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Calcareous nannoplankton in flysch sediments of the Bílé Karpaty Unit (the West Carpathians)

Vápnitý nanoplankton ve flyšových sedimentech bělokarpatské jednotky (Západní Karpaty)

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Abstract: Flysch sediments of the outer development of the Bílé Karpaty Unit (Javorina and Svodnice Formations — sensu Stráník et al. 1986) contain calcareous nannofossils which can be used for determination of the relative age of the rocks within stage to zone precision. In the Javorina Formation (Campanian—Maastrichtian) seven nannoplankton zones were delimited; they are partially identical with CC Zones (Sissingh 1977). In the Paleogene classical Martini's (1971) zonation could be used in the range of NP1—2 through NP11 Zones (lower Paleocene through lower part of the lower Eocene). The work gives definitions of determined nannoplankton zones in the Cretaceous and a systematic overview of the Cretaceous and Paleogene species of calcareous nannoplankton (including illustrations) in the Bílé Karpaty Unit.

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Introduction

The basic study of geological structure of the Bílé Karpaty Unit (Flysch Carpathians) was published by Matějka and Roth with a microbiostratigraphic passage by Hanzlíková in 1956. On the basis of facial changes two lithostratigraphic units were defined from the bottom to the top: 1. lower section of the Paleogene represented namely by variegated beds; 2. upper section of the Paleogene formed by flysch beds with noncalcareous claystones and flysch beds with calcareous claystones.

In the following years the paleontologic research in this area was reduced only to single papers. Hanzlíková (1980) made a revision of sediments of the Bílé Karpaty Unit in the basement of the Vienna Basin. She called attention to a possible flysch development already in the Senonian. Foraminiferal assemblages showed no calcareous specimens and the biostratigraphic determination had to be based on the associations of sandy benthic forms only. From the borehole Hluk V-3 situated in the western part of the Bílé Karpaty Unit microfauna was described by Hanzlíková (1984a) and nannoplankton from identical samples by Švábenická (1985). Both methods established sediments of the lower, middle and upper Eocene, foraminifers indicated even the lower Oligocene. Hanzlíková proposed to define the deep red-brown noncalcareous claystones with *Uvigerinammina jankoi* Majzon as a new lithostratigraphic member — the Gbely Member. Hanzlíková (1984b) also devised an orientational microbiostratigraphic correlation for the study of geotraverses in the Púchov area. The concept of the Bílé Karpaty Unit structure in Stráník et al. (1986) is based on the classical division of Matějka and Roth (1956). However, Stráník et al. proposed several changes in the upper part of the Paleogene.

In this paper, the biostratigraphy of the Bílé Karpaty Unit (Javorina and Svodnice Formations) was studied using two micropaleontologic methods; the classical one, based on foraminifers, and a new one, based on calcareous nannoplankton. Both methods complemented each other and provided interesting comparison and mutual checking.

The nannoplankton corpuscles were determined in all calcareous sediments of the flysch and variegated development. The nannofossil assemblages usually showed greater species diversity and contained markers permitting to determine the age of the sediments within stages to zones precision.

This article deals with calcareous nannoplankton including its taxonomic review in the flysch sediments of the outer development of the Bílé Karpaty Unit (sensu Stráník et al. 1986). The presence of turbidites is typical of flysch sediments and determination of their relative age has been rather problematic. Individual intervals of flysch rhythms show a poor fossil record. We presume that in turbidite all material is redeposited. In the pelagic interval T_e (sensu Bouma 1962) the fossils are considered an autochthonous component. This paper discusses the problem whether calcareous nannofossils in flysch sediments are an autochthonous component or merely a redeposited material and whether the nannoplankton zonation can be used for determining the relative age of the flysch sediments in the Outer Carpathians.

The sediments exhibited prevailingly or only agglutinated foraminifers and calcareous nannofossils. The species composition of agglutinated foraminifers usually indicated a broader stratigraphical range — the upper Senonian—Paleocene. Unfortunately, these assemblages lacked species (e.g. representatives of the species *Rzehakina* are very rare), which would help to determine the age of the sediments more precisely. Calcareous nannoplankton permitted to state more closely the relative age. However, we do not know yet the degree of autochthonism of nannofossils in the flysch sediments. Samples were taken predominantly from the thin T_{et-p} layers (Weidmann 1967) — from calcareous pelagites which probably were not yet products of pure quiescent sedimentation. In this rhythm phase the finest corpuscles of turbidite were probably deposited exhibiting also tiny particles of redeposited nannofossils. Simultaneously, sedimentation of autochthonous material occurred. For comparison of the assemblage contents samples from turbidite phases of flysch rhythms were taken in selected localities. They contain nannofossil taphocenoses of species similar to those of the T_{et-p} pelagites. In my opinion, the sedimentation of the material on the continental shelf and its resedimentation in the deep-sea environment took place within a relatively short time-span, maximally in the framework of one nannoplankton zone. The taphocenoses exhibited clearly redeposited nannofossils from earlier stages or formations and the stratigraphically "youngest" corpuscles which documented the sedimentation age of even turbidites on the continental shelf and thus could be considered an isochronous component of the sediment (turbidite).

The sediments were chip-sampled during mapping tours from brook beds, road cuts, abandoned quarries, etc.

Calcareous nannoplankton from sediments of the outer development of the Bílé Karpaty Unit

The Javorina Formation

Stráník et al. (1986) defined a new lithostratigraphic member — the Javorina Formation — in the Vlára development of the Bílé Karpaty Unit. It is a complex of small to medium-scale rhythmic flysch sediments with green-grey to grey claystones, usually noncalcareous and variably psammitic. They contain poor, badly preserved and stratigraphically inconclusive, usually agglutinated foraminifers and calcareous nannofossils.

The sediments of the Javorina Formation show features of "classical turbidites" which are typical of the lower part of the alluvial fan abutting on the basin plain.

S t r á n í k et al. (1986) ranges the whole complex of the Javorina Formation with the lower Paleocene. The authors explain the presence of solely Cretaceous assemblages of calcareous nannofossils in these sediments by mass redeposition into younger stages probably without development of autochthonous nannoflora.

This opinion was not confirmed by the results of nannoplankton and microfauna research in the Javorina Formation. The sediments contained relatively rich assemblages of calcareous nannofossils of Campanian—Maastrichtian age (Zones CC18—CC26 sensu S i s s i n g h 1977) without any Paleogene indications and agglutinated foraminifers of a broader stratigraphic range the Upper Cretaceous—Paleocene. Provided that all the material of the Javorina Formation Cretaceous was redeposited into the Paleogene we should answer several questions: Why the nannofossil assemblage contains solely corpuscles unequivocally determining a relatively narrow stratigraphic range of e.g. the Campanian?; why these "redeposited" associations do not contain also younger particles of the Maastrichtian? The Maastrichtian was established in the sediments of the Bílé Karpaty Unit in many localities of the variegated and flysch development. The Campanian and Maastrichtian species are commonly found as redeposited material in the Paleocene and lower Eocene assemblages of the Svodnice Formation.

Corpuscles of the calcareous nannoplankton deposited relatively slowly in quiescent environment. For a long time they were floating in a suspension with fine dust, clay and autochthonous withered organic material and together they sank to the bottom. The nannoplankton corpuscles are small (2—30 μm) and exhibit usually flat, disc-shaped outline. Calcareous nannoplankton remains longer in suspension compared with foraminiferal tests.

Redeposited nannofossils were partially protected from acidity and other adverse effects of the environment by clay minerals. Autochthonous withered coccospheres were coated with gelatine substance which for a certain period preserved the corpuscles from impairment even in great depths within CCD. S c h l a n g e r et al. (1973) studied diagenetic processes resulting from $CaCO_3$ dissolution and its secondary recrystallization. They discovered that the coccolith bodies do not dissolve entirely below the carbonate level of compensation. The authors explain this nannofossil resistance by the presence of protein mucous membrane of the primary living organism which covers calcite elements and preserves them against agresivity of the environment. Another protection of the nannofossil corpuscles in the water column below the CCD level against the adverse effects of the environment is the rain of fecal pellets containing calcareous corpuscles of nannofossils in the form of undigested remnants (Honjo 1976). These pellets are produced by zooplankton which feeds on fytoplankton. The protective role of the pellets in acid environment was verified also by laboratory methods.

When simultaneously studying foraminifers and nannoplankton in the flysch sediments we came across a conspicuous feature; the same sample exhibited a relatively rich assemblage of calcareous nannofossils while microfauna contained only agglutinated foraminifers devoid of calcareous elements. This phenomenon is typical of the sediments of the Javorina Formation. The presence of nannofossils in deep-water sediments testifies rather of corpuscle redeposition than of the material autochthony. Schlanger et al. (1973) found stratigraphic intervals completely devoid of withered calcareous foraminiferal assemblages but exhibiting nannofossils in the northern Pacific Ocean. They presume that the calcite originally contained in the foraminiferal tests dissolved and recrystallized either as micrite or deposited on skeletal remains of coccoliths, or formed an interspace mass of the sediment.

The Svodnice Formation

The flysch sediments with calcareous claystones similar to the Vsetín type of the Zlín Formation and marls of the Lacko type of Paleocene—lower Eocene age are stratigraphically the highest member of the Bílé Karpaty Unit. This complex of sediments was named the Svodnice Formation by Pesl (1968).

Compared with the Javorina Formation the sediments of the Svodnice Formation show a different development of microfauna and calcareous nannoplankton. Beside associations of agglutinated foraminifers the microfauna contained frequently also calcareous plankton and benthos. This calcareous component of foraminifers corroborated a similar relative age of the sediments as did calcareous nannofossils.

Calcareous nannoplankton indicates the age of the Svodnice Formation ranging between the Paleocene—lower Eocene. Nannofossil assemblages contain index species of standard nannoplankton zones sensu Martini (1971).

According to the nannoplankton research we may presume in the Svodnice Formation almost continuous sedimentation without significant interruption from the lower Paleocene to the lower Eocene. Rich redepositions from the Upper Cretaceous (predominantly the Campanian and Maastrichtian as well as earlier stages) are typical of these Paleogene nannofossil assemblages. It is interesting that the associations of the upper Paleocene very rarely exhibit nannofossils redeposited from the lower Paleocene, and also the lower Eocene shows abundant redepositions from the Upper Cretaceous while the species redeposited in the Paleocene almost do not occur in these taphocenoses.

In the Svodnice Formation the dependence of the nannoflora and microfauna assemblage composition on individual flysch rhythms was detailedly studied. For example in the abandoned stone quarry Modrá Voda the sediments exhibited nannofossil assemblages with a higher species diversity of upper Paleocene age (NP7 — horizon with frequent *Scapholithus fossilis*). Calcareous nannoplankton of the Paleocene may be considered an isochronous component of the sediment. The microfauna is predominantly agglutinated, with species of a broader stratigraphic range. The rare finding of *Globigerina triloculinoides* Plummer confirms this stratigraphical range. It was interesting to observe how the fossil record changed in dependence on the character of the turbidite interval. In the hemipelagite deposit T_{et} only calcareous nannoplankton was found. The washing residue contained worked up fragments of brick-red claystones which could be explained as redeposited material from the variegated strata of the Cretaceous accounting also for the presence of redeposited nannofossil corpuscles of Campanian—Maastrichtian age. The calcareous claystone — pelagite deposit T_{et-p} contained poor assemblage of nannofossils in which only species with "massive" corpuscle construction were preserved since they were more resistant against dissolving and other adverse effects of the paleoenvironment. Conversely, the microfauna was richer in this sample. Agglutinated foraminifers with rare *Rzehakina complanata* (Grzyb.) and *Matanzia varians* (Glaessner) predominated. Tiny specimens of *Globigerina triloculinoides* Plummer (P1—P4 Biochrone; the lower part of the P4 Zone can be correlated with the NP7 Zone sensu Bolli et al. 1985) formed a significant component in the sample.

Summary

Detailed research into the dependence of species composition on nannofossil taphocenoses and foraminifers on the genesis of individual flysch rhythm intervals revealed that the calcareous nannofossils and microfauna complemented each other. Calcareous nannofossils were absent only in the noncalcareous pelagites T_{ep} (sensu Weidmann 1967) which originated in deep-water environment below the carbonate

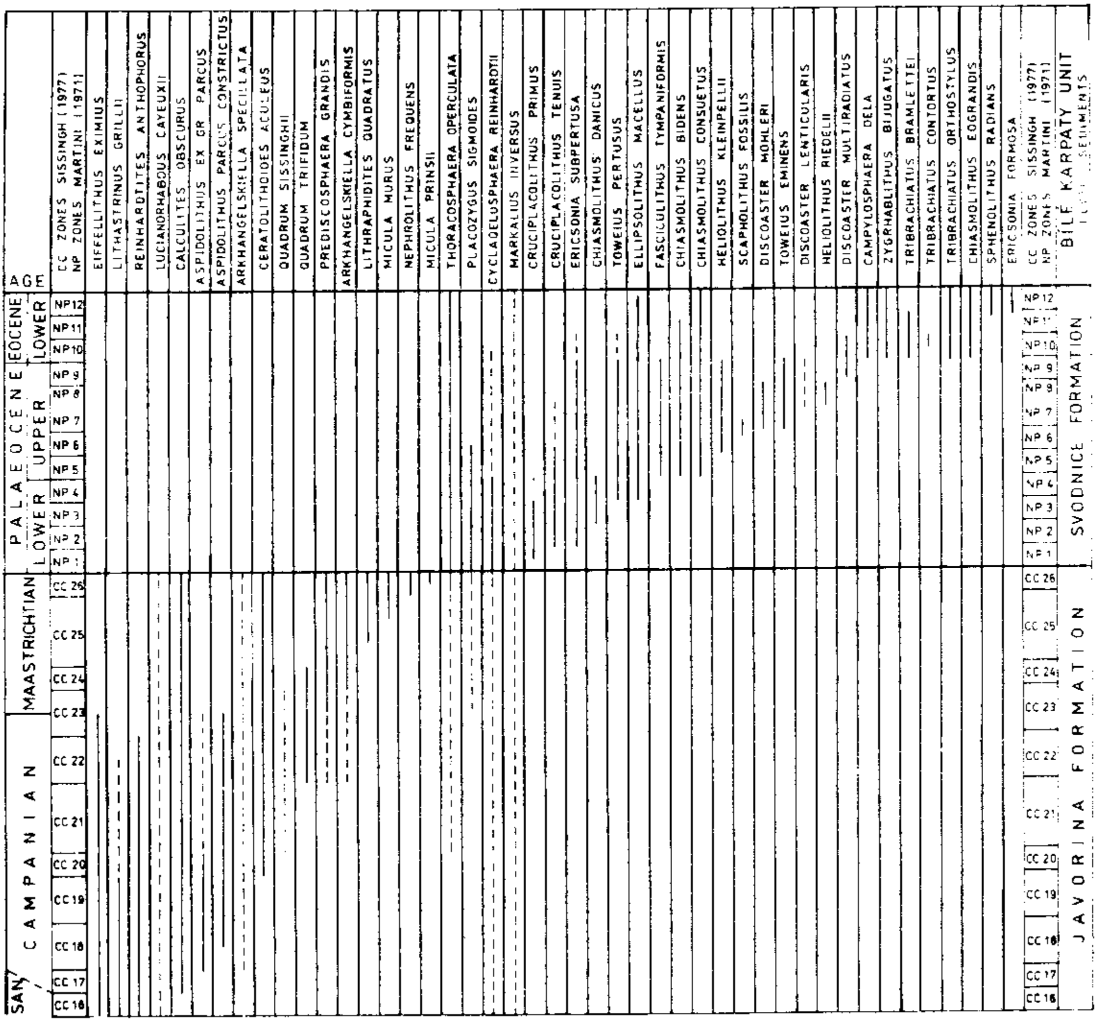
compensation level during the period of quiescent sedimentation. These sediments exhibit relatively rich assemblages of agglutinated foraminifers with a higher species diversity and a broader stratigraphic range, and very rarely plankton.

Calcareous nannofossils are found in a) calcareous as well as in weakly calcareous turbidite sediments of flysch sedimentation in the T_d intervals, where redeposited material should be rightly presumed, b) calcareous claystones of the quiescent phase of the T_e flysch rhythm sedimentation in which a long-term deposition of pelagic material is assumed. The species composition of nannofossil taphocenosis showed that in these pelagites redeposited particles as well as autochthonous and/or isochronous material accumulated. It has been documented that the stratigraphically youngest components of calcareous nannofossil taphocenosis deposited already in the finest phase of the turbidite rhythm — in clayey calcareous siltstone T_d and that it was in isochronous component of genetically complicated flysch sedimentation.

Nannoplankton zones of the flysch sediments of the Bílé Karpaty Unit

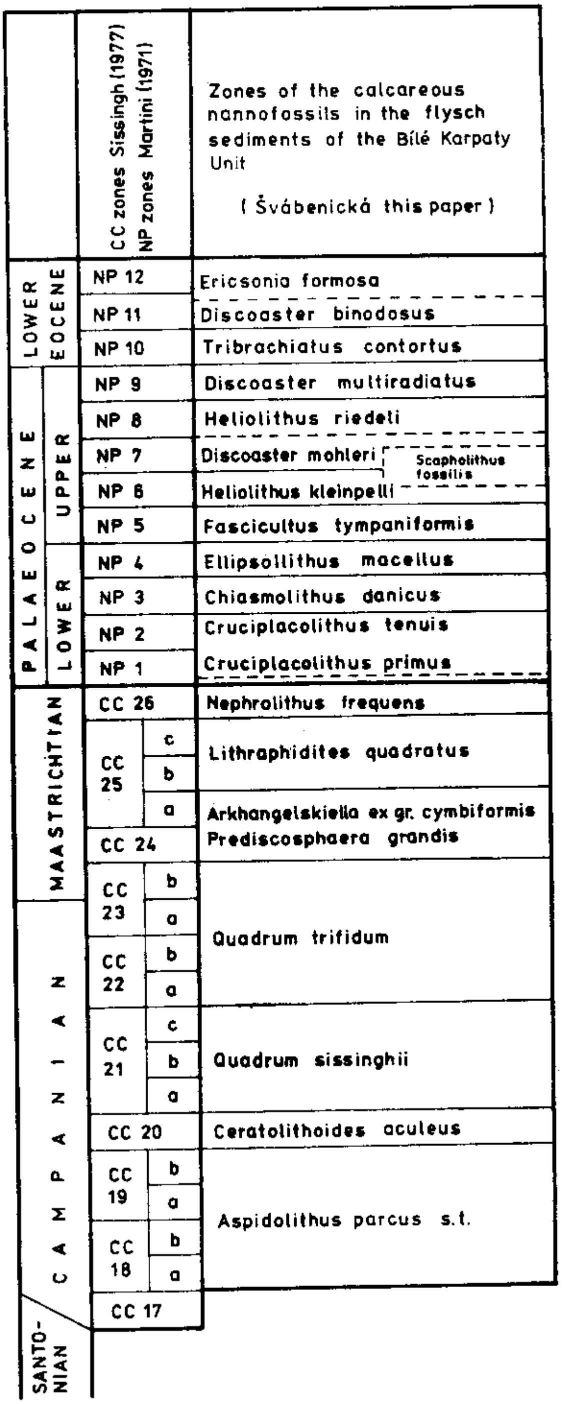
The sediments of the Bílé Karpaty Unit are relatively rich in associations of calcareous nannofossils with index species according to which samples can be ranged with nannoplankton zones permitting to determine more closely the relative age of the rocks (see text-fig. 1).

