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FINDINGS OF OLIGOCENE BEDS NEAR BANSKÁ BYSTRICA

(Pls. 12)

Abstract: The paper deals with a calcareous nannoplankton of the bore hole K-1 Kordíky. It had been determined as the "Chattian -Aquitanian" (B. Pacltová, 1966) on the basis of palynological and micropaleontological data. In recent years, a rich calcareous nannoplancton containing Cretaceous to Upper Oligocene species was found in these deposits. After excluding redeposited specimens, the nannoflora was ranked to the NP 24 25 biozones (sensu E. Martini, 1971) representing the Upper Rupelian to the Egerian. No Miocene species were found in the thanathocoenosis.

Резюме: Работа занимается изучением известкового нанопланктона из буровой скважины К-1 Кордики. На основе палинологических и микропалеонтологических данных возраст осадков был определен как „хатт-аквитанский" (Б. Пацлтова, 1966). В последнее время в этих осадках был установлен богатый известковый нанопланктон составленный из меловых по верхнеолигоценовые виды. После исключения переотложенных элементов нанофлора была включена в биозоны НП 24 25 (в смысле Э. Мартини, 1971), представляющие верхний рупельский по эгерский ярусы. В танатоценозах не были обнаружены никакие миоценовые виды.

Introduction

At geological mapping at the Banská Bystrica area, in addition to exposures also deposits of the bore hole K-1 Kordíky (situated in the village centre, 200 m S. from the church) were paleontologically processed for solution of Tertiary deposits stratigraphy. The bore hole was drilled down to 197.3 m and deposits in the interval of 26—197.3 m were determined as the Chattian — Aquitanian on the basis of analyses of pollens and foraminifers (B. Pacltová, 1966). B. Pacltová left the question of the Oligocene - Miocene boundary open due to the Upper Oligocene assemblage being characterized by the first occurrence of many species and genera that expand to maximum in the Miocene.

The foraminiferal microfauna of the bore hole was processed by I. Cícha (I. Cícha in B. Pacltová, 1966). The following species were identified in 113.3 m's depth: *Caucasina* sp., *Bolivina* aff. *reticulata* CUSHMAN, *Globigerina sp.* and the following ones in 195 m's depth: *Almaena osnabrugensis* (MÜNSTER), *Cribrononion sp., Elphidium sp., Bolivina alta* CUSHMAN, *Bolivina plicatella* CUSHMAN, *Uvigerina tenuistriata* REUSS, *Uvigerinella sp., Cassidulina subglobosa* BRADY, *Discorbis sp., Cibicides* aff. *pseudoungerianus* (CUSHMAN), *Cibicides* sp., *Globigerina praebulloides* BLOW, *Globigerina praebulloides occulosa* BLOW et BANNER.

The assemblage was dominated by planktonic foraminifers and it was ranked to the Oligocene—Miocene boundary.

Samples of the bore hole K-1 Kordíky have undergone a nannoplankton analysis recently, which has shown they contain a rich calcareous nannoflora con-

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sisting of Oligocene and redeposited Cretaceous—Eocene species. Thanathocoenoses of the following depths have been studied detailly: 197—197.3 m, 159—160 m, 99—100 m, 40.5—41 m and 19—20 m.

Paleontological evaluation of the thanathocoenoses

197—197.3 m depth

Species found: *Coccolithus pelagicus* (WALLICH) SCHILLER, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Cyclococcolithus formosus* KAMPTNER, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Chiasmolithus altus* BUKRY et PERCIVAL, *Chiasmolithus oamaruensis* (DEFLANDRE et FERT) HAY, MOHLET et WADE, *Chiasmolithus grandis* (BRAMLETTE et RIEDEL) HAY, MOHLER et WADE, *Chiasmolithus nitidus* BUKRY, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Reticulofenestra lockeri* MÜLLER, *Reticulofenestra abisecta* (MÜLLER) ROTH, *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI, *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Dictyococcites ornatus* (MÜLLER) BYSTRICKÁ, *Cribrocentrum reticulatum* (GARTNER et SMITH) PERCH-NIELSEN, *Toweius eminens* (BRAMLETTE et SULLIVAN) GARTNER, *Discolithina multipora* (KAMPTNER) MARTINI, *Transversopontis* cf. *prava* LOCKER, *Transversopontis pulcher* (DEFLANDRE) HAY, MOHLER et WADE, *Lophodolithus mochloporus* DEFLANDRE, *Helicosphaera compacta* BRAMLETTE et WILCOXON, *Helicosphaera dinesenii* PERCH-NIELSEN, *Helicosphaera recta* HAQ, *Isthmolithus recurvus* DEFLANRDE, *Blackites spinosus* (DEFLANDRE et FERT) HAY et TOWE, *Sphenolithus moriformis* (BRÖNNIMAN et STRADNER) BRAMLETTE et WILCOXON, *Sphenolithus cf. radians* DEFLANDRE, *Zygrhablithus bijugatus* (DEFLANDRE) DEFLANDRE, *Braarudosphaera bigelowi* (GRAN et BRAARUD) DEFLANDRE, *Discoaster barbadiensis* TAN SIN HOK, *Discoaster binodosus* MARTINI, *Discoaster saipanensis* BRAMLETTE et RIEDEL, *Discoaster multiradiatus* BRAMLETTE et RIEDEL, *Coronocyclus nitescens* (KAMPTNER) BRAMLETTE et WILCOXON, Cretaceous forms.

This depth's assemblage is very rich, varied and well preserved. It consists of autochthonous and redeponated specimens among which also complete coccospheres occur. The highest percentage of allochthonous specimens is found here. The most frequent species of the assemblage are: *Coccolithus pelagicus, Cyclicargolithus floridanus, Reticulofenestra lockeri, Reticulofenestra umbilica, Dictyococcites bisectus* and *Dictyococcites ornatus.* Also *Helicosphaera recta* is relatively frequent.

159—160 m depth

Species found: *Coccolithus pelagicus* (WALLICH) SCHILLER, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Cyclococcolithus formosus* KAMPTNER, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Reticulofenestra abisecta* (MÜLLER) ROTH, *Reticulofenestra lockeri* MÜLLER, *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI, *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Dictyococcites ornatus* (MÜLLER) BYSTRICKÁ, *Dictyococcites* cf. *daviesi* (HAQ)

PERCH-NIELSEN, *Cribrocentrum reticulatum* (GARTNER et SMITH) PERCH-NIELSEN, *Discolithina multipora* (KAMPTNER) MARTINI, *Discolithina pygmea* LOCKER, *Helicosphaera dinesenii* PERCH-NIELSEN, *Isthmolithus recurvus* DEFLANDRE, *Blackites spinosus* (DEFLANDRE et FERT) HAY et TOWE, *Zygrhablithus bijugatus* (DEFLANDRE) DEFLANDRE, *Braarudosphaera bigelowi* (GRAN et BRAARUD) DEFLANDRE, *Discoaster barbadiensis* TAN SIN HOK, *Discoaster saipanensis* BRAMLETTE et RIEDEL, *Discoaster deflandrei* BRAMLETTE et RIEDEL, *Discoaster multiradiatus* BRAMLETTE et RIEDEL, *Pyrocyclus hermosus* ROTH et HAY, Cretaceous forms.

The following species prevail in this rich and varied in species nannoplanctonic assemblage: *Cyclicargolithus floridanus, Reliculofenestra umbilica* and *Reticulofenestra lockeri.* Tiny placoliths of *Discolithina pygmea* (= *Transversopontis zigzag* ROTH et HAY) are very frequent. There are very many redeposited specimens here, too, their species representation is, however, different (see abundant representation of *Reticulofenestra umbilica* and other Eocene taxa). *Helicosphaera recta* numerous in the above depth does not occur here.

