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Middle Eocene calcareous nannofossils from the Roztocze region (SE Poland) — their biostratigraphic and palaeogeographic significance

A biostratigraphic study of the Palaeogene deposits from the Roztocze region (south-eastern Poland) was carried out using calcareous nannoplankton. The glauconitic sands overlying the Upper Cretaceous calcareous series are considered to be Middle Eocene in age. The coccolith assemblages are indicative of nannofossil NP 16 *Discoaster tani nodifer* Zone. The sediments were deposited during transgressive phase of the Middle-Late Eocene marine episode. The Middle Eocene epicontinental basin extended farther southward than has been stated previously.

INTRODUCTION

The marine Middle Eocene in extra-Carpathian Poland occurs in a very restricted area principally in the northern and eastern parts of the country. It consists of fine-grained glauconitic or quartz sands named the Szczecin Formation or locally the Siemień Formation. In the vicinity of Szczecin the marine sands deposited in a high energy environment grade into non-marine brown coal-bearing clays, silts, and sands of the Tanowo Formation. The sands from Siemień contain a rich assemblage of shelly fauna as well as microfossils. Palaeontological evidence (foraminifers and nannofossils) of NP 15–16 Zones were found in the vicinity of Szczecin (E. Odrzywolska-Bieńkowa, K. Pożaryska, 1978; E. Martini, 1981) and of NP 16 on the Łeba Elevation (B. Kosmowska-Ceranowicz, C. Müller, 1985). The youngest Middle Eocene (Zone NP 17) has been identified in the glauconitic sands at Siemień, north of Lublin (K. Pożaryska, E. Odrzywolska-Bieńkowa, 1988; A. Köthe, 1988), which had been previously assigned to the Upper Eocene (E. Woźny, 1966; K. Pożaryska, S. Locker, 1972). The thickness of the Middle Eocene deposits ranges from 3.5 m at Siemień to 31 m in the Szczecin borehole.

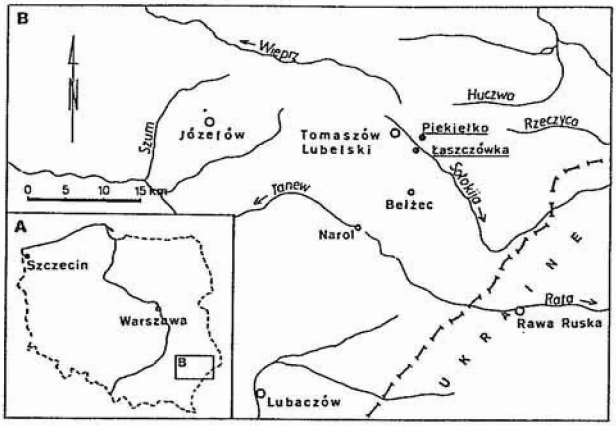

Fig. 1. Location map of studied boreholes
Lokalizacja otworów wiertniczych

During cartographic work carried out in the south-east part of the Lublin Upland, routine stratigraphic investigations (foraminifers, dinocysts, calcareous nannoplankton) indicated the presence of Middle Eocene deposits in the Sołokija Graben. The lithological and mineralogical characteristics of the deposits as well as radiometric (potassium-argon) data are given by J. Buraczyński, Z. Krzowski (1994).

The aim of this study is to analyse the calacarous nannofossils occurring in the deposits and to precisely delineate the age of them. Another objective is to evaluate the distribution pattern of Tertiary nannoplankton in the Polish Lowlands as a result of palaeogeographical conditions.

TECHNIQUES

This investigation is based upon the study of twenty samples from boreholes Łaszczówka 29 and Piekiełko 30 (Fig. 1) (see J. Buraczyński, Z. Krzowski, 1994). Smear slides were prepared using standard preparation techniques. Because of the abundance of coccoliths in studied deposits no concentration techniques were employed. All samples were studied under an OLYMPUS BHS light microscope and selected ones in the scanning electron microscope (where the photos were obtained). Relative abundance of coccolith taxa were determined in the following fashion:

— abundant = more than 10 specimens in each field of view,
— common = more than 1 specimen in each field of view,
— few to rare = 1 specimen could not be observed in every field of view.

