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MIDDLE MIOCENE (LOWER BADENIAN) CALCAREOUS NANNOFOSSILS FROM THE MUREŞ PASSAGEWAY AND FĂGET BASIN, ROMANIA

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Abstract. The calcareous nannofossils of three areas from the fossiliferous sites: Lăpugiu de Sus (Mureş Passageway), Nemeşeşti and Coştei (Făget Basin, gulf of the Pannonian Basin) have been analysed. The assemblages characterize the NN5 Zone – *Sphenolithus heteromorphus*, and especially the NN5a Subzone – *Geminilithella rotula*, which prove the Lower Badenian (Moravian) age of the investigated deposits. On the Coşu Valley, at Lăpugiu de Sus is present also the NN5b Subzone – *Helicosphaera wallichii*. The calcareous nannofossils assemblages prove the presence of tropical waters in the Lower Badenian.

Keywords: Middle Miocene (Lower Badenian), calcareous nannofossils, NN5 Zone, Mureş Passageway (Lăpugiu de Sus), Făget Basin (Nemeşeşti, Coştei).

GENERAL CONSIDERATIONS

The calcareous nannofossils from the fossiliferous sites Lăpugiu de Sus (Coşu Valley and Lăpugiu Valley), Nemeşeşti (Gemenii Valley) and Coştei have been analysed.

The Lower Badenian nannofossil assemblages from the Mureş Passageway (Lăpugiu de Sus) and from the Făget Basin (Nemeşeşti and Coştei) (Fig. 1) are some of the richest and well-preserved of this age.

During the Badenian, the Mureş Passageway represented the connection between the Transylvanian and the Pannonian basins, while the Făget Basin is considered to have been a gulf of the Pannonian Basin.

The first data concerning the calcareous nannoplankton from this area, only from Lăpugiu de Sus, are given by Papp (1976) and Mészáros in Petrescu et al. (1990). The assemblages prove the presence of the NN5 Zone – with *Sphenolithus heteromorphus*.

GEOLOGICAL SETTING

At Lăpugiu de Sus, on the Coşu Valley, in the lower part of the sedimentary succession, the sediments were accumulated in a subsident basin, and the sedimentary sequences are bounded by unconformities associated with continental deposits, while in the upper part of the succesion, at Nemeşeşti, on the Gemenii Valley, the deposits were accumulated in a more stable basin, in the course of filling, with sequences bounded by unconformities associated with coastal deposits (Hosu in Chira et al., 1999).

On the Lăpugiu Valley and Coşu Valley also occur a succesion of sedimentary deposits which consist of marls with interbedded silts and sands in the upper part of the succession.

At Coştei, the sedimentary succession, transgressively overlays the volcanic agglomerates, and consists of marls with interbedded silts.

NANNOFOSSILS ASSEMBLAGES

The calcareous nannoplankton from the Lăpugiu de Sus area contains the species which characterize the NN5 Zone – *Sphenolithus heteromorphus* and especially the NN5a Subzone - *Geminilithella rotula*.

On the Lăpugiu Valley only the NN5a Subzone - *Geminilithella rotula* was noticed, but on the Coşu Valley there is present almost the entire NN5 Zone, respectivelly the NN5a Subzone - *Geminilithella rotula* and also NN5b Subzone – *Helicosphaera wallichii*.

From the stratigraphic distribution of the species, a series of local bioevents have been observed on the Lăpugiu Valley: *Cyclicargolithus abisectus* Müller have its last occurrence simultaneous with the last occurrence of *Discoaster deflandrei* Bramlette & Riedel. The first occurrence of *Rhabdosphaera pannonica* Baldi – Beke was noticed in the upper half of the subzone.

The quantitative stratigraphic distribution differs from species to species. The assemblages are dominate by *Coccolithus pelagicus* (Wallich) Schiller, *Helicosphaera carteri* (Wallich) Kamptner and *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan.

In the Lăpugiu Valley section, it was noticed that the frequence of *Discoaster* species is normal in the lower part of the sedimentary succession and rare in the upper part. That reflects probably a diminution of temperature in the time interval of the deposition of the upper part of the Moravian succession.

