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CALCAREOUS NANNOPLANKTON OF THE MARTHASTERITES TRIBRACHIATUS ZONE FROM THE LOWER EOCENE SEDIMENTS OF SLOVAKIA

(Pl. 1—11)

Abstract: The *Marthasterites tribrachiatus* zone of the Lower Eocene, called the *Marthasterites tribrachiatus* and *Discoaster lodoensis* zone by the author in her previous works, has been found in several localities of Slovakia. In the work presented, assemblages of this zone are for the first time described using scanning electron microscopy. Calcareous nannoplankton was obtained from the Beloveža beds exposed near the village Malá Domaša (Eastern Slovakia).

Резюме: Нижнеэоценная нанопланктоновая зона с *Marthasterites tribrachiatus*, которую автор статьи до сих пор определял как зону с *Marthasterites tribrachiatus* и *Discoaster lodoensis*, была уточнена на многих местах Словакии. В предлагаемой статье приведены впервые результаты изучений ассоциации этой зоны помощью электронного микроскопа. Известковый нанопланктон происходит из беловежских слоев у села Мала Домаша (восточная Словакия).

Introduction

The Lower Eocene marine sediments contain generally rich and various assemblages of calcareous nannoplankton. Several biostratigraphic zones were possible to define in them thanks to the variety of species and the presence of specimens with a short stratigraphic range. Four nannoplankton zones can be found in the Lower Eocene Martini's Standard Stratigraphic Scale (E. Martini 1971). They are:

NP-10 the *Marthasterites concortus* zone (author W. W. Hay 1964)
NP-11 the *Discoaster binodosus* zone (authors H. P. Mohler, W. W. Hay 1967)
NP-12 the *Marthasterites tribrachiatus* zone (authors P. Brönnimann, H. Stradner 1960)
NP-13 the *Discoaster lodoensis* zone (authors P. Brönnimann, H. Stradner (1960)

The last one is placed already on the boundary of the Lower and Middle Eocene in the scale.

Different zones, adequate to local situation, have been defined for some regions where the criteria used for standard zonation cannot apply because of different calcareous nannoplankton evolution. This case is encountered e. g. with the Lower Eocene assemblages of New Zealand (A. R. Edwards 1971) and the North Atlantic (A. T. Ramsay 1971 a, b). There are usually no difficulties with the correlation of differently named zones, although the boundaries of the local zones are not identical with the ones of the standard scale. However, some authors are of different opinions on the stratigraphic interpretation of the zones. E. g. A. T. Ramsay (1971 the North

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Atlantic) places the *Discoaster multiradiatus* zone on the base of the Lower Eocene, although it represents the youngest Paleocene nannoplankton zone in the sense of standard zonation and he considers the *Discoaster tribrachiatus* and *Discoaster lodoensis* zones to be of the Middle Eocene. On the contrary, D. Bukry (1971 the Indian Ocean) ranks the *Discoaster lodoensis* zone to the middle part of the Lower Eocene and he considers also the lower part of the overlying *Discoaster sublodoensis* zone which is taken for the Middle Eocene in the Standard Nannoplankton Zonation of Martini (1971), to be of the Lower Eocene. St. Gartner (1971 Blake Plateau) considers the lower part of the *Marthasterites contortus* zone to be of the upper Paleocene and he ranks also the lower part of the *Chriphragmalithus quadratus* zone, overlying the *Discoaster sublodoensis* zone to the Lower Eocene.

The question remains open whether the non-uniform interpretations of the nannoplankton zones are the result of different opinions on the position of the boundary between the Paleocene and the Lower Eocene on one hand and the Lower and Middle Eocene on the other hand or whether the presence of the same type of nannoflora in sediments of different ages gives evidence of its continuous spreading to different regions.

Marthasterites tribrachiatus zone

The *Marthasterites tribrachiatus* zone is defined as the interval from the first occurrence of *Discoaster lodoensis* Bramlette et Riedel to the last occurrence of *Marthasterites tribrachiatus* (Bramlette et Riedel) Deflandre. The first data about the occurrence of the assemblages with two index species of the zone can be found in the work of M. N. Bramlette and W. R. Riedel (1954). They described the assemblages of the Lower Eocene of the Lodo Formation in California and the Lower Eocene of the Ramdat Formation in Trinidad and they pointed to the stratigraphic value of the both species mentioned. In 1960 P. Brönniman and H. Stradner found nannoflora of the same type in the Capdevila Formation of Cuba from where they defined the biostratigraphic zone with the type locality (Reparto Capri, on west side of the Calzade de Bejucal, between Arroyo Apolo and Arroyo Naranjo, La Habana, Cuba, Capdevila Formation).

E. Martini (1971) stated following species as common for the zone: *Discoaster binodosus* Martini, *Marthasterites tribrachiatus* (Bramlette et Riedel) Deflandre, *Discoaster diastypus* Bramlette et Sullivan, *Ellipsolithus macellus* (Bramlette et Sullivan) Sullivan, *Chiasomolithus grandis* (Bramlette et Riedel) Hay et al. intervening from the underlying zone and the following new ones joining them — *Discoaster lodoensis* Bramlette et Riedel, *Discoaster barbadiensis* Tan Sin Hok, *Discoaster distinctus* Martini, *Cyclococcolithus formosus* Kamptner, *Discoasteroides kuepperi* (Stradner) Bramlette et Sullivan, *Neococcolithes dubius* (Deflandre) Black and *Sphenolithus radians* Deflandre. Stratigraphic range of the zone corresponds to the upper part of the *Globorotalia formosa* zone (P7), the *Globorotalia aragonensis* zone (P8) and the lower part of the *Acarinina densa* zone (P9) according to W. A. Berggren (1969). As it follows from the literary data, this zone is world-spread. It was found, in addition to the localities mentioned, in Italy (F. Proto — Decima 1966), Switzerland (W. W. Hay, H. P. Mohler 1965, C. C. Kapellos 1973), France (E. Martini 1961), Germany (E. Martini 1959, 1960, S. Locker 1972), Denmark (K. Perch — Nielsen 1971), Poland (A. Radomski

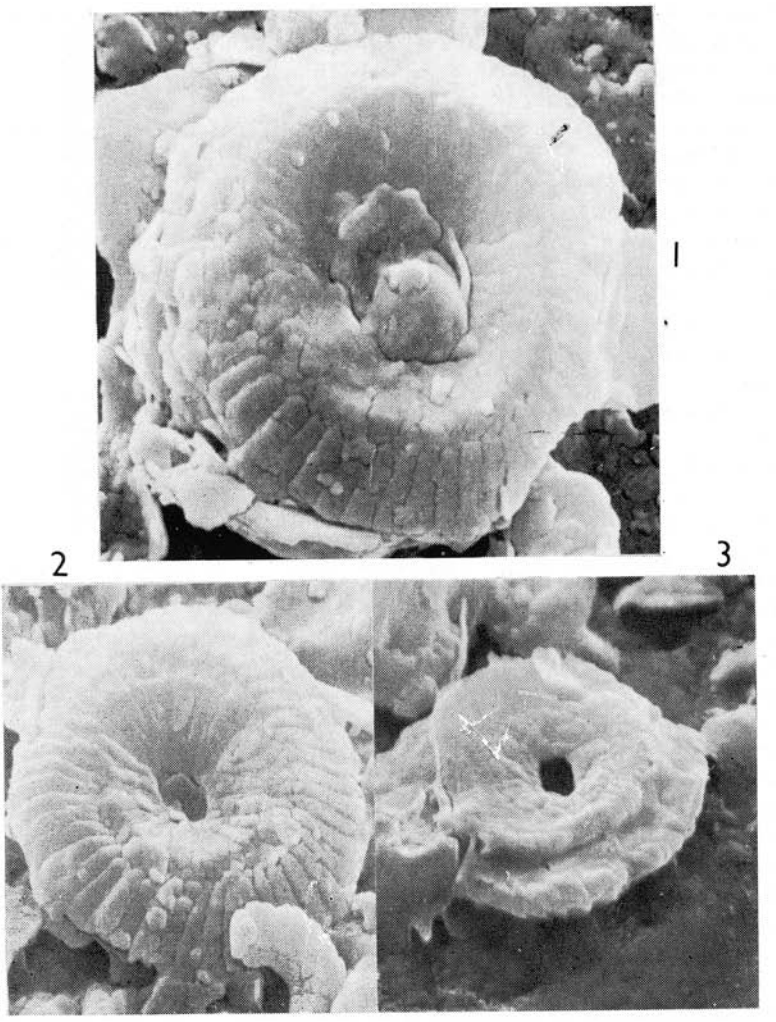


Plate I

Fig. 1, 2.: *Coccolithus sarsiae* Black, distal wiews. Fig. 1, 10 000 ×, fig. 2, 8000 ×. Fig. 3.: *Coccolithus sarsiae* Black, proximal view, 10 000 ×.

1967), USSR (C. C. Kapellos 1973), the North Atlantic (A. T. Ramsay 1971, K. Perch — Nielsen 1972) and Blake Plateau (St. Gartner 1971).

