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CRETACEOUS CALCAREOUS NANNOFOSSILS FROM CERU BĂCĂINȚI AREA, APUSENI MOUNTAINS, ROMANIA

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Abstract. The paper focuses on the Lower and Upper Cretaceous calcareous nannofossils from Ceru Băcăinți area, located between Homorod – Bozeş and Vinţu de Jos. Previous studies were carried out on foraminifera, molluscs and other organisms. The assemblages of calcareous nannofossils prove the presence of Albian–Aptian and Santonian–Lower Maastrichtian deposits, which belong to the Meteş and Bozeş formations. The assemblages belong to CC7, CC8 and CC15, CC16, CC17, CC19, CC24 Zones.

Keywords: Early Cretaceous (Aptian–Albian), Late Cretaceous (Santonian, Campanian, Ealy Maastrichtian), Alba Iulia area, Transylvania, calcareous nannofossils.

INTRODUCTION

The paper continues the studies concerning the calcareous nannofossils of several Cretaceous sites from Alba Iulia area (Transylvania).

The study concerns the Ceru Băcăinți area, located in the Bozeş-Homorod–Vinţu region, between Băcăinți and Fântânele.

Our paper is focused on the calcareous nannofossils of the Lower and Upper Cretaceous deposits cropping out on Mare and Fântânele valleys (Fig. 1).

The samples were collected from the Meteş and Bozeş formations.

The Meteş Formation (Bleahu & Dimian, 1967) (Early Cretaceous: uppermost Aptian–Middle Albian) was included in the Feneş Nappe (Unit) (Lupu, 1975), which has a wildflysh nature and overlies the Feneş and Valea Dosului formations in the northern sector of the Southern Apuseni Mountains.

Most of the deposits belong to the Late Cretaceous, assigned to Bozeş Formation.

The Bozeş Formation (Ghițulescu & Socolescu, 1941) is considered to represent a typical flysch, located between Geoagiu and Pâclişa valleys.

Previously, preliminary studies concerning the calcareous nannofossils from the southern Apuseni Mountains have been realised north of Vinţu de Jos, on Stăuinii Valley, Vurpăr area and Cetății Brook, and south of Vinţu de Jos, in the neighborhood of Blandiana (Bălc & Chira, 2002).

GEOLOGICAL SETTING

The Meteş Formation is cropping out on the Fântânele Valley, in the northern sector of the studied area.

The lithology is represented by sandstones, marls and clays, which have been considered by Iacob (1947) as belonging to Neocomian. These deposits are transgressively overlaying the Triassic ophiolites and Jurassic limestones.

The formation has a typical wildflysch nature and includes two members (Lupu et al., 1979): a lower one characterized by an olistostrome – like marly – silty facies with some interbedded turbiditic and coarse layered sandstones, and an upper member which consists of breccias with silty - marly green grey reddish matrix and exolistoliths consisting of ophiolitic rocks, Upper Jurassic massive limestones, granodiorites, and Lower Cretaceous sandstones. This features proves a southern source area of this material.

The Bozeş Formation (Bleahu et al., 1981), cropping out in the studied area (Santonian–Maastrichtian) represents a sandstone–marly flysch; it was included either in the Bozeş Nappe (Bleahu et. al., 1981), or in the Mureş Nappe (Balintoni, 1997)

It is a typical flysch formation, including two sequences: one with sandstones, limy sanstones and silty marls, and another with microconglomerates, sandstones and silty marls.

Toward the top, the flysch sequence is replaced by a mollassic one, in which conglomerate levels alternate with silty sandstones.

Within the sandstone levels the *Inoceramus balticus* Boehm, *Pachydiscus* aff. *colligatus* Bink, *Hoplitoplacenticeras vari* Schlütter point to the Campanian-Maastrichtian.

The top of the Bozeş Formation consists of continental deposits, marls, sandstones, in which the palynological data prove the Upper Maastrichtian age (Bleahu et. al., 1981).

Codrea et al. (2003) remarked that the Bozeş Formation should be restricted only to the flysh sequences, excluding any molass input. Than, the sedimentary environment abruptly changed to a fluvial plaine formation that lies disconformously on the fluvio-marine deposits.

Codrea et al. (2001, 2002) presented the lithology and the sedimentary environments of the fluvial plain deposits.

