodermes, bryozoaïres, mollusques, crustacés, etc. La plus frequente est *T. bayani transylvanica* n.spp.; on peut la considerer même une zone, d'âge priabonien (ou mérien), correspondant à la zone de nannoplancton NP 21 (qui caractérise les couches de Brebi) (Martini, Moisescu, 1974).

Il faut noter que les espéces: *T. tenuilineata, T. squamulosa, T. putoni* et *T.* ex gr. *striatula* sont citées de l'Eocène du Bassin de Paris et de la Loire inférieure, tout comme de l'Eocène supérieur de l'Italie de Nord.

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Planche

Figs. 1a, b — *Terebratulina tenuillineata* (BAUDON in Deshayes, 1860) (x 2,3).

Figs. 2 a, b — *Terebratulina squamulosa* (BAUDON in Deshayes, 1860) (x 2,2).

Figs. 3 a, b — *Terebratulina putoni* (BAUDON in Deshayes, 1860) (x 2,3).

Figs. 4 a, b — *Terebratulina* ex. gr. *striatula* (SOWERBY, 1829) (x 2,3).

Figs. 5 a, b; 6 a, b — *Terebratula petrinzelensae* n. sp MOISESCU (figs. 5 a, b-holotype, x 3; figs. 6 a, b-paratype, (x 2,3).

Figs. 7 a, b; 8 a, b; 9 a, b; 10 a, b; 11 a, b; 12 a, b — *Terebratulina bayani transylvanica* n. ssp. MOISESCU (figs. 7 a, b- holotype, x 2,2; figs.8 a, b; 10 a, b-paratypes, x 2,2; figs. 9 a, b; 11 a, b; 12 a, b - paratypes, x 2).

Figs. 13 a, b — *Terebratulina bayani* n. ssp. (x 2).

Figs. 14 a, b — *Terebratulina* n.sp. (x 2).

Fig. 15 — *Terebratulina* sp. (x 2).


1a


1b


2a


2b


3a


3b

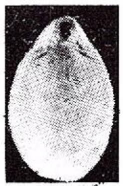

4a


4b


5a


5b


6a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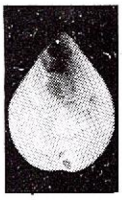
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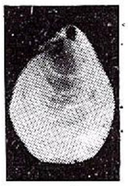
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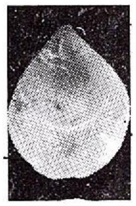
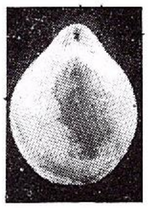

8a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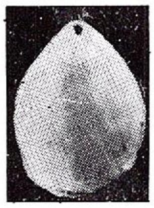
9a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10a

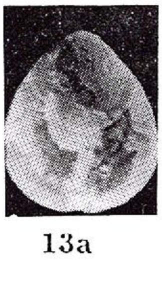

10b


11a


11b


12a


12b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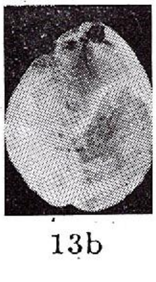
13b


14a


14b


15

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ON THE PRESENCE OF THE ICHNOGENUS RHIZOCORALLIUM IN THE VRANCEA OLIGOCENE

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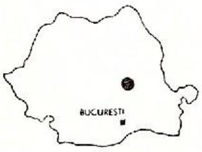

Key words: Ichnofossils. Sedimentary structures. Flysch. East Carpathians - Outer Flysch Zone. Vrancea Mountains.

Abstract: The paper points out the presence of the ichnogenus *Rhizocorallium* in the Kliwa Sandstone Formation from the Omagu "rabotage" outlier (Marginal Folds Unit, Vrancea Mountains). The presence of this biogenic sedimentary structure (trace fossils) demonstrates the existence of some moments of intense activity of a population of benthonic organisms (annelids?, crustaceans) on a semiconsolidated clastic substratum under conditions of perfect aeration of the floor of the sedimentary basin corresponding to the infralittoral stage. The identification of the ichnogenus *Rhizocorallium* in the Kliwa Sandstone Formation adds one more argument to the previous opinions (Preda, 1917; Grozescu, 1917; Macovei, 1958), according to which the sedimentation of this formation took place in a shallow marine basin.

Introduction

The Oligocene in flysch facies from the East Carpathians is macropaleontologically known by a rich fossil fauna consisting of fishes, molluscs, insects as well as plants (algae, vascular cryptograms). Pointed out by Protescu (1927), the "worm traces" from the dysodilic Oligocene have been recently identified in the Upper Dysodile Shales (Alexandrescu and Brustur, 1987) and in the Vineţişu and Podu Morii Formations hosting the ichnocoenosis with *Sabularia* (Alexandrescu, 1986, Alexandrescu & Brustur, 1984), considered an ichnostratigraphic marker (Alexandrescu et al., 1993). The present note points out for the first time the presence of the ichnogenus *Rhizocorallium* within the Oligocene deposits of Vrancea, attempting at the same time to decipher the paleoenvironmental significance of this interesting biogenic sedimentary structure.

Summary Geological Data

The region in which the occurrence with *Rhizocorallium* has been identified belongs to the Marginal Folds Unit (Vrancea), situated in the spring zone of the Şuşiţa Valley (Fig. 1 A). According to Dumitrescu (1952, 1963), the following lithostratigraphic entities appear in the region: Black Shale Formation (=Streiu Beds), Valanginian-Albian in age, Tisaru and Lepşa Formations (Upper Cretaceous), Caşin, Piatra Uscată and Buciaş Formations of Paleocene-Middle Eocene age, the latter being followed by the Bisericani and Lucăceşti Formations (Upper Eocene). The Oligocene is represented by the bituminous facies deposits with Kliwa Sandstone, namely the bituminous brown marls, Lower Dysodiles, Kliwa Sandstone and Upper Dysodiles.

Structurally the Marginal Folds Unit in this sector is characterized by eastward overturned folds that belong, according to Dumitrescu (1963), to the internal (=Greşu) digitation and to the external (=Cozia) digitation. Immediately northwards this unit is overthrust by the Tarcău Unit. It is worth mentioning that the front part of the Marginal Folds Unit, between Tulnici and Soveja, is complicated by the presence of the Moceanu and Omagu "rabotage" outliers consisting only of Oligocene deposits (Dumitrescu, 1952).

Location and Description of the Rhizocorallium Occurrence

The *Rhizocorallium* occurrence is situated in the slope of the main road DN 205F linking the Soveja and

Lepşa localities, about 350 m upstream the very acute part of this road (Fig. 1 A). Lithologically the *Rhizocorallium* outcrop consists of a dense alternation of brown-blackish, dysodilic, shaly clays and thin, Kliwa type, siliceous sandstones. Five beds (a_1, a_2, b, c, d) of thin (8–13 cm) sandstones containing *Rhizocorallium* traces (Fig. 1 B) have been identified in a sequence investigated within a stratigraphic thickness of about 18 m. It is to specify that the scanty observation data do not allow an exact assignation of the ichnofossiliferous interval within the Oligocene deposits from the Omagu "rabotage" outlier. We support the hypothesis according to which this interval belongs to the Kliwa Sandstone Formation as the shaly-clayey series is interbedded between strong Kliwa sandstone thick beds, being devoid of sideritic calcareous concretions and intercalations of tuffs and benthonic clays, lithological elements characteristic of the Upper Dysodiles.

It is worth mentioning that in regions close to the East Carpathians *Rhizocorallium* was pointed out (isolated examples) in the variegated schists (Paleocene-Middle Eocene) and the Măgura Sandstone (Upper Eocene-Oligocene) from Poland (Ksiazkiewics, 1977), and in the Upper Cretaceous from the upper flysch of the Viennese Forest (Papp, 1962).

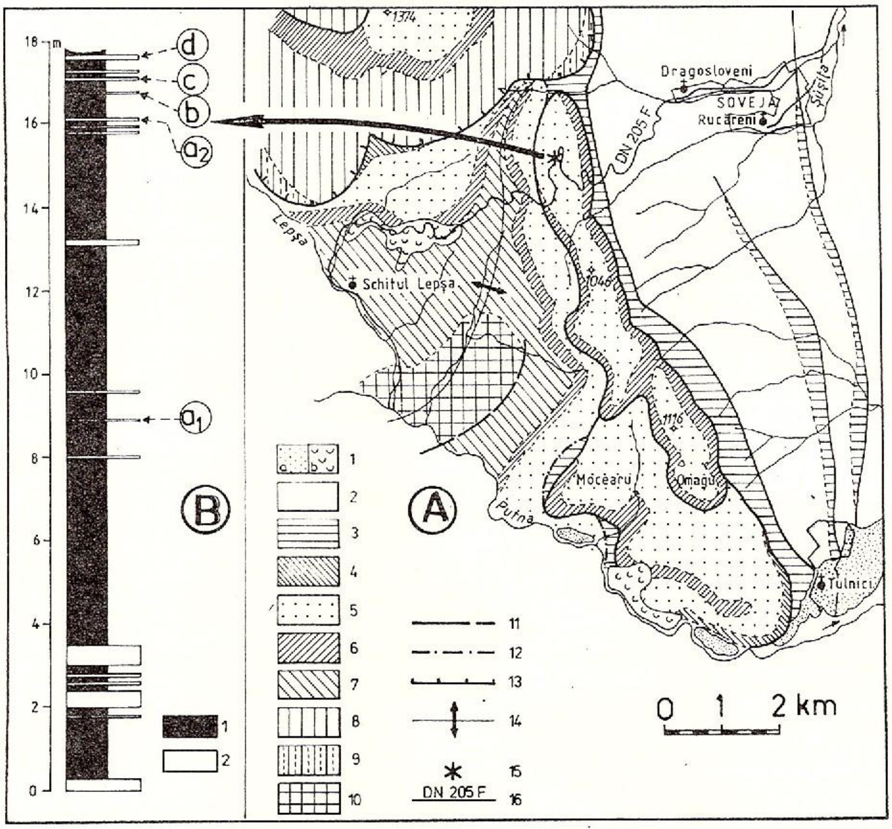

Fig. 1 – Location of the occurrence with *Rhizocorallium* in the Vrancea Mountains.

A – Simplified geological sketch (acc. to Dumitrescu, 1952): 1. Quaternary (a, terrace; b, land sliding); 2, Lower Miocene: Grey Formation; 3, Hârja Formation; 4, Oligocene: Upper Dysodile Shales; 5, Kliwa Sandstone Formation; 6, Lower menilites, brown bituminous marls, Lower Dysodile Shales; 7, Upper Cretaceous-Upper Eocene: Tisaru, Lepşa, Caşin, Piatra Uscată, Bisericani and Lucăceşti Formations; 8, Middle Eocene: Piepturi-Puica Facies; 9, Senonian: Hangu Formation; 10, Lower Cretaceous: Black Shales Formation (=Streiu Beds); 11, Fault; 12, Diapir contact; 13, overthrust line; 14, anticlinal axis; 15, ichnofossil site; 16, main road.

B – Lithological column with position of the *Rhizocorallium* beds (a_1-d): 1, alternation of dysodilic clays and Kliwa type siliceous sandstones; 2, Kliwa Sandstone.

Ichnotaxonomy.

Ichnogenus *Rhizocorallium* ZENKER, 1836
Type-ichnospecies: *Rhizocorallium jenense* ZENKER
Rhizocorallium cf. *irregulare* MAYER
Fig. 2; Plates I, II

Material. Numerous *Rhizocorallium* specimens have been observed and photographed in the above-described outcrop.

Diagnosis. Horizontal, "U"-shaped, straight or sinuous, more rarely plane-spiral burrow, with spreite structure (Fürsich, 1974).

Description. The five Kliwa type sandstone beds preserving the *Rhizocorallium* traces lie within an interval of about 9 m, the beds a_2, b, c and d being hosted within an interval reaching only 2 m in thickness. On their surface, showing sometimes clear interference ripple marks, mostly straight or slightly curved (Pl. II, Figs. 3, 4), sometimes sinuous (Pl. II, Figs. 5, 6) or even plane-spiral *Rhizocorallium* specimens can be noticed. The burrows range between 2–30 cm in length and 1.5–2.5 cm in width. Fifty-seven, apparently randomly disposed *Rhizocorallium* specimens (Fig. 2 A) can be noticed over a surface of ca. 1 m^2, belonging to bed d (Pl. I). The measurement of the orientation azimuth of the mentioned specimens indicates, however, the tendency of the burrows to group in the south-western part of the circular diagram (Fig. 2 B). Most examined specimens show the presence of the cylindrical tube with a diameter below 1 cm, without ornamentations, bordering the limb parallel to the bed surface, varying in length (Fig. 2 C). In only two cases the limb shows the very characteristic spreite structure (Pl. II, Figs. 1, 2).

Origin. Like many biogenic sedimentary structures, *Rhizocorallium* has been subject to various interpretations. Thus, Zenker considered it a coral (hence its name), then it was assigned to sponges, and especially to some algae. After Nathorst established the correct nature of this structure in 1881, in the sense that it corresponds to the vital activity of an animal organism, at present *Rhizocorallium* is regarded by most research workers as being produced by some sedentary polychetae, annelids (Basan & Scot, 1979), crustaceans (Seilacher, 1967) or even nymphs of ephemerids (Fürsich & Mayr, 1981). Starting from the fact that the ethological and ecological interpretation of the biogenic sedimentary structures is of utmost importance in solving the sedimentological, bathimetric and paleoecological problems, Fürsich (1974) revises the ichnogenus *Rhizocorallium*, following his own concept, according to which the significance of the behaviour of a biogenic structure depends on the morphological characters of the latter. Thus Fürsich (1974) assigns three ichnospecies to the ichnogenus *Rhizocorallium* as follows: *Rhizocorallium jenense*, produced by a filter-feeding organism, and *R. irregulare* and *R. uliarense* produced by deposit-feeding organisms. Therefore the short, retrusive, oblique or vertical forms account for the mode of life of a filter-feeding organism (*R. jenense*), while the long, sinuous, sometimes ramified troncho- or plane-spiral forms reflect the mode of life specific for the deposit-feeding organisms. It has also been found that the ornamentation consisting of fine striae, existing on the "U"-shaped tube on the very well preserved fossil material, indicates that the production of the *Rhizocorallium* type burrows could be achieved only in an already little consolidated substratum that increased the chance of preservation of the thus created structure.

Discussions. In our opinion, the identification of the ichnogenus *Rhizocorallium* within the "Kliwa Sandstone Formation from the Omagu "rabotage" outlier represents an important element in clarifying the paleoenvironmental conditions existing at this stratigraphic level. Thus it is worth mentioning that:

a) the investigated lithological sequence contains five moments corresponding to an intense activity of some deposit-feeding benthonic organisms (?annelids, ?crustaceans) under conditions of perfect aeration of the floor of the sedimentation basin;

b) the production and preservation of the *Rhizocorallium* type structures suppose the existence of a semiconsolidated clastic substratum, resistant to erosion, under moderate energy conditions;

c) the sedimentation of the clastic material which preserves these structures took place at small depth in the infralittoral stage. The situation in Vrancea is in accordance with the data provided by the classical *Rhizocorallium* occurrences. Thus in the Upper Jurassic of Portugal (Fürsich, 1981), England and Norway (Fürsich, 1974 a), and in the Pas de Calais region (Ager & Wallace, 1970), *Rhizocorallium irregulare*, forming colonies or associated with *Thalassinoides suevicus*, is characteristic of shallow water deposits. In the Middle Jurassic of England (Yorkshire) very long *Rhizocorallium* specimens are quoted (Farrow, 1966), which are devoid of the spreite structure specific for the shallow waters. According to Farrow (1966), the density and orientation of the *Rhizocorallium* specimens permitted the separation of the littoral deposits (high density, parallel orientation) from the sublittoral ones (low density, random orientation). In the concrete situation of Vrancea, the relatively high density and the grouping tendency of the *Rhizocorallium* specimens on bed d (Fig. 2 B) may suggest the proximity of the shore line. Also, in the Middle Jurassic of Greenland the ichnocoenosis with *Rhizocorallium* is characteristic of the regressive stage of the Vardekloft Formation (Heinberg

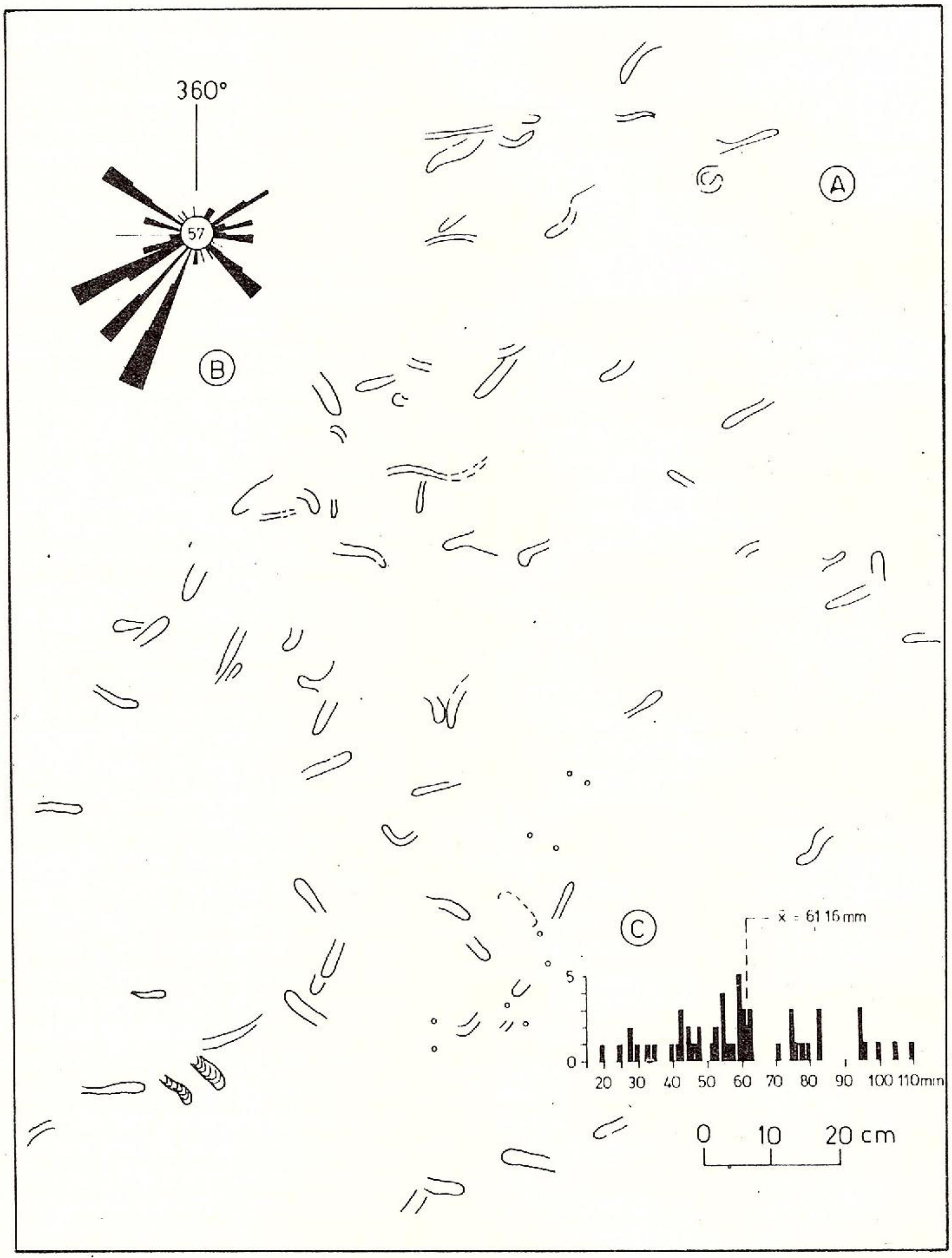

Fig. 2 – Graphic representation of the position (A), orientation (B) and variation in length (C) of 57 *Rhizocorallium* specimens on the surface of bed d.

& Birkelund, 1984). The identification of the ichnogenus *Rhizocorallium* in the Kliwa Sandstone Formation of Vrancea constitutes one more argument supporting the above-mentioned opinions concerning the formation of these deposits in a shallow marine basin (Preda, 1917; Grozescu, 1918). Macovei (1958, p. 415) uses the same context, taking into consideration the presence of the fossil isopods *Proidothea haugi* (RAC.

& COSM.), of the coal lenses associated with amber as well as of a contribution of eolian sand. It is worth noting that the presence of this biogenic structure supports the opinion put forward by Grozescu (1918), according to which the Kliwa Sandstone accumulated "under water, near the shore", which is proved by the existence of glauconite. Considering the "wave traces and the dysodile intercalations' from the Kliwa Sandstone, Preda (1917) supports the formation of these deposits "in the littoral or neritic region of the sea", at a short distance from the shore", being thus against the opinion expressed by Mrazec & Teisseyre, according to which the Kliwa Sandstone would represent a deposit of "littoral dunes";

d) the presence of the ichnogenus *Rhizocorallium* in the Kliwa Sandstone Formation undoubtedly indicates the modification at certain moments of the euxinic geochemical facies, probably as a result of the Savic movements at the Oligocene/Miocene boundary;

e) finally, the identification of the ichnogenus *Rhizocorallium* enriches the inventory of the ichnofauna of the East Carpathians Outer Flysch from Romania.

The perfect preservation and the accessibility of the *Rhizocorallium* occurrence within the Zboina-Ţina Neagră forest reservation as well as the rarity of such an occurrence lend a special importance to this ichnofossil site, a reason why we propose its inclusion in the list of geological objectives that should be protected by the law.

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Plate I

Fig — *Rhizocorallium* cf. *irregulare* MAYER

Bed d, with interference ripple-marks from the *Rhizocorallium* outcrop (main road DN 205F). Photo T. Brustur.

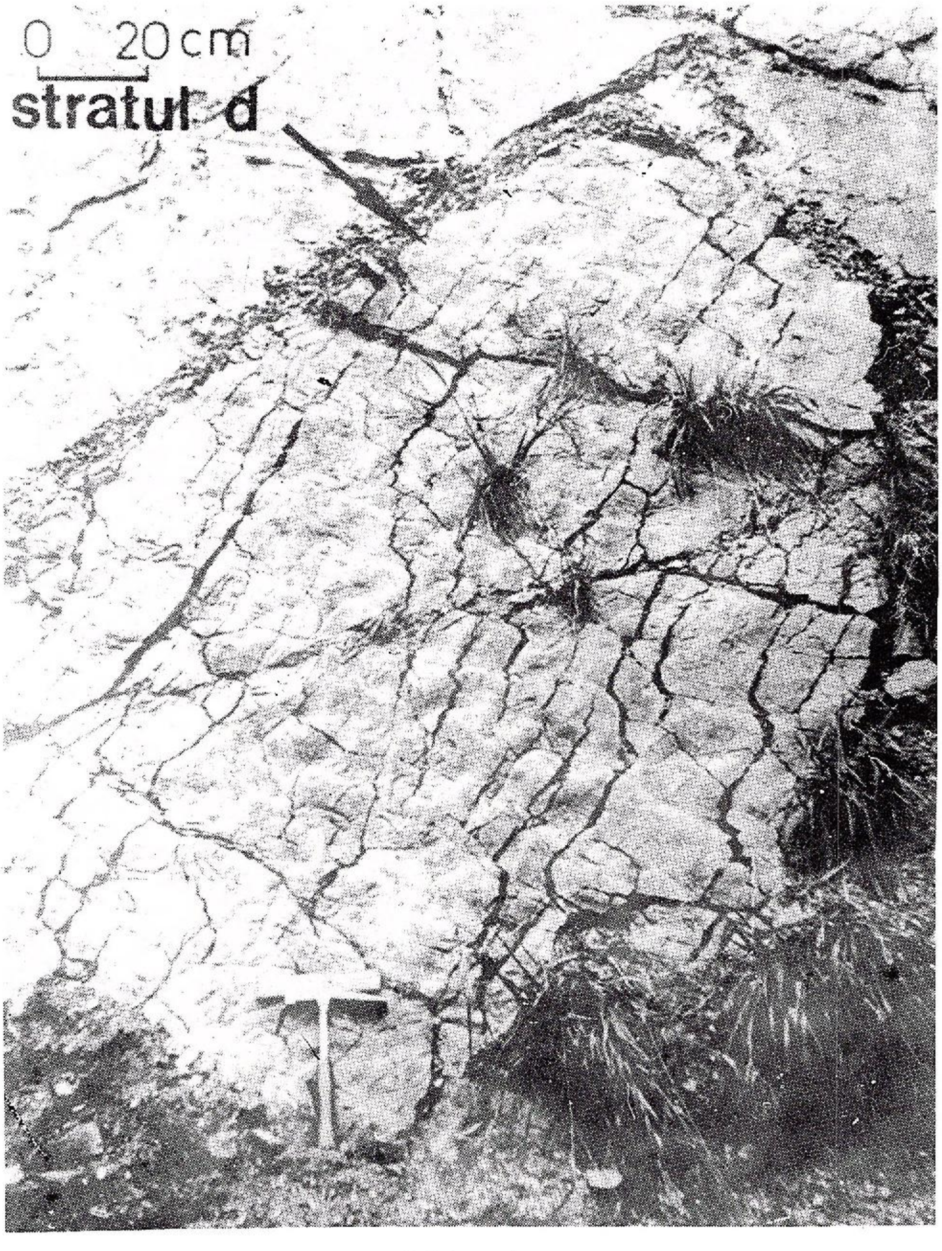
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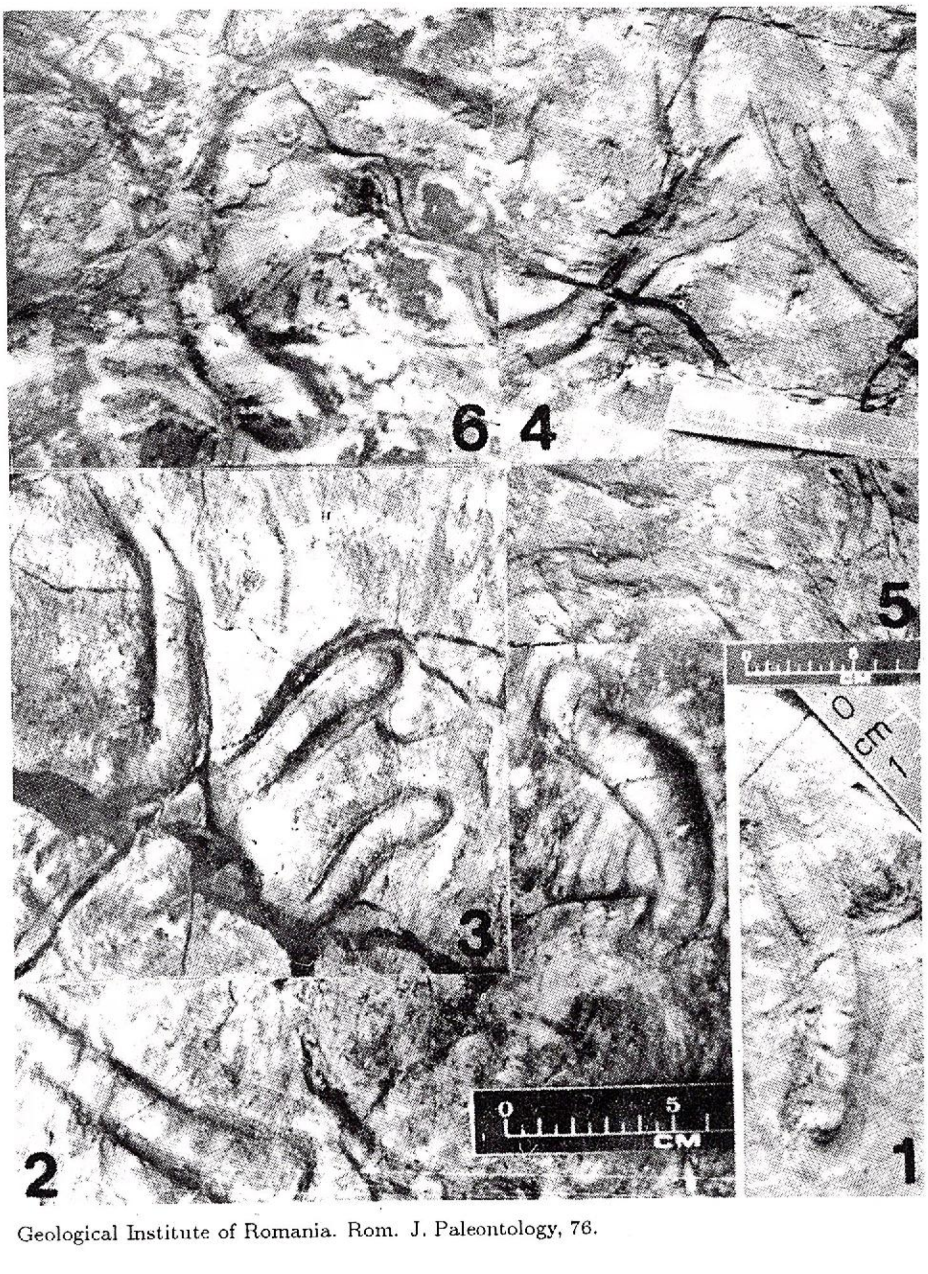
Plate II

Fig. 1 — *Rhizocorallium* cf. *irregulare* MAYER, with spreite structure.

Figs. 2, 3 — *Rhizocorallium* cf. *irregulare* MAYER. Straight and slightly curved specimens (scale as in Figure 2).

Figs. 4, 5 — *Rhizocorallium* cf. *irregulare* MAYER. Sinuous specimens (bed c).

Fig. 6 — *Rhizocorallium* cf. *irregulare* MAYER. "Aberrant" specimen (scale as in Figure 4). Photo T. Brustur.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Rom. J. Paleontology, 76, 1995, p. 63–66, Bucharest

LA FAUNE À GLYCYMERIS DES MARNES DE LINGUREŞTI (LE FLYSCH EXTERNE - CARPATES ORIENTALES)

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Key words: Paleogene. Upper Eocene. Lower Oligocene.

Abstract: *The Glycymeris Fauna from the Lingureşti Beds (the External Flysch - East Carpathians).* Within the Lingureşti marls from the Suceviţa Valley zone, Ionesi and Florea have pointed out a fossiliferous site with *Glycimeris* fauna. This fauna was identified by the above mentioned authors only up to the genus-level. Subsequently it was given to one of us (Moisescu) to identify it to the species level. Having at hands a rich comparison material, we have reached the conclusions that is a matter of a new taxa here presented as *Glycimeris ionesii* n. sp.. The *Glycimeris ionesii* n.sp. type specimens were found within an assemblage with taxa having no biostratigraphical significance. In order to establish the biostratigraphical value of this species, we have used the nannoplankton assemblage, which pointed out the NP 21 Zone. Thus the age of *Glycimeris ionesii* n.sp. is Lower Oligocene. The faunal assemblage from the Lingureşti Beds from the above mentioned region is oligotypical, euhaline marine and forms the *Glycimeris ionesii* paleobiotop.

Le gisement fossilifère à faune de glycimérides, l'objet de la présente note, a été découvert par Ionesi et Florea(1983), qui l'ont annoncé dans une étude antérieure, à côté d'une série de considérations litho- et bio-stratigraphiques.

Les spécimens de *Glycimeris* proviennent d'un dépôt de marnes sableuses,qui existe à la base du Grès de Ferestrău, du ruisseau de Rusca, affluent gauche de la vallée de la Suceviţa (Ionesi, Florea, 1983).

L'étude des formes de *Glycimeris* indique ce que nous présentons en ce qui suit:

Glycimeris (Glycimeris) ionesii n.sp. MOISESCU
(Pl., figs. 1 a, b; 2 a, b; 3–6).

Glycimeris sp. (IONESI, FLOREA, 1983, p. 33, pl. I, figs. 1–7).

Derivatio nominis: En honneur du professeur Liviu Ionesi, membre de l'Académie Roumaine, stratigraphe et paléontologue réputé.

Locus typicus: le ruisseau de Rusca, affluent gauche de la vallée de la Suceviţa (voir Ionesi, Florea, 1983, pl. II).

Stratum typicum: les marnes de Lingureşti.

Holotypus: pl., figs. 1 a, b; Coll. I.G.R.

Paratypus: pl., figs. 2 a, b; 3–6; Coll. I.G.R.

Matériel d'étude: 3 valves complètes, 6 valves incomplètes, 15 fragments de valves et 4 moulages.

Diagnose. Formes de taille moyenne, à contour arrondi-ovale, pourvues d'une surface ligamentaire étroite, mais haute, ornée de stries ligamentaires. Les dents latérales sont en nombre d'environ 5–6 sur la moitié de la valve, dont les antérieures plus courtes que les postérieures. A l'extérieur, les valves sont couvertes par des stries radiaires épaisses, surtout autours du crochet.

Description. Formes de taille moyenne, à contour arrondi-ovale, pourvues d'une surface ligamentaire étroite et haute, ornée de stries ligamentaires denses, séparées par des fossettes, qui forment un angle obtus au-dessous du crochet. Celui-ci est très reliéfé, avec la pointe petite et faiblement aiguë.

Les dents latérales (antérieures et postérieures), en nombre d'environ 5–6 sur la moitié de la valve, sont bien développées, légèrement bifides, pliées près de leur

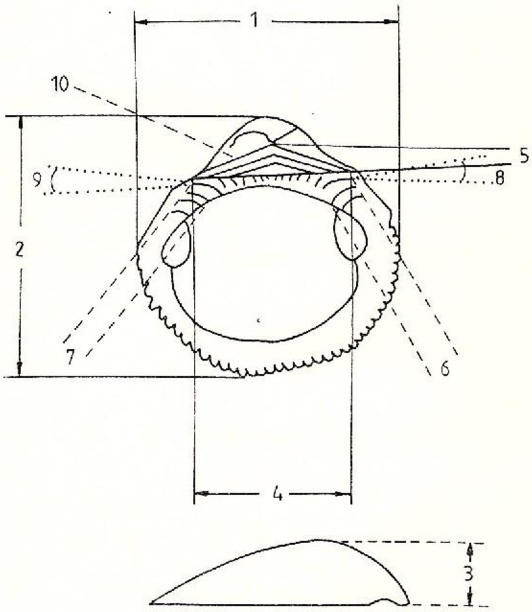

Fig. 1

Fig. - Schéma d'un exemplaire de *Glycimeris* avec indication des paramètres pris en considération pour déterminer les différents rapports utilisés dans le texte: 1, diamètre antéro-postérieur (d.a.p.); 2, diamètre umbono-ventral (d.u.v.); 3, convexité de la valve (c.); 4, longueur de l'aire ligamentaire (l.a.l.); 5, hauteur de l'aire ligamentaire (h.a.l.); 6, longueur de la plus grande dent antérieure (l.d.a.); 7, longueur de la plus grande dent postérieure (l.d.p.); 8, angle que forme avec le plan horizontal la plus grande dent antérieure; 9, angle que forme avec le plan horizontal la plus grande dent postérieure; 10, strie ligamentaire.

zone médiane en un angle obtus (120^0 environ), en formant un "V" avec la pointe orientée vers le crochet. Les exemplaires de cette espèce ne dépassent pas 6 cm en hauteur, ont une coquille très convexe, très épaisse et symétrique. A l'extérieur, les valves sont ornées de stries radiaires reliéfées, plus denses dans la zone du crochet.

Dimensions: Holotype: diamètre antéro-postérieur (d.a.p.) (fig. 1, texte) =56 mm; diamètre umbono-ventral (d.u.v.) = 43 mm; convexité de la valve (c.) =18 mm; longueur de l'aire ligamentaire (l.a.l.) =16 mm; hauteur de l'aire ligamentaire (h.a.l.) = 5,50 mm; longueur de la plus grande dent antérieure (l.d.a.) = 4 mm;longueur de la plus grande dent postérieure (l.d.p.) = 5 mm; angle d'inclinaison de la plus grande dent antérieure par rapport à l'horizontale = 8^0 environ; angle d'inclinaison de la plus grande dent postérieure par rapport à l'horizontale = 4^0; valeur de l'angle de la zone médiane des dents antérieures et postérieures = 115–120^0 environ; nombre des lignes sur l'aire ligamentaire = 4; indice des diamètres (i.d.), à savoir d.u.v./d.a.p. x 100 = 76; indice de la convexité (i.c.), à savoir c./d.a.p. x 100 = 32; indice de la surface ligamentaire (i.s.l.), à savoir h.s.l./l.a.l. x 100 = 34; indice du nombre de lignes sur la surface ligamentaire = nombre de lignes (4)/d.a.p. x 1000 = 71; indice de la longueur de la dent antérieure, à savoir l.d.a./d.a.p. x 1000 = 71; indice da la longueur de la dent postérieure, à savoir l.d.p./d.a.p. x 1000 = 89; indice de l'angle d'inclinaison de la plus longue dent antérieure, à savoir l'angle d'inclinaison/d.a.p. x 1000; indice de l'angle d'inclinaison de la plus longue dent postérieure, à savoir l'angle d'inclinaison/d.a.p. x 1000;

Paratypes :

P 1 (paratype 1): d.a.p. = 38 mm (?); d.u.v. = 38 mm (?); c. = 15 mm ; l.a.l. = 12 mm (?); i.d. = 100 (?); i.c. = 39 (?). P 2 (paratype 2): d.a.p. = 45 mm (?); c. = 16 mm ; l.a.l. = 20 mm (?); h.a.l. = 7 mm (?). P 3 (paratype 3): c. = 15 mm ; l.a.l. = 18 mm (?); h.a.l. = 6 mm (?); l.d.a. = 4 mm (?); l.d.p. = 5 mm (?). P 4 (paratype 4): d.u.v. = 25 mm ; c. = 8 mm (?). P 5 (paratype 5): c.= 12 mm ; l.a.l. = 16 mm (?); h.d.t. = 5 mm (?). P 6 (paratype 6): c. = 13 mm ; l.a.l. = 13 mm (?).

Observations. On connait de nombreuses espèces de *Glycimeris*, depuis l'Eocène inférieur jusqu'en actuel. Pour comparer les formes de *Glycimeris ionesii* n.sp. on prend en compte les formes de l'intervale Eocène supérieur - Oligocène inférieur. Les formes de *Glycimeris ionesii* n.sp. n'ont pas de termes comparatifs ni parmi les espèces de *Glycimeris* éocènes inférieures et moyennes du bassin de Paris, ni parmi celles éocènes supérieures (= priaboniennes) et oligocènes inférieures (= latdorfiennes) du nord de l'Allemagne. Donc, on peut affirmer que l'espèce décrite n'est pas de "facture" boréale. Une espèce de *Glycimeris* de type " sous-boréal", rencontrée dans les bassins : Mayence, sud-Limbourge hollandais, le nord de l'Hongrie, à savoir : *Glycimeris obovatus* (LAM.) pourrait constituer un terme comparatif pour l'espèce que nous avons décrite, si on parle de la taille et de la forme des valves similaires; les différences sont évidentes, quant à l'ornamentation, la forme et le nombre des dents latérales, tout comme l'absence de l'angle obtus, que ces dents forment à leur partie médiane. Nous considérons comme le critère le plus caractéristique , les dents latérales, la forme, le nombre et leurs disposition. A ce point de vue, la plus ancienne espèce de *Glycimeris* qui présente des dents pliées, à l'aspect de "V", est l'espèce *Pectunculus lunulatus* NYST du Latdorfien de l'Allemagne de Nord (sous-espèce de *Glycimeris pilosus* (LINNÉ) à l'avis de Báldi).

Une espèce de *Glycymeris*, qui est plus intéressante du point de vue des affinités avec la forme que nous avons décrite, est *Glycymeris latiradiatus obovatoides* BÁLDI, 1962. La ressemblance concerne les dimensions et le contour des valves, le nombre et la forme des dents latérales et aussi l'angle de ces dents avec la pointe orientée vers le haut. Tenant compte des ressemblances avec *G.latiradiatus obovatoides* de l'Egérien on peut encadrer cette espèce dans le groupe *G.latiradiatus s.l.*; il pourrait s'agir d'une espèce priabonienne de ce groupe qui se trouve à l'origine de *G.latiradiatus s. str.* de l'Oligocène, avec ses sous-espèces. En conséquence, nous pouvons affirmer que le groupe de l'espèce *G.latiradiatus* fait son début dès l'Eocène supérieur, à savoir du Priabonien, par l'espèce *G.ionesii* n.sp., en continuant son évolution dans l'Egérien par la sous-espèce *G.latiradiatus obovatoides*. Pour la valeur biostratigraphique de l'espèce *G.ionesii* n.sp., on doit prendre en compte le nannoplancton, trouvé ensemble avec cette mollusque. L'étude de nannoplancton réalisé par Melinte, indique la zone NP 21, donc l'Oligocène inférieur. On a trouvé: *Lanternitus minutus* STRADNER, *Dictyococcites bisectus* ROTH, *Ericsonia subdisticha* ROTH et HAY, *Transversopontis pulcher* (DEFLANDRE) PERCH-NIELSEN, *Cyclicargolithus floridanus* (ROTH & HAY) BUKRY, *Chiasmolithus oamaruensis* (DEFLANDRE) HAY, MOHLER & WADE, *Markalius inversus* (DEFLANDRE) BRAMLETTE & MARTINI, *Reticulofenestra placomorpha* (KAMPTNER) STRADNER, *R. umbilica* (LEVIN) MARTINI & RITZKOWSKI, *R. hillae* BUCKRY, *Helicosphaera salebrosa* PERCH-NIELSEN, *Sphenolithus moriformis* BRAMLETTE & WILKOXON, *Zygrhablithus bijugatus* (DEFLANDRE), *Coronocyclus nitescens* (KAMPTNER), *Helicosphaera euphratis* HAY, *Cyclicoccolithus formosus* KAMPTNER.

Il resulte que dans la dépression de Transylvanie l'équivalent des dépôts à *Glycimeris ionesii* n.sp. MOISESCU se trouve au niveau des marnes à bryozoaires, où on a mis en évidence toujours la Zone NP 21 (Martini & Moisescu, 1974). A côté de *Glycimeris*, les dépôts des schistes ardéziformes du bassin de la vallée de la Suceviţa, comportent des fragments de *Crassostrea* ex gr. *cyathula* (LAM.), de *Cardium* sp., de *Corbula* sp. (?) et de *Chlamys (Aequipecten)* ex gr. *biarritzensis bellicostatus* (WOOD), et aussi de très rares spécimens de *Pirenella* sp. et de *Stossichia* sp.. Il s'agit donc d'une faune oligotypique, marine euhaline constituant le paléobiotope à *Glycimeris*.

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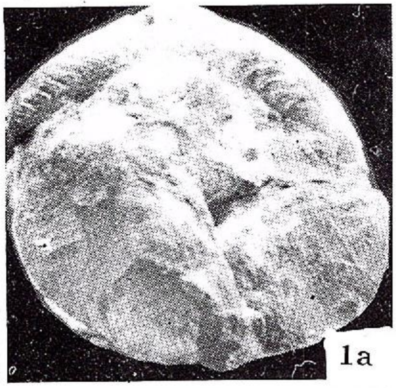
Planche

Figs. 1 a, b — *Glycimeris ionesii* n.sp. MOISESCU - holotype (x 1).

Figs. 2 a, b; 3–6 — *Glycimeris ionesii* n.sp. MOISESCU - paratypes (x 1).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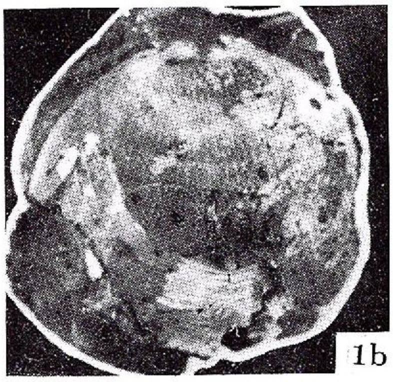
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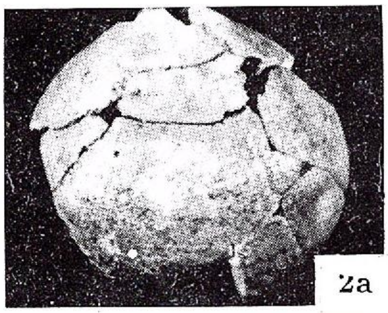
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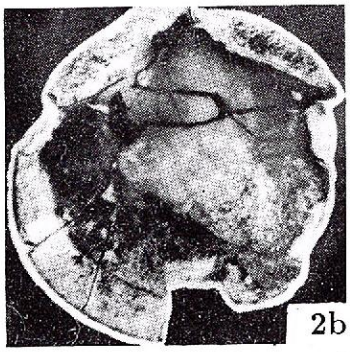
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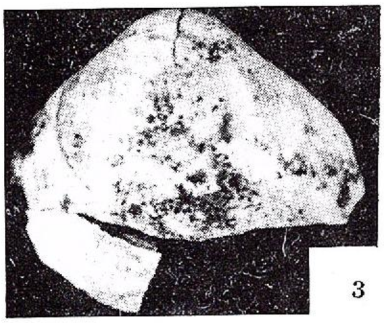
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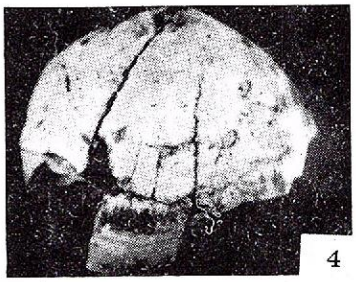
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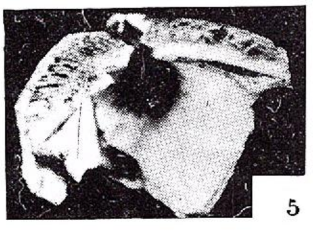
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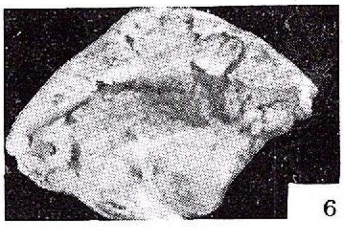
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Rom. J. Paleontology, 76, 1995, p. 67–72, Bucharest

BOEHLENSIPOLLIS HOHLI IN THE LOWER OLIGOCENE BITUMINOUS FORMATION FROM TROTUŞULUI VALLEY (EAST CARPATHIANS)

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Key words: Dinoflagellates. Eocene. Oligocene. Rupelian stage. Biostratigraphy. Paleogeography.

Abstract: In the lower part of the Bituminous Formation from Trotuşului Valley, belonging to the Tarcău Unit, rich palynological assemblages, represented by dinoflagellates, spores and pollen, have been recorded. Among them, *Boehlensipollis hohli* and *Wetzeliella (W.) gochtii* are index species for the lower part of the Rupelian.

Introduction

It is well known that the Oligocene-Lower Miocene Bituminous Formation is well developed in the East Carpathians from our country. This formation generally does not contain fossils possible to be used as stratigraphical markers.

Although some of the lithostratigraphical subunits which constitute this formation contain remarkable tanatocenoses, especially represented by fishes, bivalves, gastropods, crustacea etc. (partly studied in the last century) satisfactory conclusions could not be drawn for an accurate stratigraphical dating. Not even the micropaleontological studies have led to the long-expected results, as the microfaunas were poor and irrelevant.

In order to achieve dating we appealed to other groups of organisms, such as palynomorphs and/or nannoplankton.

Due to this paper we hope to enrich the information regarding the spores, pollen and dinoflagellates content of the Bituminous Formation from Trotuşului Valley so as to contribute to the age determination of the formation under discussion.

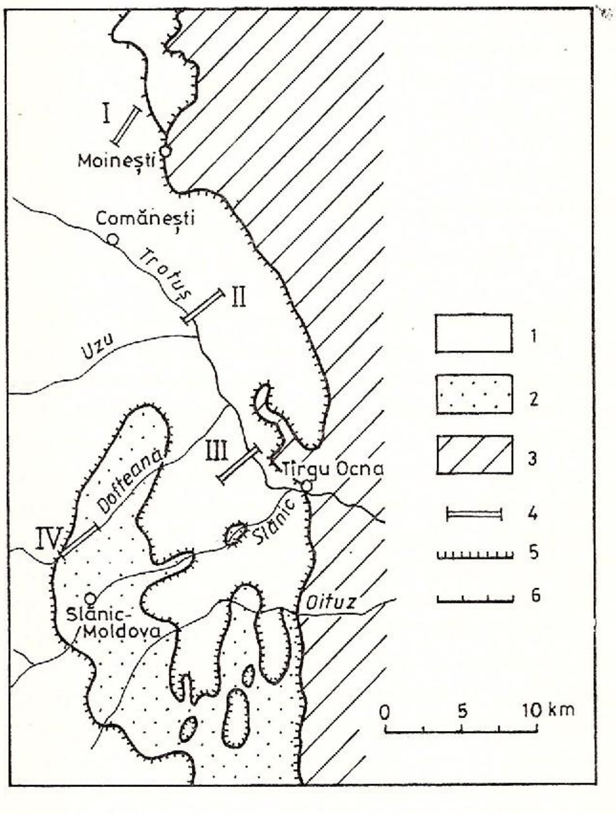

Fig. 1 – Profile distribution analysed on structural units: 1, Tarcău Unit; 2, Marginal Folds Unit; 3, Subcarpathian Unit; 4, Analysed profiles (I–II); 5, Nappes; 6, Digitation.

Brief geological data

The Bituminous Formation from the Trotuşului Valley basin consists of several lithostratigraphical entities (Fig. 3) such as: the Lingureşti Beds (syn. slate-like schists) with or without sandstone interbeddings (Fierăstrău Sandstone); bituminous marls and lower menilites; Lower Dysodile Shales (with Jaslo Limestones in the lower part); Lower Kliwa Sandstone etc.

All these beds are part of the two major structural units, namely the Tarcău Unit and the Marginal Folds Unit (or Vrancea Unit) from the Romanian East Carpathians (Fig. 1). The Bituminous Formation is very well developed in the middle and external parts within the Tarcău Unit.

Due to the superposition of the beds, the Bituminous Formation was assignable to the Oligocene. It overlies the Upper Eocene formations (Plopu and Bisericani Beds) and underlies the Lower Miocene formations.

Palynological data

The palynological material is coming from some sections in the Tarcău Unit (Fig. 1) from Lingureşti Beds, Lower Dysodile Shales and lower part of the Kliwa Sandstone.

The following sections have been sampled:

- the Lucăcioaia Brook (I) section, located NW of Moineşti locality, from the Lower Dysodile Shales (samples 3272/2, 3, 4 and 5) and from the Lower Kliwa Sandstone (sample no. 3272/1)[1];
- the Plopu Brook (II) section, left tributary of Trotuşului Valley: from Lingureşti beds (samples 3281/1–10 and from the Lower Dysodile Shales (samples 3281/14–19).

The examined palynological material can be found in the author's collection.

Previous palynological researches

The Bituminous Formation from the East Carpathians has become the object of these studies since 1960. The first palynological data on this formation were published by Costea and Balteş (1962). Balteş (1969) mentions that some dinoflagellate species might be characteristic of the Oligocene formations from Romania, such as: *Deflandrea phosphoritica, Wetzeliella rotundata, Talassysphora delicata* etc. The palynological studies of the Bituminous Formation in the East Carpathians have been subsequently continued by Olaru (1978, 1987, 1989, etc.). His results regarding the formations from Bistriţa and Trotuşului valleys have been synthesized in his master's degree (Olaru, 1978). Some of the main conclusions regarding the Bituminous Formation are: (1) the microflora from the lower part of this formation is a continuation of that from subjacent Upper Eocene formations; (2) in the upper part of the Bituminous Formation a warm subtropical climate bloom is observable, compared to arctotertiary elements occurring in subjacent formations; (3) in the lower part of the formation a poor microflora can be distinguished, being partly similar with the one from the lower part of the formation, represented by arctotertiary and subtropical elements, constituting a transition to more recent Miocene formations.

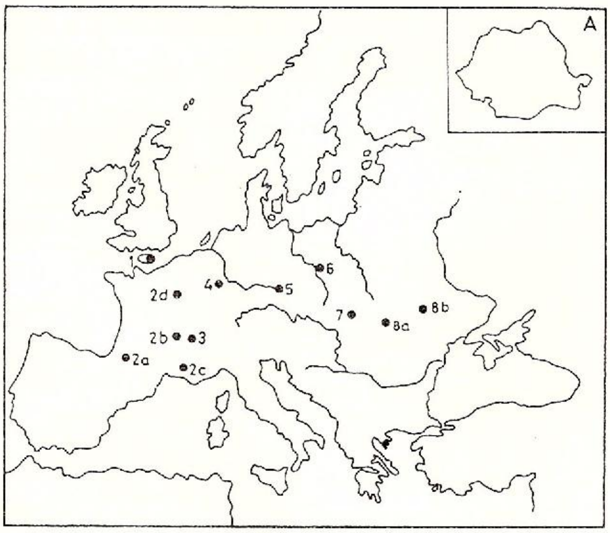

Fig. 2 – Geographical dissemination of the *Boehlensipollis* genus in Europe (A. Romania within Europe): 1, England (UK); 2, France (2 a, Aquitania Basin; 2 b, Limagne; 2 c, Marsilia Basin; 2 d, Paris Basin); 3, Switzerland; 4, Belgium; 5, East Germany; 6, West Poland; 7, Czechoslowakia; 8, Romania (8 a, Trasylvanian Basin, 8 b, East Carpathians).

Antonescu (in Alexandrescu et al., 1978) studied the deposits from the lower part of the Bituminous Formation (Lingureşti Beds, bituminous marls and lower menilites, Lower Dysodile Shales) from Moldova Valley and assigned them to the Rupelian.

Tăutu (in Micu et al., 1984) points out both a coniferous association (*Picea, Pinus, Cedrus*) in the lower part of the Bituminous Formation, from Valea Tazlăului (Marginal Folds Unit), without illustrating it, and *Myrica* spp. as new occurrence compared to those from the Upper Eocene.

The presence of *Boehlensipollis hohli* was mentioned in Lower Oligocene formations from the Transylvanian Basin (in the Curtuiuş Formation), together with other palynomorphs of the same age (Petrescu et al., 1989, Fig. 2).

Palynological associations and their stratigraphical significance

As a result of the palynological analysis of the samples from the lower part of the Bituminous Formation a rich microfloral assemblage consisting of dinoflagellates, spores and pollen has been recorded in

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[1] The sample number (3272/1, 4, etc.) represents the number of the observation point. The sampling sites are supplied in the synthetic stratigraphic column from the table (Pl. I).

the Trotuşului Valley basin. The assemblage consists of the following families: **Deflandraceae, Thalassyphoraceae, Schizeaceae, Cupresaceae, Taxodiaceae, Betulaceae, Eleagnaceae, Erigaceae, Myricaceae.**

We paid special attention to the presence of the *Boehlensipollis* and *Wetzeliella* genera from the biostratigraphical point of view, because of their restricted range, characteristic of the Lower Oligocene.

The Linguresti Beds, are located in the lower part of the Bituminous Formation and contain a palynological assemblage which can be divided in two parts: a poor lower one and a rich upper one (figure). The dinoflagellates are represented by: *Cordosphaeridium* sp. *Deflandrea phosphoritica, Deflandrea* sp. *Gonyaulacacysta* sp., *Microtytthodiscus, Tytthodiscus*, cf. *Phtanoperidinium, Palaecystodinium golzowense, Pterospermopsis* sp., *Wetzeliella (R.) draco, Wetzeliella (W.) symmetrica, Wetzeliella* sp. etc. Among these *Deflandrea phosphoritica, Microtytthodiscus* and *Tythodiscus* are more frequent (Pl. 1)

The sporo-pollinic spectrum consists of: *Leiotriletes adriennis pseudomaximus, Punctatisporites* sp. *Trilites multivallatus, Cicatricosisporites* sp. *Pityosporites microalatus, P. alatus, Inaperturopollenites hiatus, Sequoiapollenites polyformosus, Monocalpopollenites* sp., *Tricolpopollenites* sp., *Triatriopollenites* sp., *T. engelhardtioides, T. myricoides, Intratriporopollenites tilioides, Polyporopollenites* sp. *Polyvestibulopollenites verus, Tricolporopollenites* sp., *T. pseudocingulum, Boehlensipollis hohli*, cf. *Boehlensipollis* sp. and *Tetracolporopollenites* sp. According to the figure the frequency of the species ranges from rare to abundant.

The Lower Dysodile Shales have furnished two associations, namely a poor lower one and a very rich upper one. The upper association partly consists of dinoflagellates, spores and pollen from previous deposits which continue with special frequencies, to which are added *Cleistophaeridium* sp., *Gonyaulacysta* (?), *Wetzeliella (W.) gochtii, W. (W.)* cf. *gochtii, W. (W.) symmetrica, W. (W.) cf. symmetrica, Toroisporis* sp., *Levigatisporites haardti, Verrucingulatisporites* sp., *Subtriporopollenites* sp., *Polyporopollenites carpinoides, P. stelatus, P. udulosus, Porocolporopollenites* sp. and *Ericipites ericius*.

As in the previous case, the frequency of the genera is in this case variable, the spores occur only sporadically. The following specimens are more frequent: *Wetzellhella* sp., *Pityosporites alatus, P. microalatus, Subtriporopollenites* sp., *Triatriopollenites* sp. Specimens like *Wetzeliella (Rhombodinium) draco, Wetzeliella (W.)* cf. *symmetrica, Monocolpopollenites* sp., *Triatriopollenites engelhardtioides, Polyporopollenites* sp. have a moderated frequency. *Deflandrea phosphoritica, Microtytthodiscus, Tytthodiscus, Inaperturopollenites hiatus* and *Tricolporopollenites* sp. are highly abundant.

In the upper part of the Lingureşti Beds the *Normapolles*-type elements have a low frequency, whereas in the upper part of the Lower Dysodile Shales their frequency is moderated, probably reworked from Eocene formations. The *Tricuspidatus* genus is also assumed to be reworked from preexisting formations and has been recorded in the Lower Dysodile Shales.

Wetzeliella (Wetzeliella) gochtii is one of the stratigraphically valuable species at this level (upper part of the Lower Dysodile Shales). This species has a short range, it suddenly appears and disappears in the Late Lower Oligocene (Cavalier et Pomerol, 1983). Costa and Downie (1976) describe it from the Rupel Clays (Middle Oligocene, Belgium) and point out that *Wetzeliella (W.) gochtii* indicates a biozone in the Lower Oligocene, in the upper part of the Hamstead Formation. The lower boundary of this zone is defined by the first occurrence of the species.

The deposits including *Wetzeliella (W.) gochtii* (Lower Dysodile Shales) are therefore assignable to the Lower Oligocene. At this level *Wetzeliella (W.) gochtii* associates with other species of that genus, namely *Wetzeliella (R.) draco* and *Wetzeliella (W.) symmetrica.*

The Lower Kliwa Sandstone. The Lower part of this lithological entity of the Bituminous Formation furnished a microfloral association which is rich in dinoflagellates and poor in spores and pollen. Except for *Phthanoperidinium* sp., *Cordospaeridium* sp. and *Palaeoystodinium golzowensis* all the other dinoflagellates are a continuation from previous lithostratigraphical entities (Lingureşti Beds, Lower Dysodile Shales) or even from the Eocene deposits.

The spores and pollen have a lower representation. The following taxa can be mentioned: *Levigatosporites* sp., *Pityosporites alatus, P. microalatus, Inaperturopollenites hiatus, Tricolporopollenites* sp., *Monocolpopollenites* sp., *Subtriporopollenites sp.*, and *Triatriopollenites engelhardtioides* (Pl. 1).

At this stratigraphical level reworked microfloral elements have not been recorded.

The genus *Tytthodiscus* has a maximum frequency in the Lower Kliwa Sandstone whereas the species *Wetzeliella (W.) gochtii* is accompanied by the same species as in the previous lithostratigraphical units namely *Wetzeliella (R.) draco, Wetzeliella (W.) symmetrica, Wetzeliella* sp.

Paleogeographical assignment and stratigraphical value of *Boehlensipollis* and *Wetzeliella (W.) gochtii*

Boehlensipollis hohli has been described by Krutzsch

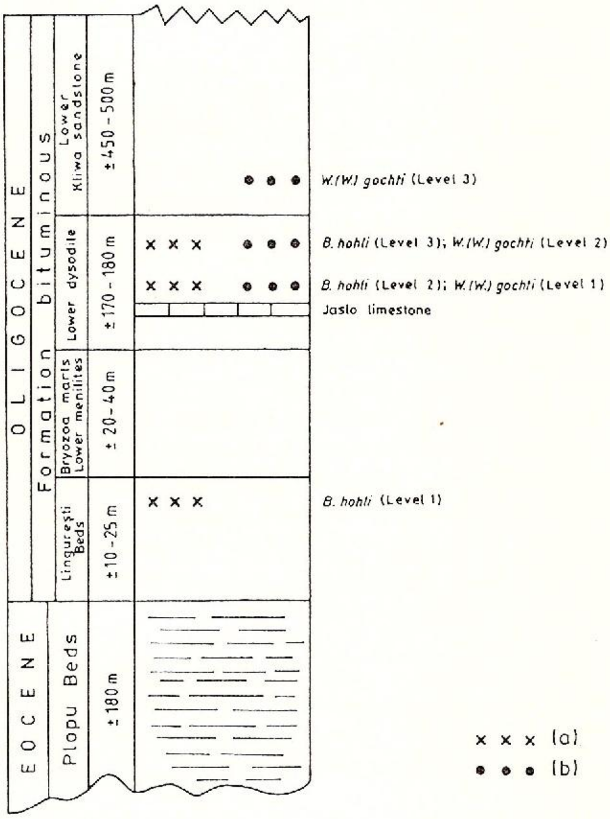

Fig. 3 – Synthetic stratigraphic column of the Bituminous Formation from Trotuşului Valley, indicating the levels with *Boehlensipollis hohli* (x) and *Wetzeliella (W.) gochtii.*

(1962) from the Oligocene marine formation in the Böhlen Quarry, near Leipzig (Fig. 2). It has been subsequently recorded in other places too. Sittler et al. (1975) underline that the stratigraphical range of *Boehlensipollis hohli* is characteristic of the entire Lower Oligocene (Stampian).

According to Gorin (1975) this form is largely represented, being an excelent biomarker in Europe. In their opinions (Gorin, 1974, 1975; Sittler et al., 1975) *Boehlensipollis hohli* disappears in the basal part of the Upper Oligocene.

In accordance with the mentioned authors it is proved that the range of the *Boehlensipollis hohli* is very restricted, as it appears during the Sanoisian and disappears in the Upper Stampian.

In the western part of Poland the Boehlensipollis genus is mentioned by Ziembinska (1974) in the Czempin Beds and by Stuchlik (1964) in the deposits from borehole II Rypin (basis of the Chattian).

In Czechoslowakia, Petracakova and Snopkova (1983) recorded *Boehlensipollis hohli* from the Lower Oligocene (Rupelian) sediments from the Orawska Verchovina Zone.

The *Boehlensipollis* genus has been recorded in the Transylvanian Basin (Fig. 2) in clayey-bituminous schists in the Ileanda Beds (Lower Oligocene) (Ionescu in Rusu et al., 1993) whereas the *Boehlensipollis hohli* species occurs in the Curtuiuş Beds (Lower Oligocene), associated with palynomorphs of the same age (Petrescu et al., 1989).

It has been established that *Wetzeliella (W.) gochtii* has also a restricted range. The first and last occurrences are in the Lower Oligocene (Costa and Downie, 1976). It has been selected as an index fossil (Wetzeliella (W.) gochtii Biozone) which occurs in the upper part of the Hamstead Clays.

Remarks on the palynomorphs from the investigated deposits

Boehlensipollis hohli and *Wetzeliella (W.) gochtii* from the microfloral assemblage in the lower part of the Bituminous Formation are stratigraphically the most significant. *Boehlensipollis hohli* has been recorded with a high frequency (26 samples) in the upper part of the Lingureşti Beds, and amounts to 1.9 % compared to the other palynomorphs (Fig. 3), among which spores represent 2.1 %, whereas the pollen amounts to 29.5 % (of which 27 % represent coniferous trees and *Tricolporopollenites* sp.).

The spores and pollen which accompany *Boehlensipollis hohli* in the Bituminous Formation from Trotuşului Valley indicate similarities with the association mentioned by Sittler et al. (1975) in the Caseneuve Marls, fish shischts, etc.

It is to mention that in the samples from the lower part of the Bituminous Formation, rich dinoflagellate associations have been recorded. As a result, in the upper part of the Lingureşti Beds, *Deflandrea phosphoritica* amounts to 6.9 %, *Thytthodiscus* to 6.9 % and *Microtytthodiscus* to 3.8 %. According to our information, the last two genera have two maximums: the first one is recorded in the upper part of the Lingureşti Beds (in the basal part of the Bituminous Formation), whereas the latter one is located in the lower part of the Kliwa Sandstone. Both genera constitute important paleoecological elements indicating the accumulation of the deposits in the littoral zone.