The nannoplankton assemblages identified from the pelitic rocks in the Coştei section characterize the NN5 Zone – *Sphenolithus heteromorphus*, respectively the NN5a Subzone – *Geminilithella rotula*.

In these assemblages there are species with a range which covers almost the entire Neogene, like: *Reticulofenestra minuta* Roth, *Reticulofenestra minutula* Gartner, *Reticulofenestra pseudoumbilicus* (Gartner) Gartner, *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan, *Calcidiscus macintyrei* (Bukry & Bramlette) Loeblich & Tappan, *Coccolithus pelagicus* (Wallich) Schiller and nannofossils which occur or have a wide distribution only in the Lower Badenian (Moravian): *Geminilithella rotula* (Kamptner) Backman, *Holodiscolithus macroporus* (Deflandre) Roth, *Helicosphaera walbersdorfensis* Müller, *Rhabdosphaera pannonica* Baldi – Beke, *Umbilicosphaera jafari* Müller, *Discoaster exilis* Martini & Bramlette, *Discoaster musicus* Stradner, *Discoaster variabilis* Martini & Bramlette.

The stratigraphic distribution of nannofossils reveals the extinction of *Coccolithus eopelagicus* Bramlette & Riedel, *Cyclicargolithus abisectus* Müller in the upper part of the Subzone NN5a (Upper Moravian) and the first occurrence of the species: *Umbilicosphaera jafari* Müller,

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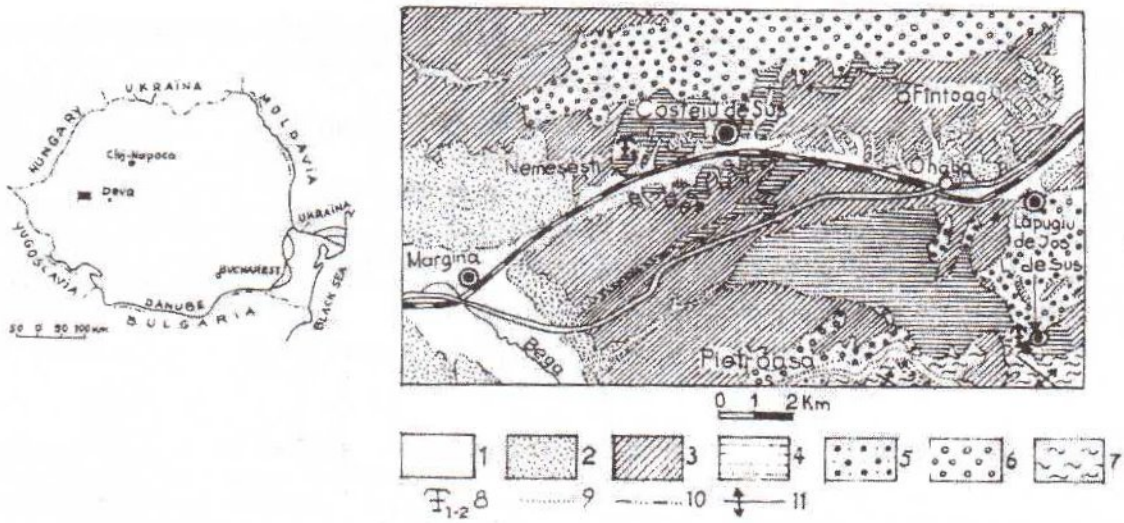

Figure 1 - Location and geological map of the studied area: Lăpugiu de Sus – Nemeşeşti (scale 1:200.000). 1 – Holocene deposits; 2 – Pleistocene deposits; 3 – Pannonian deposits; 4 - Badenian deposits; 5 – Cretaceous (Vraconian – Cenomanian) deposits ; 6 – Neogene pyroclastite, andezite; 7 – Upper Proterozoic – Paleozoic epimetamorphic crystalline; 8 – fossiliferous sites; 9 – geological limit; 10 – geologic – morphological limit ; 11 – anticline axe.

