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EARLY CRETACEOUS MICROFACIES AND ALGAE FROM THE CENTRAL – EASTERN SECTORS OF THE MOESIAN CARBONATE PLATFORM

Ovidiu N. DRAGASTAN[1], Ion Stefan POPESCU[2] and Aida POPESCU[2]

Abstract: In the middle carbonate ramp zone of the Moesian Platform (Central – Eastern sectors) at Jurassic/Cretaceous boundary and during Early Cretaceous the drilling cores from Urziceni, Ciofliceni, Stoeneşti, Videle revealed microfacies sequences of packstone, oolitic and bioclastic grainstone, wackestone and mudstone including algae, foraminifers and microproblematicae.

The algal assemblages dominated by Dasycladales pointed out the ages of carbonate sequences besides foraminifers as follows : - *Rivularia barmsteinensis, Hedstroemia moldavica, Andersenolina alpina, Mohlerina basiliensis, Mercierella ? dacica*, rarely as broken tubes (Tithonian, Ciofliceni drilling); - *Clypeina parasolkani, C. solkani, Rajkaella iailensis, K. filiformae, Decussoloculina barbeni, Axiopolina granumfestucae* (Berriasian, Urziceni drillings); - *Salpingoporella annulata, Heteroporella jaffrezoi, H. lemmensis, Clypeina solkani, Rumanolaculina robusta, Istriloculina emiliae*, Early Valanginian age and *Rajkaella bartheli*, broken thallus together with *Favreina njegosensis*, *F. dinarica*, Late Valanginian in age from Urziceni drilling; - *Salpingoporella incerta, S. ubaiydhi, S. genevensis, Korkyerella texana, Garwoodia bardosi, Scythiolina camposaurii*, Hauterivian – Barremian – Early Aptian in age, from Stoeneşti and Videle drillings.

Some assemblages are considered index zones as *Salpingoporella annulata* and *Favreina salevensis* for Valanginian – Early Hauterivian age, in the Appennines carbonate platform (Mancinelli, 1992, Chiocchini M., Farinacci A., Mancinelli V. & Potetti, 1994), Transylvanian carbonate platform (Dragastan, 1975, Dragastan, 1989, 1999, Moesian Platform included South Dobrogea (Dragastan, 1978, Neagu & Dragastan, 1984, Dragastan, Neagu, Bărbulescu & Pană, 1998, Dragastan, 2001) *Clypeina solkani, C. parasolkani*, *Salpingoporella annulata* for Berriasian – Valanginian age.

In the Pontides Carbonate Platform (Farinacci & Radoicic, 1991), from Serbian Carbonate Platform (Bucur, Conrad & Radoicic, 1995), from Provence Urgonian Platform (1989, 1993) and from Northern Calcareous Alps (Rasser & Fenninger, 2002 and Gawlich, Schlagintweit and Lein, 2003) for Jurassic / Cretaceous boundary.

The presence of *Salpingoporella genevensis* in Stoenesti core-drilling is an index species for the Late Hauterivian (and possible Early Barremian) being recorded at this interval between *Sayni Zone* and *Angulucostata Zone* in the Catalonian Pyrenees (Schroeder, Clavel, Conrad, Zaninnetti, Busnardo, Charollais & Cherchi, 2000).

The Barremian – Early Aptian showed index zone assemblages with *Salpingoporella* div. sp. and miliolids in the same carbonate platform mentioned above.

Paleoenvironmental model (Dragastan, Richter, Gielisch & Kube, 1998) indicated for dasycladaleans and pseudoudoteaceans subtidal open lagoon and for rivulariaceans subtidal restricted lagoon and more or less the same conditions for miliolids and kaminiskiinides.

The shallow water limestones which accommodate the mentioned assemblages are characterized by a regressive tendency (Late Tithonian – Cartojani / Rasova Formations), transgressive – regressive (Berriasian – Early Valanginian – Cernavoda / Dumbrăveni / Bâscoveni Formations pro parte), transgressive (Late Valanginian – Hauterivian – Cernavoda / Dumbrăveni / Bâscoveni pro parte) and regressive (Barremian – Early Aptian – Ostrov / Bâscoveni Formations – Talpa – Şopârleşti Members).

Keywords: Jurassic – Cretaceous biostratigrapy, Algae, Forams, Microfacies and Facies Shelf Zonation.

INTRODUCTION

The area which is the subject of this article is located in the Central-Eastern part of the Moesian Platform (Romania), about 60 Km north of the Danube, between the river Vedea to the West and the river Ialomita to the East (Text-Fig. 1). The investigate core of follwing drillings: Videle, Stoeneşti, Ciofliceni-Snagov, Urziceni (Text-Fig. 2).

The Moesian Platform was divide by Patrulius (1976) in three major sedimentary realms during Jurassic – Cretaceous and subsequently improved by Dragastan (2001): an Eastern carbonate shelf platform which included also Central and South Dobrogea; a Central deep – sea basin area and a Western shelf carbonate platform, narrow as areal

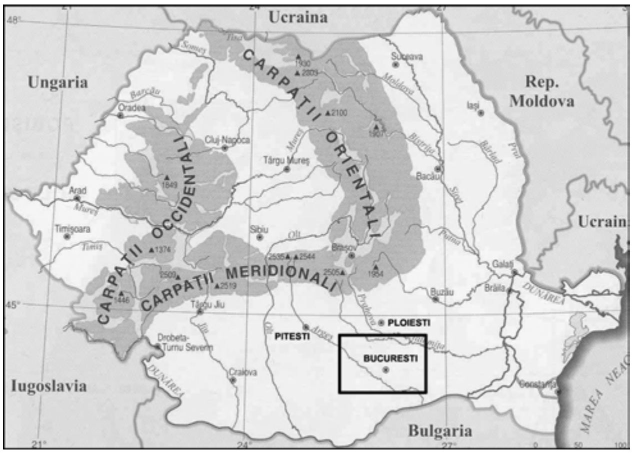

Fig. 1 – The location of study area

[1] University of Bucharest, Department of Geology / Paleontology, Bd. N. Balcescu, No. 1, 010041 Bucharest, Romania (e-mail: ovidiud @ geo.edu.ro
[2] S.C. PETROM S. A. – I.C.P.T. – Campina – C.C.P.E.G. Bucharest, Str. Toamnei, No 103, sect. 2, Bucharest, Romania (e-mail: aidapopescu @ yahoo.com)

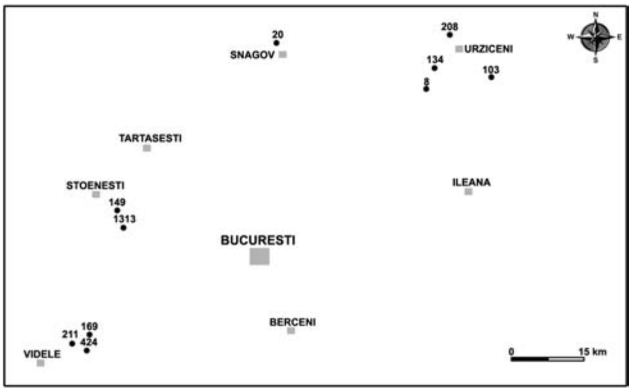

Fig. 2 – The position of the investigated drillings from the study area

and scattered by some “islands – land” (Dragastan, 2001).

During the Late Jurassic – Early Aptian age, the Eastern carbonate platform area functioned as a ramp type carbonate platform (dip angle < 1^0) situated on a passive type edge in the north Tethysian region (Text-Figs. 3, 4). From a paleobiogeographic point of view the area studied belongs to the Mesogean Province (the presence of phylloceratids in the basinal area, the adjacency of the carbonatic platform, as well as of the dasycladales, orbitolinids, stromatoporoids, corals and rudists). The taxonomic composition indicates a Foralmol type association (Text-Fig. 5). The depth of the water, based on the association of algae and forminifera, varied between 0 m and 60 m (Banner and Simmons, 1994).

In the area were recorded, to the present date, 89 species of calcareous algae, from which in this article are presented 15 species associated with forminifera and other groups of organisms whose habitat characterizes the middle and inner carbonate shelf (Text - Fig. 6).

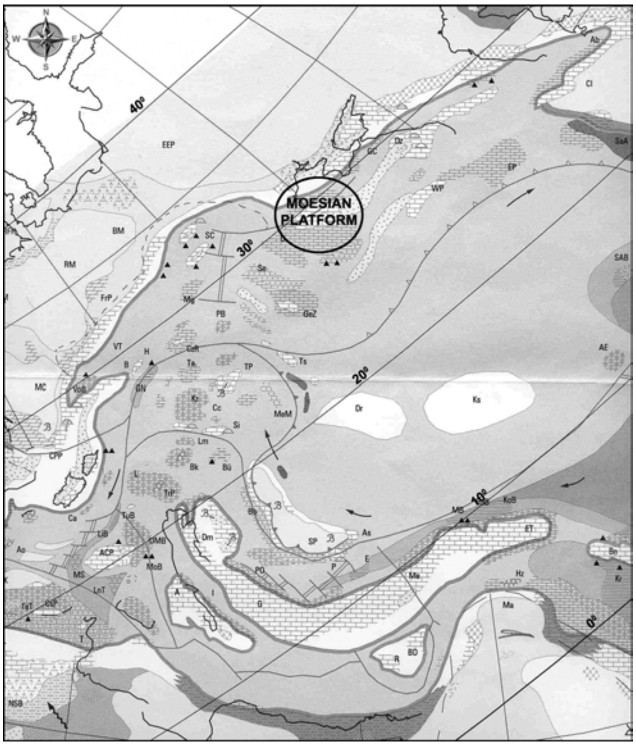

Fig. 3 – The paleogeographical position of the Moesian Platform during the Early Tithonian (after J. Dercourt *et al*., 1993)

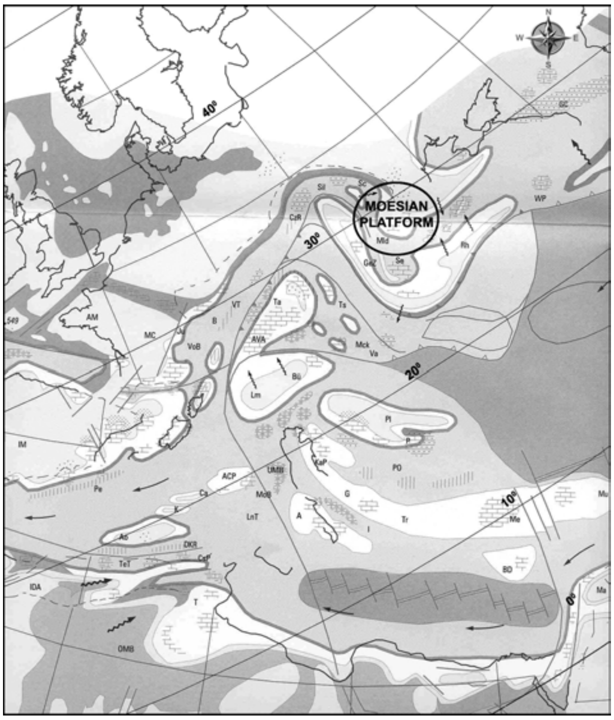

Fig. 4 – The paleogeographical position of the Moesian Platform during the Aptian (after J. Dercourt *et al*., 1993)

LITHO- AND BIOSTRATIGRAPHY OF THE LOWER CRETACEOUS DEPOSITS

The Early Cretaceous deposits crossed by drillings in the Central-Eastern part of the Moesian Carbonate Platform are disposed transgressively and discordantly over the Late Tithonian deposits of the Rasova/Cartojani Formations (represented by dolomites, oncoidal grainstones, oolitic/pisolitic grainstones and boundstones). This sequence supports, transgressively and discordantly, Albian/Vraconian deposits.