Up to the present time the stratigraphic interval with the nannoflora mentioned in the territory of Slovakia was called the *Marthasterites tribrachiatus* and *Discoaster lodoensis* zone and it was paralleled with the upper part of the *Globorotalia aragonensis zone* (H. Bystrická 1965, O. Samuel — H. Bystrická 1968). From several

Lower Eocene localities with the assemblage of this nannoplankton zone, the most suitable material for study with the electron microscopy was obtained from strata exposed at construction of a road from Malá Domaša to Kelča. They were the Beloveža strata of the Magura flysch (Exact situation described in the work of H. Bystrická, B. Lešku, O. Samuel 1970, p. 152). The following species were found in the assemblage:

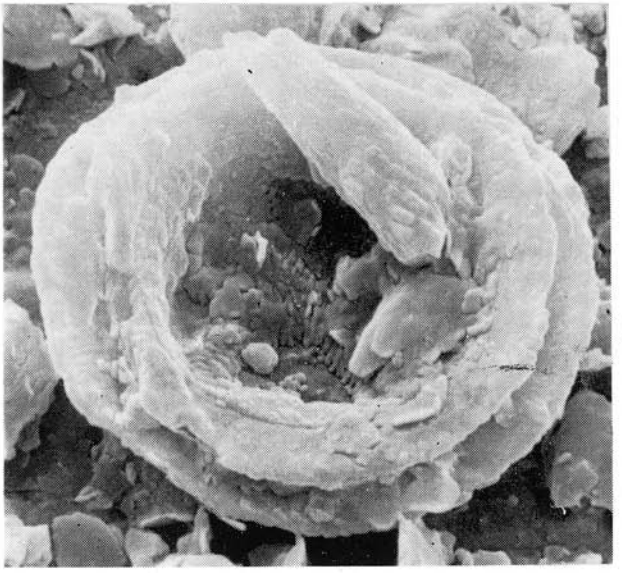
Coccolithus sarsiae Black
Cyclococcolithus formosus Kamptner
Chiasmolithus grandis (Bramlette et Riedel) Hay, Mohler, Wade
Cruciplacolithus delus (Bramlette et Sullivan) Perch — Nielsen
Markalius astroporus (Stradner) Hay et Mohler
Markalius inversus (Deflandre) Bramlette et Martini
Markalius cf. nudus Perch — Nielsen
Coronocyclus sp.
Toweius craticulus Hay et Mohler
Pontosphaera sp.
Transversopontis pulcher (Deflandre) Hay, Mohler et Wade
Lophodolithus cf. mochloporus Deflandre
Helicosphaera seminulum Bramlette et Sullivan
Helicosphaera sp.
Neococcolithes dubius (Deflandre) Black
Rhabdolithus solus Perch — Nielsen
Blackites creber (Deflandre) Hay et Towe
Zygrhablithus bijugatus (Deflandre) Deflandre
Discoaster barbadiensis Tan Sin Hok
Discoaster distinctus Martini
Discoaster elegans Bramlette et Sullivan
Discoaster lodoensis Bramlette et Riedel
Discoaster mirus Deflandre
Discoaster sp.
Discoasteroides kuepperi (Stradner) Bramlette et Sullivan
Marthasterites tribrachiatus (Bramlette et Riedel) Deflandre

Prevailing components of the assemblage are two leading species: *Discoaster lodoensis* Bramlette et Riedel and *Marthasterites tribrachiatus* (Bramlette et Riedel) Deflandre. *Discoaster mirus* Deflandre and *Discoaster barbadiensis* Tan Sin Hok are also quite numerous. *Coccolithus sarsiae* Black and *Toweius craticulus* are the most common from the placoliths.

Systematic Paleontology

Family Coccolithaceae Kamptner, 1929
Genus *Coccolithus* Schwarz, 1894
Coccolithus sarsiae Black, 1962
(pl. 1, fig. 1, 2, 3, pl. 11, fig. 4)

1962 *Coccolithus sarsiae* n. sp. — M. Black: Fossil Coccosphaeres etc., p. 125, pl. 8, fig. 2, pl. 9, fig. 2—6.
1964 *Coccolithus muiri* n. sp. — M. Black: Cretaceous and Tertiary Coccoliths etc., p. 309, pl. 50, fig. 3, 4.



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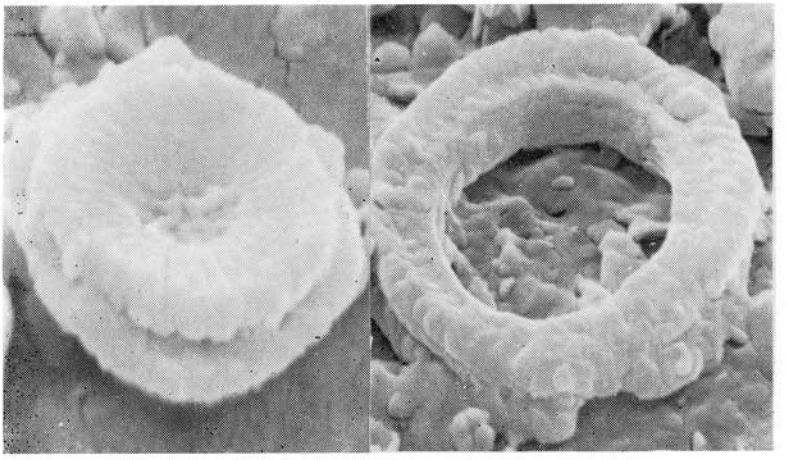

Plate II

Fig. 1.: *Chiasmolithus grandis* (Bramlette et Riedel) Hay, Mohler, Wade, proximal view, 5500 ×. Fig. 2.: *Markalius nudus* Perch-Nielsen, proximal view, 20 000 ×. Fig. 3.: *Coronocyclus sp.*, distal view, 10 000 ×.

1964 *Erisconia ovalis* nov. spec. — M. Black ibidem, p. 309, pl. 52, fig. 5, 6.

Description. Coccolithes are of a broad oval shape, different sizes. The distal disc consists of about 40—45 oblong plates slightly dextrally imbricate. The central area is large, more than 2/3 the diametre of the coccolith. ~~Its~~ depth varies. It is filled

with irregular oval granules or long, narrow, radial plates. The proximal disc is smaller, about 5/7 the diametre of the one. In it, three concentricaly placed rims are visible. The inner one is from irregular granules and fills the central area. The middle one is from oblong plates lying close together and radially arranged. The third, outer rim is from strongly imbricate plates that include with the elements of the middle rim an angle about 45 degrees.

Stratigraphic range: The Lower Eocene — the Oligocene.

Genus *Cyclococcolithus* Kamptner, 1954

Cyclococcolithus formosus Kamptner, 1963

(pl. 9, fig. 6)

1963 *Cyclococcolithus formosus* nov. spec. — E. Kamptner: Coccolithineen — Skelettreste etc., p. 163, pl. 2, fig. 8, textfig. 20.

1964 *Coccolithus lusitanicus* sp. nov. — M. Black: Cretaceous and Tertiary Coccoliths etc., p. 308, pl. 50, fig. 1, 2.

1966 *Cyclococcolithus lusitanicus* (Black) — W. W. Hay, H. P. Mohler, M. E. Wade: Calcareous nannofossils etc., p. 390, pl. 7, fig. 3—6.

1971 *Cyclococcolithina formosa* (Kamptner) Wilcoxon — J. A. Wilcoxon: *Cyclococcolithina* Wilcoxon nom. nov. etc., p. 82.

1973 *Coccolithus sarsiae* Black — C. C. Kapellos: Biostratigraphie des Gurnigelflysches, p. 105, pl. 30, fig. 1, pl. 33, fig. 6.

1973 *Coccolithus formosus* (Kamptner) Wise, n. comb. — S. W. Wise: Calcardeous Nannofossils etc., p. 593, pl. 4, fig. 1—6.

1967 *Cyclococcolithus lusitanicus* (Black) Hay, Mohler, Wade — M. N. Bramlette, J. A. Wilcoxon: Middle Tertiary Calcareous Nannoplankton etc., p. 103, pl. 3, fig. 16, 17.

Description. Round placoliths were relatively numerous in the assemblage studied. The distal disc is from 50 narrow, slightly dextrally imbricate elements. The central area is large, about 3/5 — 2/3 the diametre of the placolith. It is filled narrow, long, radially arranged plates overlapping the elements of the distal disc with well preserved specimens. The central opening is small, roud and occupies about 1/8 of the placolith.

In the material studied, we were not successful in obtaining electron micrographs of the proximal side with well preserved microstructure. There are two concentric, rather indistinct rims from oblong elements including with neighbouring rims elements an angle of about 90 degrees, on the proximal disc which is a bit smaller than the distal one.

Stratigraphic range: The Lower Eocene — the Lower Oligocene. Still rare in the Lower Eocene and not mentioned in all Lower Eocene localities.

Genus *Chiasmolithus* Hay, Mohler, et Wade, 1966

Chiasmolithus grandis (Bramlette et Riedel, 1954) Hay, Mohler et Wade, 1966

(pl. 2, fig. 1)

1954 *Coccolithus grandis* Bramlette et Riedel, n. sp. — M. N. Bramlette, W. R. Riedel: Stratigraphic Value of Discoaster etc., p. 391, pl. 38, fig. 1a, b.

1966 *Chiasmolithus grandis* — W. W. Hay, H. P. Mohler, M. E. Wade: Calcareous Nannofossils etc., p. 388.

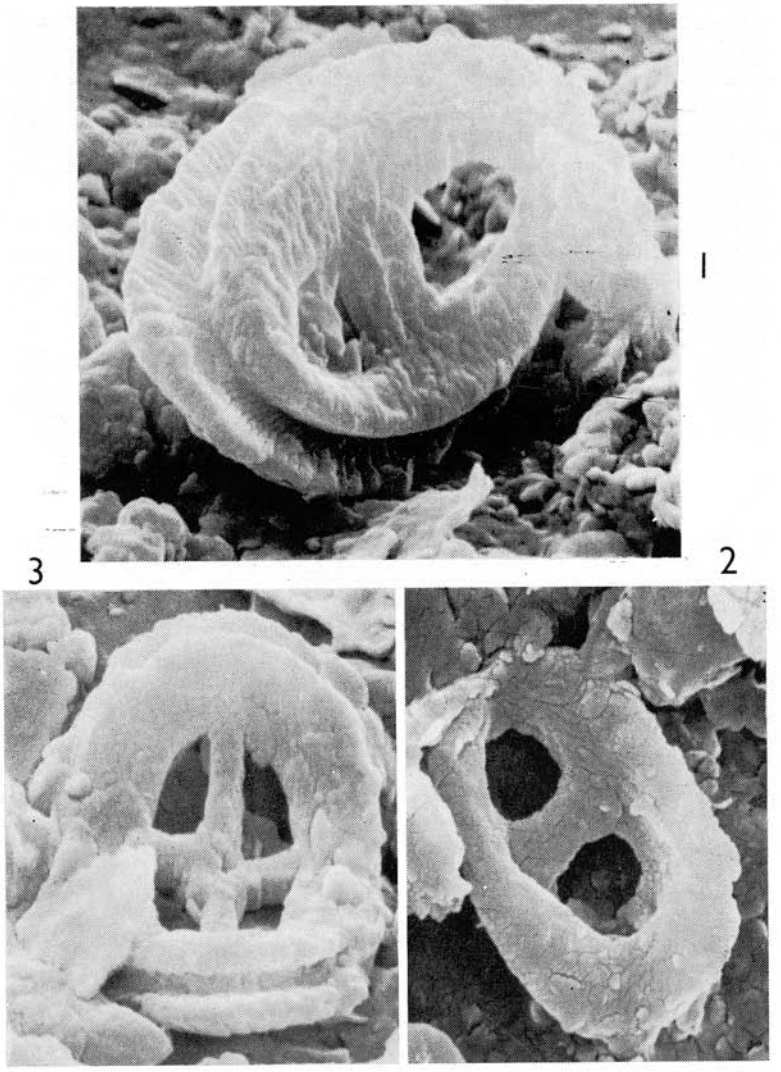

Plate III

Fig. 1, 2.: *Helicosphaera seminulum* Bramlette et Sullivan. Fig. 1, proximal view, 8000 ×, fig. 2, distal view, 7000 ×. Fig. 3.: *Cruciplacolithus delus* (Bramlette et Sullivan) Perch—Nielsen, proximal view, 10 000 ×.