Helicosphaera walbersdorfensis Müller and *Rhabdosphaera pannonica* Baldi – Beke near of the base of the subzone, also Lower Moravian.

In time, the nannofossils identified in the Coştei section present a large quantitative variability, which reflects frequent changes in salinity.

Thirty-five species of calcareous nannofossils belonging to sixteen genera have been recognized, which are almost the same in the investigated areas. The identified calcareous nannofossils from the investigated sections are presented in systematical order according to Young & Bown (1997) and with references to Perch-Nielsen (1985), Aubry (1984, 1988, 1989, 1990), a.o. (Tab. 1).

The richest samples were found at Lăpugiu de Sus and contain 25 species of calcareous nannofossils. Generally, the richest samples in the investigated areas contain between 17–25 calcareous nannofossil species.

Calcareous nannoplankton assemblages from Lăpugiu de Sus, Nemeşeşti and Coştei also, belong to the *Sphenolithus heteromorphus* Zone (NN5).

The common and the most frequent taxa for these areas are: *Sphenolithus heteromorphus* Defladre (index species for NN5 Zone – Martini, 1971) (Pl. I, Fig. 1a, 1b, 1c), *Geminilithella rotula* (Kamptner) Backman, (NN5a Subzone – Mărunțeanu, 1999) (Pl. II, Fig. 1, 2), *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre (Pl. III, Fig. 11a, 11b), *Reticulofenestra minuta* Roth (Pl. IV, Fig. 3), *Reticulofenestra minutula* Gartner, *Reticulofenestra pseudoumbilicus* (Gartner) Gartner (Pl. III, Fig. 7; Pl. IV, Fig. 1, 2), *Rhabdosphaera pannonica* Baldi-Beke (Pl. I, Fig. 6, 7, 8, 12), *Coccolithus pelagicus* (Wallich) Schiller (Pl. II, Fig. 4; Pl. IV, Fig. 1), *Coccolithus miopelagicus* Bukry (Pl. II, Fig. 8a, 8b), *Helicosphaera carteri* (Wallich) Kamptner (Pl. II, Fig. 4, 5a, 5b), *Helicosphaera walbersdorfensis* Müller (Pl. I, Fig. 9), *Discoster exilis* Martini & Bramlette (Pl. III, Fig. 3), *Discoaster variabilis* Martini & Bramlette (Pl. III, Fig. 1, 2), *Discoaster musicus* Stradner (Pl. III, Fig. 6; Pl. IV, Fig. 7), a. o.

In the assemblages there are also present: *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon (Pl. I, Fig. 2), *Sphenolithus abies* Deflandre (Pl. I, Fig. 3), *Rhabdosphaera procera* Martini (Pl. I, Fig. 4), *Rhabdosphaera sicca* Stradner (Pl. I, Fig. 5), *Umbilicosphaera jafari* Müller (Pl. I, Fig. 10), *Discoaster deflandrei* Bramlette & Riedel (Pl. III, Fig. 5), *Discoaster brouweri* Tan emend. Bramlette & Riedel (Pl. II, Fig. 4), *Triquetrorhabdulus rugosus* Bramlette & Wilcoxon (Pl. I, Fig. 11), *Micrantolithus vesper* Deflandre *in* Deflandre & Fert (Pl. III, Fig. 7 – 10), *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan (Pl. II, Fig. 3a, 3b; Pl. III, Fig. 7).

The nannofossil assemblages of these areas present great affinities. The assemblages have been studied both by light microscope (at the Babeş-Bolyai University – Cluj-Napoca, Geological Survey – Bucharest and at the Vienna University) and by electronic microscope, at the Vienna University.

The study by electronic microscope of the samples colected from Lăpugiu de Sus and also Nemeşeşti shows rich and also well-preserved assemblages in which sometimes there are entire coccospheres, like *Coccolithus pelagicus* (Wallich) Schiller (Pl. II, Fig. 4), *Cyclicargolithus floridanus* (Roth & Hay) Bukry (Pl. II, Fig. 7).

