ACTA PALAEONTOLOGICA ROMANIAE V. 5 (2005), P. 493-501

PRELIMINARY DATA ON BIOSTRATIGRAPHY AND PALAEOECOLOGY OF CALCAREOUS NANNOFOSSILS AND FORAMINIFERA IN CEPARI QUARRY (NORTH-EASTERN TRANSYLVANIA, ROMANIA)

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Abstract. In this paper we refer to a study performed in the Cepari quarry, located north of Bistriței Hills (NE Transylvania). According to our knowledge, this is the first biostratigraphic and palaeoecological study of the calcareous nannofossils from this section. The calcareous nannoplankton assemblage belongs to NN5 Zone, with *Sphenolithus heteromorphus*. According to Martini (1971) this biozone characterizes exclusively the Upper Langhian - Lower Serravallian interval corresponding to the Lower Badenian in the Transylvanian Basin. The foraminiferal assemblages exclusively consist of planktonic species (e.g. *Globigerinoides* spp., *Globorotalia* spp. and *Orbulina* sp.), which belong to the *Orbulina suturalis/Globoturborotalita druryi* biozone (Early Badenian) of the Transylvanian Basin. Concerning the paleoecological data, these are supported by some paleoclimatic-paleoecological indicator forms of calcareous nannofossils and planktonic foraminifera.

Keywords: calcareous nannofossils, foraminifera, quantitative analysis, Middle Miocene, Lower Badenian/Moravian, North-Eastern Transylvania.

INTRODUCTION

The investigated quarry is located in the northern part of the Bistriței Hills area (Cepari village, NE Transylvanian Basin). Lithologically, the studied section consists of greenish tuffs, with very thin intercalations of sandy marls, which correspond to the Dej Formation (Popescu, 1970). The most important studies concerning the geological background of the Bistrița area were carried out by Hauer & Stache (1863), Koch (1900), Pătruț (1952), Ciocârdel (1953), Bucur *et al.* (1972), and Szakács (2000). The calcareous nannofossils content of the Dej Formation from Bistrița area was analyzed by Chira & Bălc (2002), Vulc (2002, 2003) and Chira & Vulc (2003) while the foraminiferal faunas of this lithostratigraphic unit were studied by Popescu (1970), Bucur *et al.* (1972), Popescu & Cioflică (1973). The purpose of this paper is to present the results of the studies (e.g. biostratigraphy, paleoecological data) carried out on calcareous nannofossils and foraminifera assemblages obtained from the sedimentary rocks of the Cepari quarry.