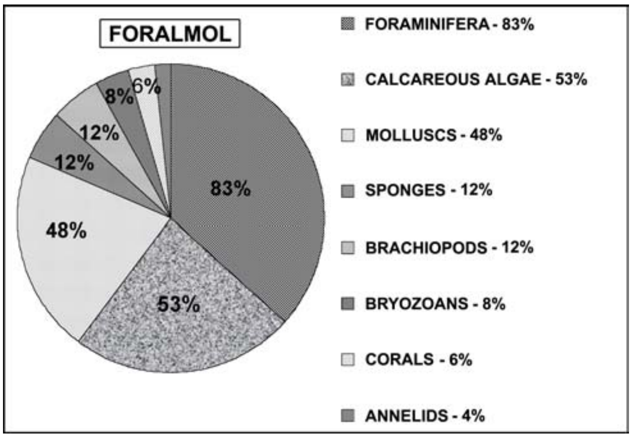

Fig. 5 – The percent repartition of the main groups of fossils recorded during Tithonian – Early Aptian interval from the Central – Eastern sector of the Moesian Carbonate Platform

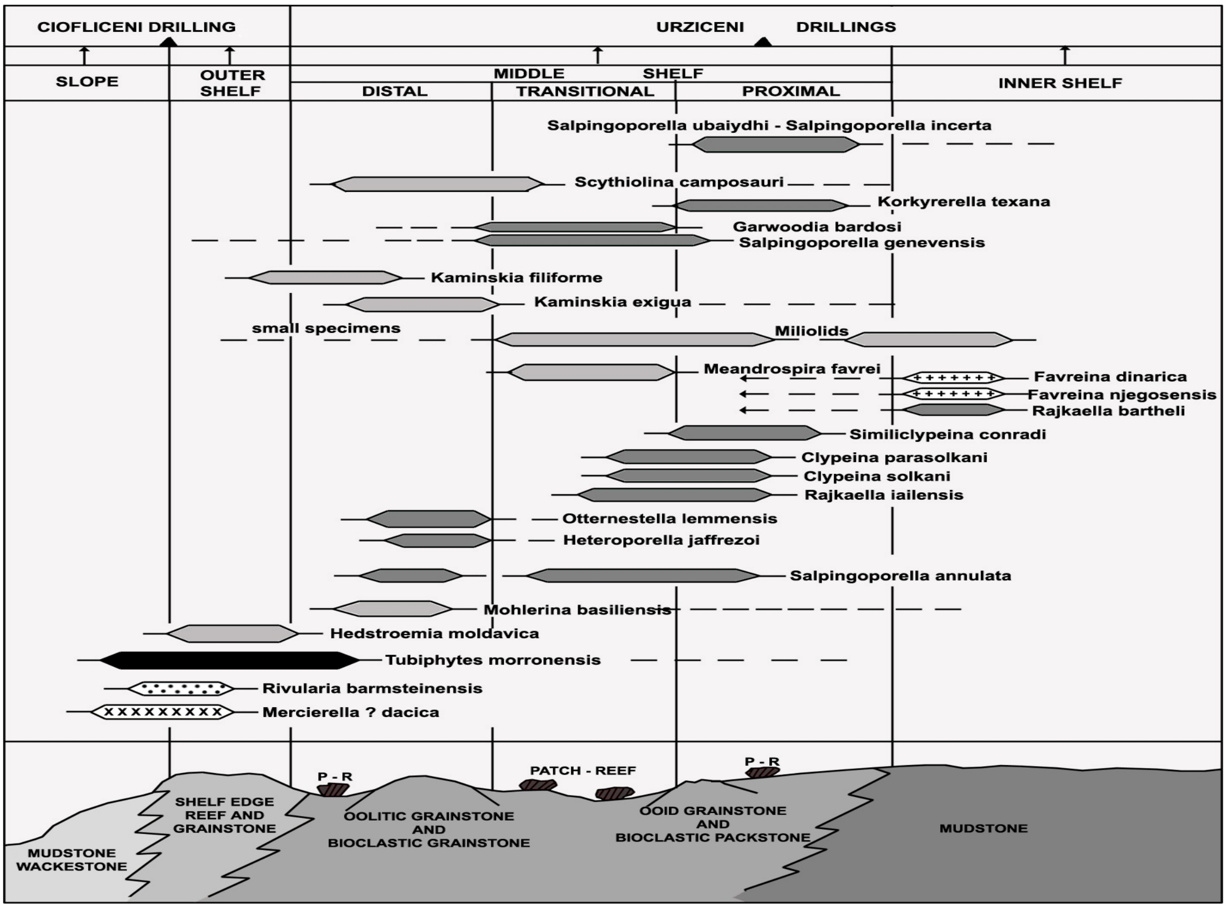

Fig. 6 – Late Jurassic - Early Cretaceous microfacies and distribution of main biogenic groups on the carbonate shelf from the Moesian Platform (Central - Eastern Sectors)

The Lower Cretaceous litostratigraphic units are the followings:

The Cernavoda/Dumbrăveni Formations (Neagu & Dragastan, 1984 emend. 1995-1996; Text-Fig. 7) has been found in complete succession, being represented by its three members:

The Hinog Member Dragastan, 1995 – 1996 (Berriasian) –- is represented by fenestral mudstones, peletal packstones, oolitic grainstones with *Anchispirocyclina lusitanica*, *Everticyclammina virguliana*, *Pseudocyclammina lituus*, *Kaminskia exigua, Kaminskia filiforme*, *Decussoloculina barbui*, *Axiopolina granumfestucae*, *Clypeina parasolkani*, *Clypeina solkani*, *Rajkaella iailensis*, *Similiclypeina conradi*.

The Alimanu Member – Avram *et al.* (Valanginian), 1998 - placed concordantly over the Hinog Member is represented by bioclastic grainstones, oolitic grainstones, boundstones, dolomitic limestones with *Andersenolina elongata*, *Andersenolina alpina*, *Pseudotextulariella salevensis*, *Istriloculina emiliae*, *Rumanoloculina robusta*, *Danubiella gracilima*, *Heteroporella lemmensis, Heteroporella jaffrezoi, Clypeina solkani, Salpingoporella annulata, Favreina salevensis, F. dinarica, Tubiphytes morronensis*, and dasyclades crossing the Berriasian/ Valanginian boundary.

The Vederoasa Member – Neagu & Dragastan, 1995 – 1996 (Hauterivian) - is the final term of the Cernavoda/Dumbrăveni formations, represented by mudstones (in case with fenestrae), wackestones and packstones. The foraminifera and algae associations are weakly represented. The frequent presence of ostracodes is characteristic.

The Ostrov Formation – Dragastan, 1985, emend. Neagu & Dragastan (Barremian – Early Aptian) - is placed transgressively and discordantly over the deposits of the Cernavoda/Dumbrăveni formations. It has three members: the Adâncata Member (Neagu & Dragastan), the Gârlița Member (Neagu & Dragastan) and the Lipnița Member (Neagu & Dragastan). It is represented by mudstones, sometimes with fenestral fabric, bioclastic packstones, bioclastic grainstones and boundstones with pachiodonts. The micropaleontological associations is represented by the following taxa: *Trocholina aptiensis, Cuneolina hensoni, Derventina sp., Scythiolina camposauri, Choffatella decipiens, Palaeodictyoconus arabicus, Orbitolinopsis kiliani, Orbitolinopsis cuvillieri, Palorbitolina lenticularis, Nezazzatinella macovei, Salpingoporella ubaiydhi, Korkyerella texana, Salpingoporella incerta, Salpingoporella carpathica* and *Salpingoporella muehlbergi*.

In the evolution of the carbonate sequences, during the Late Tithonian – Early Aptian interval,