The nannofossil content of the *Sphenolithus heteromorphus* Zone consists of *Sphenolithus heteromorphus* Deflandre, *Discoaster exilis* Martini & Bramlette, *Discoaster variabilis* Martini & Bramlette *Discoaster musicus* Stradner, *Holodiscolithus macroporus* (Deflandre) Roth (Pl. IV, Fig. 6) *Geminilithella rotula* (Kamptner) Backman (= *Calcidiscu annula* Cohen) (Pl. II, Fig. 1, 2), *Helicosphaera carte* (Wallich) Kamptner, *H.walbersdorfensis* Müller, *H wallichii* (Lohmann) Okada & McIntyre (Pl. II, Fig. 6), a.o

For the Transylvanian Basin and the Subcarpathians it was noticed that:

Discoaster brouweri Tan emended Bramlette Riedel, *Helicosphaera wallichii* (Lohmann) Okada McIntyre and *Sphenolithus abies* Deflandre hav simultaneous first occurrences before the la appearance of *Sphenolithus heteromorphus* Deflandı (Mărunțeanu & Chira, 1998) (*Helicosphaera wallichii* NN5b – Mărunțeanu, 1999).

Table 1. The distribution of the calcareous nannofossils in the three investigated areas, in systematical order.

NANNOFOSSIL SPECIES	Lăpugiu de Sus	Nemeşeşti	Coştei
Helicosphaera carteri (WALLICH, 1877) KAMPTNER (1954)	x	x	x
Helicosphaera walbersdorfensis MÜLLER (1974)	x	x	x
Helicosphaera wallichii (LOHMANN, 1902) OKADA & MCINTYRE (1977)	x	-	-
Pontosphaera multipora (KAMPTNER, 1948) ROTH (1970)	x	x	x
Syracosphaera histrica KAMPTNER (1941)	x	x	-
Rhabdosphaera procera MARTINI (1969)	-	x	-
Rhabdosphaera pannonica BALDI-BEKE (1960)	x	x	x
Cyclicargolithus floridanus (ROTH & HAY *in* HAY *et al.*, 1967) BUKRY (1971)	x	x	x
Cyclicargolithus abisectus (MÜLLER, 1970) WISE (1973)	x	-	x
Reticulofenestra pseudoumbilicus (GARTNER, 1967) GARTNER (1969)	x	x	x
Reticulofenestra gelida (GEITZENAUER, 1972) BACKMAN (1978)	x	-	x
Reticulofenestra minuta ROTH (1970)	x	x	x
Reticulofenestra minutula (GARTNER, 1967) HAQ & BERGGREN (1978)	x	x	x
Coccolithus miopelagicus BUKRY (1971)	x	x	x
Coccolithus pelagicus (WALLICH, 1877) SCHILLER (1930)	x	x	x
Coccolithus eopelagicus (BRAMLETTE & RIEDEL, 1954) BRAMLETTE & SULLIVAN (1961)	-	-	x
Calcidiscus leptoporus (MURRAY & BLACKMAN, 1898) LOEBLICH & TAPPAN (1978)	x	x	x
Calcidiscus macintyrei (BUKRY & BRAMLETTE, 1969) LOEBLICH & TAPPAN (1978)	x	x	x
Calcidiscus pataecus GARTNER 1967	x	-	-
Geminilithella rotula (KAMPTNER, 1956) BACKMAN (1980)	x	x	x
Umbilicosphaera jafari MÜLLER (1974)	x	x	x
Holodiscolithus macroporus (DEFLANDRE *in* DEFLANDRE & FERT, 1954) ROTH (1970)	x	x	x
Braarudosphaera bigelowii (GRAN & BRAARUD, 1935) DEFLANDRE (1947)	x	x	x
Micrantolithus vesper DEFLANDRE *in* DEFLANDRE & FERT (1954)	x	x	x
Micrantolithus flos DEFLANDRE *in* DEFLANDRE & FERT (1954)	x	x	x
Discoaster variabilis MARTINI & BRAMLETTE (1963)	x	x	x
Discoaster exilis MARTINI & BRAMLETTE (1963)	x	x	x
Discoaster musicus STRADNER (1959)	x	x	x
Discoaster deflandrei BRAMLETTE & RIEDEL (1954)	x	x	x
Discoaster brouweri TAN (1927) emended BRAMLETTE & RIEDEL (1954)	x	x	-
Sphenolithus heteromorphus DEFLANDRE (1953)	x	x	x
Sphenolithus abies DEFLANDRE *in* DEFLANDRE & FERT (1954)	x	x	x
Sphenolithus neoabies BUKRY & BRAMLETTE (1969)	x	x	-
Sphenolithus moriformis (BRÖNNIMANN & STRADNER, 1960) BRAMLETTE & WILCOXON (1967)	-	x	-
Triquetrorhabdulus rugosus BRAMLETTE & WILCOXON (1967)	x	x	-

