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# THE MIOCENE CALCAREOUS NANNOFOSSILS FROM BISTRIȚA AREA (TRANSYLVANIA, ROMANIA)

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**ABSTRACT**. The Middle Miocene (Badenian, Sarmatian and Pannonian) deposits from the region of Bistrița, between the localities: Susenii Bârgăului, Livezile, Bistrița, Sărata, Sărățel, Budacu de Sus (Transylvanian Basin) have been analysed from the nannofloral point of view. The nannofossils are relatively scarce, excepting the ones related to Lower Badenian deposits. Only the fossil index for NN5 Zone – *Sphenolithus heteromorphus*, and for NN6 Zone – *Discoaster exilis* have been identified.

**Keywords**: Middle Miocene, Transylvania, calcareous nannofossils.

## I. INTRODUCTION

The Middle Miocene deposits are represented, in the region of Bistrița, (located between Josenii Bârgăului, Livezile, Bistrița, Sărata, Sărățel and Budacu de Sus localities) by Badenian, Sarmatian and Pannonian sediments (Fig. 1). The investigation of these deposits were focussed, so far, mainly on foraminifera, ostracods, a. o. groups of organisms.

The prevoius geological studies in the region of Bistrița belong to Hauer & Stache (1863), Koch (1900), Ciocîrdel (1953), Pătruț (1952), and more recently to Petrescu & Chintăuan (1987), Chintăuan (1994), Chira (1999; 2000; 2001), Vulc (2002; 2003), a.o.

The purpose of this paper is to present the results of our nannofloral analysis carried out on the Middle Miocene sediments from the Bistrița region.

## II. GEOLOGICAL SETTING

The oldest Middle Miocene formations in the Bistrița region (Lower Badenian in age) are located in the western and north-western part of the studied area (between Josenii Bârgăului, Herina, Sărata and Sărățel), and belong to the Dej Formation. The Middle Badenian sediments belong to Ocna Dejului and Mireş Formation. The deposits of Mireş Formation and Iris Formation (Lower Sarmatian) are outcropping in the south-eastern part of Bistrița region (Bistrița - Cărămidărie quarry, Livezile, Budacu de Sus).

The Dej Formation consists of marls, and tuffs (the Dej Tuff), the later being well developed in the Cireşului Hill – Josenii Bârgăului area.

The Middle Badenian (= Wieliczkian) sediments are represented by salt deposits in Sărata, Sărățel and Herina areas. To remark that this type of deposits, of chemical precipitation, from the Transylvanian Basin, located on the top of Dej Formation, were previously included by Popescu (1972) in the Mireş Formation,

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which contains “Ocna Dejului Member”, the “radiolarian shales” and the “*Spirialis* marls”. Mészáros (1991) denominated the chemical precipitation deposits as “Ocna Dejului Beds”. On the western border of the Transylvanian Basin, Filipescu (1996) described the gypsum deposits, occuring in Copăceni – Sănduleşti – Cheia area, as Cheia Formation (Middle Badenian). This lithostratigraphical unit is considered to be an equivalent of the “Ocna Dejului Member”, established for the deeper salt facies, present in diapiric structures east from the border of the basin (Filipescu, 1996). In the most recent revision of the lithostratigraphic units from Transylvania (Filipescu, 2001), the salt-containing deposits of the Middle Badenian (Wieliczkian) (Late Langhian) formation was named Ocna Dejului Formation (according to Mészáros, 1991).