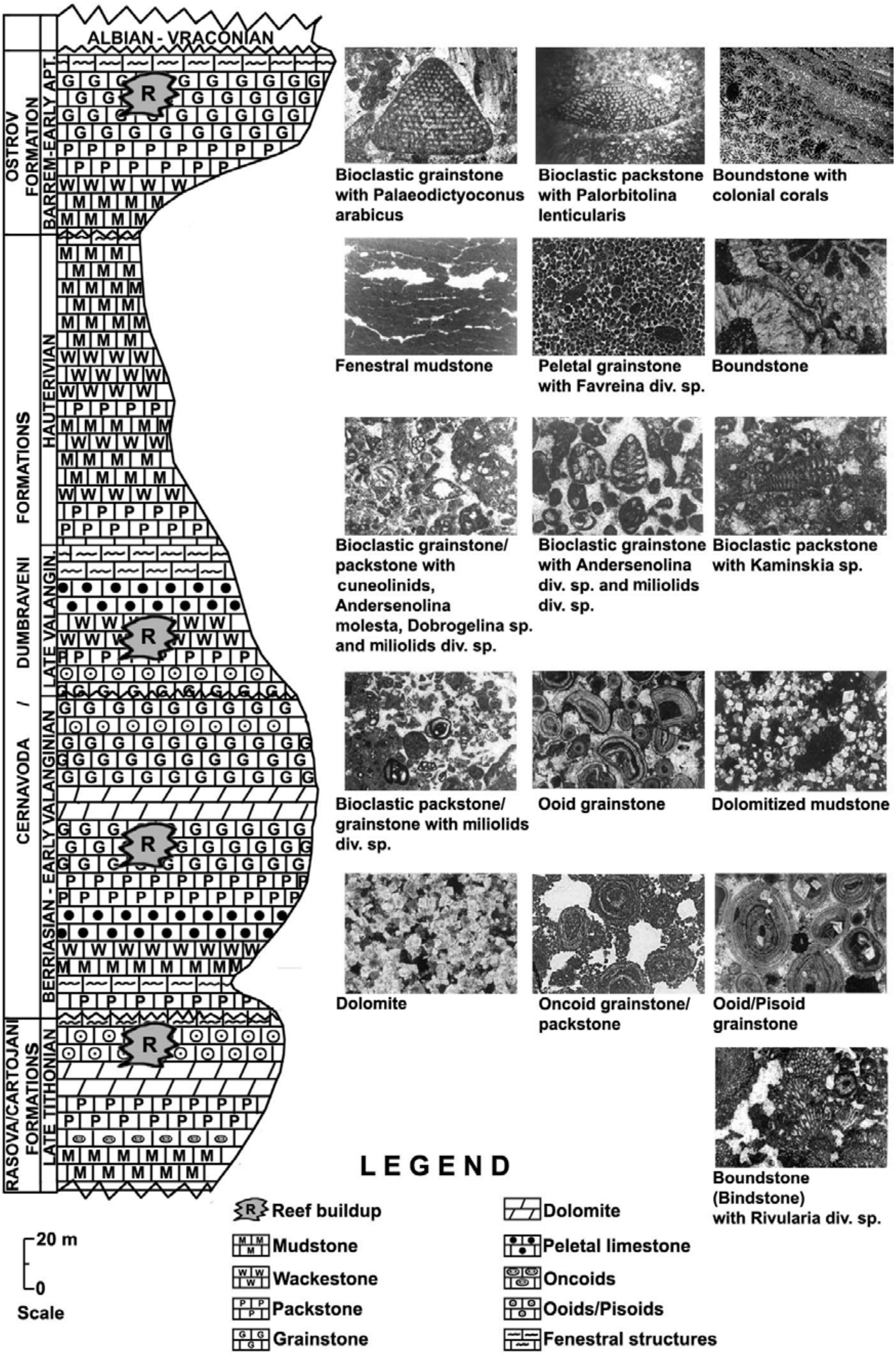

Fig. 7 - Synthetic stratigraphic column in the middle and inner ramp zones of the Moesian Carbonate Platform

there have been identified three regressive episodes (R) and two transgressive episodes (T) which are well correlated with the eustatic curve suggested by Haq *et al.* (1987). The most important transgressive episode was that corresponding to the Late Valanginian – Hauterivian (Text-Fig. 8). It is marked in the basinal area adjacent to the carbonate platform by the diversity and abundance of ammonites, by the increased content of glauconit from Late

Valanginian till Hauterivian and clay minerals. In the same time the number of bioturbated processes increased also. On the carbonate shelf this is marked by the reduction in $CaCO_3$ production and its semidrowning.

BIOSTRATIGRAPHY AND MICROFACIES

Jurassic / Cretaceous

In the studied area the Jurassic – Cretaceous boundary deposits are represented by grainstones – packstones microfacies with a small algal pellets inputs found in the Ciofliceni drilling located at the depth between – 3083 – 3084 m.

The assemblage is dominated by pseudoudoteacean *Hedstroemia moldavica,* many entire and broken thalli, besides *Tubiphytes morronensis, Mohlerina basiliensis, Protopenerolopis trochoangulata,* rivulariacean *Rivularia barmsteinensis* and rarely tubes of *Mercierella ? dacica.*

Taking into account the widespread distribution in the alpine realm of the algae and forminifers, the age of the sample core is considered Late Tithonian – Early Berriasian.

A similar, but slightly different association was described from the Carbonate platform of the Central – Southern Apennines by Chiocchini *et al.* (1994). The deep – sea slope depofacies at the Jurassic – Cretaceous boundary is represented by biozones with *Tubiphytes morronensis* and *radiolaria / Lithocodium* and *calpionellids.*

The depofacies of outer or margin of shelf (platform) corresponds to the biozone with *Tubiphytes morronensis* (Tithonian) and with subzone with *Protopeneroplis ultragranulata* (Berriasian). The pseudoudoteacean alga *Hedstroemia moldavica* (Pl. 8, fig. 8) was mentioned from the Bicaz Gorges, East Carpathians (Transylvanian Carbonate Platform) in the Tithonian – Berriasian deposits. Also the cyanophycean alga *Rivularia barmsteinensis* described from the Barmstein limestones of the North-West of Hallein / Salzburg, Calcareous Alps is considered a good "marker" for Late Tithonian – Early Berriasian slope depofacies (Loser / Salzkammergut deposits – Schlagintweit, Missoni, Lein & Gawlick, 2004).

Mercierella? dacica represented by tubes with collars of serpulid was described from Trascău – Bedeleu Range (Dragastan 1966) together with calpionellids, Tithonian – Berriasian in age. Misik, Sotak & Ziegler (1999) considered that *Mercierella? dacica* has a stratigraphical range from the Kimmeridgian – Tithonian to Berriasian.

Also Senowbari – Daryan & Dimke (2003) reported *Mercierella? dacica* in the Schwabian Alps and pointed out besides the widespread distribution of the species in the alpine realm and the stratigraphic range from Kimmeridgian to Berriassian.

Mercierella? dacica is considered as an indicator of the margin of the platform, because in Sicily (Italy) was found in the *Ellipsactinia facies* (Bucur *et al.*, 1996) and in Trascău Mts (Southern Apuseni) with calpionellids in a deep – sea slope facies (Dragastan, 1966), having a transitional distribution from the margin of the platform to the deep–sea slope.

In the Anatolian carbonate platform (Altiner, 1991) identified a Zone II with *Tubiphytes morronensis* and a Zone III with *Protopeneroplis trochoangulata* which point out the Kimmeridgian – Tithonian – Early Berriasian age.

Neocomian

The Neocomian deposits crossed by different depth – drillings covered a large stratigraphic time from Early Berriasian until Late Hauterivian.

The limestone sequences reconstructed from the base to the top corresponds to the followings sample – core drillings: 202 Urziceni (Early Berriasian), 8 Urziceni (Late Berriasian), 103 Urziceni (Early Valanginian),134 Urziceni (Late Valanginian), 1313 Stoeneşti (pro parte Late Hauterivian – Early Barremian).

Berriasian

The Early Berriasian from 202 Urziceni core depth – 2760 – 2764 m revealed packstone microfacies with foraminifers as dominant association and rarely cyanophycean alga *Rivularia barmsteinensis* also recorded from Early Berriasian (Schlagintweit *et al.*, 2004).

The foraminifers are dominate by abundance and diversity of miliolids *Decuossoloculina barbui, Axiopolina granumfestucae* (Pl. 7,Fig. 1-2) besides kaminskiinid *Kaminskia exigua* (Pl. 7, Fig. 1–2) and *Kaminskia filiforme,* all together a good marker for Early Berriasian age (Neagu, 1985, 1999).

The sample core from the depth of–2500–2501m of 8 Urziceni drilling is an oolitic grainstone and wackestone microfacies prevailing by dasycladalean algae and rarely the foraminifer *Meandrospira favrei (*Pl. 7, Fig. 4).

The algae from this "level" included *Clypeina parasolkani, Clypeina solkani, Rajkaella iailensis* and *Similiclypeina conradi* (Pl. 7, Fig. 4 – 6). The algae association point out the Late Berriasian age, although the species including the foraminifer have more or less large stratigraphic range from Berriasian – Valanginian and subsequently Hauterivian – Upper Barremian (Bucur *et al.*, 1995, 2000). *Clypeina parasolkani* was described first time from the Western Pontides by Farinacci & Radoicic (1991) and was considered a Berriasian index species.

Later Rasser & Fenninger (2002) recorded this species from he Northern Calcareous Alps in the Tithonian age deposits.

Masse (1993) in one of his most important stratigraphic attempts correlated the ammonites zones with dasyclad species from Provence and adjacent regions showing that another species of *Clypeina, Clypeina solkani* corresponds to *Boissieri Zone* being Late Berriasian in age.

DRILLING AND CORES DEPTH	AGE	MICROFACIES	ASSEMBLAGES
424 VIDELE 765 - 766 m	APTIAN	Packstone	Salpingoporella ubaiydhi Salpingoporella incerta
211 VIDELE 875 - 876 m	LATE BARREMIAN	Packstone Mudstone	Salpingoporella ubaiydhi Korkyerella texana
4330 VIDELE 911 - 911,5 m	EARLY BARREMIAN	Mudstone	Scythiolina camposauri
1313 STOENESTI 1495 - 1496 m	EARLY BARREMIAN LATE HAUTERIVIAN	Mudstone with fenestral fabrics	Garwoodia bardosi Salpingoporella genevensis
134 URZICENI 2374 - 2383 m	LATE VALANGINIAN	Mudstone Ooid Grainstone	Favreina salevensis Rajkaella bartheli
103 URZICENI 2498,5 - 2500 m	EARLY VALANGINIAN	Bioclastic Grainstone	Tubiphytes morronensis, Heteroporella lemmensis, Heteroporella jaffrezoi, Clypeina solkani, Salpingoporella annulata Axiopolina, Istriloculina emiliae Rumanoloculina robusta
8 URZICENI 2500 - 2501 m	LATE BERRIASIAN	Ooid Grainstone	Clypeina parasolkani, Clypeina solkani, Rajkaella iailensis, Similiclypeina conradi
202 URZICENI 2760 - 2764 m	EARLY BERRIASIAN	Packstone / Mudstone	Axiopolina granumfestucae, Kaminskia exigua, Kaminskia filiforme, Decussoloculna barbui
20 CIOFLICENI 3083 - 3084 m	TITHONIAN	Grainstone / Packstone	Hedstroemia moldavica, Andersenolina alpina, Mohlerina basiliensis Rivularia barmsteinensis, Tubiphytes morronensis, Mercierella ? dacica

Fig. 8 - Tithonian - Early Cretaceous microfacies and characteristic assemblages from Moesian Carbonate Platform (Central - Eastern Sectors), identified in drilling data

In the same paper Masse recorded *Rajkaella iailensis* in the *Boissieri* up to *Otopeta – Petrasiensis – Campylotoxum Zones* and has a Late Berriasian – Early Valanginian age.