Preservation of nannofossils is good to moderate throughout the investigated intervals.

RESULTS

The lowermost intervals in studied boreholes (29.0–32.5 m in Łaszczówka 29 and 51.5–57.0 m in Piekiełko 30), represented by light grey marls, yield Upper Cretaceous nannofossils with the dominant species: *Arkhangelskiella cymbiformis* Vekshina, *Biscutum constans* (Górka), *Eiffellithus turriseiffeli* (Deflandre), *Micula decussata* Vekshina and *Prediscosphaera cretacea* (Arkhangelsky). Abundance of the rod-shaped forms designated as *Microrhabdulus attenuatus* (Deflandre) with *Braarudosphaera bigelowii* (Gran et Braarud) has been observed in the samples from Piekiełko 30. *Lithraphidites quadratus* Bramlette et Martini, a marker species of the Upper Maestrichtian, was present in both cores.

The siliciclastic deposits lying immediately above the marls contain Palaeogene nannofossils. The dominant species in the assemblages are: *Coccolithus pelagicus* (Wallich) (Pl. II, Fig. 3), *Ericsonia formosa* (Kamptner) (Pl. I, Fig. 4b; Pl. II, Fig. 4) and *Reticulofenestra umbilica* (Levin) (Pl. II, Figs. 8, 9). Fairly common are: *Blackites spinosus* (Deflandre et Fert) (Pl. I, Fig. 5), *Neococcolithes dubius* (Deflandre) (Pl. I, Fig. 4a), *Pontosphaera multipora* (Kamptner), *Reticulofenestra dictyoda* (Deflandre), and the genus *Transversopontis*. The placo- and rhabdolithids are accompanied by discoasters and some species of holococcoliths, e.g. *Clathrolithus spinosus* Martini and *Zygrhablithus bijugatus* (Deflandre). Among the discoasters the most common species are: *Discoaster binodosus* Martini (Pl. I, Fig. 2), *D. distinctus* Martini (Pl. I, Fig. 1), *D. germanicus* Martini and *D. tani nodifer* Bramlette et Riedel (Pl. I, Fig. 3). The presence of *Discoaster bifax* Bukry in studied material must be stated too. Complete nannoplankton assemblages include the species listed in Figs. 2 and 3. Some specimens are figured on Plates I and II.

STRATIGRAPHIC CONCLUSIONS

For the lowermost intervals in boths holes the Upper Maestrichtian age is indicated by the presence of *Lithraphidites quadratus* Bramlette et Martini. This species has its first occurrence near the base of the *Gansserina gansseri* foraminiferal zone in the lower part of the Upper Maestrichtian. Its appearance defines nannofossil Zone NC 22 (P. Roth, 1978) which corresponds to the *Belemnitella junior* cephalopod Zone. There is no evidence of the uppermost Maestrichtian in the studied cores.

The biostratigraphic ranges of marker species found in the Palaeogene intervals of studied holes are depicted in Fig. 4. The suggestions on the age determination are stated below. The concurrence of *Chiasmolithus grandis* (Bramlette et Riedel), *Ch. solitus* (Bramlette et Sullivan), *Discoaster binodosus* Martini, *D. germanicus* Martini and *Reticulofenestra dictyoda* (Deflandre) with *Discoaster saipanensis* Bramlette et Riedel, *D. tani nodifer* Bramlette et Riedel and *Reticulofenestra umbilica* (Levin) indicate the Middle Eocene age of the assemblages. According to K. Perch-Nielsen (1985) and E. Martini, C. Müller (1986) the last occurrence of *Chiasmolithus solitus* (Bramlette et Sullivan), *Discoaster distinctus* Martini, *D. germanicus* Martini and *Helicosphaera heezenii* Bukry is in nannofossil Zone NP 16. Also, the occurrence of *Cribrocentrum faveolatum* (Reinhardt) and *Discoaster bifax* Bukry is restricted to NP 16. Moreover, the first occurrence of