In the Upper Cretaceous (Campanian—Maastrichtian) there developed taphocenoses of calcareous nannoplankton with a higher species diversity. "Running species" which start in the Lower Cretaceous or in the lower part of the Upper Cretaceous and die out at the Cretaceous/Tertiary boundary, predominate. It has been found out during sample studies that some stratigraphically important nannofossils did not occur in associations and thus it was not possible to use standard CC Zones (sensu Sissingh 1977). In the Bílé Karpaty Unit and Javorina Formation seven nannoplankton zones (see text-fig. 2) were delimited within the range of the Campanian—Maastrichtian. The lower biozone boundaries are defined by the first occurrence of a nominal species. Sissingh (1977) gives nine CC zones in the identical stratigraphic interval. The development of calcareous nannofossil assemblages and their phyllogenic link-up excludes the possibility of the absence of certain zones due to a longer discontinuation of the sedimentation. Some species are absent probably due to specific paleoecologic and paleogeographic conditions in the sedimentary basin.

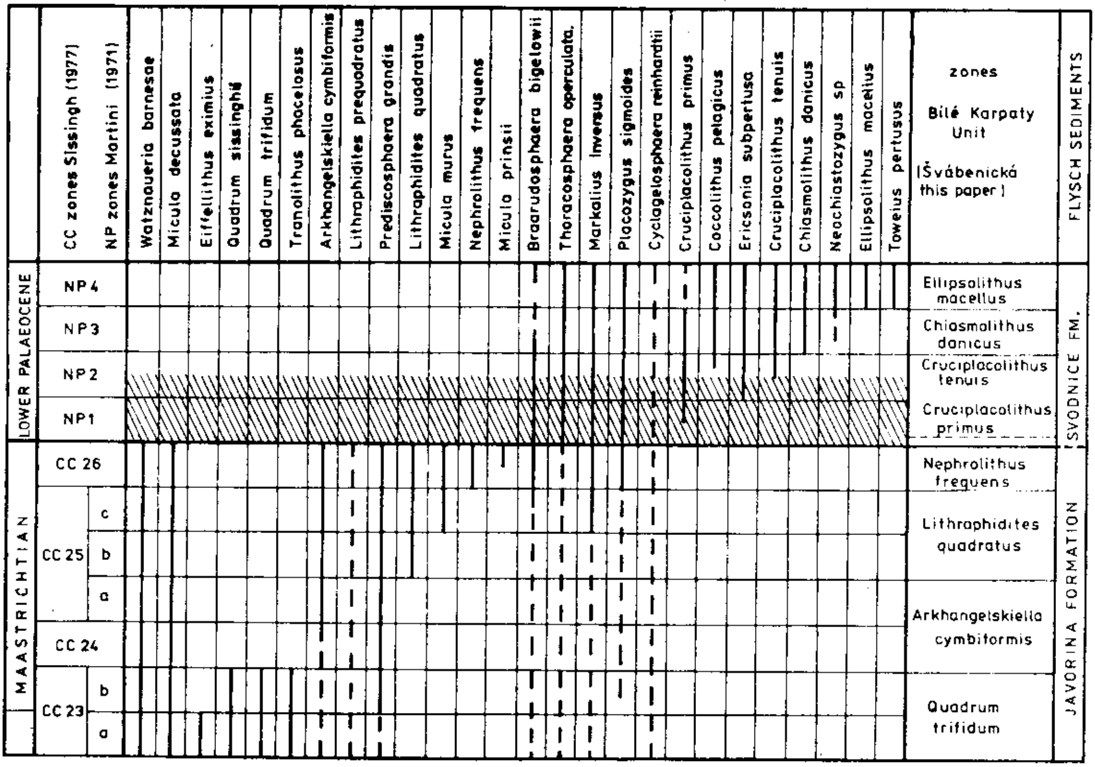


1. Distribution of stratigraphically important calcareous nannofossil species in the sediments of the Bílé Karpaty Unit

In the Paleogene of the Svodnice Formation a gradual qualitative and quantitative evolution of calcareous nannofossil assemblages from the lower Paleocene to the lower Eocene within the Zones NP1—NP2 through NP11 (sensu M a r t i n i 1971), took place. Nannofossil associations precisely identical with the NP1 Zone, with mass occurrence of *Markalius inversus* and *Thoracosphaera* sp. (sensu G a š p a r i k o v á



2. Calcareous nannofossil zones in the flysch sediments of the Bílé Kapaty Unit



3. Distribution of calcareous nannofossils on the Cretaceous-Tertiary boundary in the sediments of the Bílé Karpaty Unit

in S a l a j et al. 1978) have not been found yet in the sediments of the Bílé Karpaty Unit.

According to the micropaleontologic data from the sediments of the outer development of the Bílé Karpaty Unit we may expect flysch sedimentation without significant interruption at the Cretaceous/Tertiary boundary. *Lithraphidites quadratus* of the CC25b Zone and *Nephrolithus frequens* of the CC26 Zone (sensu S i s s i n g h 1977) were documented from the upper Maastrichtian and already in the lower Paleocene the Zones NP1—NP2 and NP3 with *Cruciplacolithus primus* (large and small form), *C. tenuis*, abundant occurrence of *Thoracosphaera operculata, Markalius inversus, Ericsonia subpertusa,* etc. — see text-fig. 3 — were found.

In the Bílé Karpaty Unit the species *Braarudosphaera bigelowii, Markalius inversus, Thoracosphaera operculata, Placozygus sigmoides* and *Cyclagelosphaera reinhardtii* (text-fig. 2) pass from the Cretaceous into the Tertiary.

Nannoplankton zones of the Cretaceous in the Javorina Formation

Aspidolithus parcus Biozone

In the Bílé Karpaty Unit the Aspidolithus parcus Zone can be presented as the zone of a partial extent of the taxon from the first occurrence of *Aspidolithus* ex gr.*parcus* (Stradner) Noel to the first occurrence of *Ceratolithoides aculeus* (Stradner) Prins and Sissingh.

Discussion: Sissingh (1977) introduced two zones in the lower Campanian: CC18 Aspidolithus parcus and CC19 Calculites ovalis. The boundary between these two zones is defined by the last occurrence of *Marthasterites furcatus*. Roth (1978) and Doeven (1983) define only the Zone Broinsonia parca in the lower Campanian, from the first occurrence of *Broinsonia parca* (synonym of *Aspidolithus parcus*) up to the first occurrence of *Ceratolithoides aculeus*. According to Perch-Nielsen (*in* Bolli et al. 1985) the interval in which *Aspidolithus parcus* occurs together with *Marthasterites furcatus* is short and frequently even absent.

In the sediments of the Bílé Karpaty Unit only single specimens of *Marthasterites furcatus* were found, mostly as an element redeposited into the Paleogene. For this reason the last occurrence of *Marthasterites furcatus* cannot be used for the boundary of the CC18/CC19 Zones and thus for delimiting the CC19 Zone Calculites ovalis.

In the Czechoslovak Carpathians, Broinsonia parca Biozone was delimited by Gašpariková (*in* Andrusov - Samuel 1983) and correlated with the foraminiferal zone of *Globotruncana arca* (lower Campanian) in the Čorštýn Unit of the Klippen Belt, in the Manín "series" and Myjavská pahorkatina hills.

Ceratolithoides aculeus Biozone

Definition: The interval from the first occurrence of *Ceratolithoides aculeus* (Stradner) Prins and Sissingh to the first occurrence of *Quadrum sissinghii* Perch-Nielsen.

Authors: Čepek - Hay (1969), emend. Martini (1976), nom. corr. Perch-Nielsen.

Age: Upper part of the lower Campanian.

Remark: In the Bílé Karpaty Unit this biozone is widespread in the flysch development of the Javorina Formation and in variegated beds. From this zone comes the first occurrence of *Placozygus sigmoides* which passes from the Cretaceous to the Tertiary in the sediments of the Bílé Karpaty Unit.

In the Czechoslovak Carpathians the Tetralithus aculeus Zone (synonym of *Ceratolithoides aculeus*) is described from the Čorštýn Unit of the Klippen Belt and from the Myjavská pahorkatina hills and correlated with the foraminiferal zone of *Globotruncana rugosa.* Its basement is formed by the Broinsonia parca Zone and overlying strata by the Lithraphidites quadratus Zone (Gašpariková *in* Andrusov - Samuel 1983).

Quadrum sissinghii Biozone

Definition: The interval from the first occurrence of *Quadrum sissinghii* Perch-Nielsen [synonym of *Quadrum nitidum* (Martini) Prins and Perch-Nielsen] to the first occurrence of *Quadrum trifidum* (Stradner) Prins and Perch-Nielsen.

Authors: Sissingh (1977), nom. corr. Perch-Nielsen (*in* Bolli et al. 1985).

Age: Lower part of the upper Campanian.

Remark: Sissingh used the stratigraphic range of *Ceratolithoides arcuatus* Prins and Sissingh for dividing the Quadrum sissinghii Zone into three subzones. However, in the sediments of the Bílé Karpaty Unit this species was not found.

Up to the present, this biozone has not been reported from the Czechoslovak Carpathians.

Quadrum trifidum Biozone

In the Bílé Karpaty Unit this zone is comprehended as the zone of a complete range of the taxon with stratigraphic age from the upper part of the upper Campanian through the lower part of the lower Maastrichtian.

Discussion: Sissingh (1977) determined two zones in the interval of the upper part of the upper Campanian through the lower part of the lower Maastrichtian: CC22 Quadrum trifidum and CC23 Tranolithus phacelosus. He defined the boundary of these zones by the last accurrence of *Reinhardtites anthophorus.* The upper part of the CC23 Zone is delimited by the last occurrence of *Tranolithus phacelosus.* Since *Reinhardtites anthophorus* occurs irregularly in the Campanian nannofossil assemblages of the sediments of the Bílé Karpaty Unit, its last occurrence is not suitable for delimiting the boundary of the CC22/CC23 Zones.

According to Perch-Nielsen (*in* Bolli et al. 1935) the last occurrence of the species *Quadrum sissinghii* and *Quadrum trifidum* is identical with the last occurrence of stratigraphically common marker *Tranolithus phacelosus* (sensu Sissingh 1977). Both representatives of the genus *Quadrum* form a conspicuous horizon in the sediments of the Bílé Karpaty Unit. Therefore it is advantageous to use besides *Tranolithus phacelosus* also the last occurrence of *Quadrum sissinghii* and *Quadrum trifidum* for stratigraphic division of these sediments.

The Tetralithus trifidus Zone is reported by Gašpariková (1984) from the lower Maastrichtian of the Czechoslovak Carpathians and it is correlated with the foraminiferal zone of *Globotruncana falsostuarti.*

Arkhangelskiella cymbiformis Biozone

In the Bílé Karpaty Unit the Arkhangelskiella cymbiformis Biozone represents an interval zone from the last occurrence of *Quadrum sissinghii* Perch-Nielsen and *Quadrum trifidum* (Stradner) Prins and Perch-Nielsen to the first occurrence of *Lithraphidites quadratus* Bramlette and Martini.

Disucussion: The CC24 Reinhardtites levis Biozone (sensu Sissingh 1977) defined as the interval from the last occurrence of *Tranolithus phacelosus* to the last occurrence of *Reinhardtites levis* cannot be used in the sediments of the Bílé Karpaty Unit. According to Perch-Nielsen (*in* Bolli et al. 1985) the last occurrence of *Tranolithus phacelosus* is roughly identical with the last occurrence of *Quadrum sissinghii* and *Q. trifidum.* A typical *Reinhardtites levis* was not determined under light microscope.

Perch-Nielsen (1972) emend. Sissingh (1977) defined the CC25 Arkhangelskiella cymbiformis Zone as the interval from the last occurrence of *Reinhardtites levis* to the first occurrence of *Nephrolithus frequens.* The CC24 and CC25 Zones are unfit for zoning of the lower Maastrichtian sediments of the Bílé Karpaty Unit.

Remark: The assemblages of the Arkhangelskiella cymbiformis Zone of the Bílé Karpaty Unit sediments rarely exhibit *Prediscosphaera grandis* Perch-Nielsen and very rarely *Lithraphidites praequadratus* Roth. In this zone *Microrhabdulus decoratus* is relatively abundant and the species *Eiffellithus eximius, Tranolithus phacelosus, Quadrum sissinghii* and *Q. trifidum* are already absent.

This zone has not been reported yet from the Czechoslovak Carpathians.

Lithraphidites quadratus Biozone

In the Bílé Karpaty Unit the Lithraphidites quadratus Zone can be defined as the zone of a partial taxon range from the first occurrence of *Lithraphidites quadratus* Bramlette and Martini to the first occurrence of *Nephrolithus frequens* Górka. In the upper part of the Lithraphidites quadratus Zone the Subzone Micula murus can be delimited from the first occurrence of *Micula murus* (Martini) Bukry to the first occurrence of *Nephrolithus frequens* Górka.

Discussion: In the upper Maastrichtian Sissingh (1997) defines the interval from the first occurrence of *Lithraphidites quadratus* to the first occurrence of *Micula murus* as the Subzone b of the interval Zone CC25 Arkhangelskiella cymbiformis. The onset of the taxon *Lithraphidites quadratus* is conspicuous in the Bílé Karpaty Unit. *Micula murus* is rare in the sediments, however also this species can be employed for a detailed stratigraphic division in the upper Maastrichtian.

In the Czechoslovak Carpathians the Lithraphidites quadratus Biozone was described by Gašpariková from the Klippen Belt of the Čorštýn Unit and from the Manín "series" and correlated with the foraminiferal zone of *Racemiguembelina varians* s.l. (Gašpariková 1984).

Nephrolithus frequens Biozone

Definition: The interval from the first to the last occurrence of *Nephrolithus frequens* Górka, i.g. up to the disappearance of majority of calcareous nannofossil species at the Cretaceous/Tertiary boundary.

Authors: Čepek and Hay (1969).

Age: Upper Maastrichtian.

Remark: This species was determined both in the variegated and flysch sediments of the Bílé Karpaty Unit. A high species diversity is typical of the calcareous nannofossil taphocenoses of this interval. The nominal species of the zone, *Nephrolithus frequens,* occurs in relatively small number in the assemblages. *Micula prinsii* which was reported only from the upper part of the CC26 Zone by Perch-Nielsen (*in* Bolli et al. 1985) was sporadically found. Nannofossil associations of this zone exhibit species which pass from the Cretaceous to the Tertiary (sensu Perch-Nielsen *in* Bolli et al., 1985) and were also established in the Paleocene of the Bílé Karpaty Unit in the Svodnice Formation: *Placozygus sigmoides, Markalius inversus, Cyclagelosphaera reinhardtii, Braarudosphaera bigelowii* and *Thoracosphaera operculata* (text-figs. 2, 3).

In the Czechoslovak Carpathians the Nephrolithus frequens Zone is reported from the Manín "series" in the Žilina area where it represents the upper Maastrichtian and corresponds with the foraminiferal zone of *Abathomphalus mayaroensis*. From its overlying strata the first Paleogene Zone NP1 Markalius inversus was described (G a š p a r i k o v á *in* A n d r u s o v - S a m u e l 1983).

Paleogene nannoplankton zones of the Svodnice Formation

Cruciplacolithus primus Biozone

In the Bílé Karpaty Unit the presence of *Cruciplacolithus primus* P e r c h - N i e l s e n (small form) is characteristic of this interval even before the onset of *Cruciplacolithus tenuis* (S t r a d n e r) H a y and M o h l e r.

D i s c u s s i o n: Calcareous nannofossil assemblage precisely corresponding to the description of the NP1 Markalius inversus Zone (H a y - - M o h l e r *in* H a y 1967) was not determined in the sediments of the Bílé Karpaty Unit. The studied material showed no *Biantholithus sparsus* B r a m l e t t e and M a r t i n i. None of the samples contained mass representation of *Markalius inversus* and *Thoracosphaera operculata* as described by G a š p a r i k o v á (*in* S a l a j et al. 1978) from the Paleogene of the Klippen Belt.

R e m a r k: In the Svodnice Formation, assemblage of calcareous nannofossils with *Cruciplacolithus primus* was determined solely in flysch sediments with prevalence of sandstone — the so called Vlára type. Both small and big forms of *Cruciplacolithus primus* still without the typical *Cruciplacolithus tenuis* in association with *Markalius inversus, Thoracosphaera operculata, Placozygus sigmoides* and *Ericsonia subpertusa* were determined in these strata.

The zone with this assemblage has not been described so far from the Czechoslovak Carpathians.

For dating of the superlying Paleogene sediments of the Bílé Karpaty Unit in the interval of the NP2 Cruciplacolithus tenuis Zone through the NP11 Discoaster binodosus Zone, M a r t i n i 's zonation (1971) can be used in its full extent.

Systematic part

Systematic classification of calcareous nannofossils and their stratigraphic distribution are took over from P e r c h - N i e l s e n (*in* B o l l i et al. 1985).

Calcareous nannoplankton of the Cretaceous

Class *Coccolithophyceae* Rothmaler 1951

Family *Ahmuellerellaceae* Reinhardt (1965)

Genus *Ahmuellerella* Reinhardt 1964

Ahmuellerella octoradiata (Górka) Reinhardt
Pl. II, fig. 3—5

1957 *Discolithus octoradiatus* sp. n.; Górka, p. 259, pl. 4, fig. 10.
1963 *Zygolithus octoradiatus* (Górka) comb. nov.; Stradner, p. 180, pl. 5, fig. 2.
1966 *Ahmuellerella octoradiata* (Górka) comb. nov.; Reinhardt, p. 24, pl. 22, figs. 3, 4.
1969 *Vagalapilla octoradiata* (Górka) comb. nov.; Bukry, p. 58, pl. 33, figs. 5—7.

Distribution: Upper Cenomanian to Maastrichtian, CC9—CC26.

Genus *Vagalapilla* Bukry 1969

Vagalapilla matalosa (Stover) Thierstein
Pl. I, figs. 1—4

1966 *Coccolithus matalosus* sp. n.; Stover, p. 139, pl. 2, figs. 1, 2; pl. 8, fig. 10.
1971 *Staurolithite matalosus* (Stover) Čepek - Hay; Manivit, p. 84, pl. 24, figs. 6—10.
1981 *Vagalapilla matalosa* (Stover) Thierstein; Smith (cum synonymy), p. 75, tab. 14, figs. 1—13.
1982 *Vekshinella matalosa* (Stover) comb. nov.; Hanzlíková, Krhovský, Švábenická, p. 145, pl. 6, figs. 15, 16.

Distribution: Albian to lower Maastrichtian.

Genus *Vekshinella* Loeblich - Tappan 1963

Vekshinella crux (Deflandre - Fert) Shafik - Stradner
Pl. II, figs. 1, 2.

1954 *Discolithus crux* sp. n.; Deflandre - Fert, p. 143, pl. 14, fig. 4; text-fig. 55.
1971 *Vekshinella crux* (Deflandre - Fert) comb. nov.; Shafik - Stradner, pl. 39, figs. 1—4.