1970 *Chiasmolithus grandis* (Bramlette et Riedel) Gartner, n. comb. — St. Gartner Jr.: Phylogenetic Lineages etc., p. 944, pl. 11, fig. 3, pl. 14, fig. 1—3.

Description. The large, broad oval species is easy to identify with the light as well as the electron microscope. The specimens from the locality studied were partly broken, partly calcite overgrown, but their microstructure was not wholly covered.

The overlapping margin of the distal disc formed by a number (according to K. Perch — Nielsen 1971, even by a hundred) of narrow, partly dextrally imbricate elements is wisible in the electron micrograph of the proximal side. Two rims are distinguishable on the proximal disc. The inner one is broader, from oblong elements and the outer one is narrower, from oblong elements orientated in the opposite direction. The central area is filled with very small granules forming four broad thorns in the central opening in the direction of the placolith axes, which is the typical feature of the species. The large central opening is spanned with a broad X-shaped crossbar. The crossbar is covered with two rows of narrow, alternately placed plates on the proximal side. Our species preserved only slight remnants of the fine grille in the central opening. They are the edge to the central opening and the crossbar.

Stratigraphic range: The Lower and Middle Eocene.

Genus *Cruciplacolithus* Hay et Mohler, 1967
Cruciplacolithus delus (Bramlette et Sullivan 1961)
Perch — Nielsen, 1971
(pl. 3, fig. 2)

1961 *Coccolithus delus* Bramlette et Sullivan, n. sp. — M. N. Bramlette, F. R. Sullivan: Coccolithophorids and Related Nannoplankton etc., p. 151, pl. 7, fig. 1 a—c, 2 a—b.
1961 *Cyatosphaera crux* (Deflandre et Fert) — W. W. Hay, K. M. Towe: Electronmicroscopic Examination etc., p. 507, pl. 2, fig. 1.
1967 *Coccolithus delus* (Bramlette et Sullivan 1961) — K. Perch — Nielsen: Nannofossilien aus dem Eozän. etc., p. 22, 23, pl. 1, fig. 1—3.
1967 *Campilosphaera dela* (Bramlette et Sullivan) — W. W. Hay, H. P. Mohler: Calcareous Nannoplankton etc., p. 1531, pl. 198, fig. 14.
1971 *Cruciplacolithus delus* (Bramlette et Sullivan 1961) n. comb. — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 22, pl. 13, fig. 7, 8.

Description. Strong inclination in the longer axis direction, unusual with the Coccoliths, caused this species with the typical features of the genus *Cruciplacolithus* being ranked to different genera. Two rims from very narrow, slightly sinistrally inclined plates are visible on the proximal disc. The outer rim forms the disc itself, while the inner one belongs to the central area. The central opening is large, about 1/2 the diametre of the placolith. The cruciform central crossbar situated in the direction of the placolith axes is narrow and it seems to be composed from oblong, narrow plates imbricate towards the central opening circumference. The distal disc is a bit larger than the proximal one and it is from the same number of plates sinistrally imbricate.

Stratigraphic range: The Upper Paleocene — the Lower Eocene.

Genus *Markalius* Bramlette et Martini, 1964
Markalius inversus (Deflandre, 1954) Bramlette et Martini, 1964
(pl. 11, fig. 5)

1954 *Cyclococcolithus leptoporus* var. *inversus* Defl. n. v. — G. Deflandre, C. Fert: Observations sur les Coccolithophorids etc., p. 150, pl. 9, fig. 4, 5.

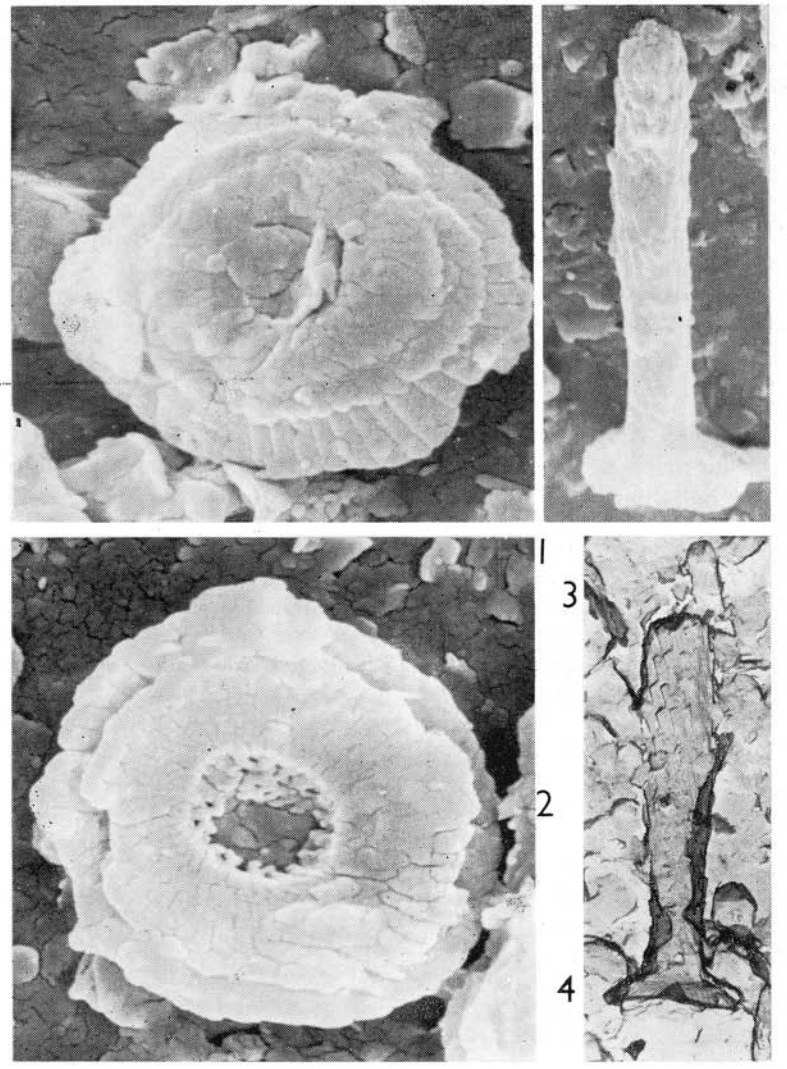

Plate IV

Fig. 1, 2.: *Toweius craticulus* Hay et Mohler. Fig. 1, distal view, fig. 2, proximal view, 10 000 ×. Fig. 3, 4.: *Rhabdolithus solus* Perch–Nielsen. Fig. 3, 6000 ×, fig. 4, 5000 × (TEM).

1964 *Markalius inversus* (Deflandre) — M. N. Bramlette, E. Martini: The Great Change in Calcareous Nannoplankton Fossils etc., p. 302, pl. 2, fig. 4—9, pl. 7, fig. 2a—b.

1971 *Markalius inversus* (Deflandre 1954) Bramlette et Martini 1964, K. Perch — Nielsen: Elektronmikroskopische Untersuchungen etc., p. 24, pl. 2, fig. 6, 7 — Cum syn.

Description. All the electron micrographs obtained show the proximal side of the placolith. The proximal disc and the narrow stripe of the slightly larger distal disc are visible in them. They are both relatively thick and lie close one on the other. They are of the same number (27—36) of wedge-shaped, close together placed plates. It is visible on the proximal disc that although they are concentrated to the central opening, they are not wholly radially oriented, but they are slightly sinistrally inclined. The central opening is about 1/3 the diametre of the proximal disc, but it can be a bit smaller or larger. It is covered with a plate, the microstructure of which is not quite distinct with our specimens. The finds of this species in our localities confirmed the assertion of K. Perch — Nielsen (1971), that the Paleogene specimens are of a smaller size than the Cretaceous ones.

Stratigraphic range: The Upper Certaceous — the Upper Eocene.

Markalius nudus Perch — Nielsen, 1971
(pl. 2, fig. 2)

1971 *Markalius nudus* n. sp. — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 24, pl. 2, fig. 4, 5, pl. 60, fig. 15.

Description. A small, round placolith is composed from two discs. The distal one is a bit larger than the proximal one. Both are from the same number, about 40, of plates. The plates are narrow, wedge-shaped, placed close together and radially arranged. The central opening is about 1/3 the diametre of the proximal disc. It is coverd with a grille from irregular granules that originated from the ends of the proximal disc plates. Our specimens with their smaller sizes and greater number of the plates differ from the typical species.

Stratigraphic range: Up to the present time described only from the Danish Lower Eocene by the author of the species.

Genus *Coronocyclus* Hay, Mohler et Wade 1966 *Coronocyclus* sp.

Description. A round species from a circumference rim enclosing a large central opening. The circumference rim is from two close together lying layers of the same size which are connected by a vertical, narrow pipe. Both layers consist of the same number, about 60, of narrow, vertical plates that are knee-bent in the middle in such a way, that the part round the central opening is in the horizontal position while the circumference part is bent up. The central pipe is from discreet irregular granules.

Family Prinsiaceae Hay et Mohler, 1967
Genus *Toweius* Hay et Mohler, 1967
Toweius craticulus Hay et Mohler, 1967
(pl. 4, fig. 1, 2, pl. 8, fig. 5)

1967 *Toweius craticulus* n. sp. — W. W. Hay, H. P. Mohler: Calcareous Nannoplankton etc., p. 1530, pl. 196, fig. 7—9, pl. 197, fig. 2, 3.