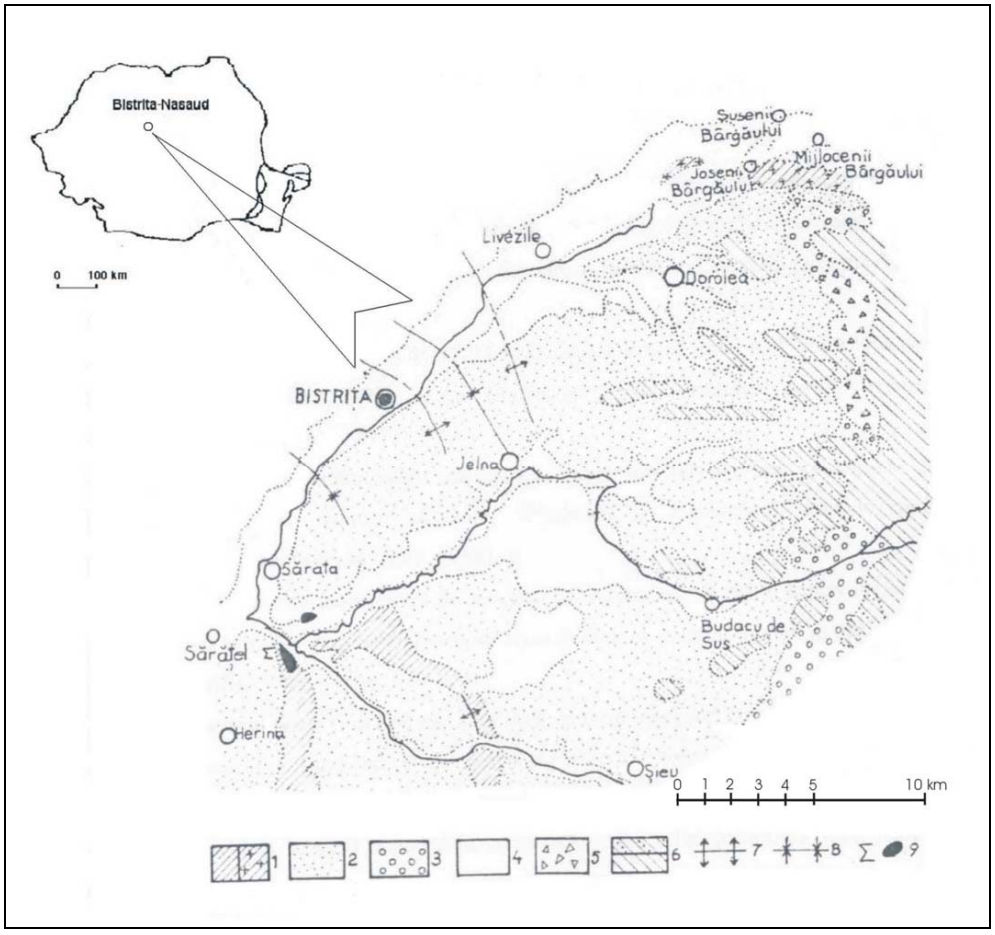


**Fig. 1.** *Location map of the studied area (Bistrița - Năsăud county): Susenii Bârgăului, Livezile, Sărata, Sărățel, Budacu de Sus. Legend: 1. Badenian, 2. Sarmatian, 3. Pannonian, 4. Quaternary fluviatile deposits, 5. Quaternary colluvial - deluvial deposits, 6. Pannonian and Quaternary magmatic rocks, 7 – anticline, 8 - syncline, 9. Salt diapir (after the geological map 1:200.000 – Marinescu & Peltz, 1967, with modifications).*

Mészáros et al. (1989), based on calcareous nannoplankton, considered the salt deposits from Turda area as belonging to the upper part of the NN5 Zone. In generally, the salt from the Transylvanian Basin was considered to be late Early Badenian in age.

The deposits of the Mireş Formation, overlying the salt formation and characterised, lithologically point of view by "radiolarian shales" and "*Spirialis* marls", are located in the neighborhood of Budacu de Sus – Budacu Valley.

The next lithostratigraphical unit is the Iris Formation, outcropping in Bistrița – Cărămidărie quarry, and represented by marls and clays.

The Feleac Formation (investigated near Domneşti), overlying the Iris Formation, consists of sandstones and sands.

The Pannonian sediments, belonging to Lopadea Formation are present at Budacu de Sus and are represented by sands, sandstones, conglomerates and marls.

## III. MIDDLE MIOCENE CALCAREOUS NANNOFOSSILS ASSEMBLAGES: GENERAL CONSIDERATIONS FOR THE TRANSYLVANIAN BASIN AND RESULTS FROM BISTRIȚA AREA

### *III.1. Material and methods*

Over 50 samples were taken to be analyzed nannofossil point of view, from the Dej, Ocna Dejului, Miriş, Iris, Feleac and Lopadea formations,.