99—100 m depth

Species found: *Coccolithus pelagicus* (WALLICH) SCHILLER, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Cyclococcolithus formosus* KAMPTNER, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Reticulofenestra lockeri* MÜLLER, *Reticulofenestra abisecta* (MÜLLER) ROTH, *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI, *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Dictyococcites ornatus* (MÜLLER) BYSTRICKÁ, *Discolithina multipora* (KAMPTNER) MARTINI, *Discolithina pygmea* LOCKER, *Isthmolithus recurvus* DEFLANDRE, *Blackites spinosus* (DEFLANDRE et FERT) HAY et TOWE, *Sphenolithus moriformis* (BRÖNNIMAN et STRADNER) BRAMLETTE et WILCOXON, *Zygrhablithus bijugatus* (DEFLANDRE) DEFLANDRE, *Discoaster barbadiensis* TAN SIN HOK, *Discoaster saipanensis* BRAMLETTE et RIEDEL, *Discoaster wemmelensis* ACHUTHAN et STRADNER, Cretaceous forms.

This depth's thanathocoenosis is rich, but its redeposited component is less varied than in the sample above.

40.5—41 m depth

Species found: *Coccolithus pelagicus* (WALLICH) SCHILLER, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Cyclococcolithus formosus* KAMPTNER, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Chiasmolithus* cf. *altus* BUKRY et PERCIVAL, *Chiasmolithus nitidus* BUKRY, *Reticulofenestra lockeri* MÜLLER, *Reticulofenestra abisecta* (MÜLLER) ROTH, *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI, *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRÝ et PERCIVAL, *Discolithina pygmea* LOCKER, *Isthmolithus recurvus* DEFLANDRE, *Blackites spinosus* (DEFLANDRE et FERT) HAY et TOWE, *Zygrhablithus bijugatus* (DEFLANDRE) DEFLANDRE, *Transversopontis pseudopulcher* PERCH-NIELSEN, *Discoaster barbadiensis* TAN SIN HOK, *Discoaster saipanensis* BRAM-

LETTE et RIEDEL, *Coronocyclus nitescens* (KAMPTNER) BRAMLETTE et WILCOXON, sporadic Cretaceous forms.

The rich nannoflora is monotonous in species. *Reticulofenestra lockeri* and *Cyclicargolithus floridanus* are the most abundant. *Dictyococcites ornatus* does not occur at this depth; according to recent data, this species does not exceed the upper boundary of the NP 24 — *Sphenolithus distentus* biozone.

19—20 m depth

Species found: *Coccolithus pelagicus* (WALLICH) SCHILLER, *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN, *Cyclococcolithus formosus* KAMPTNER, *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, *Chiasmolithus altus* BUKRY et PERCIVAL, *Chiasmolithus oamaruensis* (DEFLANDRE et FERT) HAY, MOHLER et WADE, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Reticulofenestra lockeri* MÜLLER, *Reticulofenestra* cf. *abisecta* (MÜLLER) ROTH, *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI, *Cribrocentrum reticulatum* (GARTNER et SMITH) PERCH-NIELSEN, *Dictyococcites bisectus* (HAY, MOHLER et WADE) BUKRY et PERCIVAL, *Discolithina multipora* (KAMPTNER) MARTINI *Discolithina pygmea* LOCKER, *Ericsoniella pauciperforata* (ROTH) KRHOVSKÝ, *Braarodosphaera bigelowi* (GRAN et BRAARUD) DEFLANDRE, *Discoaster barbadiensis* TAN SIN HOK, *Discoaster binodosus* MARTINI, *Pyrocyclus hermosus* ROTH et HAY, Cretaceous forms.

The interval 0—26 m consists of a landslide (J. Jaroš in J. Jaroš, J. Lozert, V. Náprstek, 1959). The nannoflora is preserved worse, but its species composition in comparison with that of the above depth does not change substancially.

Qualitative evaluation of the thanathocoenoses

The richest and best preserved specimens are found at the depth 197—197.3 m. The nannoflora gets qualitatively poorer in the direction to the overlier. At the same time, its preservation gets worse as well. Placoliths are recrystalized and mostly overgrown, which makes species identification worse and often even impossible.

All the horizons studied contain autochthonous as well as redeposited nannoflora. Allochthonous specimens come from the Cretaceous — the Lower Oligocene. Their most numerous occurrence is recorded at the depth 197—197.3 m and 159—160 m. Preservation of species transiting from the Eocene to the Oligocene does not allow to find out whether they are primary or redeposited elements of the thanathocoenoses. That is, even in obviously redeposited species, the way of preservation varies from very good to strongly recrystalized (e. g. in *Cyclococcolithus formosus*). Due to this diagenetic deterioration of the nannoflora, application of statistic techniques to find out variability evolutional sings is not possible.

In the depth 99—100 m, species diversity decreases and follows the direction to the overlier. In the depth 19—20 m, a rich, monotonous in species and badly preserved nannoplankton occurs.

Stratigraphic evaluation of the thanathocoenoses

A stratigraphic analysis of the above nannoflora is quite difficult. The thanathocoenoses obtained represent a mixture not only of stratigraphically variously restricted taxa but also of synchronous allochthonous specimens. The species stratigraphic range is the Cretaceous — the Upper Oligocene; its ecological analysis finds near-shore to pelagic specimens. Another aspect of thanathocoenosis evaluation is its preservation — connected with sedimentary conditions, which can result in selective dissolution. In certain conditions, species may be eliminated this way and this may negatively influence interpretation of diversity and density of the original assemblage. In species with a wider stratigraphic diapazone, it is very difficult even impossible to distinguish autochthonous specimens of the thanathocoenosis from allochthonous ones.

All nannoassemblages studied contain Oligocene species, which enables a rough stratigraphic orientation. After elimination of obviously allochthonous specimens (Cretaceous — Eocene ones), the following 3 groups of species can be used for more exact stratigraphic interpretations:

1. species transiting from the Upper Eocene to the Oligocene,
2. species appearing in the Eocene, but disappearing at the Oligocene — Miocene boundary,
3. species appearing in the Oligocene and not transiting to the Miocene.

The most significant are the species of the third group and they are:

Pyrocyclus hermosus	strat. diapazone the	Oligocene
Discolithina lateliptica		Oligocene
Discolithina pygmea		NP 23 — NP 24
Helicosphaera recta		NP 24 — NP 25
Chiasmolithus altus		Oligocene
Reticulofenestra ornata		?NP 23 — NP 24
Reticulofenestra abisecta		NP 24 — NP 25
Reticulofenestra lockeri		NP 23 — NP 24

According to the stratigraphic diapazone of the above species, the deposits studied belong to the Upper Oligocene — to the upper part of the NP 24 — *Sphenolithus distentus* biozone of the Upper Rupelian and to the NP 25 — *Sphenolithus ciperoensis* biozone of the Egerian. The boundary between the two biozones is not possible to find, because the last occurrence of the species disappearing in the NP 24 biozone cannot be used due to extensive redeposition, and the genus *Sphenolithus* index species cannot be used either because they do not occur in boreal bioprovinces.

In difference with the data gained by the study of sporomorfs and foraminifers, the calcareous nannoplankton analysis proves the Oligocene age of the deposits and excludes that of the Lower Miocene. No Lower Miocene species as e. i. *Triquetrorhabdusus carinatus* MARTINI or Miocene discoasters occur in the thanathocoenoses.

Notes on ecology

In evaluating the paleoecological conditions of the fossil assemblages studied, it must be taken into consideration that after excluding older redeposited spe-

cies, they may contain synchronous allochthonous species and the ones dissolved during sedimentation and diagenetic processes may be missed. Generally, high species diversity is taken for a reflection of good ecological conditions, in the case of calcareous nannoplankton mainly of a normal salinity, relatively high sea water temperature and a not too deep sea.

With regard to this aspect in evaluating the nannoflora studied, the assemblages of the depths 197—197.3 m and 159—160 m had the most favourable ecological conditions, quite numerous occurrence of Helicosphaera recta in the depth 197—197.3 m indicating a lesser depth of the sedimentary basin (or near-shore environment), while the depth 159—160 m assemblage comes from deeper water. Gradual decrease of the species diversity in the depth 99—100 m and especially 40.5—41 m indicates more considerable ecological changes. Decrease of temperature during the Upper Oligocene at a constant deepening of sea seem to have played the main role in them. They resulted in extinction of several species and in a stronger selective dissolution of less proof placoliths. B. Paclтová (1966) supposed a temporary decrease in temperatute on the basis of sporomorf species representation in the above bore hole. According to A. R. Edwards and K. Perch—Nielsen (1975) only about 1/3 of living species was found in recent deposits of the S. and SW. Pacific. The ecological conditions supposed agree with findings of B. U. Haq and G. P. Lohman (1976) who, on the basis of detailed statistical analyses of nannoplanktonic assemblages from bore holes in the N. and S. Atlantic ocean, Caribean sea and Gulf of Mexico found a gradual decrease in temperature from the NP 24 biozone bottom.