1971 *Toweius craticulus* Hay et Mohler 1967 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 32, pl. 18, fig. 1—7,7.

Description. A broad oval, almost round species. The distal disc is from three rims. The lower one, the broadest, is cut-cone-shaped. It is from about 45—50

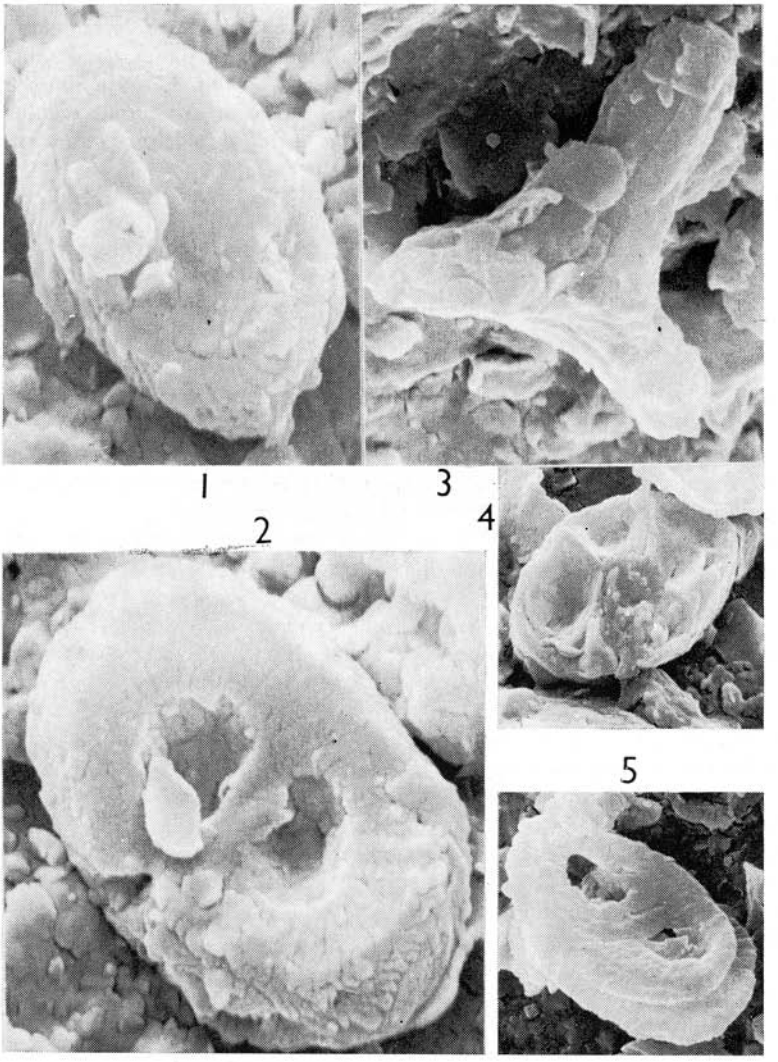

Plate V

Fig. 1.: *Pontosphaera sp.*, proximal view, 10 000 ×. Fig. 2.: *Transversoponitis pulcher* (Deflandre) Hay, Mohler et Wade, proximal view, 10 000 ×. Fig. 3.: *Zygrhablithus bijugatus* (Deflandre) Deflandre, 7000 ×. Fig. 4.: *Neococcolithes dubius* (Deflandre))Black, distal view, 5000 ×. Fig. 5.: *Helicosphaera seminulum* Bramlette et Sullivan, proximal view, 4000 ×.

narrow plates lying close together. The middle rim is the narrowest. It is from wedge-shaped plates dextrally imbricate and forming a serrate margin. The upper rim is about 2.5 times broader than the middle one. It is from long, narrow, radially arranged plates. The proximal disc is about 1/3 narrower than the distal one. It is slightly

convex. It consists of a layer of narrow, wedge-shaped plates lying close together. In some cases, a narrow rim from granules alternating with plates can be distinguished on its outer circumference. The central opening is about 1/3 the diametre of the proximal disc, or it is larger. It is covered with a grille of found, regularly placed openings. The openings are very discreet, most probably calcite overgrown with our specimens.

Stratigraphic range: The Upper Paleocene -- the Lower Eocene.

Family Pontosphaeraceae Lemmermann, 1908

Genus *Pontosphaera* Lohmann, 1902

Pontosphaera sp.

(pl. 5, fig. 1)

Description. An oval species with a high margin wall. The wall is from very narrow, sinistrally inclined plates. The central field is overgrown by a layer covering its microstructure. A serrate drawing on the circumference, however, indicates that the central plate consists of radially arranged, narrow elements. Other details, like pores, the central suture, etc. were impossible to distinguish.

The whole shape of the coccolith does not eliminate the possibility of its being a replaced representative of the genus *Parhabdolithus*.

Genus *Transversopontis* Hay, Mohler et Wade, 1966

Transversopontis pulcher (Deflandre, 1954) Hay, Mohler et Wade, 1966

(pl. 5, fig. 2)

1954 *Discolithus pulcher* Defl., cent. nov. — G. Deflandre, C. Fert: Observations sur les Coccolithoporides etc., p. 142, pl. 12, fig. 17, 18.

1966 *Transversoponits pulchra* (Deflandre) — W. W. Hay, H. P. Mohler, M. E. Wade: Calcareous Nannofossils etc., p. 391, pl. 8, fig. 5.

1971 *Transversoponits pulcher* (Deflandre 1954) Hay et al. 1966 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 39, pl. 28, fig. 6, pl. 31, fig. 23, pl. 32, fig. 5, 6.

All the electron micrographs obtained show the basal side.

Description. An oval species with the axes relation about 5 : 3 has the basal side from radially arranged plates. The oval central opening, about 1/2 of the basal side, is spanned with a crossbar in the direction of the shorter axis. The crossbar is quite distinctly visible to consist of two plates comming from the margin part and meeting in the middle of the central opening, forming an oblique suture. The crossbar splits the central opening into two large semicircle openings. The serrate sculpture visible mainly with the light microscope, was not found with our specimens.

The wall is relatively high. It is from narrow, sinistrally orientated and obliquely inclined plates.

Stratigraphic range: The Lower Eocene — the Lower Oligocene.

Genus *Lophodolithus* Deflandre, 1954

(pl. 10, fig. 3)

1954 *Lophodolithus mochlophorus* Defl., cent. nov. — G. Deflandre, C. Fert: Observations sur les Coccolithophoridés etc., p. 145, pl. 12, fig. 20—23, textfig. 69—71.

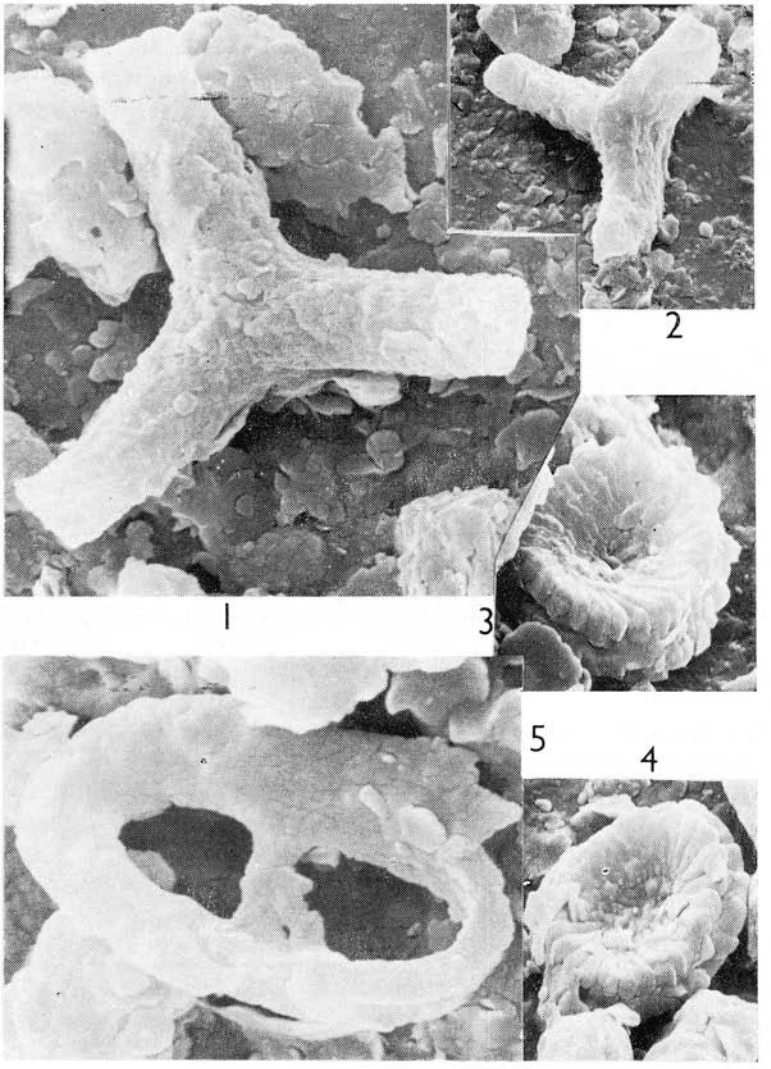

Plate VI

Fig. 1, 2.: *Marthasterites tribrachiatus* (Bramlette et Riedel) Deflandre. Fig. 1, 10 000×, fig. 2, 2500 ×. Fig. 3, 4: *Watznaueria barnesal* (Black) Perch — Nielsen, reworked specimens, 5000 ×. Fig. 5.: *Helicosphaera* sp., distal view, 9000 ×.

Description. From the material studied, only one electronmicrograph was obtained of the basal side of a species the diagnostic features of which admit its being ranked to the species *Lophodolithus mochlophorus*. The "shell" is egg-shaped, which is typical for the genus *Lophodolithus*. The wall is from narrow, slightly sinistrally inclined plates. They are curved at the central opening circumference and

form the inner side of the wall, too. The central crossbar is placed on the central opening base (i. e. near the distal side) and is shifted towards the broader end of the "shell". Its microstructure is not distinct with the specimen micrographed. The small size of our specimen, about 5 μ, when compared with typical ones, reaching even 15 μ, is not typical.