Distribution: Albian to Maastrichtian.

Family *Arkhangelskiellaceae* Bukry 1969

Genus *Arkhangelskiella* Vekshina 1959

Arkhangelskiella cymbiformis Vekshina
Pl. III, figs. 22, 23; pl. IV, figs. 13—15

1959 *Arkhangelskiella cymbiformis* sp. n.; Vekshina, p. 66 (partim), pl. 1, fig. 1; pl. 2, fig. 3 (non fig. 4).

1969 *Arkhangelskiella cymbiformis* Vekshina; Bukry, p. 21, pl. 1, figs. 1—3.
non 1981 *Arkhangelskiella cymbiformis* Vekshina; Smith, p. 28, pl. 1, figs. 16—34.

Remark: Under light microscope it shows strikingly large and morphologically conspicuous placoliths. In the central field in each quadrant *A. cymbiformis* exhibits five or less perforations situated along sutures. Sutures are parallel with the ellipse axes.

Distribution: Campanian to Maastrichtian, CC21a—CC25a rare, CC25b—CC26 frequent.

Arkhangelskiella specillata Vekshina

Pl. II, fig. 21; pl. III, figs. 20, 21

1959 *Arkhangelskiella specillata* sp. n.; Vekshina, p. 67, pl. 2, fig. 5.
1983 *Arkhangelskiella specillata* Vekshina; Doeven, p. 48, pl. 2, fig. 4.

Remark: Suture in the central field is parallel with the longer axis of elliptic disc, shorter suture is declined by 10° clockwise from the shorter ellipse axis. Disc margin is narrower than in *A. cymbiformis*. Doeven (1983) describes the following morphological differences from *A. cymbiformis:* 1) narrower disc margin, 2) oblique sutures in the central field, 3) greater number of perforations along suture margins.

Distribution: Upper part of the lower Campanian to Maastrichtian.

Genus *Aspidolithus* Noël 1969

Aspidolithus parcus constrictus (Hattner, Wind-Wise) Perch-Nielsen

Pl. IV, figs. 6, 7, 9, 10

1964 *Arkhangelskiella parca* Stradner; Bramlette-Martini, p. 298, pl. 1, figs. 1, 2.
1966 *Arkhangelskiella cymbiformis* Vekshina; Stover, p. 137 (partim), pl. 1, fig. 17 (non fig. 18).
1969 *Broinsonia parca* (Stradner) comb. nov.; Bukry, p. 23 (partim), pl. 3, figs. 3, 4 (non figs. 5—10).
1969 *Aspidolithus parcus* (Stradner) com. nov.; Noël, p. 196, pl. 1, figs. 3, 4.
1980 *Broinsonia parca constricta* ssp. n.; Hattner-Wind-Wise, p. 59, pl. 6, figs. 7—10; pl. 7, figs. 1—9.
1984a *Aspidolithus parcus constrictus* (Hattner-Wind-Wise) comb. nov.; Perch-Nielsen, p. 43.

Remark: *A. parcus constrictus* exhibits a characteristic structure of corpuscle — large, broadly oval placolith with conspicuously small central field which is very expressive in the crossed nicols. In the sediments of the Bílé Karpaty Unit it is abundant in the Campanian and rare in the lower Maastrichtian.

Distribution: Lower Campanian up to the Campanian/Maastrichtian boundary, CC18b—CC23a.

Aspidolithus parcus parcus (Stradner) Noël

Pl. IV, fig. 11; pl. V, figs. 1, 2

1963 *Arkhangelskiella parca* sp. n.; Stradner, p. 10, pl. 1, fig. 3.

1968 *Arkhangelskiella magnacava* sp. n.; Gartner, p. 38, pl. 18, fig. 25; pl. 22, fig. 9.

1969 *Broinsonia parca* (Stradner) comb. nov.; Bukry, p. 23 (partim), pl. 3, figs., 5, 6, 7 (non figs. 3, 4, 8—10).

1985 *Aspidolithus parcus parcus* (Stradner) Noël; Perch-Nielsen (*in* Bolli et al. 1985), p. 354, pl. 16, fig. 8; pl. 17.

Remark: *A. parcus parcus* corpuscles have a larger central field with more perforations than *A. p. constrictus.* In the lower Campanian sediments of the Bílé Karpaty Unit we may observe transgressive forms between *A. p. parcus* and *A. p. constrictus.*

Distribution: Lower Campanian, CC18a—CC19a.

Genus *Broinsonia* Bukry 1969

Broinsonia ex gr. enormis (Shumenko) Manivit

Pl. I, figs. 5. 9, 10

1968 *Arkhangelskiella enormis* sp. n.; Shumenko, p. 33 (partim), pl. 1, figs. 2, 3 (non fig. 1).

1969 *Broinsonia bevieri* sp. n.; Bukry, p. 21, pl. 1, figs. 8—10.

1971 *Broinsonia enormis* (Shumenko) comb. nov.; Manivit, p. 105, pl. 1, figs. 18—20.

Remark: In the sediments of the Bílé Karpaty Unit it sporadically occurs in the lower Campanian. Corpuscles of the genus *Broinsonia* are smaller than representatives of the genera *Aspidolithus* or *Arkhangelskiella.*

Distribution: Turonian to lower Campanian (Perch-Nielsen 1979).

Genus *Gartnerago* Bukry 1969

Gartnerago obliquum (Stradner) Reinhardt

Pl. IV, figs. 1—4

1963 *Arkhangelskiella obliqua* sp. n.; Stradner, p. 176, pl. 1, fig. 2.
1966 *Discolithus segmentatus* sp. n.; Stover, p. 143, pl. 3, figs. 3—6; pl. 8, fig. 19.
1980 *Gartnerago obliquum* (Stradner) Reinhardt; Hattner - Wise (cum synonymy), p. 63, pl. 18, figs. 2—9; pl. 19, fig. 1; pl. 40, fig. 1, 4.

Distribution: Lower Turonian to Maastrichtian.

Genus *Kamptnerius* Deflandre 1959

Kamptnerius magnificus Deflandre
Pl. II, fig. 22; pl. V, figs. 14—16

1959 *Kamptnerius magnificus* sp. n.; Deflandre, p. 135, pl. 1, figs. 1—4.
1981 *Kamptnerius magnificus* Deflandre; Smith (cum synonymy), p. 49, pl. 8, figs. 1—11.

Remark: In the sediments of the Bílé Karpaty Unit it occurs rarely and poorly preserved (frequently with broken off flag-like margin which is typical of this genus).
Distribution: Turonian to Maastrichtian.

Family *Biscutaceae* Black 1971

Genus *Biscutum* Black in Black - Barnes 1959

Biscutum constans (Górka) Black
Pl. III, figs. 4—6

1957 *Discolithus constans* sp. n.; Górka, p. 279, pl. 4, fig. 7.
1976 *Biscutum constans* (Górka) Black; Hill (cum synonymy), p. 123, pl. 1, figs. 32—37; pl. 13, figs. 2—4.

Distribution: Albian to Maastrichtian (Cretaceous/Tertiary boundary, ? Paleocene).

Family *Braarudosphaeraceae* Deflandre 1947

Genus *Braarudosphaera* Deflandre 1947

Braarudosphaera bigelowii (Gran - Braarud) Deflandre
Pl. V, figs. 10—13; pl. VII, figs. 11, 12

1935 *Pontosphaera bigelowi* sp. n.; Gran - Braarud, p. 388, pl. 67.
1947 *Braarudosphaera bigelowi* (Gran - Braarud) comb. nov.; Deflandre, p. 439, figs. 1—5.

Remark: In the Bílé Karpaty Unit it is rare. A relatively more frequent occurrence can be observed in the upper Maastrichtian in rich assemblages with *Nephrolithus frequens* and in the lower Paleocene in associations poor in species and quantity, with *Placozygus sigmoides, Markalius inversus* and *Cruciplacolithus primus.*

Distribution: Cenomanian to Recent.

Family *Calyptrosphaeraceae* Bourdeaux-Hay 1969

Genus *Lucianorhabdus* Deflandre 1959

Lucianorhabdus cayeuxii Deflandre

Pl. VII, fig. 13—15

1959 *Lucianorhabdus cayeuxii* sp. n.; Deflandre, p. 142, pl. 4, figs. 11—25.
1983 *Lucianorhabdus cayeuxii* Deflandre; Doeven, pl. 4, fig. 7.

Remark: In the sediments of the Bílé Karpaty Unit it occurs rarely compared to the Senonian of the central Europe boreal region. In literature a theory was presented that the genera *Calculites* and *Lucianorhabdus* could be only one genus because the oval corpuscles of the genus *Calculites* are in fact basal parts of lengthened holococcoliths of the genus *Lucianorhabdus* (e.g. *in* Wind-Wise 1977, Perch-Nielsen 1979). However, the investigation of the sediments of the Bílé Karpaty Unit did not corroborate this opinion. In the Campanian and Maastrichtian samples, *Calculites obscurus* is abundant but representatives of the genus *Lucianorhabdus* are very rare.

Distribution: Upper Santonian to Maastrichtian, CC16—CC26.

Genus *Calculites* Prins-Sissingh in Sissingh 1977

Calculites obscurus (Deflandre) Prins-Sissingh

Pl. II, figs. 18, 19

1959 *Tetralithus obscurus* sp. n.; Deflandre, p. 138, pl. 3, figs. 26—29.
1977 *Calculites obscurus* (Deflandre) comb. nov.; Prins-Sissingh (in Sissingh 1977), p. 60.
1979 *Phanulithus obscurus* (Deflandre) Wind-Wise; Perch-Nielsen, p. 249, fig. 18.

Distribution: Santonian/Campanian boundary up to the Maastrichtian, CC17—CC24 (occasionally up to CC25c).

Calculites ovalis (Stradner) Prins-Sissingh

1963 *Tetralithus ovalis* sp. n.; Stradner, p. 12, pl. 6, fig. 7.
1977 *Calculites ovalis* (Stradner) comb. nov.; Prins-Sissingh (*in* Sissingh 1977), p. 60.

1977 *Phanulithus ovalis* (Stradner) comb. nov.; Wind - Wise (*in* Wise - - Wind 1977), p. 304, pl. 34, fig. 1.

Remark: In the Bílé Karpaty Unit we can observe rare occurrence of this species in the lower Campanian, however, more frequent are transitional forms between *Calculites ovalis* and *C. obscurus*. *Calculites ovalis* occurs in association with *Aspidolithus parcus parcus;* this species has not been found yet in association with *Ceratolithoides aculeus.*

Distribution: Upper Coniacian to lower Campanian, CC14—CC19. Sediments of the boreal development of the Bohemian Cretaceous Basin exhibit *Calculites ovalis* already in the Turonian.

Family *Chiastozygaceae* Road, Hay - Barnard 1973

Genus *Chiastozygus* Gartner 1968

Chiastozygus litterarius (Górka) Manivit

Pl. IV, fig. 5; pl. VI, figs. 2—5

1957 *Discolithus litterarius* sp. n.; Górka, p. 251, pl. 3, fig. 3.
1971 *Chiastozygus litterarius* (Górka) comb. nov.; Manivit, p. 92 (partim), pl. 4, figs. 1—3 (non figs. 4, 5).

Distribution: Lower Aptian to Maastrichtian.

Family *Eiffellithaceae* Reinhardt 1965

Genus *Eiffellithus* Reinhardt 1965

Eiffellithus eximius (Stover) Perch-Nielsen

Pl. I, figs. 16, 17, 21, 22

1966 *Clinorhabdus eximius* sp. n.; Stover, p. 138, pl. 2, figs. 15, 16; pl. 8, fig. 15.
1968 *Eiffellithus eximius* (Stover) comb. nov.; Perch-Nielsen, p. 30, pl. 3, figs. 8—10; text-fig. 5d.

Remark: In the Bílé Karpaty Unit it commonly occurs in the Campanian. In the upper part of the Campanian a quantitative decrease was observed, in the Maastrichtian this genus is rare (redeposition from the Campanian?).

Distribution: Upper Turonian to the Campanian/Maastrichtian boundary, CC12—CC23a.

Eiffellithus trabeculatus (Górka) Reinhardt - Górka

Pl. II, figs. 16, 17

1957 *Discolithus trabeculatus* sp. n.; Górka, p. 277, pl. 3, fig. 9.

1967 *Eiffellithus trabeculatus* (Górka) comb. nov.; Reinhardt - Górka, p. 25, pl. 31, figs. 19, 23; pl. 32, fig. 1.

Distribution: Turonian to Maastrichtian.

Eiffellithus turriseiffeli (Deflandre) Reinhardt

Pl. I, figs. 18—20; pl. XII, fig. 2

1954 *Zygolithus turriseiffeli* sp. n.; Deflandre (*in* Deflandre - Fert), p. 149, pl. 13, figs. 15, 16.

1965 *Eiffellithus turriseiffeli* (Deflandre) comb. nov.; Reinhardt, p. 32, 35.

Distribution: Upper Cenomanian to upper Maastrichtian, CC9—CC26.

Family *Ellipsagelosphaeraceae* Noël 1965

Genus *Cyclagelosphaera* Noël 1965

Pl. III, figs. 7—9

Remark: Under light microscope *C. reinhardtii* is poorly distinguishable from *C. margerelii.* According to Perch-Nielsen (*in* Bolli et al. 1985) *C. reinhardtii* has a relatively short stratigraphic range from the upper Senonian to Paleocene and coincides with the distribution of *C. margerelii.* In the Bílé Karpaty Unit specimens of the genus *Cyclagelosphaera* occur sporadically in the Upper Cretaceous sediments and very rarely in the Paleogene. It cannot be determined precisely whether in the Paleogene it is a redeposited or autochthonous element because it always occurs with redeposited elements from the Upper Cretaceous.

Distribution: Jurassic to Paleogene.

Genus *Ellipsagelosphaera* Noël 1965

Ellipsagelosphaera britannica (Stradner) Perch-Nielsen

Pl. III, fig. 15

1963 *Coccolithus britannicus* sp. n.; Stradner, p. 10, pl. 1, fig. 7.

1968 *Ellipsagelosphaera britannica* (Stradner) comb. nov.; Perch-Nielsen, p. 71.

Distribution: Upper Liassic to Campanian.

Genus *Manivitella* Thierstein 1971

Manivitella pemmatoidea (Deflandre) Thierstein

Pl. V, figs. 17—19

1965 *Cricolithus pemmatoideus* sp. n.; Deflandre (*in* Manivit 1965), p. 192, pl. 2, fig. 8.
1971 *Manivitella pemmatoidea* (Deflandre ex Manivit) comb. nov.; Thierstein, p. 480, pl. 5, figs. 1—3.
1984 *Manivitella pemmatoidea* (Deflandre) Thierstein; Stradner-Steinmetz, p. 597, pl. 28, figs. 1—6.

Remark: Corpuscles form a broadly oval placolith with en empty great central field. Under polarized light this species can be well determined even from fragments according to saw-toothed inner element cycle.

Distribution: Berriasian to Maastrichtian.

Genus *Markalius* Bramlette-Martini 1964

Markalius inversus (Deflandre) Bramlette-Martini

Pl. V, figs. 6, 7; pl. VIII, figs. 4, 5; pl. X, figs. 7, 8

1954 *Cyclococcolithus leptoporus* Murray-Blackman var. *inversus* v. n.; Deflandre (*in* Deflandre-Fert 1954), p. 150 (partim), pl. 9, figs. 4, 5 (non figs. 6, 7).
1964 *Markalius inversus* (Deflandre) comb. nov.; Bramlette-Martini, p. 302, pl. 2, figs. 4—9; pl. 7, fig. 2.

Distribution: Albian to lower Paleocene (Danian).

Genus *Watznaueria* Reinhardt 1964

Watznaueria barnesae (Black) Perch-Nielsen

Pl. III, figs. 12—14

1959 *Tremalithus barnesae* sp. n.; Black (*in* Black-Barnes 1959), p. 325, pl. 9, figs. 1, 2.
1968 *Watznaueria barnesae* (Black) comb. nov.; Perch-Nielsen, p. 69, pl. 22, figs. 1—7; pl. 23, figs. 1, 4, 5, 16.

Remark: *Watznaueria barnesae* is the main component of the Campanian and Maastrichtian nannofossil assemblages in the Bílé Karpaty Unit. In the Maastrichtian a quantitative decrease of this species and an increase of *Micula decussata* can be observed. A similar phenomenon was described by Doeven (1983). Structure of the corpuscle is solid and massive. That is why *W. barnesae* is found even in sediments with unfavourable genesis for preservation of calcareous nannofossils. In poorly preserved material it is found in association with *Micula decussata*, representatives of the genus *Eiffellithus, Prediscosphaera* and *Reinhardtites*.

Distribution: Middle Jurassic to Maastrichtian.

Family *Microrhabdulaceae* Deflandre 1963

Genus *Lithraphidites* Deflandre 1963

Lithraphidites carniolensis Deflandre

Pl. IV, fig. 5; pl. XII, fig. 1

1963 *Lithraphidites carniolensis* sp. n.; Deflandre, p. 3486, figs. 1—8.

Distribution: Berriasian to Maastrichtian, CC1—CC26.

Lithraphidites praequadratus Roth

1978 *Lithraphidites praequadratus* sp. n.; Roth, p. 749, pl. 3, figs. 1—4.
1980 *Lithraphidites praequadratus* Roth; Hattner - Wise, p. 64, pl. 21, figs. 5—8; pl. 41, figs. 10—12.

Remark: In the Bílé Karpaty Unit it is very rare. In poorly preserved (fretted) material it is difficult to decide which specimen belongs to *L. carniolensis* and which to *L. praequadratus*.

Distribution: Campanian to Maastrichtian, CC17—CC26.

Lithraphidites quadratus Bramlette - Martini

Pl. III, figs. 1—3

1964 *Lithraphidites quadratus* sp. n.; Bramlette - Martini, p. 310, pl. 6, figs. 16, 17; pl. 7, fig. 8.
1983 *Lithraphidites quadratus* Bramlette - Martini; Doeven, pl. 3, figs. 8, 9; pl. 6, figs. 5, 6.

Remark: This morphologically significant holococcolith forms a conspicuous component of the upper Maastrichtian calcareous nannoplankton assemblages in the Bílé Karpaty Unit.

Distribution: Upper Maastrichtian, CC25b—CC26.

Genus *Microrhabdulus* Deflandre 1959

Microrhabdulus belgicus Hay - Towe

Pl. VII, figs. 9, 10

1963 *Microrhabdulus belgicus* sp. n.; Hay - Towe, p. 95, pl. 1.

Distribution: Upper Cenomanian to upper Maastrichtian, upper part of CC10—CC24, rarely CC26.

Microrhabdulus decoratus Deflandre

Pl. VII, figs. 7, 8

1959 *Microrhabdulus decoratus* sp. n.; Deflandre, p. 140, pl. 4, figs. 1—5.

R e m a r k : In the Bílé Karpaty Unit it is remarkably frequent in the Maastrichtian in association with representatives of the genera *Arkhangelskiella* and *Lithraphidites quadratus*.

D i s t r i b u t i o n : Upper Cenomanian to lower Maastrichtian, sporadically upper Maastrichtian; CC10—CC23—CC26.