At Lăpugiu de Sus (Coşu Valley) and Nemeşeşti (Gemenii Valley) the presence of these species was noticed and also that of *Geminilithella rotula* (Kamptner) Backman (= *Calcidiscus annula* Cohen) (NN5a) occurs. *Geminilithella rotula* appear also at Coştei.

It can be considered that almost the entire NN5 Zone interval is present at Lăpugiu de Sus on the Coşu Valley section and at Nemeşeşti on the Gemenii Valley section. At Coştei only the presence of NN5a is demonstrated and also at Lăpugiu de Sus on the Lăpugiu Valley section.

PALAEOECOLOGICAL DATA

The presence of *Braarudosphaera bigelowii* was noticed in almost all the samples, species which is considered to prefer low salinity and high turbidity, and to be controlled by water depth (Takayama, 1972). That species prefers shallow bays and continental shelves.

Braarudosphaera bigelowii and also *Helicosphaera carteri* are considered to be well adapted to the neritic environment.

Pontosphaera multipora (Pl. IV, Fig. 4, 5), a long ranging species, also frequent, is considered a nearshore environment species.

Most species prefer warm, tropical waters: *Sphenolithus heteromorphus*, *Helicosphaera carteri*, *Geminilithella rotula* (= *Calcidiscus annula*), and most of the *Discoaster* species, which are also frequent, had an ecological affinity for tropical and subtropical waters. These observations have been made also for other Lower Badenian sections from the Transylvanian Basin (Chira et al., 1997).

Although it is the index species for the NN6 Zone, *Discoaster exilis*, which occurs in the NN5 Zone, is either tolerant of or exhibits preference for colder water, and *Discoaster variabilis* is considered a temperate form.

For the Badenian from the Vienna Basin, Fuchs & Stradner (1977) showed that *Coccolithus pelagicus* characterizes subpolar watermasses. Rahmann & Roth (1990) considered *C. pelagicus* as a long-ranging species which provides paleoclimatic information for the latest middle Miocene to Pleistocene. *C. pelagicus* prefers cold nutrient – rich surface waters, with a temperature between 7 and 14 ^{0}C (McIntyre & Be, 1967), and therefore it is a good paleoclimatic indicator (Haq, 1977). It seems that the species might have changed its ecological preference and was not a cold – water indicator during the late Miocene. Subsequent studies, confirmed the earlier observations that *C. pelagicus* is indeed indicative of cold water even in the late Miocene (Haq, 1977; Rahman & Roth, 1990). Because it is a resistant species, the carbonate dissolution would improve the frequency of *C. pelagicus* in sediment, giving a cold aspect to the assemblages (Rahman & Roth, 1990).

Although *C. pelagicus* is a subpolar species today, it is also very abundant in lower Badenian deposits. It evolved in the tropical area during the early Cenozoic and migrated towards the poles during the mid – Cenozoic (Haq & Lohmann, 1976).

Some calcareous nannoplankton seem to be extremely rare or absent in tropical waters today, e. g. *C. pelagicus* and others. Other species, like most of *Sphenolithus* and some *Helicosphaera* seem to avoid boreal waters (Martini, 1971).