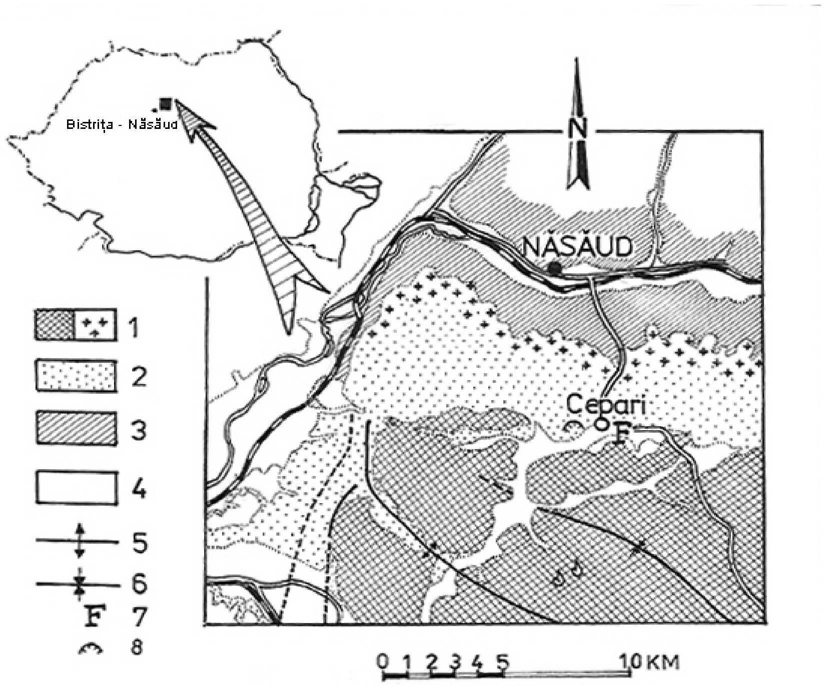

Figure 1. Location map of the studied area: Cepari quarry (after Marinescu & Peltz, 1967 with modifications). 1 - Sarmatian deposits; 2 - Badenian deposits; 3 –Lower Miocene; 4 – Quaternary fluviatile deposits; 5- anticline axis; 6- syncline axis; 7- fossiliferous site; 8 - quarry.

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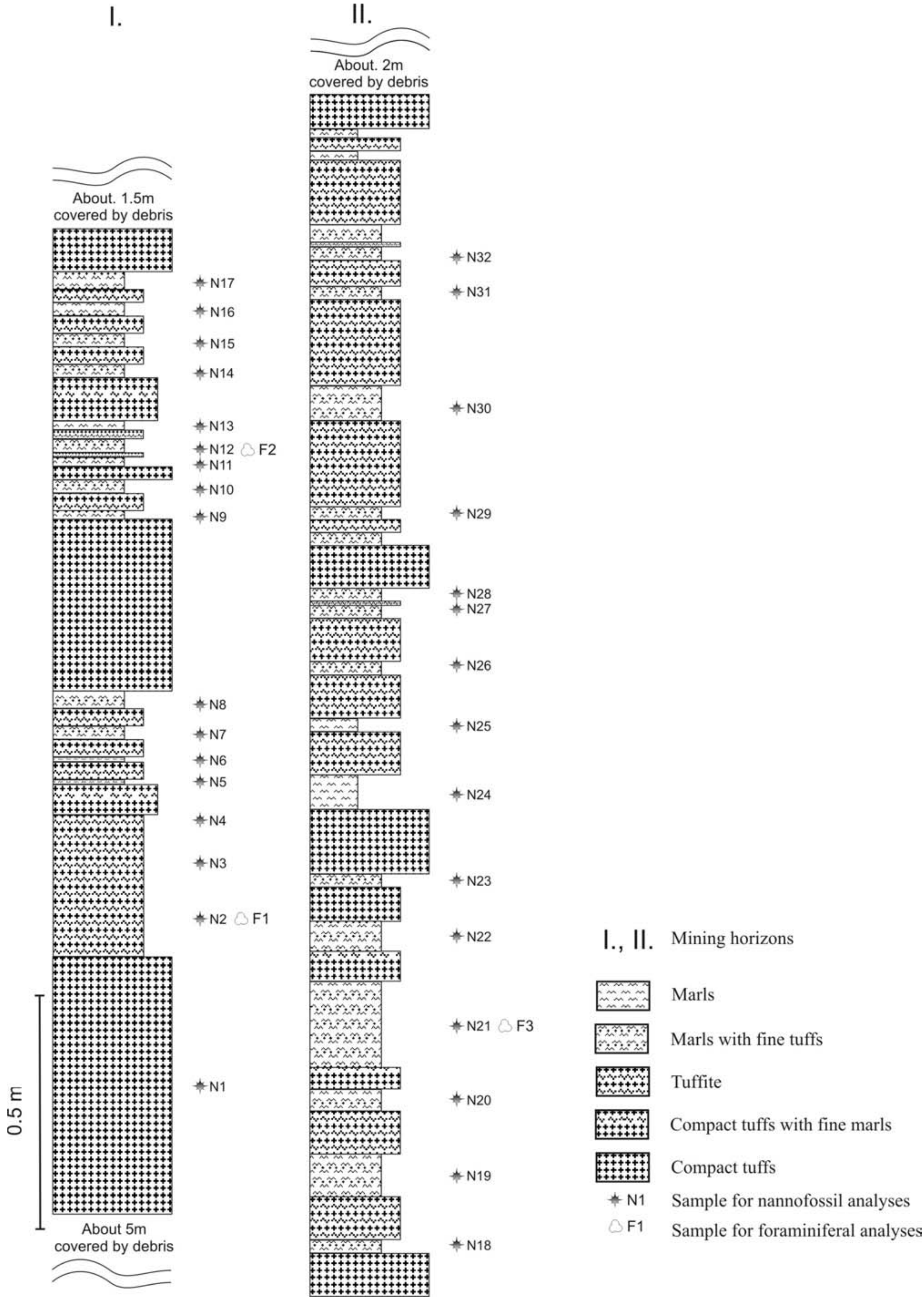