Family *Nannoconaceae* D e f l a n d r e 1963

Genus *Nannoconus* K a m p t n e r 1931

Nannoconus elongatus B r ö n n i m a n n

Pl. V, figs. 8, 9

1955 *Nannoconus elongatus* sp. n.; B r ö n n i m a n n , p. 38, pl. 1, figs. 10—14; text-fig. 2v—y.

R e m a r k : In the Bílé Karpaty Unit the representatives of the genus *Nannoconus* were found only as single specimens in the Campanian and as a redeposited element in the Paleocene.

D i s t r i b u t i o n : Barremian to lower Campanian.

Nannoconus farinacciae B u k r y

Pl. V, fig. 3

1969 *Nannoconus farinacciae* sp. n.; B u k r y , p. 67, pl. 40, figs. 9—12.

R e m a r k : In the Bílé Karpaty Unit *N. farinacciae* was found only as a redeposited element in the Paleogene of the Svodnice Formation.

D i s t r i b u t i o n : Santonian.

Family *Podorhabdaceae* N o ë l 1965

Genus *Cretarhabdus* B r a m l e t t e - M a r t i n i 1964

Cretarhabdus conicus B r a m l e t t e - M a r t i n i

Pl. VI, figs. 15—18

1964 *Cretarhabdus conicus* sp. n.; B r a m l e t t e - M a r t i n i , p. 299, pl. 3, figs. 5—8.
1981 *Cretarhabdus conicus* B r a m l e t t e - M a r t i n i ; S m i t h , p. 35 (cum synonymy), pl. 2, figs. 37—48; pl. 3, figs. 1—19.

D i s t r i b u t i o n : Berriasian to Maastrichtian.

Genus *Cribrosphaerella* D e f l a n d r e in P i v e t e a u 1952

Cribrosphaerella ehrenbergii (A r k h a n g e l s k y) D e f l a n d r e

Pl. I, figs. 6—8; pl. VI, fig. 19

1912 *Cribrosphaera ehrenbergi* sp. n.; Arkhangelsky, p. 412, pl. 6, figs. 19, 20.
1981 *Cribrosphaerella ehrenbergii* (Arkhangelsky) Deflandre; Smith, p. 39, pl. 4, figs. 18—42.

Remark: In the Bílé Karpaty Unit this species has a broad variation range from almost circular forms to oval shape and includes also corpuscles which are smaller and exhibit parallel wider sides of the oval. Smaller forms with parallel sides were found especially in the Maastrichtian.

Distribution: Albian to Maastrichtian.

Genus *Nephrolithus* Górka 1957

Nephrolithus frequens Górka

1957 *Nephrolithus frequens* sp. n.; Górka, p. 282, pl. 5, fig. 7.
1966 *Nephrolithus gorkae* sp. n.; Åberg, p. 65, pl. 1, figs., 1—5; pl. 3, figs. 1—5; text-fig. 1.
1983 *Nephrolithus frequens* Górka; Doeven, pl. 3, figs. 10, 11.

Remark: In the Bílé Karpaty Unit it is found only as single specimens.

Distribution: Upper Maastrichtian, CC26.

Genus *Stradneria* Reinhardt 1964

Stradneria crenulata (Bramlette - Martini) Noël
Pl. VI, figs. 12—14

1964 *Cretarhabdus crenulatus* sp. n.; Bramlette - Martini, p. 300, pl. 2, figs. 21—24.
1985 *Stradneria crenulata* (Bramlette - Martini) Noël; Perch-Nielsen (*in* Bolli et al. 1985), p. 385, pl. 8, figs. 88, 89; pl. 51, fig. 25.

Distribution: Berriasian to Maastrichtian, CC2—CC26.

Family *Polycyclolithaceae* Forchheimer 1972

Genus *Eprolithus* Stover 1966

Eprolithus floralis (Stradner) Stover
Pl. III, figs. 16, 17

1962 *Lithastrinus floralis sp. n.;* Stradner, p. 370, pls. 6—11.
1966 *Eprolithus floralis* (Stradner) comb. nov.; Stover, p. 149, pl. 7, figs. 4—7; 9; pl. 9, fig. 21.

Remark: Cylindrical coccolith with a relatively large central field is composed of nine radially arranged elements. It occurs only in flysch beds of the Javorina Formation in association with *Lucianorhabdus* ex gr. *cayeuxii* and with representatives of the genus *Aspidolithus*. There is no unanimity in the opinion on the last occurrence of *E. floralis*. Perch-Nielsen (*in* Bolli et al. 1985) reports this species solely till the Santonian CC15, Stover (1966) and Hill (1976) till the Campanian.

Distribution: Albian to Santonian (Campanian?).

Genus *Lithastrinus* Stradner 1962

Lithastrinus grilli Stradner

Pl. III, figs. 18, 19; pl. VI, figs. 20, 21

1962 *Lithastrinus grilli* sp. n.; Stradner, p. 369, pl. 2, figs. 1—5.
non 1980 *Lithastrinus grilli* Stradner; Doeven, pl. 4, figs. 10, 11.

Remark: *Lithastrinus grilli* has a narrow central field and six long radial rays running from the wall in two cycles. Number of rays is the species sign. Some authors range with this species also specimens with up to seven rays (e.g. Doeven 1983). But such specimens belong to *Lithastrinus septenarius* Forchheimer with a different stratigraphic range upper Coniacian to upper Santonian. In the Bílé Karpaty Unit the genus *Lithastrinus* with seven rays has not been found yet. *L. grilli* with six rays occurs very rarely in the Campanian of the Bílé Karpaty Unit.

Distribution: Lower Santonian to upper Campanian, CC15—CC22b.

Genus *Micula* Vekshina 1959

Micula concava (Stradner) Verbeek

Pl. II, figs. 6, 7

1960 *Nannotetraster concavus* sp. n.; Stradner (*in* Martini - Stradner 1960), p. 269, text-fig. 18.
1980 *Micula decussata* Vekshina; Hattner - Wise, p. 65 (partim), pl. 26, figs. 6, 9 (non figs. 7, 8).

Distribution: Lower Santonian to upper Maastrichtian, CC15—CC26.

Micula decussata Vekshina

Pl. II, figs. 8—12, 22

1959 *Micula decussata* sp. n.; Vekshina, p. 71, pl. 1, fig. 6; pl. 2, fig. 11.
1963 *Micula staurophora* (Gardet) comb. nov.; Stradner, p. 14, pl. 4, fig. 12.
1972 *Micula cubiformis* sp. n.; Forchheimer, p. 54, pl. 25, figs. 1, 3—5.

1977 *Quadrum gartneri* Prins - Perch-Nielsen; Manivit et al., p. 177, pl. 1, figs. 9, 10.

Distribution: Upper Coniacian to upper Maastrichtian, CC14—CC26.

Micula murus (Martini) Bukry

1961 *Tetralithus murus* sp. n.; Martini, p. 4, pl. 1, fig. 6; pl. 4, fig. 42.

Remark: In the Bílé Karpaty Unit it occurs in small number in the upper part of the Lithraphidites quadratus Zone of the upper Maastrichtian.

Distribution: Upper Maastrichtian, CC25c—CC26.

Micula prinsii Perch-Nielsen

1979 *Micula prinsii* sp. n.; Perch-Nielsen, p. 266, pl. 1, fig. 11, 14—16.

Remark: In the Bílé Karpaty Unit it occurs very rarely in the uppermost part of the Maastrichtian always in association with *Micula murus, Nephrolithus frequens* and *Lithraphidites quadratus*.

Distribution: Upper part of the upper Maastrichtian, CC26.

Genus *Quadrum* Prins - Perch-Nielsen in Manivit et al. 1977

Quadrum gartneri Prins - Perch-Nielsen

Pl. II, figs. 13—15

1968 *Tetralithus gothicus* Deflandre; Gartner, p. 42, pl. 24, fig. 4.

1977 *Quadrum gartneri* sp. n.; Prins - Perch-Nielsen (*in* Manivit et al. 1977), p. 177, pl. 1, figs. 9, 10.

Remark: In the Bílé Karpaty Unit it occurs sporadically especially in flysch sediments of the Javorina Formation. Further investigation will show whether this nannofossil is redeposited into the Campanian and Maastrichtian or whether it is still an autochthonous element in the lower Campanian.

Distribution: Turonian up to the Santonian/Campanian boundary, CC11—CC16.

Quadrum sissinghii Perch-Nielsen

1977 *Quadrum nitidum* (Martini) comb. nov.; Prins - Perch-Nielsen (*in* Manivit et al. 1977), p. 178.

1985 *Quadrum sissinghii* Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), p. 390, pl. 58, fig. 19.

Remark: In the Bílé Karpaty Unit it occurs in a short time range and forms an important stratigraphic horizon in the upper Campanian.

Distribution: Upper Campanian to lower Maastrichtian, CC21a—CC23b.

Quadrum trifidum (Stradner) Prins-Perch-Nielsen

1961 *Tetralithus gothicus trifidus* ssp. n.; Stradner (*in* Stradner - Papp), p. 124, text-fig. 23.

1977 *Quadrum trifidum* (Stradner) comb. nov.; Prins - Perch-Nielsen (*in* Manivit et al. 1977), p. 178.

Remark: In the Bílé Karpaty Unit it was found only in few samples but always in greater amount. It forms an important stratigraphic horizon on the Campanian/Maastrichtian boundary.

Distribution: Upper Campanian to lower Maastrichtian, CC22a—CC23b.

Family *Prediscosphaeraceae* Rood, Hay-Barnard 1971

Genus *Prediscosphaera* Vekshina 1959

Prediscosphaera cretacea (Arkhangelsky) Gartner

Pl. VI, figs. 6—9

1912 *Coccolithospora cretacea* sp. n.; Arkhangelsky, p. 140, pl. 6, figs. 12, 13.

1968 *Prediscosphaera cretacea* (Arkhangelsky) comb. nov.; Gartner, p. 19, pl. 2, figs. 10—14; pl. 3, fig. 8; pl. 4, figs. 19—24; pl. 6, figs. 14, 15; pl. 9, figs. 1—4; pl. 12, fig. 1; pl. 14, figs. 20—22; pl. 18, fig. 8; pl. 22, figs. 1—3; pl. 23, figs. 4—6; pl. 25, figs. 12—14; pl. 26, fig. 2.

Remark: In the Bílé Karpaty Unit it is a common component of Cretaceous nannofossil assemblages. A wider variability of this species was observed during study. Specimens differed in detailed structure of corpuscles which became evident especially on the electron microscope photographs. However, these small morphological variations are significant for study under light microscope and they are of no consequence for stratigraphic evaluation of the samples. In the assemblages there were often found also massive stems of corpuscles with characteristic crown on the distal end (see pl. VI, fig. 22).

Distribution: Albian to Maastrichtian; according to Perch-Nielsen (*in* Bolli et al. 1985) lower Campanian to upper Maastrichtian, CC18b—CC26.

Prediscosphaera grandis Perch-Nielsen

1979 *Prediscosphaera grandis* sp. n.; Perch-Nielsen, p. 267, pl. 2, fig. 8.

1984 *Prediscosphaera grandis* Perch-Nielsen; Stradner - Steinmetz, p. 597, pl. 36, fig. 1.

Remark: In the Bílé Karpaty Unit it occurred already in associations with representatives of the genera *Aspidolithus* and *Quadrum*. This species was never abundant in assemblages but always conspicuous due to its size.

Distribution: Maastrichtian CC23b, in the studied material rarely Campanian to Maastrichtian.

Prediscosphaera spinosa (Bramlette - Martini) Gartner
Pl. VI, figs. 10, 11

1964 *Deflandrius spinosus* sp. n.; Bramlette - Martini, p. 301, pl. 2, figs. 17—20.
1968 *Prediscosphaera spinosa* (Bramlette - Martini) comb. nov.; Gartner, p. 20, pl. 2, figs. 15, 16; pl. 3, figs. 9, 10; pl. 5, figs. 7—9; pl. 11, fig. 17.

Distribution: Lower Cenomanian to upper Maastrichtian, CC9b—CC26.

Family *Rhagodiscaceae* Hay 1977

Genus *Rhagodiscus* Reinhardt 1967

Rhagodiscus angustus (Stradner) Reinhardt
Pl. VI, fig. 1

1963 *Rhabdolithus angustus* sp. n.; Stradner, p. 178, pl. 5, fig. 6.
1980 *Rhagodiscus angustus* (Stradner) Reinhardt; Hattner - Wise, p. 66, pl. 29, fig. 9; pl. 30, fig. 1.

Distribution: Aptian/Albian boundary up to the upper Maastrichtian, CC7b—CC26.

Family *Stephanolithiaceae* Black 1968

Genus *Corollithion* Stradner 1961

Corollithion exiguum Stradner

1961 *Corollithion exiguum* sp. n.; Stradner, p. 83, figs. 58—61.
1981 *Corollithion exiguum* Stradner; Smith, p. 33, pl. 2, figs. 13—21.

Remark: Nannofossils with gentle bar-like structure of corpuscles are rare in the Bílé Karpaty Unit (only in pure pelagites).

Distribution: Upper Cenomanian to upper Maastrichtian.

Genus *Rotelapillus* Noël 1973

Rotelapillus crenulatus (Stover) Perch-Nielsen

Pl. VII, figs. 5, 6

1966 *Stephanolithion crenulatum* sp. n.; Stover, p. 160, pl. 7, figs. 25—27; pl. 9, figs. 25—27.
1984 *Rotelapillus crenulatus* (Stover) comb. nov.; Perch-Nielsen, p. 43.
1985 *Rotelapillus crenulatus* (Stover) Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), p. 402, pl. 74; pl. 75, figs. 5, 6.

Remark: In my opinion the species *R. crenulatus* and *R. laffittei* cannot be distinguished from each other under light microscope. According to Perch-Nielsen (*in* Bolli et al. 1985) the genus *R. crenulatus* is characteristic in having eight thorns distributed along the ring periphery. Another morphologic difference between the two species is in the shape of the corpuscle cross-section which can be distinguished only under light microscope.

Distribution: Hauterivian to Maastrichtian.

Family *Thoracosphaeraceae* Schiller 1930

Genus *Thoracosphaera* Kamptner 1927

Remark: In the sediments of the Bílé Karpaty Unit the representatives of the genus *Thoracosphaera* are found in the Upper Cretaceous of the Javorina Formation and in the lower Paleogene of the Svodnice Formation. *Thoracosphaera* sp. belongs among five taxons passing from the Cretaceous to the Tertiary in the Bílé Karpaty Unit.

Family *Zygodiscaceae* Hay-Mohler 1967

Genus *Glaukolithus* Reinhardt 1964

Glaukolithus compactus (Bukry) Perch-Nielsen

Pl. I, fig. 11

1969 *Zygodiscus compactus* sp. n.; Bukry, p. 59, pl. 34, figs. 1, 2.
1985 *Glaukolithus compactus* (Bukry) Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), p. 407, pl. 82, figs. 1—3.

Distribution: Barremian to Maastrichtian.

Glaukolithus diplogrammus (Deflandre) Reinhardt

Pl. I, fig. 13

1954 *Zygolithus diplogrammus* sp. n.; Deflandre (*in* Deflandre - Fert), p. 148, pl. 10, fig. 7; text-fig. 57.

1968 *Glaukolithus diplogrammus* (Deflandre) Reinhardt; Perch-Nielsen, p. 32, pl. 4, figs. 1—10.

Distribution: Valanginian to Maastrichtian.

Genus *Placozygus* Hoffmann 1970

Placozygus fibuliformis (Reinhardt) Hoffmann

Pl. I, figs. 14, 15

1964 *Glaukolithus (?) fibuliformis* sp. n.; Reinhardt, p. 758, pl. 1, fig. 4.
1964 *Zygodiscus spiralis* sp. n.; Bramlette - Martini, p. 303, pl. 4, figs. 6—8.
1981 *Zygodiscus fibuliformis* (Reinhardt) Bukry; Smith (cum synonymy), p. 82, pl. 16, figs. 16—24.
1985 *Placozygus fibuliformis* (Reinhardt) Hoffmann; Perch-Nielsen (*in* Bolli et al. 1985), p. 407, pl. 82, figs. 12—15.

Distribution: Albian to Maastrichtian.

Placozygus sigmoides (Bramlette - Sullivan) Romein

1961 *Zygodiscus sigmoides* sp. n.; Bramlette - Sullivan, p. 149, pl. 4, fig. 11.
1979 *Placozygus sigmoides* (Bramlette - Sullivan) comb. nov.; Romein, p. 46, pl. 2, figs. 4, 5.

Remark: In the sediments of the Bílé Karpaty Unit it occurs in small amount in the upper Campanian, passes the Cretaceous/Tertiary boundary and is relatively abundant in poor assemblages of the lower Paleocene flysch sediments of the Svodnice Formation.
Distribution: Maastrichtian to Paleocene.

Genus *Reinhardtites* Perch-Nielsen 1968

Reinhardtites anthophorus (Deflandre) Perch-Nielsen

Pl. V, figs. 4, 5; pl. VII, figs. 1, 2

1959 *Rhabdolithus anthrophorus* sp. n.; Deflandre, p. 137, pl. 1, figs. 21—22.
1968 *Reinhardtites anthophorus* (Deflandre) comb. nov.; Perch-Nielsen, p. 38 (partim), pl. 5, figs. 1, 5, 6 (non text-figs. 13, 14; pl. 5, figs. 2—4, 7, 8).
1983 *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen emend. Prins - Sissingh; Doeven, p. 49, pl. 2, figs. 5, 6.

Remark: *R. anthophorus* occurs irregularly in nannofossil assemblages of the Bílé Karpaty Unit and therefore its last occurrence cannot be used for boundary of the Zones CC22/CC23.
Distribution: Santonian to Campanian, CC15—CC22b.

Genus *Tranolithus* Stover 1966

Tranolithus exiguus Stover

Pl. I, fig. 12; pl. XII, fig. 4

1966 *Tranolithus exiguus* sp. n.; Stover, p. 146, pl. 4, figs. 19—21; pl. 9, figs. 3, 4.
1969 *Zygodiscus deflanderi* sp. n.; Bukry, p. 59 (partim), pl. 34, figs. 3, 5 (non fig. 4).
1981 *Tranolithus solillum* (Noël) comb. nov.; Crux, p. 638, pl. 2, figs. 7, 8, 10—12.
1985 *Tranolithus exiguus* Stover; Perch-Nielsen (*in* Bolli et al. 1985), p. 408, pl. 83, figs. 6—8.

Distribution: Albian to lower Maastrichtian.

Tranolithus gabalus Stover

1966 *Tranolithus gabalus* sp. n.; Stover, p. 146, pl. 4, fig. 22; pl. 9, fig. 5.
1976 *Tranolithus gabalus* Stover; Hill, p. 156, pl. 11, figs. 36—41; pl. 15, fig. 13.

Distribution: Hauterivian to Campanian.

Tranolithus phacelosus Stover

Pl. VII, figs. 3, 4

1966 *Tranolithus phacelosus* sp. n.; Stover, p. 146, pl. 4, figs. 23—25; pl. 9, fig. 7.