Very frequent at Lăpugiu de Sus and Nemeşeşti are also calcareous dinoflagelates (calcispheres) belonging to *Thoracosphaera heimii* (Lohmann, 1919) Kamptner (1941) (Pl. IV, Fig. 7, 8) and *Thoracosphaera deflandrei* Kamptner (1956).

Some samples contain almost exclusively fossil ascidians (tunicates) spicula, like *Micrascidites vulgaris* Deflandre & Deflandre-Rigaund (Pl. IV, Fig. 9). They are present in tropical and subtropical waters rich in carbonate, particularly coral reef areas (Varol & Houghton, 1996).

CONCLUSIONS

The Middle Miocene (Lower Badenian = Moravian) calcareous nannofossils assemblages from the Mureş Passageway at Lăpugiu de Sus (Coşu Valley) and from the Făget Basin at Nemeşeşti (Gemenii Valley) and Coştei, very rich in species and specimens, belong to the *Sphenolithus heteromorphus* Zone (NN5) (Martini, 1971).

The nannofossil assemblages present great affinities. It can be considered that almost the entire NN5 Zone interval is present at Lăpugiu de Sus and Nemeşeşti and only NN5a at Coştei.

Most species prefer warm, tropical waters.

Very frequent are also calcispheres (calcareous dinoflagelates) and fossil ascidian spicula, which prove tropical waters to have been rich in carbonate.

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PLATES

Plate I:

Fig. 1a, 1b, 1c – *Sphenolithus heteromorphus* Deflandre. L.M., 1a – NII; 1b – N+; 1c – N+; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 2 - *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon. L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 3 - *Sphenolithus* cf. *abies* Deflandre. S.E.M., x 12.000; Nemeşeşti (Gemenii Valley).
Fig. 4 - *Rhabdosphaera procera* Martini. L.M., NII; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 5 – *Rhabdosphaera sicca* Stradner. L.M., NII; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 6, 7, 8, 12 – *Rhabdosphaera pannonica* Baldi-Beke. L.M., 6 – NII; 7, 8 – N+, x 2.000; 12 - S.E.M., x 10.000; Nemeşeşti (Gemenii Valley).
Fig. 9 – *Helicosphaera walbersdorfensis* Müller. . L.M., N+; x 2000; Nemeşeşti (Gemenii Valley).
Fig. 10 – *Umbilicosphaera jafari* Müller. L.M., N+; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 11 – *Triquetrorhabdulus rugosus* Bramlette & Wilcoxon. NII; x 1.500; ; Nemeşeşti (Gemenii Valley).

Plate II:

Fig. 1 – *Geminilithella rotula* Kamptner (Backman). S.E.M., x 17.000; Lăpugiu de Sus (Coşu Valley).
Fig. 2 – *Geminilithella rotula* Kamptner (Backman) and *Coccolithus pelagicus* (Wallich) Schiller. L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 3a, 3b - *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan. L.M., 3a – NII; 3b – N+; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 4 - *Coccolithus pelagicus* (Wallich) Schiller, coccosphere, *Helicosphaera carteri* (Wallich) Kamptner, *Calcidiscus* sp. S.E.M., x 4.500; Nemeşeşti (Gemenii Valley).
Fig. 5a, 5b – *Helicosphaera carteri* (Wallich) Kamptner. L.M., 5a – NII; 5b – N+; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 6 - *Helicosphaera wallichii* (Lohmann) Okada & McIntyre. L.M., NII; x 1.500; Lăpugiu de Sus (Coşu Valley).
Fig. 7 - *Cyclicargolithus floridanus* (Roth & Hay) Bukry, coccosphere. S.E.M., x 8.500; Lăpugiu de Sus (Coşu Valley).
Fig. 8a, 8b - *Coccolithus miopelagicus* Bukry. L.M., 8a – NII; 8b – N+; x 3.000; Lăpugiu de Sus (Coşu Valley).