Stratigraphic range: The Lower and Middle Eocene.

Genus *Helicosphaera* Kamptner, 1954
(Syn. *Helicopontosphaera* Hay et Mohler, 1967)
Helicosphaera seminulum Bramlette et Sullivan, 1961
(pl. 3, fig. 1, 2, pl. 5, fig. 5)

1951 *Helicosphaera seminulum seminulum* Bramlette and Sullivan, new subspecies — M. N. Bramlette, F. R. Sullivan: Coccolithophorids and Related Nannoplankton etc., p. 144, pl. 4, fig. 1a—c, 2.

1970 *Helicopontosphaera seminulum* (Bramlette et Sullivan) n. com. — P. H. Roth: Oligocene Calcareous Nannopllankton Biostratigraphy, p. 863.

Description. A large, broad oval species with two large semicircular openings in the central area. The spirally rolled marginal part of the proximal side is distinctly visible to consist of long narrow radially oriented plates. The central opening is spanned with a wide crossbar in the direction of the shorter axis. It is from two close together lying plates. The microstructure of the plates is not distinct with the specimens studied.

The distal side is from small granules visible also on the distal side of the central crossbar.

Stratigraphic range: The Paleocene — the ~~Lower~~ Oligocene.

Helicosphaera sp.
(pl. 6, fig. 5)

Description. A big, relatively narrow oval species. The margin walls are narrow, composed by narrow plates. The distal side is covered with irregular, more or less concentrically placed granules. The terminal flange is angular and extends in two blunt thorns. The central crossbar is of the same microstructure as the distal side and it splits the central opening into two semielliptic windows. The specimen differs from the known Paleogene ones by the narrow margin wall and the angular double-serrate terminal flange.

Family Zygodiscaceae Hay et Mohler, 1967
Genus *Neococcolithes* Sujkowski, 1931
Neococcolithes dubius (Deflandre, 1954) Black, 1967
(pl. 5, fig. 4)

1954 *Zygolithus dubius* Defl., cent. nov. — G. Deflandre, C. Fert: Observations sur les Coccolithophoridés etc., p. 149, textfig. 43, 44, 68.

1964 *Chiphragmalithus dubius* (Deflandre) — F. R. Sullivan: Lower Tertiary Nannoplankton etc., p. 179, pl. 1, fig. 2.

1967 *Neococcolithes dubius* (Deflandre) nov. comb. — M. Black: New Names for Some Coccolith Taxa, p. 143.

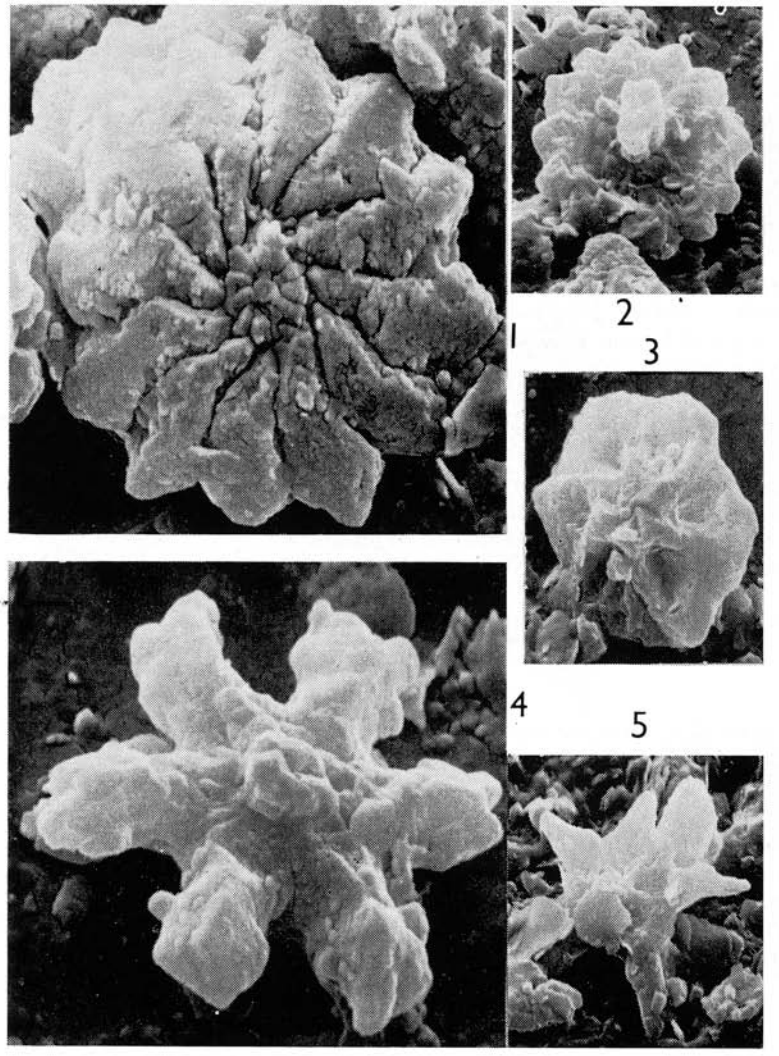

Plate VII

Fig. 1, 2.: *Discoaster barbadiensis* Tan Sin Hok. Fig. 1, distal view, 7000 ×. Fog. 2, proximal view, 4500 ×. Fig. 3.: *Discoaster* sp., probably the central part of *Discoaster lodoensis* Bramlette et Riedel, 4250 ×. Fig. 4.: *Discoaster distinctus* Martini, proximal view, 9000 ×. Fig. 5.: *Discoaster sublodoensis* Bramlette et Sullivan, proximal view, 5000 ×.

Description. Despite strong contamination it was possible to distinguish the following typical features of the species in the material studied: The wide oval circumference rim from narrow, oblique plates and the central crossbar of the broad H shape.

Stratigraphic range: The Paleocene — the Eocene.

Family Rhabdosphaeraceae Lemmermann, 1908
Genus *Blackites* Hay et Towe, 1962, emend. Stradner, 1968
Blackites creber (Deflandre, 1954) Stradner et Edwards, 1968
(pl. 10, fig. 2)

1954 *Rhabdolithus creber* Defl. cent. nov. — G. Deflandre, C. Fert: Observations sur les Coccolithophoridés etc., p. 158, pl. 12, fig. 31—33, textfig. 81, 82.
1961 *Rhabdosphaera crebra* (Deflandre) — M. N. Bramlette, F. R. Sullivan: Coccolithophorids and related Nannoplankton etc., p. 146, pl. 5, fig. 1—3.
1968 *Blackites creber* (Deflandre) nov. com. — H. Stradner, A. R. Edwards: Electron-Microscopic Studies etc., p. 29.

Description. The electron-micrograph shows a side wiew of the specimen. The microstructure of the basal disc is not distinct. The collar is about $^1/_2$ smaller than the basal disc. It consists of very small vertical plates, S-bent in the middle. The central process is a bit narrower than the collar and is of the same thickness almost along its whole length. It gradually narrows into a round point at the distal end. It is covered with tabular plates of indistinct arrangement.

Stratigraphic range: The Lower and Middle Eocene.

Genus *Rhabdolithus* Kamptner, 1953
Rhabdolithus solus Perch — Nielsen, 1971
(pl. 4, fig. 3, 4)

1971 *Rhabdolithus solus* n. sp. — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 52, pl. 45, fig. 10—13, pl. 61, fig. 36—38.

Description. A specimen of a small round basal disc and a large club-shaped stem. On the basal disc, about 40 radially arranged narrow plates are visible. The club-shaped stem is from oblong laths spirrally arranged. The shape and the arrangement of the laths are typical for the species.

Stratigraphic range: Up to now known only from the Danish Lower Eocene from the *Marthasterites tribrachiatus* zone.

Family Calyptrosphaeraceae Buodreaux et Hay, 1969
Genus *Zygrhablithus* Deflandre, 1959
Zygrhablithus bijugatus (Deflandre, 1954) Deflandre, 1959
(pl. 5, fig. 3)

1954 *Zygolithus bijugatus* Defl. cent. nov. — G. Deflandre, C. Fert: Observations sur les Coccolithophoridés etc., p. 149, pl. 11, fig. 20, 21, textfig. 59.
1954 *Rhabdolithus costatus* Defl. cent. nov. — G. Deflandre, C. Fert: Ibidem, p. 154, pl. 11, fig. 8—11, textfig. 41, 42, 70—79.
1959 *Zygrhablithus bijugatus* (Defl.) — G. Deflandre: Sur les nannofossiles calcaires etc., p. 135.
1971 *Zygrhablithus bijugatus* Deflandre 1959 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 58, fig. 7—9, pl. 59, fig. 10. Cum. syn.