Figure 2. Lithological collumn of the studied section. The location of the samples is marked

GEOLOGICAL SETTING

A thick succession (about 23 m) of the Dej Formation crops out in the Cepari quarry, consisting of by various alternations of compact greenish tuffs, tuffites, and fine marls characteristic for the Dej Formation in the Transylvanian Basin. This was considered by Popescu (1970) the most constant geological formation in the Northern part of the Transylvanian Basin. According to Szakács (2000) the average radiometric age of the tuff at Cepari quarry is 13.95 M.y. However, he considered 15 M.y. as the overall age of the Dej Formation, based on radiometric age data of samples from other outcroping points of the formation.

MATERIAL AND METHODS

Smear slides of 32 samples collected from Cepari section were examined using an Axiolab Zeiss light microscope at a magnification of 1000X to analyse quantitatively and qualitatively the calcareous nannofossils. From each slide 300 specimens or at least specimens of 200 fields of view were counted and a random traverse of the slide was investigated to identify rare species. The smear slides for quantitative calcareous nannofossils analysis were prepared using the method described by Thierstein *et al.* (1977) as reported by Negri (1988). The listed nannofossils species are indexed in Perch-Nielsen (1985) and Bown &Young (1998).

Photos of the nannofossils were taken at the Department of Geology, of Babeş-Bolyai University, using a Carl Zeiss Axioskope microscope and a digital camera.

Three samples, 250 g each, were collected for foraminiferal analyses. These were processed using standard methods: drying, boiling in water with a small quantity of sodium carbonate (Na_2CO_3), and then washing over a 63-μm mesh sieve using tap water. The foraminifera were picked from the entire >63-μm residue.

BIOSTRATIGRAPHY, MICRO- AND NANNOFOSSIL ASSEMBLAGES

The calcareous nannofossils from Cepari quarry's section are very well preserved speciemens, and show high diversity and abundance of taxa (26 species which belong to 17 genera, 12 families, and 7 orders were identified). These features in fact are typical of the Moravian (Lower Badenian) assemblages of the Central Paratethys.

The nannofossil assemblages from the Cepari quarry show abundant *Sphenolithus heteromorphus,* and the most common species are: *Coccolithus pelagicus, Coccolithus miopelagicus, Cyclicargolithus floridanus, Discoaster musicus, Discoaster exilis, Helicosphaera carteri, Pontosphaera multipora, Reticulofenestra pseudoumbilicus, Sphenolithus heteromorphus, Sphenolithus moriformis, Sphenolithus neoabies* a.o.

Species with rare distribution are: *Braarudosphaera bigelowii*, *Ilselithina fusa, Scapholithus fossilis* (=*Calciosolenia murray)* and *Triquetrorhabdulus rugosus*. Other identified forms are calcareous dinoflagellates (e.g. *Thoracosphaera heimii)*.

Based on these features, the studied calcareous nannoplankton assemblages of Early Badenian (Moravian) age were assigned to the NN5 Zone with *Sphenolithus heteromorphus* that according to the Standard Zonation (Martini, 1971) consists of *Sphenolithus heteromorphus, Discoaster exilis, Discoaster musicus, Discoaster variabilis, Holodiscolithus macroporus*, a.o.