Plate III:

Fig. 1 - *Discoaster variabilis* Martini & Bramlette. S.E.M., x 7.000; Lăpugiu de Sus (Coşu Valley).
Fig. 2 - *Discoaster variabilis* Martini & Bramlette. L.M., NII; x 4.000; Lăpugiu de Sus (Coşu Valley).
Fig. 3 - *Discoaster exilis* Martini & Bramlette. L.M., NII; x 4.000; Lăpugiu de Sus (Coşu Valley).
Fig. 4 – *Discoaster brouweri* Tan emend. Bramlette & Riedel. L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 5 – *Discoaster deflandrei* Bramlette & Riedel. L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 6 – *Discoaster musicus* Stradner. L.M., NII; x 4.000; Lăpugiu de Sus (Coşu Valley).
Fig. 7 - *Reticulofenestra pseudoumbilicus* (Gartner) Gartner. *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan, *Micrantolithus vesper* Deflandre *in* Deflandre & Fert. L.M., N+; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 8 - *Micrantolithus vesper* Deflandre *in* Deflandre & Fert. L.M., NII; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 9. *Micrantolithus vesper* Deflandre *in* Deflandre & Fert. S.E.M., x 8.000; Nemeşeşti (Gemenii Valley).
Fig. 10 - *Micrantolithus vesper* Deflandre *in* Deflandre & Fert and *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre. L.M., NII; x 2.000; Nemeşeşti (Gemenii Valley).
Fig. 11a, 11b - *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre and *Coccolithus pelagicus* (Wallich) Schiller. L.M., 11a – NII; 11b – N+; x 2.000; Nemeşeşti (Gemenii Valley).

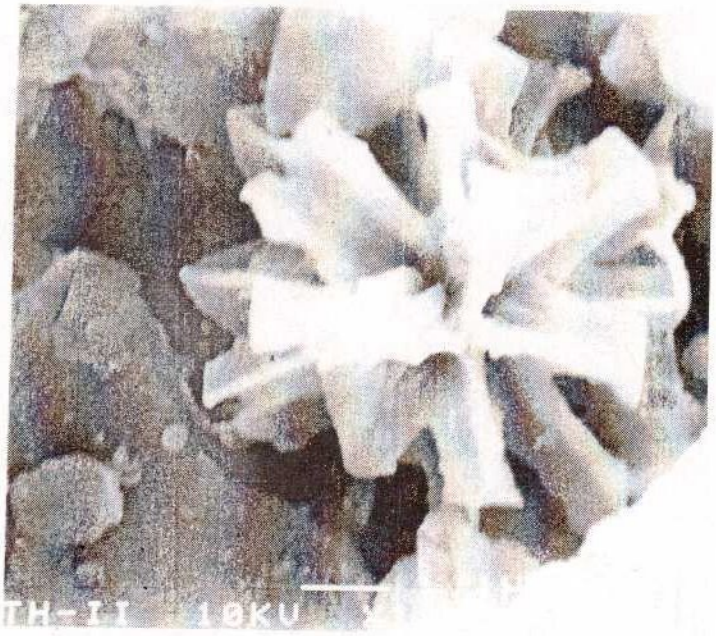
Plate IV:

Fig. 1 - *Reticulofenestra pseudoumbilicus* (Gartner) Gartner, *Coccolithus pelagicus* (Wallich) Schiller and *Reticulofenestra* sp. S.E.M., x 7.000; Lăpugiu de Sus (Coşu Valley).
Fig. 2 – *Reticulofenestra pseudoumbilicus* (Gartner) Gartner. L.M., N+, x 1.500; Lăpugiu de Sus (Coşu Valley).
Fig. 3 – *Reticulofenestra minuta* Roth. L.M., 3a – NII; 3b – N+, x 1.500; Lăpugiu de Sus (Coşu Valley).
Fig. 4, 5 – *Pontosphaera multipora* (Kamptner) Roth. 4 - S.E.M., x 8.500; 5 - L.M., NII; x 3.000; Lăpugiu de Sus (Coşu Valley).
Fig. 6 – *Holodiscolithus macroporus* Deflandre (Roth). L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 7 – *Discoaster musicus* Stradner, *Thoracosphaera* cf. *heimii* (Lohmann) Kamptner. L.M., NII; x 2.000; Lăpugiu de Sus (Coşu Valley).
Fig. 8 – *Thoracosphaera* cf. *heimii* (Lohmann) Kamptner. S.E.M., x 4.500; Nemeşeşti (Gemenii Valley).
Fig. 9 – Ascidian spicules: *Micrascidites vulgaris* Deflandre & Deflandre-Rigaund. S.E.M., x 2.000; Nemeşeşti (Gemenii Valley).