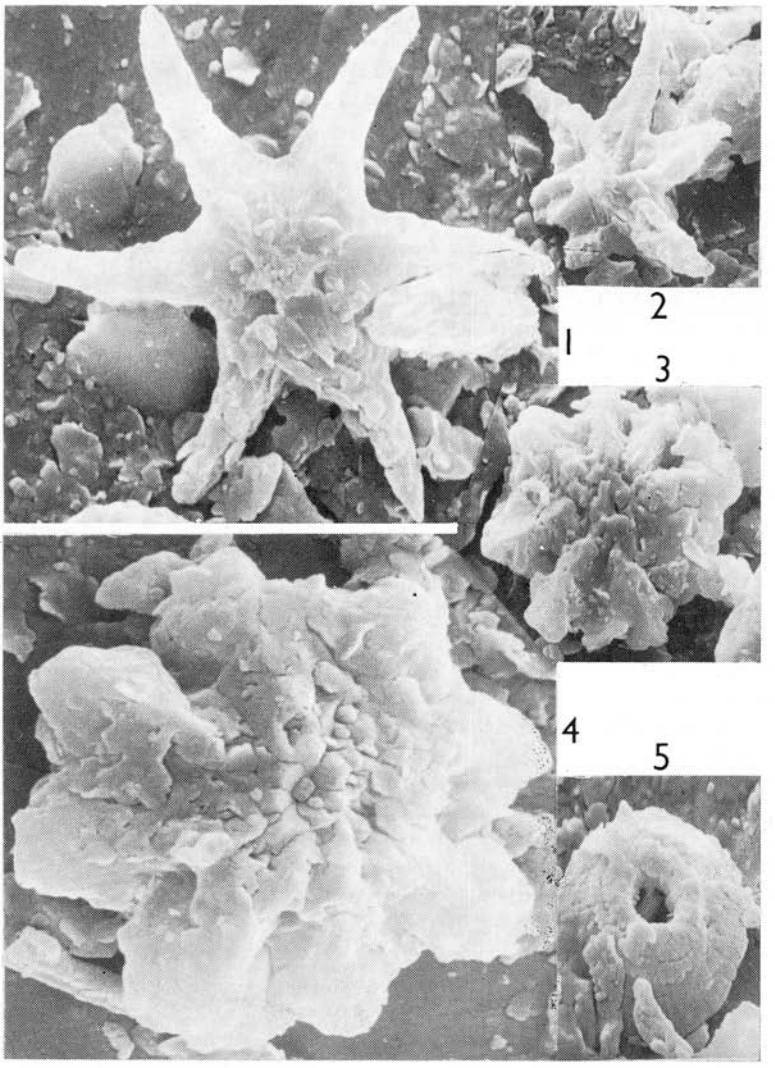

Plate VIII

Fig. 1, 2.: *Discoaster lodoensis* Bramlette et Riedel. Fig. 1, distal view, 4000 ×. Fig. 2, proximal view, 3000 ×. Fig. 3, 4.: *Discoaster mirus* Deflandre, distal views. Fig. 3, 3500 ×. Fig. 4, 5500 ×.

Description. The microstructure of the basal rim part is not distinct. A thick stem grows from the basal rim. It is of the same width along its whole length and it is semicircularly rounded at its distal end. The lengthwise suture is conspicuous. The holococcolith microstructure is visible only at the stem base.

Stratigraphic range: The Upper Paleogene? — the Lower Oligocene.

Family Discoasteraceae Tan Sin Hok, 1927
Genus *Discoaster* Tan Sin Hok, 1927
Discoaster *barbadiensis* Tan Sin Hok, 1927
(pl. 7, fig. 1, 2)

1927 *Discoaster Barbadiensis* nov. spec. typ. — Tan Sin Hok: Over de samenstelling etc., p. 119.
1927 *Discoaster Barbadiensis,* var. *Bebalaini* — Tan Sin Hok: Ibidem, p. 119, pl. 2, fig. 4.
1971 *Discoaster Barbadiensis* Tan Sin Hok, 1927 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen et., pl. 61, pl. 51, fig. 5 — cum. syn.
1971 *Heliodiscoaster barbadiensis* ssp. *barbadiensis* — B. Prins: Speculations on Relation etc., p. 1021, pl. 3, fig. 2.

Description. Asteroliths are distally convex and composed by 10—13 rays. A flat flower-shaped knob is placed in the middle of the distal side. The asterolith rays are not radial, but slightly dextrally inclined. A conspicuous, relatively long stem grows from the middle of the the proximal side.
Stratigraphic range: The Upper Paleocene — the Middle Eocene.

Discoaster distinctus Martini, 1958
(pl. 7, fig. 4)

1959 *Discoaster distinctus* n. sp. — E. Martini: Discoasteriden und verwandte Formen etc., p. 363, pl. 4, fig. 17a, b.
1971 *Agalmatoaster distinctus* — B. Prins: Speculations on Relations etc., p. 1023, pl. 4, fig. 33.
1971 *Discoaster distinctus* Martini, 1958 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 63, pl. 52, fig. 5, pl. 53, fig. 1.
Description. The most of the specimens studied is of 6 rays. Despite the overgrowing calcite layer, the diagnostic features of the species are visible — the deep narrow cut at the rays ends and the broad nodes. The conspicuous, high knob from radially arranged crystals is placed in the middle of the asterolith.
Stratigraphic range: The Lower — Upper Eocene.

Discoaster elegans Bramlette et Sullivan, 1961
(pl. 9, fig. 1, 2)

1961 *Discoaster elegans* Bramlette et Sullivan, new species — M. N. Bramlette, F. R. Sullivan: Coccolithophorids and Related Nannoplankton etc., p. 159, pl. 11, fig. 16a, b.
1961 *Discoaster stradneri* n. sp. — E. Martini: Nannoplankton aus dem Tertiär etc., p. 10, pl. 2, fig. 22, pl. 5, fig. 52.
Description. 10—12 rayed asteroliths are very similar to *Discoaster barbadiensis* Tan Sin Hok, from which they differ only by their transverse ribs on the rays. A robust long stem from wedge-shaped collumns is placed in the middle of the proximal side.
Stratigraphic range: The Lower and Middle Eocene.

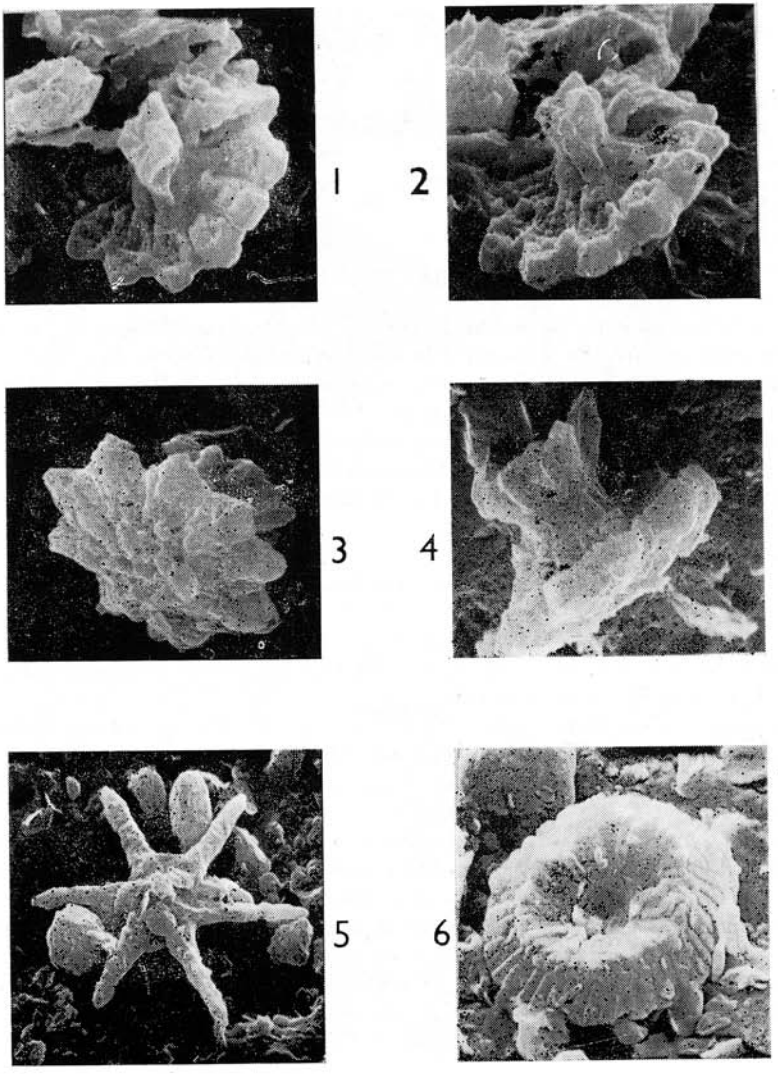

Plate IX

Fig. 1, 2.: *Discoaster elegans* Bramlette et Sullivan, proximal view, 5000 ×. Fig. 3, 4.: *Discoasteroides kuepperi* (Strander) Bramlette et Sullivan. Fig. 3, distal view, 4000 ×. Fig. 4, side view, 4500 ×. Fig. 5.: *Discoaster* sp., 2500 ×. Fig. 6.: *Cyclococcolithus formosus* Kamptner. Distal view, 4500 ×.

Discoaster lodoensis Bramlette et Riedel, 1954
(pl. 8, fig. 1, 2)

1954 *Discoaster lodoensis* Bramlette et Riedel, n. sp. — M. N. Bramlette, W. R. Riedel: Stratigraphic Value of Discoasters etc., p. 398, pl. 39, fig. 3a, b.
1971 *Curvidiscoaster lodoensis* — B. Prins: Speculations on Relations etc., p. 1021, pl. 3, fig. 18.
1971 *Discoaster lodoensis* Bramlette et Riedel 1954 — K. Perch — Nielsen: Elektronenmikroskopische Untersuchungen etc., p. 64, pl. 52, fig. 2, cum. syn.

Description. The asterolith is slightly convex, mosty 6-rayed. In proximal view, the rays are slightly sinistrally inclined. They are usually elongated, but very short with the juvenile specimens, very similar to those of *D. saipanensis* Bramlette et Riedel. Valted rays ends are lined with conspicuous ridges bending in the asterolith middle and composing a conspicuous stem. On the distal side, the rays are smooth, without any margin ridges. The central knob is flat.

Stratigraphic range: The Lower Eocene and the lower part of the Middle Eocene.

Discoaster mirus Deflandre, 1952
(pl. 8, fig. 3, 4)

1952 *Discoaster mirus* n. sp. — G. Deflandre in P. P. Grassé: Traité Zool. L, 1, p. 465, fig. 326. Non vidi.
1954 *Discoaster mirus* Defl. — G. Deflandre, C. Fert: Observations sur les Coccolithophoridés etc., p. 169, textfig. 118.
1961 *Discoaster mirus* Deflandre 1952 — E. Martini: Nannoplankton aus dem Tertiär etc., p. 12, pl. 3, fig. 24.

Description. 8-rayed specimens prevailed in the material studied. The asteroliths were considerably calcite overgrown. Their composition and morphology were partly covered. E. g. the lobes at the ends and sides of the rays preserved their original shape only in rare cases, they are mostly only indicated. In most cases, sediments fill also the interray spaces and cover the interrays sutures. A small flat knob from small concentric crystals is usually preserved in the asterolith middle. Few-rayed asteroliths may be easily mistaken with *Discoaster distinctus* Martini.

Stratigraphic range: The Lower Eocene— the Middle Lutet.