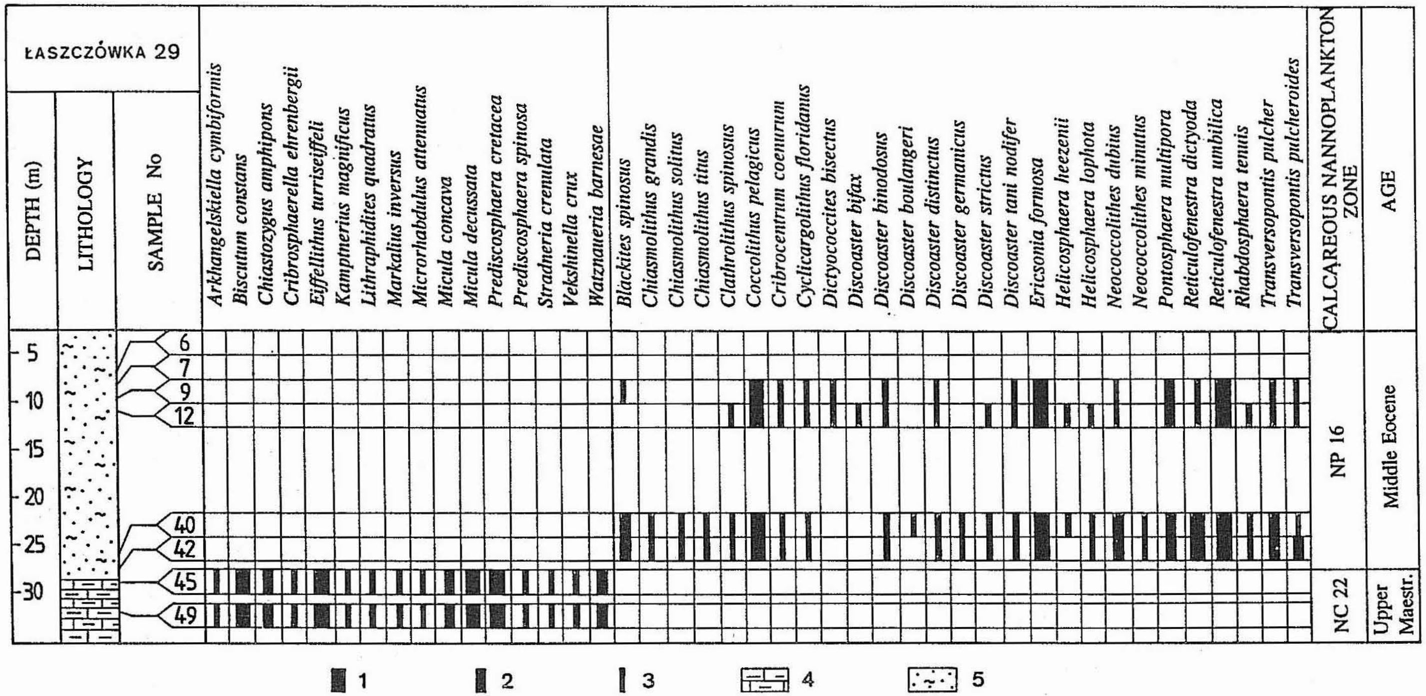

Fig. 2. Distribution of calcareous nannofossils in the borehole Łaszczówka 29 section

Coccoliths abundance: 1 — abundant, 2 — common, 3 — rare; 4 — marls, 5 — quartz-glauconitic sands with silts

Nannoplankton wapienny w profilu otworu wiertniczego Łaszczówka 29

Częstotliwość występowania: 1 — obfita, 2 — liczna , 3 — rzadka; 4 — margle, 5 — piaski kwarcowo-glaukonitowe z domieszką iłów