The foraminiferal assemblages from the Cepari quarry are characterized by a large number of generally poorly preserved (e.g. crushed, rarely partially affected by dissolution) planktonic foraminiferal specimens, that hampered the possibility to perform quantitative palaeoecological analyses. Therefore only qualitative analyses with biostratigraphic purposes and some paleoecological assumptions have been carried out on these assemblages. The identified taxa: *Globorotalia* spp., *Globorotalia bykovae*, *Globorotalia* cf. *transylvanica*, ?*Paragloborotalia* spp., *Globigerinoides trilobus*, *Orbulina suturalis*, *Globoquadrina* spp., *Globigerina* cf. *preabulloides*, *Globigerina* cf. *bulloides*, and *Globigerinoides* spp. are characteristic for the Lower Badenian (Moravian) planktonic foraminiferal assemblages in the Transylvanian Basin. Moreover, the presence of the index species (*Orbulina suturalis*) allows the identification of the *Orbulina suturalis/Globoturborotalita druryi* interval zone defined by Popescu & Crihan (2004) = M6 zone of Berggren *et al.* (1995).

PALAEOECOLOGY

Our paleoecological interpretations of the nannofossils are based on several species considered good paleobioclimatic indicators for cooler (e.g. *Coccolithus pelagicus*) or warm (e.g. *Sphenolithus heteromorphus, Coccolithus miopelagicus*) marine water conditions. Rahmann & Roth (1990) noted *Coccolithus pelagicus* as a long-ranging species which provides paleoclimatic information for Middle Miocene to Pleistocene. *Coccolithus pelagicus* prefers cold (7-14°C) nutrient rich surface waters (McIntyre & Be, 1967) and therefore it is a good paleoclimatic indicator (Haq, 1977). Although it is well known that *C. pelagicus* is a resistant species to the carbonate dissolution, and this would improve its relative frequency within the associations, giving a “cold” aspect to the assemblages (Rahmann & Roth, 1990), we can exclude selective dissolution in the case of our nannofossil assemblages. The *Sphenolithus heteromorphus* and *Coccolithus* *miopelagicus* are considered to be paleobioindicators for warm oceanic waters (Aubry, 1984).The general water temperature conditions have been estimated based on the relative abundance of the cool water forms vs. the warm water forms (see fig. 3)

As it has been mentioned above, the paleoecological interpretation of the foraminiferal assemblages is a hard task because of the poor preservation, and consequently the impossibility to perform quantitative analyses. Because of this it is not possible to interpret the relative proportion within the associations of species belonging to genera considered as warm water indices (e.g. *Globigerinoides, Orbulina*) by Bichii *et al.* (2003), are found together with species considered by the same authors as cool-temperate (e.g. *Globorotalia bykovae*) or cool water (e.g. *Globigerina* cf. *bulloides*) indices. Consequently, based on foraminiferal associations, the climatic trends can not be interpreted at this section.