MATERIAL AND METHODS

About 78 samples were collected from Meteş and Bozeş formations for their nannofossil content.

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

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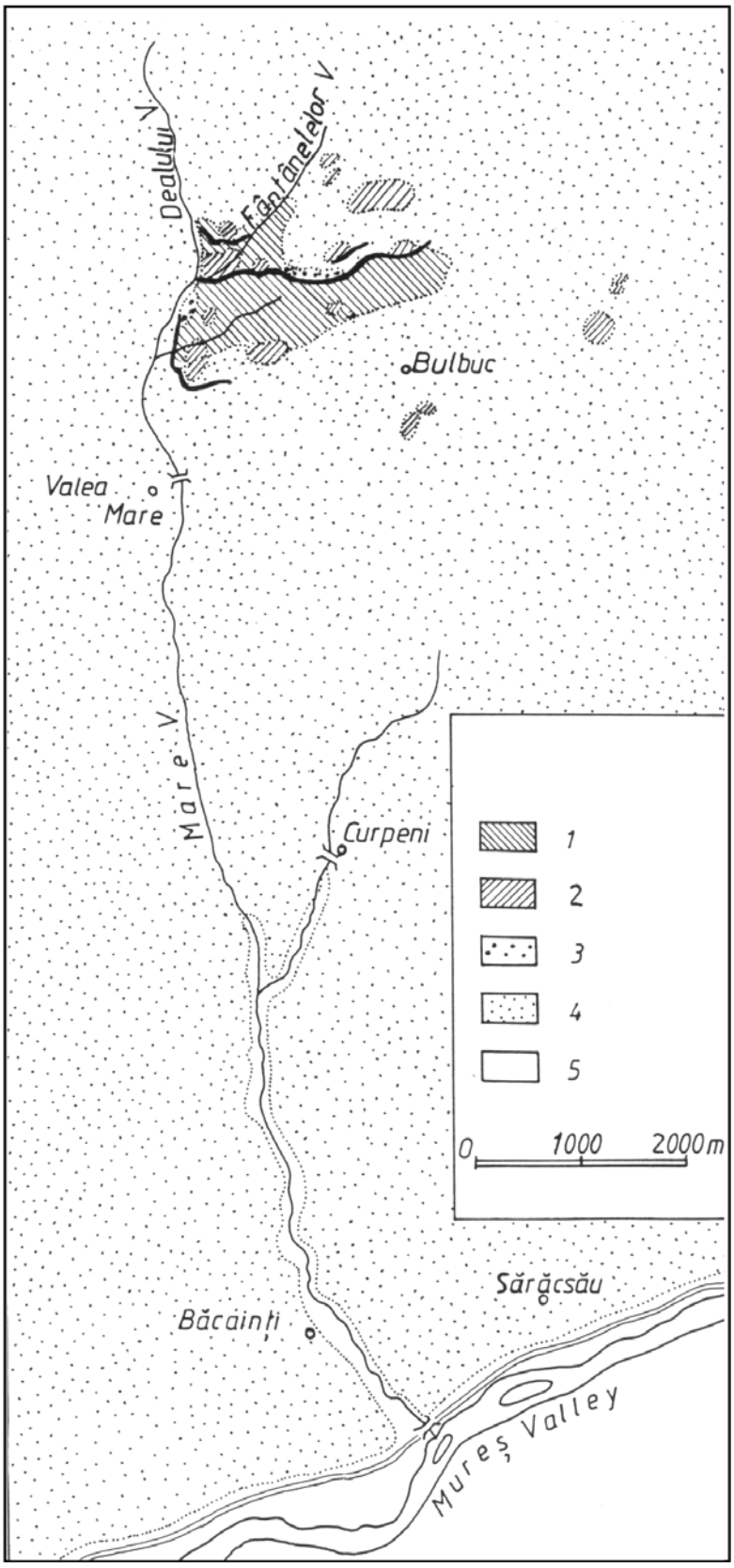

Fig. 1. Geological map of Băcăinţi area (according to Iacob, 1943) Scale 1:50.000
Legend:
1.-Triasic ophiolites;
2.-Tithonian limestones;
3.-Lower Cretaceous;
4.-Upper Cretaceous;
5.-Quaternary.

The biozones are given after Sissingh (1977) and Perch-Nielsen (1985).