1a

1b

2



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1c

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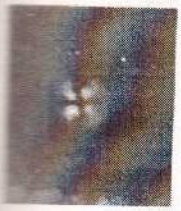
8 9



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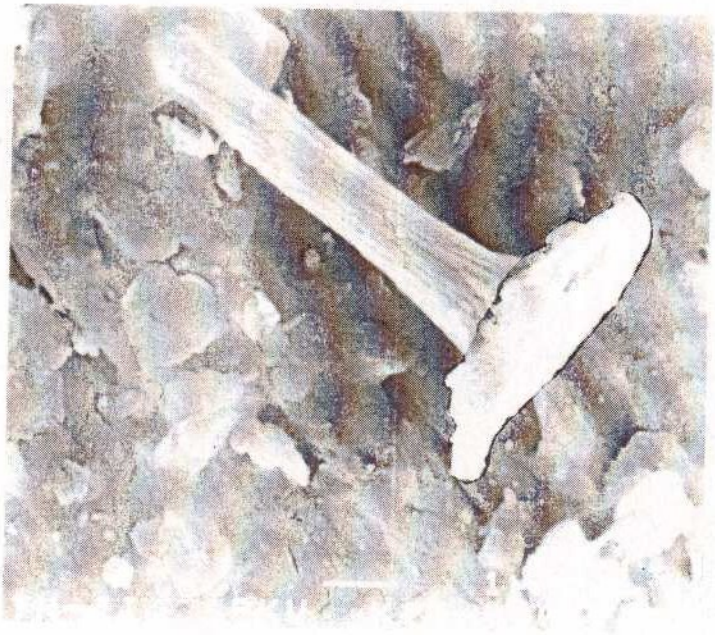

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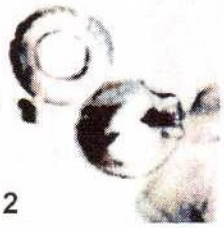

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3a

3b

5a

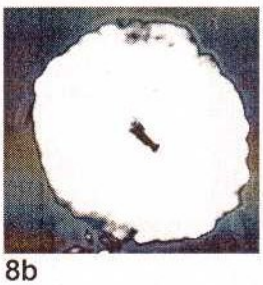
5b

6

4

7

8a



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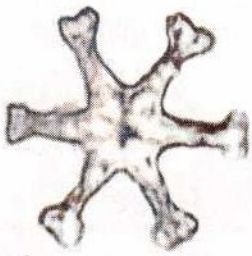

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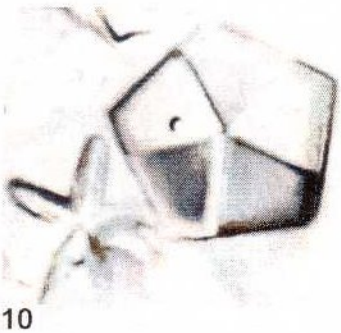

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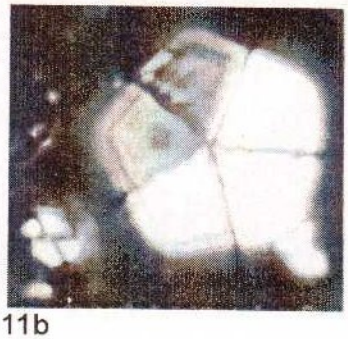
11a



11b

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