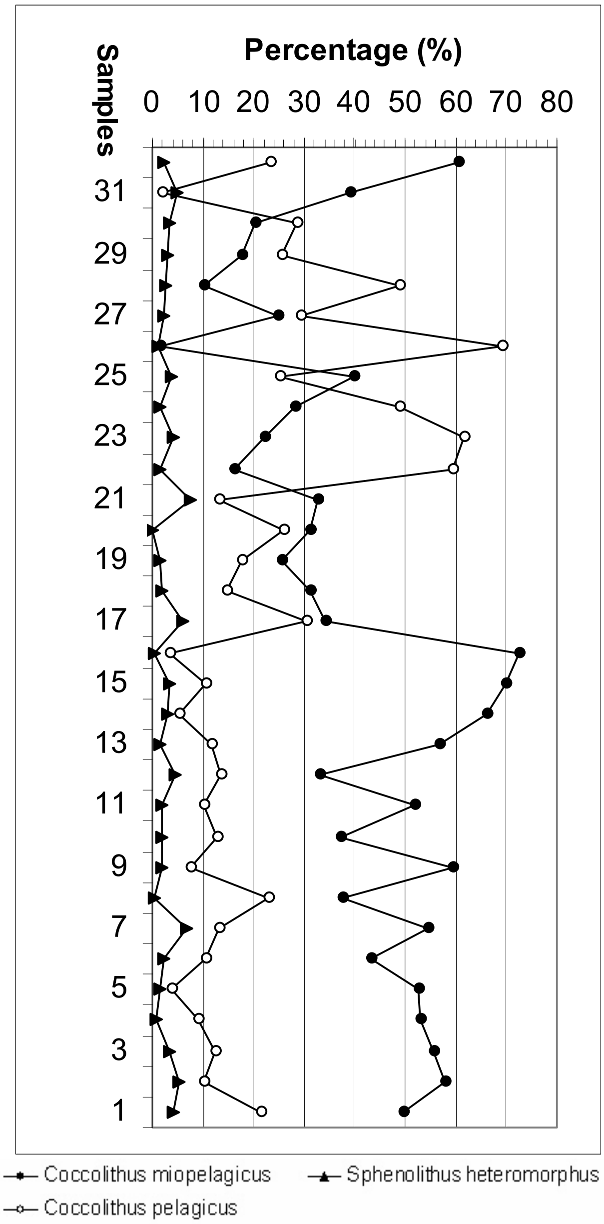

Figure 3 The relative distribution of different paleoenvironment marker species within the studied nannofossil assemblages (e.g. samples). For additional information see the text

CONCLUSIONS

Based on litological data, the deposits from Cepari quarry belong to the Dej Formation. The calcareous nannofossil and foraminifera assemblages support the Lower Badenian age of the studied section.

The quantitative analyses based on calcareous nannofossils from Cepari quarry (NE Transylvania Basin), suggest warm oceanic conditions at least at the beginning of the deposition of the investigated sedimentary succession. The top of the section points out to a cooling phase that probably could be related to local effects (short depositional time of the Dej Formation, seasonal temperature variations etc.) of the Transylvanian Basin. This interpretation is supported by the observations made by Mărunțeanu (1991), and Chira *et al.* (2000) who noted that the marine floras (and also faunas) reached their maximum proliferation in the late Early Badenian after the connection with the Tethys at the beginning of Badenian was established. They considered that the cause of this proliferation was a global warming episode which occurred during the depositional interval of Dej Formation.

In contrast, Bicchi *et al.* (2003) based on the observed major change in the composition of planktonic foraminifera faunas, concluded that the climate started to cool down during Zones N9a and NN5 (before the deposition of evaporites in the Parartethys). This could emphasize that the observed turnover within the studied calcareous nannofossil assemblages (e.g. domination of the cold water species in the upper part of the succession) of the Cepari quarry's section, may be related not only to local effects, but possibly to global ones.

However, further quantitative studies need to be carried out, to document with no doubt, that the cooling trend observed by Bicchi *et al.* (2003) in the Upper Langhian of Italy and Poland is also observable in the coeval sediments of the Transylvanian Basin.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. Alessandra Negri and Prof. Sorin Filipescu for their reviews and valuable comments made on manuscript. Thanks are also due to Prof. Ioan Bucur for the technical support, to Janeta Pop for graphical work on map, and to Dr. Dana Pop for the English corrections.

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PLATE CAPTIONS

PLATE I:

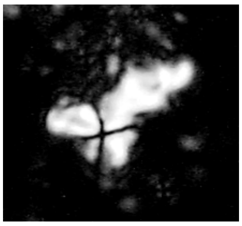
Fig.1a, 1b, 1c, 1d, 1e - *Sphenolithus heteromorphus* Deflandre. L.M., N+; x 4000 (Cepari quarry).