Conclusions

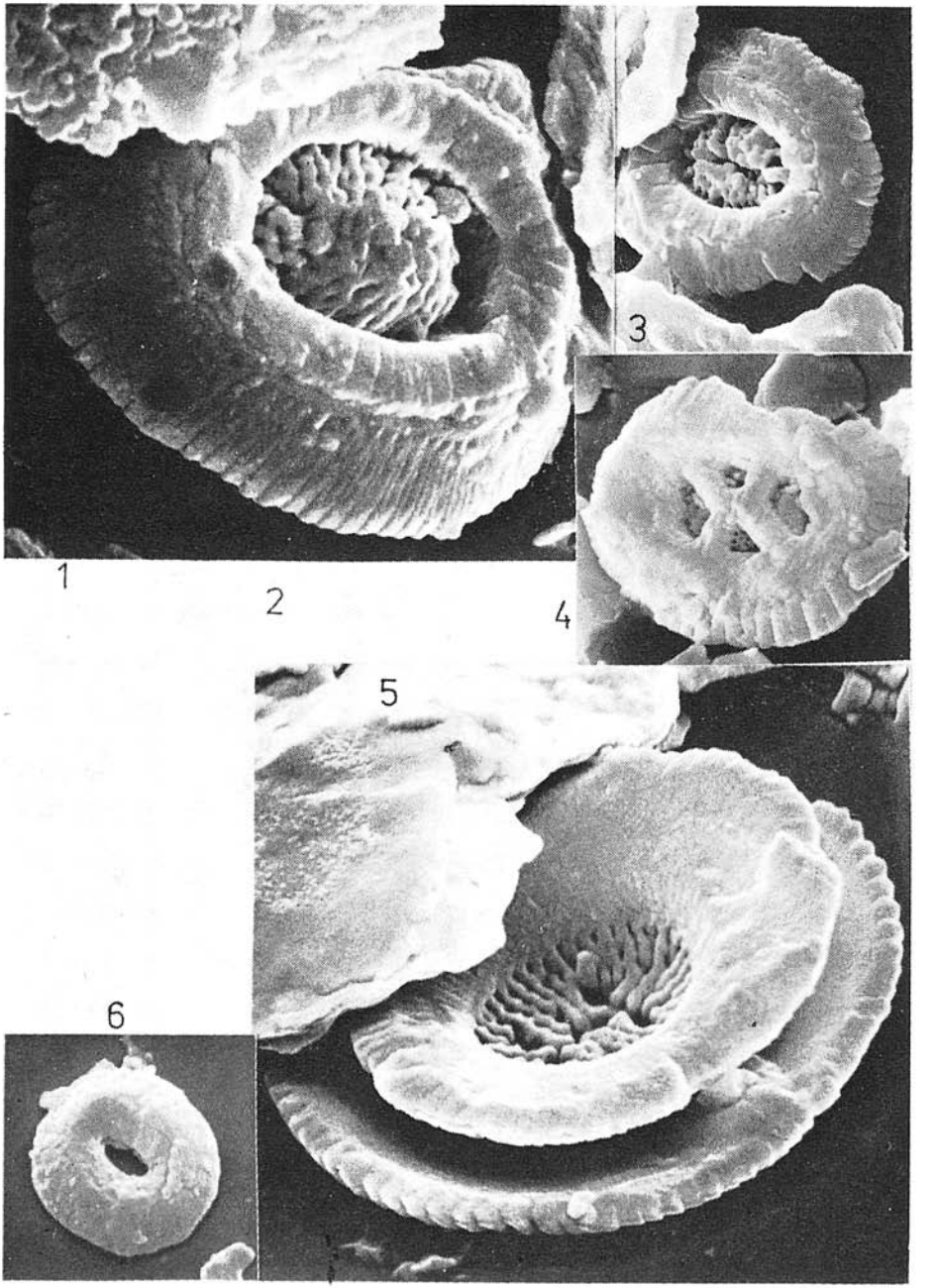
The bore hole K-1 Kordiky deposits contain rich nannoplanktonic thanathocoenoses consisting of Cretaceous — Upper Oligocene species. After elimination of redeposited specimens, the assemblages were ranked to the NP 24 — *Sphenolithus distensus* biozone (NP 25 — *Sphenolithus ciperoensis* biozone proving the Upper Oligocene age of the bed sequence.

No Miocene species, e. g. *Triquetrorhabdulus carinatus* MARTINI or Miocene discoasters were found in the thanathocoenoses, which excludes the Miocene age of the deposits.

No fresh water micro and nannoorganisms (ostracods, fresh water diatoms) were found there, either, to prove currently so much discussed possibility of the whole bed sequence being a result of a Miocene fresh water sedimentation and of all sea fossils found here being allochthonous. Our results correlate with stratigraphic and paleontologic findings of the Banská Bystrica depression gained from the bore hole JK9 (H. Bystrická, 1979 a, b) and make biostratigraphic data of the Horehronie development (M. Pulec, 1966) more complete up to the Upper Oligocene.

Translated by K. Bystrická

Plate 1



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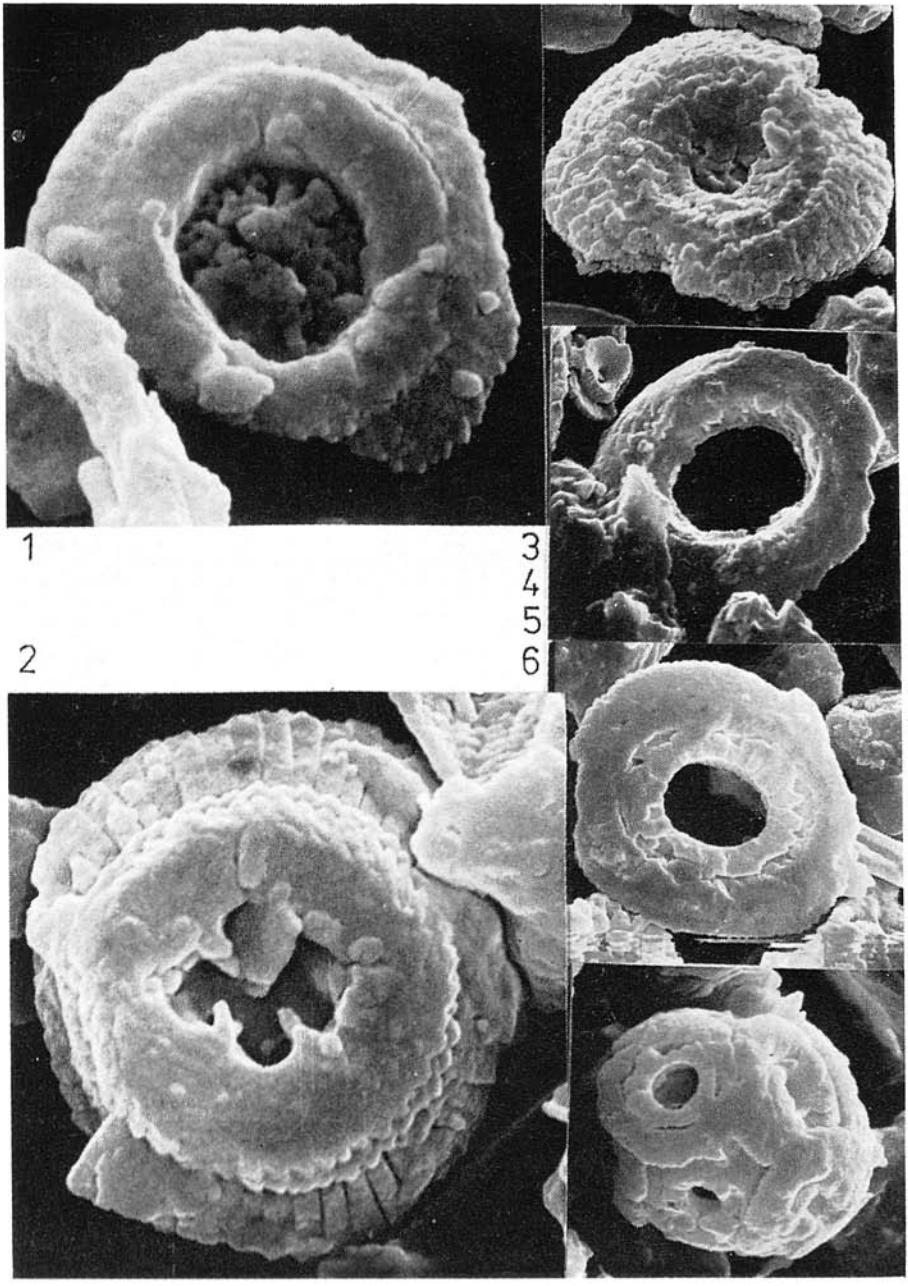