Meandrospira favrei a foraminifer that has a large distribution in the alpine realm was recorded at different levels from Late Berriasian till Hauterivian (Bucur *et al.*, 1995).

Valanginian – Hauterivian (proparte)

The Valanginian deposits crossed by two drillings, 103 and 134 Urziceni, first at sample core from a depth – 2498,5 – 2500 m and second with samples from – 2374 – 2383 m.

The core samples corresponds to bioclastic or oolitic grainstones rarely mudstones microfacies and bear two different associations:

1 – the first one, more diverse, is dominated by dasycladaleans: *Salpingoporella annulata, Clypeina solkani,* rarely *Clypeina marteli, Heteroporella jaffrezoi* and *Otternestella lemmensis*, besides *Tubiphytes morronensis* and foraminifers such as *Istriloculina emiliae, Rumanoloculina robusta* (Plates 1, 2, 3, 4, 5, 6), *Decussoloculina barbui, D. granumlentis* and *Scythiloculina confusa.*

The bioclastic components of the grainstones have a following quantitative distribution:

Salpingoporella thalli entire or broken and other dasycladalean algae = 60%; miliolids and kaminskiids species = 20%;*Tubiphytes morronensis* = 10%; microbial lumps, *Salpingoporella* thalli and foraminifers included as intraformational reworked paticles = 10%.

The age of the association dominated by *Salpingoporella annulata* is Early Valanginian.

Masse (1993, 1993 a) recorded *Salpingoporella annulata*, *Clypeina solkani* and *Clypeina marteli* from the *Boissieri – Otopeta – Petrasiensis – Campylotoxum* ammonite zones, corresponding to the Late Berriasian – Early Valanginian interval.

Although the species *Heteroporella jaffrezoi* and *Ottenestella lemmensis* described first by Bernier (1971, 1984) from Portlandian or Malm deposits must be reconsidered and accepted that these species have an extended stratigraphic range till Early Valanginian.

In the same cores samples was observed frequently levels with intraformational reworked microbial lumps including *Salpingoporella* thalli, small miliolids and rarely oncoids which correspond to a "demantelation" process of grainstone shoals (Dragastan, 2001) by the bottom currents on the middle shelf belt during the decrease of the sea-level.

2 – the second association is less diverse and monotone, being identified in the 134 Urziceni drillings at depth of – 2374 – 2383 m in a sequence of oolitic grainstone with reworked mudstone intraclasts.

The most frequent bioclast in grainstone is *Favreina njegosensis* (Pl.7, Fig.7) and rarely the dasycladacean alga *Rajkaella bartheli.* Also in the association was reported and *Favreina dinarica* (Pl.7, Fig. 8 – 9).

The age of this association is Late Valanginian and represents a mixture between normal marine and brackish waters with influence from the restrictive lagoon of inner shelf. The coprolithe species are described by Brőnnimann (1976) from the Neocomian of Dinarids and was redefined for age by Molinari – Paganelli, Pichezzi & Tilia Zuccari (1980) and by Senowbary – Daryan & Kuss (1992). Although the coprolithe species are different from the Dumbrăveni Formation, South Dobrogea, they represent the same facies and correspond to the same formation.

The presence of normal marine alga as interlayer with *Rajkaella bartheli* in a brackish facies with *Favreina* corresponds of intermingled waters on a chanell traject crossing the "prairie" with patch – reefs, representing the influence of the restrictive lagoon of inner shelf.

It is not excluded that, in this drilling the crossing 10 m core thickness comprise beside the Late Valanginian, also the Hauterivian.

Hauterivian (proparte) – Early Barremian

In the Stoeneşti core drilling from a depth – 1495 – 1496 m occurred a wackestone – mudstone microfacies with fenestral fabrics.

The algae association comprises *Salpingoporella genevensis* and *Garwoodia bardosi* (Pl.8, Fig. 7) pointed out the Late Hauterivian – Early Barremian age.

The alga *Salpingoporella genevensis* in Provence (Masse, 1993) has a stratigraphic range calibrated after ammonites zones between *Sayni – Balearis – Angulucostata* (Late Hauterivian) and *Haugi – Niklesi – Pulchella – Caliaudi* (Early Barremian).

In Ardeche (South – Eastern of France) *Salpingoporella genevensis* and *Heteroporella paucicalcarea* as allodapic components were recorded from *Angulucostata – Haugi – Niklesi* zones, being Late Hauterivian – Early Barremian in age (Schroeder *et al.* 2000).

The alga *Garwoodia bardosi* is a green pseudoudoteacean known from Bicaz Gorges, East Carpathians, Transylvanian Carbonate Platform from Tithonian – Neocomian up to Barremian – Lower Aptian (Dragastan, 1985). Also this species was reported from Valanginian of Greece (Richter, Dragastan & Gielisch, 1992) and from Barremian of Apennines (Mancinelli & Ferrandes, 2001).

Barremian – Early Aptian

This stratigraphic interval was identified in three drillings from Videle locality : 4330 Videle (depth – 911 – 911,5 m), 211 Videle (depth – 875 – 876 m) and 424 Videle (depth – 765 – 766 m).

The sampling cores represent packstones – wackestones microfacies rarely mudstones and the association contain algae and foraminifers as follows: - at depth 911 – 911,5 m *Scythiolina camposauri* (Pl. 8, Fig. 9) and *Rumanoloculina robusta,* Early Barremian age, was recorded; - at depth – 875 – 876 m, *Salpingoporella ubaiydhi* and a broken thallus stalk of *Korkyerella texana* (Pl.8, Fig. 1 – 4), Late Barremian – Early Aptian in age and at depth – 765 – 766 m the dasycladacean algae *Salpingoporella ubaiydhi* and *Salpingoporella incerta* (Pl. 8, Fig. 5 – 6) also Late Barremian and Early Aptian in age, were found.

The presence of broken thallus stalk of *Korkyrella texana* together with *Salpingoporella ubaiydhi* and *Salpingoporella incerta* enlarged the occurrences in the alpine realm of these taxa including and Moesian Platform being more or less identical in age (Barremian – Early Aptian) as Sokac (2004) demonstrated for the first time.

SHELF–FACIES ZONATION AND DISTRIBUTION OF MAJOR BIOGENIC GROUPS

In the Moesian Platform, the Early Cretaceous deposits corresponds to a major prograding sequence from the Central area to the Eastern nearshore represented by a continental strata Purbeckian – Wealdian ? facies (South Dobrogea). From the East (nearshore) a large carbonate shelf area continued to the central part of this unit where a slope and a deep sea basin with pelagic facies and ammonite is present. The basic facies belt for Cretaceous deposits from the Moesian Platform was described from the east to westwards by Dragastan (2001).

Because the studied area is "punctiform" or local and the drillings are located between localities Urziceni to the east and Videle to the West – South West the facies zonation in this limited area correspond to the middle shelf and to outer shelf and slope deep sea basin, the last recorded at Ciofliceni drilling core Late Tithonian – Early Berriasian in age.

Because the boundary between inner shelf and the middle shelf is located to the east at approximately 30 km from the Urziceni drillings and has an winding shape and a transitional character, with some influences from the inner shelf (a mixture between normal marine and brackish waters) appearing near the Urziceni area.

Inner shelf

The influences from the inner shelf correspond to a sequence of oolitic grainstones with reworked mudstones intraclasts with *Favreina* and *Rajkaella bartheli* (Text – Fig. 6). It is a mixture between brackish with normal marine waters on a channel traject crossed the area from the inner to the middle shelf.

Middle shelf

A large area from Urziceni up to Ciofliceni including also the Bucharest meridian has 60 km and from Bucharest to Videle about 50 km, fact showing that middle shelf covered a large area of around 100 km (Dragastan, 2001).

The middle shelf is represented by normal marine salinity and shallow facies dominate by wackestones – packstones, patch – reefs built by calcareous sponges (*Barroissia, Granatiparietes, Steinerella, Actinostromaria, Siphostroma)* rarely hexacorals, monopleurids and gastropods, more or less similar with the association found in the Cernavoda Formation and in the outcrops from Cernavoda and Alimanu, South Dobrogea (Dragastan, Neagu, Bărbulescu & Pană, 1998).

Another characteristics of the middle shelf is the presence of the table reefs built by calcispongi and