Fig.2a - *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon and *Helicosphaera carteri* (Wallich & Kamptner). L.M., N+; x 4000 (Cepari quarry).
2b - *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon. L.M., N+; x 4000 (Cepari quarry).
Fig. 3 - *Sphenolithus abies* Deflandre *in* Deflandre & Fert. L.M, N+; x 4000 (Cepari quarry).
Fig. 4 - *Sphenolithus neoabies* Bukry & Bramlette. L.M, N+; x 4000 (Cepari quarry).
Fig. 5 - *Coccolithus pelagicus* (Wallich & Schiller) and *Helicosphaera carteri* Wallich, Kamptner. L. M, N+; x 4000 (Cepari quarry).
Fig. 6 - *Coccolithus miopelagicus* Bukry. L.M, N+; x 4000 (Cepari quarry).
Fig. 7a, 7b - *Helicosphaera carteri* Wallich, Kamptner. L.M, N+; x 4000 (Cepari quarry).
Fig. 8 - *Helicosphaera scissura* Miller. L.M, N+; x 4000 (Cepari quarry).
Fig. 9 - *Helicosphaera ampliamperta* Bramlette & Wilcoxon. L.M, N+; x 4000 (Cepari quarry).

Plate II:

Fig. 1a, 1b - *Pontosphaera multipora* Kamptner (Roth). L.M, N+; x 4000 (Cepari quarry).
Fig. 2 - *Cyclicargolithus floridanus* (Roth & Hay *in* Hay). Bukry and *Reticulofenestra pseudoumbilicus* Gartner (Gartner). L.M, N+; x 4000 (Cepari quarry).
Fig. 3 - *Rhabdosphaera pannonica* Baldi-Beke and *Coccolithus miopelagicus* Bukry. L.M, N+; x 4000 (Cepari quarry).
Fig. 4 - *Coronocyclus nitescens* (Kamptner) Bramlette & Wilcoxon. L.M, N+; x 4000 (Cepari quarry).
Fig. 5 - *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre. L.M, N+; x 4000 (Cepari quarry).
Fig. 6 - *Umbilicosphaera rotula* Müller. L.M, N+; x 4000 (Cepari quarry).
Fig. 7- *Discoaster exilis* Martini & Bramlette. L.M, N+; x 4000 (Cepari quarry).
Fig. 8a, 8 b -*Thoracosphaera heimii* (Lohmann) Kamptner. L.M, N+; x 4000 (Cepari quarry).
Fig. 9 - *Calcidiscus protoannula* (Gartner) Loeblich & Tappan. L.M, N+: x 4000 (Cepari quarry)