According to Sittler et al. (1975) *Boehlensipollis hohli* has no preferential depositional environment, occurring in lacustrine, lagoonal or marine formation types. This taxon might be characteristic of a warm to temperate climate (Schuler and Sittler, 1976).

In the microfloral associations from the lower part of the Bituminous Formation from Trotuşului Valley, namely the Lingureşti Beds, the species *Phthanoperidinium amoenum* has not been located as it is stratigraphically restricted within the Lower Oligocene (Cavalier et Pomerol, 1983).

In the Lingureşti Beds the percentage of the dinoflagellates amounts to 18.8 %, compared to the spores and pollen. The genera *Cordosphaeridium*, *Phthanoperidinium* and *Palaeocystodinium* have also been recorded in the lower part of the Kliwa Sandstone.

Conclusions

In the lower part of the Bituminous Formation from Trotuşului Valley (Tarcău Unit) three levels containing *Boehlensipollis hohli* have been pointed out. The first one is located in the upper part of the Lingureşti Beds, the second and the third one are recorded in the middle and upper parts of the Lower Dysodile Shales, respectively (see figure and stratigraphical column, Fig. 3). The levels with *Boehlensipollis hohli* are rich both in dinoflagellates and in spores and pollen. The percentage of *Boehlensipollis hohli* amounts to 1.9 % compared to other palynomorphs.

The species *Boehlensipollis hohli* is recorded both in the western part of Europe (France, Switzerland, Germany, Belgium) and in Central and Eastern Europe (Czechoslowakia, Poland and Romania) (Fig. 2).

As regards the dinoflagellates, namely *Wetzeliella (W.) gochtii* they have been recorded in three levels: the first one in the Lower Dysodile Shales, overlying the Jaslo Limestones, the second one in the upper part of the Lower Dysodile Shales and the third one in the lower part of the Lower Kliwa Sandstone.

Based on the *Boehlensipollis hohli* and *Wetzeliella (W.) gochtii* species which have a restricted stratigraphical range within the Lower Oligocene, the lower part of the Bituminous Formation from Trotuşului Valley can be assigned to the Lower Oligocene (Stampian-Rupelian).

The microfaunal associations in the Bituminous Formation from Trotuşului Valley lead us to the conclusions that the land bordering the sedimentation basin was covered by a vegetation represented by **Taxodiaceae, Myricaceae, Cupresaceae, Eleagnaceae**, etc.

The genera *Tytthodiscus* and *Microtytthodiscus* indicate a tropical and wet subtropical climate which made possible the blooming of an abundant vegetation, supplying the vegetal organic material which generated the bitumens impregnating the rocks (the dysodile and pseudodysodile shales respectively from the East Romanian Carpathians).

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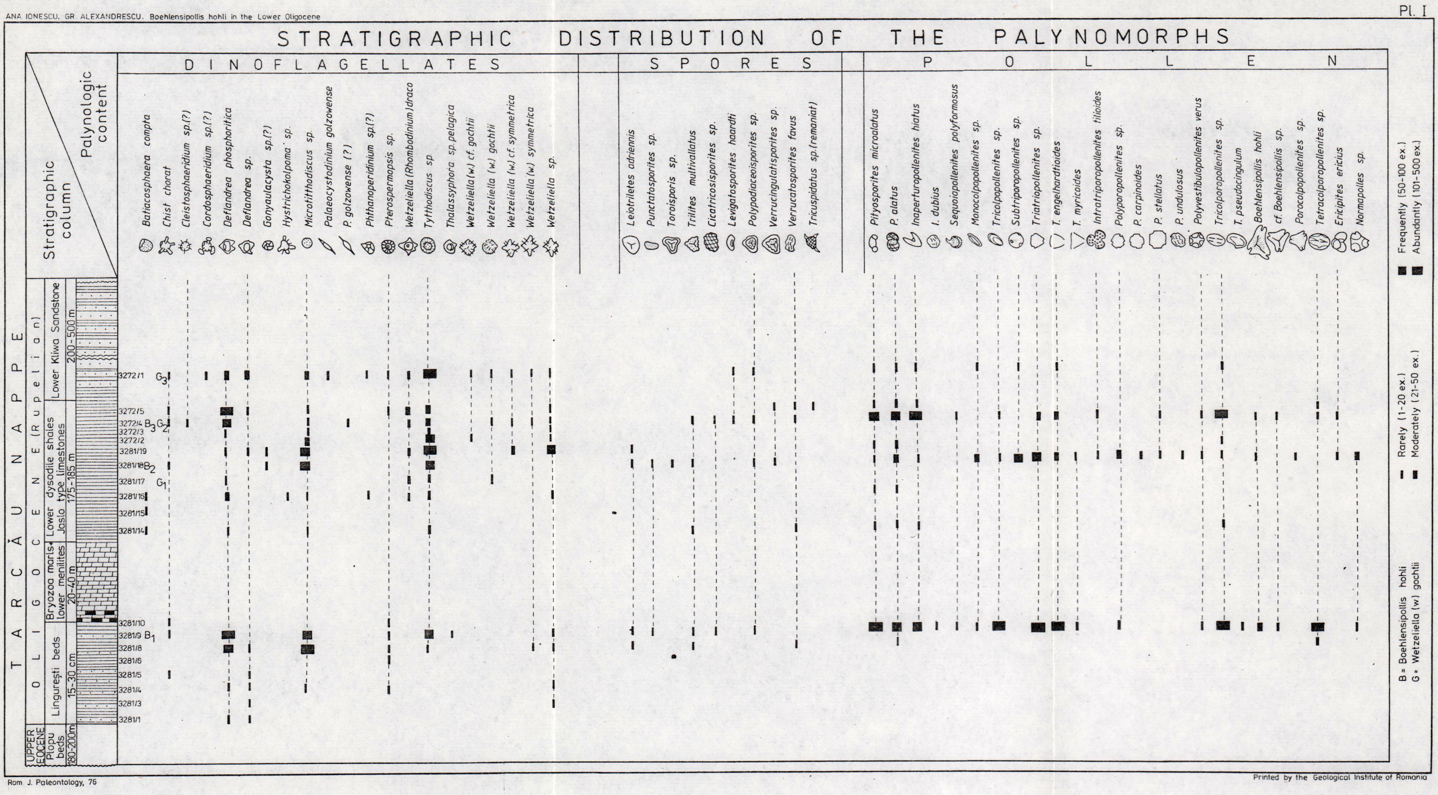

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Plate II

Boehlensipollis hohli

Fig. 1 — Sample no. 3281/9, 30μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 2 — Sample no. 3272/4, 35μ, profile I, Lower Dysodile Shales, Tarcău Nappe.

Fig. 3 — Sample no. 3281/9, 30μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

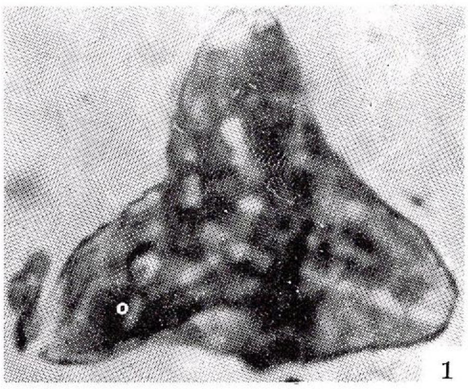
Fig. 4 — Sample no. 3281/18, 37.5μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 5 — Sample no. 3281/9, 32.5μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 6 — Sample no. 3281/9, 42.5μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Plate II

A. Ionescu, Gr. Alexandrescu – Boehlensipollis hohli in the Lower Oligocene Bituminous Formation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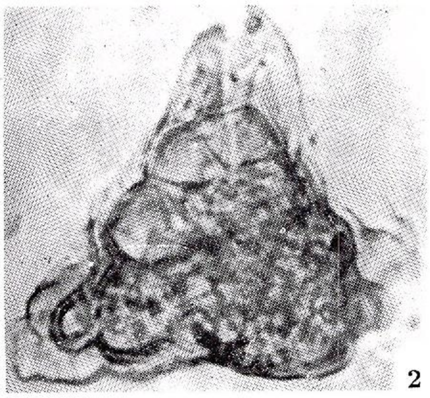
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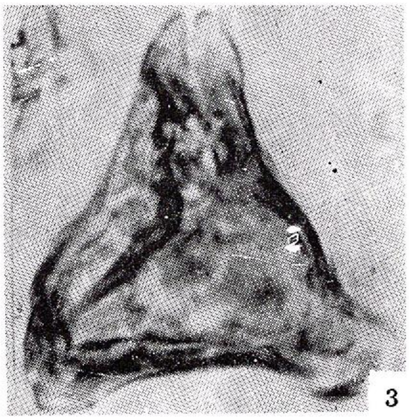
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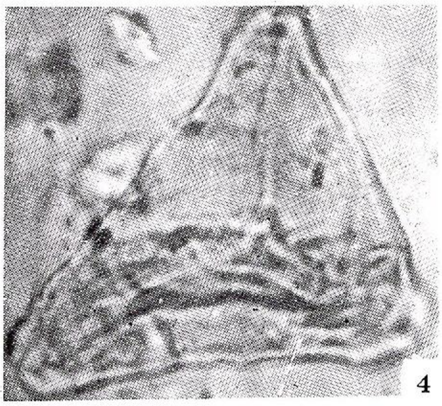
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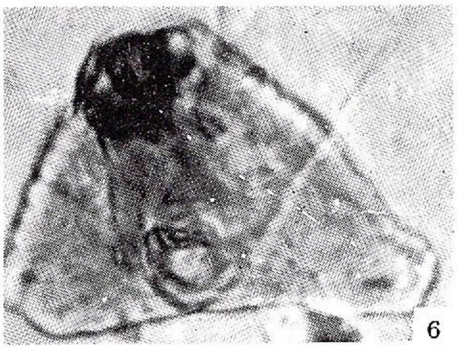
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Plate III

Boehlensipollis hohli

Fig. 1 — Sample no. 3281/9, 35μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 2 — Sample no. 3281/9, 35μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 3 — Sample no. 3281/9, 32.5μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

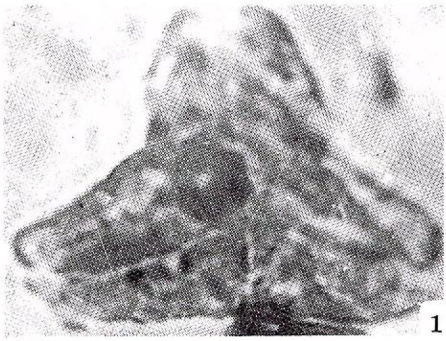
Fig. 4 — Sample no. 3281/9, 37.5μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 5 — Sample no. 3281/9, 37.5μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 6 — Sample no. 3281/9, 35μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Plate III

A. Ionescu, Gr. Alexandrescu – Boehlensipollis Hohli in the Lower Oligocene Bituminous Formation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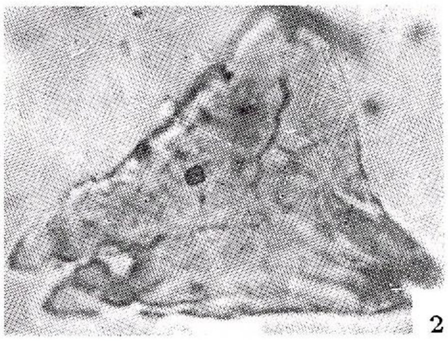
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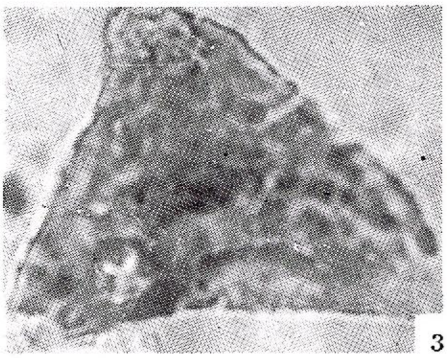
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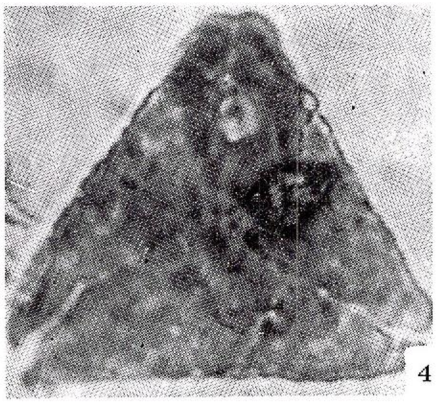
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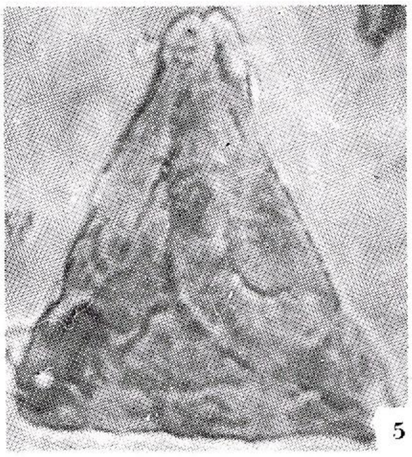
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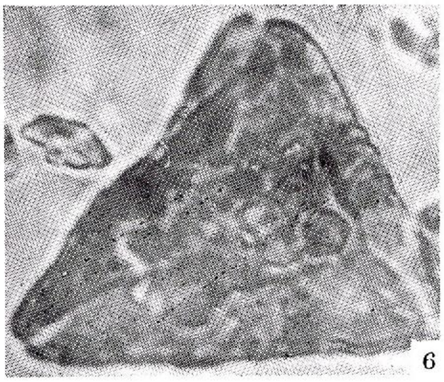
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Plate IV

Fig. 1 — *Wetzeliella (Wetzeliella)* cf. *gochtii*; sample no. 3272/4, 115–125μ, profile I, Lucăcioaia Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 2 — *Wetzeliella (Wetzeliella) gochtii*; sample no. 3272/4, 105μ, profile I, Lucăcioaia Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 3 — *Wetzeliella (Wetzeliella)* cf. *gochtii*; sample no. 3281/16, 115μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

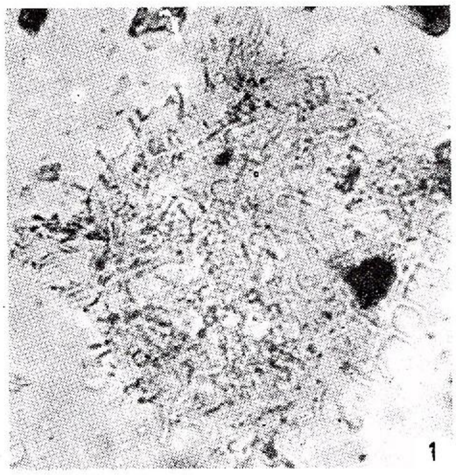
Fig. 4 — *Wetzeliella (Wetzeliella) gochtii*; sample no. 3281/17, 132.5μ–112μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 5 — *Wetzeliella (Wetzeliella)* cf. *gochtii*; sample no. 3272/1, 127μ–142.5μ, profile I, Lucăcioaia Brook, Lower Kliwa Sandstone, Tarcău Nappe.

Fig. 6 — *Wetzeliella (Wetzeliella)* cf. *gochtii*; sample no. 3272/1, 127.5μ–105μ, profile I, Lucăcioaia Brook, Lower Kliwa Sandstone, Tarcău Nappe.

Plate IV

A. Ionescu, Gr. Alexandrescu – Boehlensipollis Hohli in the Lower Oligocene Bituminous Formation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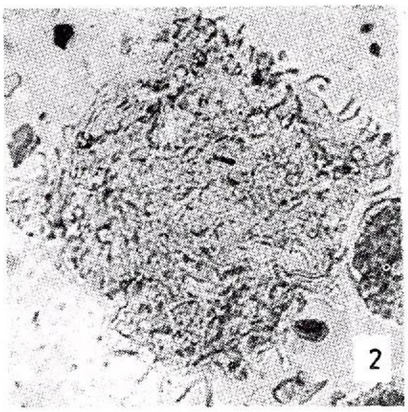
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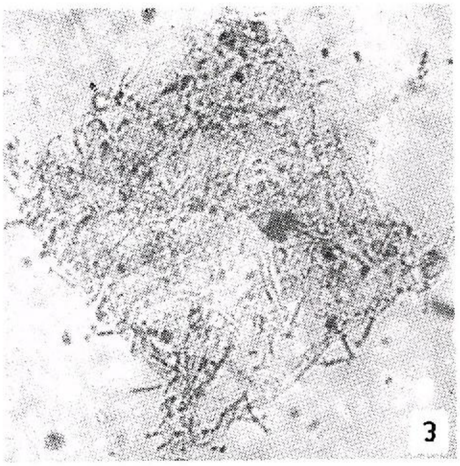
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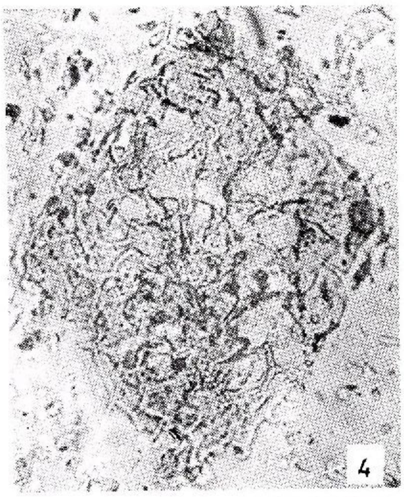
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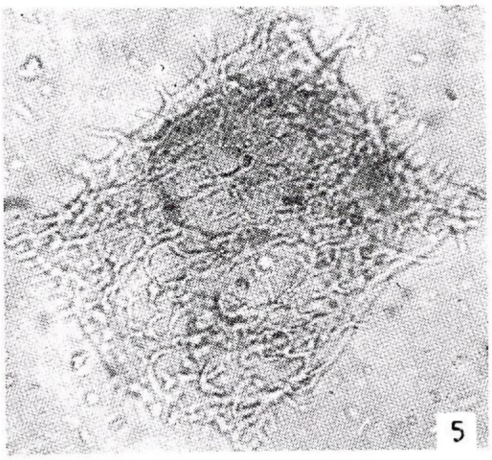
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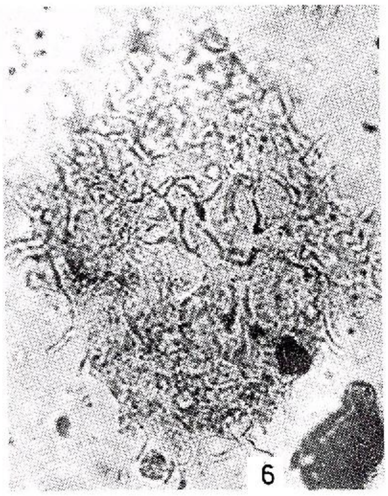
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Plate V

Fig. 1 — *Wetzeliella (Rhombodinium) draco*; sample no. 3272/5, 142.5μ, profile I, Lucăcioaia Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 2 — *Tytthodiscus* sp.; sample no. 3281/17,4. 95μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 3 — *Polyporopollenites stelatus*; sample no. 3281/18, 35μ; profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 4 — *Trilites multivallatus*; sample no. 3281/4, 52.5μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

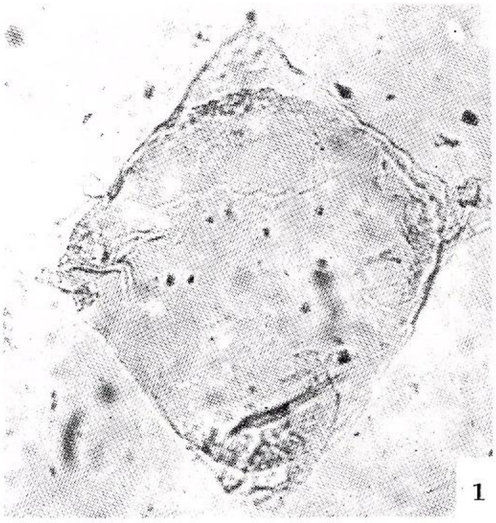
Fig. 5 — *Deflandrea phosphoritica*; sample no. 3281/9, 135μ, profile II, Plopu Brook, Lingureşti Beds, Tarcău Nappe.

Fig. 6 — *Membranophoridium aspinatum*; sample no. 3272/5, 130μ, profile I, Lucăcioaia Brook, Lower Dysodile Shales, Tarcău Nappe.

Fig. 7 — *Phthanoperidinium* sp.; sample no. 3281/16, 87.5μ, profile II, Plopu Brook, Lower Dysodile Shales, Tarcău Nappe.

Plate V

A. IONESCU, GR. ALEXANDRESCU – BOEHLENSIPOLLIS HOHLI IN THE LOWER OLIGOCENE BITUMINOUS FORMATION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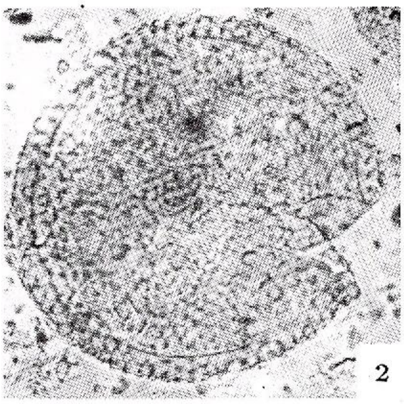
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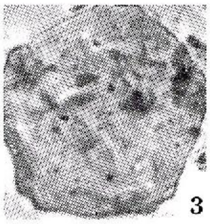
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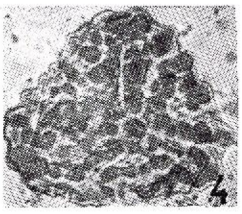
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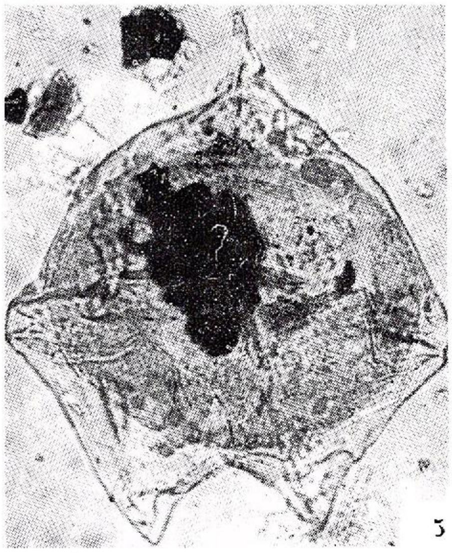
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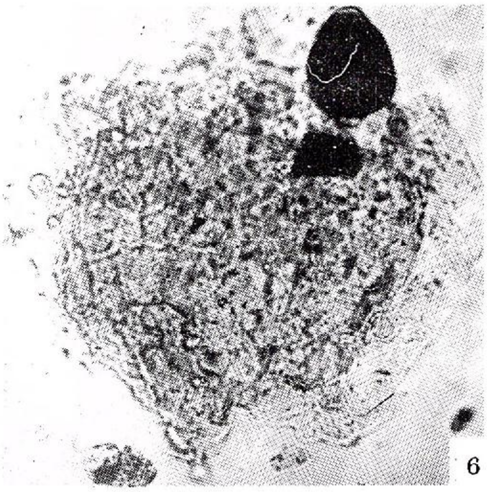
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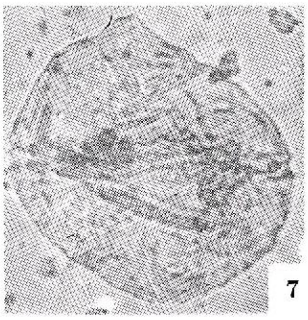
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CONSIDERATIONS ON THE FAUNA OF LENTICORBULA IN THE KISCELLIAN DEPOSITS OF THE TRANSYLVANIAN BASIN (CLUJ-TICU AREA)

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Key words: Oligocene. Kiscellian. Mollusca. Bivalvia. Systematics. Paleogene zone of NW Transylvania.

Abstract: The subspecies *Lentidium sokolovi subtriangulum* MOISESCU, 1972, recognised in the Kiscellian of the Transylvanian Basin (Cluj-Ticu area) was reconsidered according to the opinion of Popov and Titova (1984) as pertaining to *Lenticorbula subtriangula* (MOISESCU, 1972). A new *Lenticorbula* species, namely *Lenticorbula ticensis* n. sp. was also described. All the *Lenticorbula* taxa of the Dâncu-Tămaşa and Cetate Beds were presented in accordance with the mentioned synonymy.

In a previous paper dealing with the molluscs and echinids in NW Transylvania, Moisescu (1972) presented three new subspecies of *Lenticorbula*, among other groups of fossil molluscs, namely: *Lentidium sokolovi subtriangulum*, *L. helmerseni transsylvanicum* and *L. (Janschinella) garetzkii tenuitesta*.

As for the first of these subspecies, it was later recognized by Popov and Titova (1982, p. 38–39, 44, Pl. V, Figs. 39–41) who identified specimens of *Lenticorbula subtriangula* in the Othe and lower Thruta-Tahana Beds (Ahaltihe Depression), the corbule beds in the Tori and Gori areas (Georgia), the Traudonskie Beds (pre-Caucasus), the Serogoz Beds (South Ukraine) as well as in the Solenov Horizon (North Ustiurt). According to these authors the taxon described by us in 1972 shows significant differences in comparison with *Lenticorbula* (KARLOV) and, consequently, it is regarded as an independent species. Kazahasvili (1984, p. 84), studying the distribution of the molluscan fauna in the Solenov and Serogoz horizons of the Ahaltihe Depression as well as in the Tori and Gori areas, distinguished the species *L. subtriangula* among other species of *Lenticorbula*.

When we described the *Lenticorbulids* from the Transylvanian Basin we also made a comparison of our proposed new subspecies with *Lenticorbula sokolovi* and *L. helmerseni* taking into account the similitude between the two above-mentioned species from pre-Caucasus and Southern Ukraine, on the one hand, and *L. subtriangula* and *L. transsylvanica* from the Transylvanian Basin, on the other hand, including also their stratigraphic position. Thus, the adult individuals of *L. sokolovi* are always smaller than the native specimens of *L. helmerseni major* (= *L. major*) and occur mostly in deposits with a lower stratigraphic position. In the Transylvanian Basin the adults of *Lenticorbula subtriangula* are almost half the size of the adult individuals of the species *L. transsylvanica*.

We agree with the interpretation as a species of the subspecies "*Lentidium sokolovi subtriangulum*" MOISESCU, 1972; consequently its first description is here below revised and accomplished; the revision includes also the actualization of the synonymies of the two species under discussion.

In addition, a new species of *Lenticorbula: L. ticensis* n. sp. comes to emphasize so far the similitude between the bivalve assemblages of the Transylvanian Basin and of Russia and Ukraine; this new species is recorded especially in the faunal assemblage of *L. transsylvanica*, which is similar to the fauna with *L. major*.

Besides the species of *Lenticorbula* presented below, our collection of *Corbulides* also includes specimens which show similarities both with *Lenticorbula sokolovi zhizchenkoi* (Merklin, 1974, p. 144, Pl. XLVIII, Figs. 8–15) and with *L. sokolovi slussarevi* (Merklin, Pl. XLVIII, Figs. 16–22). Such specimens have been reported from the Cetate Beds. As a matter of fact, specimens of *L. sokolovi zhizchenkoi* were also mentioned by Rusu (1977, p. 128 – Table 2) from the Creaca Beds in the Prodăneşti-Jibou area.

The fauna with lenticorbules from the Dâncu-Tămaşa and Cetate Beds in the Cluj-Ticu area (NW Transylvania) represents a characteristic of the Oligo-Pliohaline, brackish-fresh water Kiscellian fauna from

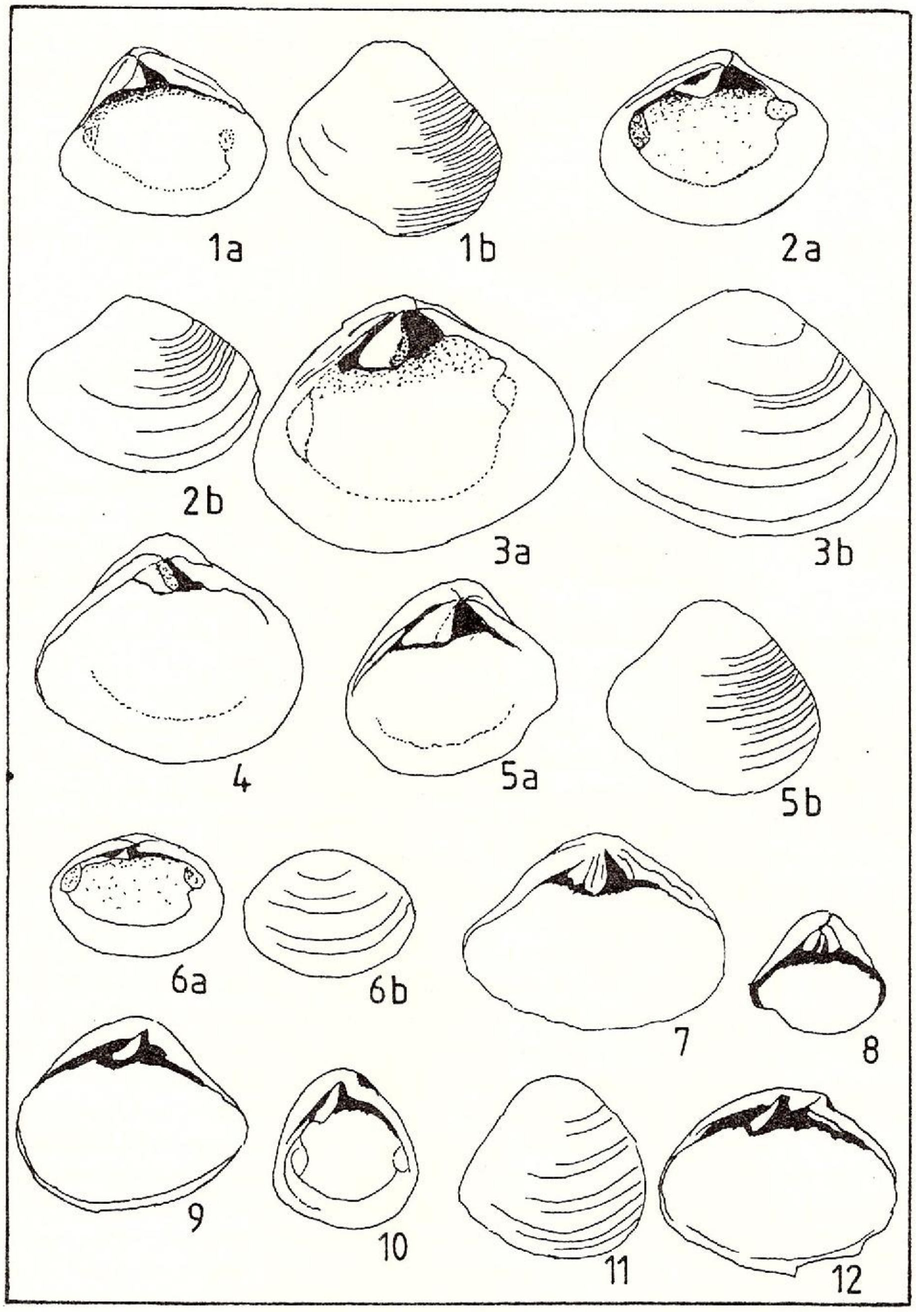

Fig. - Species and subspecies of *Lenticorbula*: 1 a, b; 2 a, b, *Lenticorbula subtriangula* (MOISESCU, 1972) (x 2); 3 a, b; 4 - *L. transsilvanica* (MOISESCU, 1972) (x 2.1); 5 a, b - *L. ticensis* n. sp. (x 2) (Moisescu, 1972, Pl. XXII, Figs. 6 a, b); 6 a, 6 b - *Lentidium sokolovi* KARLOV, 1962 x 1.3 (Karlov, 1962, p. 104, Pl. I, Figs. 1–8); 7, 9, 12 - *Corbula (Lenticorbula) helmerseni major* MERKLIN, 1974 (x 1.5) (Merklin, 1974, p. 142, Pl. XLVII, Figs. 3–5); 8, 10–11 - *C. (L.) helmerseni helmerseni* (MICHAJLOVSKI, 1912) (x 2) (Merklin, 1974, p. 142, Pl. XLVII, Figs. 11–13). Figures 6–12 for comparison.

the Early Paratethys.

1. *Lenticorbula subtriangula* (MOISESCU, 1972)
(Figs. 1, 1 a, b; 2 a, b)

Lentidium (Lentidium) sokolovi subtriangulum MOISESCU (Moisescu, 1972, p. 58, Pl. III, Figs. 1 a, b; 2 a, b; 3 a, b; Pl. IV, Figs. 2 a, b; Pl. XXII, Figs. 5 a, b; 8–9; Pl. XXIII, Fig. 2)

Lenticorbula subtriangula (MOISESCU) (Popov, Titova, 1982, p. 38, Pl. V, Figs. 39–41)

Lenticorbula subtriangula (MOIS.) (Kazahaşvili, 1984, p. 84)

Corbula subtriangula (partim) (Moisescu, 1989, p. 269) (for morph A) and

Lentidium (Lentidium) sokolovi subtriangulum MOISESCU, Moisescu, 1972, p. 61, Pl. III, Figs. 4 a, b; 5 a, b; 6 a, b; 7 a, b; 8 a, b; Pl. IV, Figs. 1 a, b; 3 a, b; 4 a, b; 5 a, b; 6 a, b; 7; 8 a, b; Pl. XXIII, Figs. 5; 6 a, b).

Corbula subtriangula (partim) (Moisescu, 1989, p. 289) (for morph B).

Remarks. When presenting the subspecies *Lentidium sokolovi subtriangulum* (Moisescu, 1972, p. 58–61) we specified that it includes two morphs (A and B). Although situated near *Lentidium sokolovi* KARLOV (Karlov, 1972, p. 106, Pl. I, Figs. 1–8), *Corbula (Lenticorbula) sokolovi sokolovi* (KARLOV, 1962) (Merklin, 1974, p. 143, Pl. XLVIII, Figs. 1–7) the species here under discussion is apart by the outline of the valves.

2. *Lenticorbula transsilvanica* (MOISESCU, 1972)
(Figs. 1, 3 a, b)

Lentidium (Lentidium) helmerseni transsylvanica (Moisescu, 1972, p. 61, Pl. IV, Figs. 9 a, b; Pl. XXIII, Figs. 7, 9, 10 a, b; 11 a, b; 12 a, b; 13, 14 a, b; Pl.XXIV, Figs. 1–3, 8–9, 10 a, b; 11).

Corbula transsilvanica (Moisescu, 1989, p. 269).

Remarks: L. transsilvanica was described by us as a new subspecies in 1972 (p. 61–63). It was compared with the subspecies *Lenticorbula helmerseni major* (MERKLIN) (=*L. major*) (Moisescu, 1972, Pl. XXIV, Figs. 4 a, b; 5 a, b; 6 a, b; 7) from the Baigubek horizon (Priaralia); it was also recognized by us in Merklin's collection from Moskow where it was erroneously labelled as *Lenticorbula helmerseni* (MICKH.). A minute study of the two taxa revealed certain differences between: the species coming from the Cetate Beds display a much stronger umbo than those described by Merklin; moreover, the posterior cardinal tooth of the left valve in case of *L. subtriangula* is less bilobated at specimens originating in Transylvania (see Figs. 1, 7, 9, 12). If we try to compare them with specimens of *Lenticorbula helmerseni* (MICH.) illustrated by Merklin (1974, p. 142, Pl. XLVII, Figs. 9–13), the differences are more striking. They concern firstly the valves outline which in the specimens considered by Merklin as *L. helmerseni* s.s. show an umbono-paleal diameter larger than the antero-posterior one, whereas in the specimens described by us the same ratio is reverse. The posterior cardinal tooth of the left valve is slightly bifid at specimens occurring in the Transylvanian Basin while the anterior cardinal tooth of the right valve is curved like in *L. subtriangula* (see also Figs. 1, 8, 10–11).

3. *Lenticorbula ticensis* n.sp.
(Figs. 1, 5 a, b)

Lentidium (Lentidium) sokolovi subtriangulum MOISESCU, morph A (Moisescu, 1972, p. 58, Pl. XXII, Figs. 6 a, b; 7; Pl. XXIII, Figs. 1, 3–4).

Corbula subtriangula (partim) (Moisescu, 1989, p. 269).

Derivatio nominis: from the name of the locality of Ticu, NW Transylvania, the sampling site of the specimens.

Locus typicus: locality of Ticu, Curtuiaşul Hill.

Stratum typicum: Dâncu-Tămaşa Beds (Kiscellian).

Holotypus: Pl. XXII, Figs. 6 a, b (Moisescu, 1972) Inv. no. 8217.

Paratypus: Pl. XXII, Figs. 1, 3, 4 (Moisescu, 1972) Inv. no. 8218.

Diagnose: Small- to medium-sized, inequivalve shell, displaying a subtriangular inequilateral outline. The right valve bears a well-developed subpyramidal anterior cardinal tooth, bordered by two fossettes of which that disposed anteriorly is very shallow, almost unobservable, and that disposed posteriorly is deep and well developed. On the left valve a posterior cardinal slightly lobed tooth is seen, that is boredered by a deep triangular fossette.

Remarks: L. ticensis n. sp. is comparable with the specimens figured by Merklin (1974, p. 142, Pls. XLVII, Figs. p-13) as *Lenticorbula helmerseni helmerseni* (see also Figs. 1, 8, 10, 11). The similarity refers to the valves outline which is subtriangular-elongated. But they differ by the aspect of the hinges and of the umbo which were largely commented at the species *L. transsilvanica*.

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CONTRIBUTIONS TO THE KNOWLEDGE OF THE CHATTIAN MOLLUSCAN FAUNA IN THE BOREHOLE 19 – HOBICENI (PETROŞANI BASIN)

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Key words: Molluscs. Chattian. Petroşani Basin. New Taxa.

Abstract: Thirty-one taxa recorded in the fossiliferous rock sequences intercepted by the borehole 19 – Hobiceni (Petroşani Basin) are here presented. Although poorly preserved, six new taxa could be identified, namely: *Arca hobicensis* n. sp., *Tellina (Peronaea) nysti* n. ssp., *Macoma elliptica* n. ssp., *Congeria* n. sp., *Polymesoda (Pseudocyrena)* n. ssp. and *Hydrobia* n. sp. The first species is better represented, all the others being characterized by few poorly preserved specimens. From the whole faunal assemblage, some species are characteristic of the Chattian, as follows: *Lucinoma pseudoheberti, Solen* ex gr. *parvus, Tellina (Moerella) weithoferi, T. (M.) langeckeri, T. (Peronaea) nysti* aff. *triangularis, Abra (Syndosmya) bosqueti, Polymesoda (Pseudocyrena) convexa cordata*, and *Stenothyra pupa*, typical of the zone PSM_{10} - Costatoleda psammobiaeformis.

The malacologic inventory of the borehole 19 – Hobiceni (Petroşani Basin) revealed (Moisescu in Muşat et al., 1988, 1989 a, unpubl. data; Moisescu, 1989 b) three categories of taxa, as follows: a. taxa previously found in other zones of the basin (Moisescu et al., 1979); b, taxa identified in this basin for the first time; c. new taxa.

This paper presents some of the molluscan taxa found in the Petroşani Basin and previously annexed in a table recorded in the borehole 19 – Hobiceni (Moisescu in Muşat et al., 1989 , unpubl. data; Moisescu, 1989 a) including 118 taxa, from which: 53 previously known in the basin, 61 found in the borehole 19 – Hobiceni for the first time, and 4 are new.

Description of the new taxa

1. *Arca hobicensis* n.sp.
(Pl. I, Figs. 1 a, b)

Leda sandbergeri n. ssp. (Moisescu in Muşat et al., 1989 , unpubl. data, Pl. IX, Figs. 2 c, d, sample 33 a; Figs. 3 b, c, sample 33 b)

Leda sandbergery n. ssp (Moisescu, 1989 a, p. 279)

Holotypus: Pl. I, Figs. 1 a, b; Col. I.G.R., sample 18, 580.

Derivatio nominis: from the previous name of the locality Valea cu Brazi (=Hobiceni), the sampling site of the holotype.

Locus typicus: borehole 19 – Hobiceni, depth 548.80–550.50 m.

Stratum typicum: Dâlja-Uricani Formation (="horizon" 2 – productive).

Dimensions (mm):[1]

a.p.d.	u.p.d.	c.	d.i.	c.i.
18.0	9.0	3.0	50	16

Description: Small-sized specimen, with typical ornamentation consisting of concentrical and radial striae, the latter visible only in the posterior part of the valves, where a carena with a small elevation is also observable. The anterior part of the valves is relatively pointed and short: posterior part seems to be rounded and at the same time more elongated. Umbo, although slightly elevated, is marked and pointed. Although the hinge is not visible, its shape suggests the "arcid" toxodont type.

The specimen, with both valves open, was found in a grey hard marl, assembled to *Gari (Gobraeus) difficilis, G. (Gobraeus) affinis, G. (Gobraeus) angustus* and *Tellina (Arcopagia) heberti*.

Remarks: Considering the general outline of the valves, the specimen presented here belongs undoubtedly to the genus *Arca*. The characteristic external ornamentation, the size of the specimen as well as the shape of the left valve argue for considering it a new species.

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[1] a.p.d = antero-posterior diameter; u.p.d.=umbono-paleal diameter; c= valve convexity; d.i.= diameter index (u.p.d./a.p.d. x 100); c.i.= convexity index (=c./a.p.d. x 100).

2. *Tellina (Peronaea) nysti* n. ssp.
(Pl. I, Fig. 17)

Gastrana ex gr. *gracilis* (LINNÉ, 1758) (Moisescu, in Muşat et al., unpubl. data, 1989 , Pl. IX, Fig. 4, sample 33 c; Moisescu, 1989 a, p. 279)

Dimensions (mm):

a.p.d.	u.p.d.	c.	d.i.	c.i.
21.0	13.0	4.5	61	20

Remarks: Taking into account the shape of the shell, the specimen described here belongs to the species *Tellina (Peronaea) nysti*; as the anterior and posterior part of the valves are narrower and blunter and the umbo typical of the species we consider it a new subspecies of *T. nysti*.

3. *Macoma elliptica* n.ssp.
(Pl. I, Fig. 18)

Tellina (Macoma) elliptica (BROCCHI, 1814) (Moisescu in Muşat et al., 1989 , unpubl. data, Pl. VII, Fig. 2 b, sample 6)

Macoma elliptica (BROCCHI, 1814) (Moisescu, 1989 a, p. 280)

Dimensions (mm):

a.p.d.	u.p.d.	c.	d.i.	c.i.
22.0	13.5	3.0	60	13

Remarks: A poorly preserved specimen of pelecypod was assigned to the species *Macoma elliptica* on the basis of the similar size and general shape of the shell. It is comparable to the individual presented by Secco (XXIX, 1901) in Plate XXII, Fig. 44 as *Macomopsis elliptica* (BR.) var. *pomella* DE GREG, as well as to the specimens described by Cossmann and Peyrot (1911, p. 267, Pl. IX, Figs. 33-35) as *Macoma elliptica* (BROCCHI). But its well-rounded dorsal part of the shell, both to the anterior and the posterior part, is a feature we consider as characteristic of a new subspecies of *Macoma elliptica*.

4. *Congeria* n.sp.
(Pl. II, Fig. 3)

Congeria tenuissima MOISESCU; Moisescu, 1964, p. 552, pl. I, Fig. 3; 1972, p. 40, Pl. XV, Fig. 13.

Congeria kochi ANDRUSOV, 1900; Moisescu in Muşat et al., 1989 , (unpubl. data), Pl. II, Fig. 1 a, sample 1 a; Moisescu, 1989 a, p. 280.

Congeria n.sp. Moisescu, 1989 b, p. 288, Pl. I, Fig. 13.

Dimensions (mm):

a.p.d.	u.p.d.	c.	d.i.	c.i.
1.2	0.8	-	66	-

5. *Polymesoda (Pseudocyrena) convexa* n. ssp.
(Pl. II, Fig. 7)

Polymesoda (Pseudocyrena) convexa n.ssp. (Moisescu in Muşat et al., unpubl. data, 1989 , Pl. XXIV, Fig. 1 b, sample 25; Moisescu, 1989 a, p. 280).

Remarks: The incomplete and poorly preserved specimen of *Polymesoda* we recorded is here considered as pertaining to a new subspecies, characterized by the outline different from that of the typical *P. convexa*.

6. *Hydrobia* n. sp.
(Pl. II, Fig. 17)

Caspia n. sp. (Moisescu, in Muşat et al., 1989 , unpubl. data, Pl. II, Fig. 1 b, sample 1 a; Moisescu, 1989 a, p. 281)

Dimensions (mm)[2]:

a.a.d.	l.w.d.	h.l.w.	a.h.	a.w.	R_1	R_2
0.8	0.4	0.3	-	-	50	37

Remarks: Although it is very poorly preserved, a fairly small-sized specimen (less than one millimeter high) has been assigned to the genus *Hydrobia*, considering the typical shape of the whorls beside the general shape of the shell, as well as the height of the last whorl characteristic of the species belonging to this genus.

The molluscan fauna from the fossiliferous lithologic sequences of the borehole 19 - Hobiceni is poorly preserved, most often pelomorphosed. However, the studies carried out (Moisescu in Muşat et al., 1989, unpubl. data; Moisescu, 1989 a), this paper inclusive, emphasized 60 taxa, unknown up to now in the Petroşani Basin, among which new species and subspecies, too. From all the studied fossiliferous assemblages some species and subspecies of molluscs specific to the Chattian are worth mentioning: *Lucinoma pseudoheberti*, *Solen* ex gr. *parvus*, *Tellina (Moerella) weithoferi*, *T. (M.) langeckeri*, *T. (Peronaea) nysti* aff. *triangulus*, *Abra (Syndosmya) bosqueti*, *Polymesoda (Pseudocyrena) convexa cordata*, and *Stenothyra pupa*. These taxa are characteristic of the zone PSM_{10} - Costatoleda psammobiaeformis.

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[2] a.a.d.=apical-apertural diameter; l.w.d=last whorl diameter; h.l.w.= height of last whorl; d.h.=aperture height; a.w.=aperture width; R_1=l.w.d./a.a.d. x 100 (=d.i.); R_2=l.w.h./a.a.d. x 100(=c.i.)

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Plate I

Figs. 1 a, b — *Arca hobicensis* n. sp. (x 1.5).

Fig. 2 — *Ledina perovalis* KOENEN, 1867 (x 1.5).

Fig. 3 — *Lucinoma borealis* (LINNÉ, 1766 (x 1.5).

Fig. 4 — *Lucinoma pseudoheberti* HÖLZL, 1962 (x 1.5).

Fig. 5 — *Diplodonta rotundata* (MONTAGU, 1803) (x 1.7).

Fig. 6 — *Lepton (Planikellia) unduliferus benoisti* COSSMANN et PEYROT, 1912 (x 1.5).

Figs. 7, 21–23 — *Gari (Gobraeus) affinis* (DUJARDIN, 1837) (x 2).

Fig. 8 — *Solen* ex gr. *parvus* HÖLZL, 1957 (x 1.5).

Figs. 9–10 — *Tellina (Moerella) weithoferi* (HÖLZL, 1962) (x 1.5).

Fig. 11 — *Tellina (Moerella) langeckeri* HÖLZL, 1957, (1.5).

Fig. 12 — *Tellina (Moerella) intexta* (KOENEN, 1894) (x 1.7).

Figs. 13–14 — *Tellina (Moerella)* ex gr. *postera* (BEYRICH, 1867) (x 1.5)

Fig. 15 — *Tellina (Peronaea) nysti* aff. *triangulus* HÖLZL, 1957 (x 1.3)

Fig. 16 — *Tellina (Serratina)* ex gr. *serrata* RENIER, 1804, (x 3.5).

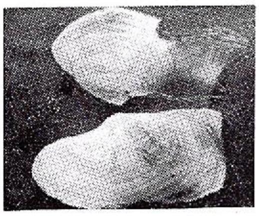
Fig. 17 — *Tellina (Peronaea) nysti* n. ssp. (x 1.5).

Fig. 18 — *Macoma elliptica* n. ssp. (x 1.5).

Fig. 19 — *Pelecyora (Cordiopsis) westendorpi westendorpi* (NYST, 1836) (x 1.5)

Fig. 20 — *Gari (Gobraeus)* ex gr. *pseudoangustus* (HÖLZL, 1958 (x 1.6)

Fig. 24 — *Gari (Gobraeus)* ex gr. *affinis* (DUJARDIN, 1837) (x 2)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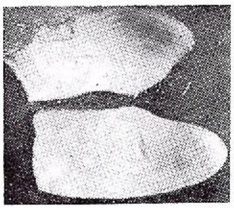
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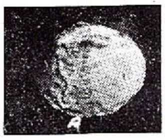
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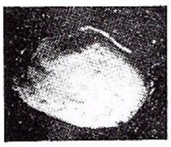
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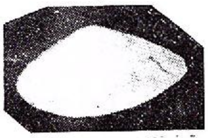
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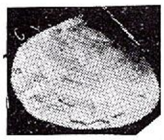
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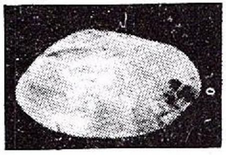
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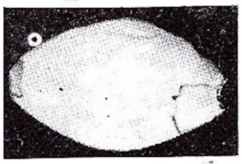
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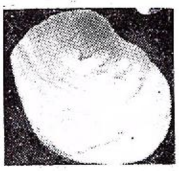
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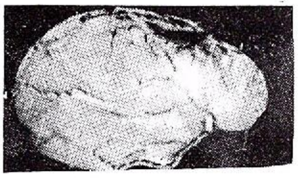
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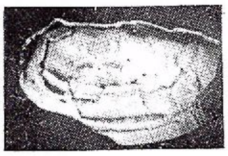
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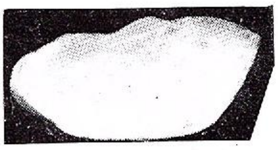
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Plate II

Fig. 1 — *Gari (Gobraeus)* ex gr. *affninis* (DUJARDIN, 1837) (x 1.6).

Fig. 2 — *Abra (Syndosmya) bosqueti* (SEMPER, 1866 (x 1).

Fig. 3 — *Congeria* n. sp. (x 7).

Fig. 4 — *Congeria brardii* (BRONGNIART, 1823) (x 4).

Figs. 5–6 — *Congeria kochi* ANDRUSOV, 1900 (x 3).

Fig. 7 — *Polymesoda (Pseudocyrena) convexa* n. ssp. (x 1.5).

Figs. 8–9 — *Polymesoda (Pseudocyrena) convexa* aff. *angusta* (HÖLZL, 1957 (x 1.5).

Fig. 10 — *Polymesoda (Pseudocyrena) convexa cordata* (HÖLZL, 1957 (x 1.5).

Fig. 11 — *Pelecyora (Cordiopsis) westendorpi westendorpi* (NYST, 1836 (x 1.5).

Fig. 12 — *Corbula (Caryocorbula) revoluta neglecta* MICHELOTTI, 1860 (x 1.4).

Fig. 13 — *Corbula* ex gr. *applanata* GÜMBEL in WOLFF, 1897 (x 1.6).

Figs. 14–15 — *Hydrobia elongata elongata* (FAUJAS in GILLET, 1953 (x 3).

Fig. 16 — *Stenothyra pupa* (NYST, 1836 (x 6).

Fig. 17 — *Hydrobia* sp. (x 7).

Fig. 18 — *Uxia* sp. (x 1.5).

Fig. 19 — *Turricula* sp. (x 1).

Fig. 20 — *Nuculana* sp. (x 1.6).

Fig. 21 — *Ledina* sp. (x 1.5).

Fig. 22 — *Lucinoma* sp. (x 1.3).

Figs. 23–24 — *Erycina (Erycina)* sp. (x 1.5).

Fig. 25 — *Kellia* sp. (x 1.2).

Fig. 26 — *Solecardia* sp. (x 1,5).

Fig. 27 — *Spaniorinus* sp. (x 1.6).

Fig. 28 — *Nassa* (Hima) sp. (x 1.5).

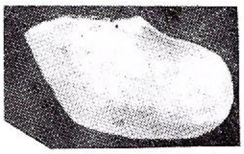
Fig. 29 — *Sanguinolaria* sp. (x 1.5).

Fig. 30 — *Erycina* (Hemilepton) sp. (x 1.5).

Fig. 31 — *Tellina (Moerella)* sp. (x 1.7).

Fig. 32 — *Dorsanum* sp. (x 1.7).

Fig. 33 — *Hydrobia* sp. (x 8).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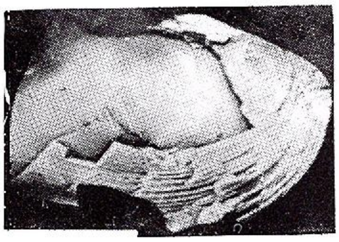
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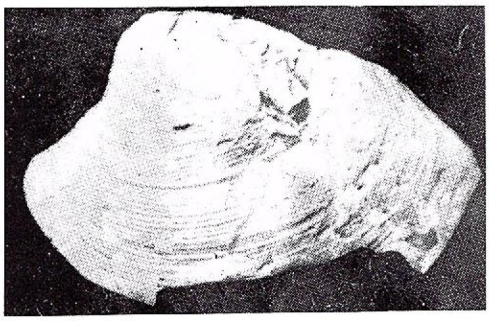
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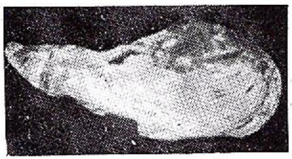
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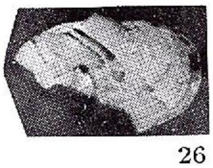
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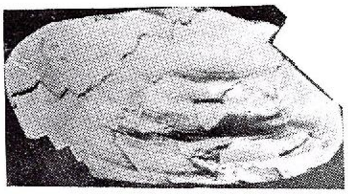
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Rom. J. Paleontology, 76, 1995, p. 81–84, Bucharest

NEW REMAINS OF INDRICOTHERIIN (PERISSODACTYLA, MAMMALIA) IN THE LOWER OLIGOCENE AT FILDU DE JOS (SĂLAJ DISTRICT, NW TRANSYLVANIA)

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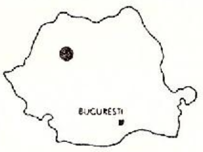

Key words: Mammalia. Oligocene. Transylvania. Taxonomy.

Abstract: The Lower Oligocene deposits cropping out in the right side of the Botiş Valley, between the localities of Fildu de Jos and Tetiş (Sălaj district), probably in the base of the Mera Beds (sensu Koch), comprise a distal fragment of a left tibia with a portion of fibula anatomically joined, assigned to a large-sized indricotheriin. These are the oldest remains of a giant rhinoceros known in Romania up till now. They might belong to the genus *Urtinotherium*.

Introduction

The radiometric measurements effectuated in the Paleogene in the Huedin area in the period 1968–1970 revealed an anomalous zone in the left side of the Botiş Valley (Sălaj district) (Fig. 1). The maximum value of the radioactive anomaly recorded was 440μr/s.

The opening up effectuated in the anomalous zone proved that radioactivity had been determined only by the presence of a fragment of phosphorized bone included in a bank of conglomeratic sandstone. The specialists who found the fragment (the late eng. S. Adamovici and dr. eng. I. Sălăjan) pointed out that the conglomeratic sandstone bed from which the fossil bone was sampled overlay a succession (about 4–5 m thick) of sandstones, marls and organogenous sandy limestones, of Oligocene age. At present, the succession is no longer visible, the fossiliferous site being covered in the course of time by the agricultural works. However, at a small distance upstream, small outcrops can be seen, which are lithologically similar to those mentioned at the sampling site of the fossil bone fragments. Their study makes us presume their origin in the lower part of the Mera Beds (sensu Koch, 1880), more precisely the upper part of the basal level separated by Moisescu (1975) as the "sandy level with Timpanotos labyrinthum alpinum and Balanus concavus". This hypothesis was confirmed by the fossiliferous calcareous sanstone bank visible in the mentioned outcrops including: *Turitella (Turitella) tricarinata communis* RISSE, *Tympanotonos (Tympanotonos) labyrinthum alpinum* (TOURNOUER), *Ampullinopsis*

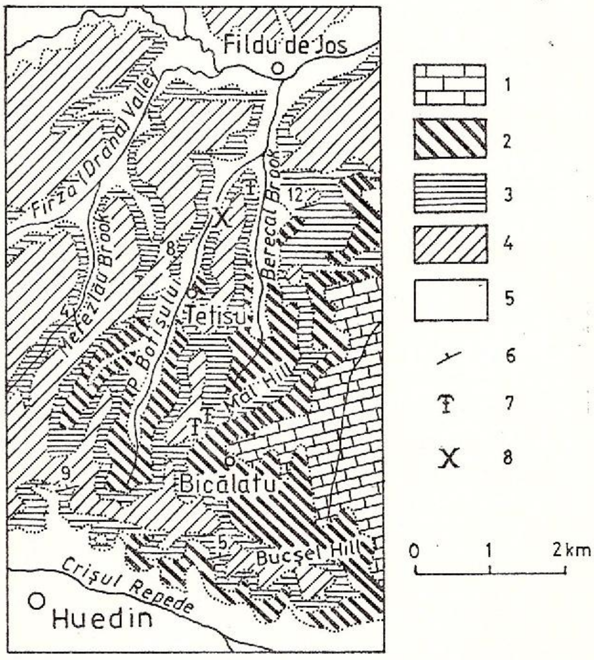

Fig. 1 – Geological sketch-map of the Huedin-Fildu de Jos area (after Moisescu, 1975; with modifications): 1, Undivided Eocene deposits; 2, Brebi Marls (Upper Eocene-Lower Oligocene); 3, Hoia Beds and Mora Beds (Rupelian); 4, Moigrad Beds (Rupelian); 5, alluvia; 6, normal bed position; 7, fossiliferous site; 8, fossil bone occurrence.

Table

Comparison of the tibia and fibula sizes (mm)

Sizes	Indricotheriinae	Paraceratherium[1]		Paraceratherium
	indet. (? Urtinotherium) Fildu-Tetiş, Transylvania	prohorovi (Bor.)	bugtiense (Pilg.)	(=Indricotherium)[2] transouralicum (M. Pavl.)
Length of the tibia fragment	299.0			
Length of the fibula fragment	141.0			
Supraarticular medio-lateral tibia diameter	172.0	143–185	230	188–212
Supraarticular antero-posterior tibia diameter	142.0	120–152		158–170
Articular medio-lateral tibia diameter	135.0	126–163		152–174
Articular antero-posterior tibia diameter	111.5			
Diaphysial medio-lateral tibia diameter	136.0	123–154		150
Diaphysial antero-posterior tibia diameter	88.0			
Epiphysial antero-posterior fibula diameter	63.0	57–61		82–110
Fibula-astragalus joint facet diameters	62.5 x 32.5	(22–26) x (36, 42)		32 x 67

1. after Gromova (1959)
2. after Borissiak (1923) and Gromova (1959)

cf. *crassatina* (LAMARCK), *Volema (Pugilina)* cf. *subcarinata* (LAMARCK), *Babylonia (Peridipsacus) caronis* (BRONGHIART) and *Cardium transsilvanicum* HOFMANN, characteristic of the Mera Beds assigned to the Lower Rupelian. One cannot be sure of the exact location of the fossil remains in the succession of Rupelian deposits in the study area; however, the Rupelian age cannot be questioned as no more recent deposits have been found in the area (Moisescu, 1975).

Paleontological description

Indricotheriinae g. et sp. indet.
(? *Urtinotherium*)

The remains of the left posterior member consist of a tibia distal fragment, anatomically connected with a small fibula fragment.

The tibia fragment in the distal third is fairly massive. The diaphysis is broken, the bone being incomplete. The lateral face, visibly concave, to the epiphysis, becomes plane-convex in the dorsal part. Median maleola massive, not prominent, the lateral one carved by the fibula joint surface. In front of the break the diaphysis displays a cross-section outlining a right-angled inequilateral triangle with curved sides. The caudal face would correspond to the hypotenuse and the median one to the short chatetus. This shape of the section is maintained along the whole length of the bone; it does not die out towards the diaphysis and for this reason the tibia fragment resembles a triangular prism. The interior of the medular channel was a good crystallization place for the diagenetic calcite, the rhombohedrons covering the cavity walls. In the epiphysis zone, the nutritive foramina occur frequently mostly on the caudal face. The joint surfaces with the astragal are unequal both as extension and as profoundness. The medial surface is narrower and more superficial in comparison with the adjacent one, larger and deeper. The crest which separates them is rounded and low, oblique (about 20^{0}) versus the antero-posterior plane of the bone.

The distal extremity of the fibula is swallen versus the hightly flattened diaphysis, with an elongated elliptical contour in cross-section. Laterally, the epiphysis is carved by a furrow for the fibular muscles. The joint facet for the astragal is oval elongated.

Comparisons and comments

Taking into account the considerable large sizes as well as the morphological characteristics the only group to which our material can be referred is that of giant rhinoceroses (indricotheriinae), aberrant specimens of the ceratomorphs.

Their presence at different stratigraphic levels of the Oligocene in the north-western part of the Transylvanian Basin has been proved many times (Gabunia, Iliescu, 1960; Rădulescu, Samson, 1989; Codrea, 1989).

The oldest remains known until now in this area, namely the dental parts (M 2/sin, P 3/dext), from the Upper Ticu Beds (Dincu Beds, sensu Rusu, 1972) at Turea-Corneşti, initially assigned to the genus *Indricotherium* (Gabunia, Iliescu, op. cit.) and then to the genus *Benaratherium* (Gabunia, 1964, 1966), define at present the new species *Benaratherium gabuniai* RĂDULESCU and SAMSON (1989). This species resembles as regards the size the nominative species *Benaratherium callistrati* GABUNIA, but it is "more primitive in respect to the dental morphology".

Defined from the Upper Oligocene at Benara (Georgia; Gabunia, 1955, Gabunia, Iliescu, 1960) genus *Benaratherium* includes small-sized indricotheriinae. Due to the scarcity of the fossiliferous sites and the fragmentation of the samples the physionomy of the two above-mentioned species is still unclear. Both the material samples at Benara and those from Transylvania do not include any tibia and therefore any direct comparison is out of question. A comparison between the metrical data of our material with those of other indricotheriinae specimens with known tibia (Tab.) reveals the appurtenance to the size-variation interval of a relatively large-sized species, *Paraceratherium prohorovi* (BORISSIAK) (Gromova, 1959, Pl. XI, Fig. 1; Pl. XII, Fig. 2; Tab. 26), but they are smaller than those characteristic of species such as *Paraceratherium (= Indricotherium) transouralicum* (PAVLOVA) (= *Indricotherium asiaticum* BORISSIAK, 1923) or *Paraceratherium bugtiense* (PILGRIM) (Gomova, 1959; Tab. 26).

Consequently, the remains presented in this paper prove the existence of a large-sized indricotheriin probably coming from the lower half of the Mera Beds (sensu Koch). This would be the oldest indricotheriin known in Romania until now. One might suppose a first moment of the giant rhinoceroses immigration from Asia to the Transylvanian areal during the Rupelian. The existence of some continental bridges between Asia Minor and the Carpatho-Balkan area (Heissig, 1979) made possible such passages at that time. Thus the giant rhinoceroses join the entelodontides, whose presence in the Moigrad Beds, suprajacent to the Mera Beds, has already been established (Kretzoi, 1941; Rădulescu, Samson, 1989); this indicates the same direction of migration (Brunet, 1979). Taking into consideration the sizes of the material discovered and the stratigraphic level we consider that it might represent the genus *Urtinotherium*, typical of the Lower Oligocene deposits in Asia (Lucas, Sobus, 1989).

The remains found at Fildu-Tetis complete the paleofaunal assemblage known in the Lower Oligocene of Romania (Rădulescu, Samson, 1989; Codrea, Şuraru, 1989).

The material is deposited in the Paleontology-Stratigraphy Collection at the Museum of the Transylvanian Basin (University of Cluj-Napoca), inventory number 20 616.

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Plate

Indricotheriinae indet. (? Urtinotherium); Rupelian; Fildu de Jos (Sălaj district), Botiş Valley.

Fig. 1 — Tibia and fibula sin., distal fragments; cranial view.

Fig. 2 — Tibia and fibula sin., distal fragments; caudal view.

Fig. 3 — Tibia and fibula sin., distal fragments; lateral view.

Fig. 4 — Cross-section through the diaphysis portion of the tibia.