Remark: An elliptic coccolith with a simple wall, in the central part showing four partially overlapping deltoid plates. The plates are a conspicuous identification sign in well preserved specimens under polarized light. In poorly preserved specimens these plates are usually fretted and form only denticulate projections in the central aperture of the corpuscle. These specimens can be easily confused with *T. exiguus*.

Distribution: Lower/upper Albian boundary to lower Maastrichtian, CC8—CC23b.

Genus *Zeugrhabdotus* Reinhardt 1965

Zeugrhabdotus embergeri (Noël) Perch-Nielsen

Pl. IV, figs. 8, 12

1959 *Discolithus embergeri* sp. n.; Noël, p. 164, pl. 1, figs. 1, 7, 8.
1963 *Parhabdolithus embergeri* (Noël) comb. nov.; Stradner, p. 8.
1985 *Zeugrhabdotus embergeri* (Noël) Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), p. 408, pl. 5, figs. 6, 7; pl. 84, figs. 4, 6, 9, 10, 14, 15,

Distribution: Kimeridgian to Maastrichtian.

Zeugrhabdotus theta (Black) Black

Pl. XII, fig. 6

1959 *Discolithus theta* sp. n.; Black (*in* Black - Barnes 1959), p. 327, pl. 12, fig. 1.
1969 *Zygodiscus theta* (Black) comb. nov.; Bukry, p. 62, pl. 36, figs. 7, 8.
1985 *Zeugrhabdotus theta* (Black) Black; Perch-Nielsen (*in* Bolli et al. 1985), p. 409, pl. 84, fig. 5.

Distribution: Albian to Maastrichtian.

Incertae sedis

Ceratolithoides aculeus (Stradner) Prins - Sissingh

Pl. III, figs. 10, 11

1961 *Zygrhablithus aculeus* sp. n.; Stradner, p. 81, figs. 53—57.
1976 *Tetralithus aculeus* (Stradner) Gartner; Thierstein, p. 350, pl. 5, figs. 22, 23.
1977 *Ceratolithoides aculeus* (Stradner) comb. nov.; Prins - Sissingh (*in* Sissingh 1977), p. 60.

Distribution: Lower Campanian to upper Maastrichtian, CC20—CC26.

Calcareous nannoplankton of the Paleogene

Class *Coccolithophyceae* Rothmaler 1951

Family *Coccolithaceae* Poche 1913

Genus *Campylosphaera* Kamptner 1963

Campylosphaera dela (Bramlette - Sullivan) Hay - Mohler

Pl. X, figs. 1, 2

1961 *Coccolithites delus* sp. n.; Bramlette - Sullivan, p. 151, pl. 7, figs. 1, 2.
1967 *Campylosphaera dela* (Bramlette - Sullivan) comb. nov.; Hay - Mohler, p. 1531, pl. 198, fig. 15.
1976 *Cruciplacolithus delus* (Bramlette - Sullivan) Perch-Nielsen; Bystrická, p. 280, pl. 3, fig. 2.

Remark: This morphologically conspicuous large placolith with semielliptic to almost rectangular ring and with central cross in the direction of ellipse axes is frequent in the lower Eocene of the Svodnice Formation in the Bílé Karpaty Unit.

Distribution: Lower to middle Eocene, NP10—NP16.

Genus *Chiasmolithus* Hay, Mohler-Wade 1966

Chiasmolithus bidens (Bramlette - Sullivan) Hay-Mohler

Pl. IX, figs. 5, 6, 11; pl. XII, fig. 3

1961 *Coccolithus bidens* sp. n.; Bramlette - Sullivan, p. 139, pl. 1, fig. 1.
1967 *Chiasmolithus bidens* (Bramlette - Sullivan) comb. nov.; Hay - Mohler, p. 1526, pl. 196, figs. 14, 15, 17; pl. 197, figs. 4, 9, 14.
1974 *Chiasmolithus bidens* (Bramlette - Sullivan) Hay - Mohler; Sherwood, p. 15, pl. 1, figs. 8—10; pl. 2, figs. 4, 5.

Remark: *Ch. bidens* has a small central field bridged with an X-shaped structure. In the Bílé Karpaty Unit it is frequent in the upper Paleocene of the Svodnice Formation and rare in the lower Eocene.

Distribution: Upper Paleocene to lower part of the lower Eocene, NP5—NP11.

Chiasmolithus consuetus (Bramlette - Sullivan) Hay-Mohler

Pl. IX, figs. 9, 10

1961 *Coccolithus consuetus* sp. n.; Bramlette - Sullivan, p. 139, pl. 1, fig. 2.
1967 *Chiasmolithus consuetus* (Bramlette - Sullivan) comb. nov.; Hay - Mohler, p. 1526, pl. 196, figs. 23—25; pl. 198, fig. 16.
1974 *Chiasmolithus consuetus* (Bramlette - Sullivan) Hay - Mohler; Sherwood, p. 15, pl. 1, figs. 11, 12; pl. 2, fig. 6.

Distribution: Upper Paleocene to lower Eocene, NP5—NP19.

Chiasmolithus danicus (Brotzen) Hay-Mohler

1959 *Cribrosphaerella danica* sp. n.; Brotzen, p. 25 (partim), text-fig. 9. (non 3—6).
1967 *Chiasmolithus danicus* (Brotzen) comb. nov.; Hay - Mohler, p. 1526, pl. 196, figs. 16, 21, 22; pl. 198, figs. 8, 12, 13.

Distribution: Upper part of the lower Paleocene to lower part of the upper Paleocene, NP3—NP6.

Chiasmolithus eograndis Perch-Nielsen

Pl. X, figs. 9, 10

1971d *Chiasmolithus eograndis* sp. n.; Perch-Nielsen, p. 53, pl. 2, figs. 5—8.

1983 *Chiasmolithus eograndis* Perch-Nielsen; Aubry, pl. 3, figs. 30, 31, 34.

Distribution: Lower Eocene, NP10—NP13.

Chiasmolithus grandis (Bramlette-Riedel) Radomski
Pl. X, figs. 15, 16

1954 *Coccolithus grandis* sp. n.; Bramlette - Riedel, p. 391, pl. 38, fig. 1.
1968 *Chiasmolithus gradis* (Bramlette - Riedel) comb. nov.; Radomski, p. 560, pl. 44, figs. 3, 4.

Remark: In the Bílé Karpaty Unit it occurs very rarely in the lower Eocene of the Svodnice Formation in association with *Ericsonia formosa.*
Distribution: Lower to middle Eocene, NP11—NP17.

Chiasmolithus solitus (Bramlette-Sullivan) Locker
Pl. IX, fig. 7

1961 *Coccolithus solitus* sp. n.; Bramlette - Sullivan, p. 140, pl. 2, fig. 4.
1968 *Chiasmolithus solitus* (Bramlette - Sullivan) comb. nov.; Locker, p. 221, pl. 1, figs. 5, 6.

Remark: In the Bílé Karpaty Unit it occurs rarely in the lower Eocene together with representatives of the genus *Tribrachiatus.*
Distribution: Lower to middle Eocene, NP10—NP16.

Genus *Cruciplacolithus* Hay - Mohler in Hay et al. 1967

Cruciplacolithus primus Perch-Nielsen
Pl. VIII, figs. 2, 3

1977 *Cruciplacolithus primus* sp. n.; Perch-Nielsen, p. 731, pl. 12, figs. 1—7.

Remark: In the sediments of the Bílé Karpaty Unit *Cruciplacolithus primus* — small form (sensu Perch-Nielsen *in* Bolli et al. 1985) is found in association with the species *Markalius inversus, Ericsonia subpertusa, Placozygus sigmoides, Braarudosphaera bigelowii* before the first occurrence of *C. tenuis.*
Distribution: Lower Paleocene, NP1—NP2 (small form), NP2—NP4, rarely up to NP8 (big form).

Cruciplacolithus tenuis (Stradner) Hay-Mohler
Pl. X, figs. 17—19

1961 *Heliorthus tenuis* sp. n.; Stradner, p. 84, figs. 64, 65.
1967 *Cruciplacolithus tenuis* (Stradner) comb. nov.; Hay - Mohler (*in* Hay et al. 1977), p. 446.

1967 *Cruciplacolithus tenuis* (Stradner) Hay - Mohler; Hay - Mohler, p. 1527, pl. 196, figs. 29—31; pl. 198, fig. 1, 17.

Distribution: Paleocene, NP3—NP9.

Genus *Coccolithus* Schwartz 1894

Coccolithus pelagicus (Wallich) Schiller

1877 *Coccosphaera pelagica* sp. n.; Wallich, p. 348, figs. 1, 2, 5, 11, 12.
1930 *Coccolithus pelagicus* (Wallich) comb. nov.; Schiller, p. 249, figs. 123, 124.

Distribution: Tertiary.

Genus *Ericsonia* Black 1894

Ericsonia formosa (Kamptner) Haq

Pl. X, figs. 3, 4

1963 *Cyclococcolithus formosus* sp. n.; Kamptner, p. 163, pl. 2, fig. 8; text-fig. 20.
1971 *Ericsonia formosa* (Kamptner) comb. nov.; Haq, p. 17, pl. 4, figs. 7, 8.

Remark: In the Bílé Karpaty Unit it occurs rarely already in the upper part of the NP11 Zone still without *Discoaster lodoensis*.

Distribution: Lower Eocene to lower Oligocene, NP12—NP21.

Ericsonia robusta (Bramlette - Sullivan) Perch-Nielsen

Pl. IX, figs. 17—19

1961 *Cyclolithus? robustus* sp. n.; Bramlette - Sullivan, p. 141, pl. 2, fig. 7.
1985 *Erisconia robusta* (Bramlette - Sullivan) Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), pl. 23, fig. 45.

Remark: Conspicuous rounded placolith with a characteristic large open central field. In the Bílé Karpaty Unit it occurs sporadically in the upper Paleocene and lower Eocene.

Distribution: Upper Paleocene, rarely lower Eocene.

Ericsonia subpertusa Hay - Mohler

Pl. VIII, fig. 1; pl. IX, figs. 13—16

1967 *Ericsonia subpertusa* sp. n.; Hay - Mohler, p. 1531, pl. 198, figs. 11, 15, 18; pl. 199, figs. 1—3.

Remark: In the Bílé Karpaty Unit it occurs already in the lower Paleocene together with *Cruciplacolithus primus, Placozygus sigmoides* and *Markalius inversus*.

Distribution: Lower to upper Paleocene.

Family *Calciosoleniaceae* Kamptner 1927

Genus *Scapholithus* Deflandre in Deflandre - Fert 1954

Scapholithus fossilis Deflandre

Pl. IX, fig. 12

1954 *Scapholithus fossilis* sp. n.; Deflandre (*in* Deflandre - Fert), p. 51 pl. 8, figs. 12, 16, 17.

Remark: In the Bílé Karpaty Unit it occurs in the upper Paleocene in a short time interval (upper part of the NP6 Zone to the lower part of the NP7 Zone). It forms a marker horizon which could be used for a more detailed stratigraphy of the Svodnice Formation.

Distribution: Lower Cretaceous (Hauterivian) to Recent.

Family *Calyptrosphaeraceae* Bordeaux - Hay 1969

Genus *Zygrhablithus* Deflandre 1959

Zygrhablithus bijugatus (Deflandre) Deflandre

Pl. X, figs. 13, 14

1954 *Zygolithus bijugatus* sp. n.; Deflandre (*in* Deflandre - Fert 1954), p. 148, pl. 11, figs. 20, 21.

1961 *Zygrhablithus bijugatus* (Deflandre) Deflandre; Bramlette - Sullivan, p. 151, pl. 6, figs. 16—18.

Remark: In the Bílé Karpaty Unit this morphologically conspicuous holococcolith occurs together with *Tribrachiatus bramlettei* already at the base of the lower Eocene in the NP10 Zone, and has been found even in the NP9 Zone is association with *Discoaster multiradiatus,* still without representatives of the genus *Tribrachiatus, Transversopontis* and *Campylosphaera.*

Distribution: Lower Eocene to upper Oligocene, NP11—NP25.

Family *Discoasteraceae* Tan 1927

Genus *Discoaster* Tan 1927

Discoaster binodosus Martini

1958 *Discoaster binodosus* sp. n.; Martini, p. 362, pl. 4, fig. 18.

1968 *Discoaster binodosus* Martini; Bystrická, p. 208, pl. 63, figs. 6—8.

Remark: In the Bílé Karpaty Unit it occurs rarely in the lower Eocene in association with representatives of the genus *Tribrachiatus.*

Distribution: Upper part of the upper Paleocene (Paleocene/ /Eocene boundary) to the middle Eocene, NP9—NP15.

Discoaster deflandrei Bramlette - Riedel

Pl. XI, fig. 2

1954 *Discoaster deflandrei* sp. n.; Bramlette - Riedel, p. 394, pl. 38, 39; te;t-fig. 1—3.
1969 *Discoaster deflandrei* Bramlette - Riedel; Bystrická, p. 83, pl. 13, figs. 1—4.

Distribution: It occurs rarely in the Eocene in the NP11 to NP20 Zones; it is frequent in Oligocene and Miocene.

Discoaster delicatus Bramlette - Sullivan

Pl. XI, fig. 1

1961 *Discoaster delicatus* sp. n.; Bramlette - Sullivan, p. 159, pl. 11, fig. 3.

Distribution: Upper part of the upper Paleocene, NP8—NP9.

Discoaster lenticularis Bramlette - Sullivan

Pl. XI, fig. 3

1961 *Discoaster lenticularis* sp. n.; Bramlette - Sullivan, p. 160, pl. 12, figs. 1, 2.
1971 *Discoaster lenticularis* Bramlette - Sullivan; Haq, p. 39, pl. 14, fig. 5.

Remark: In the Bílé Karpaty Unit it occurs already in association with *Discoaster mohleri* still before the appearance of *D. multiradiatus*.

Distribution: Upper part of the upper Paleocene to the base of the Eocene, NP9—NP10.

Discoaster mohleri Bukry - Percival

Pl. XI, fig. 5

1959 *Discoaster gemmeus* sp. n.; Stradner, p. 479, text-fig. 40.
1967 *Discoaster gemmeus* Stradner; Hay - Mohler, p. 1538, pl. 204, figs. 19, 20; pl. 206, figs. 3, 5, 6, 8.
1971 *Discoaster mohleri* sp. n.; Bukry - Percival, p. 128, pl. 3, figs. 3—5.

Distribution: Upper part of the upper Paleocene, NP7—NP8, rarely NP9.

Discoaster multiradiatus Bramlette - Riedel

Pl. XI, figs. 9, 10; pl. XII, figs. 5, 7

1954 *Discoaster multiradiatus* sp. n.; Bramlette - Riedel, p. 396, pl. 38, fig. 10.

1965 *Discoaster multiradiatus* Bramlette - Riedel; Sullivan, p. 43, pl. 10, figs. 13, 15.

Distribution: Paleocene/Eocene boundary to the lower Eocene, NP9—NP11.

Family *Fasciculithaceae* Hay - Mohler 1967

Genus *Fasciculithus* Bramlette - Sullivan 1961

Fasciculithus involutus Bramlette - Sullivan

Pl. VIII, figs. 8, 9, 13

1961 *Fasciculithus involutus* sp. n.; Bramlette - Sullivan, p. 164, pl. 14, figs. 1—5.

Remark: In the sediments of the Bílé Karpaty Unit the corpuscles of *F. involutus* occur in the upper Paleocene — they are not fixed only to the NP9 Zone associations; they frequently occur already with *Discoaster mohleri*.

Distribution: Upper part of the upper Paleocene, solely the NP9 Zone (sensu Perch-Nielsen *in* Bolli et al. 1985).

Fasciculithus tympaniformis Hay - Mohler

1967 *Fasciculithus tympaniformis* sp. n.; Hay - Mohler *in* Hay et al., p. 447, pl. 8, figs. 1—5.

1975 *Fasciculithus tympaniformis* Hay - Mohler; Proto Decima et al., p. 49, pl. 5, figs. 8, 13.

Distribution: Upper Paleocene, NP5—NP9.

Family *Heliolithaceae* Hay - Mohler 1967

Genus *Heliolithus* Bramlette - Sullivan 1961

Heliolithus kleinpellii Sullivan

Pl. IX, fig. 20

1964 *Heliolithus kleinpellii* sp. n.; Sullivan, p. 193, pl. 12, fig. 5.

1975 *Heliolithus kleinpellii* Sullivan; Proto Decima et al.; p. 49, pl. 5, figs. 17, 18.

Distribution: Upper Paleocene, NP6—NP9.

Heliolithus riedelii Bramlette - Sullivan

1961 *Heliolithus riedeli* sp. n.; Bramlette - Sullivan, p. 164, pl. 14, figs. 9—11.

1971 *Heliolithus riedeli* Bramlette - Sullivan; Martini, pl. 1, figs. 15, 16.

Remark: In the sediments of the Bílé Karpaty Unit it is very rare.
Distribution: Upper part of the upper Paleocene, NP8.

Family *Pontosphaeraceae* Lemmermann 1908

Genus *Transversopontis* Hay, Mohler - Wade 1966

Transversopontis pulcher (Deflandre) Perch-Nielsen

Pl. X, fig. 6

1954 *Discolithus pulcher* sp. n.; Deflandre (*in* Deflandre - Fert 1954), p. 142, pl. 12, figs. 17, 18.
1985 *Transversopontis pulcher* (Deflandre) Perch-Nielsen; Perch-Nielsen (*in* Bolli et al. 1985), pl. 51, fig. 12.

Remark: *Transversopontis pulcher* occurs sporadically in the lower Eocene of the Svodnice Formation in association with *Campylosphaera dela, Zygrhablithus bijugatus, Chiasmolithus eograndis* and *Discoaster multiradiatus.*
Distribution: Upper Paleocene to lower Eocene.

Transversopontis pulcheroides (Sullivan) Perch-Nielsen

Pl. X, fig. 5

1964 *Discolithus pulcheroides* sp. n.; Sullivan, p. 1983, pl. 4, fig. 7.
1971d *Transversopontis pulcheroides* (Sullivan) comb. nov.; Perch-Nielsen, p. 40, pl. 33, figs. 3, 7.

Distribution: Upper Paleocene to lower Eocene.

Family *Prinsiaceae* Hay - Mohler 1967

Genus *Toweius* Hay - Mohler 1967

Toweius eminens (Bramlette - Sullivan) Perch-Nielsen

Pl. VIII, figs. 16—21

1961 *Coccolithus eminens* sp. n.; Bramlette - Sullivan, p. 139, pl. 1, fig. 3.
1971b *Toweius eminens* (Bramlette - Sullivan) comb. nov.; Perch-Nielsen, p. 360.
1976 *Toweius eminens* (Bramlette - Sullivan) Perch-Nielsen; Wind - Wise, p. 296, pl. 5, figs. 1—3.

Remark: Elliptic to almost round placolith. A small central field shows four large perforations conspicuous under light microscope. In the sediments of the Bílé Karpaty Unit this species occurs already in the NP6 Zone still without representatives of the genus *Discoaster.*

Distribution: Upper Paleocene to Paleocene/Eocene boundary, NP7—NP10.