Discoaster sp.
(pl. 9, fig. 5)

Description. A 6-rayed flat asterolith with a round central area from which six long narrow rays spread. The central area is about $^1/_3$ the diametre of the asterolith. The rays are very narrow, straight, bluntly rounded at their ends. The interray cut-outs are of a round V-shape. Of the Paleogene species, the specimen resembles the most to *Discoaster strictus* Stradner, from which it differs with the shape of its rays that do not narrow in the distal dirrection.

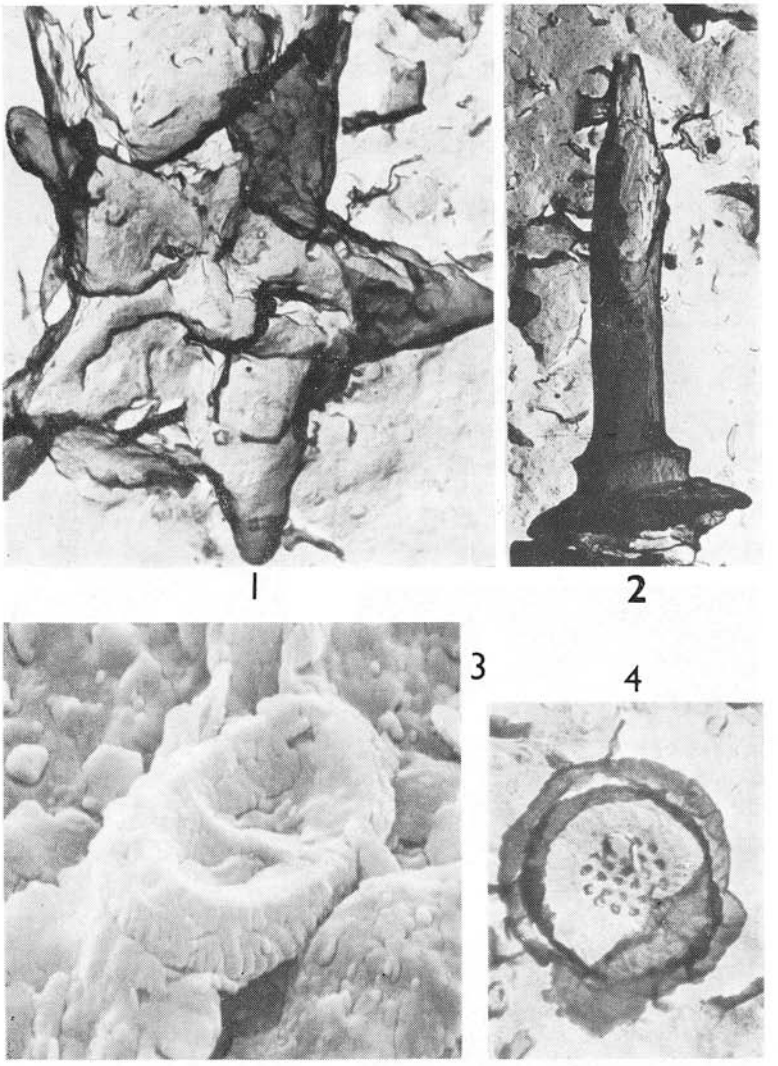

Plate X

Fig. 1.: *Discoaster cf. sublodoensis* Bramlette et Sullivan, 10 000 × (TEM). Fig. 2.: *Blackites creber* (Deflandre) Stradner et Edwards, 12 000 ×. (TEM). Fig. 3.: *Lophodolithus cf. mochloporus* Deflandre, proximal view, 10 000 ×. Fig. 4.: *Toweius helianthus* (Hay et Towe) Hay et Mohler, proximal view, 10 000 ×. (TEM).

Genus *Discoasteroides* Bramlette et Sullivan, 1961

Discoasteroides kuepperi (Stradner, 1959) Bramlette et Sullivan, 1961
(pl. 9, fig. 3, 4)

1959 *Discoaster kuepperi* nov. cent. — H. Stradner: Die fossilen Discoasteriden Östers. II. Teil, p. 478, fig. 18, 21.

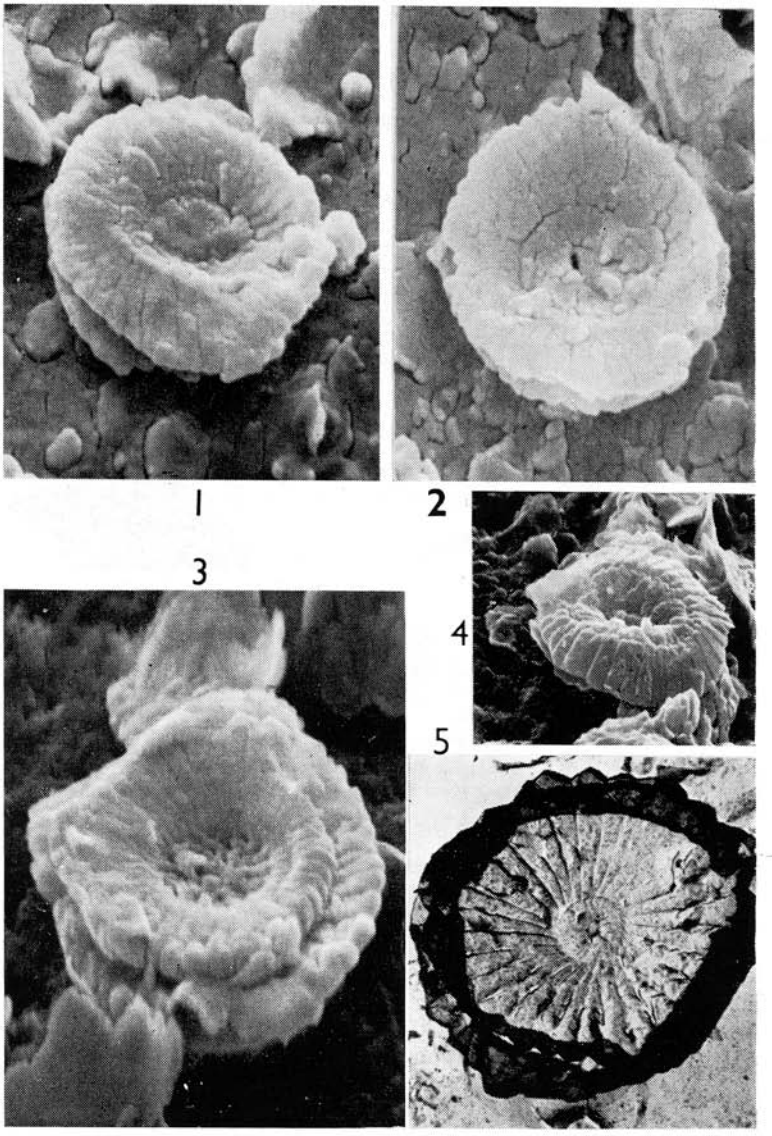

Plate XI

Fig. 1, 2.: *Markalius astroporus* (Stradner) Hay et Mohler. Fig. 1, distal view, fig. 2, proximal view, 10 000 ×. Fig. 3.: *Toweius helianthus* (Hay et Towe) Hay et Mohler, proximal view, 16 000 ×. Fig. 4.: *Coccolithus sarsiae* Black, distal view, 5000 ×. Fig. 5.: *Markalius inversus* (Deflandre) Bramlette et Martini, proximal view, 7200 ×. (TEM).

The photographs signed TEM, were made with the transmitting electron microscope Tesla BS 242 at the Natural Sciences Faculty of Comenius University in Bratislava (photos by H. Gerthofferová), the others with the scanning electron microscope JSM U3 at the Geological Institute of D. Štúr in Bratislava (photos by M. Švec and K. Šebor).

1961 *Discoasteroides kuepperi* (Stradner) M. N. Bramlette, F. R. Sullivan: Coccolithophorids and Related Nannoplankton etc., p. 163, pl. 13, fig. 16a, b, 18a—c, 19.

Description. The asterolith is slightly convex, from 7—10 rays forming a serrate outer circumference, with right angles. 1—3 conspicuous transvers ribs and a robust open stem distally broadened in the shape of a funnel, are visible on the proximal side of the rays. The stem is distincly visible to be constructed from extended middle parts of the rays. On the stem, the interray sutures change into lengthwise ribs and almost reach the serrate edge of the stem. The stem diametre is about $^2/_3$ the diametre of the asterolith, its height is about $^3/_5$ the height of the asterolith.

Stratigraphic range: The Lower Eocene — the lower part of the Middle Eocene.

Genus *Marthasterites* Deflandre, 1959

Marthasterites tribrachiatus (Bramlette et Riedel, 1954) Deflandre, 1959. (pl. 6, fig. 1, 2)

1954 *Discoaster tribrachiatus* Bramlette et Riedel, n. sp. — M. N. Bramlette, W. R. Riedel: Stratigraphic Value of Discoasters etc., p. 379, pl. 38, fig. 11.

1957 *Marthasterites tribrachiatus* (Bram. et Ried.) Defl. — G. Deflandre: Sur les nannofossiles calcaires etc., p. 138, pl. 2, fig. 1, 2.

1967 *Marthasterites tribrachiatus* (Bramlette et Riedel) Deflandre — K. Perch — Nielsen: Nannofossilien aus dem Eozän etc., p. 30, pl. 6, fig. 1—6.

Description. A 3-rayed specimen with the rays including the angle of 120 degrees. The rays are of the same length and, with the most of the specimens, of the same thickness along their whole length. They are at their distal ends. In rare cases, the rays narrow very slightly in the distal direction. The whole asterolith is slightly vaulted. The surface of our specimens is covered with small irregular granules, which is probably the result of diagenetic processes.

Stratigraphic range: The Lower Eocene.

Translated by K. BYSTRICKÁ

REFERENCES

BERGGREN, W. A. 1969: Cenozoic Chronostratigraphy, Planktonic Foraminiferal Zonation and the Radiometric Time Scale. Nature (London) 224, No. 5224, p. 1072—1075.

BLACK, M. 1962: Fossil coccospheres from a Tertiary outcrop on the continental slope. Geol. Mag., 99, p. 123—127.

BLACK, M. 1964: Cretaceous and Tertiary coccoliths from Atlantic seamounts. Paleontology (London), 7, p. 307—316.