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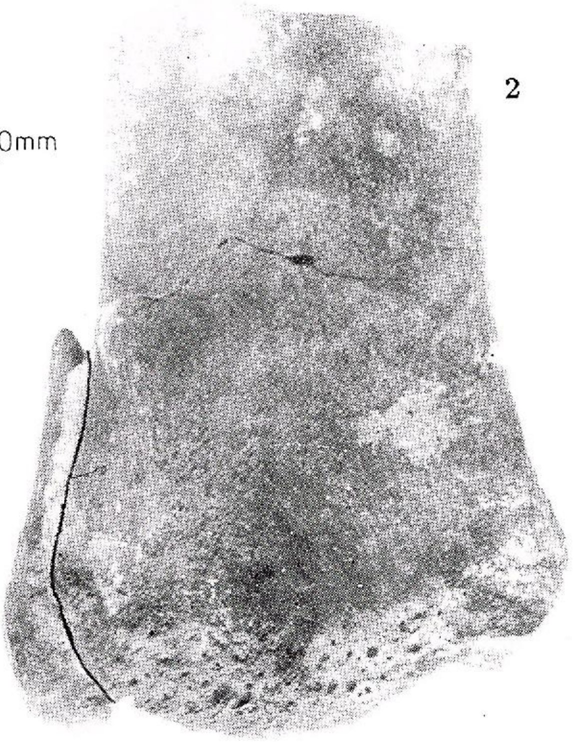

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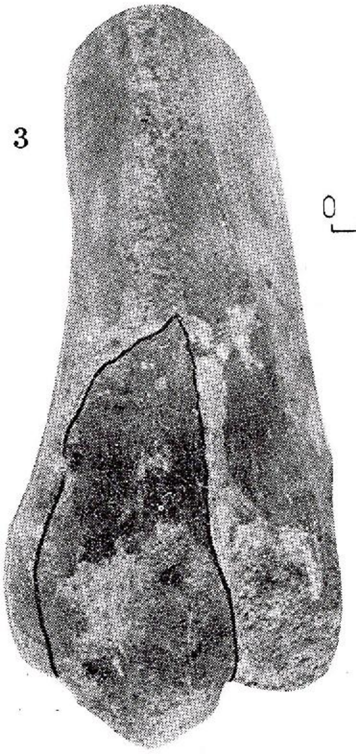

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CONTRIBUTION TO THE KNOWLEDGE OF THE SARMATIAN FORAMINIFERA OF ROMANIA

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Key words: Foraminifera. Biostratigraphy. Sarmatian. New taxa. Central Paratethys. Romania.

Abstract: Similar range of the foraminifera in the Sarmatian deposits from all Paratethys area is considered to be an important feature for regional stratigraphic correlation. In the evolution of the foraminiferal assemblages, three major changes were distinguished, roughly corresponding to the boundary of the Sarmatian substages: a) the appearance of endemic brackish species (e.g. *Lobatula dividens*) and extinction of the Badenian (Kossovian) foraminifera: this datum plane corresponds to the base of the Sarmatian; b) the appearance of genus *Dogielina* as well as other genera such as *Sarmatiella* and *Meandroloculina*, datum plane for the base of the Basarabian substage; c) the extinction of the Sarmatian foraminifera, considered as datum plane for the base of the Chersonian substage. In this work, some of the most important species occurring on the Romanian territory are described. Amongst them, some new taxa: *Articulina (?) daraensis, Dogielina simnicaensis, Fissurina bessarabica, F. carpathica, F. lamarae, Porosononion bessarabicum, P. sarmaticum* and *Elphidium nataliae.*

The Sarmatian deposits are well represented in the Romanian territory. The most important outcrops occur in the Subcarpathians, Transylvania, eastern border of the Pannonian realm, southern Dobrogea and in the northern part of Moldavia (Fig. 1).

From the biostratigraphic point of view, the Sarmatian deposits are similar all over the Paratethys. This fact is the result of the unitary paleogeographic evolution of the area and the development of a comparable fauna. The Sarmatian foraminiferal assemblages are characterized by the development of an endemic fauna. At the end of the Badenian, the Paratethys area was almost completely isolated from the open seas, which led to a continuous desalination. Therefore, the marine foraminifera from the Badenian deposits are completely replaced by non-marine (brackish) endemic ones. This important moment in the evolution of the Paratethys took place between 14 and 13.5 Ma (correlatable with Zone N 12 by planktonic foraminifera or the base of NN 7 by nannoplankton) which corresponds to the major global cooling event (Kennett, 1985 a; 1985 b). The appearance of the endemic fauna in the early Sarmatian is characterized by assemblages rich in fossil specimens but poor in species. So, the early Sarmatian deposits contain only specimens of *Lobatula dividens* (LUCZK.). Step by step, the assemblage is enriched with miliollids, articulinids, elphidiids or nonionids, all of them endemic. The most diversified foraminiferal fauna occurs during the Middle Sarmatian. In the whole Paratethys, the evolution of this fauna ceased in the Upper Sarmatian (Chersonian), a phenomenon probably induced by the decrease in salinity. No foraminifer occurs in the Upper Miocene and Pliocene in the Central Paratethys except for one level in Meotian deposits in which specimens of the genus *Ammonia* have been recorded (at least in the Carpathian area). From the same stratigraphic level, in the northern Perieuxinic-Caucasian area (eastern Paratethys) a very diversified foraminiferal assemblage has been described (Bogdanovicz, 1961; Maissuradze, 1988).

The biostratigraphy of the Sarmatian deposits based upon the endemic foraminiferal fauna, in spite of its unity in Central Paratethys, has its disadvantage: the difficulty of correlation with the open seas biostratigraphy. This correlation has been made based upon mammals, physical methods of geochronology or nannoplankton (Müller, 1974: Stradner & Suchs, 1979).

The differences between biostratigraphic scales proposed by the authors seem to be given by subjective

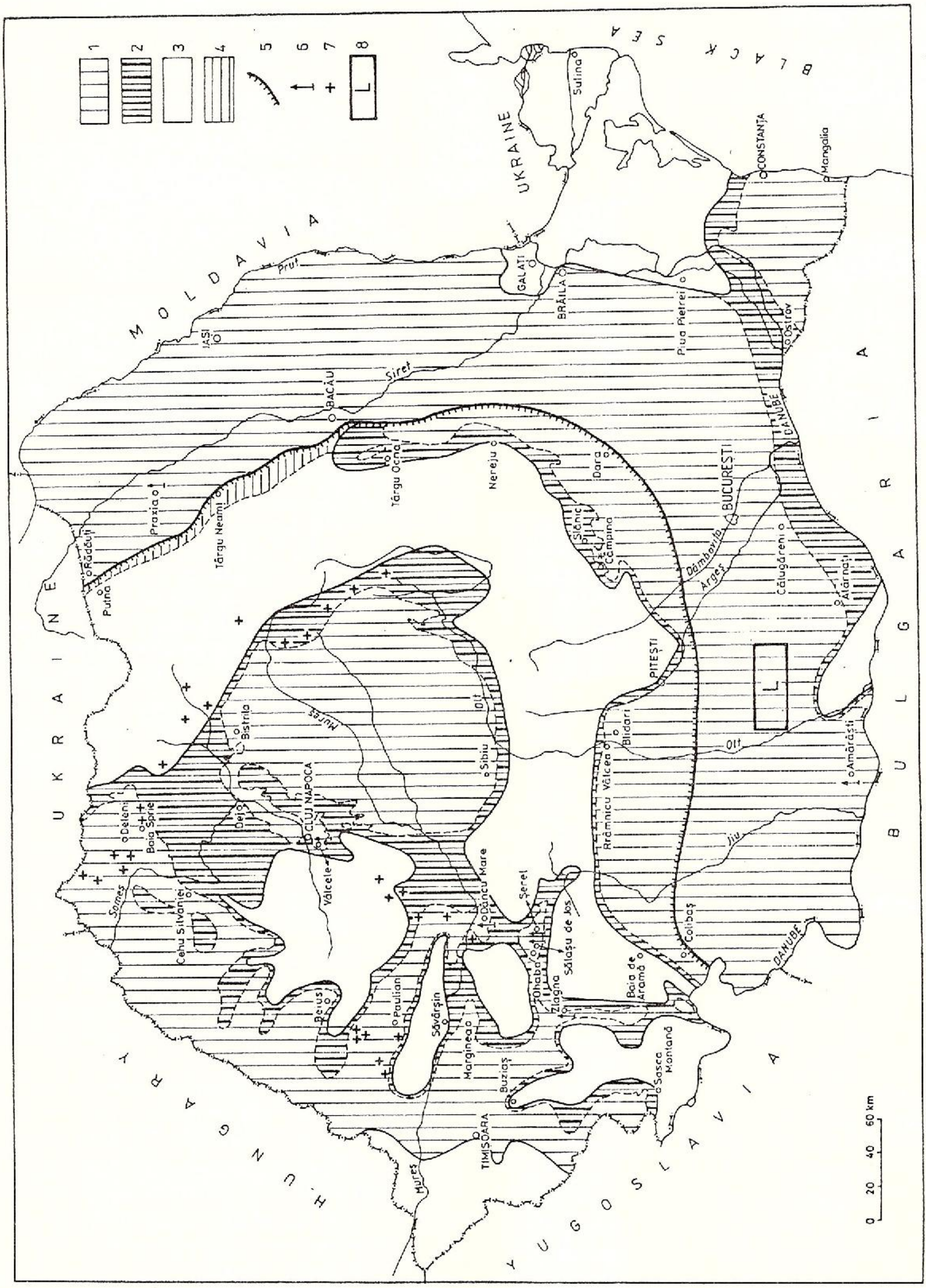

Fig. 1 - Extension of the Sarmatian deposits on the Romanian territory (after Saulea et al., 1969, modified). 1, Extension of the Sarmatian deposits in Romania in outcrops or covered by younger deposits; 2, areas in which Sarmatian deposits were probably erroded; 3, probably emerged area during Sarmatian; 4, Sarmatian deposits covered by folded sediments; 5, tectonic active line; 6, drilling; 7, volcano; 8, area with boreholes in Romanian Plain.

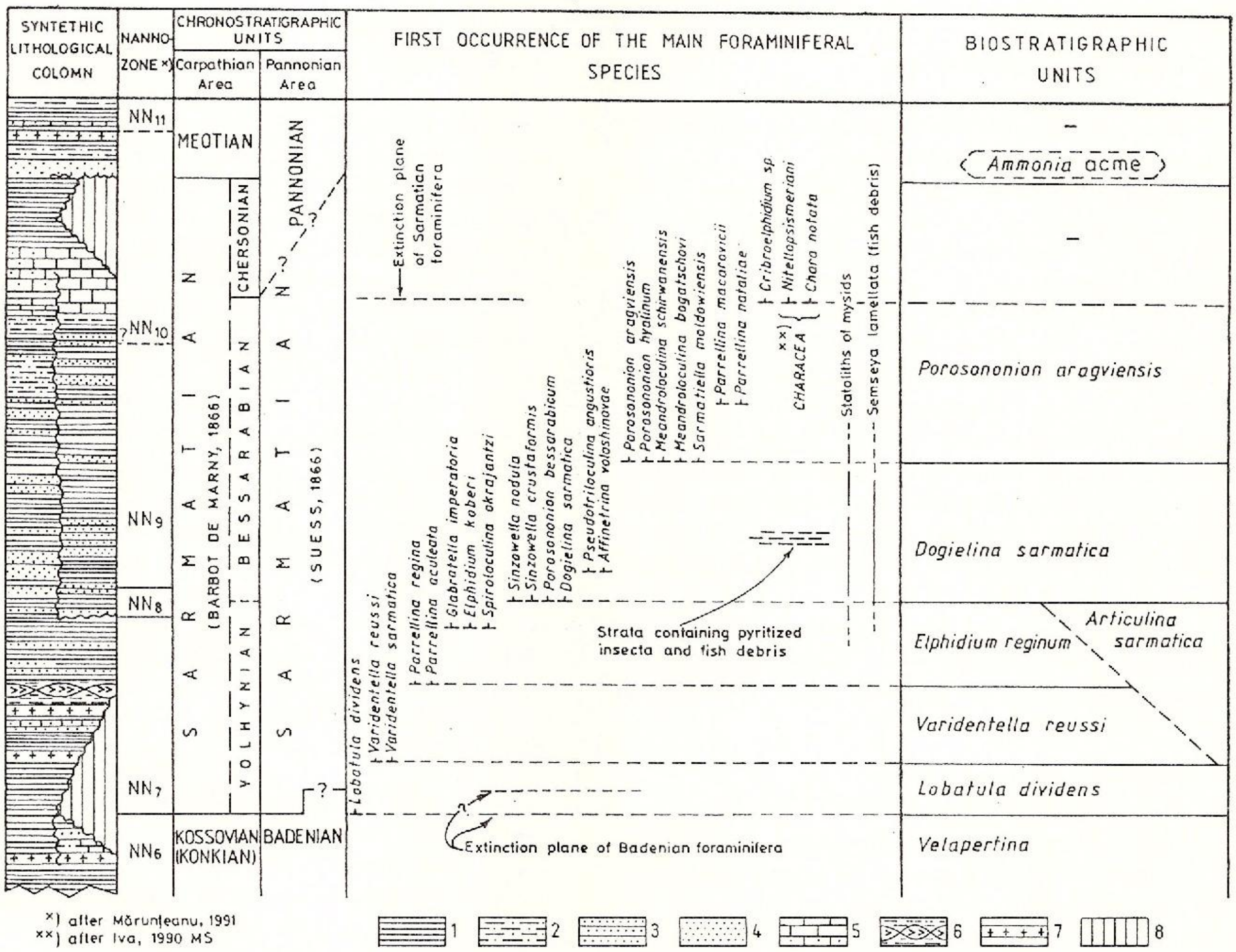

Fig. 2 – Synthetic correlation table: 1, clays; 2, siltic clays; 3, sandstones; 4, sands; 5, limestones, detrital limestones; 6, gypsum; 7, tuffs; 8, gaps.

reasons (Grill, 1941; Stancheva, 1960; Korekzne-Laky, 1968; Ionesi, 1968; Paghida-Trelea, 1969; Didkovski & Satanovskaya, 1970; Negoiţă et al., 1969; Brestenska, 1974; Cicha et al., 1975; Maissuradze, 1980, Paramonova et al., 1986).

In order to give a general image of the evolution of the foraminiferal assemblage (fig. 2), of the appearances and extinctions of the species (or genera) taken into account as datum plane for the Romanian territory, besides the study of some available outcrops, many boreholes located in the main geological units have been investigated. Among them mention should be made of Praxia (northern Moldavia); Rădoieşti, Stoicăneşti, Seaca, Dulceanca, Peretu (eastern Romanian Plain); Amărăşti (western Romanian Plain); Zlagna, Breazova (eastern border of the Pannonian realm); Serel, Sălaşu de Sus (Haţeg basin); Vâlcele (Transylvania basin). The following sections, representative for Sarmatian deposits have been sampled: Valea Darei section (Dara village, Buzău district); Valea Morilor section (Colibaşi village, Mehedinţi disstrict); Valea Gardului (Mireş village, Bistriţa-Năsăud district). Beside them, numerous isolated outcrops (Paulian, in Zlatna basin: Serel and Ohaba, in Haţeg basin; Valea Simnicel near village Blidari, Vâlcea district, in the nord-eastern Oltenia) which furnished a rich and well preserved foraminiferal assemblages are to be mentioned.

The succession of the appearances and extinctions of the species similar in the whole Paratethys should be considered as synchronous. Also, the comparison of the foraminiferal assemblages coming from shelf and deep water areas (Paramonova et al., 1986) pointed out minor differences.

Taking into account the foraminiferal range of the main species considered as index taxa, in the Sarmatian deposits in the Romanian territory, several biostratigraphic units were separated as follows:

Lobatula dividens Zone

Age: Early Sarmatian (Lower Volhynian).

Base: extinction of the Kossovian foraminifera and the appearance of the index fossil.

This biostratigraphic unit is characterized by the first appearance of *Lobatula dividens* (LUCZK.) and its luxuriant development. Sometime, in this stratigraphic interval, species typical of Upper Kossovian (probably reworked) are mentioned. Iorgulescu (1953) described this biostratigraphic unit as Zone S 1 and pointed out that, beside the index fossil (named here *Cibicides lobatus*) other species "which do not belong exclusively to this zone" occur. In the Maramureş basin (Valea Darasca, Deleni village and the surroundings of the Budeşti village) and in western Oltenia (Valea Morilor, Colibaşi village) there are the best outcrops in searching for the lower boundary of this biostratigraphic unit.

Lobatula dividens Zone was recognized in Central Paratethys, mainly in the Carpathian area (see Luczkowska, 1967; Brestenska, 1974; Cicha et al., 1975; Papp, 1975;).

Varidentella reussi Zone

Age: Lower Sarmatian (Middle Volhynian).

Base: first occurrences of the marker species.

Remarks: Varidentella reussi Zone is characerized by proliferation of the species belonging to the genus *Varidentella (V. rotundata* (GERKE), *V. sarmatica* (KARRER)) and the first occurrences of the genera *Articulina* and *Articularia*.

Elphidium reginum Zone

Age: Lower Sarmatian (Upper Volhynian).

Base: first occurrence of the index taxon.

Remarks. This biostratigraphic unit is characterized by a rich foraminiferal assemblage: many species of the underlying zone are also frequent but the elphidiids (*E. reginum, E. aculeatum*) are the species which give the dominant feature. Sometime, beside them, some specimens of the genera *Porosononion (P. martkobi, P. sarmaticum)* and *Nonion* do occur. In its upper part, the developing of some peculiar organic debris consisting of mysid statoliths (Voicu, 1971, Maissuradze & Popescu, 1987) usually mentioned in the relevant literature as *Sphaeridia* (IORGULESCU, 1953) is pointed out. The presence of the fish species *Semseya lamellata* FRANZENAU is to be pointed out, too (Dumitrică & Popescu, 1984). It is to note some other occurrences in the upper part of this zone: *Glabratella imperatoria* (d'ORBIDGY), *Elphidium koberi* TOL., *Spiroloculina okrajantzi* BOGD. and the appearance of the numerous levels containing siliceous microfossils (silicoflagellates, diatoms).

Dogielina sarmatica Zone

Age: Middle Sarmatian (Lower Basarabian).

Base: first occurrence of *Dogielina sarmatica.*

Remarks. Roughly, the base of the Basarabian substage is defined by the first occurrence of *Cryptomactra pesanseris* ANDR.. This datum plane is considered to be simultaneous with the first occurrence of *Dogielina* (Maissuradze, 1980; Paramonova et al., 1986). The stratigraphic interval corresponding to Dogielina sarmatica Zone contains also some other first appearance datum (FAD) such as: *Sinzowella nodula, S. crustaformis, Pseudotriloculina angustioris, Affinetrina voloshinovae.* The foraminiferal assemblage is rich in specimens belonging to the genera *Porosononion, Bolivina* and *Fissurina*. In two sections (Valea Simnicel, Blidari village, Vâlcea district and Valea Darei section, Dara village, Buzău district) a rich level containing pyritized small insects, some of them well preserved, were recorded. The material was donated to my colleague Fl. Marinescu to be studied. Also important to note at this level is the occurrence of foraminifera belonging to Peneroplidae (see also Paghida-Trelea, 1969; Didkovski & Satanovskaya, 1970).

Porosononion aragviensis Zone

Age: Middle Sarmatian (Upper Basarabian).

Base: first occurrence of the marker species.

Remarks. The index species of this zone was mentioned both in the shallow and deep water sediments (Paramonova et al., 1986). The assemblage of this biostratigraphic unit is similar to the previous one. The differences consist in appearance of some species such as *Porosononion umboelatum, P. hyalinum, Elphidium macarovicii* and *E. nataliae* and the extinction of some species belonging to genera *Bolivina, Elphidium* or *Retroelphidium* as well as the mysid statoliths or siliceous microfossils (silicoflagellates). It is to underline the absence of the marker species in the Subcarpathians, Getic Depression and western Oltenia, but its presence in the eastern border of the Pannonian basin, Moldavia and the Romanian Plane. Its absence in the Subcarpathians should be interpreted as a result of the facies control. The top of this zone is marked by the extinction of the foraminifera in the whole Paratethys area and the developing of a fresh-water flora and fauna. The occurrence of the first Characea (*Nitelopsis, Chara*) seems to be a good marker fossil for the next biostratigraphic unit in which the foraminifera do not occur.

The Sarmatian stage, described by Barbot de Marny and defined in the same year (1866) by Suess (see Papp, 1974; Papp et al., 1974) was divided (Simionescu, 1903) in three substages: Volhynian, Basarabian and Chersonian. These subdivisions were defined by molluscs but they have not yet established stratotypes. Because of this fact, the discussion concerning the correct definition of the three substages is not finished. There were some attempts to promote new substages (e.g. Kojumdgieva, 1971). The most famous is the "Buglowian" which was demonstrated (Vialov, ed. 1970) to represent in fact a transitional formation (not a stage) from Kossovian to Sarmatian.

Some problems concerning the correlation of the Sarmatian deposits from outer Carpathians and Pannonian realm are to be pointed out. The presence of the marker fossil for Porosononion aragviensis Zone in the Pannonian should be an argument for the correlation of the base of Pannonian stage with the base of the Chersonian. This fact has already been pointed out by Paghida-Trelea (1969, p. 145); moreover, Olteanu (1989), studying the Ostracods community, suggests the correlation of the Pannonian with the Meotian stage.

Systematics

Fam. **Ficherinidae** MILLETT, 1898
Subfam. **Nodobaculariellinae** BOGDANIWICZ, 1991
Wiesnerella CUSHMAN, 1933
Wiesnerella plana BOGD., 1952
(Pl. I, Figs. 1, 2)

Wiesnerella plana BOGDANOWICZ, 1952, p. 189, pl. 5, fig. 7.

Range: Basarabian. The holotype is coming from the Caucasian area: in Romania it was mentioned in Moldavia (Paghida-Trelea, 1969). The species was recorded from shelf facies from Haţeg basin (Ohaba village, Hunedoara dist.).

Fam. **Nubeculariidae** JONES, 1875
Subfam. **Nodophthalmidiidae** CUSHMAN, 1940
Sarmatiella BOGDANOWICZ, 1952
Sarmatiella moldawiensis BOGD., 1952
(Pl. IV, Fig. 5)

Sarmatiella moldawiensis BOGDANOWICZ, 1952, p. 219, pl. 35, figs. 3–6.

Range: Basarabian. Many specimens belonging to this taxon were recorded from shelf facies in boreholes drilled in the Moesian platform (e.g. Rădoeşti, Teleorman district).

Sarmatiella prima BOGD., 1952
(Pl. IV, Figs. 9–12)

Sarmatiella prima BOGDANOWICZ, 1952, p. 35, figs. 3–6.

Range: Basarabian. The holotype is coming from Precaucasian area. Other occurrences: southern Ukraine, Rep. of Moldavia. In Romania this species was found in Basarabian deposits (borehole Dăneasa, Olt district)

Subfam. **Meandroloculininae** BOGDANOWICZ, 1981
Meandroloculina BOGDANOWICZ, 1935
Meandroloculina conicocameralis BOGD., 1952
(Pl. III, Fig. 9; Pl. IX, Fig. 5)

Meandroloculina conicocameralis BOGD., 1952, p. 230, pl. 37, fig. 4.

Range: Basarabian. In Romania the species was recorded from shelf deposits from the Moesian platform (borehole Rădoieşti, Teleorman district). To this species were also conferred some specimens with broken initial part coming from an outcrop near Bărbăteşti village, Vâlcea district.

Meandroloculina bogatschovi BOGD., 1935
(Pl. III, Figs. 5, 6)

Meandroloculina bogatschovi BOGD. Bogdanowicz, 1952, p. 227, pl. 36, figs. 3–6.

Range: Basarabian. Common taxon in Basarabian deposits overlying the Moesian Platform (from Olt and Teleorman districts) and in Valea Simnicel section (Blidari village, Vâlcea district.).

Meandroloculina schirwanensis BOGD., 1952
(Pl. III, Figs. 7, 8)

Meandroloculina schirwanensis BOGDANOWICZ, 1952, p. 228, pl. 37, fig. 1.

Range: Basarabian. The species was encountered in borehole Rădoieşti, Teleorman district.

Subfam. **Nubeculinellinae** AVNUMELECH & REISS, 1954
Sinzowella CUSHMAN, 1933
Sinzowella crustaformis (BOGDANOWICZ), 1952
(Pl. I, Figs. 3, 4; Pl. IX, Fig. 4)

Nubecularia novorossica KARRER & SINZOW, forma *crustaformis* Bogdanowicz, 1952, p. 75, pl. 3, figs. 5, 6).

Test attached, planoconvex, medium to large sizes; initial chambers spherical, followed by a cornuspirine one, then planospiral; all chambers visible on spiral side (attached): dorsal (free) side with fine, transverse striae; wall calcareous, thick, unperforate; aperture, an elongated slit in the young stage, multiple in the adult, at the base of the last chamber (see pl. IX, fig. 4).

Range: Basarabian. Species recorded from Mid-Sarmatian deposits containing *Cryptomactra pesanseris* ANDR.. Common in Valea Simnicel section (Blidari, Vâlcea district) and Valea Darei section (Dara village, Buzău distr.).

Sinzowella nodula (KARRER & SINZOW,) 1876
(Pl. IX, Figs. 1–3)

Nubecularia novorossica KARRER & SINZOW typ. *nodulus* Karrer & Sinzow, 1876, Sitz Akad. Wiss. Wien, 74, p. 10, figs. 11-25 (fide Ellis & Messina); Bogdanowicz, 1952, p. 74, pl. 3, fig. 3

Remarks: Test attached, large, hemispherical or spherical. The large variability of their shape is a result of the mode of life. Our material is predominantly spherical.

Range: Basarabian.

Fam. **Spiroloculinidae** WIESNER, 1920
Spiroloculina d'ORBIGNY, 1826
Spiroloculina okrajantzi BOGDANOWICZ, 1947
(Pl. I, Figs. 5, 6)

Spiroloculina okrajantzi BOGDANOWICZ, 1947, p. 27, pl. 3, fig. 4; Bogdanowicz, 1952, p. 155, pl. 22, fig. 4; Didkowski & Satanovskaya, 1970, p. 46, pl. 26, fig. 3; Maissuradze, 1971, p. 62, pl. 2, fig. 4; Brestenska, 1974, p. 246, pl. 2, fig. 1.

Range: Upper Volhynian-Lower Basarabian. Common species in all Paratethys.

Fam. **Hauerinidae** SCHWAGER, 1876
Subfam. **Hauerininae** SCHWAGER, 1876
Cycloforina LUCZKOWSKA, 1972
Cycloforina moljawkovi (DIDKOVSKI), 1961
(Pl. I, Figs. 10, 11)

Quinqueloculina moljawkovi DIDKOVSKI, 1961, p. 67, pl. 11, fig. 8; Didkovski & Satanowskaya, 1970, p. 28, pl. 25, fig. 3.

Range: Basarabian. In Romania was recorded from Banat (Ohaba and Serel villages, Hunedoara district).

Cycloforina cf. *C. cristata* (MILLETT), 1898
(Pl. I, Figs. 7–9)

Remarks. Luczkowska (1974, p. 76, pl. 13, fig. 7) described some specimens recorded from Lower Sarmatian as *Cycloforina cristata* which are close to our specimens. The illustrated material is coming from Ohaba (Hunedoara district) from Volhynian-Lower Basarabian deposits.

Subfam. **Miliolinellinae** VELLA, 1957
Affinetrina LUCZKOWSKA, 1972
Affinetrina voloshinovae (BOGDANOWICZ), 1947
(Pl. I, Figs. 12–14)

Miliolina voloshinovae BOGDANOWICZ, 1947, p. 22, pl. I, fig. 7; Bogdanowicz, 1952, p. 146, pl. 21, figs. 1–4.

Range: Basarabian.

Remarks. A large intraspecific variability has been observed to this species. In the same sample there were recorded specimens with smooth surface or fine longitudinal striae and specimens with rough, pectinate surface in a gradual transition. Some of these individuals were described as subspecies (*voloshinovae, brevidentata, pectiniformis*). Maissuradze illustrated a specimen belonging to the same species as aff. *voloshinovae* (Maissuradze, 1971, p. 47, pl. 7, figs. 2, 3). Our material is coming from Ohaba (Hunedoara dis.), Valea Simnicel section (Blidari, Vâlcea district) and from many boreholes drilled in Romanian Plain (in Teleorman and Olt districts).

Pseudotriloculina CHERIF, 1970
Pseudotriloculina angustioris (BOGD.,) 1952
(Pl. II, Figs. 1, 2)

Miliolina angustioris BOGDANOWICZ, 1952, p. 127, pl. 14, fig. 4.

Range: Basarabian.

The type specimen was described from Middle Sarmatian from Caucasian area. Common in Basarabian deep-water sediments from the Subcarpathians.

Varidentella LUCZKOWSKA, 1972
Varidentella pseudocostata (VENGLINSKI), 1958
(Pl. II, Figs. 3, 4)

Miliolina pseudocostata VENGLINSKI, 1958, p. 70, pl. 10, figs. 1–3; Venglinski, 1962, p. 74, pl. IV, figs. 3, 4.

Varidentella pseudocostata (VENGLINSKI). Luczkowska, 1974, p. 140, pl. 26, fig. 7.

Range: species described from the Ukrainian Subcarpathians from the upper part of the Lower Sarmatian. Common in Volhynian deposits from Romania.

Varidentella reussi (BOGDANOWICZ), 1947
(Pl. II, Fig. 8)

Miliolina reussi BOGDANOWICZ, 1947, p. 21, pl. 1, fig. 4; Bogdanowicz, 1952, p. 119, pl. 13, fig. 1.

Varidentella reussi (BOGD.): Luczkowska, 1974, p. 141, text-figs. 48, 49.

Range: Common in Lower Sarmatian in deep-water sediments.

Varidentella sarmatica (KARRER), 1877
(Pl. II, Figs. 5-7)

Quinqueloculina sarmatica KARRER, 1877, p. 375, pl. 16, fig. 11.

Range: Volhynian-Basarabian.

Species with large intraspecific variability; Karrer described them as var. *"typica"*, *"elongata"* and *"virgata"*.

Subfam. **Tubinellinae** RHUMBLER, 1906
Articularia LUCZKOWSKA, 1974

Remarks. After Luczkowska (1974, p. 66) the genus *Articularia* differs from Articulina " in its quinqueloculine, not planospiral or irregulary milioline, initial part". The observations made by Bogdanowicz (1952) and Venglinski (1959, 1961) on "articulina-like" species which do not belong to the genus *Articulina* d'ORBIGNY are also discussed here. The basic differences between the two genera, pointed out by the authors (Luczkowska, 1974; Bogdanowicz, 1952) seem to be unsatisfactory if the trimorphism of the group is taken into account, therefore a large variability of the initial part.

Articularia articulinoides (GERKE & ISSAREVA), 1952
(Pl. III, Figs. 2-4)

Articulina (?) articulinoides GERKE & ISSAEVA (in Bogdanowicz, 1952), p. 211, pl. 33, figs. 6-8.

Range: Volhynian-Basarabian. Our specimens were recorded from Valea Darei section, Dara village, Buzău district.

Articulina d'ORBIGNY, 1826
Articulina bidentata DIDKOVSKI, 1958
(Pl. II, Figs. 9-11)

Articulina bidentata DIDKOVSKI, 1958 , p. 56, pl. 2, figs. 3-8.

Articulina bidentata bidentata DIDKOVSKI. Didkovski & Satanovskaya, 1970, p. 38, pl. 22, fig. 2.

Articulina bidentata costata DIDKOVSKI, 1958, p. 56, pl. 3, figs. 1-5; Didkovski & Satanovskaya, 1970, p. 39, p. 22, fig. 3.

Range: Basarabian.

Remarks. The two subspecies (*A. bidentata bidentata* and *A. bidentata costata*) are coming from the same level. The differences between the two taxa consist in the presence of fine longitudinal striae in *A. bidentata costata*, considered here to represent an intraspecific variability.

Articulina daraensis n. sp.
(Pl. II, Figs. 12, 13; Pl. III, fig. 1)

Articulina sp. BOGDANOVICZ, 1952, p. 206, pl. 32, fig. 3.

Description. Test slender, elongated; initial chambers arranged quinqueloculine, in microsphaeric specimens or a spherical one, followed by an cornuspirine enrolled chamber, in megalospheric, later rectilinear, pyriform, elongated, circular in transverse section; wall calcareous; surface smooth or with slightly longitudinal striae; aperture terminal, slit-like, irregular, at the end of a more or less flattened neck.

Remarks. Micro- and megalospheric specimens differ only in the arrangements of the chambers in the initial part.

Holotype. coll. I.G.R., nr. P 101520/37105, illustrated on pl. 2, fig. 12.

Type locality: Dara, Buzău district.

Age: Basarabian.

Articulina problema BOGDANOWICZ, 1952
(Pl. II, Figs. 10-14)

Articulina problema BOGDANOWICZ, 1952, p. 205, pl. 31, figs. 2-6, 9.

Remarks. Test slender, elongate, with parallel margin, increasing rapidly in size; aperture large, rounded, with thick, everted lip. The species differ from *Articularia articulinoides* in more elongated chambers, higher increasing rate and thick, everted lip.

Range: Upper Volhynian.

Dogielina BOGDANOVICZ & VOLOSHINOVA, 1949
Dogielina sarmatica (BOGDANOVICZ & VOLOSHINOVA, 1949
(Pl. III, Figs. 10, 11)

Dogielina sarmatica BOGDANOVICZ & VOLOSHINOVA, 1949, p. 185, text-figs. 1-6; Bogdanovicz, 1952, p. 215, pl. 34, figs. 5-9; Didkovski & Satanovskaya, 1970, p. 43, pl. 24, figs. 2, 6.

Range: Basarabian. This species is common in shelf and deep water facies from Moldavia and the Romanian Plain.

Dogielina simnicaensis n. sp.
(Pl. III, Figs. 12-14; Pl. IV, Figs. 1-4)

Description. Test free, elongate; early chambers quinqueloculine arranged in microspheric specimens, triloculine or rounded, slightly flattened with a spherical initial chamber followed by an enrolled cornuspirine one in the megalospheric specimens; later chambers rectilinear; wall calcareous, thick, imperforate, surface with irregular, discontinuous, vermicular, longitudinal ribs; aperture at the end of a short neck, rounded, bordered by an everted lip and numerous projections arising from inner margin of the opening.

Range: Basarabian.

Holotype: Coll. I.G.R., nr. 101521/37084, illustrated on pl. 4, fig. 2.

Type locality: Blidari (Valea Simnicel section), Vâlcea district.

Fam. **Ellipsolagenidae** SILVESTRI, 1923

Fissurina REUSS, 1850

Fissurina daraensis n. sp.

(Pl. V, Fig. 1)

Description. Test small, ovate in outline, compressed, lenticular in section; wall calcareous, smooth near aperture, finely puncticulate on the rest of the test, peripheral keel present; aperture slitlike, provided with long inner tube, curved towards one side; aboral opening somewhat obturated.

Holotype: Coll. I.G.R., nr. 101522/22037.

Age: Basarabian;

Range: Basarabian.

Type locality: Dara (Valea Darei section), Buzău district.

Remarks: This species has some affinity with "*Entosolenia mironovi*" BOGD., (1947) coming from the Upper Badenian deposits from Kuban but differs in lenticular transverse section instead of elliptical one.

Fissurina bessarabica n. sp.

(Pl. V, Fig. 3–5)

Description. Test free, small, ovate in outline, oval in transverse section; wall calcareous, finely perforate; surface smooth; aperture terminal, slitlike, provided with short inner siphon, disposed centrally; thick keel in the aboral part of the test; aboral opening obturated.

Holotype: Coll. I.G.R., nr. 101523/22038, illustrated on plate V, fig. 3.

Age: Basarabian.

Type locality: Blidari (Valea Simnicel section), Vâlcea district.

Fissurina carpathica n. sp.

(Pl. V, Figs. 2, 6)

Description: Test free, small, elliptical in outline, oval-elongate in section; wall calcareous, finely perforate; surface smooth; aperture slitlike, provided with internal, curved tube; obturated aboral opening; small thick keel in the aboral part.

Holotype: Coll. I.G.R., nr. P 101523/37106.

Age: Basarabian.

Type locality: Dara (Valea Darei section), Buzău district.

Fissurina lamarae n. sp.

(Pl. V, Fig. 7)

Diagnosis. Test free, small, elliptical in outline, lenticular in transverse section, surrounded by a peripheral keel; wall calcareous, finely perforated, with fine longitudinal ribs less elevated near apertural end; aperture terminal, slitlike, provided with inner tube curved to one side; obturated fissure-like aboral opening.

Holotype: Coll. I.G.R., nr. 101525/22040, illustrated on pl. V, fig. 7).

Type locality: Dara (Valea Darei section), Buzău district.

Age: Basarabian.

Etymology. Species named in honour L.S. Maissuradze, Tbilisi, for her contribution to the knowledge of Sarmatian foraminifera.

Remarks. In the same assemblage occur some specimens in which the ornamentation is made by vermicular ribs, included also in the same species.

Fam. **Bolivinidae** GLAESSNER, 1937

Bolivina d'ORBIGNY, 1839

Bolivina moldavica DIDKOVSKI, 1959

(Pl. V, Figs. 8–10)

Bolivina moldavica DIDKOVSKI. Didkovski & Satanovskaya, 1970, p. 143, pl. 82, fig. 7.

Range: Volhynian-Basarabian. Common species in Valea Darei section (Dara, Buzău dis.): and Valea Simnicel section (Blidari, Vâlcea dis.).

Remarks. In the variability of this species was included also *B. moldavica granensis* CICHA & ZAPLETALOVA 1963. (Sb UUG 28, p. 156, text-fig. 29), mentioned also by Brestenska (1974, p. 256, pl. 3, fig. 6) under the same name.

Fam. **Nonionidae** SCHULTZE, 1854

Florilus MONTFORT, 1808

Florilus bogdanowiczi (VOLOSHINOVA), 1952

(Pl. V, Figs. 11, 12)

Nonion bogdanowiczi VOLOSHINOVA, 1952, p. 19, pl. 1, figs. 1, 2; Maissuradze, 1971, p. 65, pl. 10, figs. 1–13.

Range: Upper Volhynian-Basarabian. The holotype was described from Caucasian area in Middle Sarmatian deposits: this species is common in Sarmatian deposits from Paratethys.

Fam. **Glabratellidae** LOEBLICH & TAPPAN, 1964

Glabratella DERREEN, 1948
Glabratella imperatoria (d'ORBIGNY), 1846
(Pl. V, Fig. 13, Pl. VI, Figs. 1–3)

Rosalina imperatoria d'ORBIGNY, 1846, p. 176, pl. 10, figs. 16–18.

Range: Upper Volhynian.

Remarks. The type species was recorded from Tarnopol, Poland. From deposits of the same age was described by Luczkowska (1967, p. 237, text-fig. 5, pl. 8, figs. 14, 15) a similar species as *Glabratella plana* which differs from *G. imperatoria* in having flatter test; the two species are suspected to be synonymous. Rare in our material excepting one sample coming from valea Fisici section (Bozioru village, Buzău district) in which the species is very abundant.

Fam. **Cibicididae** CUSHMAN, 1927

Lobatula FLEMING, 1828
Lobatula dividens (LUCZKOWSKA), 1967
(Pl. VI, Figs. 4–6)

Anomalinoides dividens LUCZKOWSKA, 1967, p. 238, pl. 9, figs. 1–5, 8, 9; text-fig. 6/3, 4.

Range: Lower Volhynian (early Sarmatian).

Remarks. This species has a very large intraspecific variability. Brestenska (1974) mentioned the same species as *Anomalinoides badenensis* (d'ORB.) and included in its synonymy *Cibicides certus* VENG., *C. (Anomalinoides) pokuticus* AIS., *C. (Anomalinoides) kaluschiensis* AIS., *C. (Anomaliniodes) postcarpaticus* AIS., *C. (Anomalinoides) transkarpaticus* (PISH.), *C. predcarpaticus* AIS., *C. menneri* SEROVA and *Anomalinoides dividens* LUCZ.. Luczkowska (1967) pointed out the differences between *Anomalinoides dividens* and *A. badenensis* d'ORB.: evolute arrangement of chambers on both sides and small peripheral aperture in *A. badenensis*. Papp & Schmid (1985, p. 65) mentioned that "the two species are identical". Of course, in this case, in conformity with I.C.Z.N. rules, the name *Cibicides certus* VENGL. (1953) has priority over all other names. Here Luczkowska's name is provisionally preserved.

Fam. **Elphidiidae** GALLOWAY, 1933

Porosononion PUTRYA, 1958

Remarks. This genus has a rapid evolution during the Sarmatian. In the relevant literature there are some well defined species such as *P. hyalinum* and *P. aragviensis.* Both species are markers for the Middle Sarmatian deposits. In Sarmatian deposits occur also specimens mentioned as *P. granosum* and/or *P. subgranosum. P. granosum* (d'ORB.) was described from Pliocene deposits; under this name were mentioned typical specimens for the Sarmatian (see Brestenska, 1974). Some paleontologists (Bogdanowicz, Didkovski, Venglinski, Maissuradze) described or mentioned these specimens as *P. subgranosum* (EGGER). This last species was recorded by Egger from Lower Miocene deposits from Ortenburg (Germany) and considered by Cushman (1939) as junior synonym of *P. tuberculatum* (d'ORB.). The topotype of "*Nonionina subgranosa*" EGGER (in Cushman, 1939, p. 13, pl. 3, figs. 16, 17) differs from the Sarmatian specimens in (1) having more flattened test, (2) slightly depressed umbilical area covered by small, rounded bosses and (3) coarsely perforate test.

Porosononion aragviensis (DJANELIDZE), 1953
(Pl. VI, Fig. 7)

Nonion aragviensis DJANELIDZE 1953, p. 156, pl. 1, fig. 3.

Porosononion subgranosum (EGGER) var. *aragviensis* (DJAN.). Bogdanowicz, 1960, p. 225, pl. 5, fig. 4.

Porosononion aragviensis (DJAN.). Maissuradze, 1971, p. 66, pl. 9, fig. 7.

Range: Basarabian.

In Romania it was recorded from Basarabian deposits of Moldavia (Ionesi, 1968; Paghida-Trelea, 1969). Our material was recorded from Ohaba (Haţeg basin) and in boreholes from Romanian Plain.

Porosononion bessarabiensis n. sp.
(Pl. VI, Figs. 8–10)

Test free, moderately compressed, with flattened sides; umbonal area with numerous rounded and elongate bosses which continued on sutures; periphery broadly rounded; chambers distinct, slightly inflated, 9–10 on the last whorl, increasing slowly in size as added; suture somewhat obscured, slightly depressed in the last chambers; wall calcareous, very distinct coarsely perforate; surface smooth except for the umbilical area; aperture a row of small openings at the base of the apertural face and circular openings on the apertural face.

Holotype: Coll. I.G.R., nr. 101527/32098, illustrated on pl. VI, fig. 8.

Type locality: Rădoieşti (borehole no. 29, m. 370–372, Olt district).

Age: Basarabian.

Range: late Volhynian (?)-Basarabian.

Remarks. This species was described as *P. subgranosus* by Bogdanowicz (1947, p. 29, pl. 4, figs. 1, 2) and Maissuradze (1971, p. 29, pl. 4, figs. 1–4). Differs from *P. sarmaticum* in larger and dense pores, less incised suture and thick test.

Porosononion hyalinum BOGDANOWICZ, 1960
(Pl. VII, Figs. 1–3)

Porosonion subgranosum (EGGER) var. *umboelata* GERKE (in Bogdanowicz, 1960, p. 255, pl. 4, fig. 6).

Porosononion subgranosum (EGGER) var. *hyalinus* BOGDANOWICZ, 1960, p. 256, pl. 5, fig. 2.

Porosononion subgranosum hyalinum BOGDANOWICZ. Maissuradze, 1971, p. 69, pl. 6, figs. 5, 6.

Range: Middle Sarmatian. In Romania it occurs in Moldavia and the Romanian Plain (in boreholes).

Porosononion sarmaticum n. sp.
(Pl. VI, Figs. 11–13)

Test free, somewhat compressed; periphery broadly rounded; umbilical area slightly elevated; chambers somewhat inflate, 10–11 on the last whorl, increasing in size as added; suture radial, slightly curved; wall calcareous, perforate; surface smooth except for umbilical area; covered by irregular bosses sometime also perforate; aperture at the base of the last chamber as small rounded openings.

Holotype: Coll. I.G.R., nr. 101528/22081.

Age: Basarabian.

Type locality: Praxia (borehole no. 19, m. 252, Suceava district.

The species was recorded also from borehole Plopi (F. 18) and from borehole 29-Rădoieşti, m. 370–372, Ramanian Plain.

Remarks. Porosononion sarmaticum differs from *P. bessarabiensis* in having irregular bosses instead of circular, smaller and rare pores, and more inflated umbilical area. Equatorial sections emphasized the existence of micro- and megalospheric specimens. The two stages differ in the adult in number of chambers on the last whorl (10–11 in microspheric and 8–10 in megalospheric).

Family **Elphidiidae** GALLOWAY, 1933
Elphidium MONTFORT, 1808
Elphidium aculeatum (d'ORBIGNY), 1846
(Pl. VII, Figs. 4–7)

Polystomella aculeata d'ORBIGNY, 1846, p. 131, pl. 6, figs. 27, 28.

Polystomella josephina d'ORBIGNY, 1846, p. 130, pl. 6, figs. 25, 26.

Elphidium aculeatum (d'ORB.). Papp & Schmid, 1985, p. 52, pl. 43, figs. 1–6.

Remarks. Papp & Schmid (1985) include *Elphidium koberi* TOL. in the synonymy of *E. aculeatum*, as young specimens. In the studied material there were recorded very young specimens of *E. aculeatum (= "josephinum")* which have nothing in common with *E. koberi*.

Elphidium koberi TOLLMANN, 1955
(Pl. VII, Figs. 8, 9)

Elphidium koberi TOLLMANN, 1955, p. 198, text-fig. 1.

Elphidium echinus SEROVA, 1955, p. 358, pl. 21, figs. 9–11; Didkovski & Satanovskaya, 1970, p. 117, pl. 70, fig. 6.

Range: Upper Volhynian. The two holotypes are coming from Lower Sarmatian: from Vienna basin (*E. koberi*) and from south-western Ukraine (*E. echinus*). This species was found in Lower Sarmatian deposits all over the Romanian territory: the best specimens were recorded from Serel, Hunedoara district and in borehole Dăneasa, m. 251, Olt district.

Elphidium macarovicii (TRELEA & SIMIONESCU), 1980
(Pl. VII, Fig. 10)

Parrellina macarovici TRELEA & SIMIONESCU, 1980, p. 69, pl. 1, fig. 6; pl. 2, fig. 3.

Diagnosis. Test large, planispiral, involute, bilaterally symmetrical; chambers numerous, 20–23 on the last whorl; sutures distinct, elevated, strongly curved backwards near the periphery; umbilical area slightly elevated; periphery acute, carinate; peripheral margin rounded; wall calcareous, finely perforate, covered by fine pustulae; aperture multiple, consisting of a row of circular openings near the base of the apertural face and numerous openings on the apertural face.

Range: Basarabian. The type specimen was described from northern Moldavia; the material here illustrated is coming from the Romanian Plain (borehole 44-Seaca, m. 306 from Upper part of the Basarabian.

Remarks. Similar specimens, coming from Cucuteni Sands (Iaşi district) were described by Protescu (1922, p. 348, pl. IV, figs. 4, 5) as a new species: *Polystomella tricostata*. This species should represent a senior synonym of *E. macarovicii*.

Elphidium nataliae n. sp.
(Pl. VII, Figs. 11, 12; Pl. VIII, Figs. 1, 2)

Diagnosis. Test large, planispiral, involute, bilaterally symmetrical, flattened; 17–19 chambers on the last whorl; rounded or slightly lobated in outline; peripheral margin acute, carinate and spinate (6–9 spines); 9–10 septal bridges in megalospheric, 14–19 in microspheric stage; umbonal area slightly depressed; aperture multiple, circular openings at the base of the apertural face and areal ones on the apertural face.

Holotype: Coll. I.G.R., nr. 101528/32041, illustrated on pl. VII, fig. 12.

Age: Middle Sarmatian (Basarabian, upper part).

Type locality: borehole Dăneasa, m. 230, Olt district.

Etymology: The name is given in honour of prof. Natalia Trelea, Univ. A. I. Cuza, Iassy.

Remarks. *Elphidium nataliae* differs from *E. macarovicii* in possesing carinal spines and by its slightly depressed umbilical area.

Elphidium joukowi SEROVA, 1955

Elphidium joukowi SEROVA, 1955, p. 355, pl. 21, figs. 1, 2.

Test flattened, with slightly depressed umbilical area: 10–12 chambers on the last whorl, separated by distinct elevated suture; 7–9 septal short bridges; peripheral outline oval, peripheral margin acute; surface covered by fine pustulae; aperture multiple, rounded openings at the base of the apertural face.

Range: Lower Sarmatian-Middle Sarmatian.

The type species is coming from Lower Sarmatian deposits from southern Ukraine. The illustrated material has been recorded from the Romanian Plain, borehole 29-Rădoieşti, Teleorman district.

Elphidium reginum (d'ORBIGNY), 1846
(Pl. VIII, Figs. 5–9)

Polystomella regina d'ORBIGNY, 1846, p. 129, pl. 6, figs. 23, 24.

Elphidium reginum (d'ORB.). Papp & Schmid, 1985, pl. 42, figs. 5–9; pl. 43, fig. 8.

Remarks. The lectotype described and illustrated by Papp & Schmit (1987) from the Baden locality, Austria, is a large specimen, biconvex, provided with 4 large spines in equatorial plane; the occurrence of this species only in Sarmatian deposits is pointed out, and the endemic features of the taxon are underlined. In our material, specimens with 3–5 spines and 11–15 chambers on the last whorl, curved suture and fine tuberculate surface are common in Middle Sarmatian deposits. Very large specimens with 3–6 large, thick spines and stelate equatorial margin occur in calcareous deposits belonging to the Upper Basarabian from the Romanian Plain (borehole 44-Seaca). Some specimens (Pl. 8, Fig. 8) should be assigned to *E. caucasicum* BOGD. and (Pl. 8, Fig. 9) to *E. cymosum* MAMEDOVA (see Trelea & Simionescu, 1979; 1980).

Elphidium hauerinum (d'ORBIGNY), 1846
(Pl. VIII, Fig. 10)

Polystomella hauerina d'ORBIGNY, 1846, p. 122, pl. 6, figs. 1, 2.

Papp & Schmid (1985, p. 128) in their revision of d'Orbigny's paper mentioned that the separation of *E. antoninum*, *E. listeri* and *E. hauerinum* is "impracticable"; the two authors suggest as valid name *Elphidium hauerninum*.

Range: Lower Sarmatian.

Elphidiella CUSHMAN, 1936
Elphidiella cf. *E. minuta* (REUSS)
(Pl. VIII, Fig. 10)

Saidovella minuta (REUSS); Trelea & Simionescu, 1980, p. 72, pl. 1, fig. 9.

Remarks. This taxon, provisionally confered here to *E. minuta* differs from the type species (see Reuss, 1865 or Cushman, 1939) by deep, incised suture near umbilical area and large septal pores separated by short bridges. The material conferred to *E. minuta* occurs in Sarmatian deposits only in the Upper Basarabian (see also Trelea & Simionescu, 1980).

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Plate I

Figs. 1, 2 — *Wiesnerella plana* BOGD. x 110, lateral view. Ohaba village, Hunedoara district. Basarabian.[1]

Figs. 3, 4 — *Sinzowella crustaformis* (BOGD.). x 90. View of the superior (free) surface. Valea Simnicei section (Blidari village, Vâlcea distr.). Basarabian.

Figs. 5, 6 — *Spiroloculina okrajantzi* BOGD.. x 110, lateral and edge views. Borehole 36-Roşiori, Teleorman distr. Basarabian.

Figs. 7–9 — *Cycloforina* cf. *cristata* (MILLETT). Figs. 7, 8 x 90, lateral view; fig. 9, x 90, apertural view. Ohaba village, Hunedoara distr. Basarabian.

Figs. 10, 11 — *Cycloforina moljawkovi* (DIDK.). Fig. 10, x 100, lateral view; fig. 11, x 340, detail on the aperture. Ohaba village, Hunedoara distr. Basarabian.

Figs. 12–14 — *Affinetrina* ex. gr. *voloshinovae* (BOGD.). Fig. 12, x 550, apertural view of fig. 14, Fig. 13 x 160, lateral view; fig. 14, x 150, apertural view. Ohaba village, Hunedoara distr. Basarabian.

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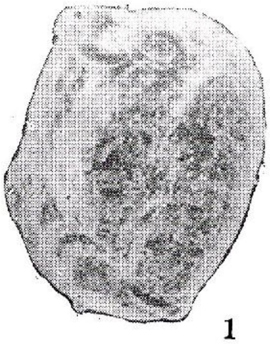
[1] For illustrations there were used the most representatives species and very well preserved; the location of the figured specimens was chosen accidentally.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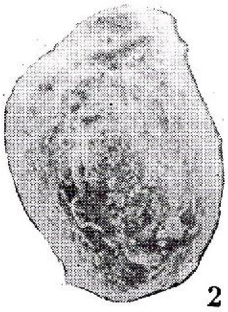
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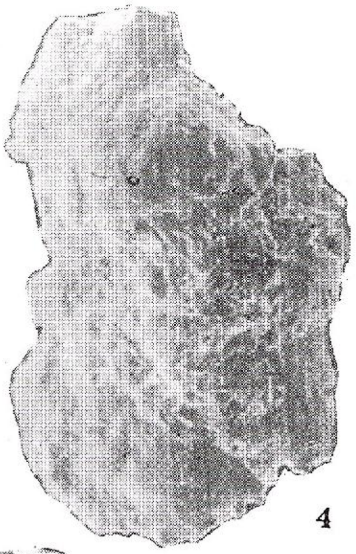
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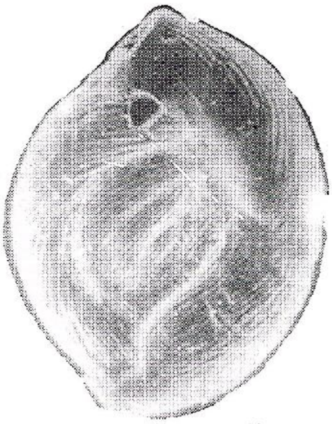
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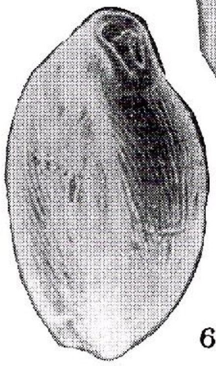
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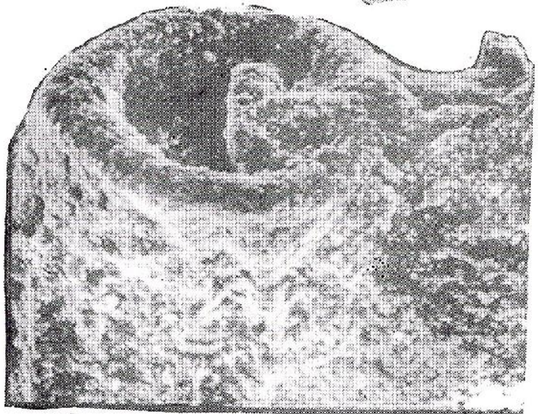
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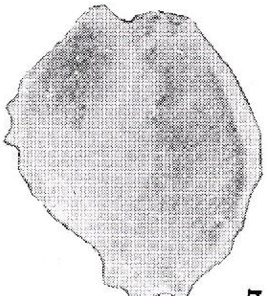
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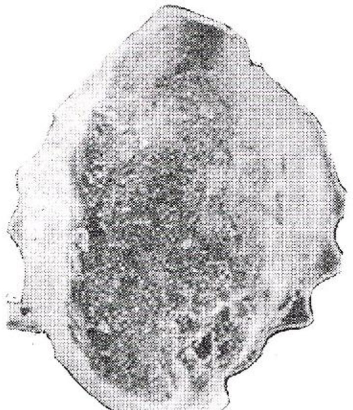
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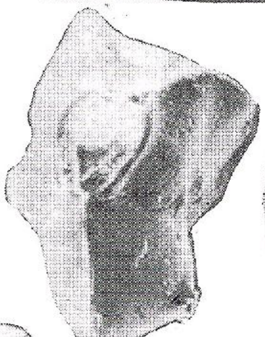
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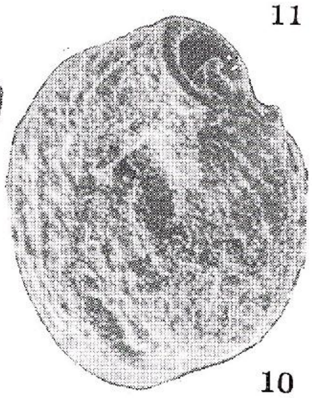
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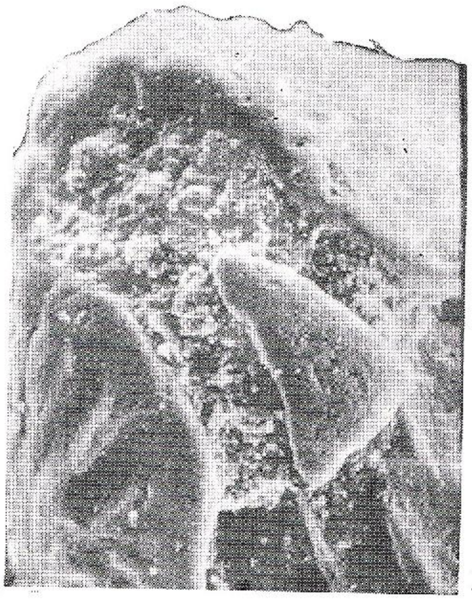
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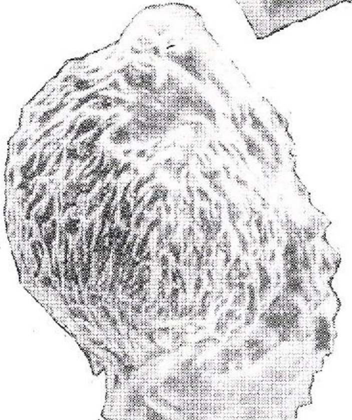
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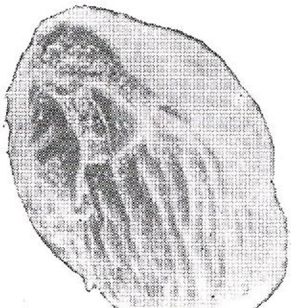
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Plate II

Figs. 1, 2 — *Pseudotriloculina angustioris* (BOGD.). x 80, lateral view. Valea Simnicel section, Blidari village, Vâlcea distr.. Basarabian.

Figs. 3, 4 — *Varidentella pseudocostata* (VENGL.). x 80, lateral views. Valea Simnicel section, Blidari village, Vâlcea distr. Basarabian.

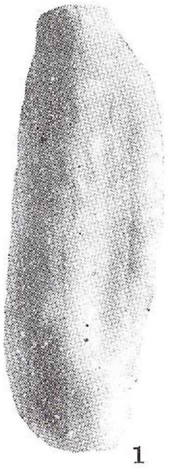
Figs. 5–7 — *Varidentella sarmatica* (KARRER). x 80, lateral views. Valea Simnicel section, Blidari village, Vâlcea distr. Basarabian.

Fig. 8 — *Varidentella reussi* (BOGD.). x 140. Valea Darei section, Dara village, Buzău distr. Volhynian.

Figs. 9–11 — *Articulina bidentata* DIDK. Fig. 9, x 450, apertural view; figs. 10, 11, x 40, lateral views. Valea Curăturii section, Govora locality, Vâlcea distr. Basarabian.

Figs. 12, 13 — *Articulina (?) daraensis* n. sp. x 70, lateral views. Fig. 12, holotype, Valea Darei section, Dara, Buzău distr. Basarabian.

Figs. 14–17 — *Articulina problema* BOGD. Fig. 14, x 60, lateral view; fig. 15, x 100, lateral view; fig. 16, x 260, lateral view, detail of fig. 15; fig. 17, x 260, apertural view. Bărbăteşti village, Vâlcea district. Upper Volhynian- (?) Lower Basarabian.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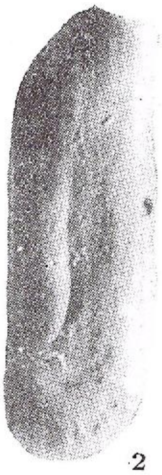
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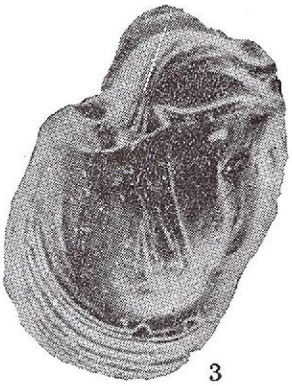
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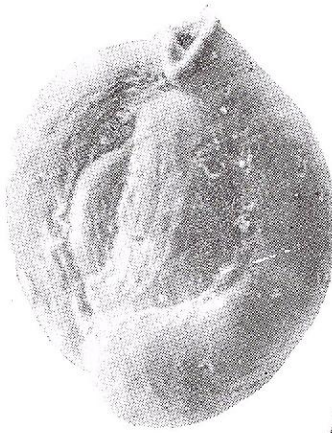
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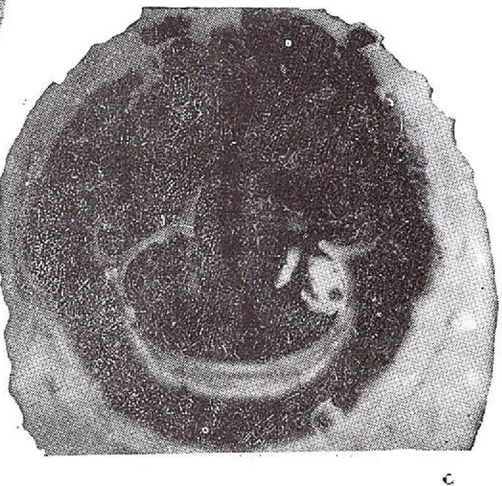
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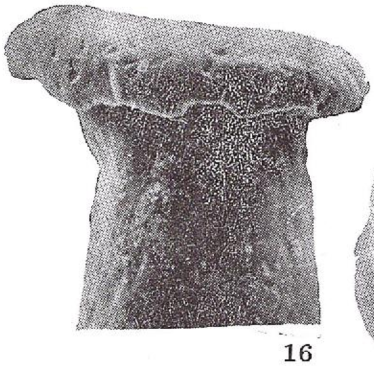
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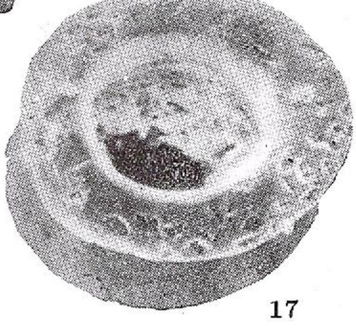
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Plate III

Fig. 1 — *Articulina (?) daraensis* n. sp. x 70, lateral view. Valea Simnicel section, Blidari village, Vâlcea distr. Basarabian.

Figs. 2–4 — *Articularia articulinoides* (GERKE & ISSAEVA). x 70, lateral views. Valea Morilor section, Colibaşi village, Mehedinţi distr. Volhynian.

Figs. 5, 6 — *Meandroloculina bogatschowi* BOGD.). x 80, lateral views. Borehole 53-Dăneasa, m. 248–250 (Olt distr.). Basarabian.

Figs. 7, 8 — *Meandroloculina schirwanensis* BOGD. x 80, lateral views. Borehole 53-Dăneasa, m 248 (Olt distr.). Basarabian.

Fig. 9 — *Meandroloculina conicocameralis* BOGD.. x 80, lateral view. Borehole 29–Rădoieşti, m. 348–350 (Teleorman distr.). Basarabian.

Figs. 10, 11 — *Dogielina sarmatica* BOGD. & VOLOSH.. x 80, lateral views. Valea Simnicel section, Blidari village, Vâlcea distr. Basarabian.

Figs. 12–14 — *Dogielina simnicaensis* n. sp. Lateral views. Fig. 12, 14, x 100; fig. 13, x 300, detail of fig. 12. Valea Simnicel section, Blidari village, Vâlcea distr. Basarabian.