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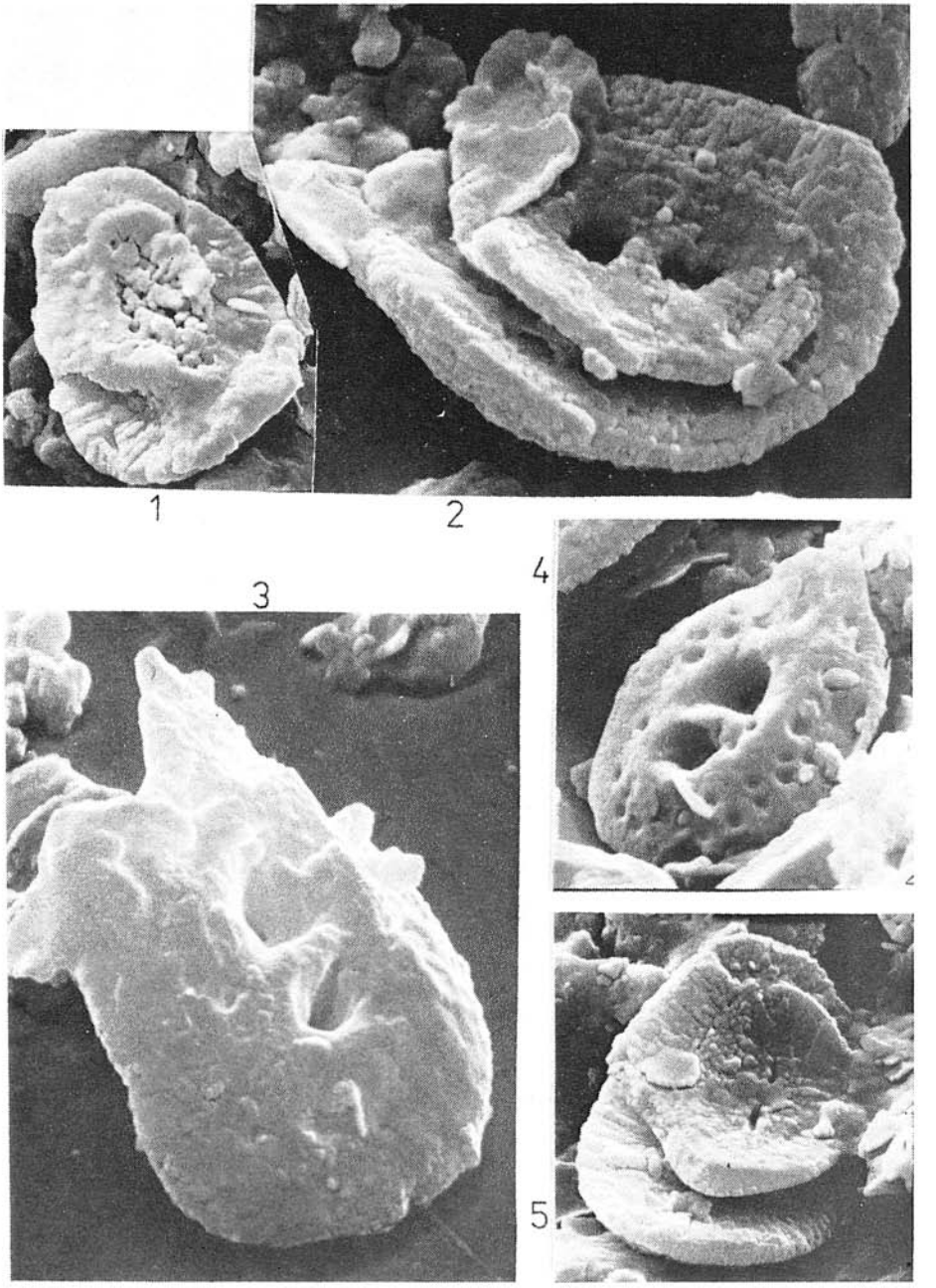

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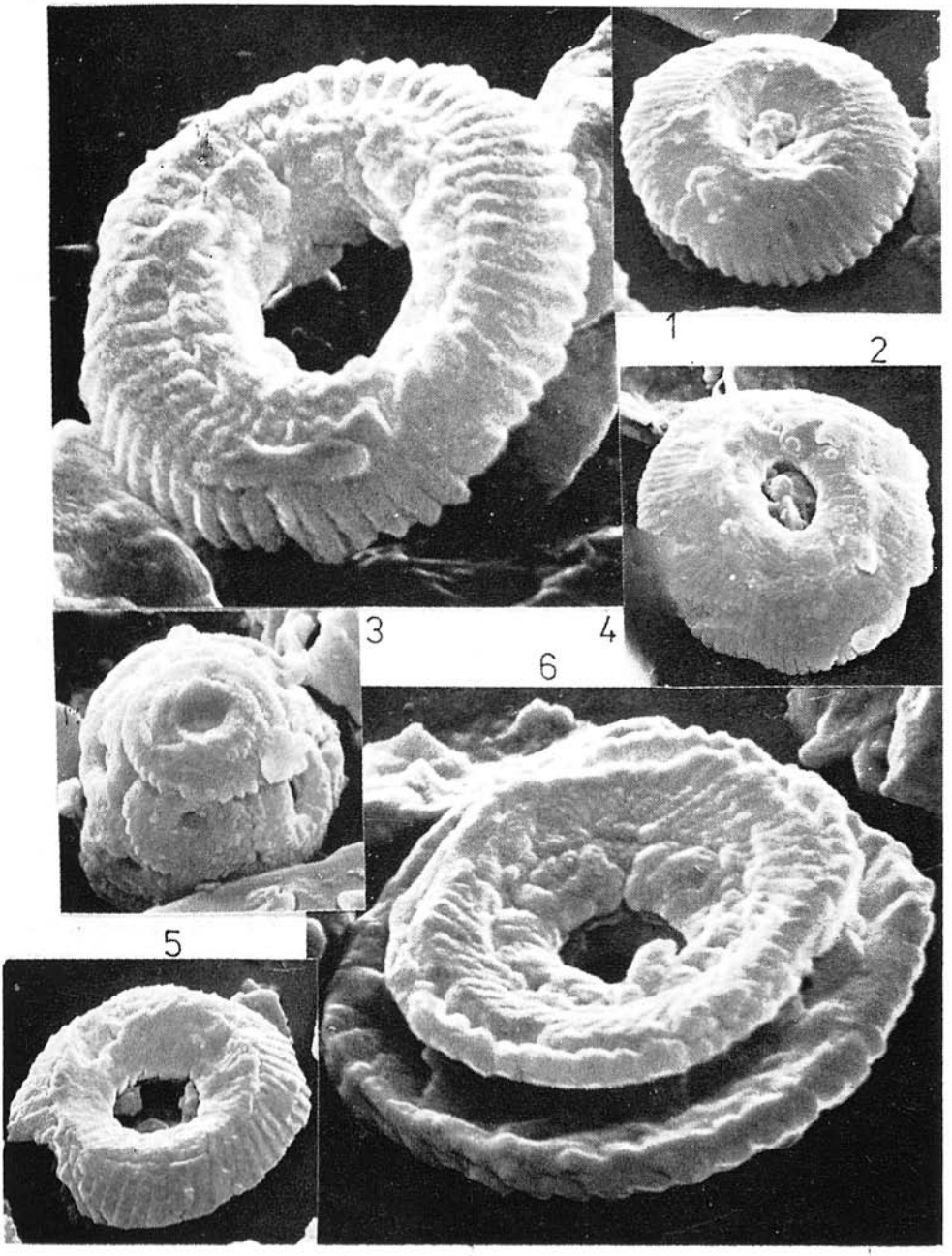