PLATE I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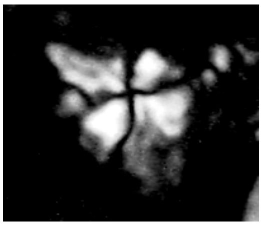
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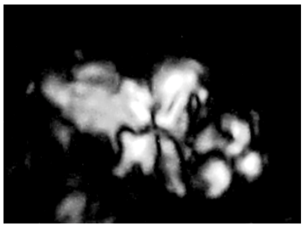
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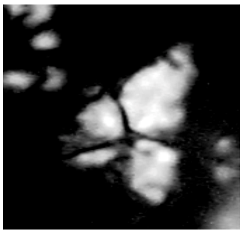
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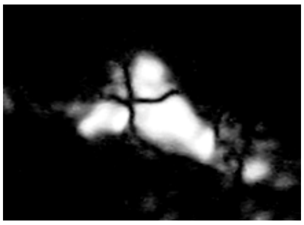
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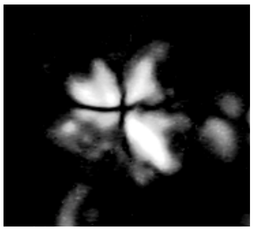
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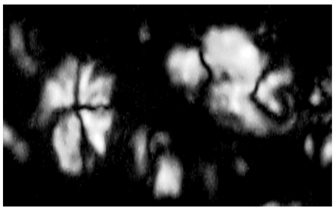
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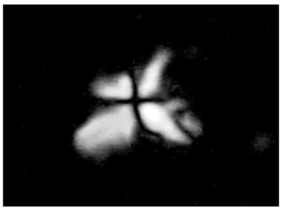
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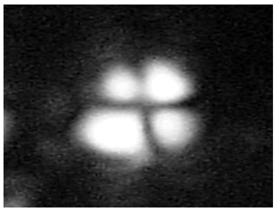
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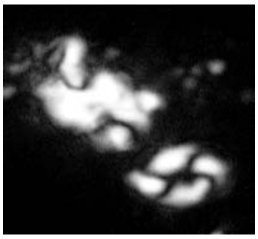
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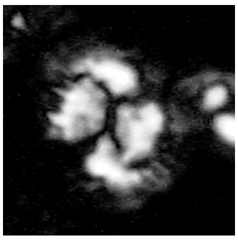
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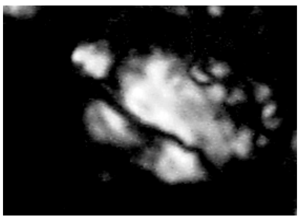
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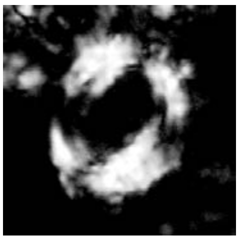
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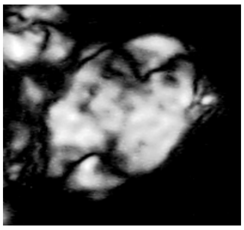

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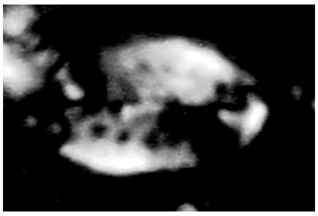

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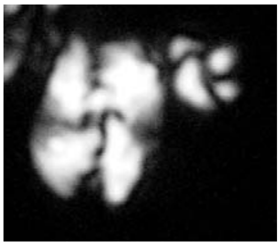

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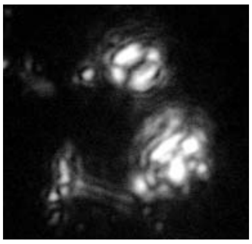

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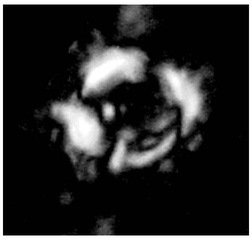

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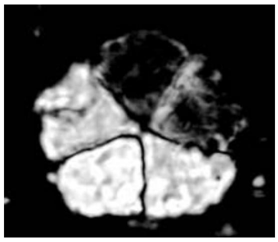
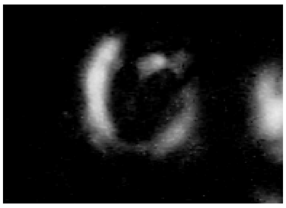
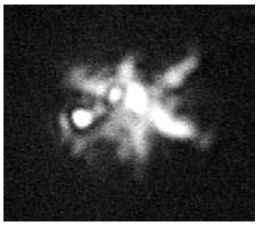