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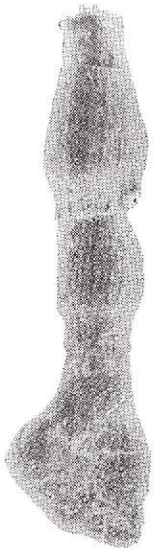
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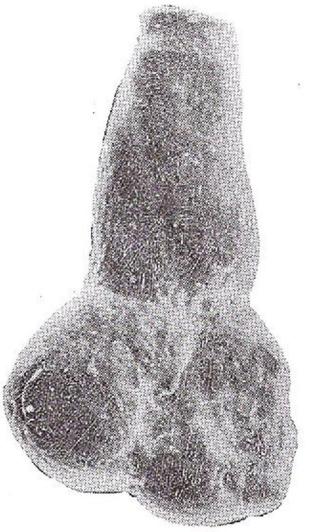
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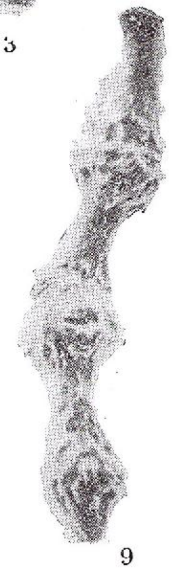
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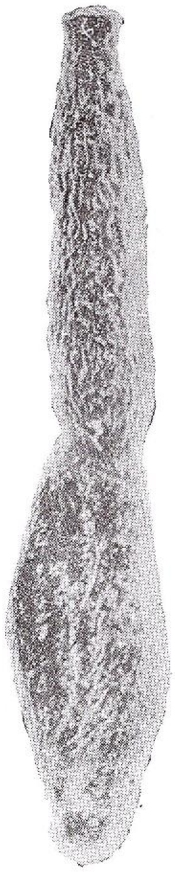
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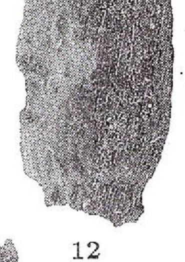
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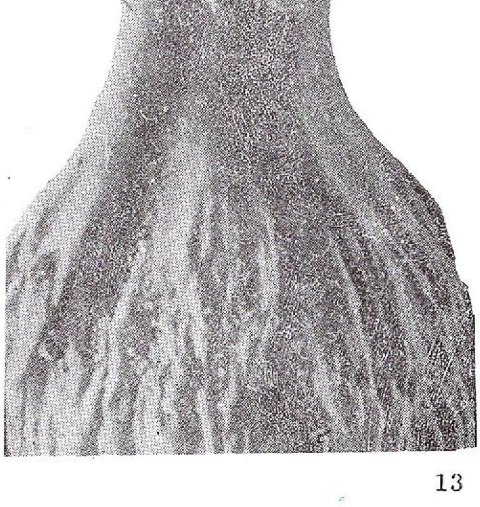
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Plate IV

Figs. 1–4 — *Dogielina simnicaensis* n. sp. Lateral views. Fig. 1, x 90, megalospheric specimen; fig. 2, x 90, holotype, microspheric specimen; fig. 3, x 100, megalospheric specimen; fig. 4, x 100, megalospheric specimen; Valea Simnicel section, Blidari village, Vâlcea district. Basarabian.

Fig. 5 — *Sarmatiella moldawiensis* BOGD. x 130, lateral view. Borehole 44-Seaca, m. 306–308 (Olt district). Basarabian.

Figs. 6–8 — *Meandroloculina* cf. *conicocameralis* BOGD.. Figs. 6, 7, x 150, lateral views; fig. 8, x 300, apertural view. Bărbăteşti village, Vâlcea district. Late Volhynian-Early Basarabian.

Figs. 9–12 — *Sarmatiella prima* BOGD.. Figs. 9, 10, x 60, lateral views; figs. 11, 12, x 250, detail on aperture of fig. 9. Borehole 34-Peretu, m. 240–242 (Teleorman district). Basarabian.


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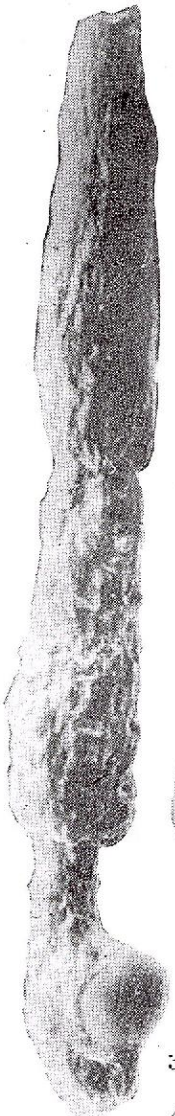
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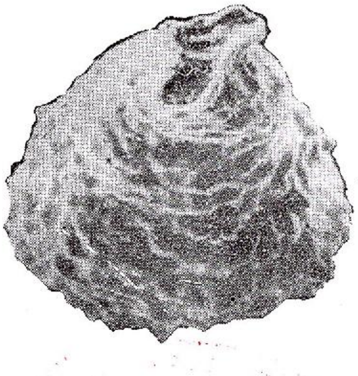
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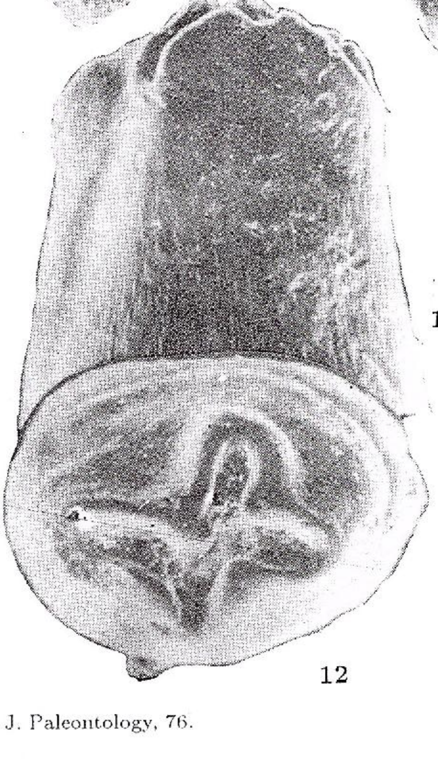
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Plate V

Fig. 1 — *Fissurina daraensis* n. sp. Holotype. x 250, lateral view. Valea Darei section, Dara village, Buzău district. Basarabian.

Figs. 2, 6 — *Fissurina carpathica* n. sp. x 250, lateral views; Fig. 6, holotype, broken specimen showing the attached inner tube on the opposite side. Valea Darei section, Dara village, Buzău district. Basarabian.

Figs. 3–5 — *Fissurina bessarabica* n. sp. x 250. Fig. 3, holotype, lateral (side) view; fig. 4, aboral view; fig. 5, apertural view. Valea Darei section, Dara village, Buzău district. Basarabian.

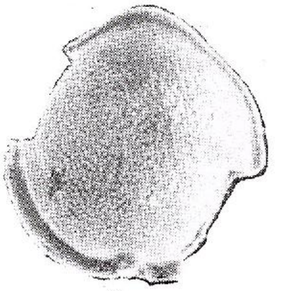
Fig. 7 — *Fissurina lamarae* n. sp. x 250, lateral view; Valea Darei section, Dara village, Buzău district. Basarabian.

Figs. 8–10 — *Bolivina moldawica* DIDK. Fig. 8, x 140, lateral view (megalospheric specimen); fig. 9, x 650, detail on surface; fig. 10, x 180, lateral view of a microspheric specimen. Borehole 29-Rădoieşti, m. 350, (Teleorman district). Basarabian.

Fig. 11 — *Nonion bogdanowiczi* VOLESH x 130, lateral view. Borehole 53-Dăneasa, m 370–372 (Olt district). Basarabian.

Fig. 12 — *Nonion bogdanowiczi* VOLOSH. x 130, lateral view. Ohaba village (Hunedoara district). Late Volhynian-Early Basarabian.

Fig. 13 — *Glabratella imperatoria* (d'ORB.) x 200, umbilical view. Valea Fisici section (Bozioru village, Buzău district). Basarabian.



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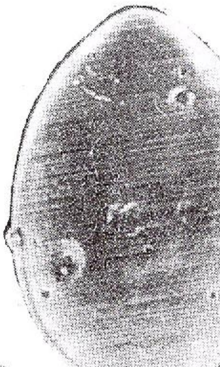

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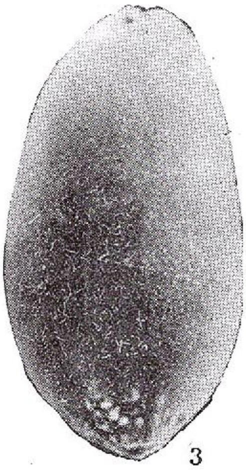

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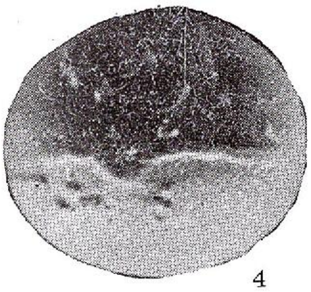

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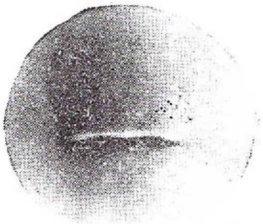

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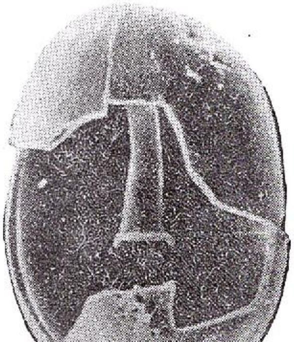

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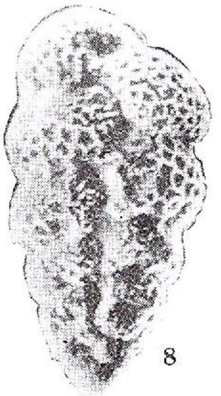

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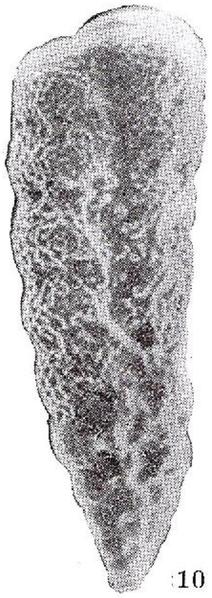

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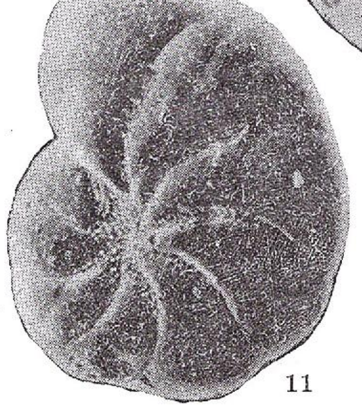

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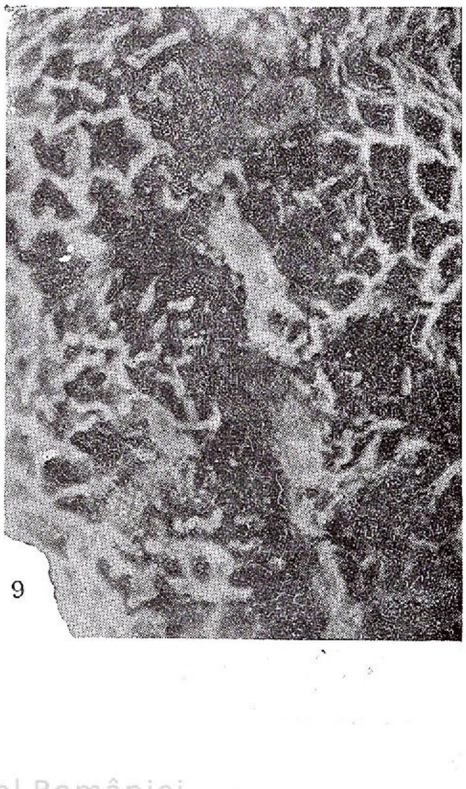

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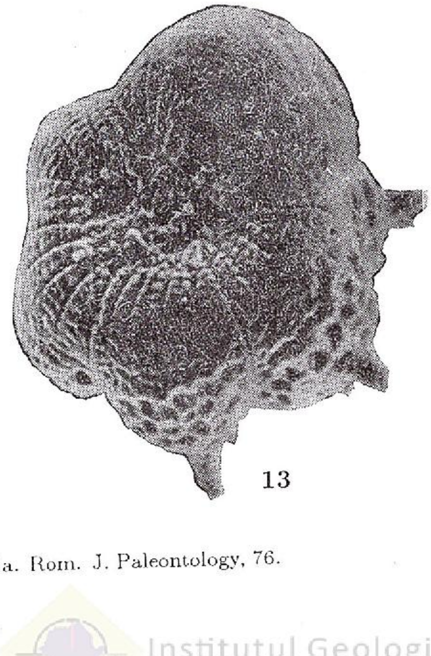

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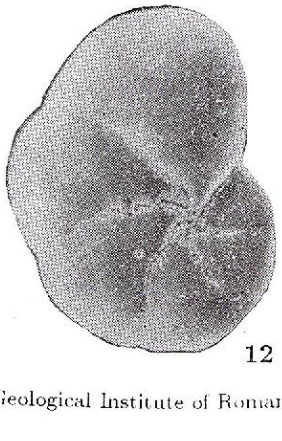

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Plate VI

Figs. 1–3 — *Glabratella imeratoria* (d'ORB.). Fig. 1, x 140, umbilical view; fig. 2, x 600, detail of fig. 1; fig. 3, x 150, lateral (edge) view. Valea Fisici section (Bozioru village, Buzău district). Basarabian.

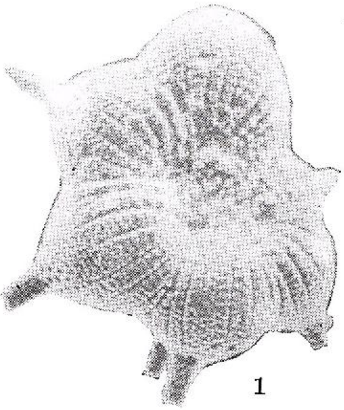
Figs. 4–6 — *Lobatula dividens* (LUCZ.). x 100. Fig. 4, umbilical (side) view; fig. 5, edge (apertural) view; fig. 6, spiral view. Valea Morilor section (Colibaşi village, Mehedinţi district). Early Sarmatian (Lower Volhynian).

Fig. 7 — *Porosononion aragviensis* (DJAN.). x 110, lateral view. Borehole 53-Dăneasa, m. 230 (Olt district). Basarabian.

Figs. 8–10 — *Porosononion bessarabiensis* n. sp. Fig. 8, holotype x 110, lateral (side) view; fig. 9, x 110, edge view, fig. 10, x 350, apertural detail of fig. 9. Borehole 29-Rădoieşti, m 370–372 (Olt district). Basarabian.

Figs. 11–13 — *Porosononion sarmaticum* n. sp. Fig. 11, 13, x 110, equatorial sections in megalospheric specimens; fig. 12, x 110, holotype, side view. Borehole 18-Plopi (Suceava district). Basarabian.

Plate VI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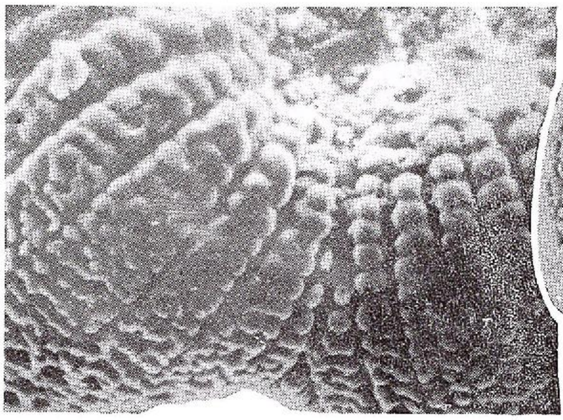
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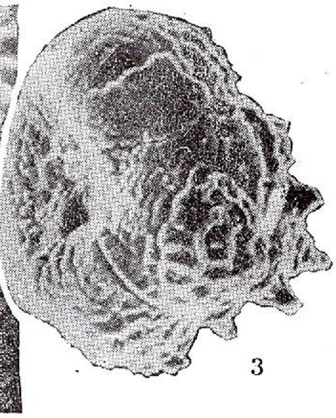
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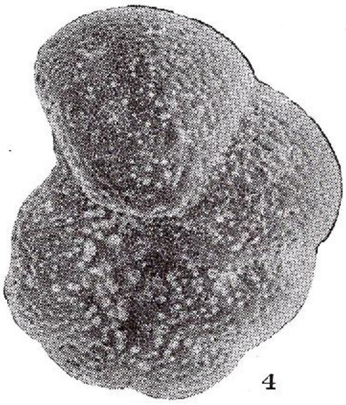
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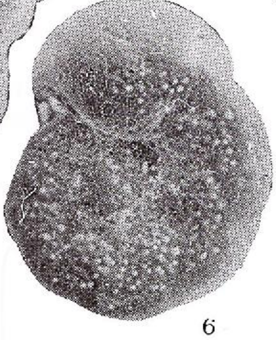
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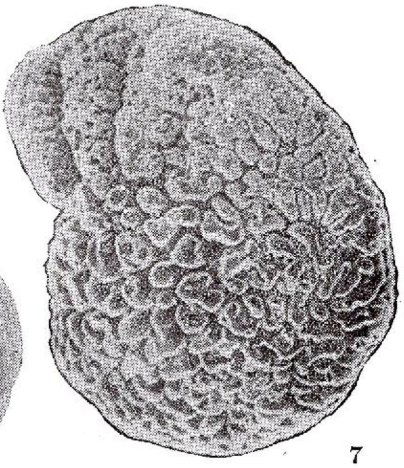
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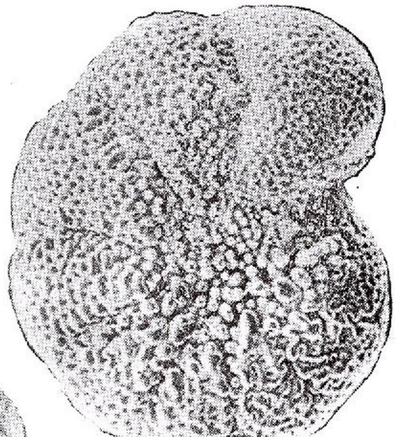
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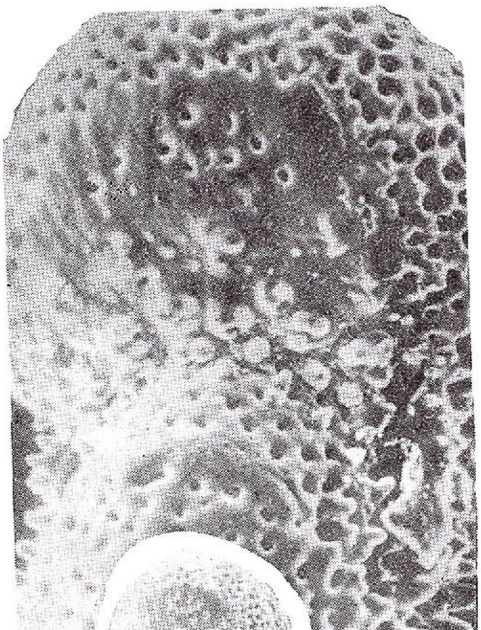
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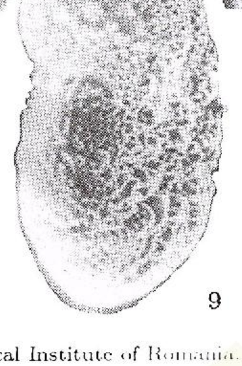
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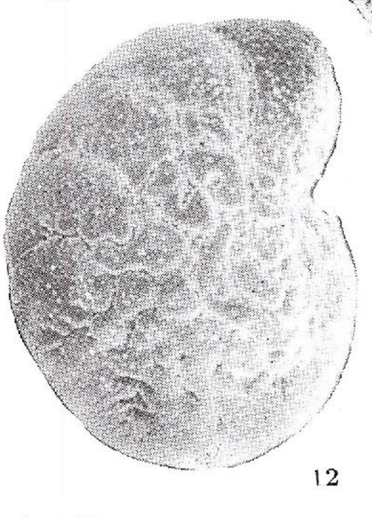
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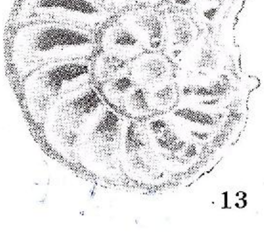
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Plate VII

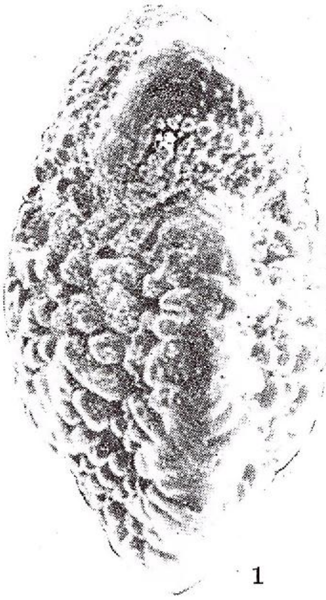
Figs. 1–3 — *Porosononion hyalinum* BOGD.. Fig. 1, x 60, edge view; fig. 2, x 60, side-edge view; fig. 3, x 30, edge view. Borehole 44-Seaca, m. 306–308 (Olt district). Basarabian.

Figs. 4–7 — *Elphidium aculeatum* (d'ORB.). Fig. 4, x 75, side view; fig. 5, x 100, side view (Ohaba village, Hunedoara district); fig. 6, x 75, side view; fig. 7, x 260, detail (Şerel village, Hunedoara district). Volhynian.

Figs. 8, 9 — *Elphidium koberi* TOLMANN. x 110, side view. Şerel village, (Hunedoara district). Volhynian.

Fig. 10 — *Elphidium macarovicii* (TRELEA & SIMIONESCU). x 45, side view. Borehole 44-Seaca, m. 306–308 (Olt district). Basarabian.

Figs. 11, 12 — *Elphidium nataliae* n. sp. Fig. 12, x 60, holotype, side view; fig. 11, x 80, transverse section (edge view). Borehole 53-Dăneasa (Olt district). Basarabian.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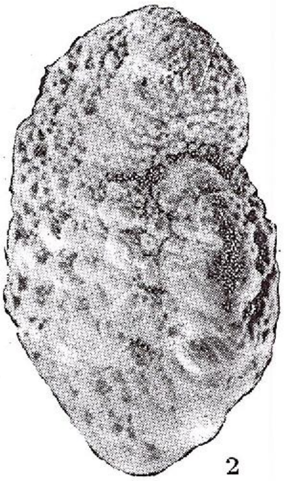
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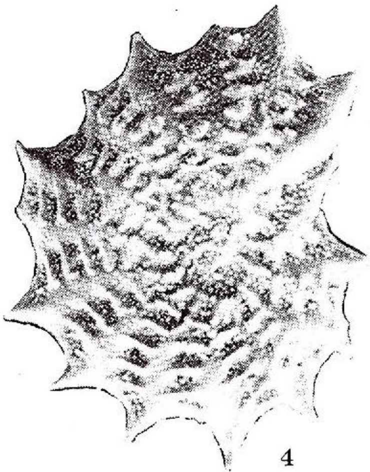
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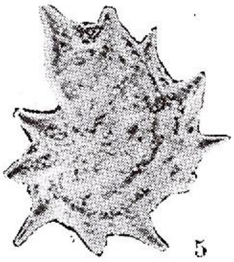
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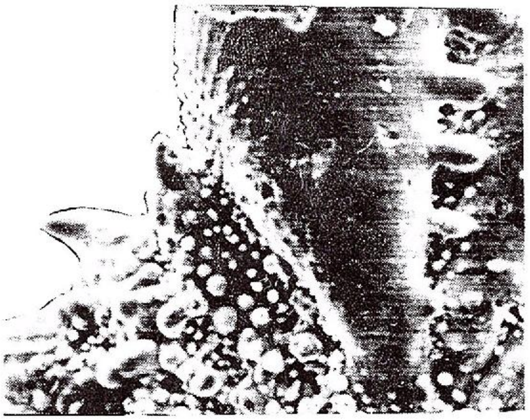
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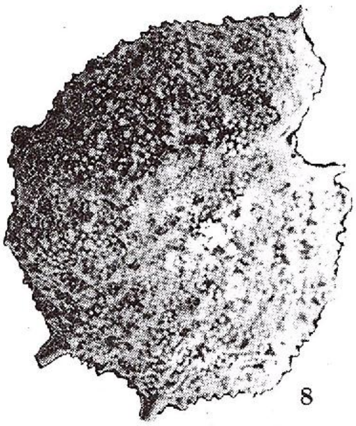
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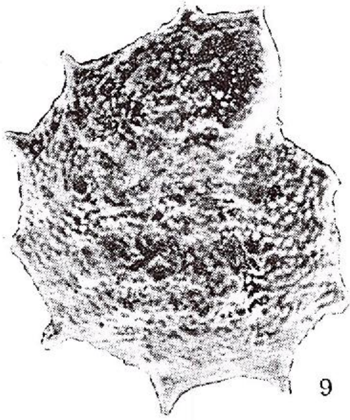
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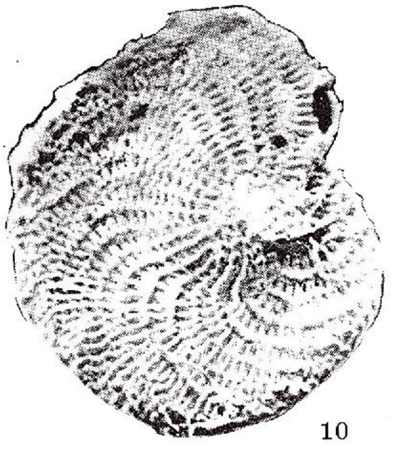
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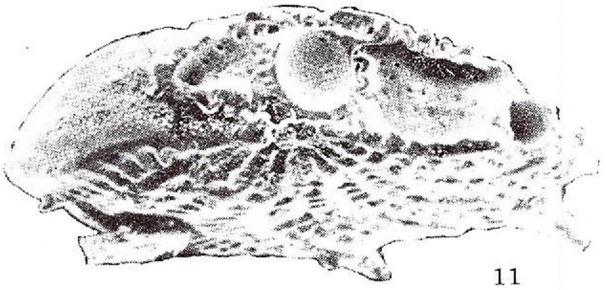
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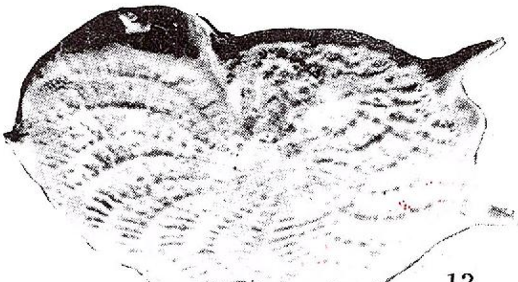
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Plate VIII

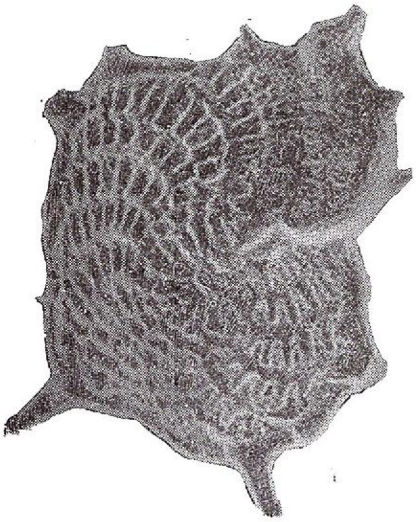
Figs. 1, 2 — *Elphidium nataliae* n. sp. x 80, side views. Borehole 53-Dăneasa m. 230 (Olt district). Basarabian.

Figs. 3, 4 — *Elphidium joukovi* SEROVA. Fig. 4, x 75, side view; fig. 3, x 600, surface detail on fig. 4. Borehole 44-Seaca, m. 306–308, (Olt district). Basarabian.

Figs. 5–9 — *Elphidium reginum* (d'ORB.). Fig. 5, x 100, side view of a young specimen; fig. 6, x 75, edge view, young specimen; fig. 7, x 260, detail on fig. 6; borehole 44-Seaca, m. 306–308. Fig. 8, x 70, side view, borehole 29-Rădoieşti (Teleorman distr.). Basarabian. Fig. 9, x 40, side view, borehole Seaca, m. 306–308, Basarabian.

Fig. 10 — *Retroelphidium subangulatum* (CZJZEK). x 130, side view. Valea Şerelului section (Şerel village, Hunedoara district). Volhynian.

Figs. 11, 12 — *Elphidiella* cf. *minuta* (REUSS). x 110. Fig. 11, side view; fig. 12, x 80, edge view. Borehole 17-Margina, m. 84 (Timişoara district). Basarabian.



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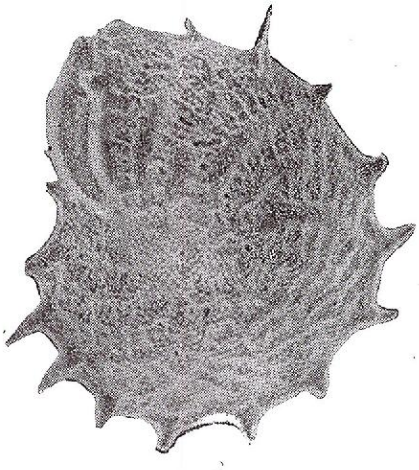

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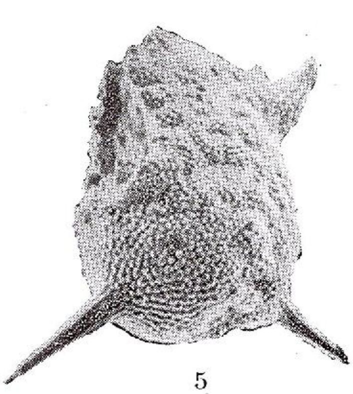

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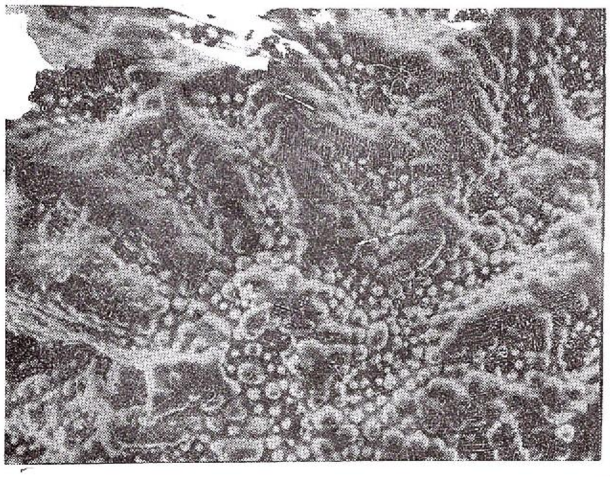

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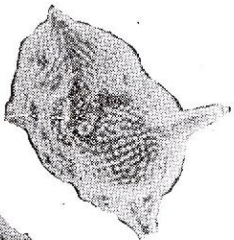

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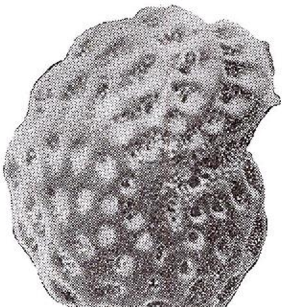

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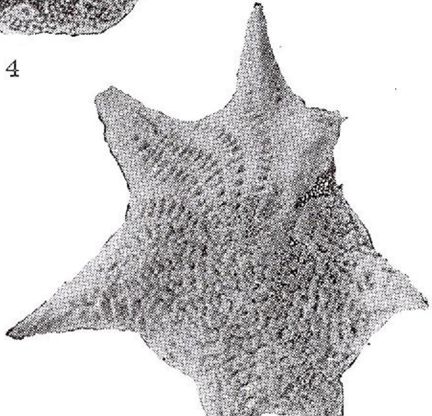

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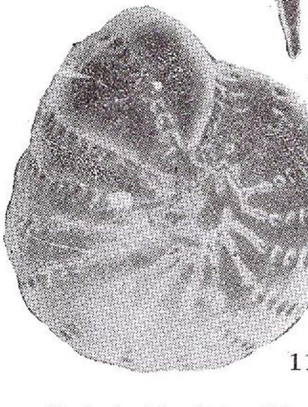

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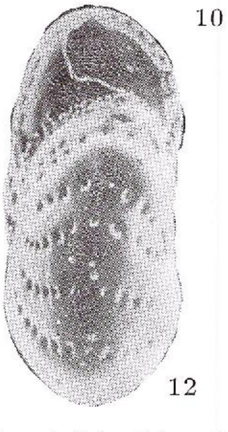

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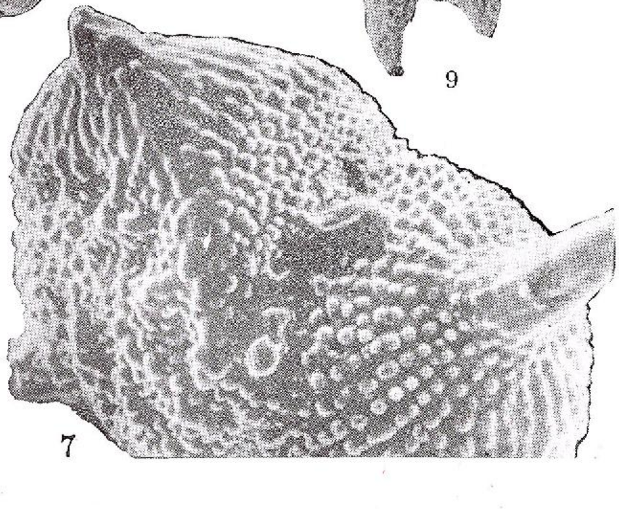

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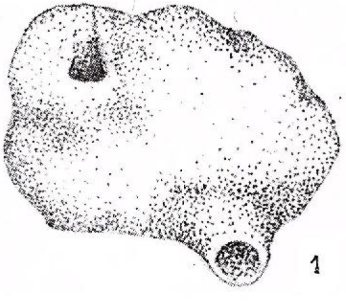
Plate IX

Figs. 1–3 — *Sinzowella novorossica* (KARRER). x 35, lateral views. Valea Darei section (Dara, Buzău district). Basarabian.

Fig. 4 — *Sinzowella crustaformis* BOGD. x 65. Equatorial section. Valea Simnicel section, Blidari village, Vâlcea district. Basarabian.

Fig. 5 — *Meandroloculina conicocameralis* BOGD. x 200. Longitudinal section. Valea Simnicel section (Blidari village, Vâlcea district). Basarabian.



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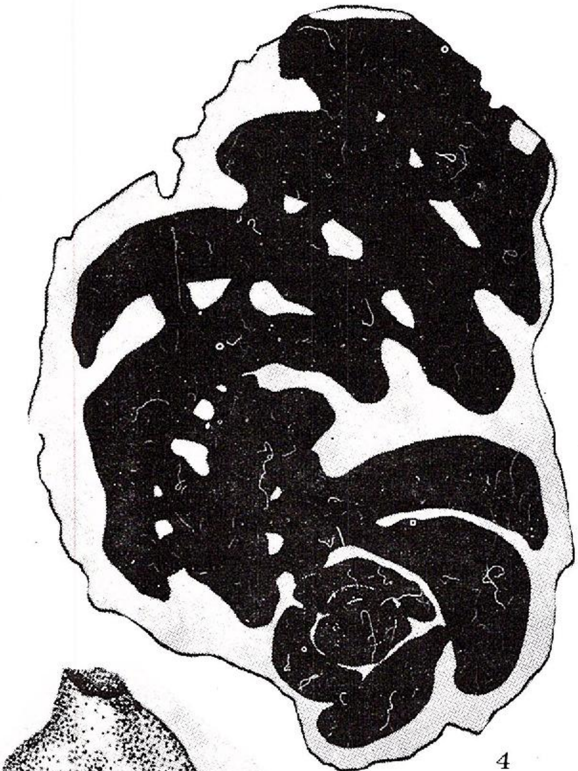

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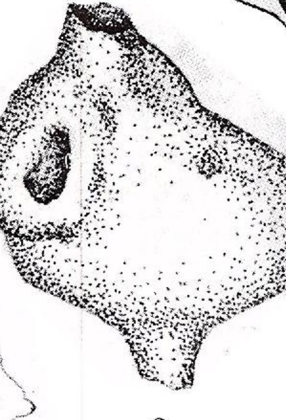

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Rom. J. Paleontology, 76, 1995, p. 99–100, Bucharest

NOELAERHABDUS BONAGALI n. sp. (CALCAREOUS NANNOPLANKTON) IN THE UPPER MALVENSIAN - ROMANIAN BANAT

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Key words: *Noelaerhabdus bonagali* n. sp. Calcareous Nannoplankton. Turnu Ruieni Formation. Upper Malvensien. Caransebeş-Mehadia Basin.

Abstract: *Noelaerhabdus bonagali* n. sp. (Calcareous Nannoplankton) in the Upper Malvensian-Romanian Banat. This paper described the species *Noelaerhabdus bonagali* n. sp., which originates in a calcareous nannofossil assemblage in the bottom of the Turnu Ruieni Beds, Upper Malvensian in age. This assemblage can be compared with that described by Bóna and Gál (1985) in the Upper Pannonian deposits in the Mecseck Mountains area.

Noelaerhabdus bonagali n. sp. occurs in the calcareous nannoplankton assemblage hosted in the siltic clays of Turnu Ruieni Formation, in the Caransebeş-Mehadia depression.

The Turnu Ruieni Formation (Marinescu and Popescu, 1987) consists of decimetric alternations of coarse pebbles and siltic clays at the bottom, which pass to a mostly sandy facies with intercalations of siltic clays and fine- to medium-grained pebbles towards the top. The fossiliferous levels usually contain a molluscan assemblage with *Congeria czjeky* (HOERNES) indicating an Early Malvensian age.

The calcareous nannoplankton content (Plate I), at the bottom of the mentioned formation, consists of: *Coccolithus pelagicus* (WALLICH), *Noelaerhabdus bozinovicae* JERKOVIC, *N. jercovici* BÓNA & GÁL, *N. bonagali* n. sp., *Bekeithelia* sp., *Reticulofenestra pseudoumbilica* (GARTNER), *Pontosphaera multipora* (KAMPTNER), *Braarudosphaera bigelowii* (GRAN & BRAARUD). This assemblage has an endemic character and it can be compared with that described by Bóna and Gál (1985), from the Upper Pannonian deposits in the neighbourhood of the Mecseck Mountains.

Family: **Noelaerhabdaceae** JERKOVIĆ, 1970
Genus: *Noelaerhabdus* JERCOVIĆ, 1970
Noelaerhabdus bonagali n. sp.

Noelaerhabdus sp. ident., J. BÓNA & M. GÁL, 1985, p. 515, pl. 78, Fig. 3.

Derivatio nominis: It is dedicated to the Hungarian researchers J. Bóna and M. Gál who found and illustrated a poorly preserved specimen of this species.

Holotypus: Plate I, Figs. 1 and 2.

Locus typicus: Valea Copacului Brook, left tributary of the Timiş River, at about 1.5 km from the Orşova-Caransebeş highway, the village of Vălişoara, south of the town of Caransebeş.

Stratum typicum: Turnu Ruieni Formation, Upper Malvensian.

Diagnosis: Species of the genus *Noelaerhabdus*, consisting of two elliptical, slightly unequal disks, the distal one larger than the proximal one. They consist of about 40 elements, arranged radially. The distal disk ends with a truncated prolongation. Both the prolongation and the two disks are penetrated by a central canal, intruded by a stick; it becomes thicker towards the terminal part where three thorn-like branches can be separated. The angle between two branches is of about 90^0. The proximal end of the stem is rounded and it reaches the central area of the proximal disk.

Dimensions: Diameter of the proximal disk 3.5 μ m, height of the truncated prolongation 1.6 m; height of the stem 6.5–7 μ m.

Diagnosis: It differs from other species of the genus *Noelaerhabdus* by the existence of the truncated prolongation and of the trifurcate stem which penetrates both the prolongation and the central areas of the two disks.

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Plate

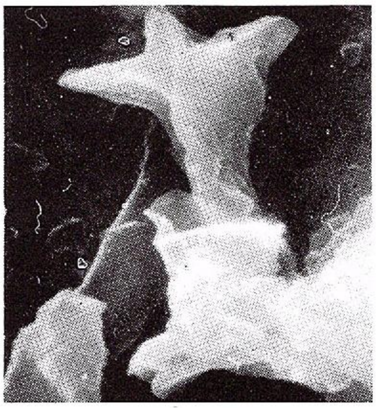
Figs. 1, 2 — *Noelaerhabdus bonagali* n. sp. 1, side view; 2, proximal view; Turnu Ruieni Beds: Valea Copacului Brook; x 7,500.

Fig. 3 — *Noelaerhabdus bozinovicae* JERKOVIČ; Turnu Ruieni Beds; Valea Copacului Brook; x 9,000.

Fig. 4 — *Noelaerhabdus jercovič* BÓNA & GÁL; Turnu Ruieni Beds; Valea Copacului Brook; x 8,500.

Fig. 5 — *Bekeithella* sp., Turnu Ruieni Beds; Valea Copacului Brook; x 7,000.

Fig. 6 — *Reticulofenestra pseudoumbilica* (GARTNER); Turnu Ruieni Beds; Valea Copacului Brook; x 7,000.



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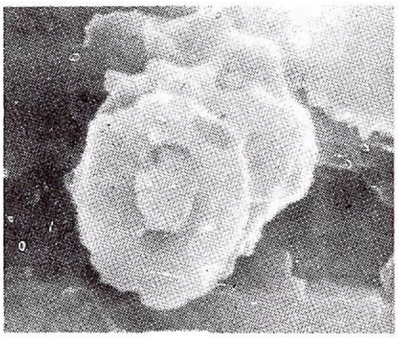

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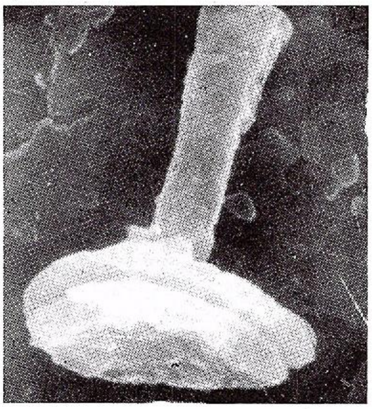

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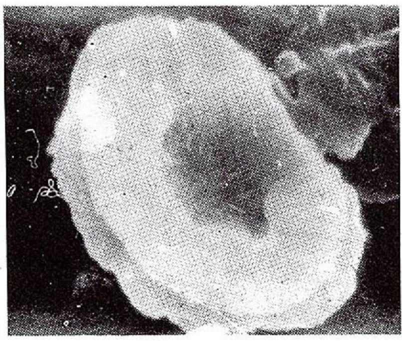

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Rom. J. Paleontology, 76, 1995, p. 101–104, Bucharest

CONGERIA (FILICARINA) FRAGILA n. sp. INTERMEDIARY SPECIES BETWEEN CONGERIA (FILICARINA) BANATICA AND CONGERIA (FILICARINA) DIGITIFERA

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Key words: Molluscs. Middle Pannonian. Banat. New taxa.

Abstract: The author describes two new congeria taxa. The species has large similarities with *C. (F.) digitifera*, but belongs to a different biological province, namely the Pannonian Basin. In the paper arguments are brought in favour of the affiliation of the "digitifera" species to the *Congeria* genus and not to the *"Dreissenomya"* one, as previously suggested (Stevanovic, 1990). The present paper gives explanatory notes with respect to the genetical affiliation of some species, besides the introduction of new taxa and phylogenetic-type contributions of the Filicarina Group.

The elaboration of the present paper became necessary due to some taxonomic and stratigraphic dimnesses in the geological literature. The absence of studies especially concerning mollusc assemblages characteristic of the widely spread "basin facies" in the Pannonian Basin compared to those regarding the "littoral facies" should be pointed out. In the same context the ignorance of the time evolution of one of the most frequent quoted Pannonian species, namely *Congeria banatica*, should be also mentioned. Jambor et al. (1985) indicated the species throughout the Pannonian (as an equivalent of the Late Sarmatian, Meotian and Pontian). In our opinion this taxon is less extended and only characteristic of the Middle Pannonian *s. str.*= Middle Malvensian. The other specimens are apparently similar to the *Congeria banatica* from the Late Pannonian *s. str.*, Early and Late Odessian, as new species which we are about to describe in the present paper. They habe been grouped in the *Filicarina* subgenus described by Marinescu in 1984, whom we wish to thank for his advice and opinions in the elaboration of the present paper.

Family **Dreissenidae** GRAY in TURTON, 1840
Genus *Congeria* LORENTHEY, 1836
Subgenus *Filicarina* MARINESCU, 1984
Type-species *Congeria banatica* R. HÖRNES, 1875

Marinescu (1984) distinguishes within the *Filicarina* subgenus: *Congeria (Filicarina) banatica* R. HÖRN., *C. (F.) scaphula* ANDRUS, *C. (F.) florianii* LUBENESCU, POPESCU and *C. (F.) digitifera* ANDRUS.. The author describes in the present paper another two taxa, namely *Congeria (Filicarina) fragila* n. sp. and *Congeria (Filicarina) fragila crisensis* n. ssp.

A typical species of this group is *Congeria banatica* R. HÓRN., 1875; unlike the other groups it has finer valves and a sharp, very narrow keel. A large keel delimits the lower sector of the ventral field from the rest of the field.

Congeria (Filicarina) fragila n. sp.
Pl. I, Figs. 5–11

1962 *Congeria banatica* R. HOERN. SZELES, pl. V, fig. 5.

1986 *Congeria* ex gr. *Congeria (Congeria) digitifera* ANDRUS., Lubenescu, Ştefănuţ, pl. I, figs. 3–7.

Holotype: Pl. I, fig. 7 (x 2,1) collection of the Geological Institute of Romania, inv. no. 18731; paratype, inv. no. 18732.

Derivatio nominis: from the shell brittleness.

Locus typicus: Borlan Valley, right tributary of Timiş Valley, about 300 m from Constantin Daicoviciu (Căvăran) Commune, Banat.

Stratum typicum: level of sandy, micaceous sands, with *Paradacna abichi* (HOERNES), *P. magna* LUBENESCU, ŞTEFĂNUŢ, *Dreissenomya* div. sp., *Valenciennius* sp., ostracoda (Lubenescu, 1982).

Diagnosis: thin, medium-sized valves, with elliptical-elongated outline, small, sharp umbo, an almost rectiliniar filiform keel, outstanding on the whole shell length, and a cardinal plane, similar to that of the congeria.

Description: The specific specimens have thin, almost flattened valves with elliptical-elongated outline. The lower limit is curved; both the dorsal and the posterior limits join suddenly in an angle of 125^0. The umbo is small, sharp and slightly convex. The keel is rectiliniar, seldomly recurved, central, filiform and outstanding on the whole valve length. The basal ventral field is suddenly cut open by the keep, so that the shell aquires an asymmetrical shape, with a narrowing appearance. The growing striae are outstanding on the whole shell surface.

The cardinal plane in some valves (Pl. I, Figs. 5, 7) is small, central and similar to that of the congeria. The imprint of the anterior adductor lies in the cardinal plane (Marinescu, 1977).

Dimensions: Holotype H 25 mm, L 14 mm, C (Convexity) 1 mm, Paratypes H 30-16 mm, L 18-8 mm, C 1-0.2 mm.

Remarks: This species is similar to *Congeria (Filicarina) digitifera* ANDRUS in the shell brittleness, morphological aspect and size. Unlike the latter one, the former lacks an anterior finger-like prolongation of the ventral limit.

It is similar to *Congeria (Filicarina) banatica* R. HÖRN. in the shell brittleness, low convexity and shape of the young samples, but unlike this one, it is larger-sized, has an elongated elliptical outline, a central keel position and a sudden connection of the annal limit to the posterior part.

The samples figured by Szeles (1962) as *Congeria banatica* indicate a morphological shape which is typical of *Congeria (Filicarina) fragila* n. sp. On the other hand its location within the Upper Pannonian from Hungary is convincing, too.

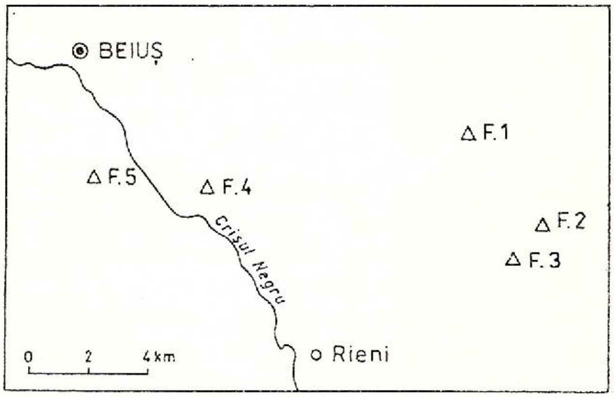

Fig. 1 – Location sketch of boreholes from the Beiuş-Rieni sector, Bihor district, graphic scale.

Both the similarity with *Congeria (Filicarina) digitifera* ANDRUS and the absence of a relevant paleontological material, determined us to describe it in 1986 under this name.

Stevanović (1990) has recently enclosed *Congeria (Filicarina) digitifera* to *Dreissenomya (Carinatocongeria)*. The presence of well preserved *Congeria (Filicarina) fragila* specimens on the inner side as well explains the affiliation of this species to the *Congeria*, but not to the *Dreissenomya* genus in the recently sampled paleontological material from Banat.

The stratigraphic location of the *Congeria (Filicarina) fragila* species was well specified in previous papers (Lubenescu, 1982, Ştefănuţ, 1986) due to rich faunal mollusc and ostracod associations with which they met. Its location is based on successions of siltic clays, sandy clays and sand interbeds, associated with *Congeria zagrabiensis* BRUS., *Paradacna abichi* HOERN., ostracoda from the Bakunella and Pontoniella groups. Within the same succession *Congeria ungulacaprae* MUENST., *C. marcovici* BRUS., *C. triangularis* PARTSCH, *C. zahalkai* SPALEK, *C. kyjovense* (SPALEK), *Dreissenomya (Sinucongeria) aperta* (DESH.), *Limnocardium (Arpadicardium) mayeri* BRUS., *Valenciennius* sp. etc. can be located. Based on these paleontological clews the formation was assigned by us to the Late Lower Pontian (Odessian), close to the Portaferrian. The absence of *Congeria rhomboidea* M. HÖRN. has constituted an argument in favour of this decision. The faunal deposits under discussion are located south of the well-known Rădmăneşti deposit.

The species is well-known from the Cărăvan Pontian, but we assume that is has a wider extension, sometimes being mistaken for *Congeria (Filicarina) banatica*.

Congeria (Filicarina) fragila crisensis n. ssp.
Pl. I, Figs. 12-18.

Holotype. Pl. I, Fig. 15 Collection of the Geological Institute of Romania, no. 18729; paratype, inv. no. 18730.

Derivatio nominis. from the Criş River.

Locus typicus: borehole 4,97 m depth, South Beiuş, fig. 1.

Stratum typicum: level of siltic clays with *Paradacna asperocostata* BRUS., *Congeria zagrabiensis* BRUS., Pontian ostracoda (Lubenescu, in press).

Diagnosis: Thin, small-sized valves, slightly rounded crochet, filiform, slightly sinuous central keel.

Description: The specimens of this subspecies have thin flattened valves with oval outline. The anterior ventral limit gradually blends with the ventral, posterior one under an angle over 90^0. The dorsal limit suddenly blends with the posterior one under an angle of approximately 125^0. The umbo is small and slightly displaced towards the anterior part. The keel is outstanding and slightly warped towards the basis, filiform, central and outstanding on the entire shell

Filicarina

Stages		Pannonian Basin	Dacic Basin
Upper			
Middle	Pontian		
Lower		*Congeria (F.) fragila* *Congeria (F.) fragila crisensis*	*Congeria (F.) digitifera*
Upper		*Congeria (F.) floriani*	
	Pannonian		
Middle		*Congeria (F.) banatica*	

Fig. 2 - Philogenetic sketch of the Filicarina Group.

length. The growing striae are visible on the whole valve surface. The cardinal plate is typical of the congeria, the septum is central and triangular.

Dimensions: Holotype H 17 mm, L 10 mm, C 1 mm, Paratypes H 24-11 mm; L 13-8 mm, C 1-0.8 mm.

Remarks. The species is morphologically similar to the previously described *Congeria (Filicarina) fragila*, therefore being considered by us as its variety. Unlike the latter species, it is smaller-sized and has a more oval, almost rhombic outline. The base ventral field is not suddenly cut by the keel and the valves have no lop-sized outline.

The species shows some morphological similarities with *Congeria (Filicarina) floriani* LUBENESCU et POPESCU, as well as differences consisting in a more elongated outline, the presence of the keel on the whole shell surface and a sudden connection of the annal limit with the posterior one.

This taxon is described from some drillings cores in the Beiuş Creek. Molluscs are frequent in the faunal association and occur in the Lower Pontian and Early Odessian, respectively: *Paradacna abichi* HOERN., *P. arcacea* (BRUS.), *Pontalmyra otyophora* (BRUS.), *Congeria zagrabiensis* (BRUS.), as well as some Pontian ostracoda (Lubenescu et al., in press). A few specimens have also been located in the the Late Pannonian/Pontian which crops out close to Blaj locality (Transylvanian Depression).

Conclusions. The stratigraphical position of *Congeria (Filicarina)* R. HÖRN. in the Pannonian *s. str.*= Middle Malvensian is known from the geological literature. At a higher stratigraphical level a related species, namely *Congeria (Filicarina) floriani* LUBENESCU et POPESCU, was located in the Middle Pannonian, having a maximum frequency. *Congeria (Filicarina) fragila crisensis* n. ssp. is described from the Early Pontian from Beiuş, but probably occurs even in the Late Pannonian. Finally, *Congeria (Filicarina) fragila* n. sp. is morphologically similar to *Congeria (Filicarina) digitifera* ANDRUS, being described in the Early Pontian-Early Odessian at Căvăran. Therefore it is worth noting that these related species have a well established place in a possible philogenetical sketch of the Filicarina Group which we intend to describe further on.

Congeria (Filicarina) digitifera ANDRUS with well established morphological characteristics is closely related to *Congeria (Filicarina) fragila* n. sp. and has already been known since the Lower Pontian=Odessian, probably having a Pannonian origin, being characteristic of another bioprovince, namely the Dacian one.

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Plate

Figs. 1, 2 — *Congeria (Filicarina) banatica* R. HÖRNES, fig. 1 (x 1) Bolvaşniţa Commune; fig. 2 (x 2) Sovata, Transylvanian Depression, Pannonian *s. str.* = Middle Malvensian.

Figs. 3, 4 *Congeria (Filicarina) florianii* LUBENESCU et POPESCU (x 1) Corund, Transylvanian Depression, Late Pannonian.

Figs. 5–11 – *Congeria (Filicarina) fragila* n. sp.; fig. 7 (x 2.1), holotype; figs. 5, 6, 9 (x 2); figs. 8, 10, 11 (x 1), Borlan Valley, Banat, Late Lower Pontian (Odessian).

Figs. 12–18 *Congeria (Filicarina) fragila crisensis* n. ssp. (x 1), boreholes South Beiuş, Early Lower Pontian (Odessian); fig. 15,holotype, borehole 4, 97–100 m depth; fig. 12, borehole 1, 40–42 m depth; fig. 14, borehole 5, 42–45 m depth; fig. 13, borehole 2, 40–42 m depth; fig. 16, borehole 4, 97–100 m depth; fig. 18, borehole 4, 18–21 m depth; fig. 17, Blaj, Transylvanian Depression, Late Panonian-Pontian.

V. LUBENESCU – CONGERIA (FILICARINA) FRAGILA n. sp.


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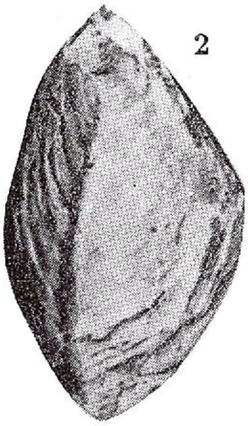
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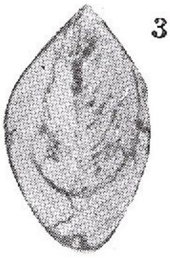
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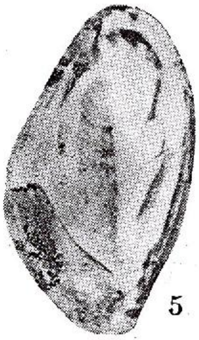
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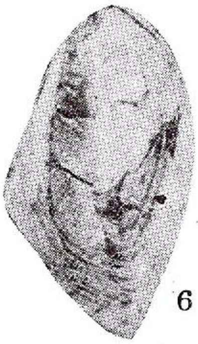
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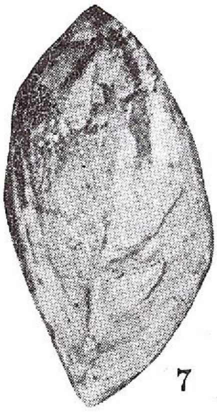
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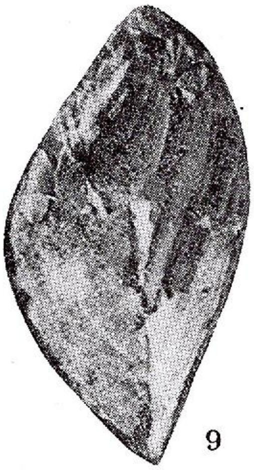
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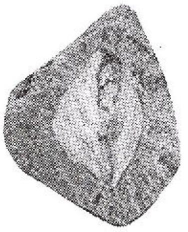
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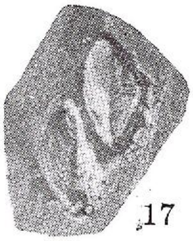
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NOUVELLES ESPÈCES DE *PARAPACHYDACNA* (BIVALVIA, FAM. LIMNOCARDIIDAE) DU DACIEN INFÉRIEUR DE LA RÉGION DE LA PLATE-FORME DU BASSIN DACIQUE

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Key words: Bivalvia. Limnocardiidae. Parapachydacna. New taxa. Biometry. Moesian Platform. Dacic Basin.

Abstract: *New species of Parapachydacna (Bivalvia, Limnocardiidae) in the Lower Dacian from the platform region of the Dacic Basin.* The forms of the *Pachydacna* genus have been particularly significant for the biostratigraphy of the Dacian from the Dacic Basin. The first issue of the *Pachydacna* genus, by the *Parapacgydacna* subgenus, is remarked at the level of the Upper Pontian (Bosphorian). The subgenus *Pachydacna* first occured in the Lower Dacian (Getian) and extenguished at the end of the Getian. Within the Lower Dacian (Getian) there are a lot of the species belonging to the nominative subgenus and to the *Parapachydacna* subgenus. During the Upper Dacian (Parscovian) only some forms of the *Parapachydacna* subgenus are present. This paper describes new species: *Pachydacna (Parapachydacna) moesica* sp. nov., *P. (P). minuta* sp. nov., and *P. (P.) unica* sp. nov.

La large distribution des dépôts daciens dans le Bassin Dacique, la multitude de faciès et le riche et varié contenu paléontologique justifient l'attention accordée à cet intervalle stratigraphique. En ce qui concerne le Dacien de la plate-forme Moesienne, on doit souligner que les informations les plus riches et les plus importantes ont été offertes par les forages à carottage continu des dernières dix années.

Quant à la biostratigraphie du Dacien du Bassin Dacique, une grande importance ont le genre *Pachydacna* pour le Dacien inférieur et le sous-genre *Psilodon* (les groupes *haueri, conversus* et *stefanescui*) pour le Dacien supérieur. En ce qui concerne le genre *Pachydacna*, il est à remarquer (Papaianopol, 1989) que le sous-genre *Pachydacna* se trouve strictement dans le Dacien inférieur (Gétien), tandis que le sous-genre *Parapachydacna*, dont les premières apparitions se trouvent au Pontien supérieur (Bosphorien), se développe largement au Dacien inférieur (Gétien); par quelques espèces il touche même la partie inférieure du Dacien supérieur (Parscovien). Jusqu'il y a peu de temps pour les parties centrale et orientale de la plate-forme Moesienne on ne connaissait le genre *Pachydacna* que des affleurements du Dobrogea du sud-ouest, entre Ostrov et Canlia (Pană, Kruck, 1972; Tătărâm et al., 1977). Les espèces de ce genre de provenance de Dobroudja, appartiennent au sous-genre *Parapachydacna* (Papaianopol, 1989). Ensuite nous avons remarqué pour la première fois la présence du sous-genre *Parapachydacna* dans quelques forages de la partie orientale de la plate-forme Moesienne (Papaianopol et al., 1989, non publié). Il s'agit de *Pachydacna* (*Parapachydacna*) aff. *dobrogiana* PAPAIANOPOL (Papaianopol et al., 1989, non publié; Papaianopol et al., 1992). Récemment nous avons immaginé un croquis paléobiogéographique du Dacien inférieur (Gétien) pour le secteur central-oriental de la plate-forme Moesienne (Papaianopol, 1994). Ainsi, nous avons remarqué un secteur oriental, entre Slobozia et le Danube, où le Gétien se caractérise par le sous-genre *Parapachydacna*, opinion soulignée par les données des forages. De tout ce matériel provenant des forages se distinguent trois espèces nouvelles, très importantes pour la biostratigraphie du Dacien de ce secteur. Les parapachydacnes de la partie orientale de la plate-forme Moesienne diffèrent de celles de la zone d'avant-fosse par la taille plus petite, les coquilles minces, fragiles et moins robustes, la convexité plus réduite et la charnière moins massive.

Les forages 160 Perişoru, 164 (ouest du village Lădeşti) et 157 Vlădeni sont emplacés au sud de la vallée de la Ialomiţa, entre les localités Slobozia et Feteşti (Fig. 1). Les forages 160 et 157 s'arrêtent au niveau du Dacien inférieur à des profondeurs de 102 m et respectivement 114 m. Le forage 164 a été intercepté aussi dans le Pontien supérieur (Fig. 2).

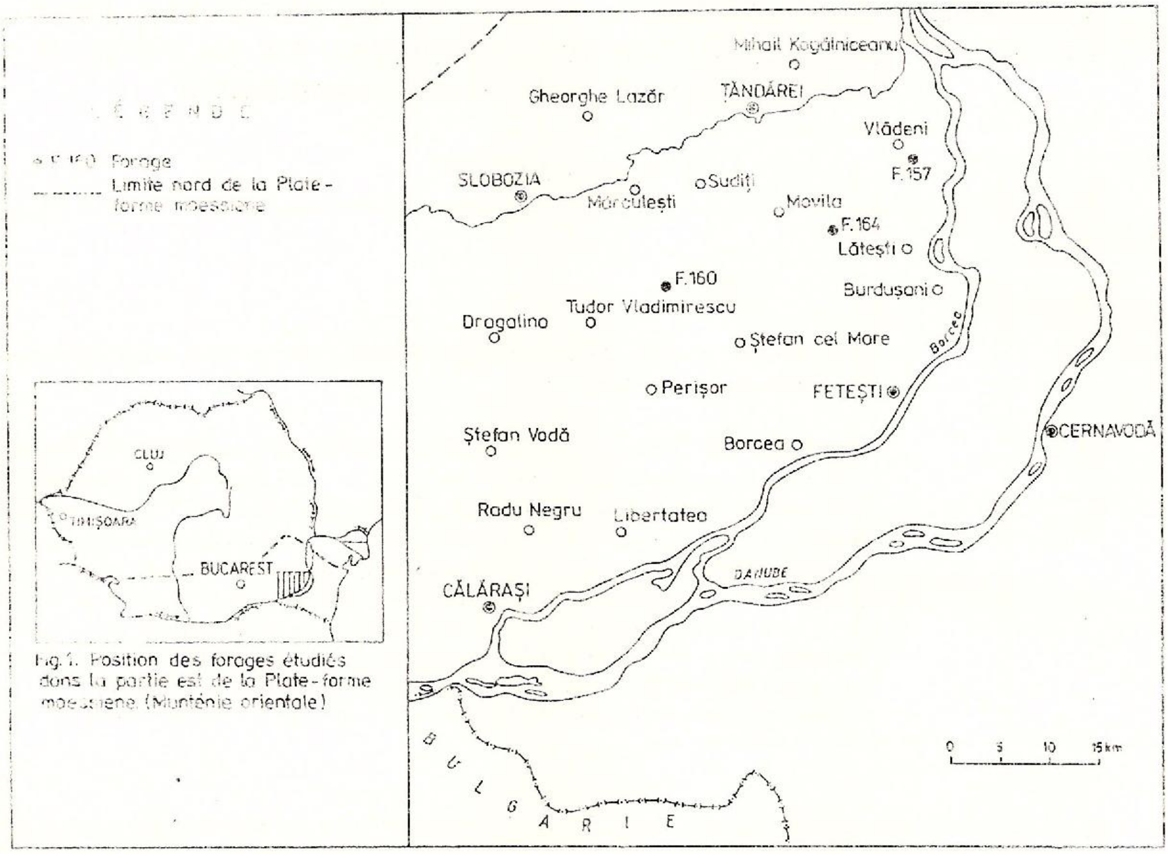

Fig. 1. Position des forages étudiés dans la partie est de la Plate-forme moesienne (Munténie orientale)

Dans ce dernier forage le Dacien inférieur (l'intervalle 132–142 m) est en totalité argileux, lithologie qui continue dans la partie inférieure du Parscovien (Pl. I). De même, pour le forage 157 (l'intervalle 93–114 m). Dans ces cas (les forages 164 et 157) la limite entre le Gétien et le Parscovien ne peut être precisée que par les mollusques. Le Gétien du forage 160 (l'intervalle 90–102 m) est aussi argileux en totalité, légèrement plus sableux vers la base. Ci dessus suivent des sables avec une faune caractéristique pour le Parscovien (Dacien supérieur).