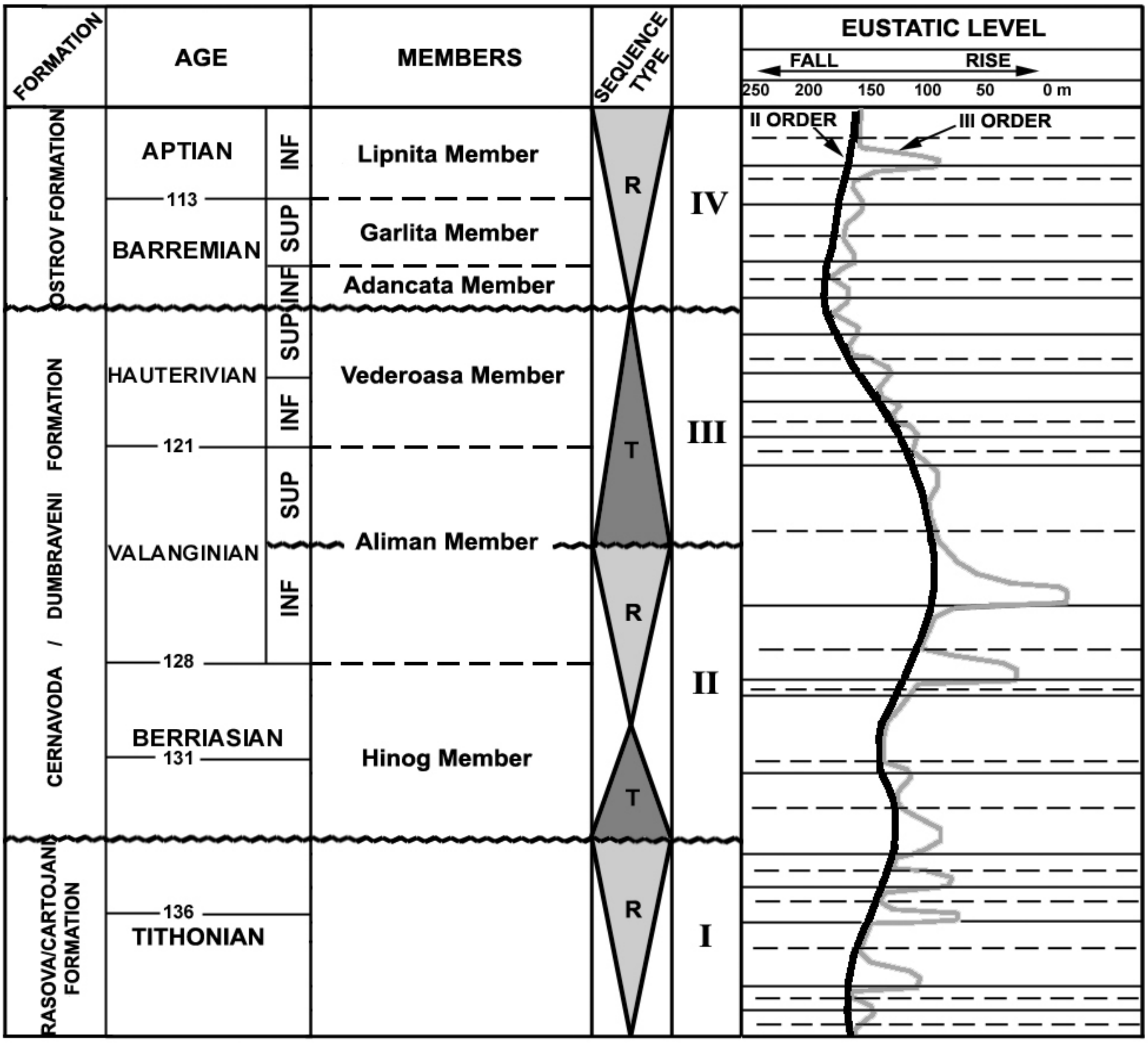

Fig. 9 - Jurassic - Cretaceous lithostratigraphy and transgressive - regressive sequences from the area investigated by drillings in the central-eastern sectors of the Moesian Carbonate Platform

of grainstone shoals elaborated by bioclastic components, intraclasts bound in a framework by microbial mat, oncoids and frequently *Tubiphytes morronensis*

The grainstone shoals also included intraformational microbial lump with many bioclasts like *Salpingoporella annulata* and foraminifers all as reworked components mobilized during the process of lithification by bottom currents.

Covering such a large area the middle shelf was divided in sedimentological and paleoenvironmental zones as follows: - proximal middle shelf; - transitional middle shelf and distal middle shelf.

We consider all three subdivisions as prograding sequence – cycles.

The **proximal middle shelf** is represented mainly by wackestones, table reefs and grainstone shoals. In the proximal zone the representative community is dominate by dasycladacean algae, *Clypeina solkani, Clypeina parasolkani, Similiclypeina conradi, Rajkaella iailensis, Korkyerella texana* and the group *Salpingoporella ubaiydhi, Salpingoporella incerta* (Text - Fig. 6). rarely appeared *Tubiphytes morronensis, Meandrospira favrei, Mohlerina basilensis* and div. species of miliolids.

The **transitional middle shelf** has wackestones – packestones depofacies with pach – reefs, rarely table reefs.

The communities of microfossils present a transitional distribution some from distal middle shelf, like *Salpingoporella annulata, Heteroporella jaffrezoi, Otternestella lemmensis* and other from the proximal middle shelf included *Clypeina* div. sp., *Similiclypeina conradi* and *Rajkaella iailensis* and miliolids *(Rumanoloculina robusta, Istriloculina emiliae).*

The typical transitional biogenic components are *Meandrospira favrei*, *Salpingoporella genevensis* and *Garwoodia bardosi.*

The both transitional and proximal middle shelf represented a large lagoon with more or less restrictive facies by the presence of secondary dolostone and rhomboedric dolomite crystals. The lagoon had have patch – reefs and grainstone shoals and in between the dasycladalean *Salpingoporella annulata* and *Rajkaella iailensis* are like an influence input of open marine lagoon environment (Dragastan, 1998, 1999).

Typical indicators of transitional middle shelf for an open lagoon environment are *Salpingoporella annulata, Salpingoporella genevensis, Garwoodia bardosi* and *Meandrospira favrei.*

The algae *Salpingoporella annulata* and *Garwoodia bardosi* recorded in the Bicaz Gorges, Haghimas Mts, Transylvanian Carbonate Platform, were found in a reef – flat shelf area till the boundary between outer shelf and slope of deep sea basin (Dragastan, 1999).

The miliolids achieved more species diversity (*Istriloculina, Scythiloculina, Rumanoloculina, Axiopolina)* in such environment rich in nutrient, oxygenation and hydrodynamic movements.

The **distal middle shelf** is dominated by packstones and grainstones depofacies, some generated bank with rare patch – reefs or without patch – reefs.

The biogenic groups which have a distal environmental "imprint" are: *Mendrospira favrei* (rarely), *Heteroporella jaffrezoi, Otternestella lemmensis* and small specimens of *Axiopolina, Scytiloculina,* very frequent *Kaminskia filiforme, Kaminskia exigua* and *Scythiolina camposauri.* The algae (dasycladaceans) show large well calcified thalli as well the test of foraminifers *Mohlerina basiliensis* and *Scythiolina camposauri.*

The kaminskiinae species are small with short or long, filiform test on the biseriate axis.

Outer shelf and slope deep sea basin

This environmental zones identified in the Ciofliceni drilling where probably the shelf edge was deliniated by a barrier reef and grainstones and the slope of deep sea basin (clinothem sensu Rich, 1951) with wackestones and mudstones deposits.

The depofacies has in common the same association composed by *Mercierella ? dacica, Rivularia barmsteinensis, Hedstroemia moldavica, Tubiphytes morronensis* and rarely *Mohlerina basiliensis.*

The species *Mercierella ? dacica* and *Tubiphytes morronensis* and rarely *Mohlerina basiliensis* were reported from the talus (slope) facies in the Plassen Formation, Northern Calcareous Alps (Schlagintweit & Ebli, 1999) and *Tubiphytes morronensis* from the outer shelf of Appeninnes (Chiochini *et al.*, 1994).

Another species the pseudodoudoteacean *Hedstroemia moldavica* was found in the reef–flat/ shelf margin facies from the Bicaz Gorges, Hăghimaş Mts., Transylvanian Carbonate Platform (Dragastan, 1999).

The major biogenic groups of shelf from the eastern-central sectors of the Moesian Platform during Late Jurassic – Early Cretaceous are benthic algae and foraminifers.

The quantitative participation of benthic groups depends of sea level changes and the types of sedimentological systems tracts. When the system was low (LST) the sea level goes down (regressive) and the foraminifers communities consists of large-medium size especially the miliolids and also the cyanophycean, pseudoudoteacean algae, *Rivularia* and *Hedstroemia.*

During the transgressive systems tracts (TST) the communities are marked by many reworked algae and foraminifers from previous tracts of the platform forming in situ grainstones or wackestones with algae, foraminifers and *Tubiphytes* mainly in the Valanginian or Late Valanginian – Hauterivian transsgressive tract.

In this prograding system the microflora and microfauna are well diversified as genera and species being also abundant in specimens.

In the Highstand system tract (HST) the benthic communities are dominated by dasycladaceans with normal well calcified thalli and the miliolids and kaminskiniids presents small and thin or filiform test case of *Kaminskia filiforme.*

CONCLUSIONS

We have used the term of Carbonate Ramp to define a sedimentological structural entity with dip $< 1^0$ which is characterized by a specific distribution of microfacies (SMF) and of the facies zones (FZ). The Carbonate Shelf represents a geomorphological entity of the marine environment characterized by the development of the carbonate factory.

- The considered area is part of a ramp carbonate platform - the Moesian Carbonate Platform which functioned as such in the eastern-central sectors during the Late Tithonian – Early Aptian interval.
- The Moesian Carbonate Platform was situated on the northern edge of the Tethys, and from a paleobiogeographical point of view was part of the Mesogean region.
- The Late Tithonian – Early Aptian deposits belong, from a lithostratigraphic point of view, to the following formations: Rasova / Cartojani Formations – Oxfordian – Late Tithonian; Cernavoda / Dumbrăveni formations – Berriasian – Hauterivian; Ostrov Formation – Barremian – Early Aptian.
- The Late Tithonian – Early Aptian deposits have been classified in four deposit sequences, separated by unconformities, expressed by subaerian erosional surfaces (dissolution - karstifying processes): Sequence I – Late Tithonian; Sequence II – Berriasian – Early Valanginian; Sequence

III – Late Valanginian – Hauterivian; Sequence IV – Barremian – Early Aptian.

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EXPLANATION OF PLATES

PLATE 1
Fig. 1-4 – Grainstone bioclastic with dominantly thalli of *Salpingoporella annulata* CAROZZI, oncoids, *Clypeina solkani* CONRAD & RADOICIC – in Fig. 4 and *Tubiphytes morronensis* CRESCENTI, Early Valanginian, Drilling 103 Urziceni, Depth -2498,5 – 2500 m, x 30.

PLATE 2
Fig.1, 3–4 – Grainstone bioclastic with thalli of *Salpingoporella annulata* CAROZZI, oncoids, rarely cortoids and *Tubiphytes morronensis* CRESCENTI, x 30.
Fig. 2 – Grainstone bioclastic with oblique and transverse sections in thalli of *Salpingoprella annulata* CAROZZI and *Istriloculina emiliae* NEAGU, x 30.
Early Valanginian, Drilling 103 Urziceni, Depth – 2498, 5–2500 m.

PLATE 3
Fig. 1 – Grainstone bioclastic with *Salpingoporella annulata* CAROZZI, *Clypeina* sp. and *Axiopolina* sp., x 30.
Fig.2, 3–4 – Grainstone bioclastic with *Salpingoporella annulata* CAROZZI, *Istriloculina emiliae* NEAGU, *Carpathiella* worm and intraformational reworked lumps with thalli of *Salpingoporella annulata* CAROZZI, x 30.
Early Valanginian, Drilling 103 Urziceni, Depth – 2498,5 – 2500 m.

PLATE 4
Fig. 1–4 – Grainstone bioclastic with different sectioned thalli of *Salpingoporella annulata* CAROZZI, *Tubiphytes morronenis,* gastropods, small oncoids and various shapes of reworked lumps with *Salpingoporella annulata* CAROZZI, Early Valnginian, Drilling 103 Urziceni, Depth – 2498,5 – 2500 m, x 30.