The smear slides were studied under the light microscope, with magnification 1000.

The listed nannofossil species are indexed in Perch-Nielsen (1985) and Young (1998).

### *III.2. Biostratigraphy*

The calcareous nannoplankton assemblages of **Badenian** age belong to **NN5** Zone – with *Sphenolithus heteromorphus* and to **NN6** Zone – with *Discoaster exilis*, according to the Standard Nannoplankton Zonation (Martini, 1971).

The Badenian nannoplankton bioevents from the Transylvanian Basin have been established by Mărunțeanu & Chira (1998).

Concerning the calcareous nannofossils, some features were evidenced for the Badenian (Moravian, Wieliczkian, and Kossovian) of the Carpathian area from Romania (Mărunțeanu & Chira, 1998):

- the lower boundary of the Badenian, corresponding to the beginning of NN5 Zone, cannot be correlated with the beginning of the Langhian, characterized by the upper part of NN4 Zone.

- the Moravian is characterized by the NN5 Zone assemblage, its lower boundary corresponding to the extinction of *Helicosphaera ampliaperta* and/or the first occurrence (FO) of *Discoaster exilis*.

- the Wieliczkian can be defined as the time interval beginning with the FO of Discoaster *brouweri*, being indicated by the upper part of NN5, and the lower part of NN6 zones.

- the Kossovian covers most of the NN6 Zone, its upper boundary being marked by the extinction of *Cyclicargolithus floridanus*.

- the Badenian top was defined, in nannoplankton terms, by the NN7 Zone, by Müller (1974), Fuchs & Stradner (1977), Rögl & Müller (1976), Mészáros (1991) a. o.

**NN5** Zone was defined by Bramlette & Wilcoxon (1967), between the last occurrences of *Helicosphaera ampliaperta* and the last appearances of *Sphenolithus heteromorphus*.

The nannofossil content of ***Sphenolithus heteromorphus* Zone (NN5)** consists of *Sphenolithus heteromorphus*, *Discoaster exilis*, *Discoaster musicus*, *Discoaster variabilis*, *Holodiscolithus macroporus*, etc.

*Discoaster brouweri*, *Helicosphaera wallichii* and *Sphenolithus abies* have simultaneous first occurrences before the last appearance of *Sphenolithus heteromorphus*.

The ***Sphenolithus heteromorphus* Zone** can be correlated with the following foraminifera zones: *Candorbulina glomerosa,* and *Candorbulina universa*/ *Globorotalia bykovae* (defined by Popescu, 1970), characterizing the **Early Badenian**, then with the basis of *Globigerina druryi*/*Globorotalia transsylvanica* (defined by Popescu & Gheța, 1984), which indicates the debut of Middle Badenian.

### *III.3. Nannofloral assemblages*

The Badenian sediments (the Dej Formation) from Cireşului Hill – Josenii Bârgăului have been considered to belong to the NN5 Nannofossil Zone (Tab. 1). To remark that in the studied area, the Dej Tuff, marking the beginning of the formation, is present.

The ***Discoaster exilis* Zone (NN6)** (Martini & Worsley, 1970) includes the stratigraphic interval between the extinction of *Sphenolithus heteromorphus* and the first occurrence of *Discoaster kugleri*. Its upper boundary can also be approximated by the last appearances of *Cyclicargolithus floridanus*.

Its lower part is characterized by the explosive development of *Discoaster brouweri* and the presence of rare *Triquetrorhabdulus rugosus*.

The nannoplankton content, specific to the ***Discoaster exilis* Zone**, consists of *Discoaster brouweri*, *Discoaster exilis*, *Discoaster variabilis*, *Helicosphaera wallichii*, *Sphenolithus abies, Triquetrorhabdulus rugosus, Syracolithus dalmaticus*, *Scapholithus fossilis*, *Helicosphaera walbersdorfensis* etc., that occur at different stratigraphic levels.