Description des espèces

Famille Cardiidae LAMARCK, 1819

Sous-famille LIMNOCARDIINAE STOLICZKA, 1861

Genre *Pachydacna* EBERSIN, 1955

Espèce type:
Pachydacna natella EBERSIN, 1959

Sous-genre *Parapachydacna* EBERSIN, 1959

Espèce type:
Limnocardium cobălcescui FONTANNES, 1886

Pachydacna (Parapachydacna) moesica sp.nov. (Pl. II, figs. 1-2)

1994 *Pachydacna (Parapachydacna)* aff. *dobrogiana* PAPAIANOPOL et al., pl. III, fig. 1; 1994, *Pachydacna (Parapachydacna) moesica* PAPAIANOPOL, pl.IV, fig. 4;

Holotype: pl. II, fig. 1, Collection de l'Institut Géologique de Roumanie, Bucarest, no. 18.582;

Derivatio nominis: de la Plate-forme Moesienne;

Locus typicus: le forage 160, l'intervalle 96–93 m, la partie est de la plate-forme Moesienne;

Stratum typicum: le niveau des argiles gris-verdâtres à *Dacicardium rumanum* (FONTANNES), *Hydrobia grandis* COBALCESCU, *Lithoglyphus decipiens* BRUSINA, *Cyprideis geticus* OLTEANU, *Amplocypris odessaensis* (ILNITZKAIA) d'âge Dacien inférieur (Gétien).

Matériel: deux valves droites et du matériel fragmentaire;

Diagnose. Valves de taille petite vers moyenne, à contour ovale, inéquilatérales. La face externe à 10 côtes antérieures et 3 costules postérieures. La charnière de la valve droite comporte deux dents cardinales, une-deux dents latérales antérieures et une dent latérale postérieure.

Description. Coquilles de dimensions petites vers moyennes, à contour ovale, modérément bombées. La

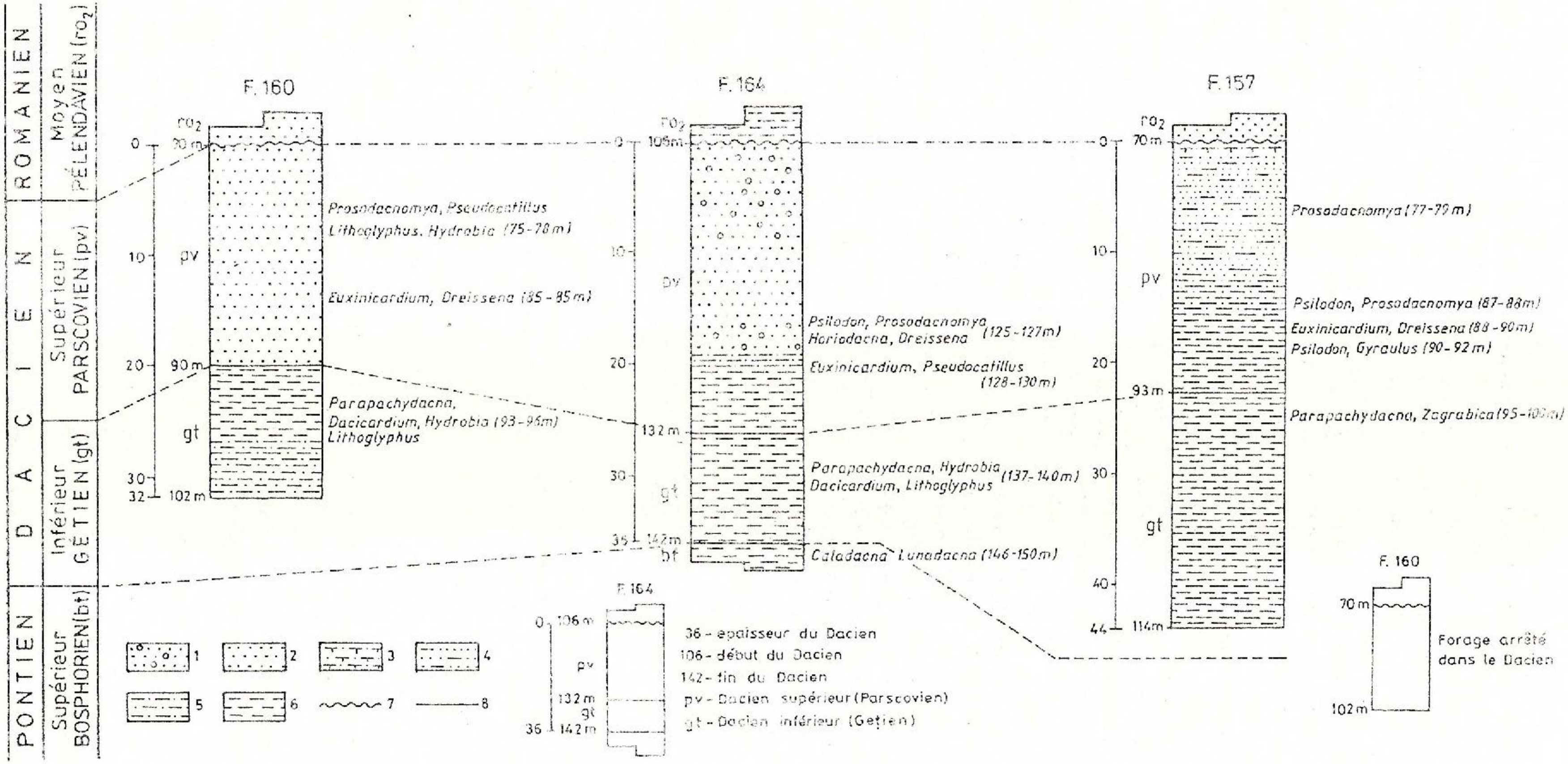

Fig. 2 – Colonnes litho-biostratigraphiques du Dacien dans les forages 160, 164 et 157: 1, sable à gravier; 2, sable; 3, grès; 4, sable argileux; 5, argile sableuse; 6, argile; 7, limite de discontinuité; 8, limite de continuité.

zone du crochet élargie et assez peu proéminente, le crochet étant petit, prosogyre, costulé et fort déplacé antérieurement. Le segment postérieur du bord cardinal est arqué. Le bord antérieur est très convexe, celui inférieur étant long et régulièrement arqué. Bord postérieur court et arqué, assez peu individualisé, se lie peu à peu avec les bords avoisinants.

Le champ antérieur, qui comporte 10 côtes, est séparé du champ postérieur par la côte qui descend du crochet dans l'angle inféro-postérieur de la valve. Les côtes sont hautes, étroites, à section triangulaire à la région du crochet, quelques unes ayant même une crête médiane. Ensuite elles s'éllargissent, s'arrondissent et s'aplatissent vers le bord inférieur. Ainsi, le champ antérieur est couvert par des côtes larges et fort arrondies. Les espaces intercôtidaux antérieurs (en nombre de 3–4) sont plus larges que la moitié des côtes voisines, les autres étant plus étroits. Sur le champ postérieur existent 3 costules fines. La charnière de la valve droite comporte une dent cardinale postérieure allongée, mince, parallèle aux bords du plateau cardinal, une dent cardinale antérieure petite, arrondie, une dent latérale antérieure inférieure bien développée, aiguë à la partie supérieure et une dent latérale postérieure allongée, lamellaire. Sur la valve droite existe aussi une petite dent latérale antérieure supérieure. A l'intérieur se trouvent des côtes internes larges, avec un fossé central, dont quelques unes peuvent dépasser la ligne qui unit les empreintes musculaires. L'empreinte de l'adducteur antérieur est arrondie et profonde. Celle du muscle postérieur est ovale, plus grande, mais superficielle. L'empreinte palléale indistincte.

Dimensions (mm) et rapports:

Les éléments morphologiques mesurés sont le diamètre antéro-postérieur (dap), le diamètre du crochet-palléal (dup) et la convexité de la valve (c).

dap	dup	c	dup/dap	c/dup
18,2	13,4	5,4	0,73	0,40
15,3	11,3	4,3	0,73	0,39

Comparaisons. P. (P.) moesica sp. nov. diffère de *P. (P). dobrogiana* PAPAIANOPOL par les valves plus allongées et moins bombées, la zone du crochet moins proéminente, le bord postérieur plus court et moins individualisé et par la longueur plus grande de la partie antérieure de la coquille.

Occurence et âge. Bassin Dacique, Plate-forme Moesienne, Dacien inférieur (Gétien).

Pachydacna (Parapachydacna) minuta sp. nov.
(Pl. II, figs. 4–5).

1994 *Pachydacna (Parapachydacna) minuta* PAPAIANOPOL, pl. IV, fig. 5.

Holotype: pl. II, fig. 4, Collection de l'Institut Géologique de Roumanie, Bucarest, no. 18.583;

Derivatio nominis: du latin minutus.

Locus typicus: le forage 160, l'intervalle 96–93 m, la partie est de la plate-forme Moesienne.

Stratum typicum: le niveau des argiles gris-verdâtres à *Dacicardium rumanum* (FONTANNES), *Hydrobia grandis* COBALCESCU, *Lithoglyphus decipiens* BRUSINA, *Cyprideis geticus* OLTEANU, *Amplocypris odessaensis* (ILNITZKAIA) d'âge Dacien inférieur (Gétien).

Matériel: deux valves (une droite et une gauche) et du matériel fragmentaire.

Diagnose. Valves de petites dimensions, minces, fragiles, à contour rectangulaire-ovale et le crochet peu saillant, couvert par 10–11 côtes et 3 costules postérieures. La charnière de la valve droite à deux dents cardinales, une-deux latérales antérieures et une latérale postérieure. Sur la valve gauche la charnière comporte une dent cardinale, une latérale antérieure et une latérale postérieure.

Description. Coquille de petites dimensions, mince, fragile, peu convexe, à contour rectangulaire-ovale, très inéquilatérale. La partie postérieure de la valve est deux à trois fois plus longue que la partie antérieure. La zone du crochet est aplatie et peu saillante, au crochet prosogyre, petit, costulé, fort déplacé antérieurement. Le rameau postérieur du bord cardinal est très long, presque droit ou peu arqué. Le bord antérieur est fort convexe. Entre le bord postérieur, long et bien individualisé et celui cardinal se forme un angle obtus. Le bord inférieur est long et arqué.

Les deux secteurs de la surface externe sont séparés par une côte aiguë. La surface externe est couverte par 10–11 côtes et 3 costules postérieures. Les côtes du champ antérieur sont tranchantes, à section triangulaire et pourvues d'une crête médiane. Elles gardent la crête médiane sur toute leur longueur. Les premières 5–6 côtes antérieures ont au bord de la valve une section triangulaire, les autres ayant une section triangulaire-arrondie. La côte la plus haute n'est pas celle qui sépare les deux champs, mais l'antérieure. Vers le bord inférieur les côtes sont moins hautes, mais gardent la section triangulaire et la crête médiane. Les espaces intercôtidaux sont très bien delimités et assez larges.

La charnière de la valve droite est munie de deux dents cardinales, une dent latérale antérieure et une dent latérale postérieure allongée et plus forte. Une fossette cardinale profonde sépare les dents cardinales. La dent latérale antérieure inférieure est assez forte. Souvent est présente aussi une petite dent latérale antérieure supérieure. La dent latérale postérieure est lamellaire et très longue. Sur la valve gauche la charnière est formée d'une dent cardinale, une dent latérale antérieure et une dent latérale postérieure lamellaire, mais beaucoup plus courte que celle de la valve droite. Parfois existe un faible rudiment de la dent cardinale postérieure.

La face interne est costulée sur une grande étendue, beaucoup de côtes arrivant jusque dans la cavité du crochet. Les côtes internes sont larges avec un fossé médian. Les empreintes des muscles sont inégales tant par les dimensions que par les profondeurs, l'antérieure étant arrondie et plus profonde que l'empreinte postérieure. L'empreinte palléale est entière.

Dimensions (mm) et rapports:

dap	dup	c	dup/dap	c/dup
11,2	8,0	2,8	0,71	0,35
10,2	8,1	3,0	0,79	0,37

Comparaisons. Par les côtes aiguës et pourvues d'une crête médiane, *P. (P.) minuta* sp.nov. s'individualise nettement par rapport aux autres parapachydacnes de cette région. Ces dernières ont dans le champ antérieur les côtes arrondies et basses. Par l'aspect des côtes externes, *P. (P.) minuta* sp.nov. ressemble à *P. (P.) angusticostata* PAPAIANOPOL, mais cette dernière est plus grande, plus robuste, plus bombée, à contour ovale ou ovale-arrondi.

Occurence et âge. Bassin Dacique, Plate-forme Moesienne, Dacien inférieur (Gétien).

Pachydacna (Parapachydacna) unica sp. nov.
(Pl. II, fig. 6).

1994 *Pachydacna (Parapachydacna) unica* PAPAIANOPOL, pl. IV, fig. 7;

Holotype: pl. II, fig. 6, Collection de l'Institut Géologique de Roumanie, Bucarest, no. 18.584;

Derivatio nominis: du latin unicus.

Locus typicus: le forage 157, l'intervalle 95–100 m, la partie est de la plate-forme Moesienne.

Stratum typicum: niveau des argiles grises à *Zagrabica carinata* ANDRUSOV, *Lithoglyphus decipiens* BRUSINA, *Bakunella djanelidzae dacica* OLTEANU, *Amnicythere multituberculata* (LIVENTAL) , d'âge Dacien inférieur (Gétien).

Matériel: une valve droite et du matériel fragmentaire.

Diagnose. Coquille de petites dimensions, mince, à contour ovale-arrondi, couverte par 10 côtes et trois costules postérieures. La charnière de la valve droite comporte deux dents cardinales, une latérale antérieure et une latérale postérieure.

Description. Valve de petite taille, mince, fragile, à contour ovale-arrondi, forte inéquilatérale à la partie postérieure bien développée et assez large. La zone du crochet est aplatie et peu reliefée au-dessus du bord cardinal. Le crochet est petit, prosogyre et couvert de côtes. Le rameau postérieur du bord cardinal est peu arqué. Le bord postérieur est long et presque droit faisant un angle obtus avec le bord cardinal.

Sur la face externe existent 10 côtes antérieures et trois costules. Au voisinage du crochet, les côtes sont proéminentes, même triangulaires, mais pas trop hautes, elles s'éllargissent et s'aplatissent vers le bord inférieur. Ainsi, on remarque des côtes lisses, presque planes. Au bord de la valve elles ont une section transversale arrondie. La côte qui sépare les deux champs de la face externe est plus étroite que celle antérieure. Seulement les premiers deux espaces intercôtidaux sont plus larges que la moitié des côtes adjacentes. Des trois costules, la mieux développée est celle qui sépare les deux champs de la face externe; les autres sont visibles seulement dans la moitié supérieure.

Le plateau cardinal, étroit, présente sur la valve droite une dent cardinale postérieure allongée, une très petite dent cardinale antérieure, une dent latérale antérieure linguale et une dent latérale postérieure lamellaire mais pas beaucoup allongée. La face interne est couverte aussi par des côtes sur une grande surface, les côtes postérieures arrivant dans la cavité du crochet. Les côtes internes ont un fossé médian. L'empreinte de l'adducteur antérieur, de forme arrondie, est plus profonde que celle du postérieur qui est ovale, plus grande, mais plus superficielle. Empreinte palléale indistincte.

Dimensions (mm) et rapports:

dap	dup	c	dup/dap	c/dup
12,2	10,4	4,3	0,86	0,41

Comparaisons. Par contour et par le caractère de toutes les côtes du champ antérieur, l'espèce décrite ressemble beaucoup à la *P. (P.) officiosa* PAPAIANOPOL, dont elle se distingue facilement par la coquille plus petite, très fragile et moins bombée, par le crochet moins saillant et par le segment postérieur du bord cardinal qui est très faible arqué.

Occurence et âge. Bassin Dacique, Plate-forme Moesienne, Dacien inférieur (Gétien).

Pachydacna (Parapachydacna) sp.
(Pl. II, fig. 9).

1994 *Pachydacna (Parapachydacna)* sp. PAPAIANOPOL, pl. IV, fig. 6;

Dans les dépôts du Dacien inférieur (Gétien) de la partie est de la plate-forme Moesienne, nous avons rencontré une valve gauche qui diffère évidemment de toutes les espèces de *Parapachydacna* du Gétien de la plate-forme Moesienne. N'ayant aucune valve droite entière, nous ne pouvons pas la nommer. La coquille très petite, modérément convexe, assez robuste, à contour ovale, très inéquilatérale. Le crochet prosogyre, couvert par des côtes, déplacé antérieurement. Elle est couverte par 11 côtes et 3 costules. Seulement près du crochet, les côtes sont étroites et triangulaires, vers le bord inférieur s'élargissant, s'arrondissant et s'aplatissant. Les derniers espaces intercostidaux sont bien individualisés, mais assez étroits; les autres sont plus larges, ayant la largeur égale ou plus grande que la moitié des côtes adjacentes. Sur la valve gauche la charnière est formée d'une dent cardinale, une dent latérale antérieure et une dent latérale postérieure allongée mais très courte. La face interne est costulée sur une grande étendue. L'exemplaire décrit diffère de *P.* (*P.*) *moesica* sp.nov. par les côtes plus proéminentes, les valves plus allongées et moins hautes et par le segment postérieur du bord cardinal qui est presque droit.

Occurence et âge. Bassin Dacique, Plate-forme Moesienne, le forage 157 (l'intervalle 95–100 m), Dacien inférieur (Gétien).

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Planche

Figs. 1-2 — *Pachydacna (Parapachydacna) moesica* sp.nov. (fig. 1 x 3, fig. 2 x 2), fig.1, holotype, leg. I. Papaianopol, fig. 1, le forage 160, l'intervalle 93-96 m; fig. 2, le forage 164, l'intervalle [illegible]; Dacien inférieur (Gétien).

Fig. 3 — *Pachydacna (Parapachydacna) dobrogiana* PAPAIANOPOL, (x 2), leg. Hanganu, village d'Ostrov, Dobrogea du sud-ouest, Dacien inférieur (Gétien).

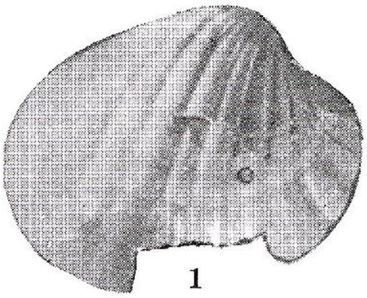
Figs. 4-5 — *Pachydacna (Parapachydacna) minuta* sp.nov., (x 5), fig. 4, holotype, leg. I. Papaianopol, le forage 160, l'intervalle 93–96 m, Dacien inférieur (Gétien).

Fig. 6 — *Pachydacna (Parapachydacna) unica* sp.nov., (x 3), holotype, leg. Papaianopol, le forage 157, l'intervalle 95–100 m, Dacien inférieur (Gétien).

Fig. 7 — *Pachydacna (Parapachydacna) officiosa* PAPAIANOPOL, (x 2), leg. Hanganu, village d'Ostrov, Dobrogea du sud-ouest, Dacien inférieur (Gétien).

Fig. 8 — *Pachydacna (Parapachydacna) angusticostata* PAPAIANOPOL, (x 2), leg. Papaianopol, la vallée Bună, village de Cuceşti, département de Vâlcea, Dacien inférieur (Gétien).

Fig. 9 — *Pachydacna (Parapachydacna)* sp., (x 5), leg. Papaianopol, le forage 157, l'intervalle 95–100 m, Dacien inférieur (Gétien).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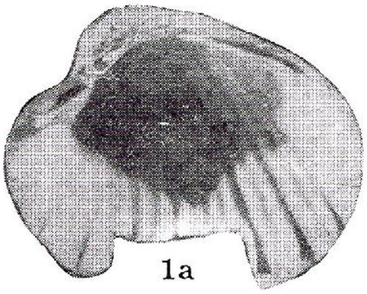
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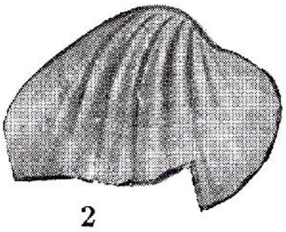
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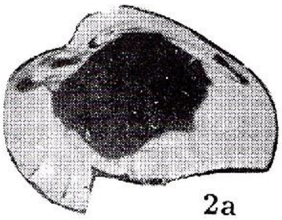
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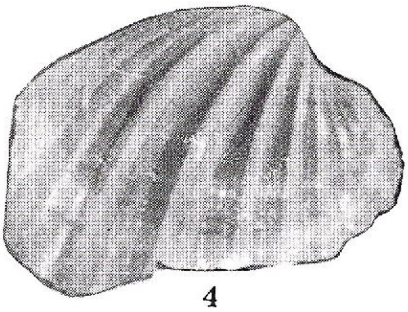
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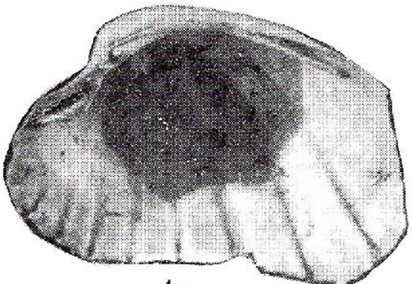
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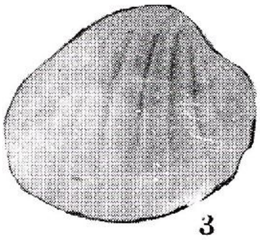
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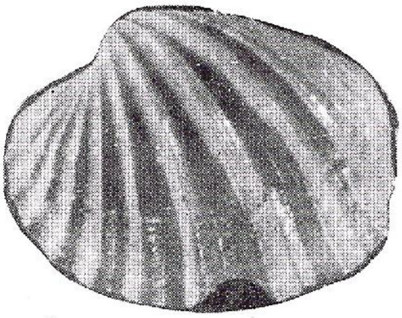
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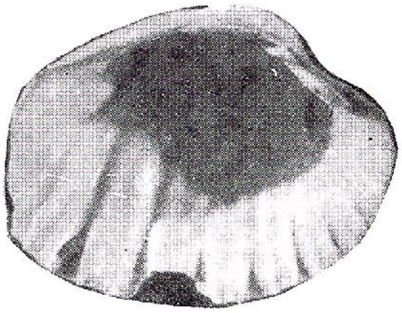
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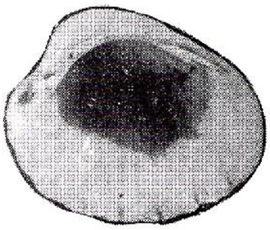
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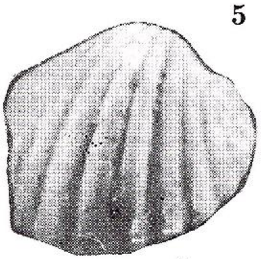
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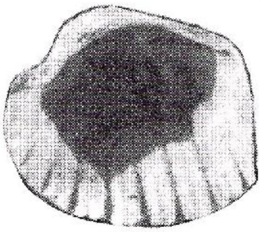
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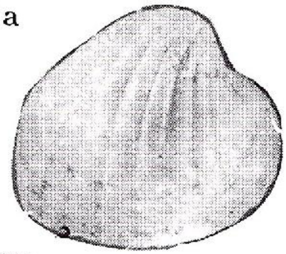
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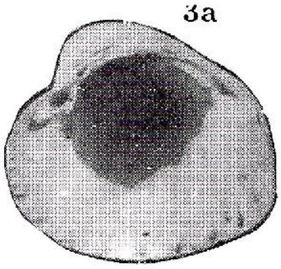
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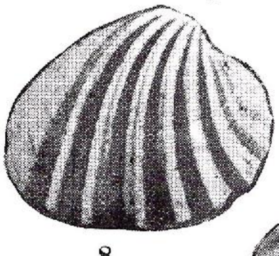
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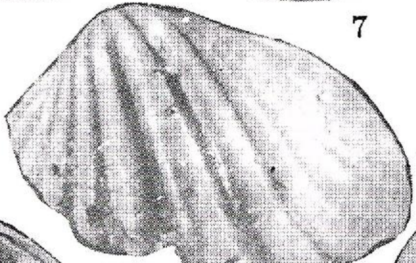
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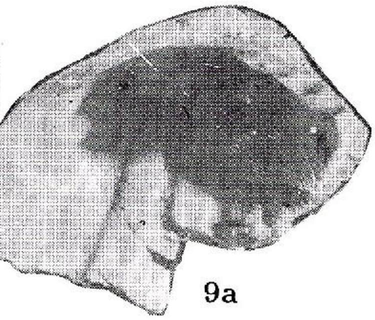
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Rom. J. Paleontology, 76, 1995, p. 111–120, Bucharest

MOLLUSQUES DACIENS DES SECTEURS CENTRAL ET ORIENTAL DE LA PLATE-FORME MOESIENNE

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Key words: Mollusca. Bivalvia. Gastropoda. Lower Dacian. Upper Dacian. Moesian Platform.

Abstract: *Dacian Mollusca from the central and eastern sectors of the Moesian Platform.* Drillings of continuous coring carried in the central and eastern part of the Moesian Platform (Wallachia) gave us a lot a new information concerning the composition of Dacian faunal complexes. The rich Dacian mollusc fauna have been intercepted in all the 27 boreholes analysed. The Getian faunas are less varied. The Parscovian deposits are richly fossiliferous . Following the Dacian deposits between the Olt River and the Danube, numerous variations could be identified at one and same stratigraphic level, not only of the lithofacies but also of the faunal assemblages. The assemblage fauna attests the Upper Dacian (Parscovian) age of the coal-bearing formation of the Dacian of the Moesian Platform. Recent information have evidenced notables differences of the paleogeographic evolution, the Upper Dacian (Parscovian) shows transgressive characters.

Les forages exécutés le dernier temps dans les parties centrale et orientale de la plate-forme moesienne (en Valachie) ont fourni de nombreuses informations pour compléter notre image concernant ce secteur. Les dépôts du Dacien de la plate-forme moesienne reposent en continuité, ou en discontinuité, sur ceux du Pontien supérieur (Bosphorien). Au point de vue paléogéographique, le secteur de la plate-forme moesienne délimité par l'Olt et le Danube, appartient au bassin Dacique, bassin délimité par les Carpates, les Prébalkans et la Dobroudja. Ayant au début une position intermédiaire entre la Paratéthys centrale à l'ouest (bassin Pannonien) et la Paratéthys orientale à l'est, le bassin Dacique nous apparait après le Pontien supérieur comme un grand golf du bassin Euxinique, mais avec des caractères propres différents de celui-ci. Comme bioprovince distincte, le Bassin Dacique a été individualisé depuis le Badénien supérieur. Comme unité paléogéographique, le bassin Dacique couvre tant la zone de l'avant-fosse (partie nord du bassin Dacique), que la plate-forme moesienne (partie sud du Bassin Dacique).

A la suite de l'étude des nombreux forages entre l'Olt et le Danube, nous avons eu la possibilité d'obtenir des informations plus complètes concernant les faunes de mollusques d'âge dacien.

Après les études de Sabba Ştefănescu (1894, 1896) sur le forage de Mărculeşti (partie est de la plate-forme moesienne), les faunes de mollusques du Pliocène de la plate-forme moesienne n'ont plus été étudiées. Wenz (1942) a repris quelques uns des exemplaires figurés pour la première fois par Sabba Ştefănescu.

Au cours de nos études de dernière décénnie nous avons présenté une partie de la faune de mollusques du Dacien (Papaianopol et al., 1985, 1986, 1988, 1989, non publiés). Certains de ces spécimens font l"objet de plusieurs notes (Lubenescu et al., 1987; Papaianopol et al., 1987; Papaianopol, Lubenescu, 1987; Papaianopol et al., 1992; Papaianopol, 1992).

La très riche et très variée macrofaune que nous avons prélevée provient de 60 forages, dont 27 sont plus importants (voir fig. 1). Des informations complètes concernant toute la succession du Dacien nous ont été fournies par les forages qui ont touché les dépôts du Pontien supérieur aussi.

La faune de mollusques du Dacien inférieur (Gétien)

De 27 forages commentés, les dépôts du Dacien inférieur (Gétien) ont été interceptés par 16 (fig. 2). Cet intervalle comporte des argiles, des sables et des mélanges en diverses proportions de ces deux. En poursuivant de proche en proche les dépôts gétiens entre l'Olt et le Danube, on a constaté que les psammites et pélites n'ont aucune distribution significative dans les successions lithologiques de cet intervalle (pl. II).

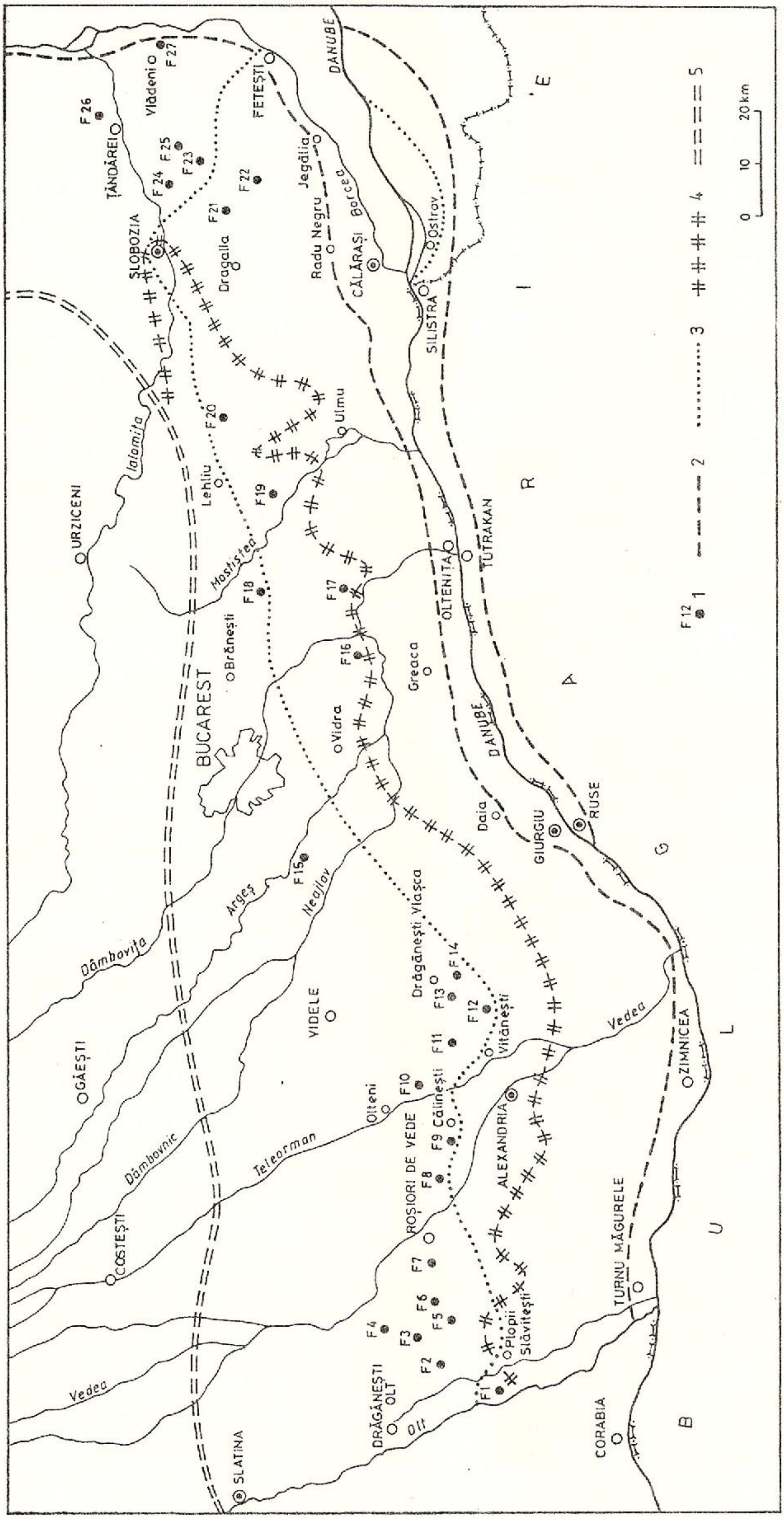

Fig. 1 - Position des forages étudiés et l'extension du Dacien dans la Plate-forme Moesienne (secteur Olt-Danube): 1, forage; 2, ligne de bord pendant le Dacien supérieur (Parscovien); 3, ligne de bord pendant le Dacien inférieur (Gétien); 4, limite sud du faciès charbonneux d'âge dacien supérieur; 5, limite nord de la Plate-forme Moesienne.

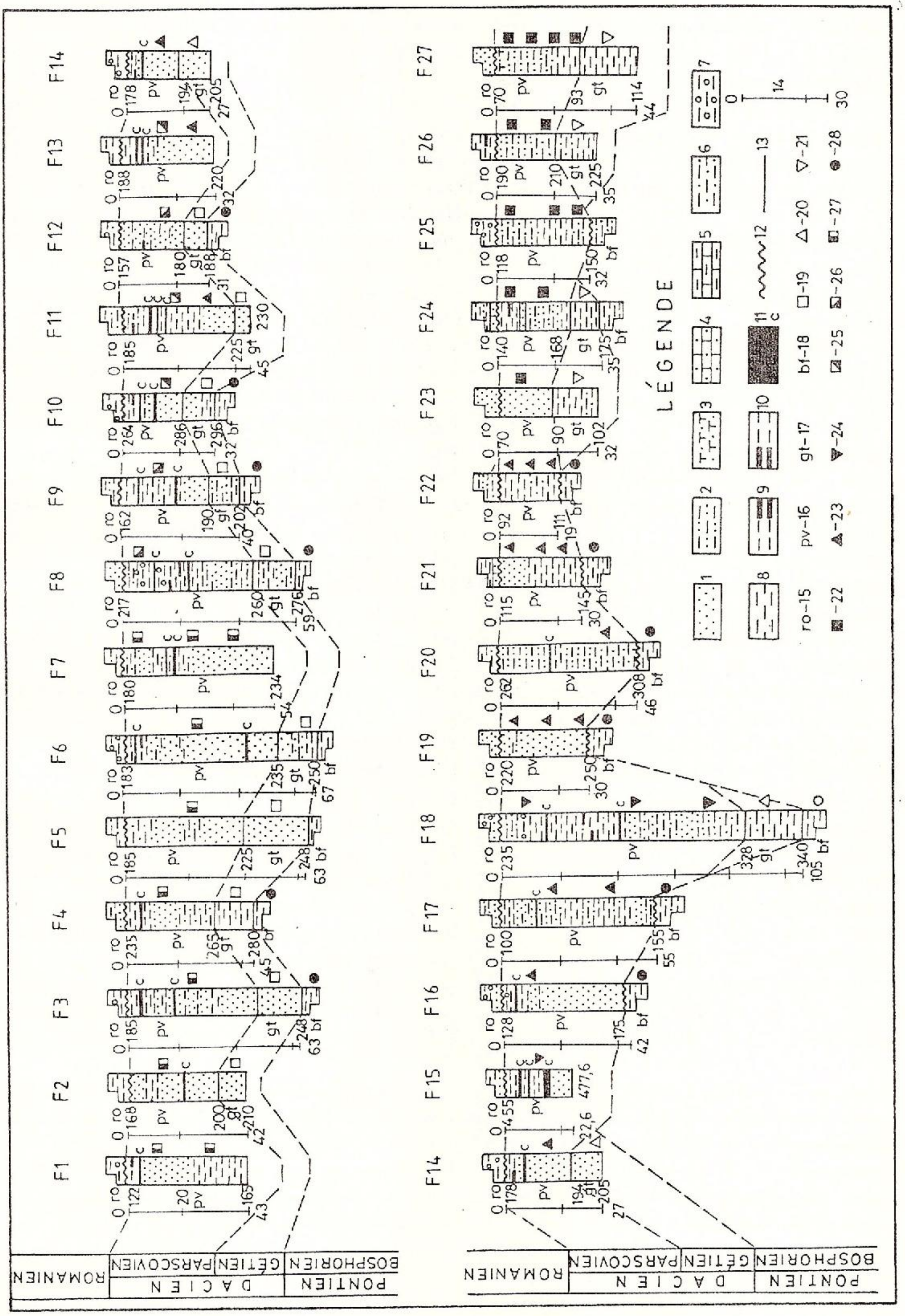
ROMANIEN
DACIEN
PARSCOVIEN
GÉTIEN
PONTIEN
BOSPHORIEN
F1
F2
F3
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Fig. 2

Ainsi, il y a des situations quand les sables sont prédominants (forages 3, 5, 12, 14) et à une petite distance la lithologie du même intervalle devient exclusivement argileuse (le cas du forage 4, situé à 6 km nord du forage 3). Il y a aussi des cas où le Gétien comporte des argiles à la partie inférieure et des sables à celle supérieure (forage 10). Dans d'autres cas, les argiles ou les argiles sableuses sont prédominantes, les sables étant subordonnés (forage 8), ou existe en totalité une alternance des argiles et des sables (forage 6).

La synthèse des observations concernant les variations lithofaciales du Gétien a montré que la région délimitée par l'Olt (à l'Ouest) et le Danube (à l'Est) comporte deux secteurs:

- un secteur occidental, délimité par les vallées de l'Olt et de la Dâmboviţa, où dans les successions lithologiques du Gétien les sables ont un rôle important, et
- un secteur oriental, délimité par la vallée de Dâmboviţa à l'ouest et celle du Danube à l'est, où le Gétien comporte, presque exclusivement, des argiles et des argiles sableuses.

Dans la partie ouest de la surface étudiée, entre l'Olt et le Teleorman, dans six forages, la faune de mollusques comprend les suivants taxons: *Zamphiridacna orientalis* (SABBA), *Z. becenensis* ANDREESCU, *Limnocardium (Euxinicardium) virgatum* PAPAIANOPOL, *Dacicardium rumanum* (FONTANNES), *D. dacianum* (PAPAIANOPOL), *Prosodacna (Prosodacna)* aff. *semisulcata* (ROUSSEAU), *Dreissena rimestiensis* FONTANNES, *D. berbestiensis* FONTANNES, *D. polymorpha* PALLAS, *Viviparus getianus* LUBENESCU, *V. conicus* LUBENESCU, *V. duboisi* (MAYER-EYMAR), *Theodoxus rumanus* (SABBA), *Lithogliphus decipiens* BRUSINA, *Hydrobia syrmica* NEUMAYR, *H. grandis* COBĂLCESCU, *Valenciennius dacicus* PAVNOTESCU. Les faunes de ce type ont été trouvées dans les forages : 2 (l'intervalle 210–205 m), 3 (l'intervalle 248–235 m), 5 (l'intervalle 238–225 m), 6 (les intervalles 247–243 m, 243–238 m et 238–235 m), 8 (l'intervalle 267–265 m) et 9 (l'intervalle 198–195 m).

Vers l'est, entre la vallée du Teleorman et la vallée de la Mostiştea, le Gétien a été séparé dans cinq forages. Pour cette zone on doit remarquer que les informations plus complètes concernant la succesion du Gétien proviennent de les secteurs est et ouest de ce zone. Pour un secteur central, situé au sud-est et sud-ouest de Bucarest les données sont incomplètes parce que les forages se sont arrêtés au-dessous du complexe houiller situé à la partie supérieure du Dacien supérieur. A l'est de la vallée du Teleorman dans les forages 10 (l'intervalle 290–286 m), 11 (l'intervalle 230–227 m), 12 (l'intervalle 188–186 m), et 14 (l'intervalle 199–194 m) on a trouvé: *Dacicardium rumanum* (FONTANNES), *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Pseudocatillus* sp., *Dreissena polymorpha* PALLAS, *Viviparus conicus* LUBENESCU, *V. cucestiensis* LUBENESCU, *Theodoxus rumanus* (SABBA), *Hydrobia grandis* COBĂLCESCU, *Lithoglyphus decipiens* BRUSINA, *Zagrabica reticulata* SABBA.

A l'ouest de la vallée de la Mostiştea, dans le forage 18 (l'intervalle 336–333 m), la faune gétienne comprend: *Zamphiridacna orientalis* (SABBA), *Dacicardium rumanum* (FONTANNES), *Hydrobia syrmica* NEUMAYR, *Zagrabica carinata* ANDRUSOV.

Entre la vallée de la Mostiştea et le Danube (partie orientale de la plate-forme Moesienne de Munténie) la faune de mollusques d'âge gétien comporte: *Pachydacna (Parapachydacna) moesica* PAPAIANOPOL, *P. (P.) minuta* PAPAIANOPOL, *P (P.) unica* PAPAIANOPOL, *Dacicardium rumanum* (FONTANNES), *Lithoglyphus decipiens* BRUSINA, *Hydrobia syrmica* NEUMAYR, *Zagrabica carinata* ANDRUSOV. Les faunes de ce type, à parapachydacnes, ont été trouvées dans les forages 23 (l'intervalle 96–93 m), 26 (les intervalles 222–220 m et 216–212 m) et 27 (l'intervalle 100–95 m).

Basés sur le matériel paléontologique étudié et sur les observations concernant la distribution aréale des formes gétiennes, nous avons imaginé un croquis paléobiogéographique du Gétien, pour le secteur central-est de la plate-forme moesienne (Papaianopol, 1994). Dans ce cadre ont été separés trois sec-

Fig. 2 – Colonnes litho-biostratigraphiques du Dacien dans les forages emplacés dans la Plate-forme Moesienne (secteur Olt-Danube): 1, sable; 2, sable argileux; 3, grès; 4, grès calcaire; 5, marnocalcaire; 6, argile sableuse; 7, argile à concretions calcaires; 8, argile; 9, argile charbonneuse; 10, lignite argileux; 11, lignite; 12, limite de discontinuité; 13, limite de continuité; 14, épaisseur du Dacien; 15, Romanien; 16, Dacien supérieur (Parscovien); 17, Dacien inférieur; 18, Pontien supérieur (Bosphorien); 19, association à *Parapachydacna, Dacicardium, Zagrabica, Hydrobia*; 20, association à *Zamphiridacna, Dacicardium, Hydrobia*; 21, association à *Zamphiridacna, Euxinicardium, Dreissena, Viviparus, Valenciennius*; 22, association à *Psilodon, Limnodacna, Horiodacna, Pseudocatillus, Euxinicardium, Prosodacnomya, Zamphiridacna, Dreissena, Viviparus*; 23, association à *Horiodacna, Prosodacnomya, Limnodacna, Pseudocatillus, Dreissena, Hydrobia, Lithoglyphus*; 24, association à *Zamphiridacna, Pseudocatillus, Hydrobia*; 25, association à *Theodoxus, Melanopsis, Bulimus, Dreissena*; 26, association à *Dacicardium, Pseudocatillus, Pseudoprosodacna, Lithoglyphus*; 27, association à *Prosodacnomya, Horiodacna, Gyraulus, Hydrobia*; 28, association à *Lunadacna, Chartoconcha, Caladacna, Phyllocardium*.

teurs qui, de l'est à l'ouest, sont les suivants:

1 – *un secteur oriental*, compris entre la ville Slobozia et le Danube, où le Gétien est caractérisé par la présence des spécimens du sous-genre *Parapachydacna*. A ce secteur appartiennent aussi les dépôts du Gétien qui se développent dans la Dobroudja du sud-ouest;

2 – *un secteur* compris entre la ville Slobozia et la vallée du Neajlov où les genres *Zamphiridacna* et *Dacicardium* ont un rôle important;

3 – *un secteur occidental* entre les vallées du Neajlov et de l'Olt oú les macrofaunes gétiennes sont dominées par *Zamphiridacna*, *Euxinicardium* et *Dreissena*.

La microfaune d'ostracodes comprend des espèces des genres *Bakunella, Leptocythere, Cyprideis, Pontoniella, Amnicythere, Caspiocypris, Cytherissa, Cypria* (nous remercions notre collegue Olteanu qui les a déterminés).

La faune de mollusques du Dacien supérieur (Parscovien)

Dans tous les forages discutés ont été rencontrés les dépôts du Dacien supérieur (Parscovien).

Au point de vue lithologique le Dacien supérieur, tout comme le Dacien inférieur, est constitué de sables, sables argileux, argiles sableuses et argiles. En même temps il diffère du Gétien par la présence de très rares intercalations de grès, ou grès calcaires et surtout par l'existence du faciès à charbon. Ce dernier comporte des couches de lignite, des lignites argileux et des argiles charbonneuses. D'habitude, les couches de charbon se trouvent à la partie supérieure du Parscovien.

Il y a de rares situations quand le Parscovien comporte en exclusivité des sables (forage 23), avec ou dépourvus de sables argileux (forage 19), ou même d'argiles (forage 12). Quand à la partie supérieure du Parscovien se développe le faciès charbonneux, à sa partie inférieure se trouvent des sables surmontés par des argiles et argiles à couches de lignite (forages 3, 11, 13, 14, 15, 16). Mais, il y a aussi des situations quand à la partie inférieure du Dacien supérieur se trouvent des argiles, rarement à intercalations d'argiles sableuses, supportant des argiles à charbon (forages 1, 4, 8, 18). Enfin, il y a des forages qui ont traversé seulement des argiles et argiles sableuses, totalement dépourvues (forage 25) ou avec de rares (forage 17) intercalations des sables. On constate donc que les variations lithologiques sont très importantes à de faibles distances, seulement de quelques kilomètres (forages 23, 24, 25).

Dans les parties centrale et orientale de la plate-forme moesienne le faciès houiller d'age parscovien présente lui aussi un développement discontinu. On peut ainsi séparer deux secteurs diférents par rapport à la façon de développement des faciès charbonneux:

– *un secteur* qui se développe dans la partie ouest-centrale de la Munténie, délimité par l'Olt à l'ouest et l'alignement Slobozia-Călăraşi à l'est, caractérisé par l'existence d'un faciès houiller, plus ou moins important, à la partie supérieure du Parscovien;

– *un secteur oriental* de cet alignement vers l'est jusqu'au Danube, ou le faciès charbonneux n'existe plus, étant remplacé par d'autres faciès toujours du Dacien supérieur. Ce secteur couvre aussi la partie sud-ouest de la Dobroudja.

Dans huit forages situés entre la vallée de l'Olt et la vallée du Teleorman, les dépôts du Parscovien sont très richement fossilifères. Nous avons en vue les forages 1 (les intervalles 153–150 m et 138–135 m), 2 (l'intervalle 186–183 m), 3 (l'intervalle 211–205 m), 4 (l'intervalle 249–246 m), 5 (l'intervalle 208–205 m), 6 (les intervalles 224–221 m et 204–201 m), 7 (les intervalles 214–207 m, 205–201 m et 184–181 m) et 8 (l'intervalle 222–220). Les suivantes associations de bivalves et de gastropodes ont été déterminées: *Pseudocatillus moesicus* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *Dacicardium moesicum* ANDREESCU, *D. rumanum* (FONTANNES), *D.* aff. *dacianum* (PAPAIANOPOL), *Limnocardium (Euxinicardium) orolesi* PAPAIANOPOL, *L. (E.) munteniae* PAPAIANOPOL, *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Zamphiridacna zamphiri* (COBĂLCESCU), *Horiodacna rumana* SABBA, *Prosodacnomya stenopleura* (SABBA), *Pisidium iasiense* COBĂLCESCU, *Dreissena baraganica* ANDRUSOV, *D. polymorpha* PALLAS, *Lithoglyphus decipiens* BRUSINA, *L. amplus* BRUSINA, *L. acutus* COBĂLCESCU, *L. harpaeformis* COBĂLCESCU, *Hydrobia grandis* COBĂLCESCU, *H. syrmica* NEUMAYR, *Gyraulus (Gyraulus) rumanus* WENZ, *Melanopsis (Melanopsis)* aff. *bergeroni* SABBA.

Vers l'est, entre la vallée du Teleorman et la vallée de la Mostiştea, dans les forages 10 (l'intervalle 274–272 m), 11 (les intervalles 205–202 m et 198–195 m), 12 (l'intervalle 179–176 m), 13 (les intervalles 220–214 m et 200–198 m), 14 (l'intervalle 189–185 m), 15 (l'intervalle 460–458 m), 16 (l'intervalle 139–129 m), 17 (les intervalles 143–140 m et 116–114 m) et 18 (les intervalles 320–318 m, 285–284 m et 246–241 m) les macrofaunes parscoviennes comprendent: *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *Limnocardium (Euxinicardium) orolesi* PAPAIANOPOL, *L. (E.) peregrinum* PAPAIANOPOL, *Horiodacna rumana* SABBA, *Prosodacnomya stenopleura* (SABBA), *Zamphiridacna zamphiri* (COBĂLCESCU), *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, *Dacicardium dacianum* (PA-

PAIANOPOL), *D. valahicus* PAPAIANOPOL, *D. rumanum* (FONTANNES), *Unio (Rumanunio) rumanus* TOURNOUËR, *Dreissena baraganica* ANDRUSOV, *D. polymorpha* PALLAS, *Melanopsis (Melanopsis) covurluensis* COBĂLCESCU, *Bulimus (Tylopoma) heleni* (COBĂLCESCU), *B. (Daciella) valdecarinatus* WENZ, *Hydrobia grandis* COBĂLCESCU, *H. syrmica* NEUMAYR, *Lithoglyphus harpaeformis* COBĂLCESCU, *L. amplus* BRUSINA, *L. decipiens* BRUSINA, *Theodoxus licherdopoli* (SABBA), *T. rumanus* (SABBA), *Gyraulus (Gyraulus) rumanus* WENZ, *Viviparus murgescui* COBĂLCESCU.

Dans quelques forages de ce secteur (les forages 10 et 15) le faciès charbonneux est bien développé (l'épaisseur de la couche principale de charbon est comprise entre 2 et 3 m). Les dépôts qui précèdent l'installation de ce faciès comportent de nombreux exemplaires de *Melanopsis, Theodoxus* et *Dreissena*, montrant une salinité plus réduite par rapport aux séquences antérieures.

Entre la vallée de la Mostiştea et le Danube (partie est de la plate-forme moesienne) la faune de mollusques d'âge parscovien contient: *Prosodacna (Psilodon) arioni* COBĂLCESCU, *P. (P.) damienensis* COBĂLCESCU, *Horiodacna rumana* SABBA, *Prosodacnomya stenopleura* (SABBA), *Zamphiridacna zamphiri* (COBĂLCESCU), *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, *Limnocardium (Euxinicardium) peregrinum* PAPAIANOPOL, *L. (E.) orolesi* PAPAIANOPOL, *Pseudocatillus baraganicus* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *P. humilis* PAPAIANOPOL et LUBENESCU, *P. quadrangularis* PAULIUC, *Pisidium iasiense* COBĂLCESCU, *Dreissena baraganica* ANDRUSOV, *D. polymorpha* PALLAS, *Melanoides abchasica* (SENINSKI), *Lithoglyphus decipiens* BRUSINA, *L. amplus* BRUSINA, *L. harpaeformis* COBĂLCESCU, *Hydrobia syrmica* NEUMAYR, *N. grandis* COBĂLCESCU, *Gyraulus (Gyraulus) rumanus* WENZ, *Bullimus (Tylopoma) heleni* (COBĂLCESCU), *B. (T.) speciosus* (COBĂLCESCU), *B. (T.) conicus* (COBĂLCESCU), *Viviparus heberti* COBĂLCESCU, *V. murgescui* COBĂLCESCU. Ces faunes ont été trouvées dans les forages 19 (les intervalles 250–245 m , 238–235 m et 226–223 m), 20 (l'intervalle 300–298 m), 21 (les intervalles 139–133 m, 133–127 m et 121–115 m), 22 (les intervalles 110–106 m,99–96 m et 96–92 m), 23 (les intervalles 87–85 m et 78–75 m), 24 (les intervalles 164–162 m, 154–151 m et 143–142 m), 25 (les intervalles 145–140 m, 138-132 m et 126–120 m), 26 (les intervalles 208–205 m et 200–198 m) et 27 (les intervalles 92–90 m, 90–88 m, 88–83 m et 79–77 m).

La faune d'ostracodes du Parscovien comprend des espèces de: *Tuberocandona, Moesiella, Caspiolla, Amnicythere, Cyprideis, Candona, Caspiocypris, Pontoniella, Leptocythere, Cyprinotus.*

Nous avons étudié la manière de développement du même intervalle stratigraphique allant de l'Olt au Danube, le long de la plate-forme moesienne. Grâce aux forages, on a pu remarquer la distribution spatiale des mollusques du Parscovien (Papaianopol, 1994, pl. II). De l'est vers l'ouest on a delimité six secteurs:

1 – *un secteur*, entre les localités Slobozia et Feteşti, où le Parscovien se caractérise par la présence du sous-genre *Psilodon.* Ce secteur couvre aussi la Bulgarie du nord-est et la Dobroudja du sud-ouest;

2 – *le deuxième* comporte les genres *Horiodacna, Prosodacnomya, Limnodacna* et *Dreissena* qui sont très bien représentés;

3 – *le troisième*, au sud, sud-est et sud-ouest de Bucarest, couvre une surface avec les genres *Zamphiridacna, Pseudocatillus* et *Hydrobia*;

4 – *le quatrième*, entre les vallées du Teleorman et du Neajlov, au nord de la ville d'Alexandria, comporte les faunes qui contient des nombreux exemplaires de *Melanopsis, Theodoxus, Bulimus, Dreissena*, indiquant un milieu dulçaquicole;

5 – *le cinquième* se trouve au sud du secteur 4, les faunes se caractérisent par la fréquence des exemplaires de *Dacicardium, Pseudocatillus* et *Lithoglyphus*;

6 – enfin *le sixième*, à l'ouest de la région étudiée, délimité par la vallée de l'Olt et la ville de Roşiorii de Vede, comporte fréquemment les genres *Prosodacnomya, Horiodacna* et *Gyraulus.*

Commentaires sur les faunes

Dans la partie centrale-est de la plate-forme moesienne au niveau du Dacien on remarque deux étapes différentes. Il débute avec une phase régressive, le Gétien, qui occupe une surface beaucoup plus restreinte par rapport au Pontien supérieur (Bosphorien) et le Dacien supérieur (Parscovien). En ce qui concerne le Pontien supérieur, on remarque qu'il est fortement ingressif, reposant soit sur des formations sarmatiennes, soit sur celles du Crétacé. Quant au secteur discuté, les terrains anciens dépassent largement vers le sud les dépôts pontiens antérieurs.

A l'est de l'Olt, la limite méridionale des formations gétiennes passe au nord de la localité Plopii Slăviteşti, ensuite se dirige vers le nord-est jusqu'au sud du village de Licuriciu, d'où elle descend vers le sud-est jusqu, au nord de Vităneşti, d'où elle reprend la direction nord-est jusqu'à Slobozia. D'ici elle redescend de nouveau, vers sud-est jusqu'au nord de Feteşti. Couvrant de minces surfaces, les dépots du Gétien existent aussi en Dobroudja du sud-ouest.

Comme on à mentioné déjà, contrairement à la partie occidentale du bassin Dacique, dans les secteurs central et oriental de la plate-forme moesienne, les dépôts du Dacien supérieur montrent la plus large extension, ils dépassant de beaucoup vers le sud le

Gétien. D'habitude cette extension pousse ainsi la limite méridionale de 25–30 km vers le sud, mais au niveau de la vallée de la Vedea et entre les localités de Slobozia et de Radu Negru elle dépasse même 30 km. De même, en Dobroudja du sud-ouest le Parscovien occupe des surfaces plus grandes que le Gétien (Tătărâm et al., 1971).

Aux parties ouest et centrale de la Munténie, se développe un faciès charbonneux, plus ou moins fort à la partie supérieure du Parscovien. Le Dacien supérieur représente sur la plate-forme moesienne intervalle le plus importante de carbogénèse. Les couches de charbon du Parscovien sont les plus importantes, tant par leurs nombre, que par leur épaisseur. Les charbons des dépôts romaniens sont le plus souvent moins épais avec un développement discontinu. Le faciès charbonneux du Dacien supérieur de la zone de plate-forme s'individualise par une épaisseur relativement réduite et aussi par un moindre nombre de couches. Les intercalations de charbon situées à la partie inférieure, sont les plus épaisses. Généralement, ces couches s'épaisissent ou s'éffilent jusqu'à leurs complète disparition. A l'est de l'Olt, la limite méridionale de l'extension du faciès houiller se situe au sud des localités Plopii Slăviteşti et Alexandria. Ultérieurement, cette limite au trajét sinueux, va vers le nord-est, jusqu'à Slobozia, ne dépassant pas l'alignement Slobozia-Călăraşi. Le niveau de charbon est de plus en plus profond vers le nord.

En ce qui concerne la faune de mollusques d'âge dacien on doit remarquer que les faunes de mollusques du Parscovien sont plus riches et plus variées que celles du Gétien. Bien que ces dernières soient souvent très riches en individus (l'observation concerne surtout le secteur délimité par les vallées de l'Olt et du Teleorman), elles sont peu variées,quant au genres et espèces. Un plus grand nombre d'espèces a été trouvé toujours dans les dépôts gétiens du secteur délimité par l'Olt et le Teleorman. Ainsi, les faunes gétiennes, plus riches et variées dans le secteur ouest de la Munténie arrivent oligo-spécifiques sur la partie est de la plate-forme moesienne.

Nous trouvons intéressant à remarquer que nulle part dans ce secteur etudié n'existe pas le sous-genre nominatif de *Pachydacna*, mais seulement le sous-genre *Parapachydacna*. En plus, aucun des forages entre Slobozia et le Danube n'a pas rencontré de vraies lumachelles au niveau du Gétien; les mollusques se trouvent comme des exemplaires isolés. En échange, de vraies lumachelles de cet intervalle stratigraphique existent à la partie ouest de la Munténie (entre les vallées de l'Olt et du Teleorman). Quant à la composition des faunes gétiennes on a remarqué que les genres *Zamphiridacna, Dacicardium, Dreissena* et *Viviparus* sont fréquentes, tandis que les sous-genres *Euxinicardium* et *Parapachydacna* et le genre *Zagrabica* soient rares.

En comparant les faunes gétiennes de la zone de plate-forme de la Munténie avec celles de la dépression subcarpathique on peut observer que les faunes de mollusques, du secteur de plate-forme entre les vallées de l'Olt et du Teleorman, rappellent certaines situations rencontrées à la partie est de la Dépression Gétique (entre Argeşel et Olt). Dans cette région se trouve toute la faune de mollusques du Gétien, à l'exception de *Pachydacna*, qui est très rare ou absente. D'autres fois, la faunes gétienne du secteur est de la plate-forme moesienne (entre les villes Slobozia et Feteşti) est semblable à celle trouvée sur quelques coupes du secteur des plis diapirs de la Munténie (plus exactement la sous-zone de plis diapirs internes). Ainsi, par exemple, dans la vallée de Izvorul Palăncii on a rencontré une faune gétienne comportant exclusivement le sous-genre *Parapachydacna*.

Eu même temps, les faunes de mollusques d'âge parscovien (Dacien supérieur) sont très bien représentées, tant par le nombre d'individus, que par le nombre d'espèces. Presque dans tous les forages, au niveau du Parscovien, ont été trouvés des sables lumachelliques ou des niveaux fossilifères à caractère lumachellique. Il y a des cas lorsque dans la succession stratigraphique du Parscovien on remarque l'existence de quelques intercalations lumachelliques (deux, trois ou même quatre).

La faune de mollusques du Parscovien n'est pas homogène dans le secteur étudié. Bien que presque partout dans les dépôts du Parscovien se trouvent des limnocardiidés, on doit remarquer que les bivalves ont été rencontrées surtout dans la moitié orientale de la plate-forme de la Munténie, encadrée par les vallées de l'Argeş et du Danube. Des limnocardiidés se trouvent aussi dans la moitié occidentale de la plate-forme de la Munténie (parfois même un grand nombre de spécimens) mais ici sont plus caractéristique les niveaux fossilifères où prédominants numériquement sont les gastropodes. Dans ce secteur occidental, compris entre la vallée de l'Olt et la vallée de l'Argeş, parmi les limnocardiidés plus fréquents sont rencontrés les genres *Pseudocatillus, Pseudoprosodacna, Dacicardium* et parfois *Horiodacna*. A l'exception du *Pseudoprosodacna* toutes les autres existent aussi toujours dans la moitié orientale de la plate-forme de la Munténie. Dans la partie est de la plate-forme moesienne (entre Slobozia et Feteşti) parmi de mollusques parscoviens existent aussi des spécimens du sous-genre *Psilodon*, à coté du genre *Viviparus*, celui-ci représenté par des exemplaires de grande taille.

L'ensemble macrofaunique du Dacien supérieur du secteur oriental de la plate-forme moesienne englobe aussi des espèces présentes dans la zone d'avant-fosse de la Munténie (la zone des plis diapirs externes) comme *Prosodacna (Psilodon) arioni* COBĂLCESCU, *P. (P.) damienensis* COBĂLCESCU, *Prosodacnomya stenopleura* (SABBA), *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, *Horiodacna rumana* SABBA, *Limnocardium (Euxinicardium) munteniae* PAPAIANOPOL, *L. (E.) peregrinum* PAPAIANOPOL, *L. (E.) orolesi* PAPAIANOPOL, *Pseudocatillus quadrangularis* PAULIUC, *Dacicardium dacianum* (PAPAIANOPOL), *D. valahicus* PAPAIANOPOL, *Lithoglyphus amplus* BRUSINA, *L. decipiens* BRUSINA, *Hydrobia grandis* COBĂLCESCU, *Gyraulus (Gyraulus) rumanus* WENZ, *Viviparus rumanus* (TOURNOUËR), *V. heberti* COBĂLCESCU.

Parmi les *Psilodon* de la plate-forme moesienne (y compris la Dobroudja du sud-ouest) on remarque des espèces comme *Prosodacna (Psilodon) haueri* COBĂLCESCU, *P. (P.) arioni* COBĂLCESCU et *P. (P.)damienensis* COBĂLCESCU. Il faut séparer les psilodontes des groupes *P. conversus, P. stefanescui* et *P. euphrosinae*, qui, dans la région du stratotype du Dacien supérieur (la vallée du Slănic de Buzău) caractérisent les dépots de la partie terminale du Parscovien. On pourrait conclure donc que dans le secteur étudié le Dacien supérieur est incomplètement développé manquant les derniers niveaux. Une situation similaire on l'a trouvée aussi dans l'avant-fosse (la zone des plis diapirs externes de la Munténie) où également manquent les dépôts à psilodontes des groupes *P. stefanescui* et *P. euphrosinae*.

Les conditions favorables existantes dans ce secteur du bassin Dacique pendant le Dacien supérieur (Parscovien) ont facilité le développement de cette riche faune, qui a été merveilleusement conservée. On peut supposer un secteur d'eaux calmes, peu profondes, richement oxigénées permettant la conservation des coquilles très fines comme celles de *Horiodacna, Limnodacna, Euxinicardium, Pseudocatillus*.

Vers la partie supérieure du Parscovien, couvrant une grande surface de la partie ouest-centrale de la Munténie, s'est installé un marais, à végétation abondante, favorable à la carbonification, mais impropre au développement des limnocardiidés. Ici se sont bien développée les *Melanopsis, Theodoxus, Bulimus, Dreissena*, qui souvent succèdent à la prémiere couche de charbon dans la région d'Alexandria. Non seulement au sud de ce marais eutrophe, engendrant des charbons, mais aussi dans la partie est de la plate-forme moesienne, donc contemporaines du faciès houiller, ont persistés des eaux saumâtres, bien aérées, avec une très riche faune de mollusques, caractéristique pour le Dacien supérieur.