PALAEONTOLOGICAL STUDIES IN ALBA IULIA AREA AND THE CORRELATION WITH HAȚEG DEPRESSION

Previous studies in the investigated area were carried out by Palfy (1902), Nopcsa, (1905), Iacob (1943), Ilie, (1955), Dimian & Popa – Dimian (1964), Bleahu & Dimian (1967), Tomescu et al. (1969), Antonescu (1973), Antonescu et al. (1983), Grigorescu (1987), Codrea et al. (2001, 2002, 2003), a. o.

Palfy (1902) tried to establish the presence of Cretaceous formations in the Vințu de Jos area.

Iacob (1943) remarked the presence of Neocomian and Campanian deposits.

The geological map of the studied area, according to Iacob (1943) (Fig. 1) gives the location of the Lower and Upper Cretaceous deposits from the Băcăinți area.

The Uppermost Aptian–Middle Albian age of the Meteş Formation is indicated by the micropalaeontological assemblage, in which *Hipocrepina depressa* Vasicek, *Haplophragmoides concava chapniaun, Plectorecurvoides alternans* Noth. are characteristic, as well as by the palynologic assemblage in which *Cllasopollis classoides, Deflandrea penella, Perriosaccites radiatus* and *Perriosaccites radiatus* are frequent (Antonescu, 1973; Bleahu et al., 1981).

A critical review concerning the various opinions on the age of the continental deposits, especially in the south-western Transylvanian Depression belongs to Grigorescu (1987).

A study of the Late Cretaceous deposits in Alba Iulia–Sebeş area realized by Codrea et al. (2001), established the Campanian–Early Maastrichtian age of the deposits. The typical foraminifera taxa for the upper part of the Maastrichtian are lacking. The authors noticed that the agglutinated foraminifera (*Goesella rugosa, Caudammina gigantea*) are common especially for the Campanian and the Maastrichtian, and that the planktonic species are dominated by taxa which are common for the Campanian and the base of the Maastrichtian (*Heterohelix globulosa, Globotruncana arca, G. ventricosa, G. calcarata* a.o.). Typical evolved taxa (*Plummerita, Gansserina, Kassablana, Abatomphalus*) characteristic for the upper part of the Maastrichtian are missing (Filipescu in Codrea et al., 2001).

The Upper Cretaceous deposits from Alba Iulia area can be correlated with the sediments of the same age from the Hațeg Depression (Codrea et al., 2001).

The correlation can be realised on the base of the reptilian fauna and the calcareous nannofossils.

The first study concerning the calcareous nannofossils from the Hațeg area was realised by Ianoliu et al. (1980). The age was considered Upper Santonian–Campanian-Lower Maastrichtian. The assemblages contain: *Arkhangelskiella cymbiformis, A. costata, Ahmuellerella octoradiata, Lithraphidites carniolensis, Calculites* (=*Tetralithus*) *obscurus.* These assemblages demonstrate the presence of the NC21 – NC22 biozones, after Roth (1978).

In the north-western Hațeg area, Melinte (in Grigorescu & Melinte, 2002) remarked the presence of the CC14–CC18 biozones for the Middle Coniacian–Upper Santonian deposits (Ştei Formation) and the upper part of CC18 up to CC22, characteristic for the uppermost Santonian–Uppermost Campanian deposits (Răchitova Formation). The youngest Cretaceous marine deposits have been considered Upper Campanian in age.

We can conclude that earlier studies realised in Alba Iulia area only concern the vertebrates, mollusks, foraminifera and pollen.

The corresponding ages established for the Cretaceous deposits were the Uppermost Aptian–Middle Albian, and the Santonian–Maastrichtian intervals.

LOWER CRETACEOUS CALCAREOUS NANNOFOSSIL ASSEMBLAGES

From the Lower Cretaceous deposits, 13 samples have been investigated.

The analysed samples from Fântânele Valley with *Hayesites* cf. *irregularis* (Thierstein in Roth & Thierstein, 1972) Applegate et al. in Covington & Wise, *Nannoconus steinmanni* Kamptner, 1931, *Braarudosphaera stenorhetha* Hill, 1976, *Prediscosphaera columnata* (Stover, 1966) Perch-Nielsen, 1984*, Conusphaera mexicana* Trejo, 1969*,* plead for the existence of Aptian and Albian deposits belonging to CC7 Zone (*Chiastozygus litterarius*), and CC8 Zone (*Prediscosphaera columnata*).