The **NN6 Zone** can be correlated to *Globigerina druryi*/*Globorotalia transsylvanica* and *Velapertina* foraminifera Zones, which characterize the **Middle**, and respectively the **Late Badenian**.

Based on detailed studies of the Badenian calcareous nannofossils of Romania, the **subzones** corresponding to the **Wieliczkian** (Mărunțeanu et al., 2000) have been established. This allowed the establishment of several bioevents that are very important for regional and worldwide biostratigraphic correlations. On their basis, the *Sphenolithus heteromorphus* – NN5 and *Discoaster exilis* - NN6 standard zones, which exclusively characterize Badenian nannoplankton assemblages, were subdivided into several subzones, as follows: *Geminilithella rotula* – NN5a, that defines the Moravian Substage; *Helicosphaera wallichii* – NN5b and *Discoaster variabilis* – NN6a, typical for Wielician Substage; *Syracosphaera histrica* – NN6b, *Syracolithus dalmaticus* – NN6c and *Calcidiscus pataecus* – NN6d, which characterize the Kossovian Substage.

The Wieliczkian, (after Mărunțeanu et al., 2000), characterized by *Helicosphaera wallichii* - NN5b and *Discoaster variabilis* - NN6a subzones, can be correlated to the Uppermost Langhian, defined by the uppermost parts of the *Eu-discoaster musicus*

Subzone (Theodoridis, 1984) or *Helicosphaera walbersdorfensis/Sphenolithus heteromorphus* Subzone (Fornaciari et al., 1996) and with the Lowermost Serravallian, defined by *Helicosphaera walbersdorfensis* and *Helicosphaera stalis* subzones (Theodoridis, 1984) or *Sphenolithus heteromorphus*/ *Reticulofenestra pseudoumbilicus* - MNN6a and *Reticulofenestra pseudoumbilicus* - MNN6b subzones (Fornaciari et al., 1996).

The Wieliczkian deposits with salt are present in the investigated area at Sărata and Sărățel (Tab.1).

In the opinion of Young (in Bown, 1998), the mentioned nannoplankton assemblages correspond to the **intervals C partim** and **D partim**. **Interval C** (NN4-**5**/CN3-**4**) was defined by the LO of *Sphenolithus belemnos* to LO of *Sphenolithus heteromorphus*. *Sphenolithus heteromorphus* is a distinctive and abundant species which characterizes this interval. This interval shows a rich diversity, including new species like *Calcidiscus premacintyre*i and *Discoaster exilis*. The most common species are: *Cyclicargolithus floridanus, Coccolithus pelagicus, Calcidiscus* spp., *Sphenolithus moriformis, S. heteromorphus, Discoaster exilis, Helicosphaera carteri, Umbilicosphaera jafari,* and *U. rotula*. **Interval D** was defined from the LO of *Sphenolithus heteromorphus* to FO of *Catinaster* (**NN6**-7/**CN5a**-b). This interval is of low diversity. Many species from the earlier assemblages are rare, such as: *Cyclicargolithus floridanus, Sphenolithus heteromorphus,* a.o. The most common species are considered to be: *Reticulofenestra pseudoumbilicus, Coccolithus pelagicus, Calcidiscus leptoporus, Discoaster exilis, Helicosphaera carteri, Umbilicosphaera jafari,* and *U. rotula*. Other species, e.g. *Triquetrorhabdulus rugosus*, which is less common, are considered to be more useful for biozonation purposes (Young in Bown, 1998).

According to Peryt (1997), the studied Middle Badenian evaporites studied from Upper Silezia (Poland), belong to the lower part of the NN6 zone.

The Sarmatian assemblages prove a high frequence of the species *Calcidiscus leptoporus, Cyclicargolithus floridanus, Calcidiscus macintyrei, Coccolithus miopelagicus, Coccolithus pelagicus, Triquetrorhabdulus rugosus, Sphenolithus abies, Sphenolithus moriformis*. Rarely specimens of *Sphenolithus heteromorphus*, the index species for NN5 Zone were remarked.

The assemblages also contain: *Reticulofenestra pseudoumbilicus, Pontosphaera multipora, Syracosphaera histrica, Discoaster* cf*. musicus, Umbilicosphaera* cf*. jafari, Holodiscolithus macroporus*.