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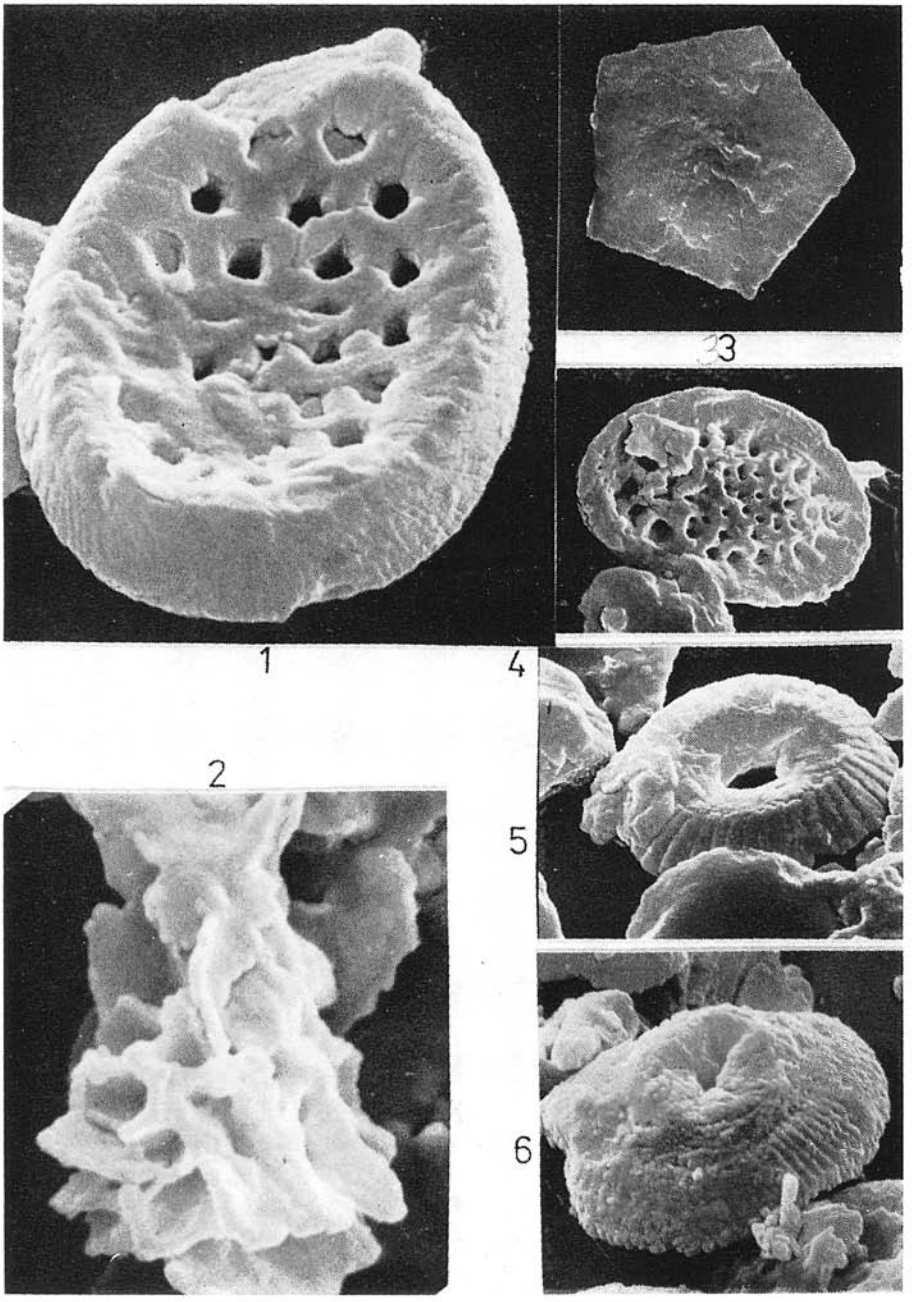