En ce qui concerne la salinité des eaux pendant le Dacien, nous estimons qu'au niveau du Dacien inférieur (Gétien) la salinité variait entre $0{,}5\text{–}5^0/_{00}$ (type mixo-oligohalyne). Cette supposition est fondée sur le grande nombre d'exemplaires de *Viviparus* et de *Dreissena* existant dans la partie ouest de la Munténie. Sans fluctuations majeures, une faible augmentation de la salinité, jusqu'à des valeurs de $6\text{–}7^0/_{00}$ est possible (partie inférieure du type mixo-mésohalyne). Pour ce dernier nous avons en vue les niveaux à nombreux *Zamphiridacna* et *Euxinicardium*.

Pendant le Dacien supérieur (Parscovien) la communauté de mollusques a évolué dans un bassin à salinité de type mixo-oligohalyne $(0{,}5\text{–}5^0/_{00})$. Tandis que, dans la partie ouest-centrale de la zone de plateforme de la Munténie s'installe le marais générateur de charbon, le milieu était lymnique (à salinité moins de $0{,}5^0/_{00}$), mais restait le type mixo-oligohalyne au sud de ce marais eutrophe et à la partie est de la plateforme moesienne.

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Planche I

Fig. 1 — *Zamphiridacna orientalis* SABBA (a) et *Dreissena polymorpha* PALLAS (b) ; (x 1), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 2 — *Viviparus getianus* LUBENESCU (a) et *Dreissena polymorpha* PALLAS (b), (x 1), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 3 — *Limnocardium (Euxinicardium) virgatum* PAPAIANOPOL (a) et fragment de *Zamphiridacna orientalis* (SABBA) (b), (x 1), le forage 5, l'intervalle 230–237 m, Dacien inférieur (Gétien).

Fig. 4 — *Zamphiridacna orientalis* (SABBA) (a) et *Dreissena berbestiensis* (b), (x 1), le forage 5, l'intervalle 230–237 m, Dacien inférieur (Gétien).

Fig. 5 — *Zamphiridacna becenensis* ANDREESCU, (x 1), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 6 — *Valenciennius dacicus* PAVNOTESCU, (x 1), le forage 6, l'intervalle 238–243 m, Dacien inférieur (Gétien).

Fig. 7 — *Zagrabica carinata* ANDRUSOV, (x 5), le forage 18, l'intervalle 333–336 m, Dacien inférieur (Gétien).

Fig. 8 — *Theodoxus rumanus* (SABBA), (x 3), le forage 6, l'intervalle 238–243 m, Dacien inférieur (Gétien).

Fig. 9 — *Lithoglyphus decipiens* BRUSINA, (x 3), le forage 9, l'intervalle 195–198 m, Dacien inférieur (Gétien).

Fig. 10 — *Viviparus cucestiensis* LUBENESCU, (x 1), le forage 12, l'intervalle 186–188 m, Dacien inférieur (Gétien).

Fig. 11 — *Viviparus conicus* LUBENESCU (x 1), le forage 12, l'intervalle 186–188 m, Dacien inférieur (Gétien).

Fig. 12 — *Viviparus duboisi* (MAYER-EYMAR), (x 1), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 13 — *Hydrobia grandis* COBĂLCESCU, (x 5), le forage 9, l'intervalle 195–198 m, Dacien inférieur (Gétien).

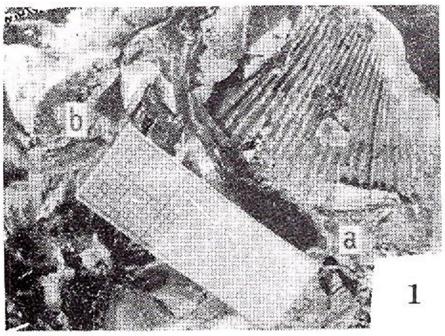
Figs. 14–15 — *Dreissena rimestiensis* FONTANNES, (x 3), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 16 — *Dacicardium dacianum* (PAPAIANOPOL), (x 2), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Figs. 17–18 — *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, (x 2), le forage 10, l'intervalle 287–290 m, Dacien inférieur (Gétien).

Fig. 19 — *Psilodon* sp., (x 3), le forage 9, l'intervalle 195–198 m, Dacien inférieur (Gétien).

Planche I



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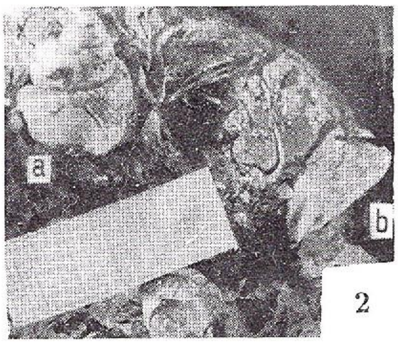

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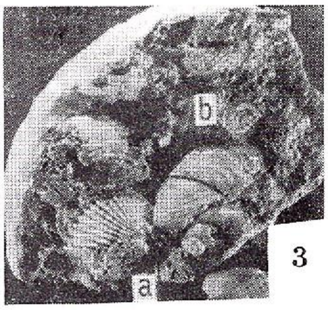

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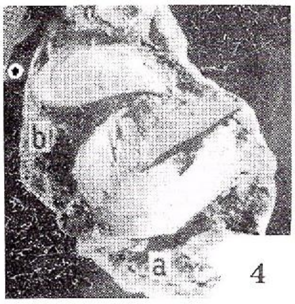

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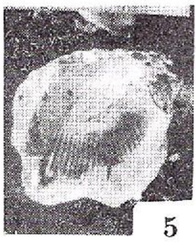
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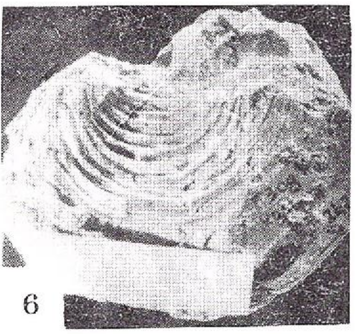
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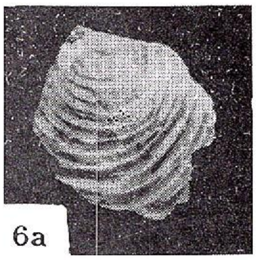
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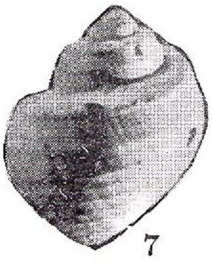
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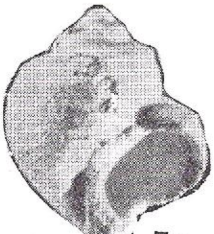
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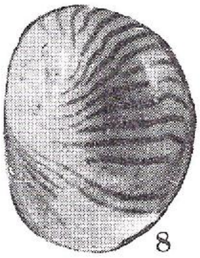
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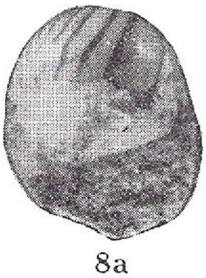
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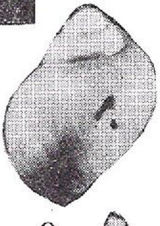
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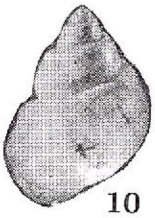
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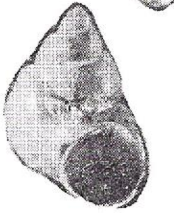
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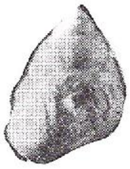
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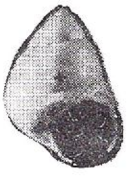
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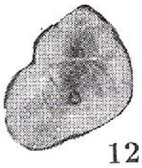
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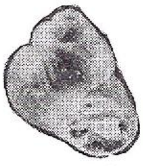
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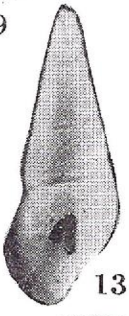
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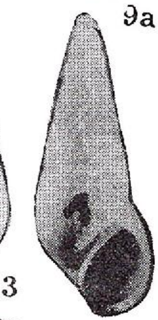
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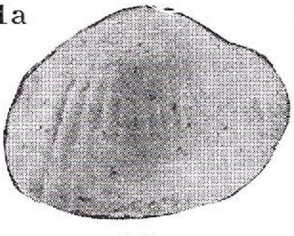
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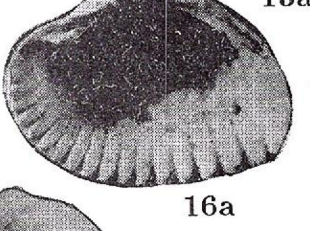
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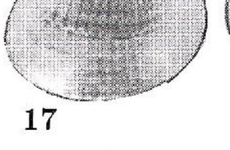
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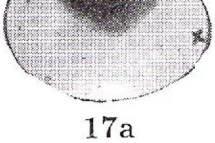
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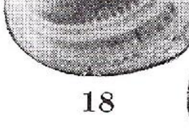
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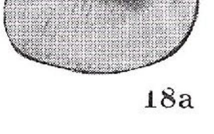
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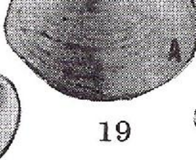
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Planche II

Figs. 1, 2 — *Zamphiridacna becenensis* ANDREESCU, (x 1,5), le forage 6, l'intervalle 243–247 m, Dacien inférieur (Gétien).

Fig. 3 — *Dacicardium rumanum* (FONTANNES), (x 3), le forage 18, l'intervalle 333–336 m, Dacien inférieur (Gétien).

Fig. 4 — *Pachydacna (Parapachydacna) moesica* PAPAIANOPOL, (x 3), le forage 23, l'intervalle 93–96 m, Dacien inférieur (Gétien).

Fig. 5 — *Pachydacna (Parapachydacna) minuta* PAPAIANOPOL, (x 5), le forage 23, l'intervalle 93–96 m, Dacien inférieur (Gétien).

Fig. 6 — *Pachydacna (Parapachydacna)* sp., (x 5), le forage 27, l'intervalle 95–100 m, Dacien inférieur (Gétien).

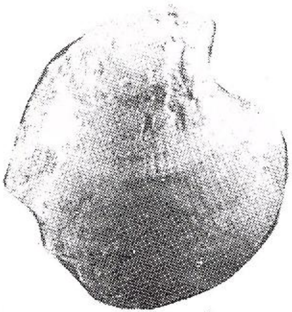
Fig. 7 — *Pachydacna (Parapachydacna) unica* PAPAIANOPOL, (x 3), le forage 27, l'intervalle 95–100 m, Dacien inférieur (Gétien).

Fig. 8 — *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, (x 5), le forage 21, l'intervalle 115–121 m, Dacien supérieur (Parscovien).

Fig. 9 — *Dacicardium valahicus* PAPAIANOPOL, (x 3), le forage 18, l'intervalle 284–285 m, Dacien supérieur (Parscovien).

Fig. 10 — *Dacicardium dacianum* (PAPAIANOPOL), (x 2), le forage 18, l'intervalle 284–285 m, Dacien supérieur (Parscovien).

Fig. 11 — *Dacicardium moesicum* ANDREESCU, (x 3), le forage 1, l'intervalle 115–121 m, Dacien supérieur (Parscovien).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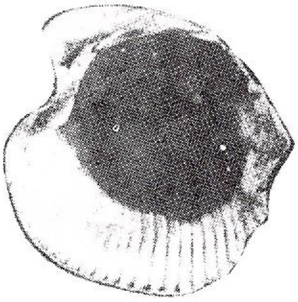
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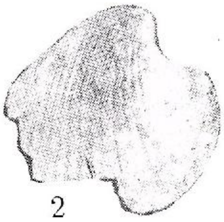
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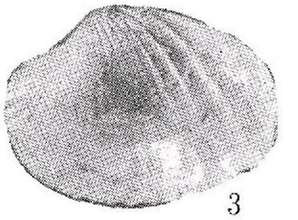
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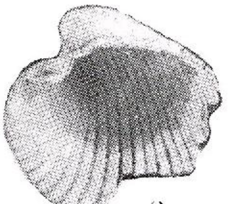
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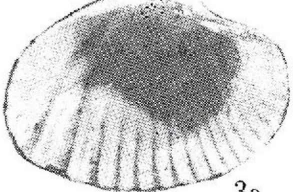
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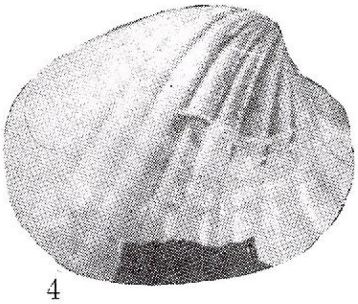
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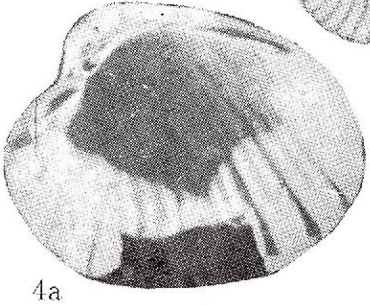
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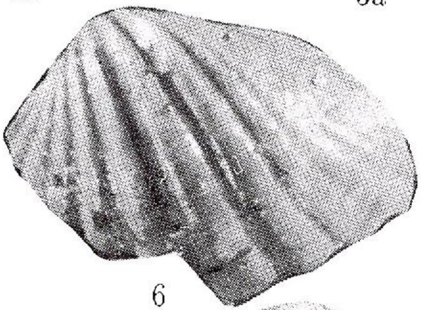
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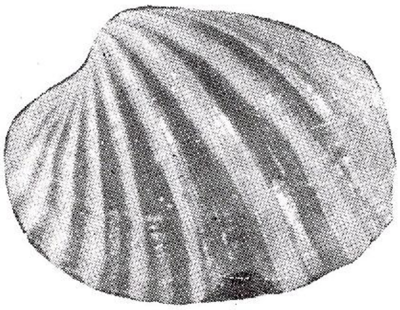
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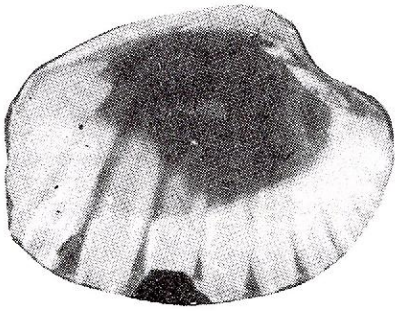
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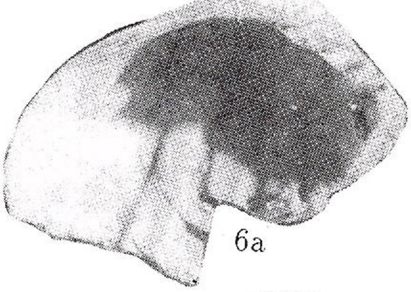
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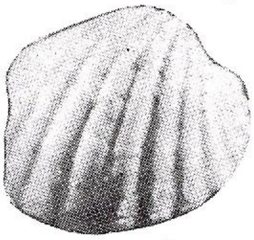
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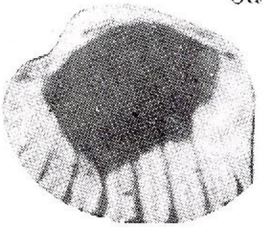
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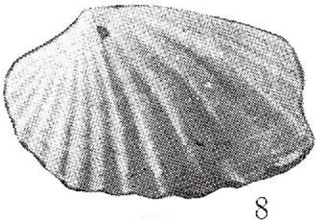
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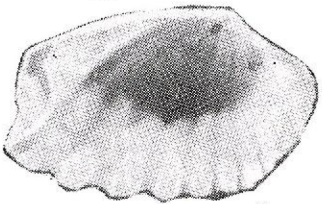
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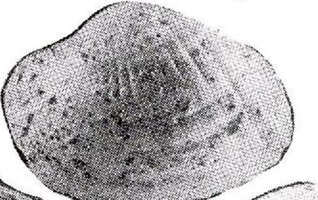
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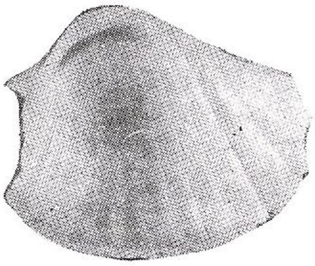
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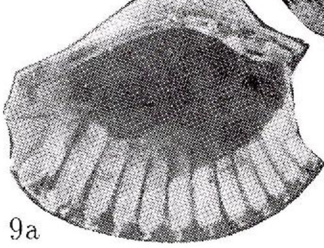
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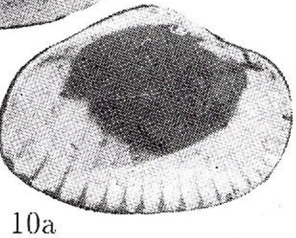
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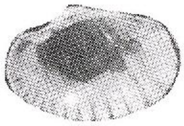
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Planche III

Fig. 1 — *Horiodacna rumana* SABBA, (x 3), le forage 21, l'intervalle 115–121 m, Dacien supérieur (Parscovien).

Fig. 2 — *Limnocardium (Euxinicardium) munteniae* PAPAIANOPOL, (x 5), le forage 24, l'intervalle 152–154 m, Dacien supérieur (Parscovien).

Fig. 3 — *Limnocardium (Euxinicardium) peregrinum* PAPAIANOPOL, (x 3), le forage 22, l'intervalle 85–87 m, Dacien supérieur (Parscovien).

Figs. 4, 5 — *Limnocardium (Euxinicardium) orolesi* PAPAIANOPOL, (x 3), fig. 4, le forage 21, l'intervalle 115–121 m; fig. 5, le forage 6, l'intervalle 221–224 m, Dacien supérieur (Parscovien).

Figs. 6, 7 — *Pseudocatillus moesicus* PAPAIANOPOL et LUBENESCU, (fig. 6 x 5; fig. 7 x 3), fig. 6, le forage 27, l'intervalle 88–90 m; fig. 7, le forage 1, l'intervalle 135–138 m, Dacien supérieur (Parscovien).

Figs. 8, 9 — *Pseudocatillus baraganicus* PAPAIANOPOL et LUBENESCU, (fig. 8 x 5; fig. 9 x 3), fig. 8, le forage 27, l'intervalle 88–90 m; fig. 9, le forage 1, l'intervalle 135–138 m, Dacien supérieur (Parscovien).

Figs. 10, 11 — *Prosodacnomya stenopleura* (SABBA), (fig. 10 x 3; fig. 11 x 2), fig. 10, le forage 21, l'intervalle 115–121 m; fig. 11, le forage 18, l'intervalle 284–285 m, Dacien supérieur (Parscovien).

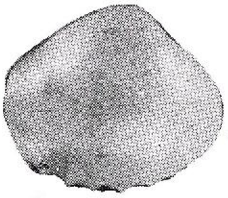
Fig. 12 — *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, (x 3), le forage 12, l'intervalle 176–179 m, Dacien supérieur (Parscovien).

Fig. 13 — *Prosodacna (Psilodon) damienensis* COBĂLCESCU, (a) et *Prosodacna (Psilodon) arioni* COBĂLCESCU (b), (x 1), le forage 24, l'intervalle 158–161 m, Dacien supérieur (Parscovien).

Fig. 14 — *Prosodacna (Psilodon) arioni* COBĂLCESCU, (x 1), le forage 25, l'intervalle 132–138 m, Dacien supérieur (Parscovien).

Fig. 15 — *Zamphiridacna zamphiri* (COBĂLCESCU), (x 3), spécimen jeune, le forage 6, l'intervalle 221–224 m, Dacien supérieur (Parscovien).

Planche III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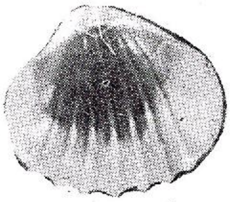
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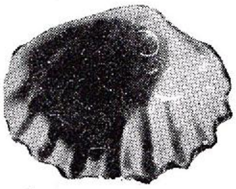
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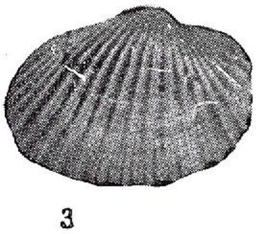
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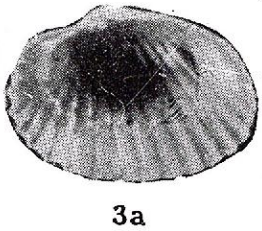
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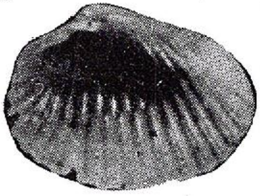
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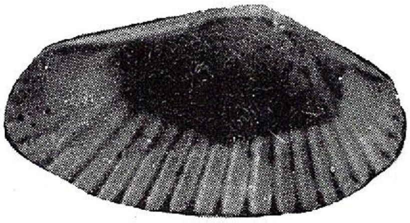
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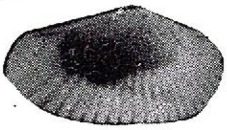
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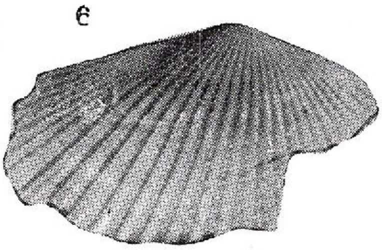
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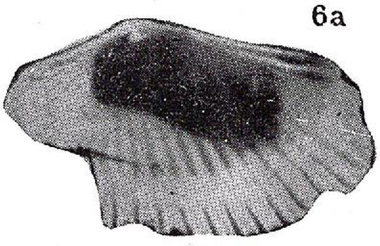
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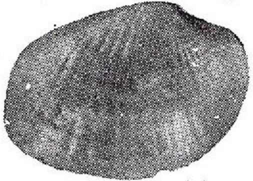
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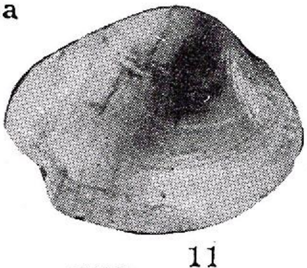
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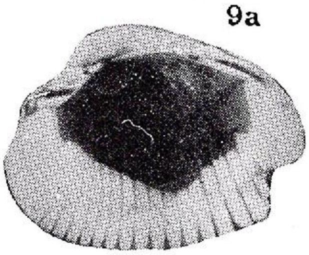
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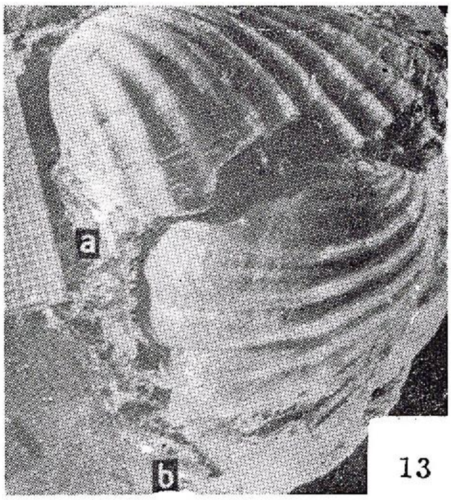

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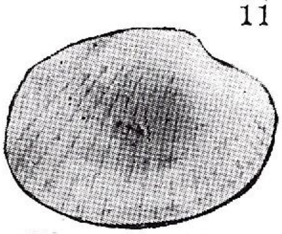
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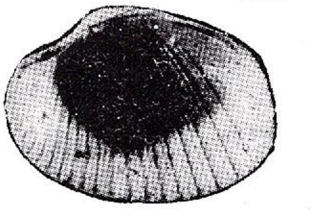
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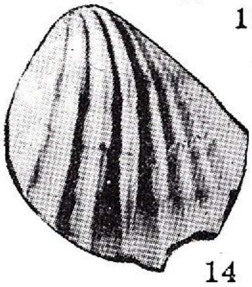
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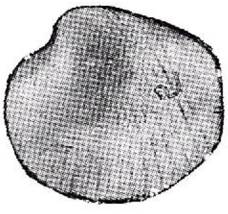
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Planche IV

Figs. 1, 2 — *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, (x 5), le forage 17, l'intervalle 140–143 m, Dacien supérieur (Parscovien).

Fig. 3 — *Dreissena baraganica* ANDRUSOV, (x 3), le forage 6, l'intervalle 221–224 m, Dacien supérieur (Parscovien).

Fig. 4 — *Melanopsis (Melanopsis) covurluiensis* COBĂLCESCU, (x 3), le forage 34, l'intervalle 199–205 m, Dacien supérieur (Parscovien).

Fig. 5 — *Melanopsis (Melanopsis) bergeroni* SABBA, (x 3), le forage 34, l'intervalle 299–205 m, Dacien supérieur (Parscovien).

Fig. 6 — *Theodoxus licherdopoli* (SABBA), (x 3), le forage 34, l'intervalle 199–205 m, Dacien supérieur (Parscovien).

Fig. 7 — *Theodoxus rumanus* (SABBA), (x 3), le forage 34, l'intervalle 199–205 m, Dacien supérieur (Parscovien).

Fig. 8 — *Lithoglyphus amplus* BRUSINA, (x 3), le forage 4, l'intervalle 246–249 m, Dacien supérieur (Parscovien).

Fig. 9 — *Lithoglyphus harpaeformis* COBĂLCESCU, (x 3), le forage 6, l'intervalle 221–224 m, Dacien supérieur (Parscovien).

Fig. 10 — *Lithoglyphus decipiens* BRUSINA, (x 3), le forage 4, l'intervalle 246–249 m, Dacien supérieur (Parscovien).

Fig. 11 — *Bulimus (Daciella) valdecarinatus* WENZ, (x 3), le forage 10, l'intervalle 272–274 m, Dacien supérieur (Parscovien).

Fig. 12 — *Bulimus (Tylopoma) heleni* (COBĂLCESCU), (x 3), le forage 24, l'intervalle 162–164 m, Dacien supérieur (Parscovien).

Fig. 13 — *Bulimus (Tylopoma) speciosus* (COBĂLCESCU), (x 3), le forage 24, l'intervalle 162–164 m, Dacien supérieur (Parscovien).

Fig. 14 — *Bulimus (Tylopoma) conicus* (COBĂLCESCU), (x 3), le forage 24, l'intervalle 162–164 m, Dacien supérieur (Parscovien).

Fig. 15 — *Hydrobia grandis* COBĂLCESCU), (x 5), le forage 12, l'intervalle 176–179 m, Dacien supérieur (Parscovien).

Fig. 16 — *Hydrobia syrmica* NEUMAYR, (x 5), le forage 1, l'intervalle 135–138 m, Dacien supérieur (Parscovien).

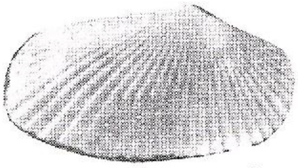
Fig. 17 — *Gyraulus (Gyraulus) rumanus* WENZ, (x 5), le forage 6, l'intervalle 221–224 m, Dacien supérieur (Parscovien).

Fig. 18 — *Melanopsis (Melanopsis)* aff. *draghiceniani* COBĂLCESCU, (x 3), le forage 1, l'intervalle 135–138 m, Dacien supérieur (Parscovien).

Fig. 19 — *Viviparus murgescui* COBĂLCESCU, (x 1), le forage 24, l'intervalle 158–161 m, Dacien supérieur (Parscovien).

Fig. 20 — *Viviparus heberti* COBĂLCESCU, (x 1), le forage 25, l'intervalle 132–138 m, Dacien supérieur (Parscovien).

Planche IV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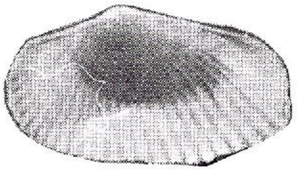
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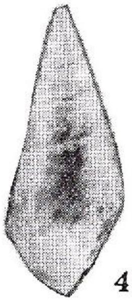
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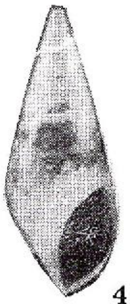
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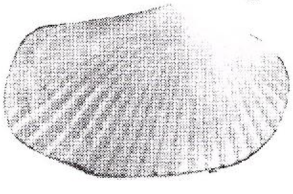
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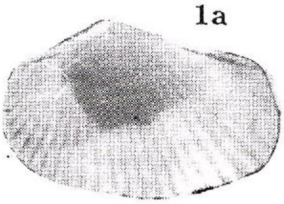
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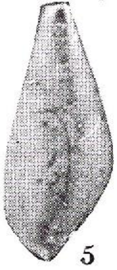
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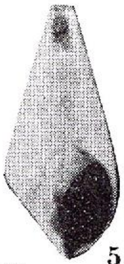
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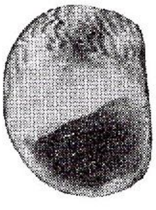
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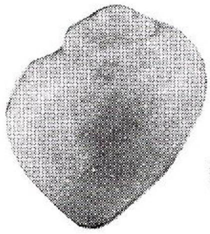
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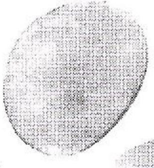
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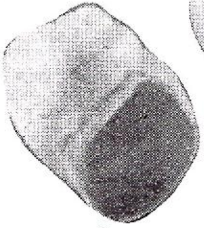
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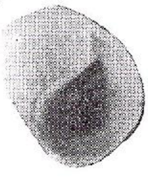
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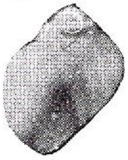
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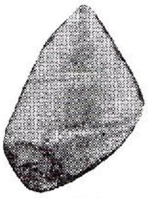
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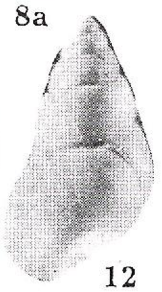
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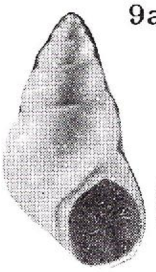
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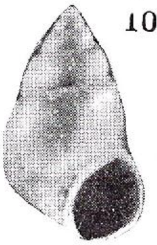
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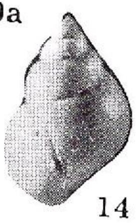
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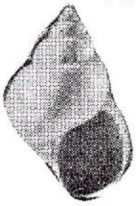
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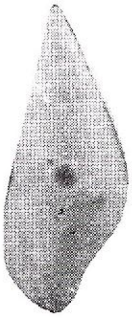
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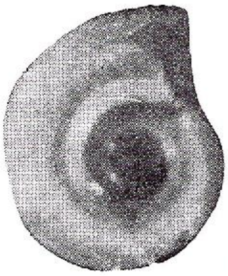
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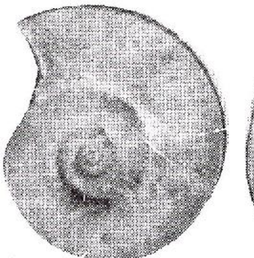
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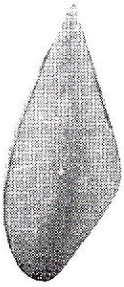
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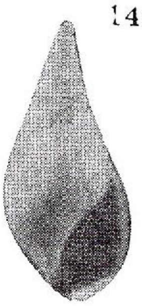
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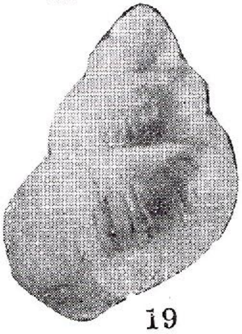
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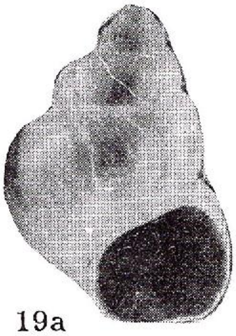
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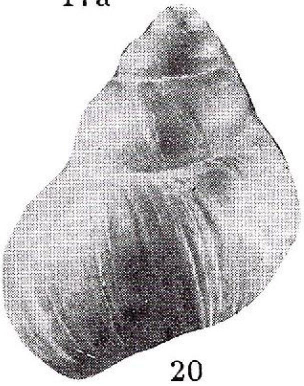
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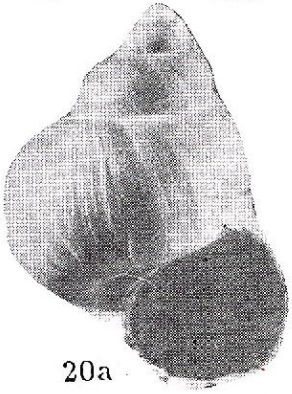
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Rom. J. Paleontology, 76, 1995, p. 121–126, Bucharest

PALEOBIOGEOGRAPHY OF DACIAN MOLLUSCA ON THE MOESIAN PLATFORM (OLT-DANUBE SECTOR) BETWEEN DRĂGĂNEŞTI OLT AND FETEŞTI

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Key words: Dacian Mollusca. Lower Dacian. Upper Dacian. Moesian Platform. Paleobiogeography.

Abstract: Starting from the growth of the state of knowledge of the Dacian macrofaunas from the Moesian Platform, a first attempt to specify the areal distribution of the Dacian macrofaunas, both for the Lower Dacian (Getian) and the Upper Getian (Parscovian) is presented. Three sectors are separated for the Lower Dacian from the east towards the west as follows: I – with *Parapachydacna*; II – with *Dacicardium* and *Zamphiridacna*; III – with *Zamphiridacna, Euxinicardium* and *Dreissena*. At the level of the Upper Dacian five sectors were distinguished from the east towards the west: I – with *Psilodon*; II – with *Horiodacna, Prosodacnomya, Limnodacna* and *Dreissena*; III – with *Zamphiridacna, Pseudocatillus* and *Hydrobia*; IV – with *Theodoxus, Bulimus* and *Melanopsis*; V-with *Dacicardium, Pseudocatillus* and *Lithoglyphus*. In the central and eastern parts of the Moesian Platform the Dacian begins with a regressive phase, the Lower Dacian covering smaller areas than the Upper Pontian and the Upper Dacian. A transgressive moment is noticed at the level of the Upper Dacian, the Parscovian exceeding much the deposition area of the Lower Dacian (Getian) towards the south.

In recent years remarkable progress has been achieved in the knowledge of the Dacian biostratigraphy on the Moesian Platform. This was mainly possible due to the numerous drillings with continuous coring carried out for an energetic coal (lignite), the Dacian being the principal coal-bearing formation on the Moesian platform.

The Dacian deposits on the Moesian Platform overlie either in continuity or discontinuity of sedimentation the deposits belonging to the Miocene. In the Moesian Platform area the Miocene is represented by the Badenian, Sarmatian, Meotian and Pontian. The Miocene together with the Pliocene (Dacian plus Romanian) make up the pile of deposits representing the last sedimentation cycle on the Moesian Platform.

Since the end of the Upper Badenian the Moesian Platform paleogeographically belonged to the Dacic Basin, a sedimentation basin with an intermediary position between the Pannonian Basin to the west and the Ponto-Aralo-Caspian Basin to the east.

Numerous boreholes have been investigated in the platform sector between the Olt and the Danube for several years. These investigations were concerned especially with the Dacian deposits not only because the Dacian (namely the Upper Dacian) is economically important, but also due to the sometimes impressive richness in mollusc faunas.

Concerning the platform Dacian faunas, it is worth mentioning that in 1894 Sabba Ştefănescu figured some forms encountered in the borehole at Mărculeşti. The more or less sporadic information regarding the platform Dacian deposits between the Olt and the Danube has been completed only in the last ten years with numerous biostratigraphic, lithostratigraphic, paleontological, paleogeographic and paleoenvironmental data (Radu et al., 1983, unpubl. data; Papaianopol et al, 1985, unpubl. data, 1986, unpubl. data, 1987, unpubl. data, 1988, 1989, unpubl. data, 1992; Lubenescu et al., 1986, 1987; Papaianopol, Lubenescu, 1987; Papaianopol, Marinescu, 1994).

Recently the individualization of a new lithostratigraphic unit ranking as a group has been proposed (Papaianopol, Marinescu, 1994, in press). This is the Bucureşti Group (Dacian plus Romanian), characterized by the development over large areas of the coaly facies (especially in the western and central parts of the Moesian Platform) as well as by the high frequency of the detrital deposits (sands). Thus it resembles the

Olt-Vedea and Optaşi-Cartojani Groups separated by Pauliuc et al., (1979) in the succession of Miocene deposits on the Moesian Platform. Outlined as shown above, the Bucureşti Group includes the Merişani (Lower Dacian), Călineşti (Upper Dacian) and Izvoarele (Romanian) Formations proposed by Lubenescu et al. (1987). As regards the Merişani Formation, it should be mentioned that Lubenescu et al. (1987) considered that it includes both the Upper Pontian (Bosphorian) and the Lower Dacian (Getian). Taking into account both some faunal elements mentioned by Pauliuc et al. (1979) within the Cartojani Formation (some species of *Pontalmyra, Dreissena* and *Viviparus*, widespread in the Upper Pontian of the Dacic Basin) and the prevailingly pelitic character of the Bosphorian on the Moesian Platform, we consider (Papaianopol et al., 1987, 1988, 1989, unpubl. data, Papaianopol, Marinescu, 1994, in press) that this formation should include also Upper Pontian deposits. Therefore the Merişani Formation overlying the Cartojani Formation comprises only deposits which sedimented during the Lower Dacian (Getian).

Paleobiogeography of Dacian Molluscs

The information on the Dacian macrofaunas provided by the boreholes drilled between the Olt and the Danube made possible a first attempt of reconstructing the areal distribution both for the Lower Dacian (Pl. I) and the Upper Dacian (Pl. II). Especially important for this reconstruction were the boreholes that intercepted not only the Dacian but also the Pontian. Piercing the whole Dacian succession, these boreholes showed both the places where the Dacian is represented by its substages (Getian and Parscovian) and those in which the Upper Dacian overlies directly the Pontian (namely the Upper Pontian). Equally important are also the boreholes that stopped in the Lower Dacian, which although do not make possible the following of some complete Dacian sequences, indicate, however, the presence of the Lower Dacian. Besides the specifications related to the biostratigraphy of the Dacian deposits, the mentioned boreholes provided also interesting information on the extent of the Lower and Upper Dacian.

As regards the Getian macrofaunas (Lower Dacian) from the investigated boreholes, it should be underlined that these are less rich and diverse as compared to those existing at the Upper Dacian level. This situation differs from the foredeep zone, where, on numerous profiles along this structural unit, the Lower Dacian macrofaunas are very well represented, including not only a large number of individuals, but also a lot of species.

Another difference worth mentioning consists in the fact that no specimens that might be assigned to the nominative *Pachydacna* subgenus were found in any of the investigated boreholes. The genus *Pachydacna* is represented only by the subgenus *Parapachydacna* and only in the eastern part of the platform sector between the Olt and the Danube.

The attempt of specifying the areal distribution of the Dacian macrofauna also implies a faunal prognosis, on the basis of which we might try to approximate the types of faunal assemblages we could expect to encounter in the boreholes which are to be carried out between the Olt and the Danube.

It is worth mentioning that the sketches provided for the two Dacian substages constitute a first attempt of this kind and are therefore liable to modifications and improvements. Each new borehole may, by the information it provides, bring about to a certain extent changes in the above-mentioned viewpoints. The numerous boreholes investigated both from the platform and the foredeep zone showed that each place investigated by boreholes is marked by certain individual faunal characteristics, important modifications of the faunas being often noticed even within small distances.

Paleobiogeography of the Lower Dacian (Getian)

Pl. I

From the present state of knowledge of the Lower Dacian molluscan faunas three sectors (Pl. I) can be separated from the east towards the west between the Olt and the Danube as follows:

I - an eastern sector between Slobozia and the Danube, where the Getian is characterized by the presence of the specimens of the subgenus *Parapachydacna*. This sector includes also the Getian deposits of south-western Dobrogea;

II - a sector situated between the Neajlov Valley and Slobozia, where the macrofaunas are represented especially by *Dacicardium* and *Zamphiridacna*. This sector provided the least data on the Getian faunas as most boreholes stopped under the first coal bed from the Upper Dacian.

III - a western sector situated between the Olt and the Neajlov Valleys, where the macrofaunas are dominated by *Zamphiridacna*, *Euxinicardium* and *Dreissena*.

Boreholes 23, 24, 26 and 27 from sector I contain Getian macrofauna consisting of *Pachydacna (Parapachydacna)* aff. *dobrogiana* PAPAIANOPOL, *P. (P.)* aff. *danubialis* PAPAIANOPOL, *Pseudocatillus* sp., *Lithoglyphus decipiens* BRUSINA, *Hydrobia syrmica* NEUMAYR, *Zagrabica carinata* ANDRUSOV.

The Getian macrofauna from borehole 18 (sector II) consists of *Zamphiridacna orientalis* (SABBA), *Dacicardium rumanum* (FONTANNES), *D.* aff. *dacianum* (PAPAIANOPOL), *Hydrobia syrmica* NEUMAYR, *Zagrabica carinata* ANDRUSOV.

The Getian macrofaunas from sector III (boreholes 2, 3, 5, 6, 8, 9, 10, 11, 14) are more diverse, the following forms being determined: *Zamphiridacna orientalis* (SABBA), *Z. becenensis* ANDREESCU, *Limnocardium (Euxinicardium) virgatum* PAPAIANOPOL, *Dacicardium rumanum* (FONTANNES), *D. dacianum* (PAPAIANOPOL), *Prosodacna (Prosodacna)* aff. *semisulcata* (ROUSSEAU), *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Dreissena rimestiensis* FONTANNES, *D. berbestiensis* FONTANNES, *D. polymorpha* PALLAS, *Viviparus getianus* LUBENESCU, *V. duboisi* (MAYER-EYMAR), *V. conicus* LUBENESCU, *V. cucestiensis* LUBENESCU, *Theodoxus rumanus* (SABBA), *Hydrobia syrmica* NEUMAYR, *H. grandis* COBALCESCU, *Zagrabica reticulata* SABBA, *Z. carinata* ANDRUSOV, *Valenciennius dacicus* PAVNOTESCU.

Paleobiogeography of the Upper Dacian (Parscovian)

The richness and variety of the faunas as well as the greater number of boreholes make easier the drawing up of the paleobiogragraphic sketch for the Upper Dacian.

The study of the structure of the Upper Dacian (Parscovian) macrofaunal assemblages led to the separation of six sectors (Pl. II) from the east towards the west:

I – *an eastern sector* situated between Slobozia and Feteşti, where the macrofaunas are marked by the frequent occurrences of the subgenus *Psilodon*; this sector includes also south-western Dobrogea and north-eastern Bulgaria.

II – towards the *west a central sector* can be separated, where the genera *Horiodacna, Prosodacnomya, Limnodacna* and *Dreissena* play an important role within the microfauna;

III – to the *south, south-east and south-west of Bucharest* another sector could be outlined, where the macrofaunal complexes contain frequent forms of *Zamphiridacna, Pseudocatillus* and *Hydrobia*;

IV – *between the Teleorman and Neajlov Valleys and north of Alexandria* a sector with strongly fresh water macrofaunas was individualized. The assemblages contain frequent forms of *Theodoxus, Bulimus* and *Melanopsis*.

V – *south of the above-mentioned sector* an area was separated in which the macrofaunal assemblages are characterized by the high frequency of the *Dacicardium, Pseudocatillus* and *Lythoglyphus* specimens;

VI – finally, in a western sector, situated between the *Olt Valley and Roşiorii de Vede*, in the Upper Dacian deposits *Prosodacnomya, Horiodacna* and *Gyraulus* specimens are often encountered.

In sector I (boreholes 23, 24, 25, 26, 27) the Upper Dacian molluscan faunas consist of: *Prosodacna (Psilodon) haueri* COBALCESCU, *P. (Ps.) arioni* COBALCESCU, *P. (Ps.) damienensis* COBALCESCU, *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, *Zamphiridacna zamphiri* (COBALCESCU), *Prosodacnomya stenopleura* (SABBA), *Horiodacna rumana* SABBA, *Limnocardium (Euxinicardium) peregrinum* PAPAIANOPOL, *L. (E.) munteniae* PAPAIANOPOL, *L. (E.) orolesi* PAPAIANOPOL, *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *P. quadrangularis* PAULIUC, *Dreissena baraganica* ANDRUSOV, *D. polymorpha* PALLAS, *Gyraulus (Gyraulus) rumanus* WENZ, *Lithoglyphus decipiens* BRUSINA, *L. amplus* BRUSINA, *L. harpaeformis* COBALCESCU, *Hydrobia syrmica* NEUMAYR, *H. grandis* COBALCESCU, *Melanopsis (Melanopsis) draghiceniani* COBALCESCU, *Bulimus (Tylopoma) heleni* (COBALCESCU), *B. (T.) conicus* COBALCESCU, *Viviparus heberti* COBALCESCU, *V. rumanus* TOURNOUËR, *V. murgescui* COBALCESCU.

Of the molluscan faunas from the Upper Dacian on the platform zone between the Olt and the Danube, those from the sector between Slobozia and Feteşti are the most diverse.

The Upper Dacian macrofaunas are rich and diverse also in sector II (boreholes 16, 17, 20, 21, 22). The main elements are: *Horiodacna rumana* SABBA, *Prosodacnomya stenopleura* (SABBA), *Limnodacna gilletae* PAPAIANOPOL et MOTAŞ, *Dreissena baraganica* ANDRUSOV, in addition to which there exist: *Dacicardium rumanum* (FONTANNES), *Zamphiridacna zamphiri* (COBALCESCU), *Limnocardium (Euxinicardium) orolesi* PAPAIANOPOL, *L. (E.) peregrinum* PAPAIANOPOL, *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *Dreissena polymorpha* PALLAS, *Gyraulus (Gyraulus) rumanus* (WENZ), *Lithoglyphus amplus* BRUSINA, *L. harpaeformis* COBALCESCU, *Hydrobia grandis* COBALCESCU, *H. syrmica* NEUMAYR, *Melanopsis (Melanopsis) draghiceniani* COBALCESCU, *Melanoides abchasica* SENINSKI.

In sector III (boreholes 15, 18) the Upper Dacian mollusc assemblages contain: *Zamphiridacna zamphiri* (COBALCESCU), *Z. motasi* PAPAIANOPOL, *Z.* aff. *rotundata* PAPAIANOPOL, *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *Prosodacnomya stenopleura* (SABBA), *Limnocardium (Euxinicardium) peregrinum* PAPAIANOPOL, *Dacicardium dacianum* (PAPAIANOPOL), *D. valahicus* PAPAIANOPOL, *Dreissena baraganica* ANDRUSOV, *Lithoglyphus decipiens* BRUSINA, *Hydrobia grandis* COBALCESCU, *H. syrmica* NEUMAYR, *Viviparus murgescui* COBALCESCU.

The Parscovian macrofaunas from sector IV (boreholes 10, 11, 13) point to the existence of a strongly freshened environment. They are marked by the prevalence of the forms *Melanopsis (Melanopsis) bergeroni* SABBA, *M. (M.) covurluensis* COBALCESCU, *Bulimus (Tylopoma) heleni* (COBALCESCU), *B. (T.) speciosus* (COBALCESCU), *Bulimus (Daciella) valdecarinatus* WENZ, *Theodoxus licherdopoli* (SABBA), *Dreissena polymorpha* PALLAS, *Dacicardium rumanum* (FONTANNES), *D.* aff. *validus* PAPAIANOPOL et POPESCU. There may also exist: *Horiodacna rumana* SABBA, *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Pseudocatillus moesicus* PAPAIANOPOL et LUBENESCU, *Dreissena baraganica* ANDRUSOV, *Lithoglyphus amplus* BRUSINA, *Lithoglyphus harpaeformis* COBALCESCU.

In sector V (boreholes 8, 9, 12) the molluscan faunas are dominated by the specimens of the genera *Dacicardium*, *Pseudocatillus* and *Lithoglyphus*. These include the forms: *Dacicardium rumanum* (FONTANNES), *D. dacianum* (PAPAIANOPOL), *D. moesicum* ANDREESCU, *Pseudocatillus humilis* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *P. moesicus* PAPAIANOPOL et LUBENESCU, *Horiodacna rumana* SABBA, *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Limnocardium (Euxinicardium) munteniae* PAPAIANOPOL, *Lithoglyphus decipiens* BRUSINA, *L. amplus* BRUSINA, *L. harpaeformis* COBALCESCU, *Hydrobia grandis* COBALCESCU.

The Upper Dacian macrofaunal assemblages from sector VI (boreholes 1, 2, 3, 4, 5, 6, 7) are quite diverse, including the forms: *Horiodacna rumana* SABBA, *Prosodacnomya stenopleura* (SABBA), *Limnocardium (Euxinicardium) munteniae* PAPAIANOPOL, *L. (E.) orolesi* PAPAIANOPOL, *Pseudocatillus moesicus* PAPAIANOPOL et LUBENESCU, *P. baraganicus* PAPAIANOPOL et LUBENESCU, *Dacicardium moesicum* ANDREESCU, *D.* aff. *rumanum* (FONTANNES), *Zamphiridacna zamphiri* (COBALCESCU), *Pseudoprosodacna moesica* PAPAIANOPOL et LUBENESCU, *Pisidium iasiense* COBALCESCU, *Dreissena baraganica* ANDRUSOV, *D. polymorpha* PALLAS, *Gyraulus (Gyraulus) rumanus* WENZ, *Melanopsis (Melanopsis)* aff. *draghiceniani* COBALCESCU, *Hydrobia grandis* COBALCESCU, *H. syrmica* NEUMAYR, *Lithoglyphus decipiens* BRUSINA, *L. amplus* BRUSINA, *L. harpaeformis* COBALCESCU.

Concerning the paleobiogeographic sketch of the Upper Dacian it should be underlined that it is not so strict, in the sense that the forms mentioned as prevalent in a certain sector cannot be encountered in other zones, too. The molluscan faunas mentioned for the six sectors clearly indicate the fact that certain species may be encountered in greater or smaller numbers in two, three, four, five or even in all six sectors separated. There are even some boreholes in which the Upper Dacian contains almost all the genera and subgenera of molluscs characterizing this interval from the Moesian Platform. Thus for example in the boreholes from the eastern part of the platform, where the beds with *Psilodon* can be identified, the various forms of this subgenus associate with *Horiodacna, Zamphiridacna, Pseudocatillus, Dacicardium, Euxinicardium, Prosodacnomya, Dreissena, Gyraulus, Lithoglyphus, Viviparus*. In separating the areas with the prevalence of the various Upper Dacian assemblages, that is the six mentioned sectors, we took into consideration first those macrofaunal elements which by their frequency are the most characteristic of the Parscovian macrofaunal assemblage form a certain area.

In the area of the Moesian Platform the Pontian (especially) by its upper substage – the Bosphorian) exceeds much towards the south the Meotian deposition area, overlying sometimes directly either the Bessarabian or the Cretaceous. More complete Pontian successions are to be found in the northern half of the Moesian Platform. Exceeding the Lower and Middle Pontian, the Upper Pontian (Bosphorian) may extend southwards up to the Danube and even beyond it. Concerning the two Dacian subdivisions, two moments can be distinguished. The Dacian successions from the boreholes drilled in Muntenia show that in the central and eastern parts of the Moesian Platform, the Dacian begins with a regressive phase, the Lower Dacian (Getian) covering smaller areas than the Upper Pontian (Bosphorian) and the Upper Dacian (Parscovian).

In the platform sector between the Olt and the Danube, from the west towards the east, the southern boundary of the Lower Dacian (Getian) passes north of the Plopii Slăviteşti locality, extending northwestwards to south of Licuriciu. From Călineşti it goes down towards Vităneşti and then steadily goes up north-westwards. From south of Bucharest it gradually goes up north-eastwards towards Slobozia, whence it descends south-eastwards to north of Feteşti (Pl. I). The Lower Dacian (Getian) crops out over small areas also in south-west Dobrogea.

At the level of the Upper Dacian (Parscovian) a new transgressive moment can be noticed, the Parscovian exceeding much the deposition area of the Lower Dacian towards the south (Pl. II). The Upper Dacian covers larger areas than the Lower Dacian also in south-west Dobrogea (Tătărâm et al., 1977).

Taking into account the macrofaunal assemblages they contain (Stoykov, 1964, 1967, 1972, 1974: Stoykov, Breskovsky, 1966) the Dacian deposits cropping out south of the Danube in Bulgaria (Ruse, Tutrakan, Silistra regions) are considered to belong to the

Upper Dacian. The molluscan fauna comprises the forms *Psilodon, Horiodacna, Zamphiridacna, Prosodacnomya, Rumanunio, Hydrobia.*

Thus in south-west Dobrogea it is considered that the Getian is no longer found west of the Ostrov locality, disappearing between Ostrov and Silistra.

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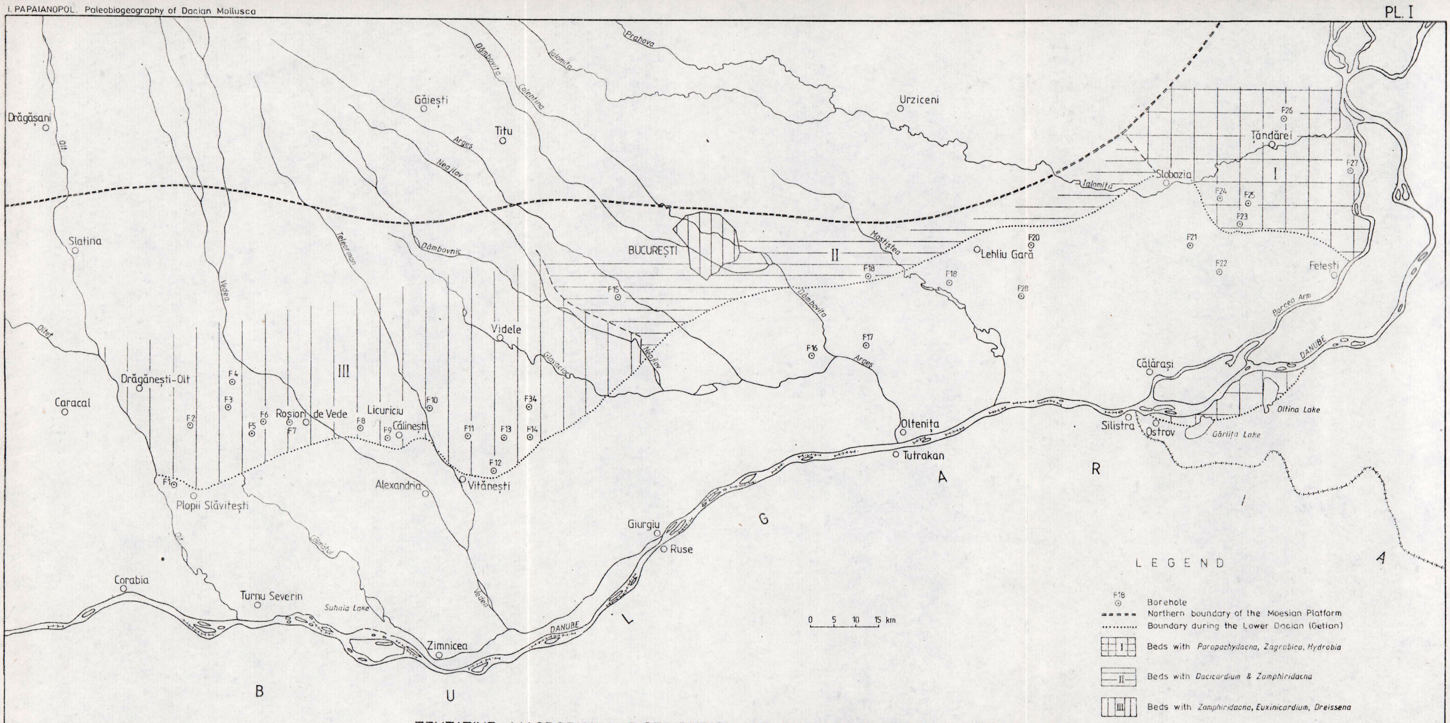
Plate I

Tentative distribution of the macrofaunas at the Lower Dacian (Getian) level. 1, borehole; 2, northern boundary of the Moesian Platform; 3, shore line during the Lower Dacian (Getian); 4, *Parapachydacna*, *Zagrabica*, *Hydrobia* beds; 5, *Dacicardium*, *Zamphiridacna* beds; 6, *Zamphiridacna*, *Euxinicardium*, *Dreissena* beds.

Plate II

Tentative distribution of the macrofaunas at the Upper Dacian (Parscovian) level. 1, borehole; 2, northern boundary of the Moesian Platform; 3, shore line during the Upper Dacian (Parscovian); 4, *Psilodon* beds, 5, *Horiodacna*, *Prosodacnomya*, *Limnodacna*, *Dreissena* beds; 6, *Zamphiridacna*, *Pseudocatillus*, *Hydrobia* beds; 7, *Pseudocatillus*, *Theodoxus*, *Bulimus*, *Melanopsis* beds; 8, *Dacicardium*, *Pseudoprosodacna*, *Lithoglyphus* beds; 9, *Prosodacnomya*, *Horiodacna*, *Gyraulus* beds.



TENTATIVE MACROFAUNA DISTRIBUTION AT THE LOWER DACIAN (GETIAN) LEVEL

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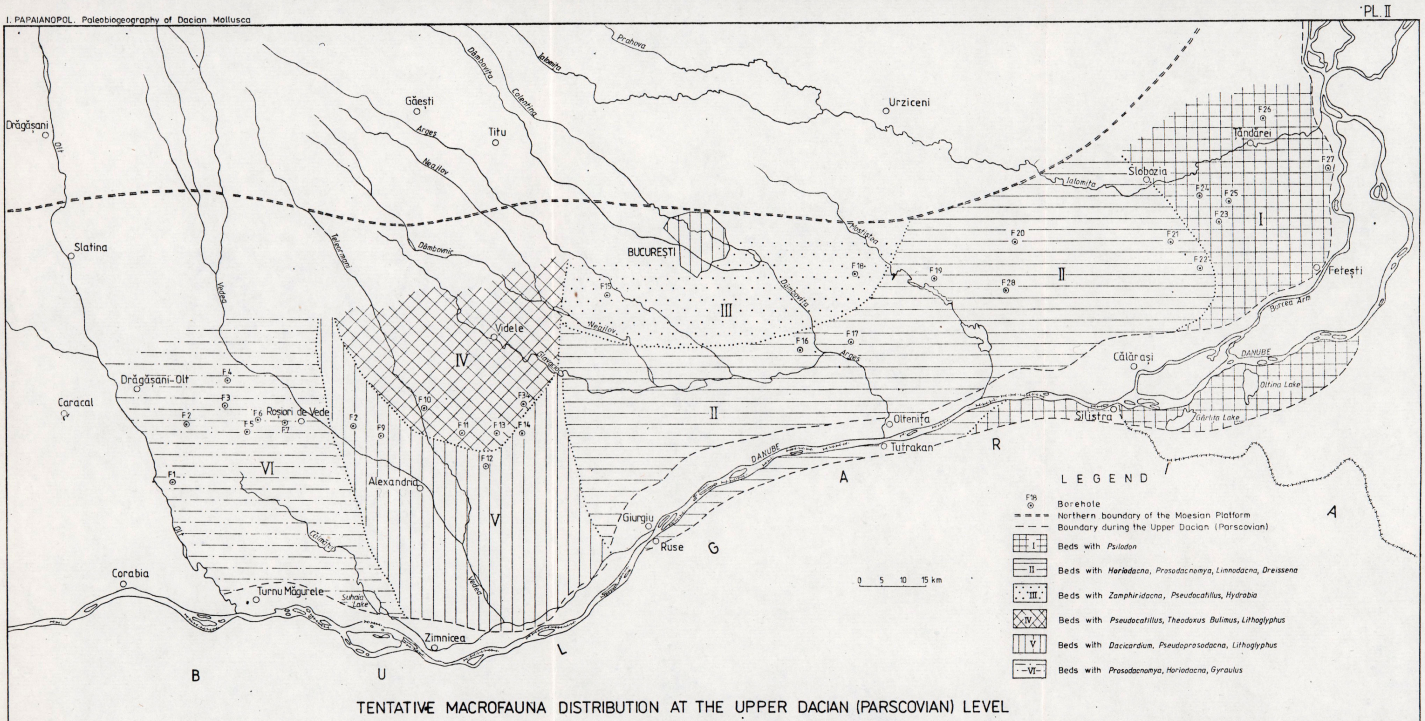

TENTATIVE MACROFAUNA DISTRIBUTION AT THE UPPER DACIAN (PARSCOVIAN) LEVEL

Printed by the Geological Institute of Romania

Rom. J. Paleontology, 76, 1995, p. 127–130, Bucharest

NEW SPECIES OF UNIONIDS IN THE MIDDLE ROMANIAN IN THE WESTERN PART OF THE DACIC BASIN

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Bulevardul Bucureştii Noi 93–97, Bl. B 3, sc. C, ap. 121, sector 1, Bucureşti.

Key words: Mollusca. Unionidae. Middle Romanian. Taxonomy. New taxa. Getic Depression.

Abstract: In Gilortului (Capul Dealului, Vladimir) and Amaradiei Valleys (Stoina) five new species occur: *Pristinunio gilortui* n. sp., *Rytia bielzi elongata* n. sp., *Rytia obliqus* n. sp., *Sulcopotomida amaradica* n. sp., *Sulcopotomida getica* n. sp. Within the Middle Romanian a lower part with clays, sands and coal beds with "moulded" unionids and an upper sandy part with ornamented unionids from the Middle Romanian can be distinguished.

The Middle Romanian (Pelendavian) was defined by Andreescu (1982) and corresponds to the interval in which especially the moulded unionids and ornamented viviparids develop luxurianly in the Dacic Basin. The most important contributions to the knowledge of unionids in Oltenia are those due to: Bielz (1864), Tournouër (1880), Porumbaru (1881), Fontannes (1886), S. Ştefănescu (1896), Ionescu-Argetoaia (1918), Teisseyre (1907), Wenz (1942), Pană et al. (1981).

The specimens which we are about to describe proceeding from fossiliferous places occur in the Middle Romanian deposits and crop out in Gilortului (Capul Dealului and Vladimir villages) and Amaradiei Valleys (Stoina village).

The study of geological columns at Capul Dealului (north of Filiaşi), Cerului Valley (Vladimir) Gornet Valley and other columns at Strehaia, Filiaşi, Argetoaia, Bâlta, Bucovăţ point out that:

– the lower part of the Middle Romanian consists of marls, clays, sands and thin coal beds (0.10–0.20 m); in these deposits we have encountered: *Rugunio condai* (PORUMBARU), *Rugunio turburensis* (FONTANNES), *Rytia bielzi* (CZEKELIUS), *Rytia bielzi elongata* n. sp. *Sulcopotomida herjei* (PORUMBARU), *Sulcopotomida amaradica* n. sp., *Sulcopotomida* n. sp., *Viviparus bifarcinatus* (BIELZ), *Viviparus stricturatus* NEUMAYR (Capul Dealului, Gornet Valley).

– the upper part of the Middle Romanian consists prevailingly of sands with *Pristinunio pristinus* (BIELZ), in places only *Pristinunio davilai* (PORUMBARU) (upper part of Cerului Valley, Argetoaia), in places associated with moulded unionids such as *Rytia brandzae* (SABBA), *Wenziella gorjensis* (TEISSEYRE) and viviparus of the *Viviparus turgidus* (BIELZ) Group, *Viviparus rudis* NEUMAYR (Bilta, Hurezani).

In the area which has been studied by us, Andreescu's previously separated subzones (1982) of the Middle Romanian could not be delimited, as indicator taxa did not occur in the succession which had been indicated by this author.

Taxonomy

Family **Unionidae**

Subfamily **Unioninae**

Genera *Pristinunio* STARABOGATOV, 1970

Pristinunio gilortui sp. nov.

Pl. I, figs. 5–11

Holotype: Pl. I, fig. 1, Collection of the Geological Institute of Romania, Bucharest, inv. no. 18723.

Derivatio nominis: from Gilort River, from the vicinity of which it proceeds;

Locus typicus: Cerului Valley, Gorj district;

Stratum typicum: sandy horizon with *Pristinunio pristinus* (BIELZ), *Pristinunio davilai* (PORUMBARU), *Viviparus rudis* (NEUMAYR), *Viviparus turgidus* (BIELZ);

Description: large, thick, convex, oval-elongated shell, strongly inequilateral, with umbos prosogir, outstanding. Its anterior limit gradually advances into the posterior one; its ventral, almost straight limit gradually rises towards the posterior one. The anterior part is short whereas the posterior one is approximately three times more elongated and grows subsequently narrower. The posterior part is convex. The dorsal limit is slightly inclined towards the posterior one.

The keel begins from the umbos towards the anterio-posterior, slightly marked angle. The shell presents increasing striae. The right valve has two cardinal teeth, one of them being well developed and embattled, and two lateral posterior teeth, the internal one being rudimentary. The left valve has two cardinal teeth, the internal one being developed and toothed, and two lateral, posterior, almost equal teeth.