The Pannonian deposits which contain representative mollusks and ostracods are very scarce in calcareous nannofossils (Tab. 1).

**Table 1.**

Representative calcareous nannofossils from Bistrița area
(according to the classification of Young & Bown, 1997).

| **NANNOFOSSIL SPECIES** | Josenii Bârgăului (Cireşului Hill) | Sărățel | Bistrița – Cărămidărie quarry | Budacu de Sus |
|---|---|---|---|---|
| **CALCAREOUS NANNOPLANKTON: HETEROCOCCOLITS** **Family Helicosphaeraceae** | | | | |
| *Helicosphaera carteri* (WALLICH, 1877) KAMPTNER (1954) | X | | X | X |
| *Helicosphaera wallichii* (LOHMAN, 1902) OKADA & MCINTYRE (1997) | X | | | X |

| | | | | |
|---|---|---|---|---|
| *Helicosphaera mediterranea* (MUELLER, 1974) | | | X | |
| *Helicosphaera euphratis* (MUELLER, 1974) | | | X | |
| *Helicosphaera walbersdorfensis* (MUELLER, 1974) | | | X | |
| **Family Pontosphaeraceae** | | | | |
| *Pontosphaera multipora* (KAMPTNER, 1948) ROTH (1970) | X | X | X | X |
| **Family Calciosoleniaceae** | | | | |
| *Calciosolenia murrayi* DEFLANDRE IN DEFLANDRE & FERT (1954) | | | X | |
| **Family Syracosphaeraceae** | | | | |
| *Syracosphaera histrica* KAMPTNER (1941) | | X | | X |
| **Family Rhabdosphaeraceae** | | | | |
| *Rhabdosphaera pannonica* BALDI-BEKE (1960) | X | | X | |
| **Family Noelaerhabdaceae** | | | | |
| *Cyclicargolithus floridanus* (ROTH & HAY *in* HAY *et al*., 1967) BUKRY (1971) | X | X | X | X |
| *Reticulofenestra pseudoumbilicus* (GARTNER, 1967) GARTNER (1969) | X | X | X | X |
| *Reticulofenestra minuta* ROTH (1970) | | | X | |
| **Family Coccolithaceae** | | | | |
| *Coccolithus miopelagicus* BUKRY (1971) | X | X | X | X |
| *Coccolithus pelagicus* (WALLICH, 1877) SCHILLER (1930) | X | X | X | X |
| **Family Calcidiscaceae** | | | | |
| *Calcidiscus leptoporus* (MURRAY & BLACKMAN, 1898) LOEBLICH & TAPPAN (1978) | | | | X |
| *Umbilicosphaera jafari* MÜLLER (1974) | | | X | X |
| *Umbilicosphaera rotula* | X | | | |
| **NANNOLITHS**<br>**Family Braarudosphaeraceae** | | | | |
| *Braarudosphaera bigelowii* (GRAN & BRAARUD, 1935) DEFLANDRE (1947) | | | X | |
| **Family Discoasteraceae** | | | | |
| *Discoaster musicus* STRADNER (1959) | X | | X | X |
| *Discoaster* cf. *musicus* STRADNER (1959) | X | | X | X |
| *Discoaster deflandrei* BRAMLETTE & RIEDEL (1954) | X | | X | |
| *Discoaster brouweri* TAN (1927) emended BRAMLETTE & RIEDEL (1954) | | | X | |
| *Discoaster variabilis* MARTINI & BRAMLETTE (1963) | X | | X | |
| *Discoaster exilis* MARTINI & BRAMLETTE (1963) | X | | X | |
| **Family Sphenolithaceae** | | | | |
| *Sphenolithus heteromorphus* DEFLANDRE (1953) | X | X | X | |
| *Sphenolithus moriformis* (BRÖNNIMANN & STRADNER, 1960) BRAMLETTE & WILCOXON (1967) | X | | | X |
| *Sphenolithus abies* DEFLANDRE *in* DEFLANDRE & FERT (1954) | X | X | X | X |
| *Sphenolithus neoabies* BUKRY & BRAMLETTE | X | | | |
| **Family Triquetrorhabdulaceae** | | | | |
| *Triquetrorhabdulus rugosus* BRAMLETTE & WILCOXON (1967) | | X | X | X |
| **CALCAREOUS DINOFLAGELLATES** | | | | |
| *Thoracosphaera heimii* (LOHMANN 1919) Kamptner 1941 | X | X | X | X |
| *Thoracosphaera* sp. | X | X | X | X |