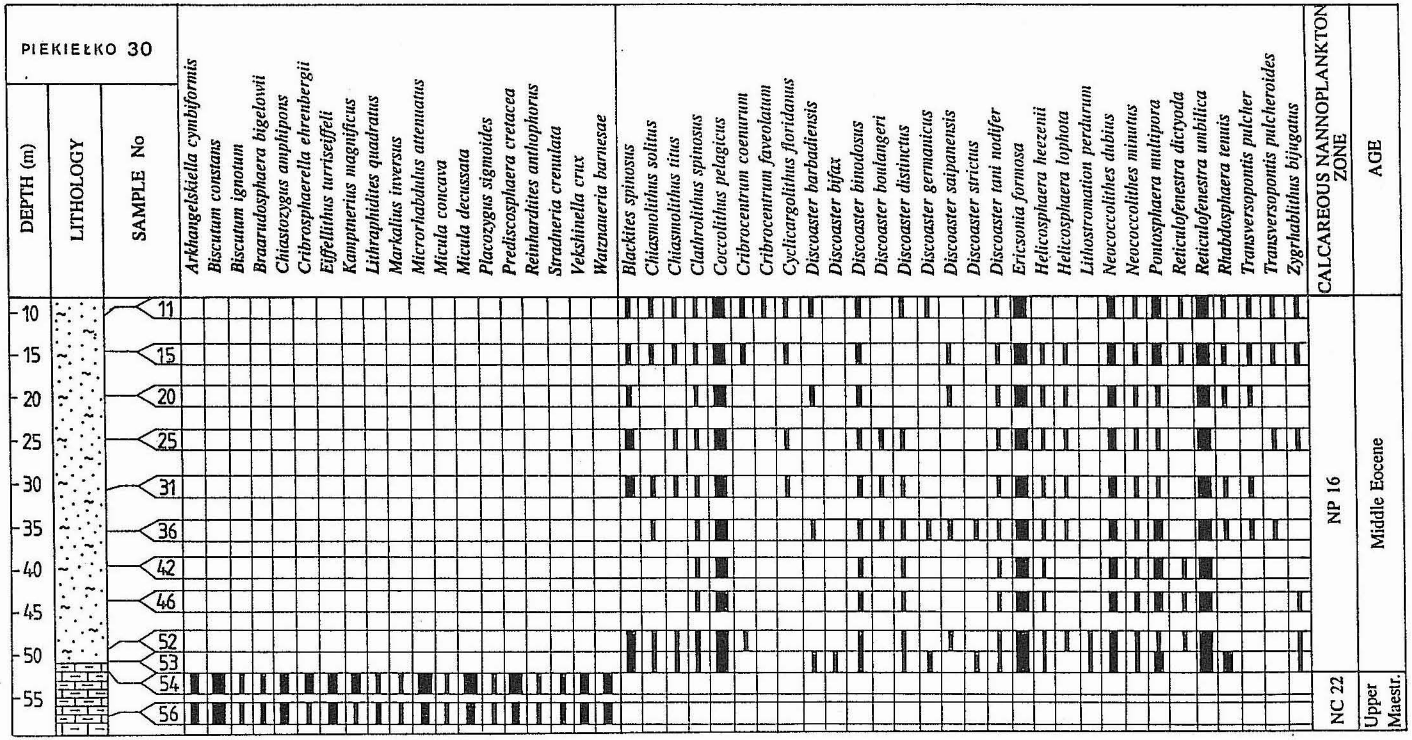

Fig. 3. Distribution of calcareous nannofossils in the borehole Piekiełko 30 section
Explanations as in Fig. 2
Nannoplankton wapienny w profilu otworu wiertniczego Piekiełko 30
Objaśnienia jak na fig. 2