PLATE 5
Fig. 1–2 – Grainstone bioclastic with *Salpingoporella annulata* CAROZZI and *Otternesella lemmensis* (BERNIER), oblique – longitudinal section, *Tubiphytes morronenesis* CRESCENTI, *Clypeina marteli* EMBERGER and *Rumanoloculina robusta* NEAGU.
Fig. 3–6 – Grainstone bioclastic with *Heteroporella jaffrezoi* (BERNIER) – (Fig.3, transverse section , Fig.4,6, oblique longitudinal sections, Fig.5, tangential section), *Salpingoporella annulata* in Fig.5 – 6, *Rumanoloculina robusta* NEAGU , Fig.1,3,5, x 30; Fig. 2, 6, x 60; Early Valanginian, Drilling 103 Urziceni, Depth – 2498, 5 – 2500 m.

PLATE 6
Fig. 1-2 – Grainstone bioclastic with *Salpingoporella annulata* CAROZZI, *Decussoloculina barbui* NEAGU and reworked microbial lumps.
Fig. 3 – Grainstone with large reworked microbial lumps including small thalli of *Salpingoporella annulata* CAROZZI, and *Scythiloculina confusa* NEAGU.
Fig. 4 – Grainstone bioclastic with *Salpingoporella annulata* CAROZZI and reworked microbial lumps including *Salpingoporella annulata* CAROZZI, *Decussoloculina granumlentis* NEAGU and *Istriloculina emiliae* NEAGU.
Fig. 5 – Grainstone with reworked microbial lumps including *Kaminskia cuneata* NEAGU.
Fig. 6 – Grainstone with *Salpingoporella annulata* CAROZZI and *Danubiella gracilima* NEAGU. Early Valanginian, Drilling 103 Urziceni, Depth – 2498, 5 – 2500 m, all, x 30.

PLATE 7

Fig. 1–2 – Packstone and wackestone with *Kaminskia exigua* NEAGU and *Axiopolina granumfestucae* NEAGU, Early Berriasian, Drilling 202 Urziceni, Depth – 2760 – 2764 m.
Fig. 3 – Grainstone with *Rajkaella iailensis* (MASLOV) DRAGASTAN & BUCUR, Late Berriasian, Drilling 8 Urziceni, Depth – 2500 – 250 m.
Fig. 4–6 – Grainstone oolitic with *Clypeina parasolkani* FARINACCI & CONRAD and *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETI) in Fig.4, *Clypeina parasolkani* FARINACCI & CONRAD and a broken thallus of *Similiclypeina conradi* BUCUR in Fig. 5 and *Clypeina solkani* CONRAD & RADOICIC. Late Berriasian, Drilling 8 Urziceni, Depth – 2500 – 2501m.
Fig. 7 – Grainstone with reworked ooids and mudstone intraclasts, *Rajkaella bartheli* (BERNIER) and broken *Favreina njegosensis* BRÖNNIMANN, Late Valanginian, Drilling 134 Urziceni, Deph -2374 – 2383 m.
Fig. 8-9 – Grainstone oolitic and reworked mudstone intraclasts with *Favreina dinarica* BRŐNNIMANN, Late Valanginian, Drilling 134 Urziceni, Depth – 2374 – 2383 m.
All figures, x 30.

PLATE 8

Fig. 1–2, 4 – Wackestone and mudstone wih fenestral fabrics and *Salpingoporella ubaiydhi* RADOICIC.
Fig. 3 – Wackestone – mudstone with *Salpingoporella ubaiydhi* RADOICIC and a broken thallus stalk (see arrows) of *Korkyerella texana* (JOHNSON), Late Barremian – Early Aptian, Drilling 211 Videle, Depth – 875 – 876 m.
Fig. 5–6 – Mudstone with *Salpingoporella ubaiydhi* RADOICIC and in Fig. 6 wackestone with *Salpingoporella incerta* (SOKAC & NIKLER), Late Barremian – Early Aptian, 424 Videle, Depth – 765 – 766 m.
Fig. 7 – Wackestone and mudstone with fenestral fabrics and *Garwoodia bardosi* DRAGASTAN in assemblage with *Salpingoporella genevensis* CONRAD, Late Hauterivian – Early Barremian, 1313 Stoenesti, Depth – 1495 – 1496 m.
Fig. 8 – Grainstone with *Hedstroemia moldavica* DRAGASTAN, Tithonian – Early Berriasian (?), Drilling 20 Ciofliceni, Depth – 3083 – 3084 m.
Fig. 9 – Packstone and wackestone with *Scythiolina camposauri* (SARTONI & CRESCENTI) NEAGU *Rumanoloculina robusta* NEAGU, Early Barremian, Drilling 4330 Videle, Depth – 911 – 911,5 m.
All figures, x 30.

PLATE 1

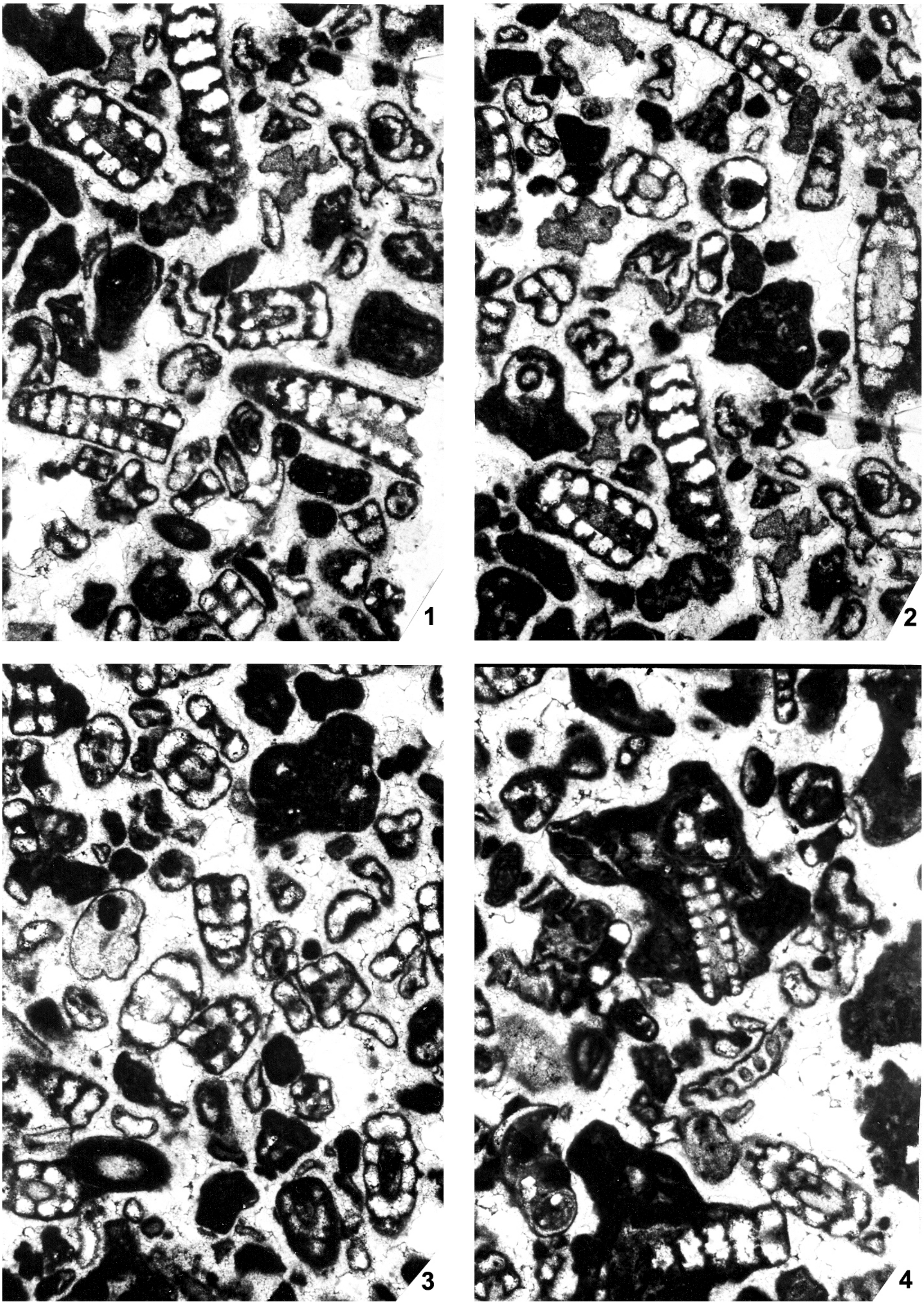
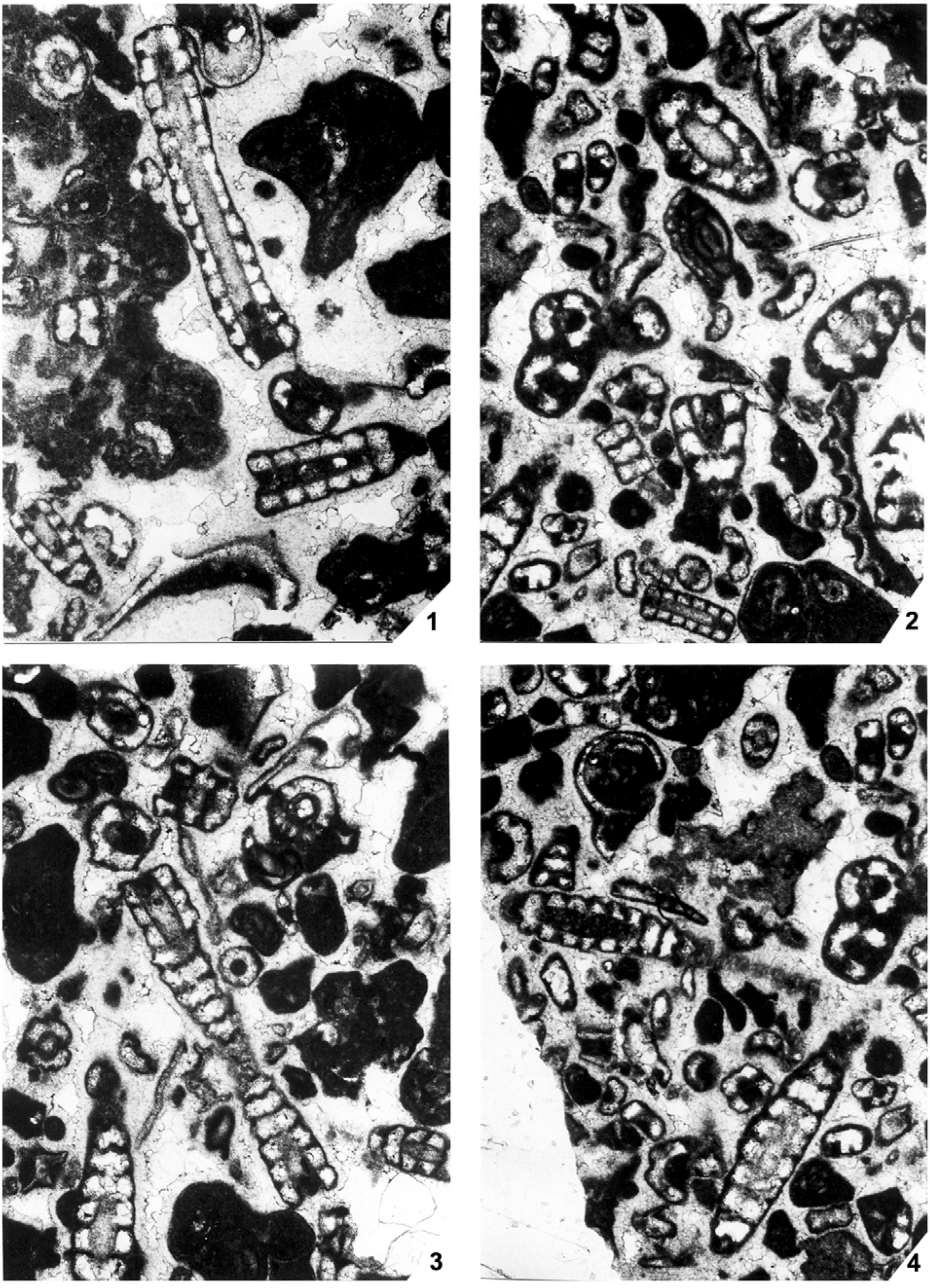