These zones approximatively correspond to BC19 – BC23 (Bown et al., 1998), defined in the boreal realm.

Hayesites irregularis is widely used as a basal Aptian marker at low-latitudes, being considered as rare or sporadic in the boreal realm (Bown et al., 1998).

The LO of *Nannoconus steinmanni* and the LO of *Conusphaera mexicana* were used by Perch-Nielsen (1979) for subdividing CC7a of Sissingh (1977).

Generally, a turnover occurring at the Barremian/Aptian boundary, when common were *Eprolithus*, *Flabellites* and *Hayesites* whilst nannoconids declined ("nannoconids crisis") is noticeable (Erba, 1994).

Prediscosphaera columnata Zone (CC8) was defined from the FO of *P. columnata* to the FO of *Eiffelithus turriseifelii* and is characteristic for the Albian.

The analysed assemblages also contain:

Watznaueria barnesae (Black in Black & Barnes, 1959) Perch-Nielsen, 1968, *Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre, 1952, *Zeugrhabdotus elegans* (Gartner, 1968) Burnett in Gale et al., 1996, *Assipetra terebradentarius* (Applegate et al. in Covington & Wise, 1987) Rutledge and Bergen in Bergen, 1994, *Calculites* sp., *Thoracosphaera* sp. (Pl. I). Sometimes *Eiffellithus turriseiffelii* Deflandre (in Deflandre and Fert, 1954) Reihardt, 1965*, Rhagodiscus sp., Sollastites sp., Cretarhabdus conicus* Bramlette and Martini, 1964*, Retecapsa surirella* Deflandre and Fert, 1954*, Lithraphidites carniolensis* Deflandre, 1963*, Farhania varolii* (Jakubowski, 1986) Varol, 1992 are also present.

The Lower Cretaceous nannofosils from Romania have been investigated by Melinte (in Avram et al., 1996), in sites from the Carpathian flysch, Svinița, Reşița and South Dobrogea. The presence of both Tethyan and Boreal species is worth to mention.

Our study is the first one investigate the Lower Cretaceous calcareous nannofossils from the Apuseni Mountains.

UPPER CRETACEOUS CALCAREOUS NANNOFOSSIL ASSEMBLAGES

The 65 samples investigated from Fântânele and Mare valleys certainty prove the presence of CC15, CC16, CC17, CC19 and CC24 biozones belonging to Santonian – Campanian–Early Maastrichtian. It is worth to mention the presence of species which are characteristic for Maastrichtian: *Arkhangelskiella cymbiformis* Vekshina, 1959, *Arkhangelskiella maastrichtiana* Burnett, 1997*, Rusellia laswelli* and *Russellia bukry*.

On Fântânele Valley the Lower/Upper Cretaceous boundary was identified. The marker species *Reihardites anthophorus* (CC15 Zone) indicates the presence of the Early Santonian.

On Mare Valley the calcareous nannofossils assemblages contain the following marker species, according to Sissingh (1977), Perch-Nielsen (1985), a.o.: *Reihardtites anthophorus* (CC15 Zone), *Lucianorhabdus cayeuxii* (CC16 Zone) – Late Santonian; *Calculites obscurus* (CC17 Zone) – Late Santonian/Early Campanian; *Calculites ovalis* (CC19 Zone); the upper part of Early Campanian; *Reinhardtites levis* (CC24 Zone) – Early Maastrichtian (Pl. I, II).

Reinhardtites antophorus Zone (CC15) was defined by Sissingh (1977) from the FO of R. *antophorus* to FO of *Lucianorhabdus cayeuxii* and proves the late Early Santonian age.

Lucianorhabdus cayeuxii Zone (CC16) was defined by the FO of *L. cayeuxii* to FO of *Calculites obscurus* Sissingh (1977) and demonstrates the presence of the Late Santonian. The assemblage contains also *Calculites ovalis*. It is worth to mention that Thierstein (1976) included *C. ovalis* in *C. obscurus* and correlated its FO with the base of the Santonian, considering it the best marker for the Coniacian/Santonian boundary (Perch-Nielsen, 1985).

Calculites obscurus Zone (CC17) defined by the FO of *C. obscurus* to FO of *Broinsonia parca* (= *Aspidolithus parcus*) is considered to be a bioevent which coincides with the Santonian/Campanian boundary.