## IV. CONCLUSIONS

In conclusion, in the Bistrița area, the calcareous nannofossils allow us to evidence the presence of the Middle Miocene deposits, belonging to Badenian (NN5 – NN6), Sarmatian (NN7 – NN9) and Pannonian (NN10 – NN11).

Only for the Badenian deposits the marker species from the standard zonations have been identified: *Sphenolithus heteromorphus* (NN5) and *Discoaster exilis* (NN6) (Martini's zonation, 1971).

The data concerning the calcareous nannofossils, based on the assemblage with *Discoaster exilis, D. variabilis, Triquetrorhabdulus rugosus*, *Cyclicargolithus floridanus*, a.o., allow us to attribute the analysed clays from the salt to Wieliczkian.

The extinction of *Cyclicargolithus floridanus* is considered to mark the limit between NN6/NN7 Zones.

The index species for NN5 - *Sphenolithus heteromorphus* was rarely noticed in the analysed samples, as well as the index species for NN6 – *Discoaster exilis* was observed in the analysed samples too. But the whole assemblage is scarce in calcareous nannofossils as compared to the abundance of nannofloras that generally characterize the Moravian (Early Badenian) (NN5 Zone – with *Sphenolithus heteromorphus*).

NN6 Zone – with *Discoaster exilis* is marked at the upper part by the last appearance of *Cyclicargolithus floridanus*. It is characteristic for Wieliczkian and Kossovian.

Generally, in Central Paratethys, the beginning of NN6 Zone can be correlated with the first appearance of *Triquetrorhabdulus rugosus*. The frequence of *Cyclicargolithus floridanus* is decreasing towards the upper part of the zone.

The studied deposits at the level of salt, can be considered to belong to the upper part of NN5 Zone (NN5b Subzone) and the lower part of NN6 Zone (NN6a Subzone), both corresponding to Middle Badenian (Wieliczkian).

The nannofossils assemblages of the Pannonian deposits, as well as those of the Sarmatian ones, are very scarce, and the marker species are lacking. Generally, they are attributed to NN7 – NN11 Zones.

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**Plate I, Fig.** (x 2.000):

1a, 1b - *Sphenolithus heteromorphus* Deflandre. 1a - N+; 1b - N+; Budacu de Sus.
2a, 2b - *Cyclicargolithus floridanus* (Roth & Hay) Bukry. 2a - NII; 2b-N+; Josenii Bârgăului – Cireşului Hill.
3 - *Sphenolithus abies* Deflandre. N+; Josenii Bârgăului - Cireşului Hill.
4 - *Sphenolithus neoabies, Coccolithus pelagicus* (Bukry & Bramlette) Wallich, Schiller. N+; Josenii Bârgăului - Cireşului Hill.
5 - *Umbilicosphaera rotula* Müller. NII;
6a, 6b - *Coccolithus miopelagicus* Bukry. 6a - NII; 6b - N+; Josenii Bârgăului -Cireşului Hill.
7a, 7b - *Coccolithus pelagicus* (Wallich) Schiller. *Coccolithus miopelagicus* Bukry. 7a – NII; 7b - N+; Budacu de Sus.

**Plate II Fig.** (x 2.000):

1, 2, 3 - *Discoaster variabilis* Martini & Bramlette. NII; 1, 2 - Josenii Bârgăului Cireşului Hill; 3 - Budacu de Sus.
4, 5 - *Discoaster musicus* Stradner. NII; 4 - Josenii Bârgăului – Cireşului Hill; 5 - Budacu de Sus.
6, 7 - *Discoaster exilis* Martini & Bramlette. NII; Budacu de Sus.
8, 9, 10 - *Discoaster cf. brouweri (*Bramlette & Riedel) Tan. NII; 8 – Bistrița - Cărămidărie quarry; 9, 10 - Budacu de Sus.
11, 12 - *Discoaster deflandrei* Bramlette & Riedel. NII; 11 - Josenii Bârgăului –Cireşului Hill; 12 - Bistrița - Cărămidărie quarry.