PLATE 2



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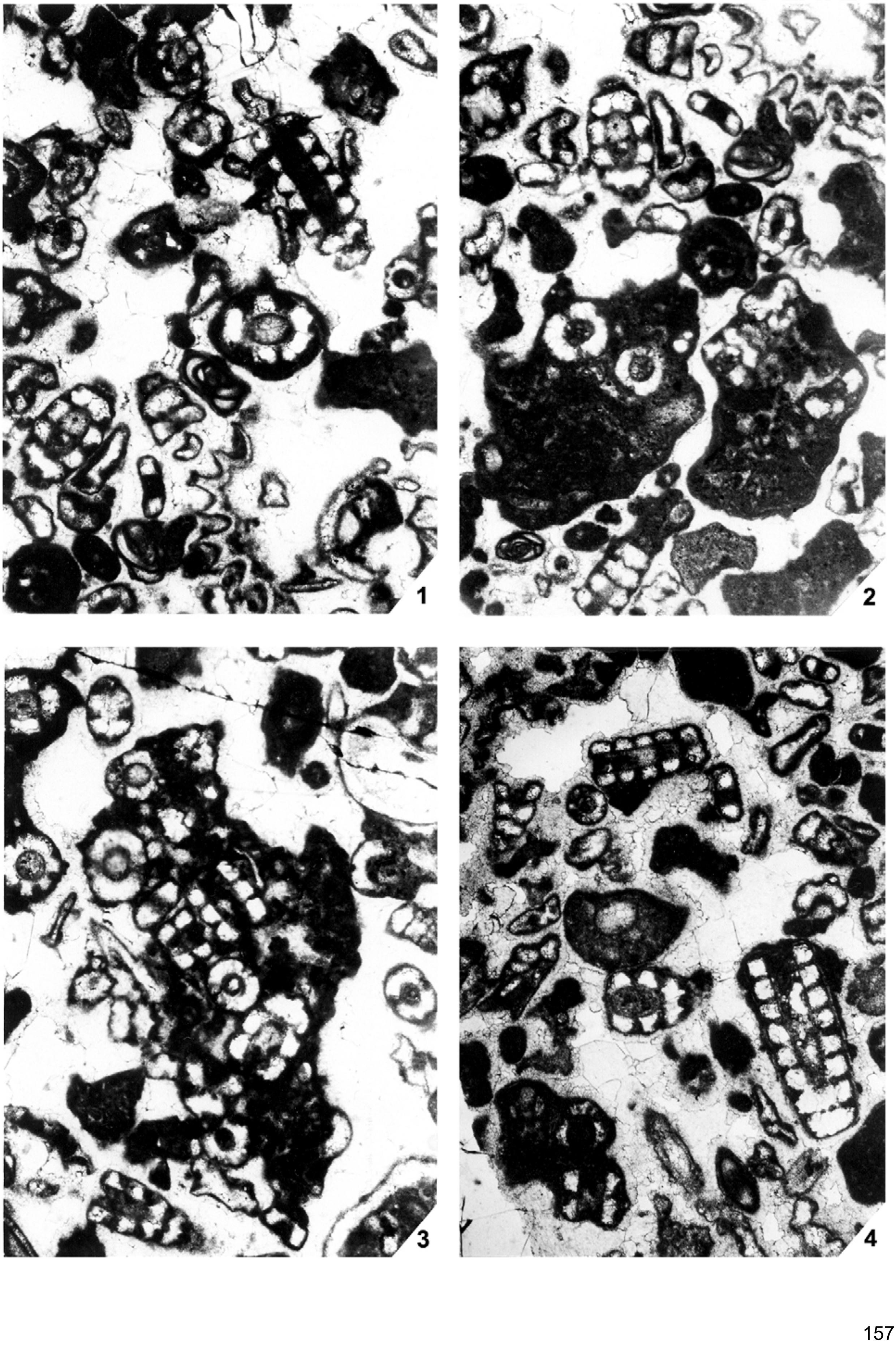

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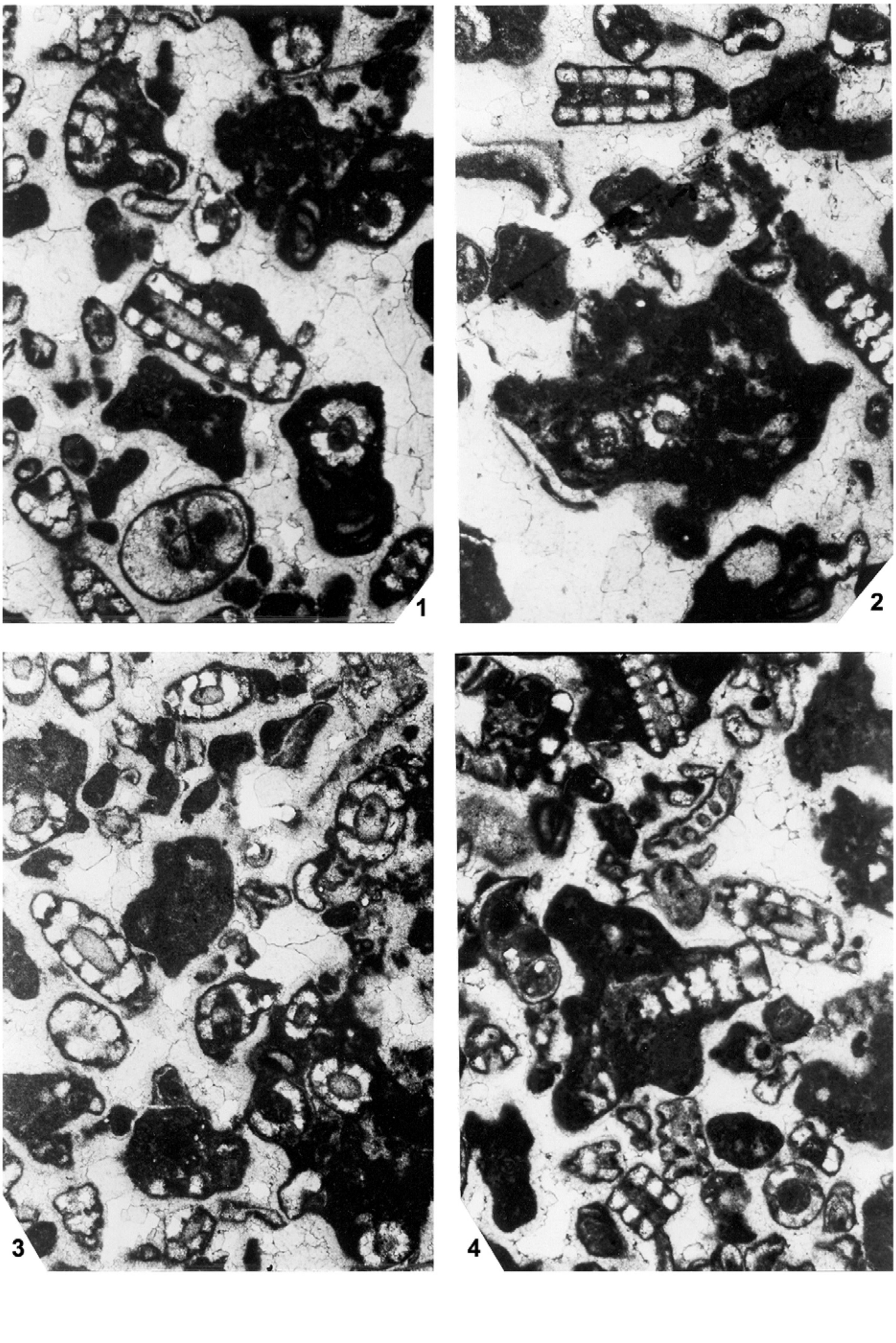