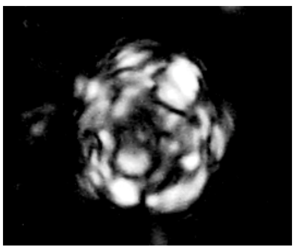
5



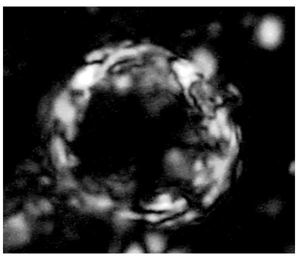
6



7



8a



8b

9

Number of samples	(cm)	Number of specimens	Species richness	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*Coccolithus miopelagicus*	*Coccolithus pelagicus*	*Coronocyclus nitescens*	*Calcidiscus protoanula*	*Cyclicargolithus floridanus*	*Discoaster exilis*	*Discoaster musicus*	*Helicosphaera carteri*	*Helicosphaera ampliaperta*	*Helicosphaera euphratis*	*Helicosphaera scissura*	*Helicosphaera wallichii*	*Pontosphaera multipora*	*Rhabdosphaera pannonica*	*Reticulofenestra pseudoumbilicus*	*Calciosolenia murray*	*Sphenolithus abies*	*Sphenolithus heteromorphus*	*Sphenolithus moriformis*	*Sphenolithus neoabies*	*Syracosphaera histrica*	*Triquetrorhabdulus rugosus*	*Thoracosphaera heimii*	*Umbilicosphaera rotula*		*Globorotalia* cf. *transylvanica*	*Globorotalia bykovae*	?*Paragloborotalia* sp.	*Globigerinoides trilobus*	*Orbulina suturalis*	*Globigerinoides* spp.	*Globigerina* cf. *praebulloides*	*Globigerina* cf. *bulloides*
32	619	300	8			149	64		15				53		1							3	12		3													
31	610	300	7			174	30			28			36					13					16		3													
30	584	300	12		6	167	37		1	13	9		48			2							10		5	1		1										
29	559	300	11		4	159	27			3		1	50			1		1		51			2		1													
28	540	300	11		4	158	11			2			41			1	1		1	70			5		6													
27	536	300	10			130	31		1	5			45			1		2		76			7		2													
26	523	300	11			163	39		1	5	10	6	26						1	28			20	1														
25	510	300	9			113	69		2		9	2	9							93			1						2									
24	494	300	10			178	23		8	3	11	3	16							51			6	1						X	X			X		X	X	X
23	474	300	13		2	111	38		2	31		2	63			1	2	2		39			6		1													
22	461	300	13			155	30	1	2		2	2	16						1	79		1	6	2	3													
21	440	300	10			99	41		2	4	2		37					1		99			13		2													
20	423	300	10			170	35		3		14		14					1		57			4		1				1									
19	405	300	9			198	16				8		10							44			9	1	1	13												
18	389	300	12		1	210	31		1		2	1	16					2		19			10		2	5												
17	215	300	10			218	10			3	3		10					1		27			1		2	25												
16	209	300	15	2	1	103	91	1	3	2	11		20				1	1		41			18	1	3	1												
15	202	300	12		2	94	44		2	1	35		47							67		2	6															
14	195	300	10			77	53		6		3	8	44						2	101			5			1												
13	182	300	8		2	93	78			1	2	1	57						2	64																		
12	178	300	13		8	98	39		4	1	4		45					1		70			22		1	6	1				X			X		X	X	X
11	174	300	14		4	49	178	3			2		6	2				6		35	1	1	5		1	4			3									
10	169	300	14		1	67	185			4	1		19		2	1		2	1				12	1	1			3										
9	162	300	11		1	84	147	2	1	1			15							38		1	4					6										
8	119	300	13		3	119	75		4	4			16							51		1	11	4	4	1		7										
7	112	300	11		4	5	207						3			2		3	1	69			3	1				2										
6	106	300	7			74	88				1		19							107			7					4										
5	101	300	12			30	147		3	4	1	4	20		2					70			8		2	1		8										
4	92	300	16		2	53	77			3	7	6	22				1	1		113		1	9	1	1		1	2										
3	82	300	14			61	86	1		2	11	2	35		3					82			10	1	3	1		2										
2	69	300	15		1	117	6	2					29		1					100		1	15	2	8	15		1	2	X	X	X	X	X	X			
1	30	43	5			26	10						3							3			1															

Table 1. Counts of calcareous nannofossils, and the identified foraminifera species in the Cepari section.