BLACK, M. 1967: New names for some coccolith taxa. Proc. Geol. Soc. London, no. 1640, p. 139—145.

BRAMLETTE, M. N. — MARTINI, E. 1964: The great change in the calcareous nannoplankton fossils between the Maestrichtian and the Danian. Micropaleontology (New York), 10, no. 3, p. 291—322.

BRAMLETTE, M. N. — RIEDEL, W. R. 1954: Stratigraphic value of discoaster and some other microfossils related to Recent coccolithophorids. J. Paleontol. (Tulsa), 28, p. 385—403.

BRAMLETTE, M. N. — SULLIVAN, F. R. 1961: Coccolithophorids and related nannoplankton of the early Tertiary in California. Micropaleontology (New York), 7, no. 2, p. 129—174.

BRAMLETTE, M. N. — WILCOXON, J. A. 1967: Middle Tertiary calcareous nannplankton of the Cipero Section, Trinidad. Tulane Stud. Geol. Pal. (New Orleans), 5, no. 3, p. 93—131.

BRÖNNIMANN, P. — STRADNER, H. 1960: Die Foraminiferen und Discoasteridenzonen von Kuba und ihre interkontinentale Korrelation. Erdoel Zeitsch. (Wien), 76, p. 364—369.
BURKY, D. 1971: Cenozoic calcareous nannofossils from the Pacific Ocean. San Diego Soc. Nat. Hist., Trans. 16, No. 14, p. 303—328.
BUKRY, D. 1971: Coccolith stratigraphy Leg. 6 Deep Sea Drilling Project. Initial Reports of the Deep Sea Drilling Project 6, Washington, p. 965—986.
BUKRY, D. 1973: Low — latitude coccolith biostratigraphic zonation. Initial Reports of the Deep Sea Drilling Project, 15, Wasthington, p. 685—703.
BUKRY, D. 1974: Cretaceous and Paleogene coccolith stratigraphy, Deep Sea Drilling Project, Leg. 26. Initial Reports of the Deep Sea Drilling Project, 26, Washington, p. 669—673.
BUKRY, D. 1974: Coccolith and siliceflagellete stratigraphy, eastern Indian Ocean, Deep Sea Drilling Project Leg 22, Initial Reports of the Deep Sea Drilling Project, 22, Washington, p. 601—607.
EDWARDS, A. R. 1971: A calcareous nannoplankton zonation of the New Zealand Paleogene. Proceedings of the II Planktonic conference Roma 1970, I, Roma, p. 381—419.
BYSTRICKÁ, H. 1963: Die unter eozänen Coccolithophoridae (Flagelleta) des Myjavaer Paleogens. Geol. Sborn. Slov. Akad. Vied (Bratislava), 14, no. 2, p. 269—281.
BYSTRICKÁ, H. 1965: Der stratigraphische Wert von Discoasteriden im Paleogen der Slowakei. Geol. Sborn. slov. akad. vied (Bratislava), 16, no. 1, p. 7—10.
BYSTRICKÁ, H. — LEŠKO, B. — SAMUEL, O. 1970: Stratigrafia paleogénnych sérií severne od Malej Domaše. Geol. práce. Správy (Bratislava), 51, p. 149—163.
DEFLANDRE, G. — FERTH, CH. 1954: Observations sur les Coccolithophoridés Actuels et Fossiles en microscopie ordinaire et électronique. Ann. Paléont. (Paris), 40, p. 115—176.
EDWARDS, A. A. 1971: A calcareous nannoplankton zonation of the New Zealand Paleogene. Proceedings of the II Planktonic conference Roma 1970, I, Roma, p. 381—419.
GARTNER, St. Jr. 1970: Phylogenetic Lineages in the Lower Tertiary Coccolith genus Chiasmolithus. Proc. North. Amer. Paleont. Convention, C. p. 930—957.
GARTNER, St. Jr. 1971: Calcareous nannofossils from Joides Blake Plateau cores and revision of Paleogene nannofossils zonation. Tulane Stud. Geol. Paleon. (New Orleans), 8, no. 3, p. 101—121.
HAY, W. W. 1964: Utilisation stratigraphique des discoastéridés pour la zonation du Paléocène et l'Éocène inférieur. Mem. Bur. Rech. Géol. Min. (Paris), 28, p. 885—889.
HAY, W. W. — MOHLER, H. P. 1967: Calcareous nannoplankton from early Tertiary rocks of Pont Labau, France, and Paleocene-early Eocene correlations. J. Paleont. (Tulsa), 41, p. 1505—1541.
HAY, W. W. — MOHLER, H. P. — ROTH, P. H. — SCHMIDT, R. R. — BOUDREAUX, J. E. 1967: Calcareous nannoplankton zonation of the Cenozoic of the Gulf Coast and Caribbean-Antilean area, and transoceanic correlation. Trans. Gulf. Coast Assoc. Geol. Soc. (Miami), 17, p. 428—480.
HAY, W. W. — MOHLER, H. P. — WADE, M. E. 1966: Calcareous nannofossils from Nal'chik (Northwest Caucasus). Eclog. Geol. Helv. (Basel), 59, p. 379—399.
HAY, W. W. — TOWE, K. M. 1962: Electron microscope examination of some coccoliths from Donzacq (France). Eclog. Geol. Helv. (Basel), 55, p. 497—517.
KAMPTNER, E. 1954: Untersuchungen über den Feinbau der Coccolithen. Arch. Protisttenkde (Jena), 100, p. 1—90.
KAMPTNER, E. 1962: Coccolithineen — Skelettraste aus Tiefseeablagerungen des Pazifischen Ozeans. Ann. Naturhist. Mus. (Wien), 66, p. 139—204.
KAPELLOS, Ch. Ch. 1973: Biostratigraphie des Grunigel-flysches. Schweiz. Paläont. Abhand. (Basel), 96, p. 1—177.
LOCKER, S. 1972: Coccolithineen aus dem Paläogen Mitteleuropas. Paläont. Abh., Abt. B, Paläobot. (Berlin), 3, no. 5, p. 735—853.
MARTINI, E. 1959: Discoasteirden und verwandte Formen im NW-deutschen Eozän (Coccolithophorida). Senckenberg. Leth. (Frankfurt am Mein), 40, p. 137—157.
MARTINI, E. 1960: Braarudosphaeriden, Discoasteriden und verwandte Formen aus dem Rupelton des Mainzer Beckens. Notizbl. hess. L. Amt. Bodenforsch. (Wiesbaden), 88, p. 65—87.
MARTINI, E. 1961: Nannoplankton aus dem Tertiär und der obersten Kreide von SW-Frankreich. Senckenberg. Leth. (Frankfurt am Mein), 42, p. 1—41.
MARTINI, E. 1971: Standart Tertiary and Quarternary calcareous nannoplancton zonation. Proc. II Planctonic conference Roma 1970, II Roma, p. 739—785.

PERCH - NIELSEN, K. 1971: Elektronenmikroskopische Untersuchungen an Coccolithen und verwandten Formen aus dem Eozän von Dänemark. Biol. Skriften (Kopenhagen), 18, no. 3, p. 1—137.
PERCH - NIELSEN, K. 1972: Remarks on late Cretaceous to Pleistocene coccoliths from the North Atlantic. Initial Reports of the Deep Sea Drilling Project. (Washington), 12, p. 1003—1069.
PRINS, B. 1971: Speculations on relations, evolution and stratigraphic distribution of discoasters. Proc. II Planctonic Conference, Roma 1970, Roma, 2, p. 1099—1120.
PROTO DECIMA, F. 1966: Correlazioni fra zone a Foraminiferi planctonici e zone a Discoasteridi nell'Eocene inferiore di Pederoba. Mem. Acad. Patavina di SS. LL. AA., Cl. Sc. Mat. e Nat. (Padova), 79, p. 3—15.
RADOMSKI, A. 1967: Some stratigraphic units based on nannoplankton in the Polish Outher Carpathians. Bjul. Inst. Geol. (Warszawa), 211, p. 385—393.
RAMSAY, A. T. S. 1971: The investigation of Lower Tertiary sediments from the North Atlantic. Proc. II Planctonic Conference, Roma 1970, Roma II, p. 1039—1055.
RAMSAY, A. T. S. 1971: The Study of Lower Tertiary Calcareous Nannoplankton from the North Atlantic Ocean by Means of Scanning Electron Microscopy. Scan. elekt. microscopy. Systemat. and evolut. applic., Systemat. Assot., Spec., 4, p. 179—209.
ROTH, P. H. 1960: Oligocene calcareous Nannoplankton Biostratigraphy. Eclog. Geol. Helv. (Basel), 64, no. 3, p. 799—881.
SAMUEL, O. — BYSTRICKÁ, H. 1968: Stratigraphische Korrelation der Plankton-Foraminiferen mit dem Nannoplankton des Paleogens in den Westkarpaten der Slowakei. Geol. Zborn. Geol. Carpathica (Bratislava), 19, no. 1, p. 117—129.
STRADNER, H. 1959: Die fossilien Discoasteriden Österreichs II. Erdoelzechsr. (Wien), 75, H. 12, p. 472—488.
STRADNER, H. — EDWARDS, A. R. 1968: Electron microscopic studies on Upper Eocene coccoliths from the Oamaru Diatomite, New Zealand. Jb. Geol. Bundesanst. (Wien), Sb. 13, p. 1—66.
STRADNER, H. — PAPP, A. XXXX: Tertiäre Discoasteriden aus Österreichs und deren stratigraphische Bedeutung. Jb. Geol. Bundesanst. (Wien), Sb. 7, p. 1—242.
SULLIVAN, F. R. 1964: Lower Tertiary nannoplankton from California Coast Ranges I. Paleocene. Californ. Univ. Pubs. Geol. Sci., 44, no. 3, p. 167—227.
TAN SIN HOK 1927: Over de samrstelling en het onstaan van krijt en margelgesteenten van de Molukken. Jaarb. Mijnv. Nederl., 55, p. 111—122.
WISE, Sh. W. 1973: Calcareous nannofossils from cores recovered during Leg 18, Deep Sea Drilling Project: Biostratigraphy and observations of diagenesis. Initial Reports of the Deep Sea Drilling Project. Washington, 18, p. 569—615.

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