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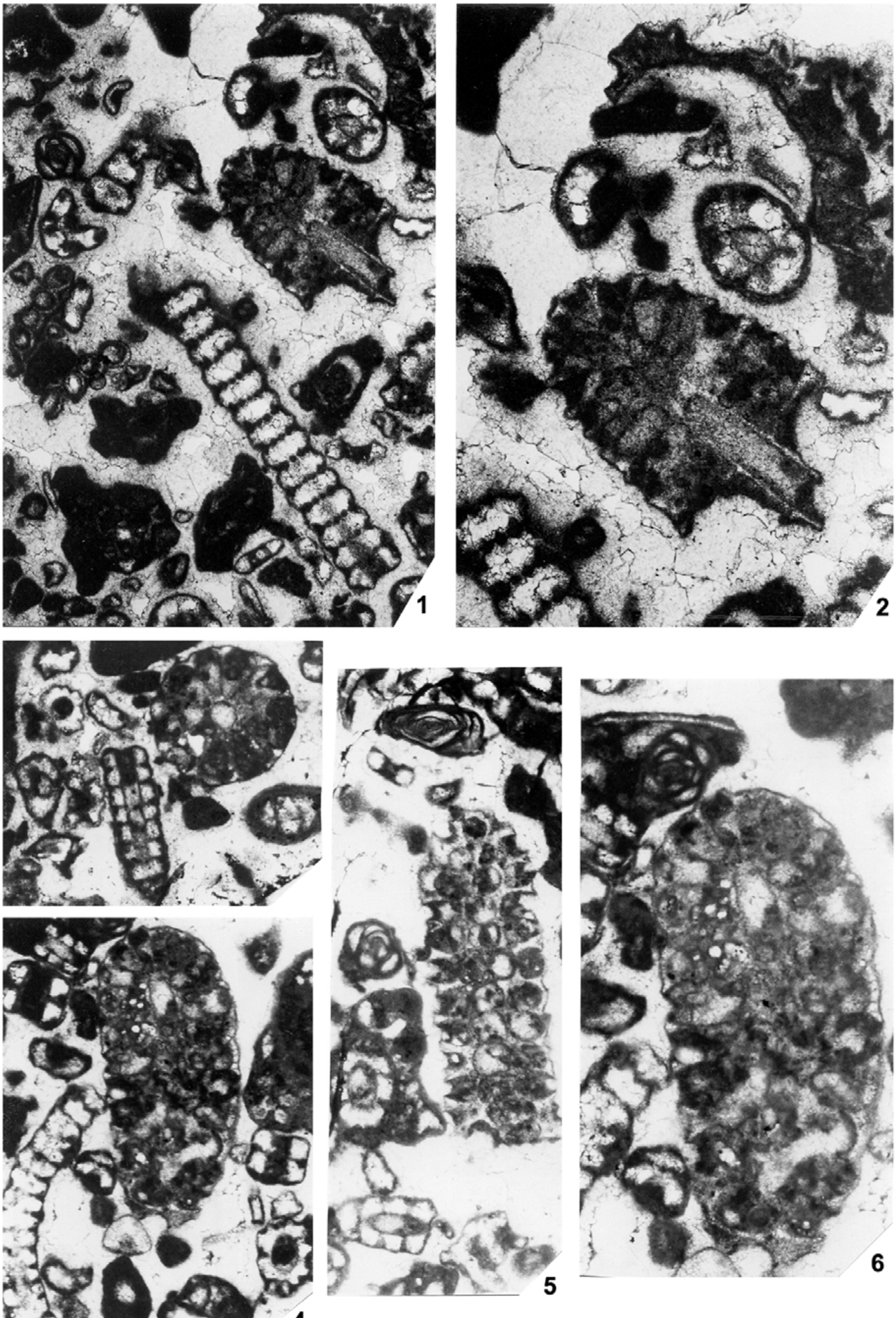

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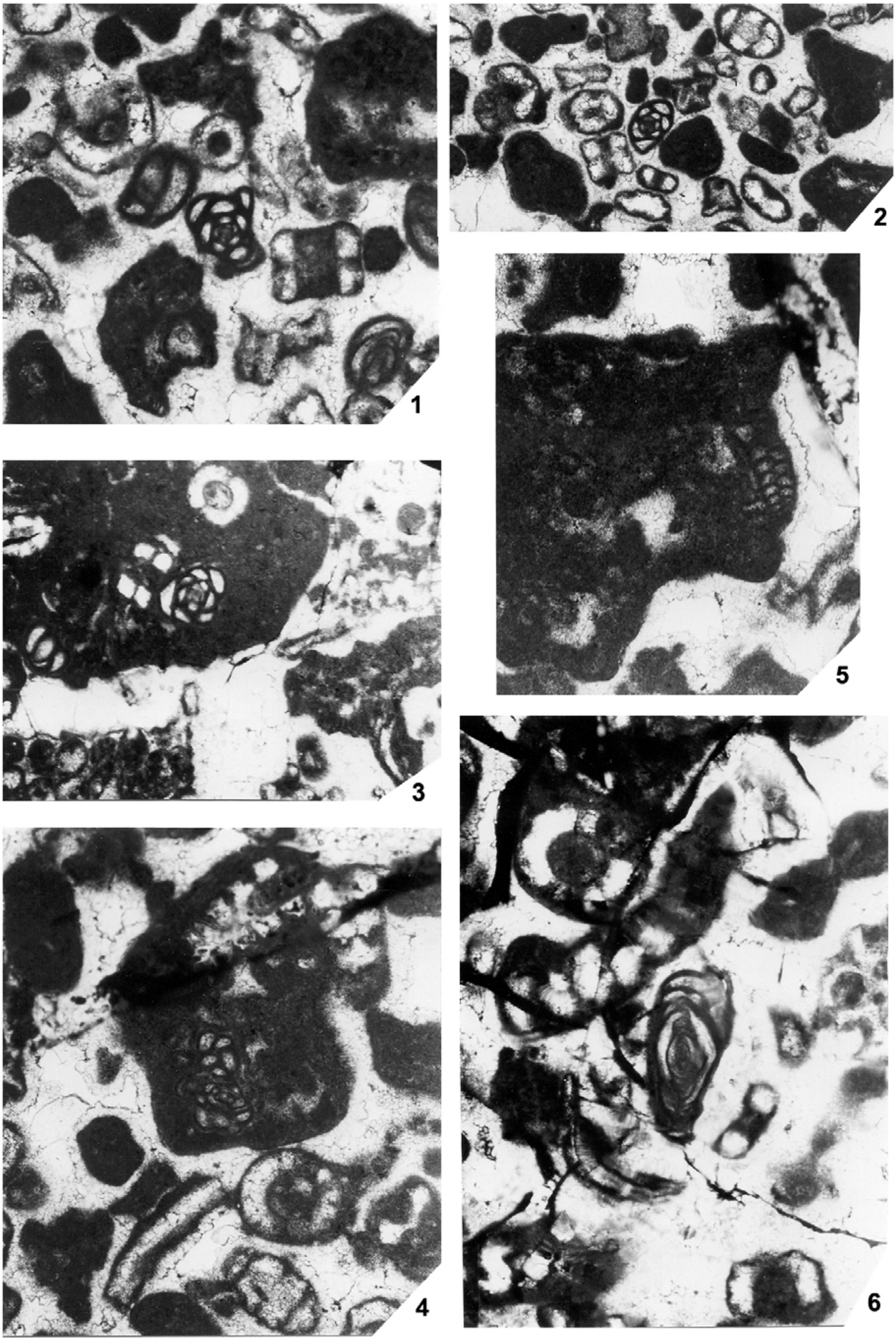

PLATE 7

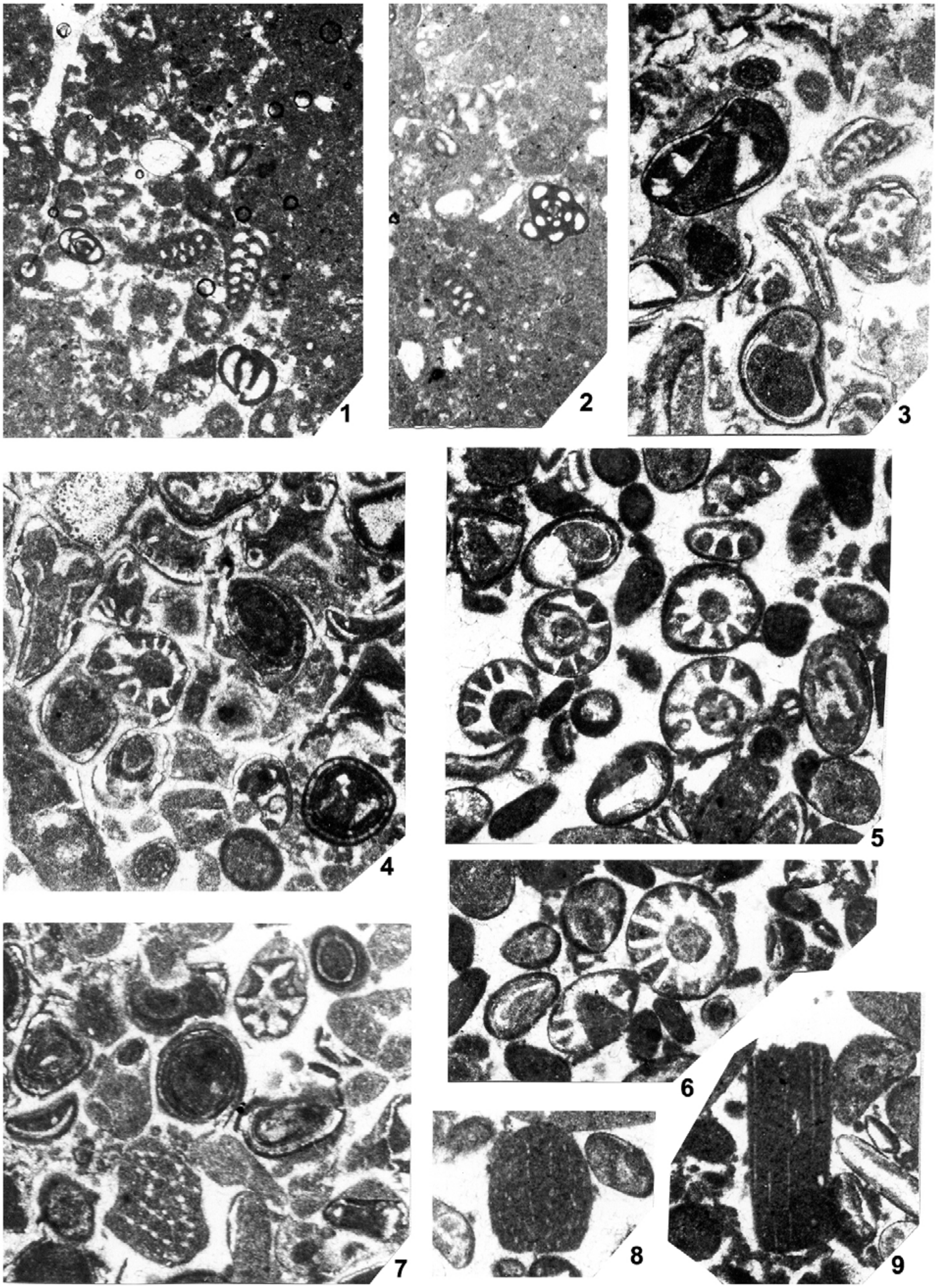

PLATE 8