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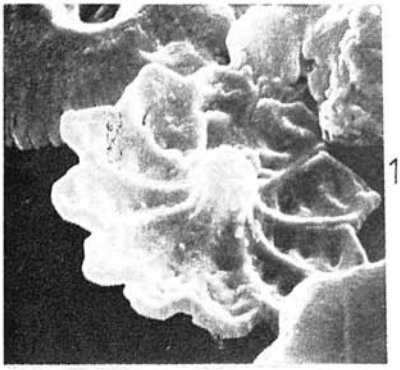
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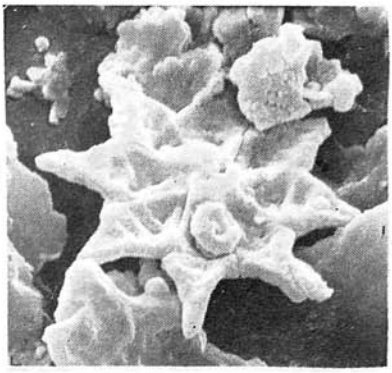
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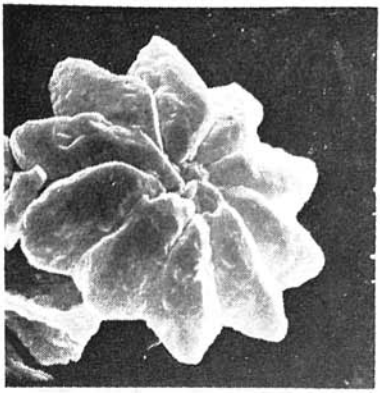
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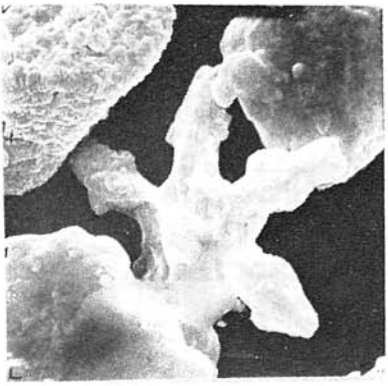
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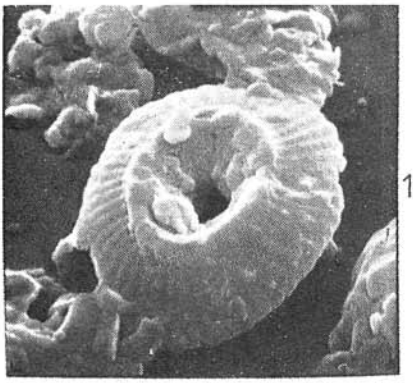
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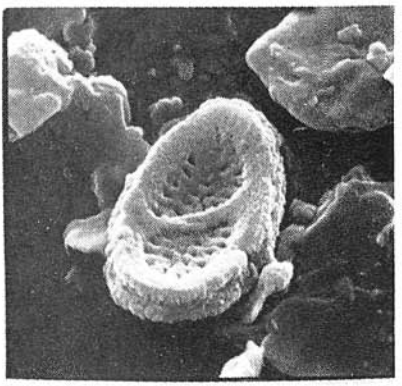
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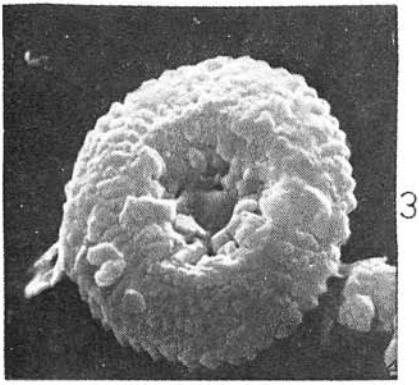
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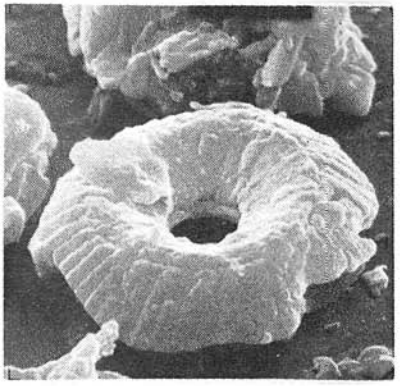
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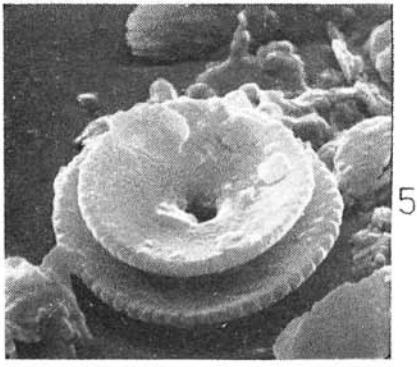
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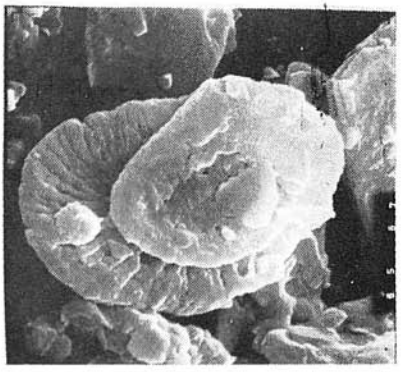
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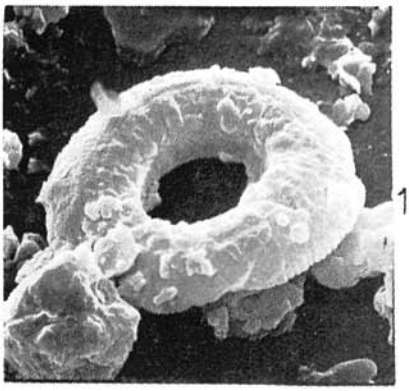
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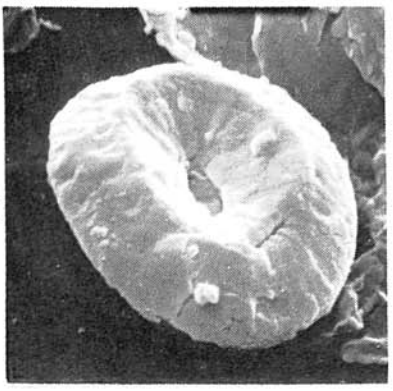
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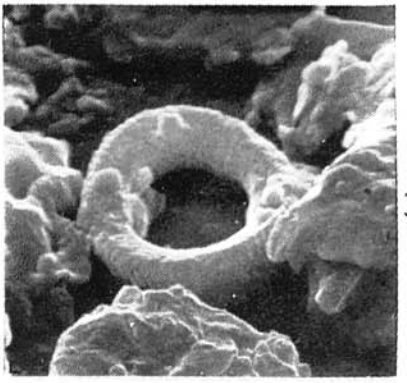
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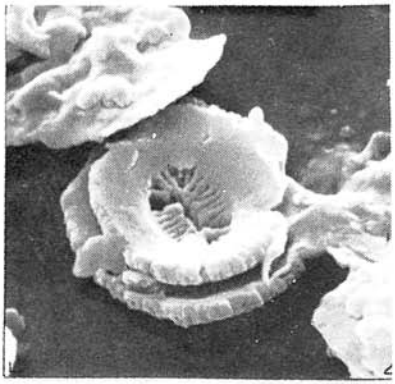
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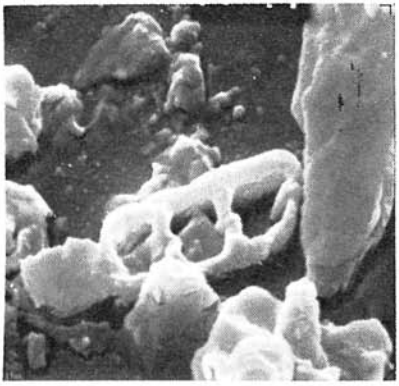
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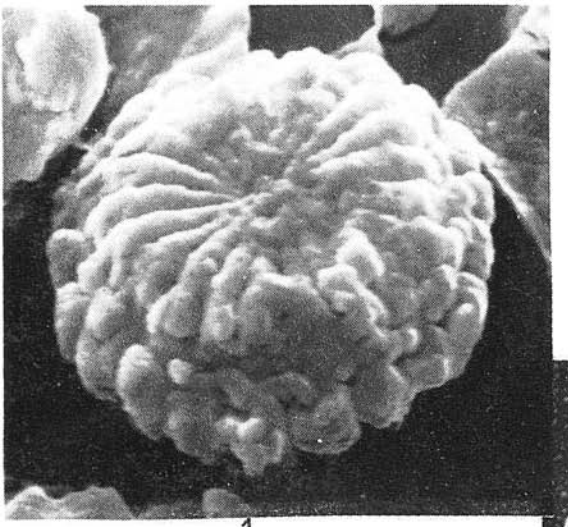
Plate 9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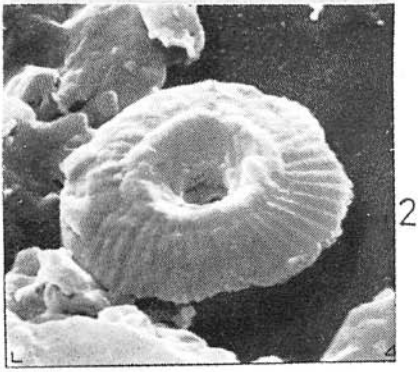
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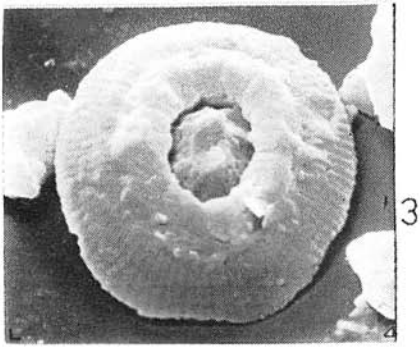
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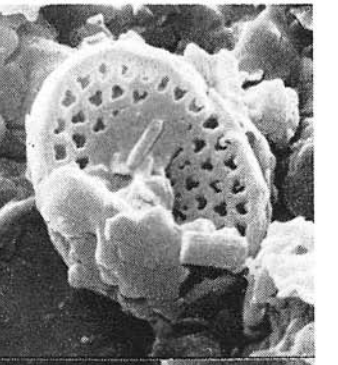
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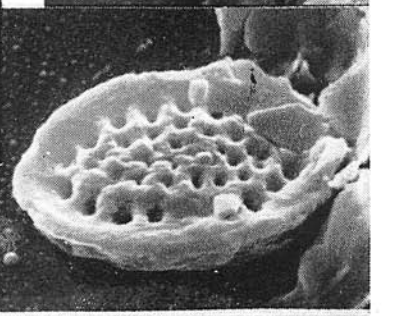
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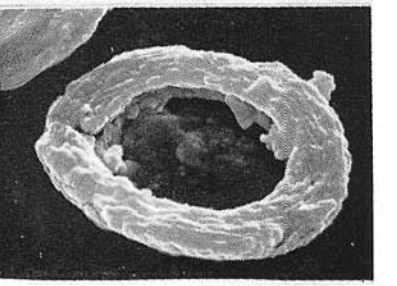
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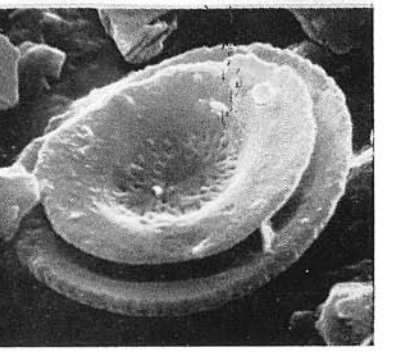
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Plate 10