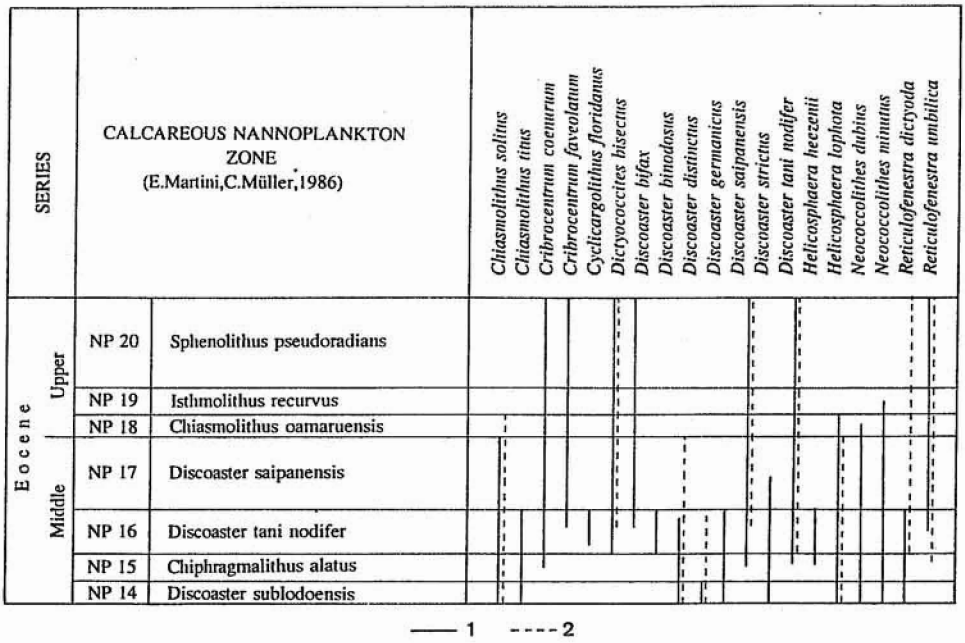

Fig. 4. Stratigraphical ranges of marker species found in the studied sections
1 — after K. Perch-Nielsen (1985), 2 — after E. Martini, C. Müller (1986) (if differs)
Zasięgi stratygraficzne gatunków indeksowych, występujących w badanych profilach
1 — według K. Perch-Nielsen (1985), 2 — według E. Martiniego, C. Müller (1986) (jeśli się różnią)

Cribrocentrum coenurum (Reinhardt) and *Dictyococcites bisectus* (Hay, Mohler et Wade) is within the upper part of this zone. The siliciclastic deposits occurring in the intervals between 9.5–27.9 m in Łaszczówka 29 and between 10.2–50.5 m in Piekiełko 30 are assigned to the upper part of the NP 16 *Discoaster tani nodifer* Zone which corresponds to the upper part of the Middle Eocene.

The Bartonian, a classic Palaeogene stage, is actually placed within the upper part of NP 16 Zone and NP 17 Zone on the basis of the nannofossils found in the type-section (M.-P. Aubry, 1983). Thus, the studied deposits are determined to be Middle Eocene (chronostratigraphic unit), and they could be correlated with the Bartonian (classic stage of the Eocene). The upper part of coccolith Zone NP 16 coincides with the P 13 *Orbulinoides beckmanni* Zone of the planktonic foraminiferal zonation.

PALAEOGEOGRAPHIC AND ENVIRONMENTAL INFERENCES

The calcareous nannofossil record of the Roztocze region revealed new data on Middle Eocene palaeogeography and on the development of Palaeogene transgressions on the Polish Lowlands. F. Gramann, F. Kockel (1988) assumed that in the Middle Eocene the sea which came from the west, reached only the northern part of Poland (the Szczecin area, the