**Plate III Fig.** (x 2.000):

1a, 1b - *Calciosolenia murray* Deflandre in Deflandre & Fert.. 1a - NII; 1b - N+; Bistrița - Cărămidărie quarry.
2a, 2b - *Rhabdosphaera pannonica* Baldi-Beke. 2a - NII; 2b - N+; Josenii Bârgăului – Cireşului Hill.
3a, 3b - *Rhabdosphaera pannonica* Baldi-Beke. 3a - NII; 3b - N+; Bistrița - Cărămidărie quarry.
4a, 4b - *Syracosphaera cf. hystrica* Kamptner. 4a - NII; 4b - N+; Sărățel.
5 - *Reticulofenestra pseudoumbilicus* Gartner. N+; Josenii Bârgăului - Cireşului Hill.
6a, 6b, 7 - *Calcidiscus leptoporus* (Murray & Blackman) Loeblich & Tappan. 6a - NII; 6b - N+; Budacu de Sus. 7 - N+; Bistrița – Cărămidărie quarry.

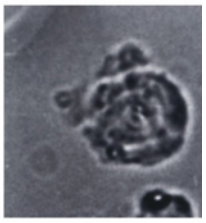
**Plate IV Fig.** (x 2.000):

1a, 1b - *Helicosphaera carteri* Wallich, Kamptner. 1a - NII; 1b - N+; Josenii Bârgăului – Cireşului Hill.
2a, 2b - *Helicosphaera wallichii* Lohmann (Okada & McIntyre). 2a - NII; 2b - N+; Josenii Bârgăului - Cireşului Hill.
3a, 3b - *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre. 3a - NII; 3b - N+; Bistrița – Cărămidărie quarry.
4 - *Umbilicospahera jafari* Müller, *Coccolithus pelagicus* Wallich, Schiller. N+; Budacu de Sus.
5 - *Coccolithus pelagicus* Wallich, Schiller, *Coccolithus miopelagicus* Bukry. N+; Budacu de Sus.
6a, 6b - *Thoracosphaera heimii* Lohmann, Kamptner. 6a - NII; 6b - N+; Josenii Bârgăului.
7 - *Thoracospahera heimii* Lohmann, Kamptner. N+; Bistrița – Cărămidărie quarry.

## Plate I


1a

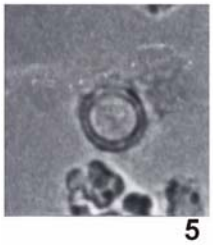

1b


2a


3


4


2b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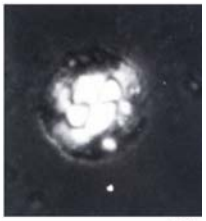
6a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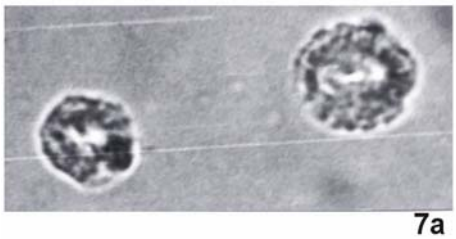
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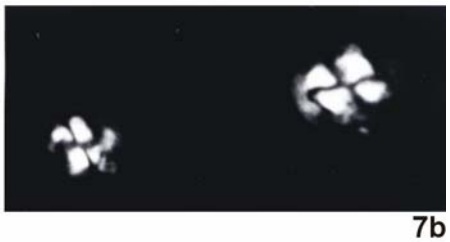
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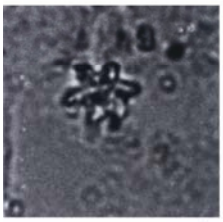
**Plate II**