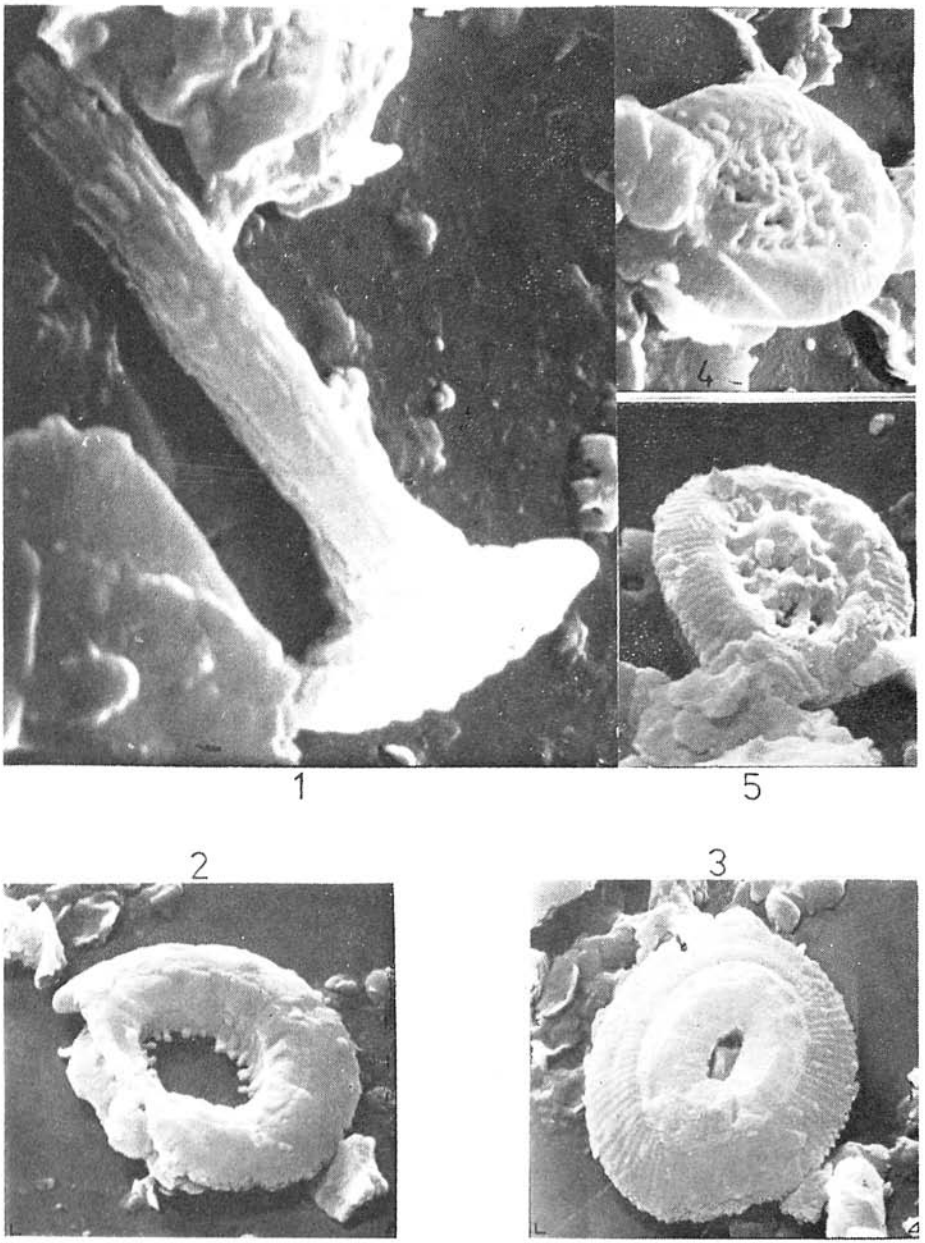


Plate 11

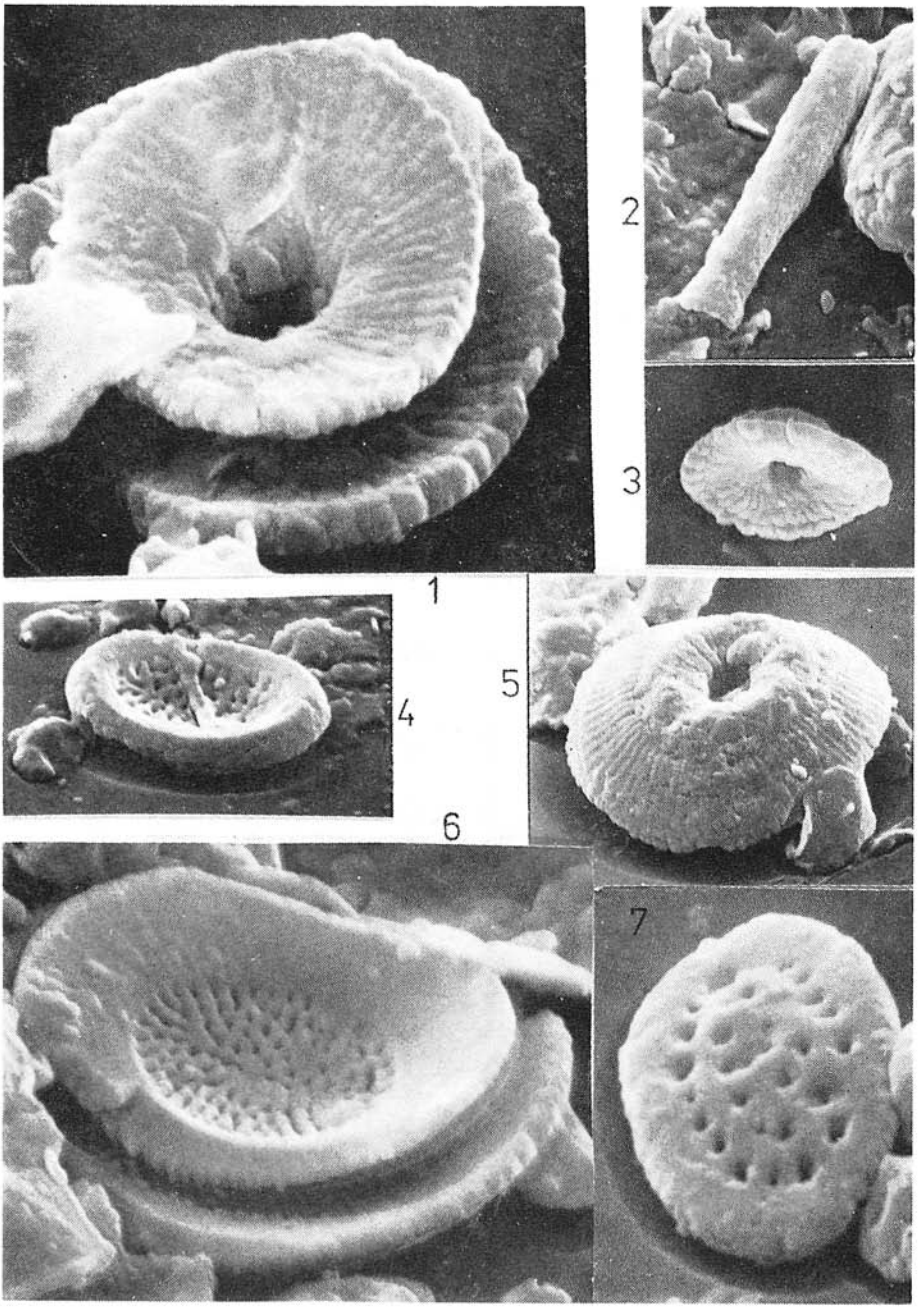
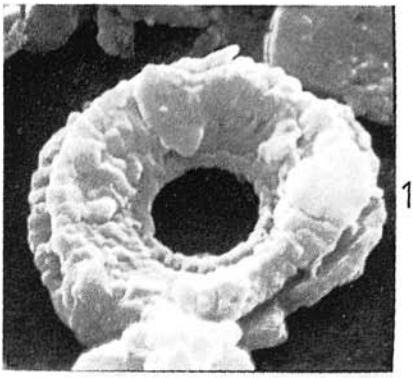