Dimensions (mm):

Length (l)	Height (h)	Convexity (c)
92.5	51.8	19.5
91.0	51.0	20.0
89.0	49.0	19.4

Comparisons: Unlike *Pristinunio pristinus* it is both larger in size and has an elongated and narrow posterior part.

Occurrence: Dacic Basin. Middle Romanian=Pelendavian.

Subfamily **Psilunionae** STARABOGATOV, 1970

Genera *Rytia* SABBA ŞTEFANESCU, 1896

Rytia bielzi elongata sp. nov.

Pl. II, figs. 1–3

Holotype: Pl. II, fig. 1, Collection of the Geological Institute of Romania, Bucharest, inv. no. 18721.

Derivatio nominis: from the elongated valve forms.

Locus typicus: Capul Dealului Village, Gorj district.

Stratum typicum: clays and sands with *Rytia bielzi* (CZEKELIUS), and *Viviparus bifarcinatus* (BIELZ).

Description: Sturdy, triangular-rounded, strongly inequilateral convex, thick valves. Short anterior part and a twice as large posterior part. The dorsal bended limit gradually descends towards the posterior one. Anterior rounded limit. Slightly rounded ventral limit with a sinus in the posterior part. Distorted-rounded posterior limit. From the umbos towards the inferior-posterior angle a relative narrow, well individualized folds descends, in front of which there always exists a depressionary zone. High prominent prosogir umbos with a very deep umbo cavity. On the external surface concentric, highly thickened folds which are very well developed, especially in the median and superior parts of the shell can be recorded. On these folds irregular thickenings and even tubercles are observable. On the right valve the bend includes two cardinal teeth, one of them strong, the other one rudimentary, and two lateral posterior teeth, a lamellar superior and a rudimentary, inferior one. The left valve bend has two cardinal unequal teeth (the posterior one being better developed) and two lateral posterior elongated teeth.

Dimensions (mm):

Length (l)	Height (h)	Convexity (c)
48.0	52.0	23.0
48.5	51.0	23.0
47.2	52.6	23.5

Remarks: Unlike *Rytia bielzi* (CZEKELIUS) this form has a larger anterior-posterior diameter, a wider and well developed posterior part, a stronger external sculpture and an outstanding sinus in the ventral part.

Occurrence: Dacic Basin. Middle Romanian=Pelendavian.

Rytia obliqus sp. nov.

Pl. III, fig. 2

Holotype: Pl. III, fig. 2, Collection of the Geological Institute of Romania, Bucharest, inv. no. 18719.

Derivatio nominis: from the Latin oblique.

Locus typicus: Stoina village, Gornet Valley, Gorj district;

Stratum typicum: level of clays and sands with *Rugunio turburensis* (FONTANNES), *Viviparus stricturatus* (NEUMAYR) and *Viviparus bifarcinatus* (BIELZ).

Description: Sturdy, large-sized, convex shell, with triangular outline and highly inequilateral. Short, slightly rounded anterior part and a twice as large posterior part. Bended ventral limit, with a superior limit inclined towards the posterior one. Prominently twisted umbos, displaced towards the anterior part, exceeding the anterior limit of the shell. The utmost shell upwarping is in the middle of the valve. Growing striae and thickened concentric folds especially in the umbo and median zones, as well as tubercles and elongated thickenings are observable on the external surface. Strong dentition: two unequal cardinal teeth on the left valve, the internal one better developed than the external one, and two lateral lamellar, almost equal teeth.

Comparisons: *Rytia obliqus* sp. nov. is similar to *Unio pauli* NEUMAYR in the shell outline, but different by its absence of the two keels and presence of adornments. Unlike *Rytia slavonica* (M. HORNES) it is larger-sized, has wider umbos, displaced towards the anterior part and a larger valve width.

Occurrence: Dacic Basin. Middle Romanian= Pelendavian.

Genera *Sulcopotomida* STARABOGATOV, 1970

Sulcopotomida amaradica sp. nov.

Pl. III, figs. 1, 3, 4

Holotype: Pl. III, fig. 1, Collection of I.G.R., inv. no. 18716.

Derivatio nominis: from Amaradiei Valley.

Locus typicus: Gornetu Valley, Stoina commune, Gorj district.

Stratum typicum: grey marlaceous levels with *Rytia bielzi* (CZEKELIUS) and *Viviparus stricturatus* (NEUMAYR).

Description: large, sturdy, convex, inequilateral shell, with oval outline. Flattened prosogir umbo. Convex anterior limit, gradually advancing towards a slight convex ventral limit and gradually rising towards the posterior limit. The anterior part of the shell is very short, whereas the posterior one is elongated and narrower. The posterior branch of the cardinal line is longer and almost rectilinear. The right valve has a strong cardinal, in places embattled tooth, two cardinal rudimentary teeth, a lamellated posterior tooth and a rudiment. The left valve has two cardinal, oblique teeth, the internal one larger and two lateral posterior lammelated teeth. The valve ornamentation consists of 5–6 concentric thick waving folds which are in places underlined in the median and umbo zones. Prominent ribs have a series of tubercles on the crest which begins from the umbos towards the inferior-posterior angle.

Dimensions (mm):

Length (l)	Height (h)	Convexity (c)
83.0	47.0	16.0
75.0	44.5	16.0
70.0	44.0	15.0

Comparisons: Unlike *Sulcopotomida herjei* (PORUMBARU) this specimen has a larger, convex shell, a rounded anterior limit, a more bended inferior limit and a simplified sculpture.

Unlike *Sulcopotomida cymatoides* (BRUSINA) it has a larger umbo-ventral diameter, a better developed posterior part and a rounded anterior limit.

Occurrence: Dacic Basin. Middle Romanian= Pelendavian.

Sulcopotomida getica sp. nov.

Pl. II, figs. 4–5

Holotype: Pl. II, fig. 4, Coll. of I.G.R. no. 18717.

Derivatio nominis: from the Getae who lived in this territory at the beginning of our era.

Locus typicus: level of clays and sands with *Rugunio turburensis* (FONTANNES) and *Viviparus bifarcinatus* (BIELZ).

Description: Middle-sized, strongly inequilateral shell, with triangular-oval outline. The flattened umbo is slightly underlined over the cardinal limit and strongly displaced towards the anterior part. In most of the cases the umbo peak exceeds the cardinal tooth. The cardinal limit is long and slightly bended. Both the anterior and the posterior limits are slightly convex and gradually join the neighbouring ones. The anterior part is short, whereas the posterior one is twice and a half as long. The sculpture consists of 6–7 underlined concentric, thickened, slightly waving folds, separated by deep ditches which are visible up to the inferior part of the valve. In the upper part of the valve, fine perpendicularly ordered costules can be noticed between these folds. On the surface of these folds and especially on the peak between the crochet and the inferior-posterior angle, the tubercles are rarely ordered.

The right valve bend consists of a cardinal triangular and a lammelated posterior lateral tooth. The left valve consists of two cardinal and two lateral lamellated posterior teeth.

Dimensions (mm):

Length (l)	Height (h)	Convexity (c)
60.0	42.0	14.8
47.0	32.0	12.0
46.0	31.0	11.0

Comparisons: Unlike *Sulcopotomida porumbari* (TOURNOUER) the above described form has a less anterior displaced umbo and slightly rounded anterior and cardinal limits.

Occurrence: Dacic Basin. Middle Romanian=Pelendavian.

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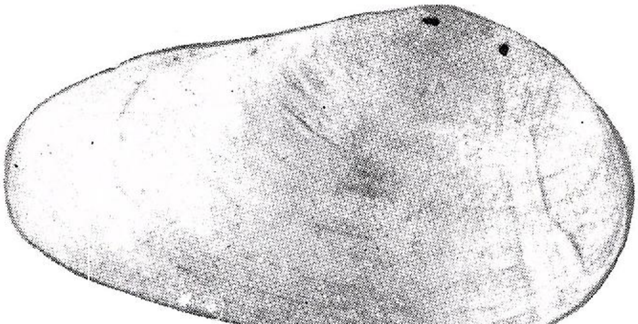
Plate I

Figs. 1–3 — *Pristinunio gilortui* sp. nov. (x 1), fig. 1, holotype, Valea Cerului (Vladimir), Gorj district, Middle Romanian=Pelendavian.



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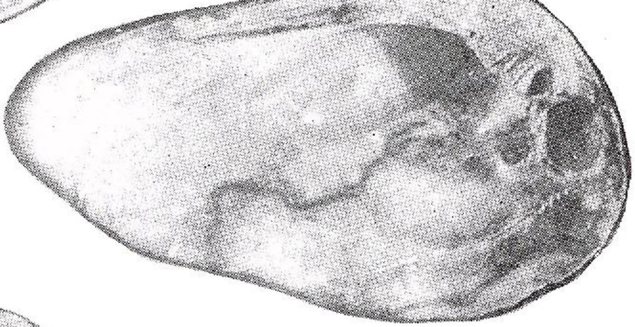

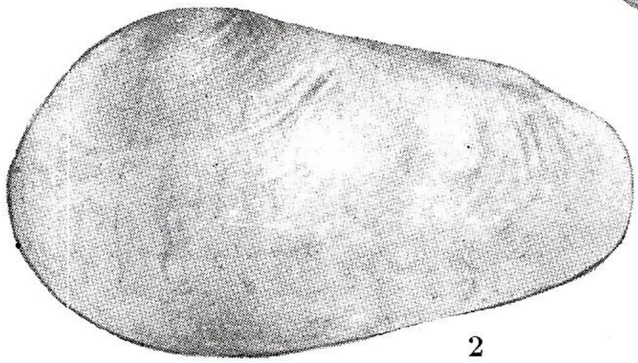

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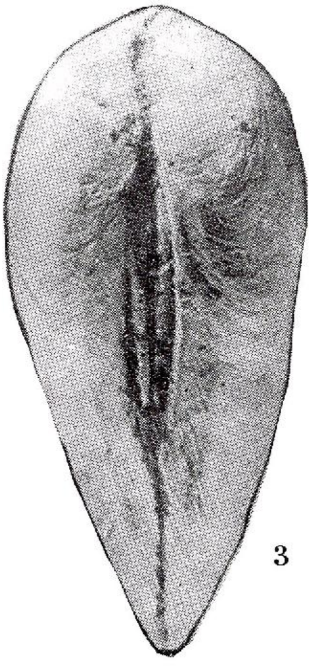

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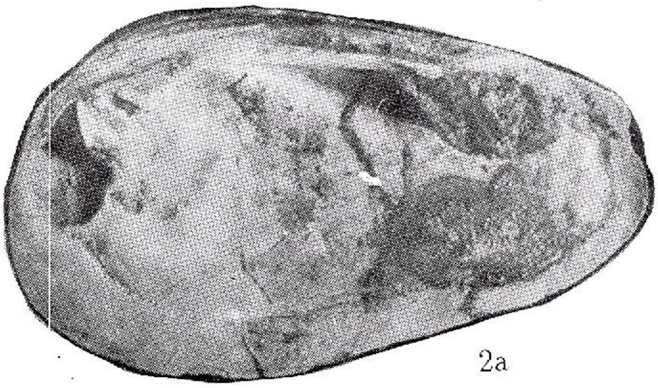

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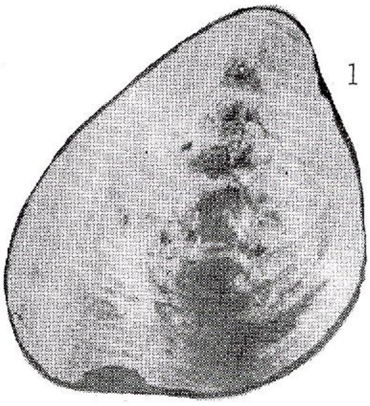
Plate II

Figs. 1–3 — *Rytia bielzi elongata* sp. nov. (x 1), fig. 1, holotype, Capul Dealului (N. Filiaşi), Gorj district, Middle Romanian=Pelendavian.

Figs. 4–5 — *Sulcopotomida getica* sp. nov. (x 1) fig. 4, holotype, Valea Cerului (Vladimir), Gorj district, Middle Romanian=Pelendavian.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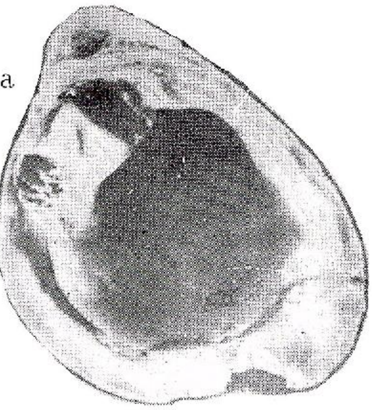
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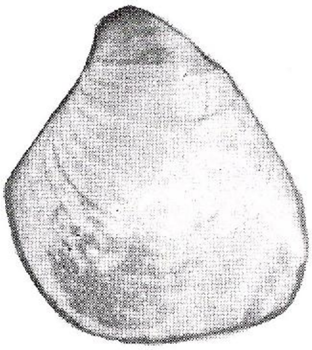
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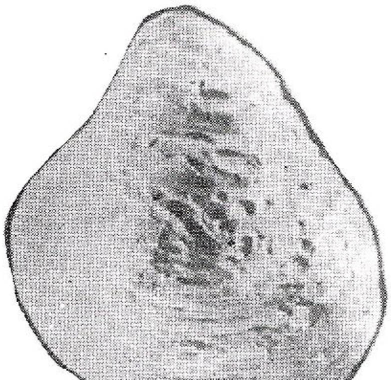
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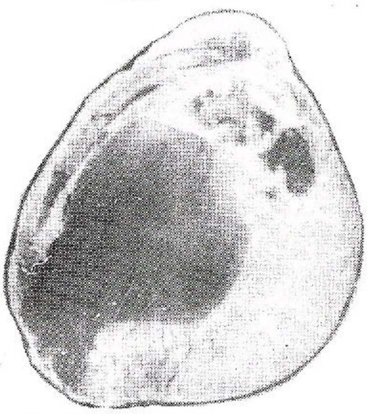
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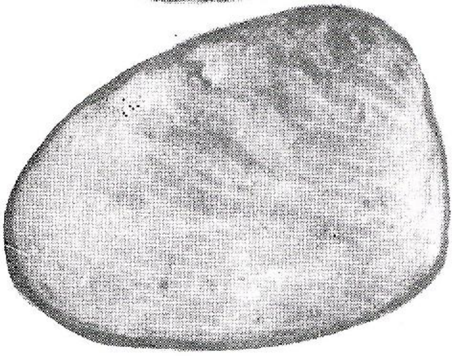
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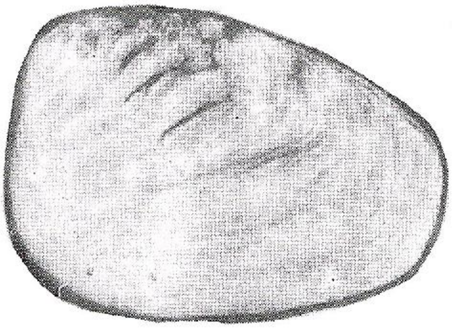
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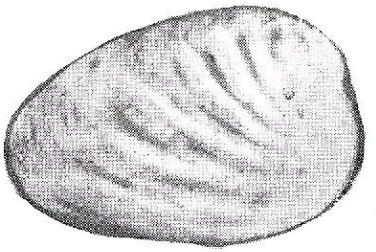
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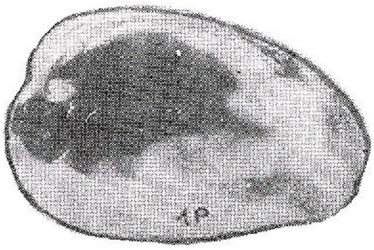
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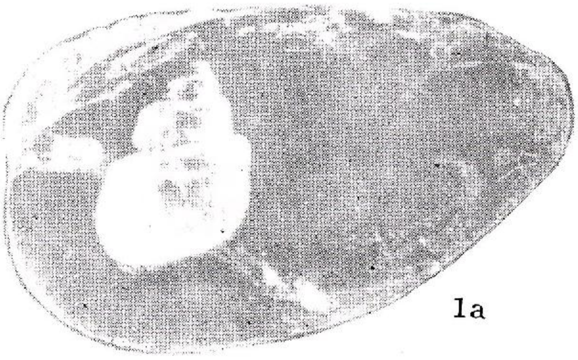
Plate III

Figs. 1, 3, 4 — *Sulcopotomida amaradica* sp. nov. (x 1), fig. 1, holotype, Valea Gornet (Stoina), Gorj district, Middle Romanian=Pelendavian.

Fig. 2 — *Rytia obliqus* sp. nov. (x 1) fig. 2, holotype, Valea Gornet (Stoina), Gorj district, Middle Romanian=Pelendavian.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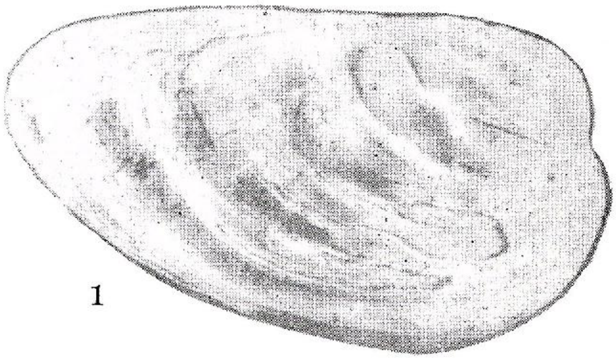
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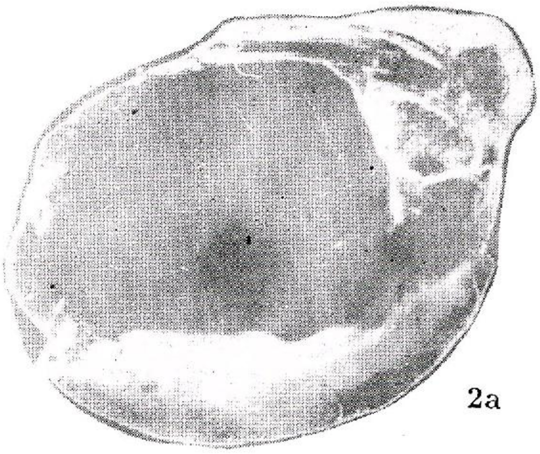
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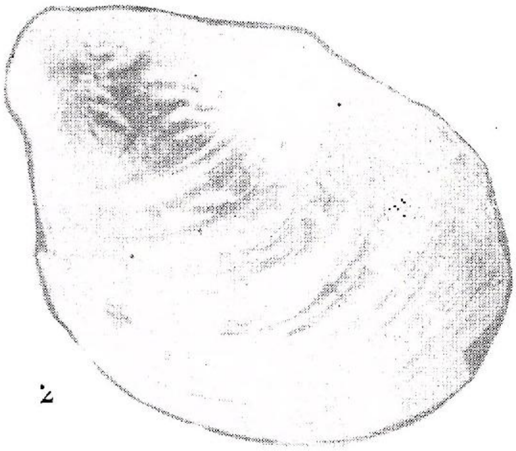
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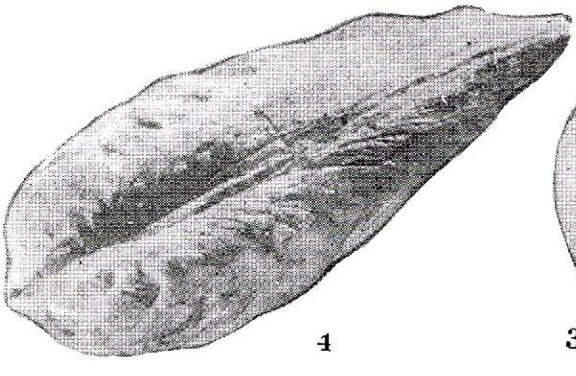
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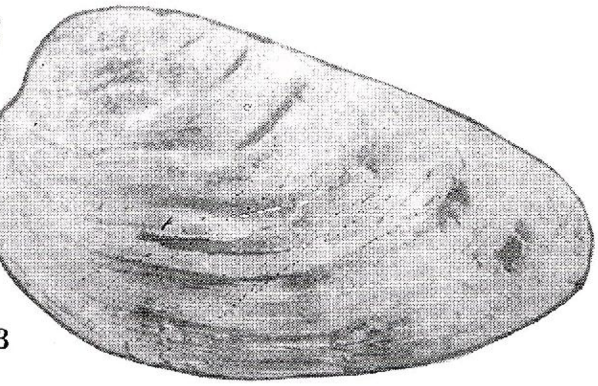
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Rom. J. Paleontology, 76, 1995, p. 131-136, Bucharest

ESPÈCES DE NANNOPLANCTON DES DÉPÔTS ROMANIENS DU SECTEUR ENTRE LES VALLÉES DE COSMINA ET DE CRICOVUL DULCE (MUNTÉNIE, BASSIN DACIQUE, ROUMANIE)

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Key words: Nannoplankton. Bivalvia. Gastropoda. Romanian. East Carpathians-Subcarpathian- Diapir Fold Zone.

Abstract: *Nannoplankton Elements in the Romanian Deposits between the Cosmina Valley and the Cricovul Dulce Valley (Dacic Basin, Muntenia, Romania).* The study area belongs to the diapir fold zones individualized in Muntenia, between the Buzău and Ialomiţa Valleys. The Romanian deposits represent the last Neogene teren being situated between the Cosmina and Prahova Valleys, on the Buştenari homocline. Westward, in the area between the Prahova and Cricovul Dulce Valleys, the Romanians deposits are found in anticlinal and synclinal structures spread from the south to the north. Taking into account the macrofaunas constitution, Middle Romanian deposits are presumed to occur in the study area, too. The data on Romanian in the area under discussion have been recently improved by new evidence supplied by the core drillings carried out for coals. In some of the samples taken off from three boreholes, at certain intervals, calcareous nannoplankton assemblages have been reported. Due to the lack zonal markers the nannofossil assemblages have been assigned to the biozones of the standard zoning (Martini, 1971) as a result of the superposition of the life intervals of the taxa *Ceratolithus rugosus*, *Amaurolithus bizzarus*, *A. separatus* and *Reticulofenestra pseudoumbilica*. It has been established that the assemblages reported from boreholes F3 Cosmina (213–216 m) and F2 Cosmina (180–188 m) belong to Zone NN15- Reticulofenestra pseudoumbilica, and those from boreholes F1 Edera (170–173 m) and F2 Cosmina (127–147 m) can be referred to Zone NN16 - Discoaster surculus.

Les terrains romaniens sont très bien développés entre les vallées de la Cosmina et du Cricovu Dulce. Ce secteur de la Dépression Subcarpatique appartient à la zone des plis diapirs de la Munténie, zone délimitée par la vallée du Buzău et la vallée de la Ialomiţa.

Le Romanien représente le dernier intervalle néogène de ce secteur, de l'homocline de Buştenari. Vers l'ouest, entre la vallée de la Prahova et la vallée du Cricovu Dulce, les dépôts romaniens sont présentes dans plusieurs structures. Les données mentionnées par les auteurs (Hanganu, 1966; Iliescu et al., 1975, non publiées; Nicolaescu et al., 1976, non publiées; 1980; Lubenescu, Nicolaescu, 1987) et les informations concernant les particularités du Romanien de ce secteur ont été enrichies par de nouveaux éléments obtenus des forages (Papaianopol et al., 1985, 1989).

Dans la partie occidentale du secteur investigué, entre la vallée de la Prahova et la vallée du Cricovu Dulce , le Romanien comporte des faunes à unionidés "sculptés" qui attestent la présence des dépôts d'âge romanien moyen couvrant ceux du Dacien inférieur (Gétien). Existe donc une importante lacune stratigraphique (Papaianopol et al., 1985, non publiées), point de vue accepté aussi par d'autres auteurs (Lubenescu, Nicolaescu, 1987). Après Botez (1923) qui a présenté pour la première fois le contenu faunique des dépôts "levantins" de Moreni (où à côté des unionidés ont été rencontrés des gastéropodes appartenant aux genres *Viviparus*, *Melanopsis*, *Tylopoma* et *Theodoxus*), d'autres auteurs ont contribué à la connaissance des faunes de ce secteur important de la Dépression Subcarpatique de Munténie: Ghenea et Ghenea (1970), Nicolaescu et al., (1980), Lubenescu, Nicolaescu (1987), Papaianopol et al., (1989), non publiées; Papaianopol (1992).

Les macrofaunes romaniennes rencontrées entre la vallée du Cricovu Dulce et la vallée de la Prahova, plus précisément le long des vallées Cervenia, Nisipoasa et Valea lui Dan), comportent: *Rugunio lenticularis* (SABBA), *R. mojsvari* (PENECKE), *R. condai*

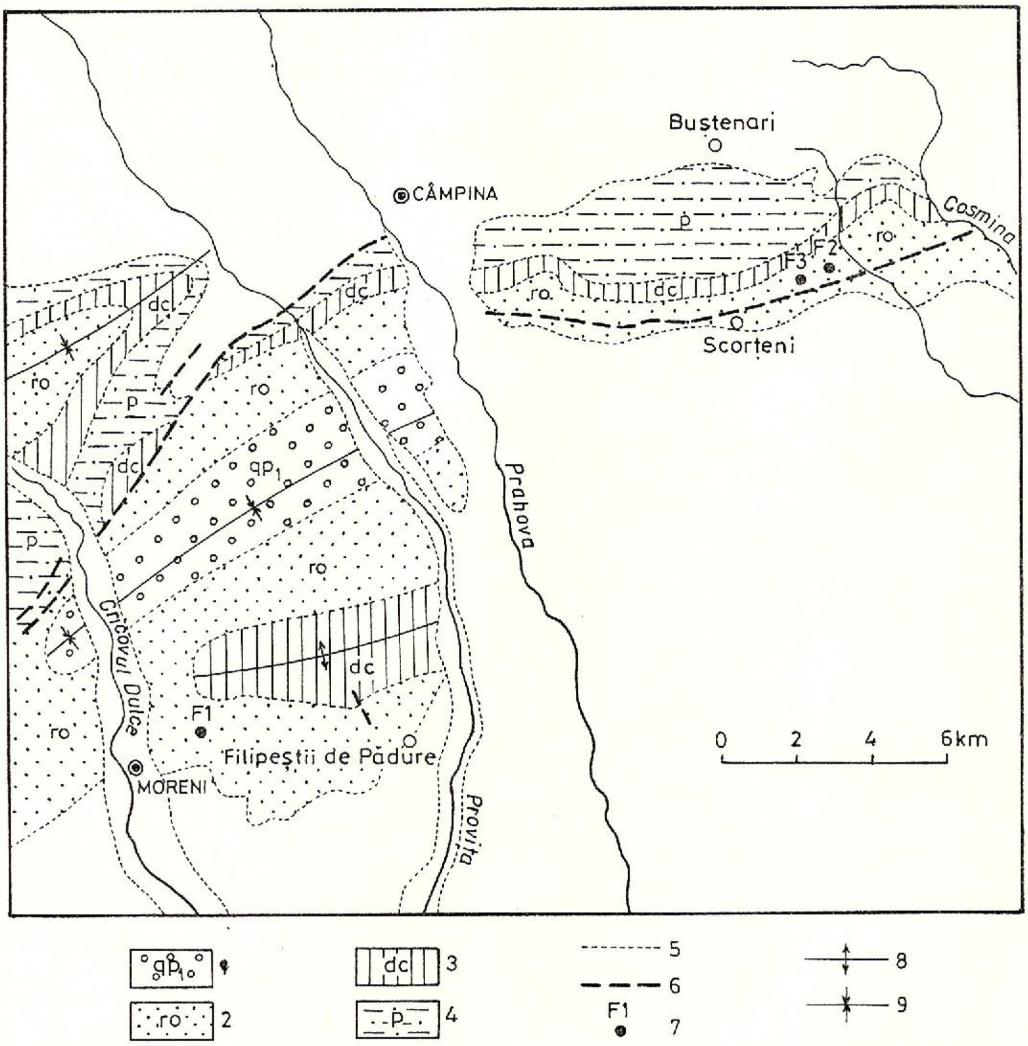

Fig. 1 – Esquisses géologiques de la région discutée (d'après les données de l'IGR) avec l'emplacement des forages commentés: 1, Pléistocène inférieur; 2, Romanien; 3, Dacien; 4, Pontien; 5, limite géologique; 6, faille; 7, forage; 8, anticlinal; 9, synclinal.

(PORUMBARU), *Rytia brandzae* (SABBA), *R. motruensis* (IONESCU-ARGETOAIA), *Wenziella subclivosa* (TEISSEYRE), *Sulcopotomida herjei* (PORUMBARU), *S. cymatoides* (BRUSINA), *Cuneopsidea beyrichi* (NEUMAYR), *C. oriovacensis elongata* LUBENESCU, *C. oriovacensis truncata* LUBENESCU, *Pristinunio transcarpaticus* (TEISSEYRE), *P. mutabilis* PAPAIANOPOL, *P. pristinus*(BIELZ), *P. davilai* (PORUMBARU), *Psilunio (Psilunio) moreniorum* (BOTEZ), *P. (P.) stoliczkai* (NEUMAYR), *P. (P.) salinus* PAPAIANOPOL, *P. (P.) pteris* PAPAIANOPOL, *P. (P.) inermis* PAPAIANOPOL, *P. (Cyclopotomidae) munieri* (SABBA), *P. (C.) excellentis* PAPAIANOPOL, *Viviparus craiovensis* (TOURNOUËR), *V. bifarcinatus* (BIELZ), *V. stricturatus* NEUMAYR, *Melanopsis (Melanopsis) rumana* TOURNOUËR, *M. (Lyrcaea) onusta* SABBA, *Theodoxus quadrifasciatus* (BIELZ).

Le forage 1 Edera se situe à l'ouest de la vallée du Cricovu Dulce, sur le flanc méridional de l'anticlinal de Siliştea Dealului (Fig. 1). Le long de l'axe de l'anticlinal affleurent les dépôts du Dacien inférieur, tandis que le long des flancs se développent ceux du Romanien moyen. Le forage 1 Edera a percé les formations du Romanien moyen jusqu'à la profondeur de 290 m. On y a rencontré (Planche II) jusqu'à 185 m, des dépôts prédominants argileux et argilo-sableux, avec de couches à concrétions calcaires. Surtout à la partie inférieure existent des intercalations de sables médiogranulaires jaunâtres et des couches minces de lignite.

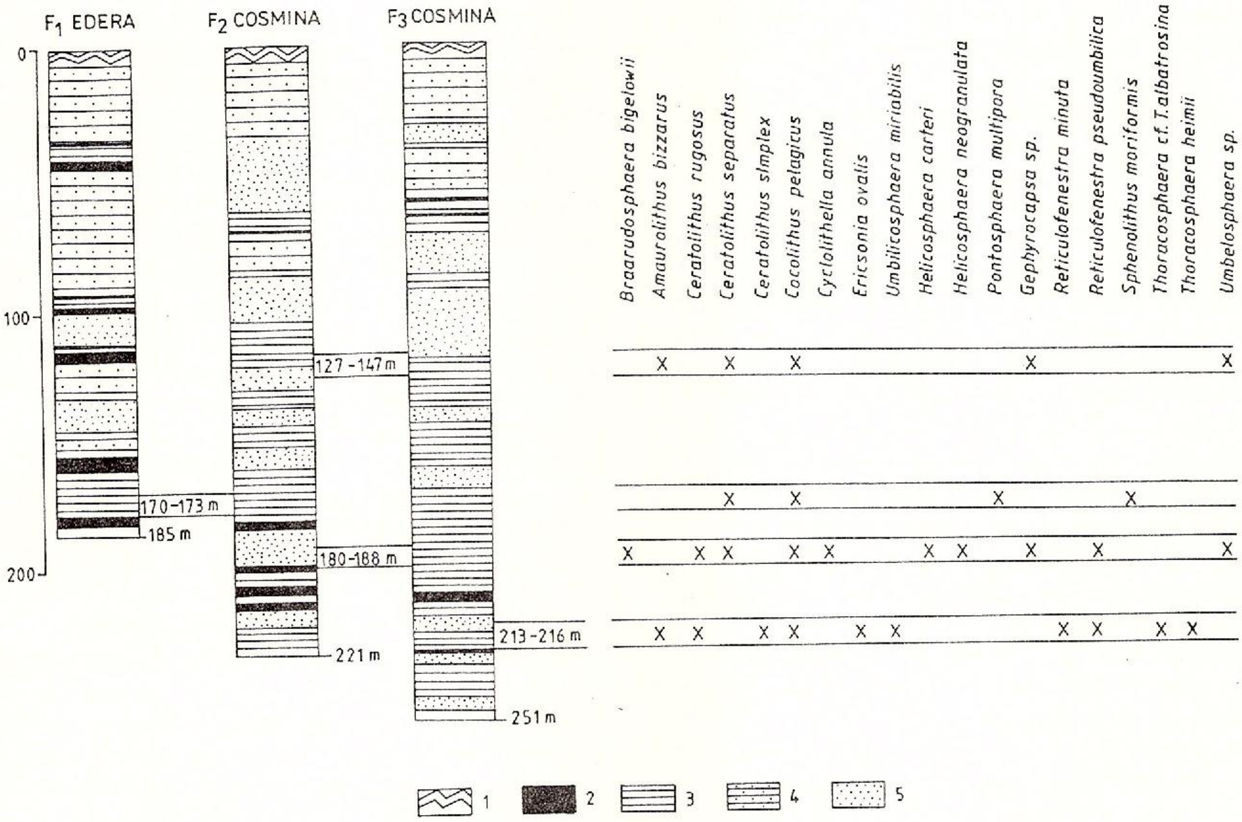

Fig. 2- Le contenu en nannofossiles calcaires des dépôts romaniens entre les vallées de la Cosmina et du Cricovu Dulce: 1, sol végétal; 2, charbons; 3, argile; 4, argile sableuse; 5, sable.

Aux intervalles 88-92 m et 170-173 m les associations fauniques comportent : *Psilunio (Psilunio)* aff. *prominulus* (SABBA), *Viviparus bifarcinatus* (BIELZ), *V. stricturatus* NEUMAYR, *Melanopsis (Melanopsis) pterochila* BRUSINA, *M. (M.) esperioides* SABBA, *Theodoxus quadrifasciatus* (BIELZ), *T. scriptus* (SABBA), *Cyprideis torosa* (JONES), *Candona neglecta* (SARS), *Iliocypris gibba* (RAMDOHR), *I. magna* OLTEANU. Les ostracodes ont été déterminés par notre collègue Olteanu R. que nous remercions beaucoup.

Vers l'est, sur l'homocline de Buştenari, entre la vallée de la Prahova et la vallée de la Cosmina, les dépôts romaniens reposent sur ceux du Dacien supérieur (Parscovien). On a deja signalé que le Dacien supérieur (Parscovien), complètement développé vers la vallée du Buzău, se présente peu à peu moins complet vers l'ouest, la lacune stratigraphique augmentant vers la vallée de la Prahova (Papaianopol et al., 1985, 1989), à l'ouest de cette vallée, le Dacien supérieur (Parscovien) n'affleurant plus.

Dans le forage 2 Cosmina (Fig. 1) on a attribué au Romanien les dépôts interceptés jusqu'à la profondeur de 221 m. Lithologiquement il comporte de: argiles, argiles sableuses, sables argileux et sables, avec des couches de charbon à la partie inférieure. Dans la moitié inférieure de la succession dominent les argiles et à celle supérieure les sables, les sables argileux et les argiles sableuses. Les mollusques rencontrés aux intervalles 215-218 m, 198-196 m et 172-177 m comportent: *Viviparus bifarcinatus* (BIELZ), *V. stricturatus* NEUMAYR, *Melanopsis (Melanopsis) pterochila* BRUSINA, *M. (M.) onychia* BRUSINA, *M. (M.) breastensis* SABBA, *M. (Lyrcaea) onusta* SABBA, *Theodoxus scriptus* (SABBA), *T. licherdopoli* (SABBA). Les faunes d'ostracodes (déterminées par Olteanu) englobent: *Iliocypris gibba* (RAMDOHR), *I. lanceolata* OLTEANU, *I. magna* OLTEANU, *I. globosus* OLTEANU, *Eucypris famosa* SCHNEIDER, *Cyprideis torosa* (JONES), *Candona neglecta* (SARS), *Romaniella dacica* OLTEANU, *Hastacandona albicans* (BRADY).

Des contenus fauniques semblables ont été rencontrés aussi dans le forage 3 Cosmina (aux intervalles 219-221 m et 180-183 m) (Fig. 1).

Lithologiquement, on constaté qu'à la partie inférieure du forage 2, prédominent les dépôts argileux (accompagnés par des couches de charbon), tandis qu'à celle supérieure il y a une alternance de sables, argiles et argiles sableuses.

Quant aux macrofaunes romaniennes de ce secteur, on a remarqué (Papaianopol et al., 1989) qu'elles sont souvent très riches parfois s'agissant même de niveaux lumachelliques, mais oligospécifiques, dominés par *Viviparus*, *Theodoxus* et *Melanopsis*. Les formes présentées sont plus ou moins fréquentes tant au Romanien inférieur qu'à celui moyen aussi. On a remarqué (Papaianopol, 1989) la présence de quelques niveaux lumachelliques où abondent *Viviparus bifarcinatus* (BIELZ) et *Viviparus stricturatus* NEUMAYR.

Selon Iliescu et al. (1975), l'intervalle aux charbons du Romanien, comporte les *Viviparus* mentionnés et à côté des unionidés "sculptés" (genre *Cuneopsidea*), ce qui est en faveur de l'âge romanien moyen.

Il y a peu de temps, les paléontologistes, considéraient que les algues calcaires unicéllulaires n'avaient pas vivre dans des milieux à salinité réduite, ressortant donc que les dépôts pliocènes des bassins Dacique et Ponto-Caspique ne peuvent pas comporter d'éléments du nannoplancton.

Reinhardt (1972), après un étude de laboratoire sur une culture d'algues calcaires unicellulaires actuelles, arrive à la conclusion que l'intervalle optimal de salinité pour celles-ci serait de 1,7–4,5$^0/_{00}$.

Les premières mentions de nannoplancton dans la Paratéthys regardent les dépôts miocènes supérieurs-pliocènes du Bassin Pontique (Liulieva en Semenenko et Liulieva, 1978). Ainsi ont été mises en évidence les zones NN 10–NN 14 au niveau du Méotien supérieur-Kimmérien. Les ensembles de nannoplancton mentionnés par le même auteur dans les dépôts couialnikien–aktchagyliens (correspondant approximativement au Romanien) sont insignifiants au point de vue biostratigraphique.

En partant des conclusions des spécialistes et supposant l'existence des liaisons paléogéographiques entre le Bassin Dacique et la Paratéthys orientale (Pană et al., 1968) l'idée ayant à sa base l'existence de limnocardiidés au niveau du Romanien dans le secteur de courbure des Carpates orientales, nous avons analysé une série d'echantillons provenant des dépôts romaniens de l'avant-fosse carpatique, prélevés des forages 1 Edera, 2 Cosmina et 3 Cosmina (Pl. I).

L'ensemble du nannoplancton calcaire provenant du forage 1 Edera (l'intervalle 170–173 m) (Fig. 2) comporte: *Ceratolithus separatus* BUKRY, *Coccolithus pelagicus* (WALLICH), *Pontosphaera multipora* (KAMPTNER) et *Sphenolithus moriformis* (BRÖNIMANN & STRADNER).

Des ensembles encore plus riches sont présentes dans le forage 2 Cosmina (Fig. 2); les échantillons prélevés de l'intervalle 180–188 m comportent: *Braarudosphaera bigelowii* DEFLANDRE, *Amaurolithus* sp., *Ceratolithus rugosus* BUKRY & BRAMLETTE, *C. separatus* BUKRY, *Coccolithus pelagicus* (WALLICH), *Cyclolithella annula* (COHEN), *Helicosphaera carteri* (WALLICH), *H. neogranulata* GARTNER, *Gephyrocapsa* sp., *Reticulofenestra pseudoumbilica* (GARNER). Un peu plus en haut, l'intervalle 127–147 m, on a rencontré: *Amaurolithus bizzarus* (BUKRY), *Ceratolithus separatus* BUKRY, *Coccolithus pelagicus* (WALLICH), *Gephyrocapsa* sp., *Umbelosphaera* sp.

L'association de nannofossiles calcaires rencontrée dans le forage 3 Cosmina (l'intervalle 213–216 m) (Fig. 2) est mieux représentée: *Amaurolithus bizzarus* (BUKRY), *Ceratolithus rugosus* BUKRY & BRAMLETTE, *Ceratolithus* cf. *C. simplex* BUKRY, *Coccolithus pelagicus* (WALLICH), *Ericsonia ovalis* BLECK), *Umbilicosphaera miriabilis* LOHMANN, *Discoaster brouweri* TAN, *Reticulofenestra minuta* ROTH, *R. pseudoumbilica* (GARTNER), *Thoracosphaera* cf. *Th. albatrosina* KAMPTNER, *Thoracosphaera heimii* (LOHMANN).

On ne peut tirer de conclusions sur l'encadrement de ces associations quant à l'échelle standard (Martini, 1971; Martini et Müller, 1986), qu'uniquement en superposant les intervalles de vie des taxons (Perch-Nielsen in Bolli et al., 1985): *Ceratolithus rugosus* (les zones NN 13–NN 18), *Amaurolithus bizzarus* (les zones NN 12–NN 16), *Amaurolithus separatus* (les zones NN 15 terminale – NN 18) et *Reticulofenestra pseudoumbilica* (qui disparait à la limite NN 15–NN 16).

Ainsi, dans le forage 3 Cosmina, l'association déterminée dans l'intervalle 213–216 m comporte aussi *Reticulofenestra pseudoumbilica* à côté de *Amaurolithus bizzarus* et *Ceratolithus rugosus*, donc elle pourrait être encadré dans n'importe quelle zone entre NN 13 (Ceratolithus rugosus) et NN 15 (Reticulofenestra pseudoumbilica). Nous sommes d'avis qu'elle appartient à la zone NN 15 (Reticulofenestra pseudoumbilica) tenant compte qu'en dessus (l'intervalle 180–188 m) du forage 2 Cosmina, est présente la partie terminale de la zone NN 15 (Reticulofenestra pseudoumbilica); on y existe *Amaurolithus separatus* à côté de *Amaurolithus bizzarus*, *Ceratolithus rugosus* et *Reticulofenestra pseudoumbilica*.

La présence de *Amaurolithus separatus* (le forage 1 Edera, 170–173 m) et de *Amaurolithus bizzarus* (le forage 2 Cosmina, 127–147 m), en absence de *Reticulofenestra pseudoumbilica*, permet d'encadrer ces associations à la zone NN 16 (Discoaster surculus).

Les associations de nannofossiles susmentionnées se caractérisent par: des contenus très pauvres en genres et espèces; l'absence ou l'apparition sporadiques des taxons markers zonaux; l'existence d'un nombre très réduit d'individus de la meme espèce; les dimensions réduites des exemplaires (surtout pour les genres *Amaurolithus* et *Ceratolithus*), par rapport à celles des spécimens existant dans des conditions normales de salinité.

La présence du nannoplancton dans les dépôts romaniens peut indiquer quelques ingressions marines très brèves de la Téthys (par la Mer d'Egée) étant au contact avec l'extrémité orientale du Bassin Dacique par la Paratéthys orientale (le Bassin Euxinique).

Le nombre petit de taxons, genres et espèces, ainsi que les dimensions plus réduites des spécimens, par rapport aux holotypes, peuvent être attribués à la salinité très faible des eaux traversées et surtout du bassin de sédimentation.

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Planche

Fig. 1 – *Ceratolithus simplex* BUKRY; N II; forage F_3 Cosmina, l'intervalle 213–216 m; x 3000.

Fig. 2 – *Amaurolithus bizzarus* (BUKRY); N II; forage F_2 Cosmina, l'intervalle 127–147 m; x 1500.

Figs. 3, 4 – *Ceratolithus separatus* BUKRY; fig. 3, N II; fig. 4, N +; forage F_1 Edera, l'intervalle 170–173 m; x 3000.

Fig. 5 – *Ceratolithus rugosus* BUKRY & BRAMLETTE; N II; forage F 3 Cosmina, l'intervalle 213–216 m; x 1500.

Fig. 6 – *Amaurolithus* sp.; forage F_3 Cosmina, l'intervalle 213–216 m; x 3000.

Fig. 7 – *Thoracosphaera* cf. *Th. albatrosina* KAMPTNER; forage F_1 Edera, l'intervalle 170–173 m; x 1500.

Figs. 8, 9 – *Reticulofenestra pseudoumbilica* (GARTNER); fig. 8, N II; fig. 9, N +; forage F_3 Cosmina, l'intervalle 213–216 m; x 3400.

Fig. 10 – *Reticulofenestra minuta* ROTH; N +; forage F_3 Cosmina, l'intervalle 213–215 m; x 3400.

Fig. 11 – *Umbelosphaera* sp.; N II; forage F_2 Cosmina, l'intervalle 213–216 m; x 3400.

Fig. 12 – *Cyclolithella annula* (COHEN); N II; forage F_2 Cosmina, l'intervalle 180–188 m; x 3000.

Fig. 13 – *Coccolithus pelagicus* (WALLICH); N +; forage F_1 Edera, l'intervalle 170–173 m; x 1500.

Fig. 14 – *Ericsonia ovalis* BLACK; N +; forage F_2 Cosmina, l'intervalle 213–216 m; x 1500.

Fig. 15 – *Pontosphaera multipora* (KAMPTNER); N +; forage F_2 Cosmina, l'intervalle 180–188 m; x 1500.

Fig. 16 – *Sphenolithus moriformis* (BRÖNIMANN & STRADNER); N +; forage F_1 Edera, l'intervalle 170–173 m; x 2000.


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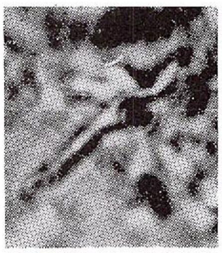
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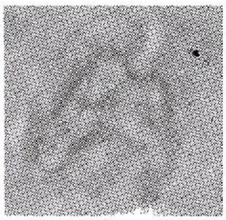
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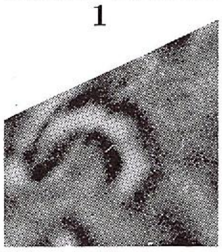
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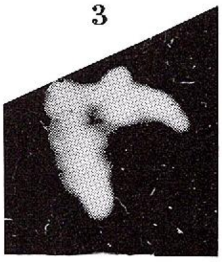
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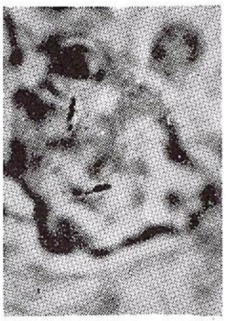
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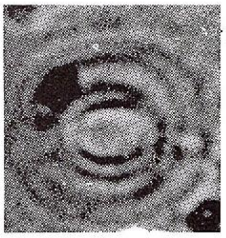
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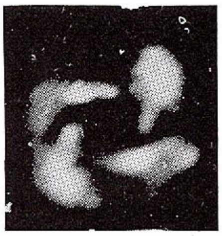
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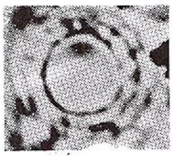
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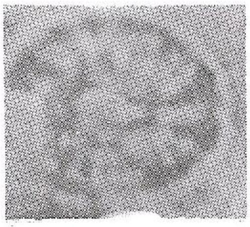
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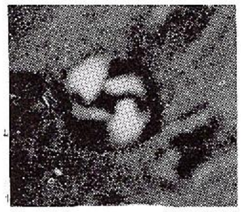
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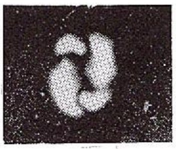
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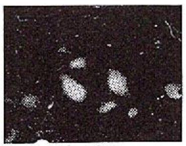
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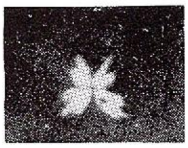
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AN ATTEMPT TO RECONSTITUTE THE EVOLUTION OF THE MEAN ANNUAL TEMPERATURE IN THE NEOGENE OF ROMANIA

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Key words: Paleoclimatic reconstitution. Fossil plants. Mean Annual Temperature. Neogene. Romania.

Abstract: The paleoclimatic reconstitution proposed by the author of this paper is based on the relations between the mean annual temperature (MAT) and the percentage value for species with entire margins leaves (EML) from the main Neogene paleofloras. The results have been corroborated with the data supplied by paleoecological and taphonomic studies. The thermic curve obtained indicates a general decrease trend of the MAT from 19°C in the Aquitanian to 13.5°C at the end of the Romanian. Fluctuations with minima and maxima have been recorded, which correspond to similar climate phenomena observed on a global or regional scale.

1. Introduction

The paleoclimate studies published in the last decades showed the existence, on a global or regional scale, of temperature fluctuations during the Tertiary. Among them mention should be made of the papers elaborated by: Wolfe and Hopkins (1967), Mai (1967), Blanc et al. (1974), Knobloch (1975), Wolfe (1971, 1981), Demarcq (1987), Gregor and Velitzelos (1987) a.s.o.

Several hypotheses have been suggested as concerns the major climate changes, as follows: continental drift (Köppen, Wegener, 1924), change of the dip of the Earth's rotation axis (Milankovici, 1938), variations of the solar radiation intensity (Cailleux, 1950) and others briefly studied by Furon (1958, 1972) and Wolfe (1981).

Up till now for the Neogene of Romania general qualitative climate characterizations have been made by Givulescu (1978, 1980) and quantitative data referring to the mean annual temperature (MAT) at different stratigraphic levels have been presented by Em. Pop (1936), Gh. Pop (1957), Petrescu (1969), Ţicleanu et al. (1975), Petrescu and Nicorici (1984), Petrescu et al. (1987, 1988, 1989) a.s.o.

The lack of a general view on the MAT evolution for the Neogene of Romania determined us to make an attempt to reconstitute it.

2. Terminology and methodology

For the paleoclimate reconstitutions for temperature several parameters are used, as follows: effective real temperature, mean annual temperature, mean annual range of temperature, as well as other parameters analysed by Axelrod and Bailey (1969, p. 169). According to Wolfe (1971, 1981) one of the most useful parameters in paleoclimatology is MAT, a point of view adopted by us, too.

The MAT research methods used in the past were based on the fossil plants and they can be grouped into two categories. The former category includes paleoecological methods using the principle of actuality based on the extrapolation of the ecological requirements of the present correspondents, either of fossil taxa (paleoautecological) or of fossil vegetal associations (paleosynecology). The main deficiencies of these methods are connected with the possible incorrect determination of the taxa, uncertainties when establishing the actual correspondents, the change in geological time of the requirements versus temperature by adaptation to the environment, changes of the phytocenotic behaviour, etc.

The latter category of methods takes into account the relation between the foliar physiognomy and the plants growth conditions (physiognomic methods). Thus, Bailey and Sinnott (1915) pointed out the link between the type of the leaves margins (entire or non-entire) and climate, a relationship used later on by many researchers, e.g. Wolfe and Hopkins (1967), Wolfe (1971, 1981), Dolph (1978), and Givulescu (1978, 1980, 1983, 1986 a, 1988). To the same effect Raunkiaer (1934) took into consideration the leaves size and the venation system, criteria used by many researchers who also established their limits, among which mention should be made of Dilcher (1973) and Givulescu (1983, 1986 a).

The drawbacks of the physiognomic methods are first due to the fact that a paleoflora represents an extract of the original flora (Roth, Dilcher, 1978), allows climate reconstitutions with an acceptable confidence degree. In order to avoid these drawbacks it is necessary to effectuate a careful taphononic study of the fossil vegetal remains (FVR) constituting the study paleoflora so that to specify their autochthony, hypautochthony and allochthony, namely their origin in one or several stages of vegetation with different climate conditions.

We agree with Wolfe's point of view (1981) concerning the role of the MAT and we present here a first attempt of an mean annual temperature curve starting from the similarities between the Neogene vegetation, particularly the Miocene one in Romania, and the actual vegetation in some areas in E and SE Asia. We consider that these similarities permit the use of the function resulting from the diagram of the relation between MAT and EML (entire margin leaves) for some present plant associations in E Asia obtained by Wolfe (1981, Fig. 4) on the basis of the data published by several researchers. On this diagram we plotted the EML percentage calculated by Givulescu (1978, 1980, 1983, 1988 and in press) for the main Neogene paleoflora of Romania (Fig. 1).

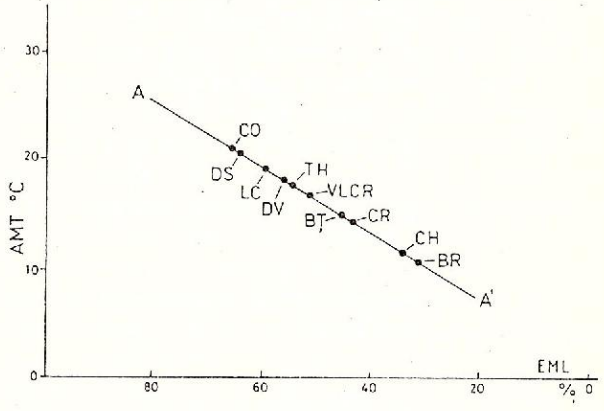

Fig. 1 - Plotting of the percentage values for species with entire margin leaves (EML) in the main Neogene floras of Romania. A-A function obtained by Wolfe (1981, Fig. 4) for present forests in Eastern Asia. Paleofloras: CO=Coruş; DS=Daia-Săcădat; LC=Luncşoara; DV=Deva; TH=Tihău; VLCR=Valea de Criş; BT=Băiţa; CR=Cornitel; CH=Chiuzbaia; BR=Borsec.

The MAT values obtained were then analysed for each paleoflora and corroborated with the data supplied by paleoecological methods. This analysis included several aspects.

First of all the arctotertiary elements were considered with care taking into account Furon's opinion (1958, 1972) according to which many of these elements show wide range of tolerance for temperature, the occurrence area of many of them ranging between 15^{0}C and 30^{0}C in latitude, e.g. *Cornus sanguinea, Fagus sylvatica, Carpinus betulus*, a.s.o. This also results from the study of the areals illustrated by Brockman (1968) for some actual species in North America, many arctotertiary species being spread from the Great Lakes area up to the Florida Peninsula. Among them it is to note: *Salix nigra, S. lasiandra, S. interior* (from Alaska to Mexico), *Populus deltoides, Ostrya virginiana, Carpinus caroliniana, Betula nigra, Carya tomentosa, C. glabra, Fagus grandifolia, Ulmus americana, U. rubra, Acer rubrum* (from the Labrador Peninsula up to near the south of Florida), *Fraxinus americana, Rhus copallina, Cornus floridana, C. alternifolia*, etc. Many of these species are regarded as actual correspondents of the Neogene species of Romania.

It is worth mentioning that certain arctotertiary species occur only in areas with a warm climate, with temperatures (MAT) ranging between 16^{0}C and 18^{0}C, e.g. the Florida Peninsula: *Salix caroliniana, S. laevigata, Populus palmeri, Quercus champanii* and *O. lyrata* (oaks with lobate leaf), *Alnus oblongifolia, Ulmus crassifolia, Tilia caroliniana, T. floridana, Acer leucoderme, A. barbatum*, etc. The species *Salix, Populus, Alnus, Ulmus, Tilia, Acer* etc. are also found only in areas with MAT of 16-18^{0}C.

Therefore, the arctotertiary species can be regarded as markers of a temperate climate but also as elements with wide range of tolerance for temperature to be studied paleothermically; all this leads to errors when estimating the climate conditions. Nevertheless, one has to consider that the relationships between the arctotertiary and the paleotropical elements represent a major climate marker.

In contrast with the arctotertiary elements, among the paleotropical elements there are some strict tropical thermophiles. Thus, Schnell (1970) mentioned: *Schizeaceae* (especially genus *Lygodium*), *Musaceae, Sapindaceae, Sterculiaceae*, etc. The thermophile group also includes most of the Lauraceae, particularly species belonging to the genus *Cinnamomum* with a wide spreading at MAT ranging between 15 and 20^{0}C, as well as azonal elements such as *Glyptostrobus europeus* (see Givulescu, 1983, p. 26), *Taxodium distichum, Myrica lignitum* and *Byttneriophyllum tiliaefolium*.

The present correspondent of the species *G. europaeus*, *G. pensilis* in SE Asia is formed in zones with MAT ranging between 19.3^{0}C and 24.4^{0}C (acc. to Wang, 1961). For this taxon Andreansky (1955) also mentioned zones with MAT=17.7^{0}C.

It seems that in the Neogene *G. europaeus* could vegetate at an MAT below 15^{0}C but not below 13^{0}C. Colani (1920) showed that when cultivated as an ornamental plant in France, especially in Paris where MAT=11.6^{0}C, *G. pensilis* "remains all the time stunted in its growth" which indicates a state of lower ecological pesimum.

As to the fossil species *B. tiliaefolium*, the morphological features of its leaves are, as follows: acuminate, entire margin, cordate base and palm-shaped nervation starting from a swell of the petiole situated at the base of the leaf, and they correspond to those considered by Wolfe (1981, p. 135) typical of plants growing in a tropical-humid climate. As a matter of fact Engler included the Sterculiaceae, a family comprising *B. tiliaefolium*, among the tropical and subtropical plants. The thermophile characteristics of the species have been presented in another paper (Ţicleanu, 1989).

A significant role in the correct estimation of temperature is also played by the frequency of occurrence of a thermophile taxon in the paleofloral associations within a certain stratigraphic interval; it also makes possible the separation of relict species, of no importance from the climate point of view. Also, the wide development and in several fossiliferous sites of typical thermophile taxa indicates a warm climate.

Considering all this the paleoautecological interpretaions for temperature have to be based on the thermophile taxa, especially when they belong to several taxonomic groups of a paleoflora.

The paleosynecological studies permit the establishing of quite large ranges for MAT and AMA of temperature. In this respect the spreading of the mesophile forests in the northern hemisphere presented by Wolfe (1981, Fig. 4) is significant.

Results (Description of the MAT curve)

Each paleoflora that might supply, by its richness, paleoclimate data has been studied according to the above-mentioned criteria. Thus, the data supplied by the correlation of the EML and MAT (Fig. 1) have been maintained or correlated on the basis of the paleoecological and taphonomic researches. We have also considered and analysed critically all the quantitative data mentioned in the literature referring to the MAT of different stratigraphic intervals.

In the paleoclimatic analysis all the paleofloras taken into account were situated at minimum latitude differences, a fact favoured by the location of most of them in the Coruş-Borod zone. We have also considered the reference to the same altitude level – the lower plains. In order to meet these requirements altitude corrections have been made based on the actual normal thermal gradient -6.4^{0}C/1000 m cf. Strahler (1973).

For the Coruş flora (Givulescu, 1970; Ţicleanu, Givulescu, 1978) the presence of the thermophile taxa – e.g. *Lygodium haulfusii, L. gaudinii, Daphnogene* div. sp., *Castanopsis furcinervis, Paleocarya orsbergensis* – and the palm-trees indicate an MAT=19^{0}C.

Givulescu (1970) considered that the majority of the Coruş taxa came from a subtropical forest of lauraceae. At present, in the northern hemisphere the laurel-type forests occupy, according to Brockmann and Jerosch (mentioned by Strahler, 1973), two distinct areas: in China between the tropic of Cancer and the parallel 35^{0} lat N, and in the Florida Peninsula, the adjacent continental zone inclusive. The southern part of each of the two mentioned areas is crossed by the annual isotherm of 20^{0}C. In the SE China the lauraceae forest area is bordered by the tropical forest.

Although still under discussion as regards its stratigraphic position and consisting of a reduced number of elements, the Tihău paleoflora, situated by Petrescu (1969) in the lower part of the Burdigalian, indicates a cooling of the climate that can be correlated with that considered by Blanc et al. (1974) for France and by Wolfe (1981) for North America.

The climate maximum during the Langhian is less proved by the fossil floras described in Romania till now (Roman & Ţicleanu, 1986) but it is justified by the rich paleofloras in the Pannonian area (Hungary and Yugoslavia). Thus, according to Hably (1985) the Karpatian and the Lower Badenian comprise a lot of thermophile taxa: *Lygodium, Zyzyphus paradisiacus*, five species of *Daphnogene* and palm-trees, all of them pointing to a subtropical climate with an MAT probably about 19^{0}C. This temperature has been also confirmed by palynological studies. Nagy (1967) indicated at the Karpatian level a maximum development of the tropical elements (more than 12 per cent). A similar situation is indicated by the "Tortonian" (Badenian) paleoflora in Serbia where, according to Pantić (1956), the lauraceae are abundant and the arctotertiary elements are poorly represented.

A further argument in favour of the above-mentioned facts is represented by the location of the maximum development of the corals in the Pannonian area, according to Kordos et al. (1987), at 15–15.5 MY. In Romania, faunas synchronous to this development of the corals, e.g. the faunas at Delineşti and Lăpugiu, are considered by Gh. Popescu (oral communication) of about 16 MY.

The Kossovian in Oltenia (Stancu & Ţicleanu, 1975; Ţicleanu, 1984) included many thermophiles, among which *Daphnogene, Libocedrites, Palaeocarya, Myrica lignitum* and *Gleditschia*. At the Kossovian-Volhynian boundary Petrescu et al. (1988) estimated an MAT ranging between 14 and 16^{0}C, therefore a cooling which will reach its maximum at the level of Deva flora where the percentage of EML=46.42% (Givulescu, in press) corresponds to MAT=15^{0}C. This cooling correlates with that established by Wolfe and Hoppkins (1967) in North America and mentioned by numerous researchers mentioned by Blanc et al. (1974) for Europe, as well. The faunas studied by Demarcq (1987) indicate also a significant cooling at this level corresponding to the Serravalian.

Starting with the Luncşoara paleoflora an increase of MAT has been recorded, culminating with the Daia-Săcădat paleoflora, as shown by the increase of the EML percentage from 60.71 to 65.75 % (Givulescu, in press).

Although the Daia Săcădat paleoflora comprises many typical thermophiles, e.g. the lauraceae, *Sapindus, Zyzyphus*, and the last occurrence of palm-trees, we cannot agree with MAT=20^{0}C shown on the diagram. Probably the real MAT was about 19^{0}C even 1^{0}C below it, a superrepresentation of the thermophiles determined by local orographic conditions being possible.

As compared to the end of the Sarmatian (sensu Suess), in the Pannonian of the Crişului Valley there is a decrease of the MAT which, according to the diagram, can reach 16.5^{0}C or even one degree above it if the relatively large number of the lauraceae genera is considered. The lack of the palm-trees is of note.

MAT decreases much more at the level of the Cornitel flora; however, it cannot reach 14.5^{0}C as shown on the diagram. As in case of the Crişului Valley flora, one has to consider there that the accumulation of the paleoflora took place near the basin margin where the leaves supply from an upper vegetation level situated 200–300 m above the lake level is quite probable. Thus, MAT at the marker level was at least 1.5–2^{0}C higher, probably 16–16.5^{0}C.

Pannonian E was marked by a new temperature raise, as shown by the Delureni paleoflora where EML=54.34 % (Givulescu, 1985) corresponding to MAT=17^{0}C. Among the *Daphnogene* species preserved only the species *D. bilinica* is to be mentioned, which seems to have a wide range of tolerance for temperature than other species; other Lauraceae occur as well, but Sapindaceae and palm-trees are lacking.

The fossil floras have not been studied yet at the Odessian level, so that the slight decrease of MAT on the thermal curve is presumed only based on field evidence.

A new increase of MAT indicated by the Chiuzbaia paleoflora took place during the Portaferrian. That paleoflora is the most complete Pontian flora known in Europe up to now, studied in detail by Givulescu for a long time (more than two decades). In a synthesis paper on Chiuzbaia area, Givulescu (1988) calculated EML=30–32.15 % which corresponds to an MAT =12^{0}C. This value could be 2–3^{0}C higher taking into accound the nine *Lauraceae* species, among which *Daphnogene bilinica* and *D. polymorpha*. It is supposed that the thermophiles, *G. europaeus, Libocedrites salicornioides* and *Paleocarya orsbergensis* inclusive, the last ones at their last occurrences, belong to a lower altitude level than the forest with *Fagus-Quercus-Acer-Carpinus-Carya*.

Taking into account, on the one hand, the normal thermic gradient 6.4^{0}C/1000 m, a gradient valid at present between Baia Mare and Igniş Summit, below which the Chiuzbaia paleoflora is situated, and, on the other hand, the altitude of the fossil forest estimated by Givulescu (1980) at 700–800 m, it results that nearby the level of the Pannonian lake, the MAT reaches 16.5^{0}C in the Portaferrian.