Toweius pertusus (Sullivan) Romein

Pl. VIII, figs. 10—12

1965 *Coccolithus pertusus* sp. n.; Sullivan, p. 32, pl. 3, figs. 5, 6.
1971b *Toweius craticulus* Hay - Mohler; Perch-Nielsen, p. 360, pl. 13, figs. 7—10; pl. 14, figs. 1, 2.
1979 *Toweius pertusus* (Sullivan) comb. nov.; Romein, p. 131, pl. 4, figs. 8—11.

Remark: Small, elliptic to almost round placolith. Central field takes up to one half of the corpuscle diameter and is filled with a grille with 8 to 20 perforations. In the Bílé Karpaty Unit it occurs already in the upper part of the lower Paleocene, in the Zone NP4. Bystrická (*in* Andrusov - Samuel 1983) also reported this species already from the NP4 Zone. Gašpariková (*in* Salaj et al. 1978) even delimited the Subzone Toweius craticulus (synonym of *T. pertusus*) in the upper part of the NP4 Zone.

Distribution: Upper Paleocene, rarely lower Eocene, NP6—NP9 (rarely up to NP12) sensu Perch-Nielsen (*in* Bolli et al. 1985), in the studied material the upper part of the lower Paleocene.

Toweius tovae Perch-Nielsen

1971b *Toweius tovae* sp. n.; Perch-Nielsen, p. 359, pl. 13, figs. 1, 2, 5; pl. 14, figs. 8, 9.

Remark: An elliptic to round placolith with 6 pores in the central field. Perch-Nielsen (*in* Bolli et al. 1985) reported a very short stratigraphic range of this species — solely the NP9 Zone (on the boundary of the CP8a/b Subzones sensu Okada - Bukry 1980). In the sediments of the Bílé Karpaty Unit it was found always with other species of the genus *Toweius* in association with *Heliolithus kleinpellii, Discoaster mohleri,* etc. already in the NP7—NP8 Zones, i.e. stratigraphically lower than reported Perch-Nielsen.

Distribution: Upper part of the upper Paleocene, NP9 (sensu Perch-Nielsen *in* Bolli et al. 1985).

Family *Sphenolithaceae* Deflandre 1952

Genus *Sphenolithus* Deflandre in Grassé 1952

Sphenolithus anarrhopus Bukry - Bramlette

1969 *Sphenolithus anarrhopus* sp. n.; Bukry - Bramlette, p. 140, pl. 3, figs. 5—8.
1975 *Sphenolithus anarrhopus* Bukry - Bramlette; Proto Decima et al., p. 51, pl. 6, fig. 10.

Distribution: Upper Paleocene to lower part of the lower Eocene, NP6—NP10 (? up to NP11).

Sphenolithus primus Perch-Nielsen

Pl. VIII, figs. 6, 7

1971b *Sphenolithus primus* sp. n.; Perch-Nielsen, p. 357, pl. 11, fig. 4; pl. 12, figs. 4, 5, 7—12; pl. 14, figs. 22—24.

Distribution: Upper part of the lower Eocene up to lower part of the lower Eocene, NP4—NP11.

Sphenolithus radians Deflandre

Pl. X, figs. 11, 12

1954 *Sphenolithus radians* sp. n.; Deflandre (*in* Deflandre - Fert 1954), pl. 12, figs. 36—38; text-fig. 109—112.
1973 *Sphenolithus radians* Deflandre; Locker, p. 772, pl. 11, figs. 3, 4.

Remark: In the sediments of the Bílé Karpaty Unit it occurs rarely in the NP11 Zone.

Distribution: Lower to upper Eocene, NP11—NP19.

Family *Zygodiscaceae* Hay - Mohler 1967

Genus *Neochiastozygus* Perch-Nielsen 1971a

Neochiastozygus concinnus (Martini) Perch-Nielsen

Pl. VIII, figs. 14, 15

1961 *Zygolithus concinnus* sp. n.; Martini, p. 18, pl. 3, fig. 35; pl. 5, fig. 54.
1971c *Neochiastozygus concinnus* (Martini) comb. nov.; Perch-Nielsen, p. 59, pl. 4, fig. 6; pl. 7, figs. 4—6.

Distribution: Upper Paleocene, NP5—NP8.

Neochiastozygus distentus (Bramlette - Sullivan) Perch-Nielsen

1961 *Zygolithus distentus* sp. n.; Bramlette - Sullivan, p. 150, pl. 6, figs. 4—7.
1971c *Neochiastozygus distentus* (Bramlette - Sullivan) comb. nov.; Perch-Nielsen, p. 61, pl. 4, figs. 1—4; pl. 7, figs. 1—3.

Distribution: Upper part of the upper Paleocene to lower part of the lower Eocene, NP8—NP11.

Genus *Zygodiscus* Bramlette - Sullivan 1961

Zygodiscus adamas Bramlette - Sullivan

1961 *Zygodiscus adamas* sp. n.; Bramlette - Sullivan, p. 148, pl. 4, figs. 9, 10.

Distribution: Upper part of the upper Paleocene to lower part of the lower Eocene, NP8—NP11.

Zygodiscus herlyni Sullivan

1964 *Zygodiscus herlyni* sp. n.; Sullivan, p. 186, pl. 6, figs. 1—3.

Distribution: Upper Paleocene, NP7—NP9.

Zygodiscus plectopons Bramlette - Sullivan

1961 *Zygodiscus plectopons* sp. n.; Bramlette - Sullivan, p. 148, pl. 4, fig. 12.
1975 *Zygodiscus plectopons* Bramlette - Sullivan; Proto Decima et al., p. 51, pl. 6, fig. 22.

Distribution: Paleocene to lower Eocene.

Incertae sedis

Genus *Ellipsolithus* Sullivan 1964

Ellipsolithus distichus (Bramlette - Sullivan) Sullivan
Pl. IX, figs. 1—4

1961 *Coccolithus distichus* sp. n.; Bramlette - Sullivan, p. 152, pl. 7, fig. 8.
1964 *Ellipsolithus distichus* (Bramlette - Sullivan) comb. nov.; Sullivan, p. 184, pl. 5, figs. 4—6.
1973 *Ellipsolithus distichus* (Bramlette - Sullivan) Sullivan; Locker, p. 760, pl. 7, fig. 17.

Distribution: Upper Paleocene to lower Eocene.

Ellipsolithus macellus (Bramlette - Sullivan) Sullivan
Pl. IX, fig. 8

1961 *Coccolithus macellus* sp. n.; Bramlette - Sullivan, p. 152, pl. 7, figs. 11—13.
1964 *Ellipsolithus macellus* (Bramlette - Sullivan) comb. nov.; Sullivan, p. 184, pl. 5, fig. 3.
1975 *Ellipsolithus macellus* (Bramlette - Sullivan) Sullivan; Proto Decima et al.; p. 51, pl. 6, fig. 15.

Distribution: Upper part of the lower Paleocene to lower Eocene, NP4—NP12.

Genus *Tribrachiatus* Shamrai 1963

Tribrachiatus bramlettei (Brönnimann - Stradner) Proto Decima

1960 *Marthasterites bramlettei* sp. n.; Brönnimann - Stradner, p. 336, figs. 17—20, 23, 24.
1975 *Tribrachiatus bramlettei* (Brönnimann - Stradner) comb. nov.; Proto Decima et al., p. 49, pl. 4, figs. 17, 18.

Distribution: Lower part of the lower Eocene, NP10—NP11.

Tribrachiatus contortus (Stradner) Bukry
Pl. XI, fig. 7

1958 *Discoaster contortus* sp. n.; Stradner, p. 187, figs. 35, 36.
1959 *Marthasterites contortus* (Stradner) comb. nov.; Deflandre, p. 139.
1972 *Tribrachiatus contortus* (Stradner) comb. nov.; Bukry, p. 1081.

Remark: In the Bílé Karpaty Unit this morphologically conspicuous species is well preserved in the lower Eocene, in the NP10 Zone in association with *Discoaster multiradiatus, Tribrachiatus bramlettei, Transversopontis pulcher,* etc.
Distribution: Lower Eocene, upper part of the NP10 Zone.

Tribrachiatus orthostylus Shamrai
Pl. XI, figs. 6, 8; pl. XII, fig. 6

1954 *Discoaster tribrachiatus* sp. n.; Bramlette - Riedel, p. 379, pl. 38, fig. 11.
1963 *Tribrachiatus orthostylus* sp. n.; Shamrai, p.38, pl. 2, figs. 13, 14.
1976 *Marthasterites tribrachiatus* (Bramlette - Riedel) Deflandre; Bystrická, p. 295, pl. 6, figs. 1, 2.

Distribution: Lower Eocene, NP10—NP12 (rarely to NP15).

K tisku doporučil J. Krhovský
Přeložila T. Hlavatá

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Explanation of plates

Abbreviations used: trans. light = transmitted light; x-nic. = crossed nicols.

Pl. I

1—4. *Vagalapilla matalosa* (Stover) Thierstein; 1, 2 — Javořina 31D, 1 — trans. light, 2 — x-nic.; 3, 4 — Janegov Mlyn 1162/3, x-nic.

5, 9, 10. *Broinsonia ex gr. enormis* (Shumenko) Manivit; 5 — Svinárský brook 40, x-nic.; 9, 10 — Javořina 31A, 9 — trans. light, 10 — x-nic.

6—8, 24. *Cribrosphaerella ehrenbergii* (Arkhangelsky) Deflandre; 6—8 — Svinárský brook 40, 6 — trans. light, 7, 8 — x-nic.; 24 — Zemianske Podhradie 9A, trans. light.

11. *Glaukolithus compactus* (Bukry) Perch-Nielsen; Janegov Mlyn J149/9, x-nic.

12. *Tranolithus exiguus* Stover; Javořina 31D, x-nic.

13. *Glaukolithus diplogrammus* (Deflandre) Reinhardt; Vyškovec 51A, x-nic.

14, 15. *Placozygus fibuliformis* (Reinhardt) Hoffmann; Vyškovec 51A, x-nic.

16, 17, 21, 22. *Eiffellithus eximius* (Stover) Perch-Nielsen; 16, 17 — Svinárský brook 40, 16 — trans. light, 17 — x-nic.; 21, 22 — Javořina 31D, 21 — trans. light, 22 — x-nic.

18—20, 23. *Eiffellithus turriseiffeli* (Deflandre) Reinhardt; 18, 19 — Javořina 31D, 18 — trans. light, 19 — x-nic.; 20, 23 — Kostolník 5, x-nic.

×2500

Pl. II

1, 2. *Vekshinella crux* (Deflandre et Fert) Shafik et Stradner; Kostolník 5, 1 — trans. light, 2 — x-nic.
3—5. *Ahmuellrella octoradiata* (Górka) Reinhardt; 3, 4 — Javořina 31A, 3 — trans. light, 4 — x-nic.; 5 — Svinárský brook, x-nic.
6, 7. *Micula* cf. *concava* (Stradner) Verbeek; Vápenky 209, 6 — trans. light, 7 — x-nic.
8—12. *Micula decussata* Vekshina; 8, 9 — Uhlisko brook 11C, 8 — trans. light, 9 — x-nic.; 10 — Vápenky 209, x-nic.; 11, 12 — Javořina 31A, x-nic.
13—15. *Quadrum gartneri* Prins et Perch-Nielsen; Svinárský brook 40, 13 — trans. light, 14, 15 — x-nic.
16, 17. — *Eiffellithus trabeculatus* (Górka) Reinhardt et Górka; Janegov Mlyn J162/3, 16 — trans. light, 17 — x-nic.
18, 19. *Calculites obscurus* (Deflandre) Prins et Sissingh; Javořina 31A; 18 — trans. light, 19 — x-nic.
20. *Aspidolithus* ex gr. *parcus* (Stradner) Noël; Javořina 31D, x-nic.
21. *Arkhangelskiella specillata* Vekshina; Janegov Mlyn J149/2, x-nic.
22. *Micula decussata* Vekshina, *Kamptnerius magnificus* Deflandre; Javořina 31D, trans. light. ×2500

Pl. III

1—3. *Lithraphidites quadratus* Bramlette et Martini; Vyškovec 51A, 1, 2 — trans. light, 3 — x-nic.
4—6. *Biscutum constans* (Górka) Black; 4, 5 — Uhlisko brook 11C, 4 — trans. light 5 — x-nic.; 6 — Vyškovec 51A, x-nic.
7—9. *Cyclagelosphaera reinhardtii* (Perch-Nielsen) Romein; 7, 8 — Uhlisko brook 11A, 7 — trans. light, 8 — x-nic.; 9 — Filipovo valley 4A, x-nic.
10, 11. *Ceratolithoides aculeus* (Stradner) Prins et Sissingh; Javořina — Velička 31A, 10 — trans. light, 11 — x-nic.
12—14 *Watznaueria barnesae* (Black) Perch-Nielsen; Svinárský brook 40, 12 — trans. light, 13, 14 — x-nic.
15. *Ellipsagelosphaera britannica* (Stradner) Perch-Nielsen; Janegov Mlyn J162/3, x-nic.
16, 17. *Eprolithus floralis* (Stradner) Stover; Javořina 31A, 16 — trans. light, 17 — x-nic.
18, 19. *Lithastrinus grillii* Stradner; Janegov Mlyn J162/2, 18 — trans. light, 19 — x-nic.
20, 21. *Arkhangelskiella specillata* Vekshina; Javořina 31A, 20 — trans. light, 21 — x-nic.
22, 23. *Arkhangelskiella cymbiformis* Vekshina; Uhlisko brook 11C, 22 — trans. light, 23 — x-nic. Figs. 1—21 ×2500
Figs. 22, 23 ×2000

Pl. IV

1—4. *Gartnerago obliquum* (Stradner) Reinhardt; 1, 2 — Svinárský brook 45B, 1 — trans. light, 2 — x-nic.; 3, 4 — Vyškovec 51A, 3 — trans. light, 4 — x-nic.
5. *Chiastozygus litterarius* (Górka) Manivit; *Lithraphidites carniolensis* Deflandre; Žítková 12A, x-nic.
6, 7, 9, 10. *Aspidolithus parcus constrictus* (Hattner) Perch-Nielsen; 6, 7 —

Janegov Mlyn J151, 6 — trans. light, 7 — x-nic.; 9 — Javořina 31A, x-nic.; 10 — Svinárský brook 45B, x-nic.

11. *Aspidolithus parcus parcus* (Stradner) Noël; Svinárský brook 45B, x-nic.

8, 12. *Zeugrhabdotus embergeri* (Noël) Perch-Nielsen; 8 — Žítková 12A, x-nic.; 12 — Janegov Mlyn J149/9, x-nic.

13—15. *Arkhangelskiella cymbiformis* Vekshina; 13, 14 — Vyškovec 51A, 13 — trans. light; 14 — x-nic.; 15 — Zemianske Podhradie 9A, x-nic. ×2000

Pl. V

1, 2. *Aspidolithus parcus parcus* (Stradner) Noël; Javořina 31A, 1 — trans. light, 2 — x-nic.

3. *Nannoconus* cf. *farinacciae* Bukry; Svinárský brook 45B, trans. light.

4, 5. *Reinhardtites* cf. *anthophorus* (Deflandre) Perch-Nielsen; 4 — Janegov Mlyn J149/9, x-nic.; 5 — Javořina 31A, x-nic.

6, 7. *Markalius inversus* (Deflandre) Bramlette et Martini; Zemianske Podhradie, 6 — trans. light, 7 — x-nic.

8, 9. *Nannoconus elongatus* Brönnimann; Javořina 31A, 8 — trans. light, 9 — x-nic.

10—13. *Braarudosphaera bigelowii* (Gran et Braarud) Deflandre; 10, 11 — Žítková 12A, 10 — trans. light, 11 — x-nic.; 12, 13 — Vyškovec 51A, 12 — trans. light, 13 — x-nic.

14—16. *Kamptnerius magnificus* Deflandre; 14, 15 — Vápenky 209, 14 — trans. light, 15 — x-nic.; 16 — Javořina 31D, trans. light.

17—19. *Manivitella pemmatoidea* (Deflandre) Thierstein; 17 — Svinárský brook 45B, x-nic.; 18, 19 — Javořina 31A, 18 — trans. light, 19 — x-nic. ×2500

Pl. VI

1. *Rhagodiscus angustus* (Stradner) Reinhardt; Vyškovec 51A, x-nic.

2—5. *Chiastozygus litterarius* (Górka) Manivit; 2, 3 — Svinárský brook 45B, 2 — trans. light, 3 — x-nic.; 4, 5 — Žítková 12A, 4 — trans. light, 5 — x-nic.

6—9. *Prediscosphaera cretacea* (Arkhangelsky) Gartner; 6, 7 — Uhlisko brook 11C, 6 — trans. light, 7 — x-nic.; 8, 9 — Vyškovec 51A, 8 — trans. light, 9 — x-nic.

10, 11. *Prediscosphaera spinosa* (Bramlette et Martini) Gartner; 10 — Javořina 31D, x-nic.; 11 — Vyškovec 51A, x-nic.

12—14. *Stradneria crenulata* (Bramlette et Martini) Noël; 12 — Svinárský brook 45B, x-nic.; 13, 14 — Žítková 12A, x-nic.

15—18. *Cretarhabdus conicus* Bramlette et Martini; 15, 16 — Zemianske Podhradie 9A, 15 — trans. light, 16 — x-nic.; 17, 18 — Javořina 31A, 17 — trans. light, 18 — x-nic.

19. *Cribrosphaerella ehrenbergii* (Arkhangelsky) Deflandre; Uhlisko brook 11C, trans. light.

20, 21. *Lithastrinus grillii* Stradner; Svinárský brook 40, 20 — trans. light, 21 — x-nic.

22. *Prediscosphaera* sp.; Janegov Mlyn J162/3, trans. light. ×2500

Pl. VII

1, 2. *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen; Javořina 31D, 1 — trans. light, 2 — x-nic.

3, 4. *Tranolithus phacelosus* Stover; Myjava brook, 7, 3 — trans. light, 4 — x-nic.

5, 6. *Rotelapillus crenulatus* (Stover) Perch-Nielsen; Svinársky brook 40, 5 — trans. light, 6 — x-nic.