Calculites ovalis Zone (CC19) defined by the LO of *Marthasterites furcatus* to FO of *Ceratolithoides aculeus*, indicates the late Early Campanian.

Reinhardtites levis Zone (CC24) was defined by the LO of *Tranolithus phacelosus* to LO of *Reinhardtites levis*, indicating the Early Maastrichtian. Sissingh (1977) remarked that the LO of *R. levis* coincides with a distinct and interregional increase in number of large *Arkhangelskiella* representatives (Perch-Nielsen, 1985).

These biozones correspond approximately to UC11 (CC15) and UC18 (CC24) (after Burnett, 1998).

UC11 was defined from the FO of *Lithastrinus grillii* to the LO of *L. septenarius* (Upper Coniacian to Lower Santonian).

UC18 (Upper Lower Maastrichtian) was defined from the LO of *Tranolithus orionatus* to the LO of *Reinhardtites levis*.

For the Romanian territory the important bioevents for the Santonian–Maastrichtian interval have been considered to be the following:

- for the Santonian: the FO of *Reinhardtites antophorus*, followed by the FO of *Lucianorhabdus cayeuxii* and the FO of *Calculites obscurus*.
- for the Campanian – the FO of *Broinsonia parca constricta*, FO of *Ceratolithoides aculeus aculeus*, FO of *Quadrum sissinghii*, FO of *Quadrum trifidum*.
- for the Maastrichtian – the FO of *Arkhangelskiella cymbiformis* (according to Melinte, in Ion et al., 1998).

In the investigated area, the identified biozones certainly correspond to the Santonian, Campanian, and the Early Maastrichtian.

Some species that are characteristic for the Maastrichtian: *Arkhangelskiella cymbiformis*, *A. maastrichtiana, Russelia laswelli, R. bukry* are also present.

Most of the samples contain a relatively large number of species: 30 – 46. The most frequent forms are: *Watznaueria barnesae* (Black in Black & Barnes, 1959) Perch-Nielsen, 1968*, Lucianorhabdus maleformis* Reinhardt, 1966*, Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre, 1952*, Calculites ovalis* (Stradner, 1963) Prins & Sissingh in Sissingh, 1977*, Micula decussata* Vekshina, 1959*,* a.o.

CONCLUSIONS

In the investigated area of the Southern Apuseni

Mountains, Easrly and Late Cretaceous deposits are present, belonging to the Meteş and the Bozeş formations. These deposits belong to the CC7, CC8 (Lower Cretaceous), and CC15, CC16, CC17, CC19, CC24 (Late Cretaceous) (after the zonations of Sissingh, 1977; Perch–Nielsen, 1985) biozones.

In conclusion, the investigated calcareous nannofossils from Ceru Băcăinți area, lead us to the assignement of an Albian–Aptian age for the Meteş Formation, and a Santonian, Campanian and Lower Maastrichtian age for the Bozeş Formation respectively.

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PLATES

PLATE I

Lower Cretaceous calcareous nannofossils from Fântânele Valley (Figs. 1 – 9) and Upper Cretaceous calcareous nannofossils from Fântânele and Mare valleys (Figs. 10 – 17)

1a, 1b – *Watznaueria barnesae* (Black in Black & Barnes, 1959) Perch-Nielsen, 1968. 1a – N+; 1b – NII; x 2.000.

2a, 2b – *Zeugrhabdotus elegans* (Gartner, 1968) Burnett in Gale et al., 1996. 2a – N+; 2b – NII; x 2.000.

3 – *Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre, 1952 . N+; x 2.000.

4a, 4b, 4c – *Assipetra terebrodentarius* (Applegate et al. in Covington & Wise, 1987) Rutledge and Bergen in Bergen, 1994. 4a, 4c – N+; 4b – NII; x 2.000

5 – *Braarudosphaera stenorhetha* Hill, 1976. N+; x 2.000

6. *Calculites* sp. N+; x 2.000

7a, 7b – *Nannoconus steinmannii* Kamptner, 1931. 7a – N+; 7b – NII; x 2.000

8a, 8b. – *Thoracosphaera* sp. 8a – N+; 8b – NII; x 2.000

9 – *Hayesites* cf. *irregularris*.(Thierstein in Roth & Thierstein, 1972) Applegate et al. in Covington & Wise, 1987. N+; x 2.000

10a, 10b, 11 - *Watznaueria barnesae* (Black in Black & Barnes, 1959) Perch-Nielsen, 1968. N+; 10a, 10b, 11 – NII; x 2.000.