1


2


3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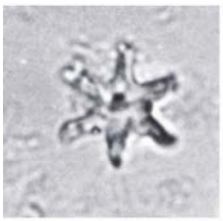
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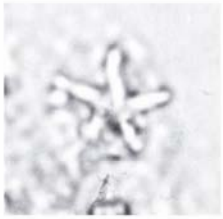
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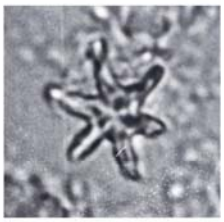
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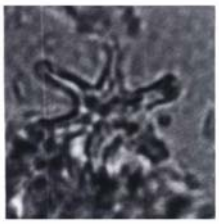
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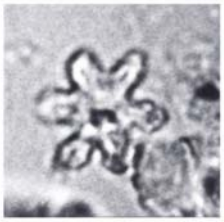
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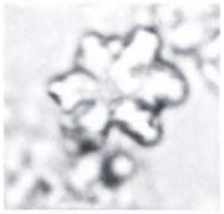
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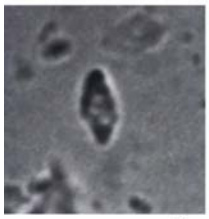
## Plate III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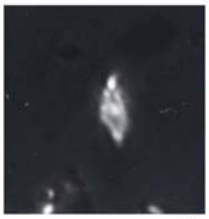
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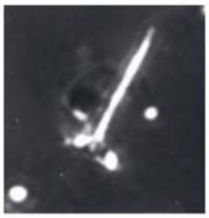
2a


3a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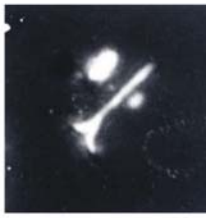
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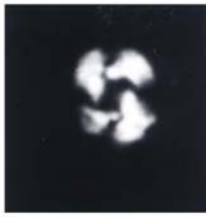
4a


4b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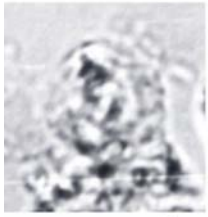
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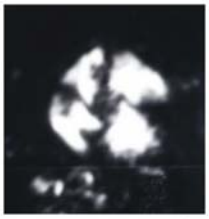
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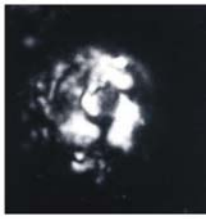
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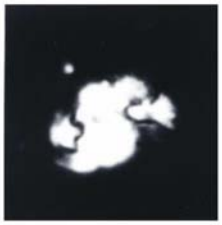
## Plate IV


1a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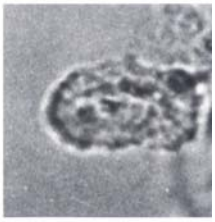
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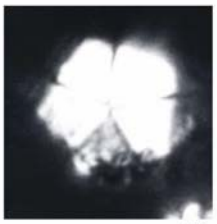
3a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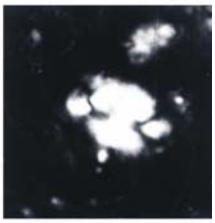
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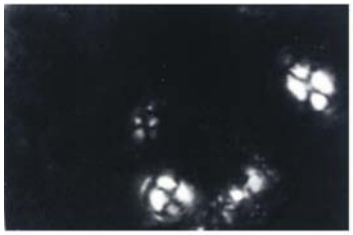
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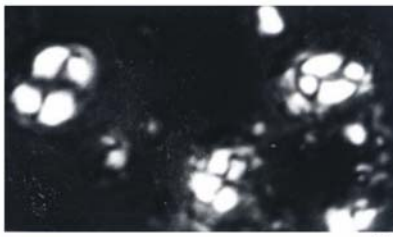
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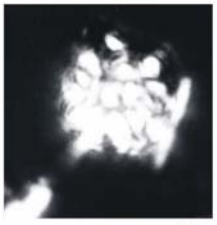
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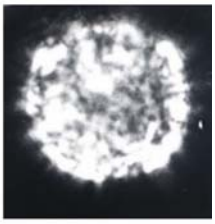
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