7, 8. *Microrhabdulus decoratus* Deflandre; Kostolník 5, 7 — trans. light, 8 — x-nic.
9, 10. *Microrhabdulus belgicus* Hay et Towe; Janegov Mlyn J162/3, 9 — trans. light, 10 — x-nic.
11, 12. *Braarudosphaera* sp.; Kostolník 5, 11 — trans. light, 12 — x-nic.
13—15. *Lucianorhabdus cayeuxii* Deflandre; 13, 14 — Javořina 31D, 13 — trans. light, 14 — x-nic.; 15 — Janegov Mlyn J162/2, trans. light. ×2000

Pl. VIII

1. *Ericsonia subpertusa* Hay et Mohler; sv. Štěpán quarry 7h, x-nic.
2, 3. *Cruciplacolithus primus* Perch-Nielsen; Studený hill 17A, 2 — trans. light, 3 — x-nic.
4, 5. *Markalius inversus* (Deflandre) Bramlette et Martini; Klanečnice brook 4A, 4 — trans. light, 5 — x-nic.
6, 7. *Sphenolithus primus* Perch-Nielsen; Modrá Voda quarry 5A, 6 — trans. light, 7 — x-nic.
8, 9, 13. *Fasciculithus involutus* Bramlette et Sullivan; 8, 9 — Bílý hill 11, 8 — trans. light, 9 — x-nic.; 13 — Čerešenková hill 59, x-nic.
10—12. *Toweius pertusus* (Sullivan) Romein; Modrá Voda quarry 5A, 10 — trans. light, 11, 12 — x-nic.
14, 15. *Neochiastizygus concinnus* (Martini) Perch-Nielsen; Čerešenková hill 59, 14 — trans. light, 15 — x-nic.
16—21. *Toweius eminens* (Bramlette et Sullivan) Perch-Nielsen; 16, 17 — Čakanov 8B/85, 16 — trans. light, 17 — x-nic.; 18, 19 — Velká n. Veličkou 9, 18 — trans. light, 19 — x-nic.; 20, 21 — Podbranč 1A, 20 — trans. light, 21 — x-nic. ×2500

Pl. IX

1—4. *Ellipsolithus distichus* (Bramlette et Sullivan) Sullivan; 1, 2 — Bílý hill 11, 1 — trans. light, 2 — x-nic.; 3, 4 — Velká n. Veličkou 9, 3 — trans. light, 4 — x-nic.
5, 6, 11. *Chiasmolithus bidens* (Bramlette et Sullivan) Hay et Mohler; 5, 6 — Modrá Voda quarry 5A, 5 — trans. light, 6 — x-nic.; 11 — Bzová 6A, trans. light.
7. *Chiasmolithus solitus* (Bramlette et Sullivan) Locker; Louka 1, trans. light.
8. *Ellipsolithus macellus* (Bramlette et Sullivan) Sullivan; Čerešenková hill 59, x-nic.
9, 10. *Chiasmolithus sp.* cf. *Ch. consuetus* (Bramlette et Sullivan) Hay et Mohler; Bzová 6A, 9 — trans. light, 10 — x-nic.
12. *Scapholithus fossilis* Deflandre; Modrá Voda quarry 5A, x-nic.
13—16. *Ericsonia subpertusa* Hay et Mohler; 13, 14 — Studený hill 17A, 13 — trans. light, 14 — x-nic.; 15, 16 — Klanečnice brook 4A, 15 — trans. light, 16 — x-nic.
17—19. *Ericsonia robusta* (Bramlette et Sullivan) Perch-Nielsen; Javorník 12C, 17 — trans. light, 18, 19 — x-nic.
20. *Heliolithus kleinpellii* Sullivan; Čerešenková hill 59, x-nic. ×2500

Pl. X

1, 2. *Campylosphaera dela* (Bramlette et Sullivan) Hay et Mohler; Velká n. Veličkou 11, 1 — trans. light, 2 — x-nic.

3, 4. *Ericsonia formosa* (Kamptner) Haq; Velká n. Veličkou 11, trans. light.
5. *Transversopontis pulcheroides* (Sullivan) Perch-Nielsen; Javorník 12D, x-nic.
6. *Transversopontis pulcher* (Deflandre) Perch-Nielsen; Šance-Nová Hora J31, x-nic.
7, 8. *Markalius inversus* (Deflandre) Bramlette et Martini; sv. Štěpán quarry 7j, 7 — trans. light, 8 — x-nic.
9, 10. *Chiasmolithus eograndis* Perch-Nielsen; Velká n. Veličkou 11, 9 — trans. light, 10 — x-nic.
11, 12. *Sphenolithus radians* Deflandre; Velká n. Veličkou 10, x-nic.
13, 14. *Zygrhablithus bijugatus* (Deflandre) Deflandre; Bílý hill 10E, 13 — trans. light, 14 — x-nic.
15, 16. *Chiasmolithus grandis* (Bramlette et Riedel) Radomski; Bílý hill 10E, 15 — trans. light, 16 — x-nic.
17—19. *Cruciplacolithus sp.* cf. *C. tenuis* (Stradner) Hay et Mohler; Modrá Voda quarry 5A, 17 — trans. light, 18, 19 — x-nic.

×2500

Pl. XI

1. *Discoaster delicatus — multiradiatus*; Modrá Voda quarry 5B.
2. *Discoaster deflandrei* Bramlette et Riedel; Javorník 20.
3. *Discoaster lenticularis* Bramlette et Sullivan; Podbranč 1A.
4. *Discoaster sp.* cf. *D. gemmifer* Stradner; Šance-Nová Hora J31.
5. *Discoaster mohleri* Bukry et Percival; Podbranč 1A.
6, 8. *Tribrachiatus orthostylus* Shamrai; 6 — Bílý hill 10D; 8 — Javorník 13 E.
7. *Tribrachiatus contortus* (Stradner) Bukry; Bílý hill 10E.
9, 10. *Discoaster multiradiatus* Bramlette et Riedel; 9 — Bílý hill 11, 10 — Šance-Nová Hora J31.

×2500

Pl. XII

1. *Lithraphidites carniolensis* Deflandre; Svinárský brook 40, ×6000.
2. *Eiffellithus turriseiffeli* (Deflandre) Reinhardt; Podbranč 15, ×10500.
3. *Chiasmolithus bidens* (Bramlette et Sullivan) Hay et Mohler; Klanečnice brook 5, ×6000.
4. *Tranolithus exiguus* Stover; Svinárský brook 40, ×10400.
5, 7. *Discoaster multiradiatus* Bramlette et Riedel; 5 — Bílý hill 11, ×7000; 7 — Javorník 12B, ×8000.
6. *Zeugrhabdotus theta* (Black) Black; Svinárský brook 40, ×9400.
8. *Tribrachiatus orthostylus* Shamrai; Javorník 13E, ×5200.

Light micrographs by author, SEM photographs by F. Odehnal.

Vápnitý nanoplankton ve flyšových sedimentech bělokarpatské jednotky (Západní Karpaty)

(Résumé anglického textu)

Lilian Švábenická

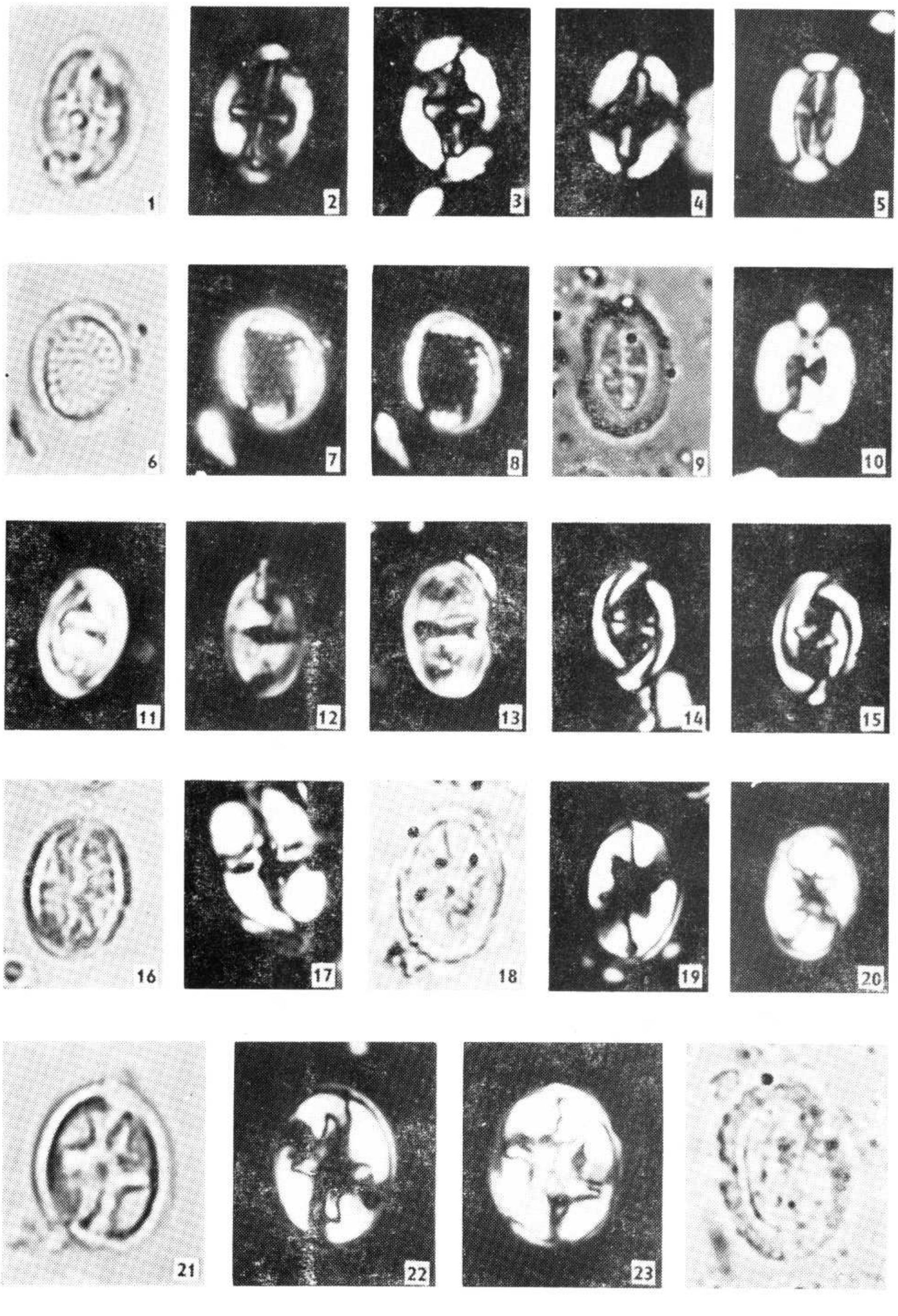
Předloženo 29. ledna 1988

Flyšové sedimenty vnějšího vývoje bělokarpatské jednotky (javorinské a svodnické souvrství sensu Stráník et al. 1986) obsahují společenstva vápnitých nanofosilií s druhy, pomocí kterých můžeme stanovit relativní stáří hornin s přesností na stupně až zóny. Vzorky byly odebrány převážně z vrstviček T_d a T_{et-p} flyšových rytmů.

V javorinském souvrství se vyskytuje nanoplankton stáří spodní kampan až svrchní maastricht bez paleogenních indicií. Bylo zjištěno 62 druhů nanofosilií. Vzhledem k odchylnému biofaciálnímu vývoji nemohla být použita v celém rozsahu zonace Sissingha (1977). Pro oblast bělokarpatské jednotky bylo vymezeno 7 nanoplanktonových zón, které se částečně kryjí s CC zónami (sensu Sissingh 1977): Aspidolithus parcus, Ceratolithoides aculeus, Quadrum sissinghii, Quadrum trifidum, Arkhangelskiella cymbiformis, Lithraphidites quadratus a Nephrolithus frequens. Souběžně studovaná mikrofauna obsahovala pouze aglutinované foraminifery bez vápnitých forem širšího stratigrafického rozsahu svrchní křída—paleocén.

Ve svodnickém souvrství byl zjištěn odlišný vývoj mikrofaun a vápnitého nanoplanktonu ve srovnání s javorinským souvrstvím. Mikrofauny obsahovaly vedle aglutinovaných foraminifer i vápnitý plankton a bentos a doložily obdobné relativní stáří jako vápnité nanofosilie. Nanoplankton (zjištěno 47 druhů) udává stáří svodnického souvrství spodní paleocén až spodní eocén ?NP1—NP2 až NP11 (sensu Martini 1971). Pro flyšové sedimenty svodnického souvrství jsou charakteristické hojné redepozice ze svrchní křídy. Přeplavený paleogenní materiál se v paleocénu a spodním eocénu vyskytoval ojediněle.