A quite similar situation is observed in case of the Borsec paleoflora considered by Petrescu et al. (1988) of Pontian age. There the EML percentage corresponds to a MAT=11^{0}C but considering that the paleoflora comes from 2–3 vegetation stages (Pop, 1936) the real situation is much changed. The RVF mixture coming from the paleophitocenoses situated at different altitudes was favoured by the reduced sizes of the basin and by the great relief power. In that case we consider that MAT=16.5^{0}C estimated by Pop (1936) is close to the real one.

According to Ţicleanu et al. (1975) during the Portaferrian at Visag (Lugoj basin) MAT=13–15^{0}C but although the vegetation altitude level was mentioned, this was less taken into account than the arctotertiary elements coming from the upper stage compared to the coal-generating swamps. In this sense MAT was ca. 2^{0}C higher than our estimations (16–17^{0}C).

On the basis of the paleozoological researches, Demarcq (1987) found out a heating moment about 5.4 MY ago in the Mediterranean Sea which corresponds to the Getian-Pontian boundary where the Cărbuneşti flora occurs. On this paleoflora cf *Oreodaphne* sp. has been determined (Ţicleanu in Pauliuc et al., 1970) revised by Givulescu as Sassafrás, this representing the last lauraceas known in the Neogene of Romania. The Dedoviţa paleoflora (Ţicleanu et al., 1982), of Getian age, was erroneously intercepted based on the MAT estimated to have values of 17–19^{0}C because of the unilateral utilization of the paleoautecological criteria. The diagram in Figure 2 shows MAT=15–16^{0}C, namely 2–3^{0}C higher than that considered by Petrescu et al. (1989 a). Therefore, we consider that, for the time being, the problem of MAT at the Getian level is not clear enough. As already mentioned in this paper the increase of temperature in the Mediterranean area influenced, in our opinion, the Carpathian area, too.

The exuberant development of the forests with the

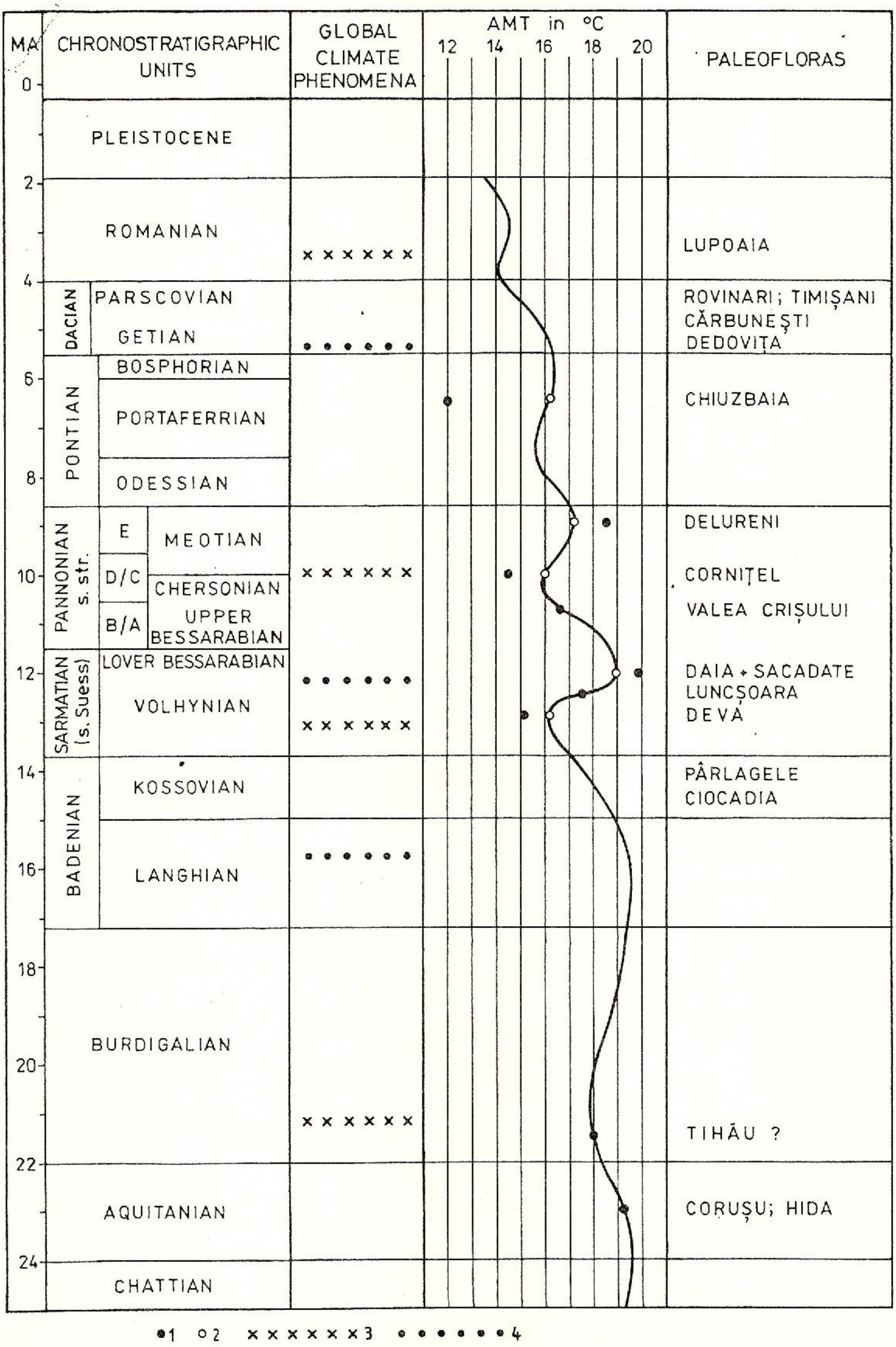

Fig. 2 – MAT curve for the Neogene of Romania: 1, values resulting from the diagram; 2, corrected values; Global or regional climate phenomena: 3, minima; 4, maxima.

thermophiles *Glyptostrobus* and/or *Byttneriophyllum* during the Parscovian made us suppose special climate conditions due not only to MAT but also to abundant precipitations, probably more than 1500 mm/year.

A slight decrease of temperature took place in the base of the Romanian; however, a sensitive temperature increase occurred, as mentioned by Petrescu et al. (1989 b) who estimated it to reach 13–14°C.

Referring to the MAT of the Middle Romanian it is to note the peculiar species of the genus *Trapa*, considered thermophile by Ager (1963), at the level of the X coal bed in the Urdari zone (Oltenia), where the following species are to be found: *Trapa urceolata, T. expectata, T. givulescui, T. victoriae* and *T. moravica*. This abundance of species could be determined only by optimum climate conditions. The thermophile character of the present species *T. natans* in the Danube Delta results from Topa's observation (Flora in Romania, v. 530 p.) that temperature during the blooming period of this species has to be above 20°C.

Referring to the Villafranchian paleoflora at Ceyssac (France) Grangeon (1957) mentioned a temperature 2–3°C higher than the present one. Using the same degree of magnitude it results that compared to the present MAT values in the southern part of Oltenia (11°C) the same parameter reached values of 13–14°C toward the end of the Romanian when the paleophitocenoses with *Glyptostrobus* and *Byttneriophyllum* became dextinct.

4. Conclusions

The MAT curve presented by us for the Neogene in Romania contains some aspects still unelucidated related both to the insufficient knowledge of some paleofloras or of the reduced content of certain stratigraphic intervals, and to the difficulties, sometimes quite great, resulting from the difficulty to locate correctly in time some paleofloras as well as the different opinions concerning the temporal content of some Neogene chronostratigraphic units (e.g. Andreescu, 1987; Pevzner, 1987, a.s.o.).

The MAT evolution in the Neogene of Romania shows a general decrease trend from 19°C in the Aquitanian to 13.5°C at the Pleistocene boundary. Against this background of gradual decrease of MAT there were several fluctuations with minima and maxima which generally correspond to similar climate phenomena recorded on a global or regional scale.

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UTILIZATION OF THE PALEOBOTANICAL DATA IN THE STUDY OF THE COAL DEPOSITS

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Key words: Coal deposits. Coal genesis. Paleobotanical data. Neogene. Romania.

Abstract: The mode in which the main premises necessary for the coal genesis are achieved on the Romanian territory during the Neogene is analysed based on the paleobotanical data. The phytological premises were ensured through the existence of over 90 coal-generating taxa constituting a series of vegetal communities dominated by elements typical of the Miocene to Middle Sarmatian level, later on replaced by the Pliocene ones. The identification of the taxa and especially of the coal-generating communities is of great importance in the geological researches for coal. As regards the climatic premises, the existence of some temperature and humidity minima and maxima is underlined, naturally corresponding to the main coal-generating stages from the Neogene. The paleogeographic premises are evaluated starting from the establishment of the vegetal communities and then, through the paleosynecological analysis, the main characteristics of the depositional environment can be reconstructed.

1. Introduction

It is known that the formation of the coal deposits depends on the existence of several premises, the most important being the phytologic, climatic, tectonic and paleogeographic ones. The temporal and spatial superposition of these premises was possible only in certain stratigraphic intervals (coal-generating stages) and only in some areas (Carboniferous basins).

As regards the use of the term "carboniferous basin", it should be mentioned that, according to Vetter (1981), it corresponds to the general meaning which is currently being used for designating all the formations containing coals.

It is difficult to establish a hierarchy of the importance of these premises, the lack of them making impossible the coal genesis, while a partial achievement of one premise is reflected in the quantity and quality of the resulted coals.

A special role in the appreciation of the premises necessary for the genesis of the coal accumulations, especially of the phytologic, climatic and paleogeographic ones, is played also by the paleobotanical researches, and implicitly by the palynological ones.

2. Coal-generating and paleophythocoenotic elements (phytologic premises)

The vegetal origin of coals has been known since the 16th century but the establishment of the coal generating plant species and especially of the different vegetal communities has been possible only in the last decades.

The great and almost constant frequency of the fossil vegetal remains (FVR) belonging to certain taxa in the coal deposits indicates their participation in the genesis of the coal-generating phytomass. Thus, taking into consideration the constant presence of the FVR belonging to *Glyptostrobus europaeus* in the Neogene coal deposits from Europe, Schimper (1872) attributed an important role to this taxon in the coal genesis, which was later confirmed by numerous researchers such as Teichmüller (1958), Knobloch (1973), Givulescu (1960) etc.. The investigations carried out by me in Oltenia (Ţicleanu et al., 1985; Ţicleanu, 1986 b) confirmed the special participation of this taxon in the coal genesis.

The progress achieved in paleobotanics and coal petrography rendered evident the fact that various taxa appear associated with the coal deposits, a lot of these associations representing fossil vegetal communities

Table 1
Stratigraphic Distribution of the Main Edificator
Plants of the Vegetation from the Neogene Coal-Generating Swamps

Taxa	Chronostratigraphic Units										
	Aq	Bg	Ln	Ks	Vh	Bs 1	Bs 2	Ch	Me	Pt	Dc + Ro
A. Phylum Pteridophyta											
Osmunda lignitum	+	+									
Osmunda regalis	–	–	–	–	–	–	–	–	–	–	+
B. Phylum Pinophyta											
Taxodium dubium	+								+	+	
Glyptostrobus europaeus	+	+	+	+	+	+	+	+	+	+	+
Glyptostroboxylon tenerrum	+	+	+	+	+	+	+	+	+	+	+
Sequoia abietina	+	+			+				+		+
C. Phylum Magnoliophyta											
a. Class Dicotyledonatae											
Liquidambar europaeum	+				+		+			+	+
Alnus kefersteini							+			+	
Alnus cecropiaefolium							+			+	
Betula macrophylla				+			+			+	
Salix div. sp.	+				+					+	+
Byttneriophyllum tiliaefolium							+	+	+	+	+
Myrica lignitum	+	+	+	+	+	+	+	+	–	–	–
b. Class Monocotyledonatae											
Phragmites oeningensis	+	+	+	+	+	+	+	+	+	+	+
Typha latissima	+			+	+					+	+

that furnished the parental material of coals. It is the merit of the German school of paleobotanics and coal petrography to have pointed out for the first time such coal-generating vegetal communities (see Teichmüller, 1958).

In Romania the first observations on the constant presence of some taxa or taxa associations in the Neogene coal deposits were made by Givulescu (1960) in connection with "the *Glyptostrobus* and *Taxodium* forest swamp phytocoenoses in which *Byttneriophyllum tiliaefolium* also occurs". Later on the same author (Givulescu, 1964, 1968) attributes an important role in the genesis of the coals from the Sărmăşag and Comăneşti deposits to the *Byttneriophyllum-Glyptostrobus* association as well as to other taxa.

Without going into details on the history of the researches devoted to the establishment of the main edificator plants of the Neogene coal-generating vegetation in Romania, it is worth mentioning that authors such as Givulescu, Petrescu and Ţicleanu considered in various papers that a lot of other taxa, beside the above-mentioned ones, contributed to the coal genesis.

Based on the analysis of the ecological necessities of the present correspondents of the fossil plants and taking into account also their association with the coal deposits, it was concluded that of the more than 590 taxa known so far (Givulescu and Ţicleanu, 1983) in the Neogene flora of Romania, only about 90 species participated in the genesis of the coal-generating phytomass, the most important of them being presented in Table 1.

A succint review of the coal-generating elements belonging to the great taxonomic units shows the prevalence of those from the angiosperms with a large number of species, genera and even families adapted to the life in the telmatic realm, and therefore with a contribution to the coal-genesis.

Although having an important role in the coal-genesis, the Neogene gymnosperms of Romania participated in the constitution of the vegetation of the coal generating swamps, especially by the representatives of three genera belonging to the family Taxodiaceae: *Taxodium*, *Glyptostrobus* and *Sequoia*. In the coal deposits from some small intermontane carboniferous basins (e.g. Bozovici, Borod) the FVR of the family Pinaceae (genus *Pinus*) also occur but the latter does not seem to have played an important role.

The important role played by *Taxodium* and *Glyptostrobus* has been obviously favoured by the presence of the deciduous leaves that furnished annually a great phytomass amount.

The relatively reduced number of FVR belonging to ferns in the coal deposits may mean a reduced importance of the latter for the coal genesis; but taking into account the fact that ferns were exclusively annual herbaceous plants growing directly on peat, the latter drastically diminished their possibility of reaching the sediments. The possibility that under optimal climatic conditions ferns should produce a considerable phytomass amount is great, their contribution to the coal genesis being thus greater than shown by their fossils.

Beside their importance for the constitution of the coal-generating phytomass and directly connected to this, the taxa participating in the coal-genesis are also precious indicators of coaly facies, a reason why their identification in the deposits of a region in outcrops or boreholes should be one of the main concerns of the paleobotanical researches. The analysis made by Givulescu (1984) for the Pontian deposits at Odeşti represents such an example. It has also been noticed (Ţicleanu, 1986) that in the Pliocene coal deposits of Oltenia, there is a relationship between the number of *Glyptostrobus* AFVR and the total thickness of the coals from a borehole, which, though not of proportionality, as stated there, indicates, however, such a tendency.

For lack of the macroscopic FVR the identification of the possible coal-bearing deposits can be also achieved by palynological researches. Such an example is provided by the researches carried out by Petrescu and Nicorici (1977) in the Sarmatian deposits from the Borod Basin, where the palynomorphs show an almost perfect superposition of the acmes for: phytoplankton, ferns and taxodiaceans with coal layers.

The analysis of the stratigraphic distribution of the coal-generating taxa (Ţicleanu, 1986) shows that a gradual diminution of the prevalence of the Miocene ones (*Taxodium, Nyssa, Myrica* etc.) in favour of those prevailing in the Pliocene (*Glyptostrobus, Byttneriophyllum* and *Salix*) took place, a tendency which results also from Table 1. The floral modifications are evident beginning with the Middle Sarmatian and were naturally reflected in the composition of the vegetation, that is in the composition of the coal-generating plants, a fact that has already been mentioned (Ţicleanu, 1986 a, p. 244). These communities have been reconstructed up to the level of paleophytocoenoses (Ţicleanu, 1986 b, 1992 a, b).

In conclusion, the achievement of the phytological (floral and phytocoenotic) premises in all the Neogene coal-generating stages was possible due to the existence of a rich flora consisting of mostly arboreal hygro- and hydrophyte plants belonging to several angiosperm species and to a few gymnosperm ones which constituted a great number of vegetal communities specific for the telmatic environment.

3. Climatic premises (temperature and humidity)

The abundant development of the coal-generating floras depended first on a climate in which the essential element was represented by the precipitation quantity, probably of over 1.500 mm/year and in a lower degree on temperature. The latter remark was made by Jemciujnikov (1955), who considered that the genesis of the Permian coals took place in a temperate but necessarily humid climate.

On the whole the hygrophyte plants are good indicators of the precipitation quantity but they can also grow under lower atmospheric humidity conditions than those characteristic of the coal-generating swamps when the level of phreatic water is constantly maintained close to the surface, as in the case of the gallery type forests. However, the paleophytocoenoses of the forest swamps consisting especially of hygrophyte arborescent species such as those formed by *Glyptpstrobus, Byttneriophyllum, Salix* etc. constitute good biological indicators of the precipitation quantity and atmospheric humidity, especially when their development over larger areas can be proved. During the Neogene there existed variations of the precipitation quantity, the maxima naturally overlapping the coal-generating stages.

As regards temperature, along with humidity, it influences directly and decisively the development and distribution of the vegetation. Such an example is represented by the correlation between the two climatic elements in determining the phytomass quantity in the present forests from the humid regions. Thus, according to Walter (1973), as the thermic conditions in these forests improve, the phytomass increases from 189 t/ha in the boreal zones to 342–366 t/ha in the temperate zone and to 440 t/ha at the tropics.

Beside the role played by temperature in the development of the vegetation, one should also mention its implications in the biochemical processes from peatbogs through the control of the bacteriological activity (Teichmüller, in Stach et al., 1981), which accounts for the importance of this factor in the genetic study of the coal deposits.

Numerous methods (see Wolfe and Hopkins, 1967; Axelrod and Bailey, 1969; Furon, 1973 and others) are used for the reconstruction of the paleoclimatic conditions based on the study of the fossil plants. Without giving further details, it is worth mentioning that according to Ţicleanu (1995 a), during the Neogene, the mean annual temperature tended to decrease from 19^0C in the Aquitanian to 13.5^0C at the end of the Romanian. Thus a series of variations were recorded, some of them corresponding to the climatic variations that manifested on a regional and even global scale. The superposition of the acmes established for these variations on the main Neogene coal-generating stages was noticed.

4. Paleogeographic premises

One of the main conditions necessary for the genesis of the coal deposits was the existence of large areas of low euthrophic swamps subjected to a subsidence, the rate of which was equal to the accumulation rate of the vegetal material originating from the vegetal communities that used to cover these swamps. Such conditions were achieved either in the paralic or in the intracontinental domain (see Wilson, 1976) in accumulation plains of various origin: fluviatile, lacustrine, deltaic or combined. Some stages in the evolution of these accumulation plains were favourable to the setting of the telmatic environment and a vegetation characterized by the presence of the coal-generating vegetal communities (paleophytocoenoses).

The distribution of the various paleophytocoenoses within the coal-generating swamps was controlled first of all by the hydrological regime, as is also the case in the present euthropic swamps; secondly a complex of control factors acted, such as: substratum quality (edaphic factors), Eh (aerobic, anaerobic conditions etc), ph etc. This variety of control factors determined the specific composition of the paleophytocoenoses, the establishment of these factors enabling the correct reconstruction of the physico-chemical characteristics of the depositional environment (see Ţicleanu, 1995 b).

According to the zonation pattern of the coal-generating swamps presented by Teichmüller (1958), to which some specifications have been added depending on the hydrological regime, the coal-generating swamps presented several more or less concentric zones. From the exterior towards the interior these zones are: the marginal zone, which does not undergo floodings but has a phreatic level close to the substratum; the seasonally flooded zone, covered by water a few months per year; the almost permanently flooded zone, characterized by the short time (2–3 months per year) water withdrawal; the permanently flooded zone, with depths below 2 m, and the zone with free water.

Each of the mentioned zones is characterized by the presence of some taxa and taxa associations adapted to the respective conditions. The investigations showed that during the Neogene most of the paleophytocoenoses characteristic of the various zones underwent modifications or were replaced by other phytocoenoses.

In the Aquitanian-Lower Sarmatian the marginal zones were occupied by forests with *Sequoia*, associated or not with *Pinus*, palm-trees and other taxa. Subsequently the role of the *Sequoia* forests decreased, the main edificator plant being replaced by other species.

The seasonally flooded zones were dominated by swamps with Myricaceae and Cyrilaceae in the Aquitanian-Lower Sarmatian. Since the Bessarabian swamp forests with deciduous hygrophyte broad-leaved trees appeared in this zone formed by *Byttneriophyllum* and various species of *Alnus, Betula* and *Salix*. The paleophytocoenosis with *Byttneriophyllum* and *Glyptostrobus* was also frequent in that period, being largely developed especially since the Pontian. During the Pliocene a great participation of the paleophytocoenoses formed from different *Salix* species was noticed.

The almost permanently flooded zones were initially dominated by *Taxodium dubium*, and since the Badenian by *Glyptostrobus*, which reached its maximal development in the Pontian-Romanian interval.

The permanently flooded zones with depths below 2 m had more conservative communities, in which *Phragmites* and *Typha* prevailed, there existing also large areas covered by paleophytocoenoses formed by aquatic plants such as *Stratiotes, Potamogeton, Ceratophyllum, Nelumbium* etc..

It follows from the above statements that the various paleophytocoenoses provided various amounts of parental material for coals in time. The dominance of a paleophytocoenosis depended to a great extent on the depositional environment which influenced the morphology of the coal-generating swamp and determined the extension of each of the described zones.

As regards the chemical composition of the parental material of coals, it varied from one paleophytocoenosis to another due to the chemism differences among the edificator taxa.

The zones differing from one another by their hydrological regime presented also important differences concerning the environmental conditions in which peat accumulated. The combination of a diverse parental material with various accumulation conditions determined the existence of a variety of coal facies named by Teichmüller, Thomson (1958) in accordance with the vegetal community which generated them. Thus the notion of coal facies has a pronounced genetic character.

Based on the paleobotanical and petrographic data concerning coals, the humito-genetic maps (Ţicleanu and Biţoianu, 1988) could be drawn out. Such an example is the map achieved for coal layer II from the Borod Basin, which shows that the coal in the eastern part of the basin formed in a peat-bog from a lacustrine accumulation plain. On the other hand, in the western part, where the basin gets larger, only the marginal zones were covered by coal-generating swamps, the central zone being covered by aquatic vegetation or being open water.

In order to show the possibilities offered by the study of the fossil plants in the reconstruction of the paleogeographic conditions in which the coal from Oltenia formed, the results of the taphonomic and paleoecological investigations carried out on the cores of 18 boreholes (Figure) have been used. Thus the autochthonous AFVR coming from coal-generating communities dominated by one of the main taxa: *Glyptostrobus, Byttneriophyllum, Salix* div. sp., and *Phragmites*, have been analysed.

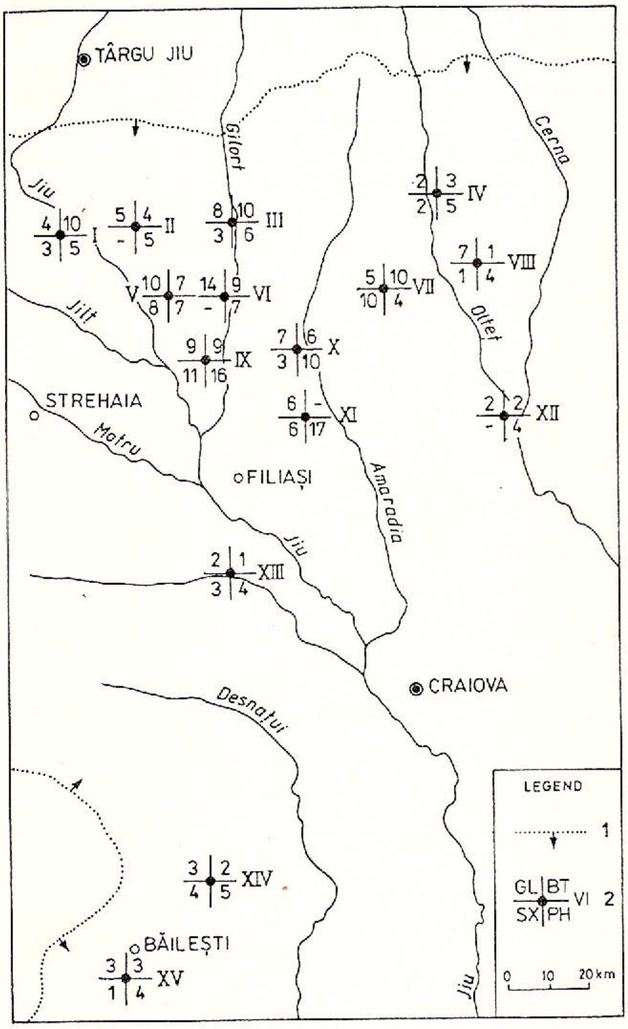

Fig. - Map showing the distribution of the boreholes for which there are determinations of the frequency of the autochthonous AFVR belonging to the main coal-generating taxa: 1, occurrence boundary of the coal beds; 2, boreholes and number of autochthonous AFVR for taxa: GL-*Glyptostrobus europaeus*; BT-*Byttneriophyllum tiliaefolium*; SX-*Salix* div. sp.; PH-*Phragmites oeningensis*. Boreholes: I – Valea cu Apă; II – Ţicleni; III – Petreşti; IV – Grădiştea; V – Daia; VI – Aninoasa; VII – Hălăngeşti; VIII – Tetoiu; IX – Brăneşti; X – Stoina; XI – Mucreni; XII – Berbeşti; XIII – Corniţa; XIV – Cioroiaşu; XV – Băileşti.

The autochthonous character of the AFVR has been established based on the criteria briefly presented in another paper (Ţicleanu, 1992) and subsequently detailed (Ţicleanu, 1995 b). The hypautochthonous accumulations which represent 14–20% of the sum of both types of AFVR have also been taken into consideration.

The presence of the autochthonous AFVR over the whole area in which coal deposits develop demonstrated the autochthonous character of the latter, showing at the same time that in certain evolutionary stages of the carboniferous basin, large areas were covered by peat swamps. The analysis of the distribution of the four main edificator plants (Fig. 1) shows that approximately north-west of the alignment of the boreholes 31 Brăneşti and 60108-Hălăngeşti the seasonally flooded zones prevailed as the number of the AFVR indicating the paleophytocoenosis with *B. tiliaefolium*, characteristic of these zones, reaches the highest values (10) at the periphery of the basin. Farther towards the inner part of the basin the number of the AFVR coming from the forests with *Glyptostrobus*, set in the zones permanently covered by waters, increases to maximum (14), and, finally, the above-mentioned zonality is confirmed by *Phragmites oeningensis* which is represented by 17 AFVR in the permanently flooded zones, those over 2 m depth included, covered by the floating vegetal formation with reed, formed of *Phragmites* ryzomes and covering large lacustrine areas. This distribution pattern as well as the fact that irrespective of their thickness and structure, the coal layers, especially layers V-X, show a remarkable continuity, lead to the conclusion that in certain moments most of the basin changes into swamp; thus for instance, in my opinion, coal layer V covers the whole development area of the coal deposits in Oltenia.

As regards the position of the autochthonous AFVR, they appear either connected with the coal layers, in the wall, bed or in the terrigenous intercalations, or included in the coaly clays among the coal layers.

The analysis of the vertical distribution of the autochthonous AFVR shows the alternation of paleophytocoenoses dominated by coal-generating taxa corresponding to the coal layers with paleophytocoenoses formed especially of the species *Carya* and *Alnus*. Such dissimilarities were also mentioned by Nanii (1982) without connecting them with genetic or paleogeographic aspects, pointing out the "alternation" of the *Alnus* or *Carya* pollen with that of *Taxodiaceae*. In my opinion, it is obvious that the alternation of the two types of paleophytocoenoses has a paleogeographic and genetic significance, demonstrating the existence of some telmatic phases when the coal-generating paleophytocoenoses and those of some fluviatile phases developed, proved by the extension of the flood plain vegetation formed by the species *Alnus, Carya, Salix* etc..

In many cases the coal is overlain by a *Glyptostrobus* and/or *Byttneriophyllum* fossil foliage overlain in its turn by clays without FVR or containing *Nelumbio* leaves as well as aquatic plant fruits, which points to the "drowning" of the swamp and its temporary transformation into a lake (lacustrine phase). Autochthonous AFVR with *Glyptostrobus, Byttneriophyllum, Salix* div. sp. occur only afterwards in some clay interbeds. Their presence in the central zone of the basin can only be interpreted as a consequence of the intensification of colmation and withdrawal of the lake, the respective AFVR originating from the natural levees.

Therefore an alternation of phases can be noticed as follows: telmatic, lacustrine, fluvial, fluvio-lacustrine. In the last mentioned phase small flooding plains may form through the disruption of the natural levees during great floods, the formation of crevasses allowing the covering with water of large areas. If these plains happened to exist up to the accumulation of a peat layer, a lens-shaped coal layer with limited development formed. In places a lacustrine phase can be noticed in the base of the coal layers, as in the case of layer VIII from the Rovinari quarry.

Such an alternation of phases shows similarities to the four phases, telmatic, limnic, fluvial and fluviolimnic, pointed out in the Neogene coal deposits from Germany by Nebert (1983) based on heavy mineral analyses.

If in the northern sector of the basin (on the inner flank of the Carpathian Foredeep and to a less extent on the outer flank) there is an accumulation plain at the foot of the mountains, alternatively covered by rivers, shallow lakes and swamps, in the southern sector, superposed on the Moesian Platform, there is a different situation. Here, except for the stage in which coal layer V accumulated, with a remarkable development, the coal accumulation took place in delta plains as estimated by Siskov, Angelov (1984) for the Lom Zone (Bulgaria). I think that the Lom Depression Zone was continued on the Romanian territory by a fluviatile organism with a delta consisting of delta plains covered by a typical coal-generating vegetation. This hypothesis is supported also by the insular development of layer V in the Băileşti, Negoi, Giubega, Sălcuţa etc. zones.

In order to establish as accurately as possible the physico-chemical characteristics of the depositional environment, the careful reconstruction of the plant communities through paleophytocoenotic methods is first necessary. It should be followed by the paleosynecological study on the basis of which the main environmental conditions in which the paleophytocoenosis developed are established: water depth, water level variation, hydrodynamic conditions, Eh, ph, T^0 C etc..

5. Paleophytocoenoses and stratigraphy of the coal deposits

It has already been shown that several modifications took place in Romania as regards both the flora and the coal-generating vegetation. These changes favour the use of some taxa such as *Lygodium, Taxodium* etc., but especially some paleophytocoenoses, in the dating of the coal layers even if the time span is quite long, that is Lower Miocene, Pliocene etc.. Such a possibility is the more so important as most of the coal deposits are devoid of other index fossils.

Locally certain AFVR may constitute markers allowing the correlation of some coal layers. This is the case of the *Byttneriophyllum* and *Salix* level from the wall of coal layer VIII between the Motru and the Jiu Valleys, encountered in the Lupoaia, Roşiuţa, South Jilţ, Pinoasa and North Peşteana quarries.

6. Conclusions

The complex paleobotanical study of all the FVR from the coal deposits makes possible the reconstruction of the morphological aspect of the coal-generating swamps and the evaluation of the areas covered by different paleophytocoenoses and therefore by coal facies. Once the paleophytocoenoses identified, and interpreting the results of the taphonomic research, the coal facies and the main characteristics of the depositional environment are established. Also the paleobotanical and palynological researches allow the establishment of the age of the continental deposits, the reconstruction of the relief of the areas bordering the basins, and of the paleoclimatic conditions. Over restricted areas the FVR can be used even for the correlation of the coal layers.

The results obtained substantially contribute to the establishment of the criteria of spatial distribution of the coal complexes and coal layers, the knowledge of which allows the improvement of the geological research for coal deposits.

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TAPHONOMIC RESEARCHES ON THE FOSSIL PLANTS FROM THE PLIOCENE COAL DEPOSITS IN OLTENIA

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Key words: Phytotaphonomy. Fossil plants. Pliocene. Coal deposits. Oltenia. Romania.

Abstract: The paper has a methodological character, presenting the types of taphonomic observations carried out by the author on the fossil vegetal remains (FVR) and their accumulations (AFVR) from 20 coal quarries and from over 12,500 m of cores from the boreholes that intercepted the Pliocene coal deposits. Based on these observations the 764 studied AFVR were divided into the following categories: autochthonous – 577, hypautochthonous – 140, allochthonous –24, and 24 of various origins. This classification points to the autochthonous character of the investigated coals. The taphonomic observations also make possible: the outlining of the vegetal communities up to the paleophytocoenosis level; the study of the temporal and spatial evolution of the vegetation (genetic and ecologic series) as well as the pointing out of some other characteristics of the depositional environment necessary for the coal genesis.

1. Introduction

Taphonomy, as a branch of paleontology, was introduced by Efremov (1940) with a view to establishing the embedding laws of the fossil vegetal and animal remains, and the formation mode of the fossil deposits. Weigelt (1919, 1927) had previously used the term biostratonomy for the study of the position of fossils within the sedimentary rocks. Later on Müller (1951) added another discipline to biostratonomy, namely the fossil diagenesis.

Enlarging the initial meaning given to taphonomy by Efremov, Lawrence (1971, p. 594–595) shows that it includes both the biostratonomy and the fossil diagenesis. Thus, according to the latter author, taphonomy constitutes the basis in any reconstruction of the life environment of fossil animals and plants, being indispensable to the paleoecological studies.

Considering the importance of the paleophytoecological researches in deciphering the formation conditions of the coal deposits in Oltenia, a detailed taphonomic analysis of the fossil vegetal remains (FVR) from the coal deposits was necessary. This analysis, carried out over a period of more than twelve years of researches, was possible due to the existence of the more than 20 coal quarries and the more than 12,500 linear metres of cores coming from the exploration boreholes drilled in the various zones of the investigated area.

The coal quarries, by their dimensions in the horizontal and vertical planes, the length of the working front ranging from a few hundred metres to 1.5–2 km, and reaching locally over 70 m in height, as is the case of the Lupoaia quarry, allowed the identification of numerous accumulations of fossil vegetal remains (AFVR). Also, by the advancement of the working fronts of the quarries, the development of the various AFVR could be followed in the horizontal plane at certain stratigraphic levels.

As one of the main tasks of paleoecology consists in establishing on the field the AFVR type, namely whether they represent allochthonous, autochthonous or hypautochthonous elements, it is necessary that the taphonomic observations first of all meet this requirement. In this sense, the quarries constitute a vast investigation domain, permitting the achievement of a methodology which, beside the classical elements, comprises several new criteria in approaching the taphonomic problems, thus allowing the delimitation of the fossil vegetal communities to the paleophytocoenosis level. By their indicatory function, the thus delimited paleophytocoenoses contributed to the reconstruction of the physico-chemical conditions of the depositional environment form the coal-generating swamps (Ţicleanu, 1992).

2. General notions regarding the AFVR

The fossil plants within the sedimentary deposits are represented especially by various fossilized, more or less determinable, in places fragmentary, organs (leaves, fruits, seeds etc.), thus constituting fossil vegetal remains. Most of the FVR were included in sediments as a result of some accumulation processes, being therefore accumulations of fossil vegetal remains (AFVR).

These AFVR may represent either fossil vegetal communities or accidental fossil associations, both terms being introduced by Craig (1953). According to Ager (1963, p. 183), the fossil communities have ecological (paleosynecological) implications, pointing to the importance of establishing the elements of the taphonomic investigation in view of a correct estimation of the relation between the living place of the plants and the accumulation and fossilization place of the FVR belonging to them as well as of the transport distance in the cases when two places do not coincide.

Attempts at establishing the transport distance of the FVR have been made for a long time. Thus in his study on the paleoflora at Borsec, Pop (1936) presented a scheme for the estimation of the transport distance and the participation degree of the various taxa in the vegetation constitution based on the frequency and association of the various vegetal organs of the fossil taxa. This scheme was also used by Givulescu (1957) in the study of the paleoflora at Cornițel and later on in numerous papers on Romanian paleobotany.

Recently special attention has been given to the control factors of the spreading and preservation of the leaves, fruits and pollen belonging to the present-day plants in the estimation of the transport distance of the FVR. Thus for instance Roth, Dichler (1978) studied the percent of leaves fallen off the trees on the shore of a lake from North America, finding that it decreases rapidly as the distance from the shore increases. The percent comes close to zero in the case of the leaves with a surface of over 20 cm^2 at a distance of 10 m from the shore. The smaller-sized leaves exposed to the sun are the most likely to reach great distances towards the centre of the lake.

Based on experimental data and field investigations Ferguson (1970) studies the influence of the various control factors of the leaves spreading through wind and water, the most important ones being: weight, size, shape and petiole of leaves; he also analysed various aspects connected with the characteristics of the depositional environment that influenced the transport, penetration, and preservation of the leaves within sediments.

Owing to the multitude of factors controlling the spreading and especially the preservation within sediments of the various parts of the plants, only few of them reach the fossil state, so that according to Roth, Dilcher (1978), the discovered paleofloras most often represent only an extract of the original vegetation.

In order to establish the AFVR type and obtain information on the vegetation composition and evolution and thus know the physico-chemical characteristics of the environment in which coal formed, several observations regarding both the FVR and AFVR they constitute are further presented.

3. Observations on the FVR

The taphonomic researches laid stress on the characteristics (shape, size etc.) and distribution within the AFVR of the FVR.

3.1. Origin, shape and size

The character of an AFVR can be established based on the organ type the FVR comes from, its shape and size. Thus the light winged fruits (e.g. of *Carpinus*, *Ulmus* etc.) may come from great distances (see Pop, 1936). This fact is more evident when these fruits occur only isolated, as is the case of those of *Carpinus*, from the coal layer II from the Poiana Seciuri quarry. The small-sized leaves can be also transported at great distances. It is worth noting that the association in large amounts of the fruits and leaves belonging to the same taxon pleads for the location of the respective tree in the immediate vicinity of the sedimentation place.

The entire and numerous large-sized leaves indicate the origin from the close vicinity. At the same time the large size of the leaves is a paleoecological indicator, pointing to a highly humid climate (Ferguson, 1978). The frequent *Byttneriophyllum* leaves occurrences from over 178 AFVR encountered in Oltenia constitute such an example.

The very large-sized leaves, such as the *Nelumbo* ones, entire and parallel to the bedding, such as those under coal layer X from the Pinoasa quarry, where they form a level over a large area, represent strictly autochthonous AFVR, and indicate the presence of the puddle with aquatic vegetation reaching up to 2–3 m in depth.

The presence of numerous leaves varying in size, belonging to a single taxon and occurring over a single bedding surface reflects the anisotropy phenomenon and pleads for a strict autochthonous character.

Another type of organ, the *Glyptostrobus* deciduous stems, have a reduced flotability, especially when they have also female cones, which makes difficult the transport over distances exceeding a few metres.

The branches of *Sequoia* – an evergreen tree – are not deciduous as in the case of other taxodiaceeans and therefore their occurrence within deposits is accidental, a reason why the interpretation of their frequency within a paleoflora should be carefully regarded. The presence of the branches of this taxon having sharp and relatively rigid leaves as well as their great weight make difficult the transport, and therefore the place where it has been found cannot be far from the one in which the tree used to live.

Although winged, the *Byttneriophyllum giganteum* fruits (see Ţicleanu, 1989) are heavy owing to their large size, therefore difficult to carry by air streams and probably having a low flotability. In most cases they occur along with the large-sized *Byttneriophyllum* leaves, in this case their transport being reduced and pointing to their autochthonous character. These characteristics determined a step by step dissemination, and only in swampy zones, which contributed to the disappearance of the species (see Ţicleanu, 1989).

3.2. Orientation

This element is important especially for the characterization of the FVR belonging to the species with lanceolate leaves such as the *Salix* ones. The presence of several FVR belonging to this taxon on stratified faces having various orientations in the surface points to the autochthonous character. Their orientation in a certain direction, possibly also accompanied by sorting, indicates the influence of some still water currents and the hypautochthonous character.

Such situations were found in the Romanian from the Pinoasa and South Peşteana quarries.

3.3. Distribution of the bedding faces

The manner in which the FVR cover the bedding surface is also important. The leaves of a taxon are close and most often superposed when they come from the immediate vicinity.

The leaves of a taxon, which are isolated and rare, may belong to some trees that are secondary in the paleophytocoenosis or dominant within a more distant association.

3.4. Frequency index

The frequency at which the FVR belonging to a taxon occur within an accumulation may offer valuable information on the character of this accumulation. In order to make a more correct interpretation, the frequency index (FI) has been used with the following scale:

1 – very rare (single specimens);

2 – rare (2–5 specimens);

3 – frequent (5–10 specimens);

4 – very frequent (over 10 specimens);

5 – fossil foliage (leaves of the order of tens).

Although subject to improvement, this scale shows the strict autochthonous character for FI = 5. The indices 3 and 4 may represent secondary taxa within the paleophytocoenosis but also elements subject to a short transport. The indexes 1 and 2 generally belong to the allochthonous elements.

Of the total number of 178 AFVR in which the *Byttneriophyllum tiliaefolium* taxon was found, 28 are fossil foliages, the most frequent being those from the roof of layer VII from the Lupoaia quarry as well as those above layer X from the South Peşteana quarry and from some other quarries. All these prove the existence of some pure paleophytocoenoses formed by this tree.

Another example of fossil foliage is represented by the *Glyptostrobus europaeus* accumulations from the roof of layer VI, East Rovinari quarry, but especially from the roof of the main layer from the Panga (Berbeşti) quarry, where the deciduous stems of this species are so frequent, reaching a thickness of 0.3–0.5 m, that they give a specific felt-like aspect to the rock, constituting a lithotype: the "*Glyptostrobus* clay".

3.5. The aspect of the FVR

The data obtained from the frequency of the FVR can be corroborated with the integrality index (iI) as regards the aspect of the FVR in the deposit, an important element in the appreciation of the transport. The following scale was used for the iI:

1 – highly fragmented vegetal detritus, when the original vegetal organs cannot be recognized;

2 – fragments allowing the identification of the parental vegetal organ;

3 – fragments preserving several characters connected to the morphological aspect (margins, nervation, peak etc.);

4 – leaves devoid of some parts (peak, base or small portions);

5 – intact leaves and fruits.

The integrality indexes from 1 to 3 show the allochthonous character but may sometimes be also the result of an intrabasinal transport due to the action of the waves from the free water puddle of the swamps, as is sometimes the case during the storms from the lakes and puddles from the Danube Delta.

When, in the case of an accumulation, the leaves are entire (iI=5), especially if they belong to some taxa with membraneous leaves, these come from the immediate vicinity and the burial took place rapidly, before the biological decay and physical factors could bring about any destruction. Corroborating iF and iI, it can be stated that when their sum is equal to or exceeds 8 the FVR are surely autochthonous.

3.6. Other remarks

Some plants show interesting peculiarities for the taphonomic study. Thus in the case of *Stratiotes aloides* from the Danube Delta the direct dissemination in the substratum is specific (Botnariuc, 1961). The same dissemination mode was also probably present in the case of *Stratiotes dacicus*, frequently found in the coal deposits, in the coal strata inclusively.

The occurrence of the *Stratiotes* fruits in the xylitic coal lithotype (Ţicleanu et al., 1989), therefore in the *Glyptostrobus* paleophytocoenosis, proves the existence in the paleobiotope of the latter of some depression areas covered by water just in the short interval in which the waters retire from the zones covered by this vegetal community.

3.7. Observations on the FVR from the coal layers

Special attention has been given to the observations on the FVR within coals and especially on fossil wood (xylite). Most of the fossil woods within coals, in various carbonification stages, as shown by the various colours ranging from light-yellow to black-brown, come from the roots, stems and branches of *Glyptostroboxylon tenerum*.

Within the coal layers the stems and branches are disposed parallel to bedding, and the roots only occur in growth position with the structure, crossing the bedding. The larger branches show an oval-flattened section near the stem, unlike the stems with elliptical flat section. The calculus of the flattening of the fallen stems makes possible the establishment of the compaction ratio of the original peat. The measurements carried out so far indicate the 1:3 ratio.

3.8. Aspects connected with the diagenesis of the vegetal remains from the coal deposits

The FVR presenting diagenetic effects visible with the naked eye occur both in the coal layers and in the deposits including them. In this sense pyritizations, especially of the fossil woods, are the most frequent. In places pyritized leaves also occur. The ligneous fruits, especially those of Stratiotes, often show pyritizations. All these point to reducing environments during embedding.

The pyritized FVR undergo transformations at the contact with the phreatic waters rich in oxygen or the atmospheric air, sulphides changing into sulphates. This phenomenon is obvious in the case of the pyritized leaves within coals. By the transformation of the concentrated pyrite especially in the primary, secondary and tertiary nervures into calcium sulphate, the nervation appears white on the bedding surface of coals, in contrast with the brown-black colour of coals, a reason why the leaves look like phantoms. Such phantoms have been identified in Oltenia, belonging to the taxa *Byttneriophyllum, Salix, Alnus, Glyptostrobus* etc. and proving their participation in the coal genesis.

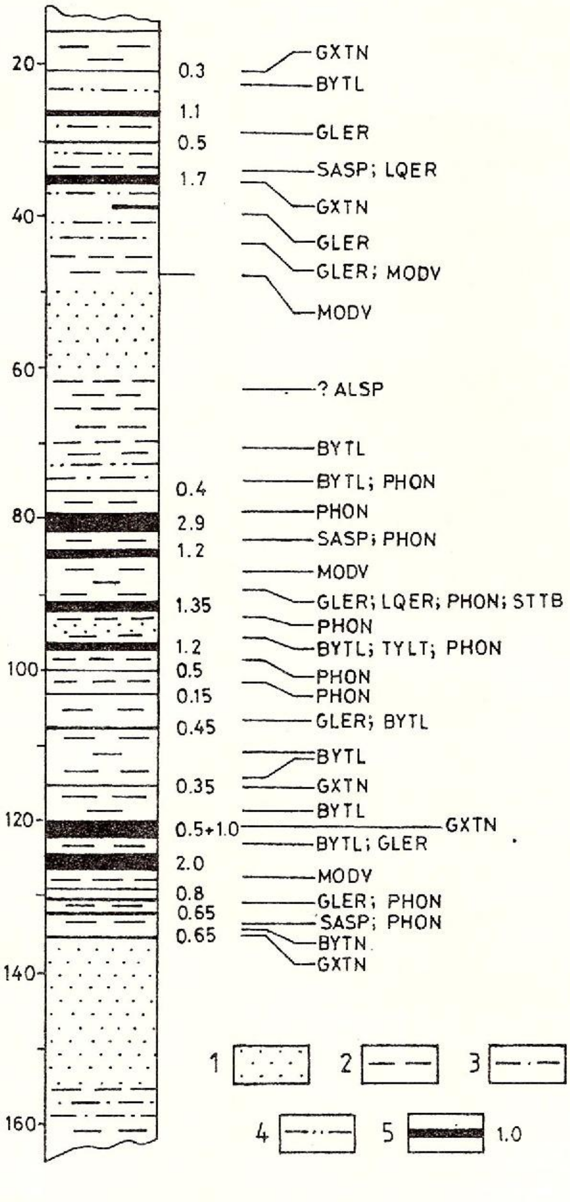

Fig. 1 – Lithostratigraphic column showing the position and content of the AFVR from the Petreşti borehole:
1, sands; 2, clays; 3, siltic clays; 4, sandy clays; 5, coal bed and its thickness in m. Symbols for various taxa: ALSP – *Alnus* sp., BYTL – *Byttneriophyllum tiliaefolium*, GLER – *Glyptostrobus europaeus*, GXTN – *Glyptostroboxylon tenerum*, LQER – *Liquidambar europaeum*, MODV – diverse monocotyledons, PHON – *Phragmites oeningensis*, SASP – *Salix* sp., STTB – *Stratiotes dacicus*, TYLT – *Typha latissima*.

4. Observations on the AFVR

These observations refer to aspects connected with the mode in which the FVR are associated in the deposits, forming accumulations of fossil vegetal remains (AFVR), and are related to various aspects such as: shape, size, structure etc., and the relationships among the various AFVR and between these and the deposits they contain.

4.1. Lithofacies of the host rock

Holy (1978) shows that the pelitic facies is characteristic of the autochthonous accumulations, the allochthonous ones appearing especially in the prevailingly arenitic ones.

It has been found that in the Pliocene of Oltenia the FVR belonging to the coal generating paleophytocoenoses occur up to 50 times more frequently in clays than in fine sands, so that the lithological criterion is important for establishing the autochthonous character.

4.2. Shape, size and structure

Concerning the shape and size, the FVR appear as follows:

1. *Disperse*, when the FVR occur completely isolated and in the mass of the host rock.
2. *In clusters* varying in size, usually centimetric to decimetric, with the randomly disposed FVR, often corroded, produced by water streams and locally even by sands slidings that took place after the embedding.
3. *Lens-shaped*, of generally reduced, decimetric, thicknesses, rarely up to over 1 m, and of metric lengths, with the FVR disposed on the bedding faces but also, more rarely, in various positions with respect to these.
4. *Stratiform*, extended over large areas that may locally exceed hectares, and thicknesses ranging from a few millimeters to 1–4 m. The FVR are disposed prevailingly parallel to the bedding.

Within the stratiform FVR two types can be distinguished: a *monosequential one*, when the FVR occur on a single bedding face, and a *multisequential one*, consisting of the repetition on several bedding faces of the FVR with the same specific composition. The sequences may recur at intervals of the order of millimeters and centimeters. A typical example of multisequential AFVR is represented by the situation above coal layer VIII A from the East Rovinari quarry. According to this view, the sequence has a significance similar to that accepted by ecologists (see Neacşu, Apostolescu, 1982, p. 556) and reflects the moment of the fall of leaves off the trees.

In the case of the multisequential AFVR, as a rule 1–2 taxa frequently occur on the bedding faces, reflecting the species prevailing in the paleophytocoenoses, and 2–4 taxa with reduced participation coming from the secondary species within paleophytocoenoses or from other more distant ones.

4.3. "Fossil forests"

The trunks preserved in growth positions, usually disposed in the wall of the coal beds, represent a special category of strictly autochthonous AFVR. The distance among the trunks observed in Oltenia ranges between 3–6 m and 10–20 m. Such a fossil forest was encountered in the Lupoaia quarry, above coal layer VI as well as above various coal layers from the Jilţ South, Pinoasa, Tismana, Gîrla, Poiana, Peşteana North, Alunu, Berbeşti West, Cerna quarries etc.

"Fossil forests" are present also in the intercalations among the coal layers. A good example is the former forest between coal layers II and III from the Alunu quarry (local nomenclature). The position of the forest and the lithofacies of the deposits containing the roots indicate its location on a natural levee.

4.4. Relationships among the autochthonous AFVR

Vertical changes of the AFVR have been often noticed in quarries and boreholes, reflecting the changes in the ecological conditions leading to more or less complete genetic series.

For example in the East Rovinari quarry *Stratiotes* seeds occur in the base, under coal layer VIII A, which are first rare, then very frequent, included in a coaly clay. There follows argillaceous coal passing to xylitic coal originating from a *Glyptostrobus* forest. This situation reflects a progressive succession, the *Stratiotes* paleophytocoenosis being gradually replaced by the *Glyptostrobus* one, this substitution pointing to the decrease of the water depth and the change in the hydrological regime from a zone which is permanently covered by water to one in which water lacks 2–3 months per year.

The vertical passages from the xylitic coal layer (*Glyptostrobus* paleophytocoenosis) to the *Byttnériophyllum* and *Glyptostrobus* paleophytocoenosis, as in the case of some layers from the roof of layer VI from the Lupoaia quarry and in some other situations, are very frequent.

If the genetic series are frequent and easy to follow, the ecological ones can be pointed out more rarely owing to the very large areas in which paleophytocoenoses developed compared to the areas of direct observation.

4.5. Relationships between the autochthonous AFVR and the coal layers

The AFVR may occur in the roof, floor and in the thin intercalations within the layers (Fig. 1). The great frequency of the AFVR from the roof of the coal layers usually shows the coal genesis from vegetal associations arranged in progressive series, and in regressive series for those from the floor of the layers.

The significance of the great frequency of the *Byttneriophyllum* paleophytocoenosis in the floor of the xylitic coals has been shown above. If the water depth had continued to decrease, mesohygrophyte forests would have formed, but the swamp was gradually flooded by waters, there existing a transition from the telmatic phase to the lacustral one which corresponds to a generally short interval in which the trees still survive, especially those from the more uplifted zones, still furnishing for a time leaves separated by thin clay intercalations corresponding to the flooding moments. After this interval the lacustral phase sets in definitively and the leaves accumulation stops. The existence of some lacustral phases after the telmatic ones was pointed out by Nebert (1983) for a deposit in Germany.

The mostly centimetric clay intercalations with plants, existing between two thick coal layers, are the most valuable. They formed during catastrophic floods that carried a lot of terrigenous material. The FVR within these clays undoubtedly represent the plants from which peat formed, the rests of which were surprised by the floods. The large number of specimens, locally constituting fossil foliages plead for an autumnal flood. The rapid burial after death and the fact that they do not show traces of the impact of the biological decay agents also support this idea.

The roots frequently found in the floor of the coal layers represent another autochthonos feature. A special category is represented by the roots and rootlets that occur in the pelites at the base of the coal layers, indicating an aquatic or swampy vegetation.

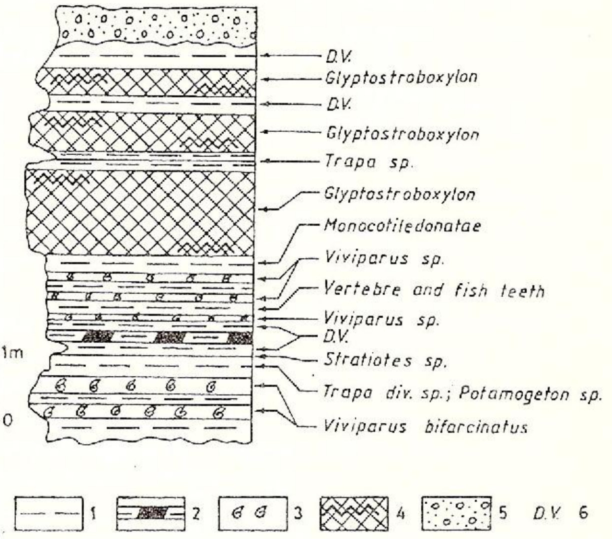

Fig. 2 – Litho-biostratigraphic column in the outcrop at the confluence of the Valea Mare with the Valea Tărîia: 1, clays; 2, coaly clays; 3, viviparid lumachelles; 4, xylitic coals; 5, Quaternary gravels; 6, DV = vegetal detritus.

4.6. Relationships between the AFVR and the fossil mollusc assemblages

The coal deposits from Oltenia are characterized by the frequent mollusc association, especially gastropods from the genera *Viviparus, Theodoxus* and *Melanopsis* with FVR belonging to the aquatic plants: *Potamogeton, Ceratophyllum, Stratiotes* etc.. The outcrop on the Tărăia Brook, at the confluence with the Valea Mare (Fig. 2), constitutes an outstanding example. The mentioned associations also occur along with the *Glyptostrobus* FVR, a fact explained by the close position of this FVR to the free water lacustral zones.

Anodonta and *Hyriopsis* molds locally occur in the AFVR from the roof of the layers, therefore at the transition from a telmatic to a lacustrine facies.

4.7. Characteristics of the investigation of the AFVR within the coal quarries

Beside the large vertical and horizontal openings, the exploitation system enables the use of two specific investigation methods within quarries.

A first method consists in the investigation of the roof of the coal layer prepared for exploitation. In this case the area investigated in the horizontal plane may reach tens of hectares. This method is especially efficient in determining the density of the trees in the *Glyptostrobus* forests.

Another method consisted in following for a period of several (2–8) years the successive sections of the paleofloral content at the same stratigraphic level as the work front advanced. This method resembles much that of the "transversal itineraries" used (according to Pîrvu, 1981) in the study of the present-day vegetation.

Due to these facilities only the observations within the quarries (Ţicleanu, 1990) have been used in the description of the main paleophytocoenoses from the coal generating swamps.

5. Results

The taphonomic analysis applied in the investigation of the FVR from the Pliocene coal deposits in Oltenia allowed the separation of three categories within the 764 AFVR as follows: 577 autochthonous, 140 hypautochthonous and 20 allochthonous. Another 24 AFVR are represented by vegetal detritus that may have various origins.

The ratio between the autochthonous AFVR (along with the hypautochthonous ones) and the allochthonous ones is of 37:1, which clearly indicates the allochthonous character of the coal deposits in Oltenia. This conclusion is also supported by the great frequency of the fossil forests from the wall of the coal layers and of the fossilized roots from the floor of these layers.

Based on the 577 autochthonous AFVR there have been described the paleophytocoenoses and formations that made up the vegetation of the coal-generating swamps (Ţicleanu, 1992), which developed under conditions specific for each of them; this made possible their use as indicators of the physico-chemical characteristics of the depositional environment (Fig. 3)

The ratio between the autochthonous AFVR and the hypautochthonous ones is of 4:1, and as most AFVR are situated in the intervals between the coal layers, characterizing the limnic and fluviatile phases, it results that during these phases, part of the accumulated material (ca 25 %) was being carried between the basins by air and water currents. During the telmatic (palustrine) phases the hypautochthonous char-

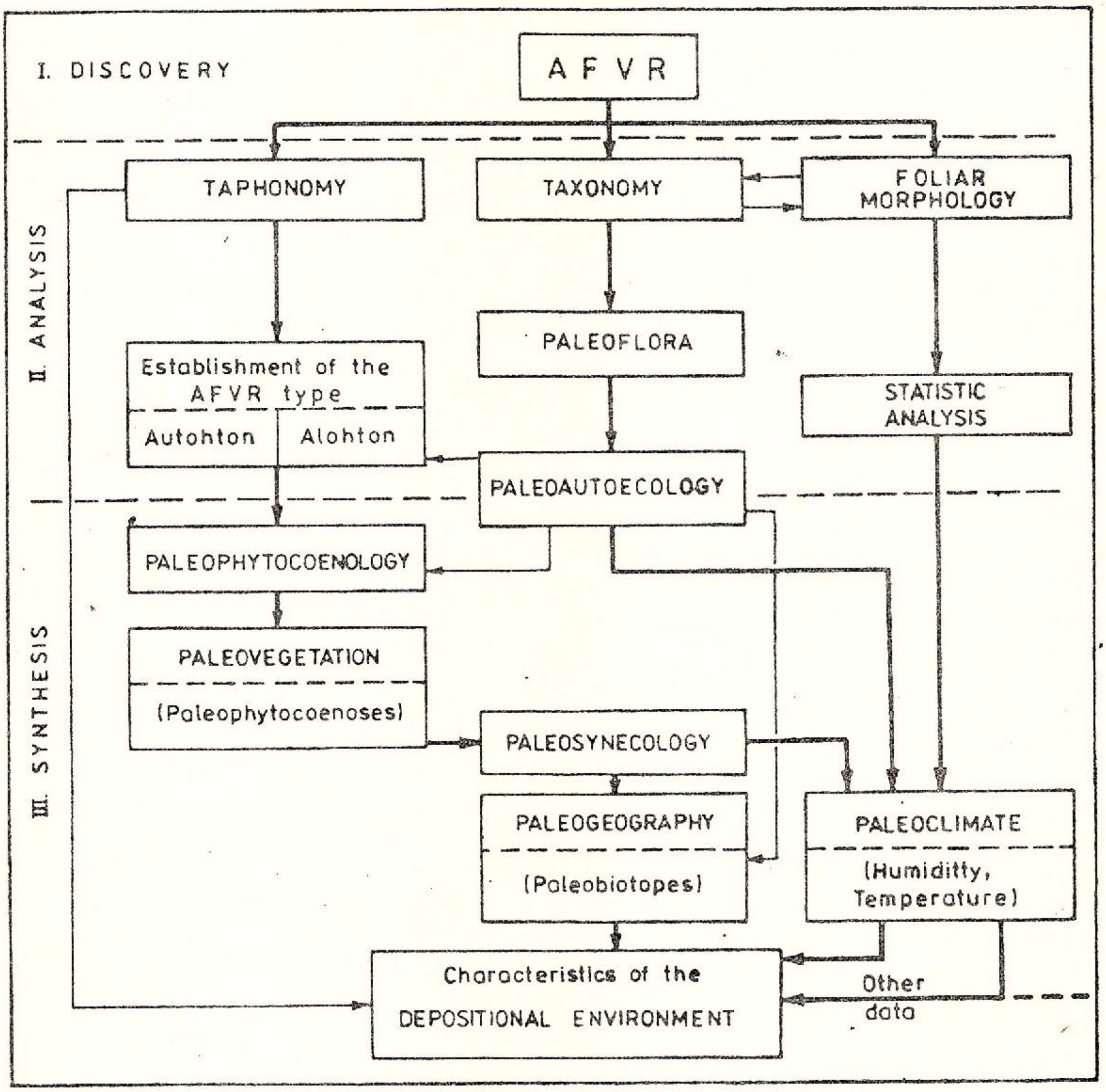

Fig. 3 – Stages of research on the reconstruction of the main characteristics of the depositional environment based on the AFVR.

acter, due to the water currents, was drastically reduced owing to the maximal extension of the areas covered by the palustrine vegetation and of those with stagnant waters, often weakly aerated as a result of the exuberant development of the aquatic vegetation.

The existence of some populations and paleophytocoenoses indicating the riparian facies in the boreholes from the central zone of the basin reflects the existence of some natural levees and points to the great development at certain times of the fluviatile depositional environment to the detriment of the lacustrine and/or palustrine ones.

The great number of AFVR within the intervals between the coal layers indicates a rich hygro-hydrophyte vegetation that can only be connected with the great development of some flood plains. The prevalence of the AFVR with great integrality index shows a rapid burial, in the absence of the biological decay factors (fungi, bacteria, etc.); this fact can be explained by the coincidence of the fall of leaves (during the autumn) with the great floods that carried remarkable amounts of argillaceous material.

The taphonomic analysis provided numerous other data on the relationships between paleophytocoenoses, the vegetation evolution, and the relationships between paleophytocoenoses and paleobiotopes (see Ţicleanu, 1992).

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Citările din text trebuie să includă numele autorului şi anul publicării. Exemplu: Ionescu (1970) sau (Ionescu, 1970). Pentru doi autori: Ionescu, Popescu (1969) sau (Ionescu, Popescu, 1969). Pentru mai mult de doi autori: Ionescu et al. (1980) sau (Ionescu et al., 1980). Pentru lucrările care se află sub tipar, anul publicării va fi înlocuit cu "in press". Lucrările nepublicate şi rapoartele vor fi citate în text ca şi cele publicate.

Abstractul, maximum 20 rînduri (pe filă separată), trebuie să fie în limba engleză şi să prezinte pe scurt principalele rezultate şi concluzii (nu o simplă listă cu subiecte abordate).

Cuvintele cheie (maximum 10) trebuie să fie în limba engleză sau franceză, corespunzător limbii în care este lucrarea (sau abstractul, dacă textul este în română), prezentate în succesiune de la general la specific şi dactilografiate pe pagina cu abstractul.

Bibliografia se va dactilografia la două rînduri, în ordine alfabetică şi cronologică pentru autorii cu mai mult de o lucrare. Abrevierile titlului jurnalului sau ale editurii trebuie să fie conforme cu recomandările respectivelor publicaţii sau cu standardele internaţionale.

Exemple:

a) jurnale:

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– , Pavelescu, L. (1954) Contribuţii la studiul mineralogic al zăcămîntului de la Muşca. *Comm. Acad. Rom.*, IV, 11-12, p. 658-991, Bucureşti.

b) publicaţii speciale:

Strand, T. (1972) The Norwegian Caledonides. p. 1-20. In: Kulling, O., Strand, T. (eds.) Scandinavian Caledonides, 560 p., Interscience Publishers.

c) cărţi:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., Bucureşti.

d) hărţi:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50,000, sheet Cîmpulung. Inst. Geol. Geofiz., Bucureşti.

e) lucrări nepublicate sau rapoarte:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. I.G.R., Bucureşti.

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b) special issues:

Strand, T. (1972) The Norwegian Caledonides. p. 1–20. In: Kulling, O., Strand, T. (eds.) Scandinavian Caledonides, 560 p., Interscience Publishers.

c) books:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., Bucureşti.

d) maps:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50,000, sheet Cîmpulung. Inst. Geol. Geofiz., Bucureşti.

e) unpublished papers or reports:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. I.G.R., Bucureşti.

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