12a, 12b – *Lithraphidites* sp. 12a – N+; 12b – NII; x 2.000.

13a, 13b - *Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre, 1952 . 13a - N+; 13b – NII; x 2.000.

14a, 14b – *Tranolithus orionatus* (Reinhardt, 1966) Perch-Nielsen, 1968. 14a – N+; 14b – NII; x 2.000.

15a, 15b – *Prediscosphaera grandis* Perch-Nielse, 1979. 15a – N+; 15b – NII; x 2.000.

16a, 16b – *Prediscosphaera cretacea* (Arkhangelsky, 1912) Gartner, 1968. 16a – N+; 16b – NII; x 2.000.

17a, 17b – *Radiolithus planus* Stover, 1966. 17a – N+; 17b – NII; x 2.000.

PLATE II

Upper Cretaceous calcareous nannofossils from Mare Valley

1a, 1b, 1c – *Arkhangelskiella cymbiformis* Vekshina, 1959. 1a, 1b – N+; 1c – NII; x 2.000.

2a, 2b – *Arkhangelskiella maastrichtiana* Burnett, 1997. 2a - N+; 2b - NII; x 2.000.

3a, 3b – *Arkhangelskiella confusa* Burnett, 1997. 3a - N+; 3b - NII; x 2.000.

4a, 4b - *Micula staurophora* (Gardet, 1955) Stradner, 1963. 4a - N+; 4b - NII; x 2.000.

5a, 5b - *Calculites ovalis* (Stradner, 1963) Prins & Sissingh in Sissingh, 1977. 5a - N+; 5b - NII; x 2.000.

6a, 6b - *Lucianorhabdus cayeuxii* Deflandre, 1959. 6a - N+; 6b - NII; x 2.000.

7 – *Lucianorhabdus maleformis* Reinhardt, 1966. N+; x 2.000.

8 – *Calculites percenis* - N+; x 2.000.

9a, 9b –*Russelia laswellii* - N+; x 2.000.

10a, 10b – *Russelia bukryi* - N+; x 2.000.

11 – *Eiffelithus eximius* (Stover, 1966) Perch-Nielsen, 1968). N+; x 2.000.

12 – *Eiffelithus turriseiffellii* (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965. N+; x 2.000.

13a, 13b – *Eiffelithus gorkae* Reinhardt, 1965. 13a - N+; 13b - NII; x 2.000.

14a, 14b – *Helicolithus anceps* (Gorka, 1957) Noel, 1970. 14a - N+; 14b - NII; x 2.000.

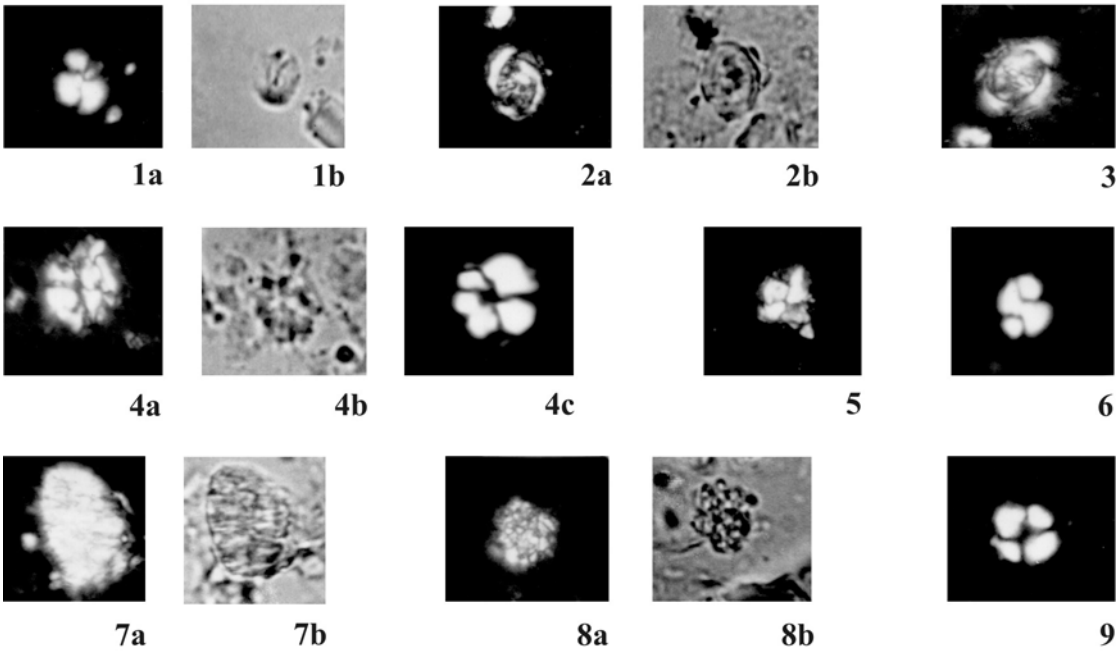
15a, 15b – *Marthasterites furcatus* (Deflandre in Deflandre & Fert, 1954) Deflandre, 1959. 15a - N+; 15b - NII; x 2.000.