northern Marginal Trough and Peribaltic Depression). The occurrence of Middle Eocene deposits southeast of the Lublin Upland indicates larger extent of the sea during its transgressive phase. A similarity of coccolith assemblages from Szczecin borehole (E. Martini, 1981) and from Roztocze suggests a connection between these two areas. Moreover, a lack of nearshore species in studied nannofloras as well as the lithofacies features of the sediments (J. Buraczyński, Z. Krzowski, 1994), indicate neritic rather than a littoral environment. The epicontinental basin ranged farther southward than was shown on the palaeogeographical map of NW Europe compiled by F. Kockel (1987), and it could have been connected with that in the Euxyno-Caspian area. The palaeontological record of NP 17 and NP 18 in amber-bearing deposits north of the Lublin Upland was reported by B. Kosmowska-Ceranowicz *et al.* (1990). The authors postulated the presence of a delta alimented from the Ukrainian Massif. The origin of it could result from eustatic sea level fall in the uppermost Middle Eocene (P.Vail *et al.*, 1977) which was also observed in the northwest European basin (F. Gramann, F. Kockel, 1988).

Taxonomic composition of the coccolith assemblages from the Middle Eocene in Poland in comparison with that of southern European assemblages (Tethys, Transdanubian area — S. Monechi, H. Thierstein, 1985; M. Baldi-Beke, 1984) shows lack of sphenolithids. However the climate was warm enough for growth of discoasters even in high latitudes.

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ŚRODKOWOEOCEŃSKI NANNOPLANKTON WAPIENNY Z ROZTOCZA I JEGO ZNACZENIE STRATYGRAFICZNE I PALEOGEOGRAFICZNE

Streszczenie

Osady silikoklastyczne (drobnoziarniste piaski i mułowce z glaukonitem) leżące na utworach mastrychtu górnego w rowie Sołokija (otwory wiertnicze: Łaszczówka 29, Piekiełko 30) (fig. 1) zawierają liczny i dobrze zachowany nannoplankton wapienny (tabl. I, II). Analiza składu taksonomicznego zespołów wykazała środkowo-eoceński wiek utworów — poziom nannoplanktonowy NP 16 *Discoaster tani nodifer* (fig. 2–4). Utwory te mogą być także korelowane z piętrem bartońskim. Obecność morskich utworów eocenu środkowego na Roztoczu świadczy o większym zasięgu basenu w fazie transgresywnej niż to do tej pory postulowano. Podobieństwo zespołów nannoplanktonu z Roztocza i z otworu wiertniczego Szczecin IG 1 wskazuje na istnienie połączenia między tymi obszarami.