Plate 12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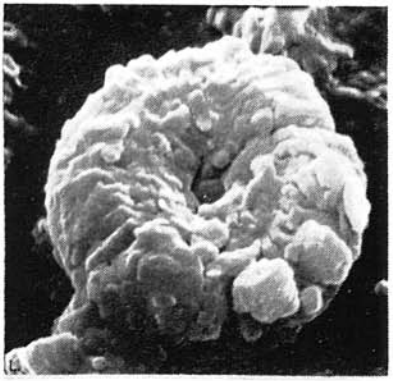
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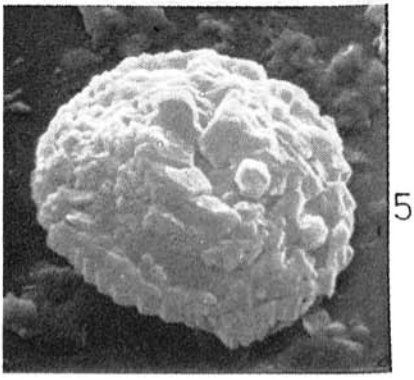
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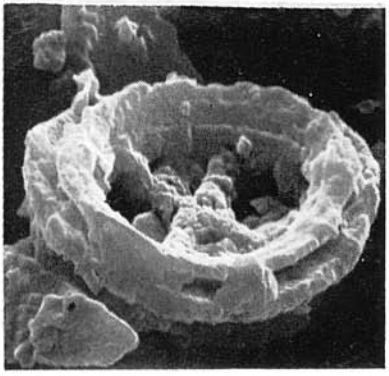
6

Plate 1

Figs. 1, 3, 5. *Reticulofenestra lockeri* MÜLLER. Magn. 10 000×, 4500×, 7000×.
Fig. 2. *Chiasmolithus grandis* (BRAM. et RIED.) HAY MOH, et WADE. Magn. 2250×.
Fig. 4. *Chiasmolithus altus* BUK. et PERC. Magn. 5000 ×.
Fig. 6. *Coccolithus pelagicus* (WALL.) SCHILL.
Depth 197—197.3 m.

Plate 2

Fig. 1. *Cribrocentrum reticulatum* (GART. et SMITH) PERCH-NIEL. Magn. 10 000×.
Fig. 2. *Toweius eminens* (BRAM. et SULL.) GART. Magn. 10 000 ×.
Fig. 3. *Cyclococcolithus formosus* KAMPT. — strongly recrystalized specimen. Magn. 4000 ×.
Figs. 4, 5, 6. *Reticulofenestra umbilica* (LEV.) MART. et RITZ. Magn. 3000 ×, 3000 ×, 3750 × (coccosphaere).
Depth 197—197.3 m.

Plate 3

Fig. 1. *Helicosphaera dinesenii* PERCH-NIEL. Magn. 3000 ×.
Figs. 2, 3. *Helicosphaera recta* HAQ. Magn. 6500 ×, 8000 ×.
Fig. 4. *Helicosphaera reticulata* BRAM. et WILC. Magn. 4000 ×.
Fig. 5. *Helicosphaera compacta* BRAM. et WILC. Magn. 3500 ×.

Plate 4

Figs. 1, 3, 4. *Cyclicargolithus floridanus* (ROTH et Hay) Bukry, Magn. 4500 ×, 10 000 × 5000× (coccosphaere).
Fig. 2. *Reticulofenestra lockeri* MÜLLER. Magn. 4000 ×.
Figs. 5, 6. *Cyclococcolithus formosus* KAMPT. Magn. 4000 ×, 10 000 ×.
Depth 197—197.3 m.

Plate 5

Figs. 1, 4. *Discolithina multipora* (KAMPT.) MART. Magn. 9000 ×, 4000 ×.
Fig. 2. *Sphenolithus* cf. *radians* DEFL. Magn. 10 000 ×.
Fig. 3. *Braarudosphaera bigelowi* (GRAN. et BRAA.) DEFL. Magn. 2500 ×.
Fig. 5. *Cyclococcolithus formosus* KAMPT. Magn. 3500 ×.
Fig. 6. *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC. Magn. 3500 ×.
Depth 197—197.3 m.

Plate 6

Figs. 1, 3, 5. *Discoaster barbadiensis* T. S. H. Magn. 5000 ×, 3500 ×, 5000 ×.
Fig. 2. *Discoaster saipanensis* BRAM. et RIED. Magn. 3000 ×.
Fig. 4. *Discoaster binodosus* MART. Magn. 3000 ×.
Fig. 6. *Zygrhablithus bijugatus* (DEFL.) DEFL. Magn. 3500×.
Fig. 7. *Chiasmolithus nitidus* BUK. Magn. 4000 ×.
Depth 197—197.3 m.

Plate 7

Figs. 1, 3, 5. *Cyclicargolithus floridanus* (ROTH et HAY) BUK. Magn. 5000 ×, 5000 ×, 4000 ×.
Fig. 2. *Discolithina pygmea* LOCK. Magn. 5000 ×.
Fig. 4. *Cyclococcolithus formosus* KAMPT. Magn. 4000 ×.
Fig. 6. *Helicosphaera dinesenii* PERCH-NIEL. Magn. 3500 ×.
Depth 159—160 m.

Plate 8

Fig. 1. *Reticulofenestra umbilica* (LEV.) MART. et RITZ. Magn. 2250 ×.
Fig. 3, 5. *Pyrocyclus hermosus* ROTH et HAY. Magn. 4000 ×, 5000 ×.
Fig. 2. *Coccolithus eopelagicus* (BRAM. et RIED.) BRAM. et SULL. Magn. 4500 ×.
Fig. 4. *Dictyococcites* cf. *danicus* BLACK. Magn. 5000 ×.
Fig. 6. *Isthmolithus recurvus* DEFL. Magn. 5000 ×.
Depth 159—160 m, figs. 3, 5, 6. Depth 99—100 m, figs. 1, 2, 4.

Plate 9

Fig. 1. *Discoaster wemmelensis* ACHUT. et STRAD. Magn. 10 000 ×.
Fig. 2. *Cyclicargolithus floridanus* (ROTH et HAY) BUK. Magn. 5000 ×.
Figs. 3, 7. *Reticulofenestra lockeri* MÜLLER. Magn. 4000 ×, 4500 ×.
Figs. 4, 5. *Discolithina multipora* (KAMPT.) MART. Magn. 3500 ×, 5000 ×.
Fig. 6. *Discolithina lateliptica* BALDI-BEKE. Magn. 4500 ×.
Depth 99—100 m. Fig. 6 from depth 197—197.3 m.

Plate 10

Fig. 1. *Blackites spinosus* (DEFL. et FERT) HAY et TOWE. Magn. 8500 ×.
Fig. 2. *Reticulofenestra umbilica* (LEV.) MART. et RITZ. Magn. 4000 ×.
Fig. 3. *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC. Magn. 3000 ×.
Figs. 4, 5. *Dictyococcites ornatus* (MÜLL.) BYSTR. Magn. 5000 ×, 5000 ×.
Depth 99—100 m.

Plate 11

Fig. 1. *Cyclicargolithus floridanus* (ROTH et HAY) BUK. Magn. 9000 ×.
Figs. 2, 3. *Blackites spinosus* (DEFL. et FERT) HAY et TOWE. Magn. 4500 ×, 5000 ×.
Figs. 4, 7. *Discolithina pygmea* LOCK. Magn. 5000 ×, 10 000 ×.
Fig. 5. *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC. Magn. 3500 ×.
Fig. 6. *Reticulofenestra lockeri* MÜLLER. Magn. 10 000 ×.
Depth 40.5—41 m.

Plate 12

Fig. 1. *Markalius inversus* (DEFL.) BRAM. et MART. Magn. 4000 ×.
Fig. 2. *Coccolithus eopelagicus* (BRAM. et RIED.) BRAM. et SUL. Magn. 4250 ×.
Fig. 3. *Reticulofenestra umbilica* (LEV.) MART. et RITZ. Magn. 2500×.
Fig. 4. *Discolithina multipora* (KAMPT.) MART. Magn. 5000 ×.
Fig. 5. *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC. Magn. 4500 ×.
Fig. 6. *Chiasmolithus oamaruensis* (DEFL. et FERT.) HAY, MOH. et WADE. Magn. 2500 ×.

Depth. 19—20 m.
All photographs were made by the scanning electron microscope JSM U3 at the D. Štúr Geological Institute in Bratislava.

Operators: K. Šebor, M. Švec

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