16a, 16b – *Marthasterites inconspicuus* Deflandre, 1959. 16a - N+; 16b - NII; x 2.000.

17a, 17b – *Ceratolithoides arcuatus* Prins & Sissingh in Sissingh, 1977. 17a - N+; 17b - NII; x 2.000.

18a, 18b – *Zeugrhabdotus bicrescenticus* 18a - N+; 18b - NII; x 2.000.

19 – *Zeugrhabdotus embergeri* (Noel, 1959) Perch-Nielsen, 1984. N+; x 2.000.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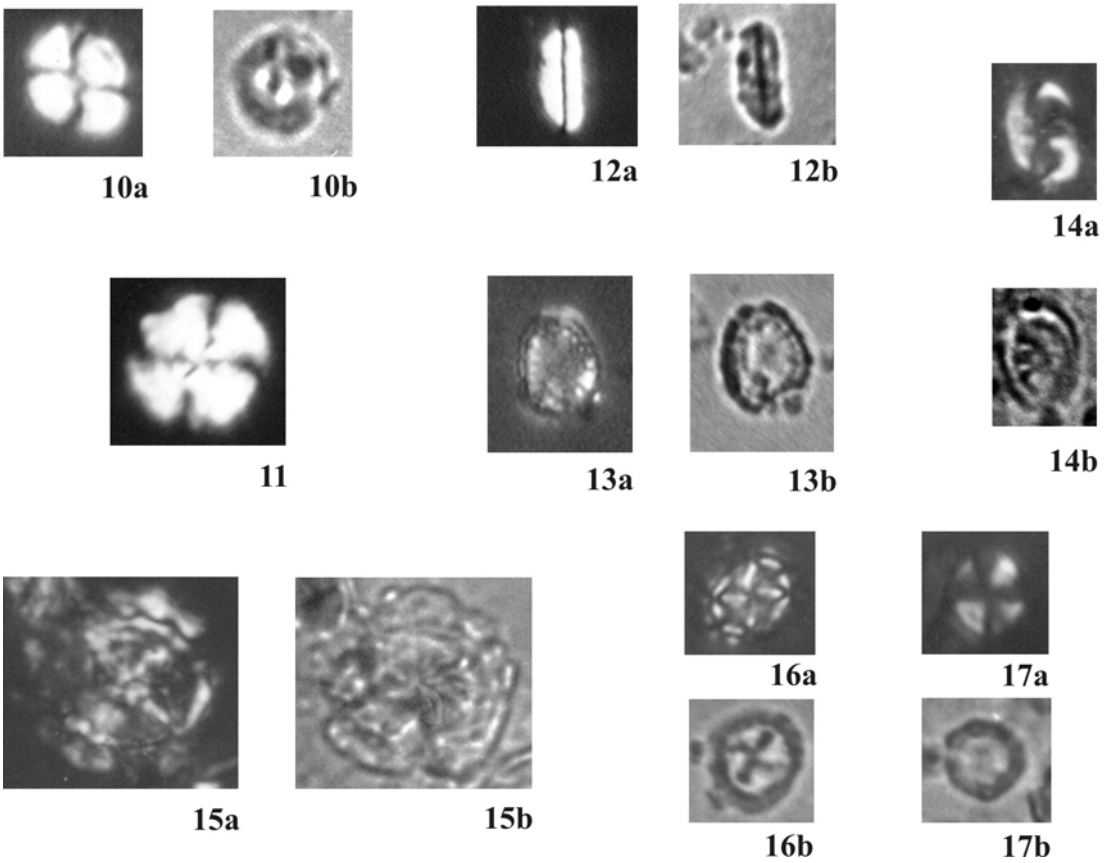
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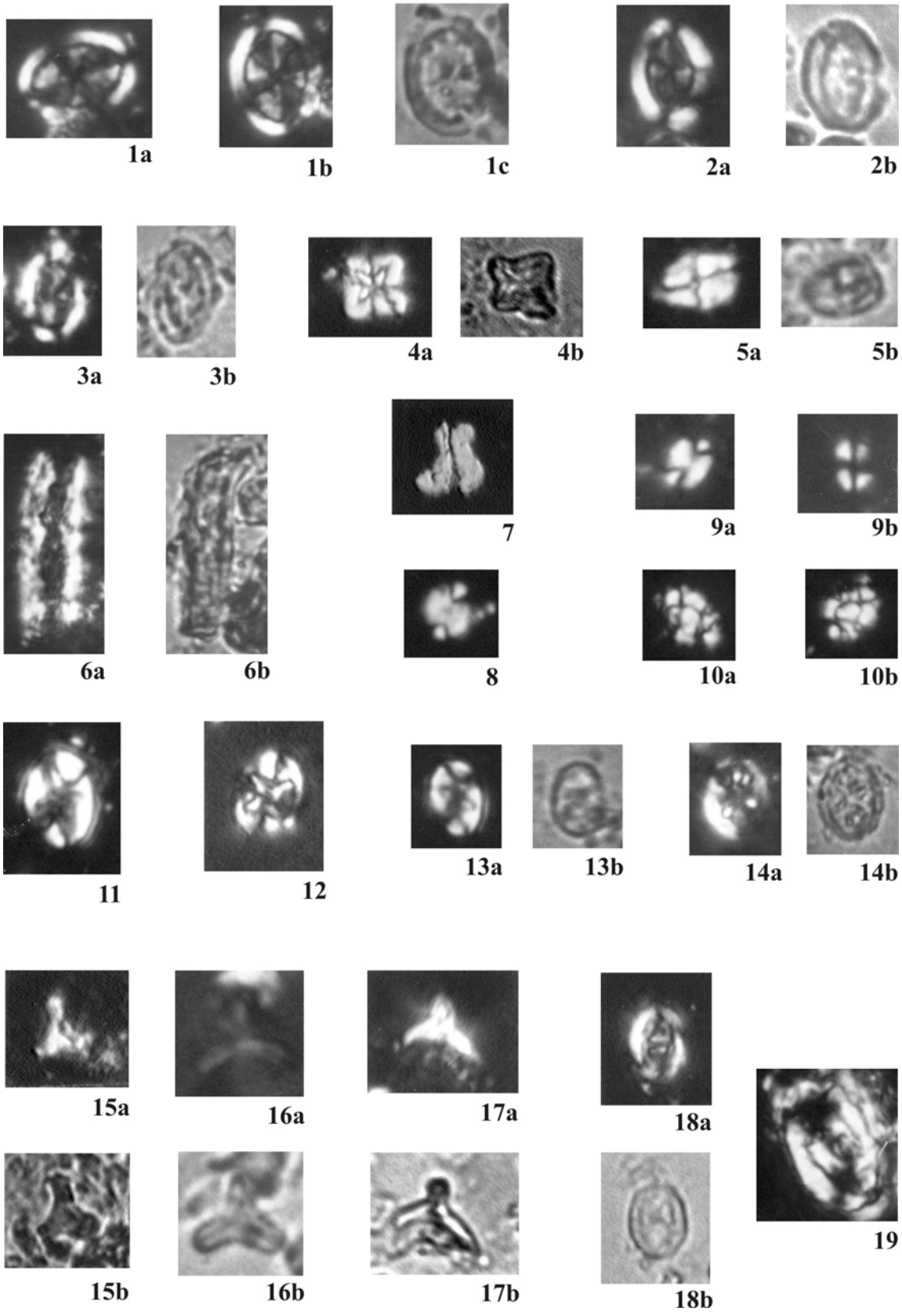
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