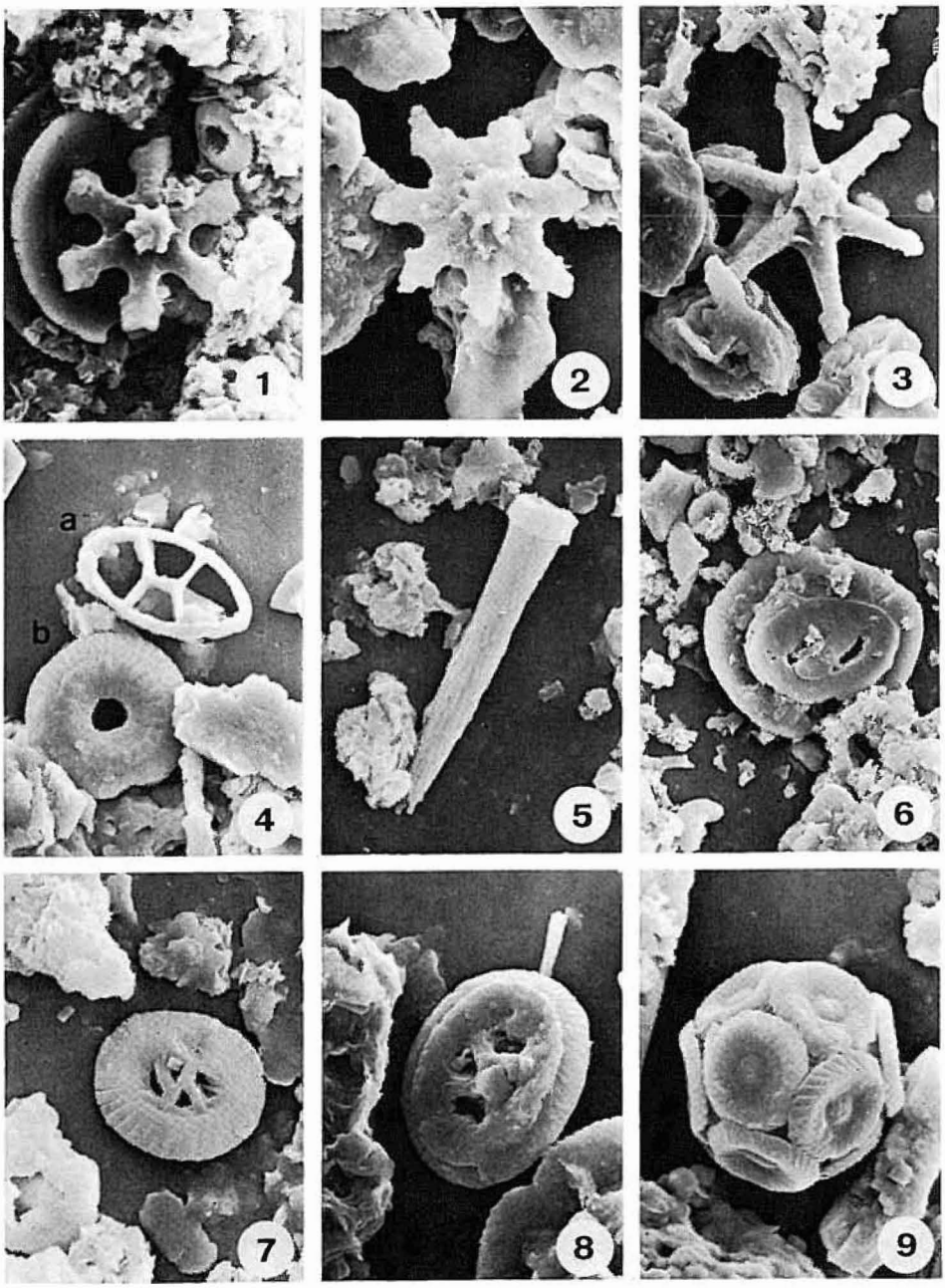

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PLATE I

Fig. 1. *Discoaster distinctus* Martini, x 3600
Fig. 2. *Discoaster binodosus* Martini, x 3600
Fig. 3. *Discoaster tani nodifer* Bramlette et Riedel, x 2800
Fig. 4. a — *Neococcolithes dubius* (Deflandre), b — *Ericsonia formosa* (Kamptner), x 2800
Fig. 5. *Blackites spinosus* (Deflandre et Fert), x 5000
Fig. 6. *Helicosphaera lophota* Bramlette et Sullivan, x 2500
Fig. 7. *Chiasmolithus titus* Gartner, x 4500
Fig. 8. *Chiasmolithus solitus* (Bramlette et Sullivan)
Fig. 9. *Markalius inversus* (Deflandre), x 4000

All specimens from the borehole Łaszczówka 29, depth 27.9 m
Wszystkie okazy pochodzą z otworu Łaszczówka 29 z głęb. 27,9 m

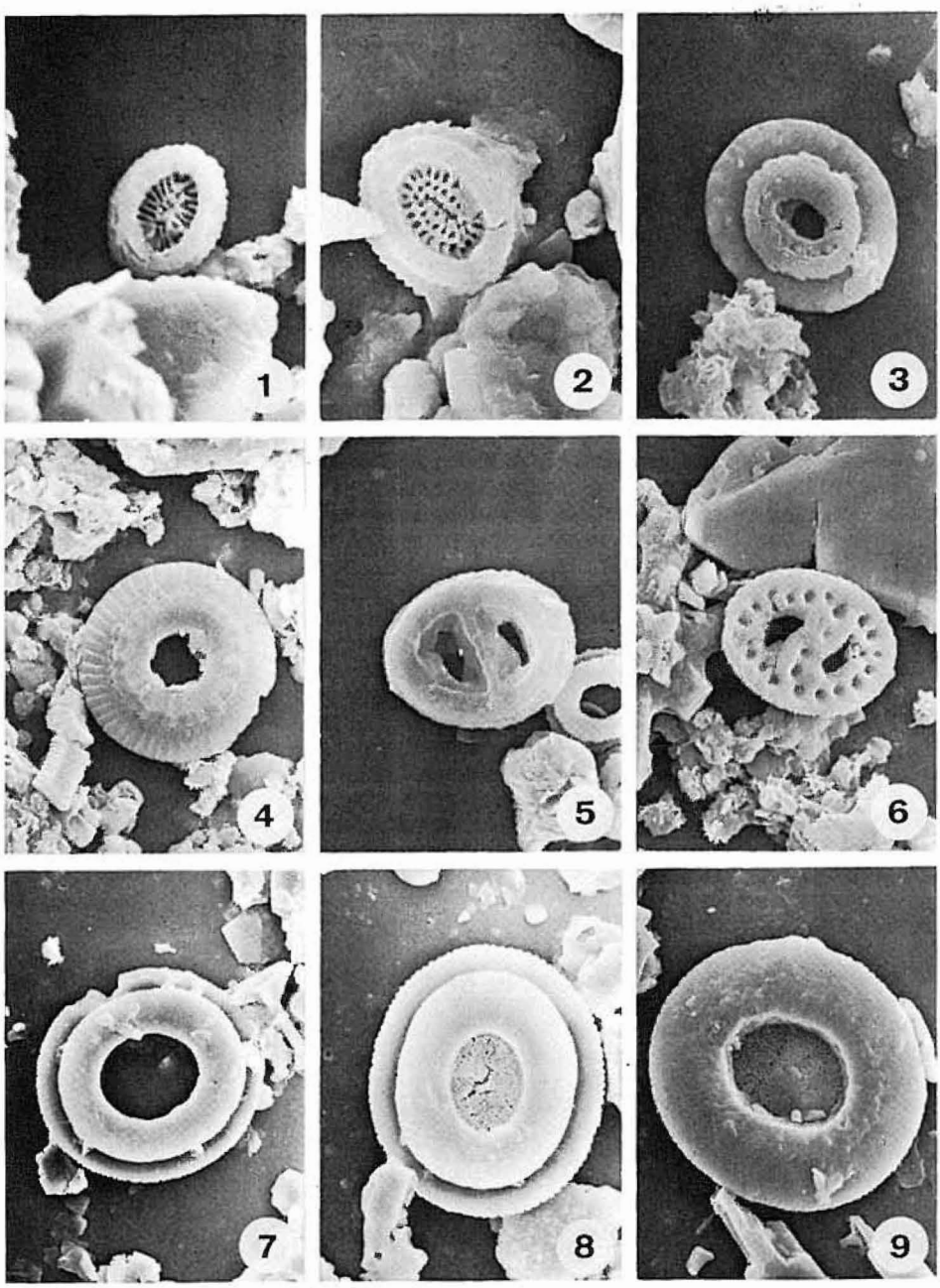

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PLATE II

Fig. 1. *Cribrocentrum faveolatum* (Reinhardt), x 5000
Fig. 2. *Cribrocentrum coenurum* (Reinhardt), x 6000
Fig. 3. *Coccolithus pelagicus* (Wallich), x 5500
Fig. 4. *Ericsonia formosa* (Kamptner), x 2800
Figs. 5, 6. *Transversopontis pulcheroides* (Sullivan): 5 — proximal side (strona proksymalna), x 4500, 6 — distal side (strona dystalna), x 4000
Fig. 7. *Reticulofenestra placomorpha* (Kamptner), x 2000
Figs. 8, 9. *Reticulofenestra umbilica* (Levin): 8 — proximal side (strona proksymalna), x 2500, 9 — distal side (strona dystalna), x 2800

All specimens from the borehole Łaszczówka 29, depth 27.9 m
Wszystkie okazy pochodzą z otworu Łaszczówka 29 z głęb. 27,9 m