Studium druhové skladby společenstev vápnitého nanoplanktonu a mikrofauny ukázalo závislost výskytu obou skupin v jednotlivých intervalech flyšových rytmů T_d a T_e. Vápnité nanofosilie se nevyskytují pouze v nevápnitých jílovcích T_{ep}, které vznikly v období klidové sedimentace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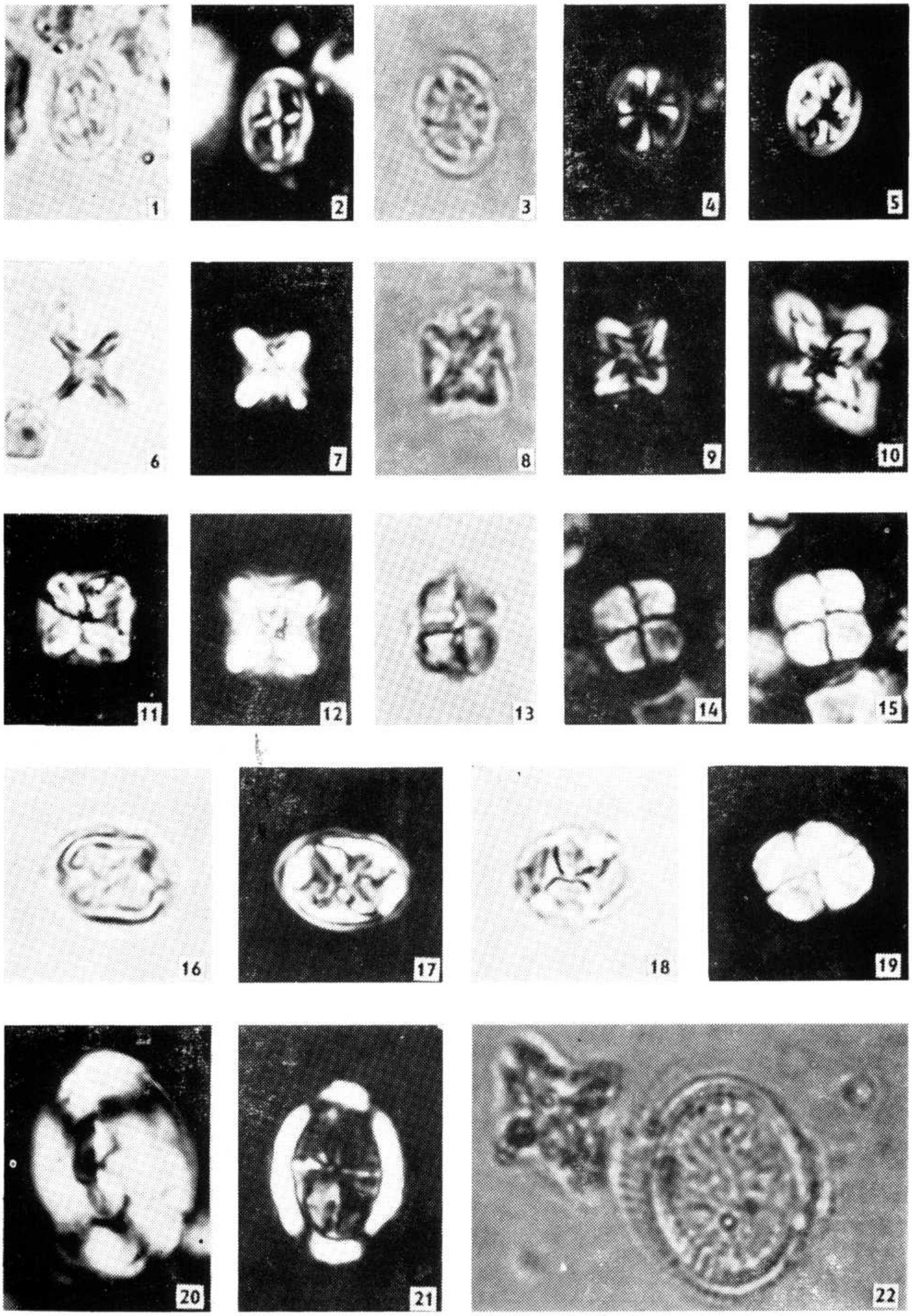
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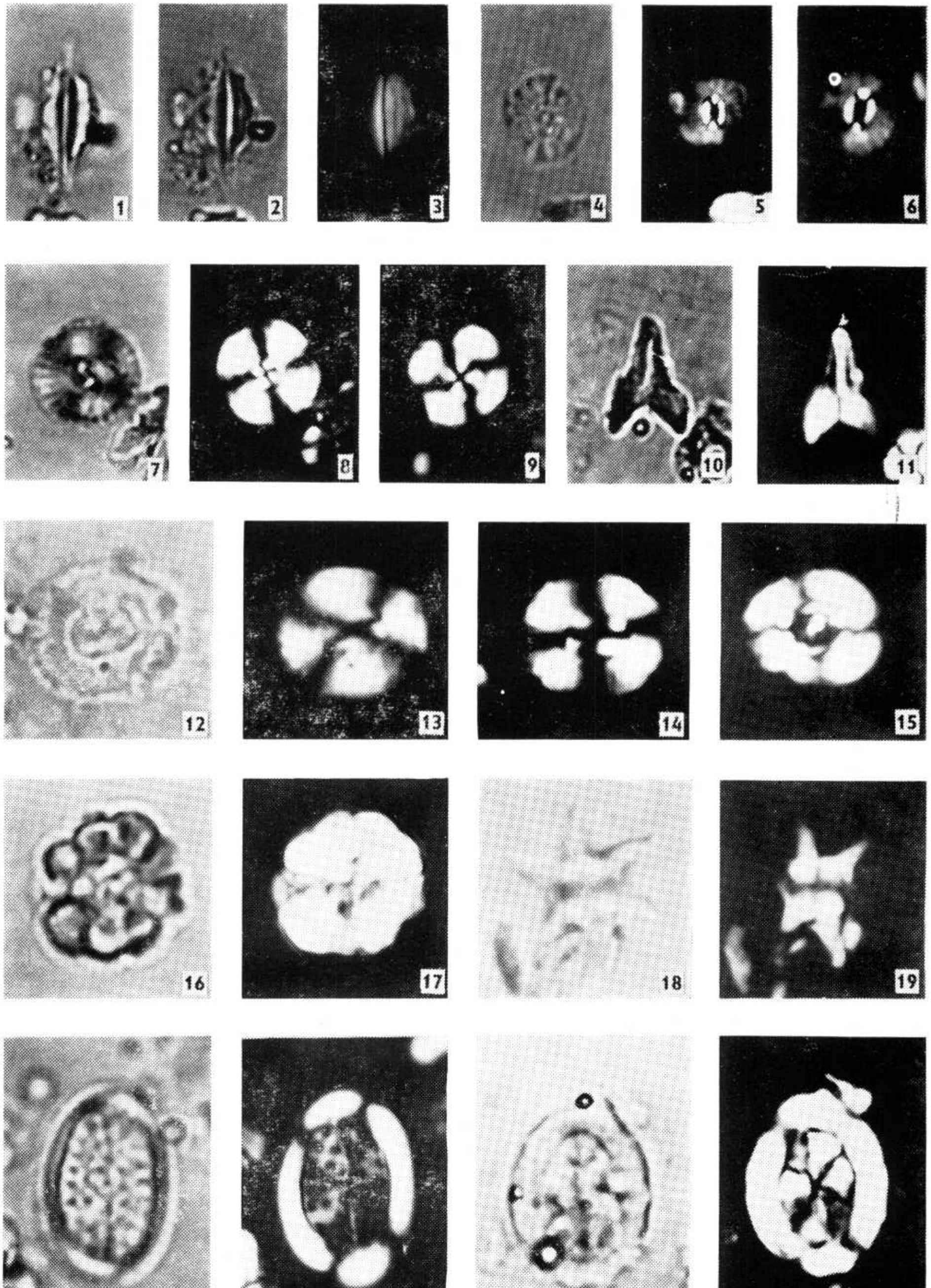
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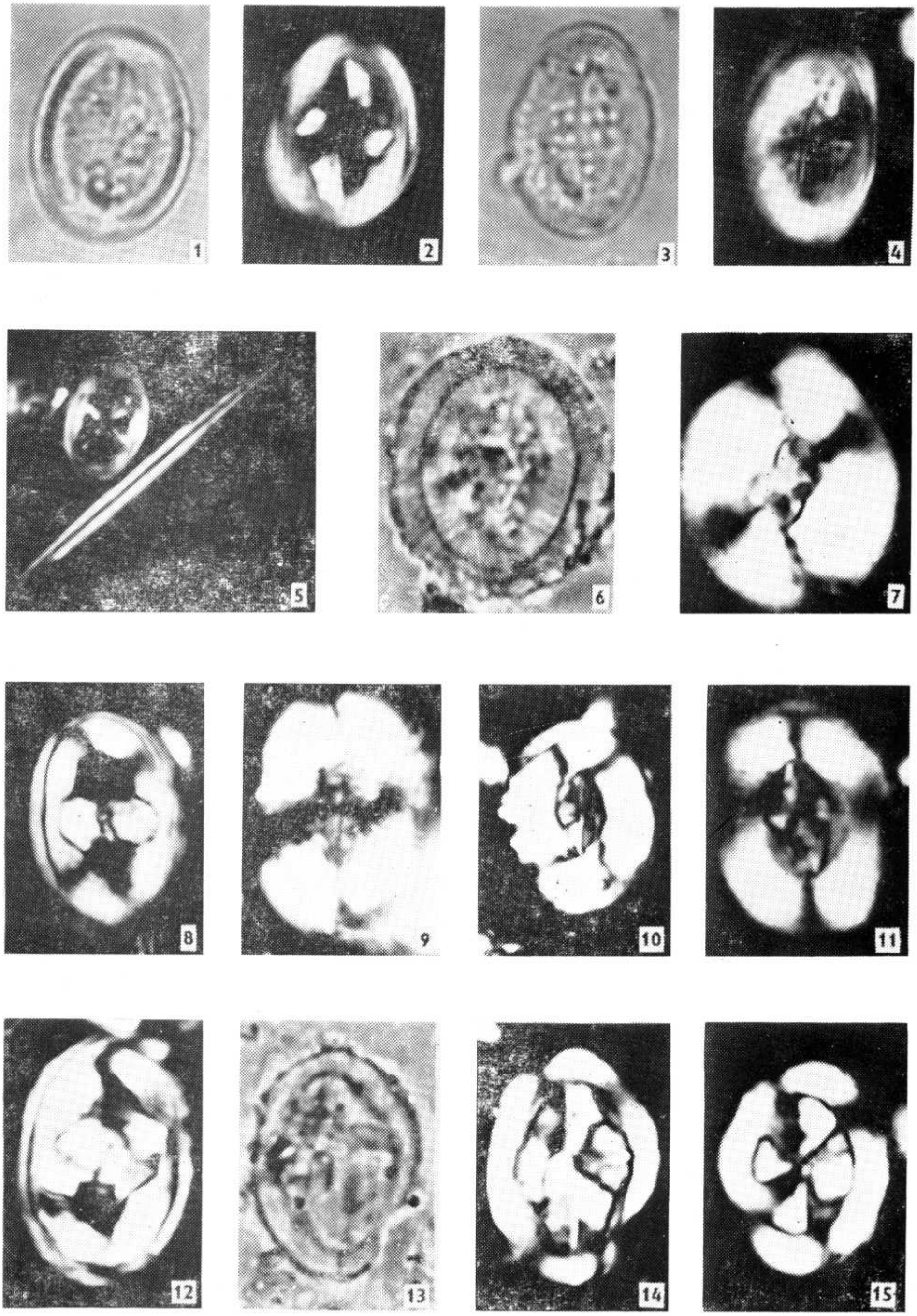
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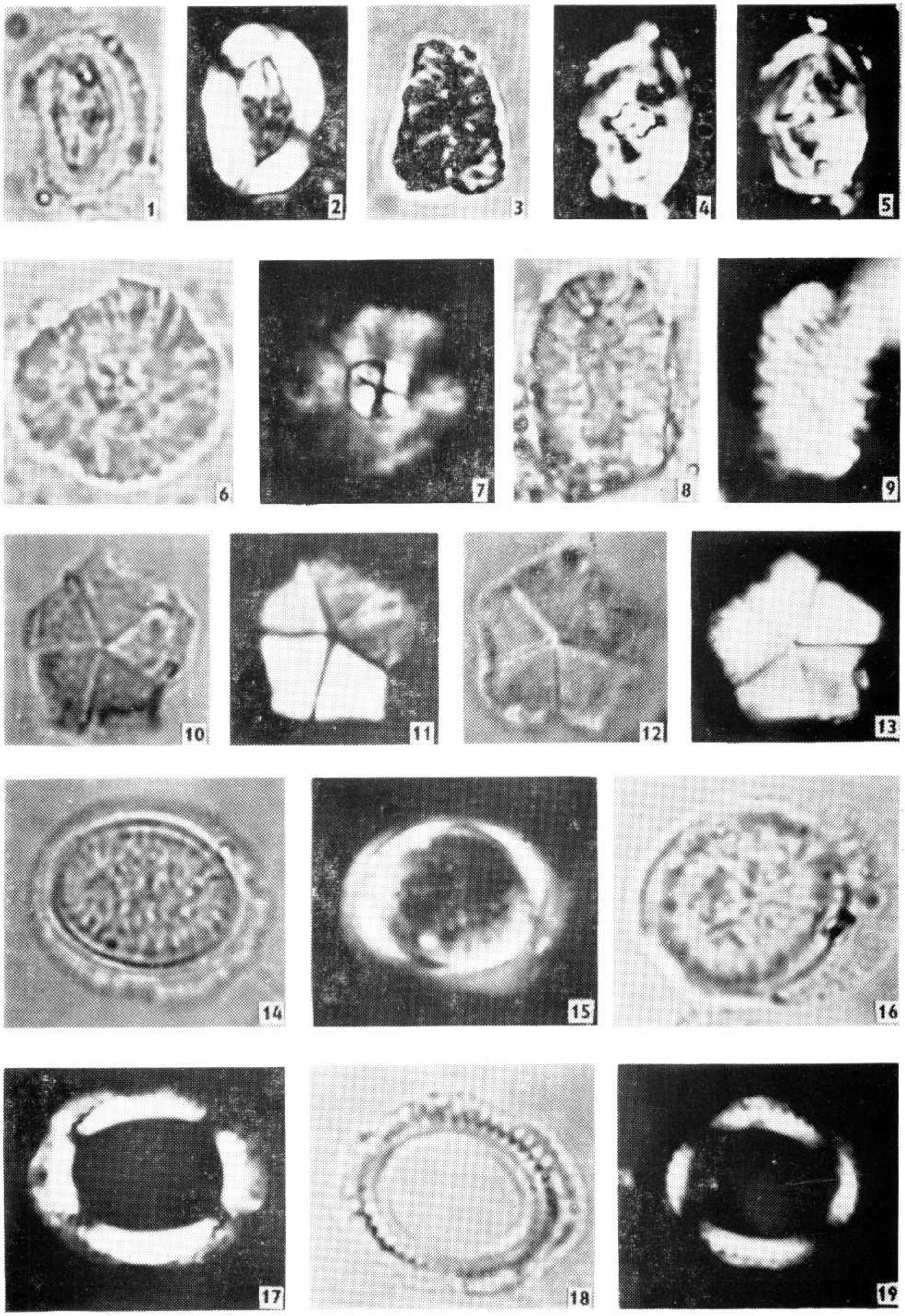
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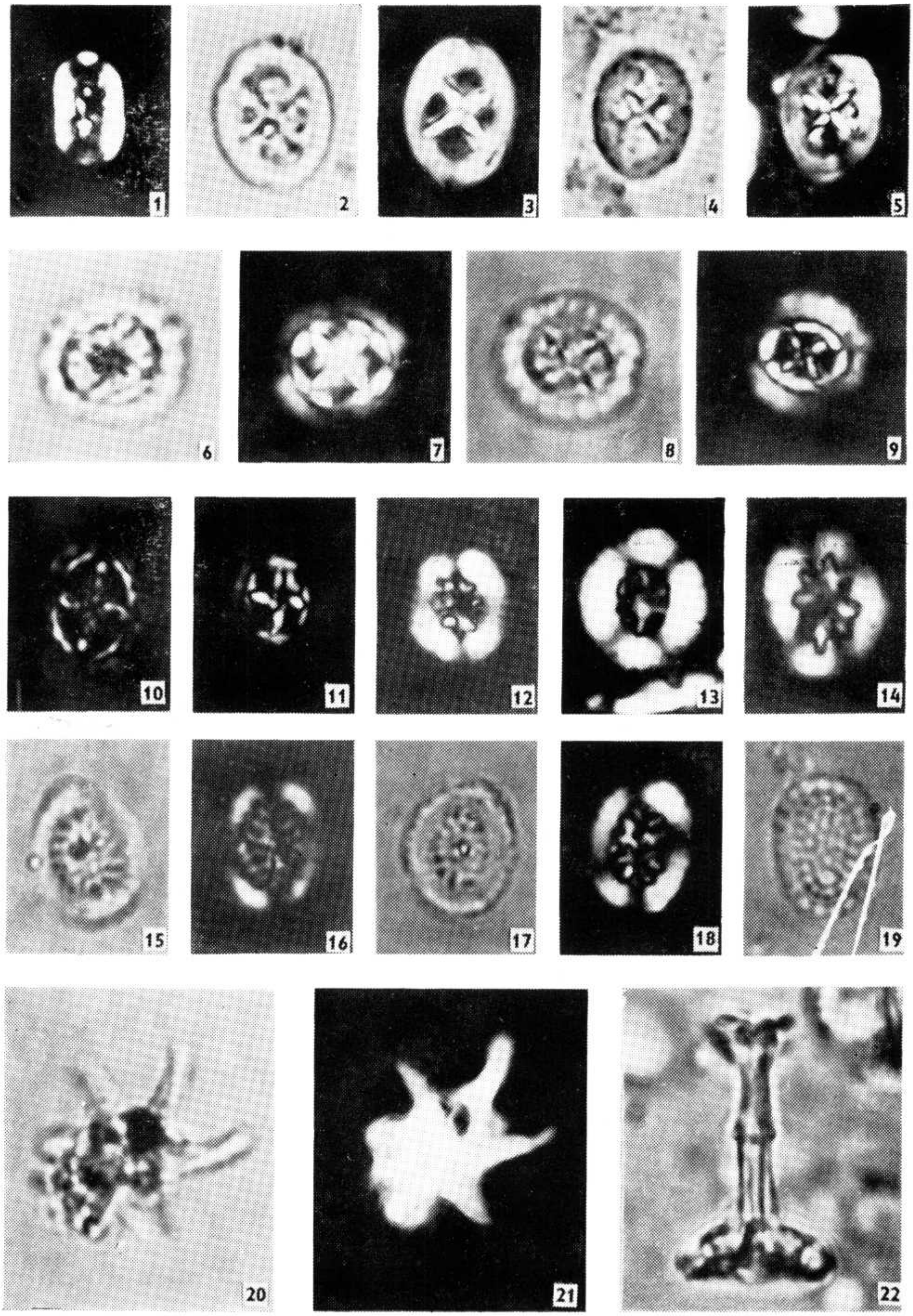
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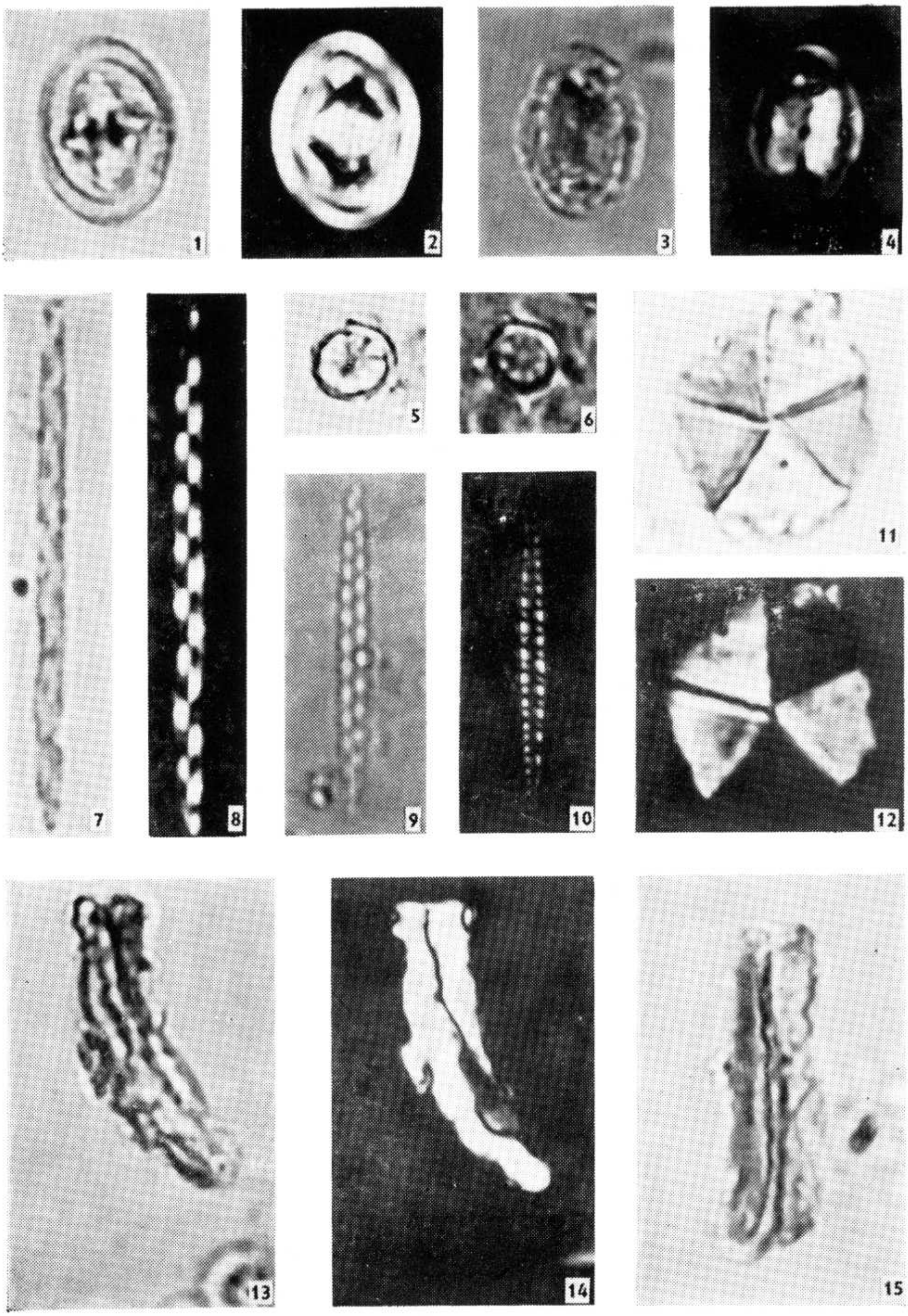
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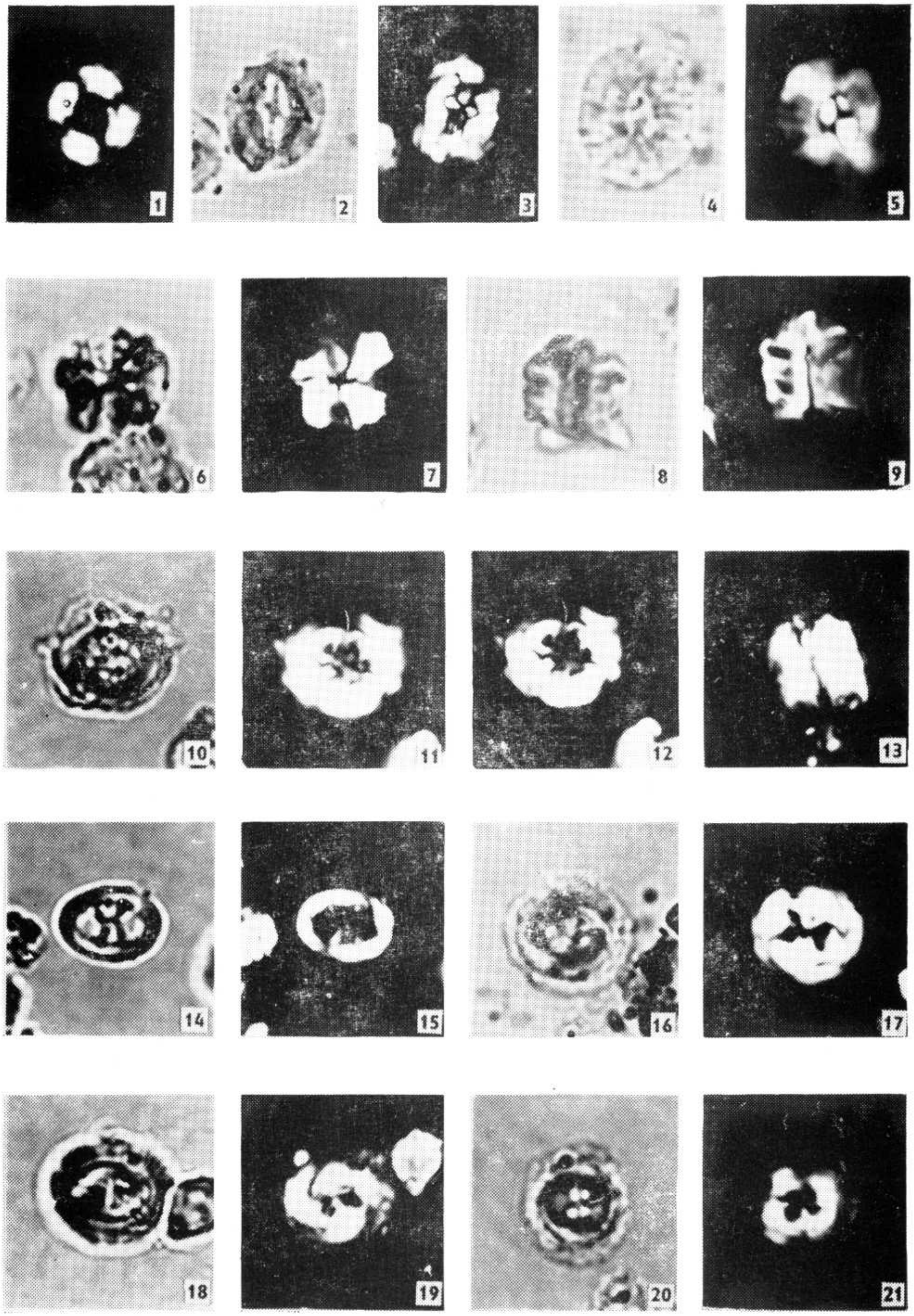
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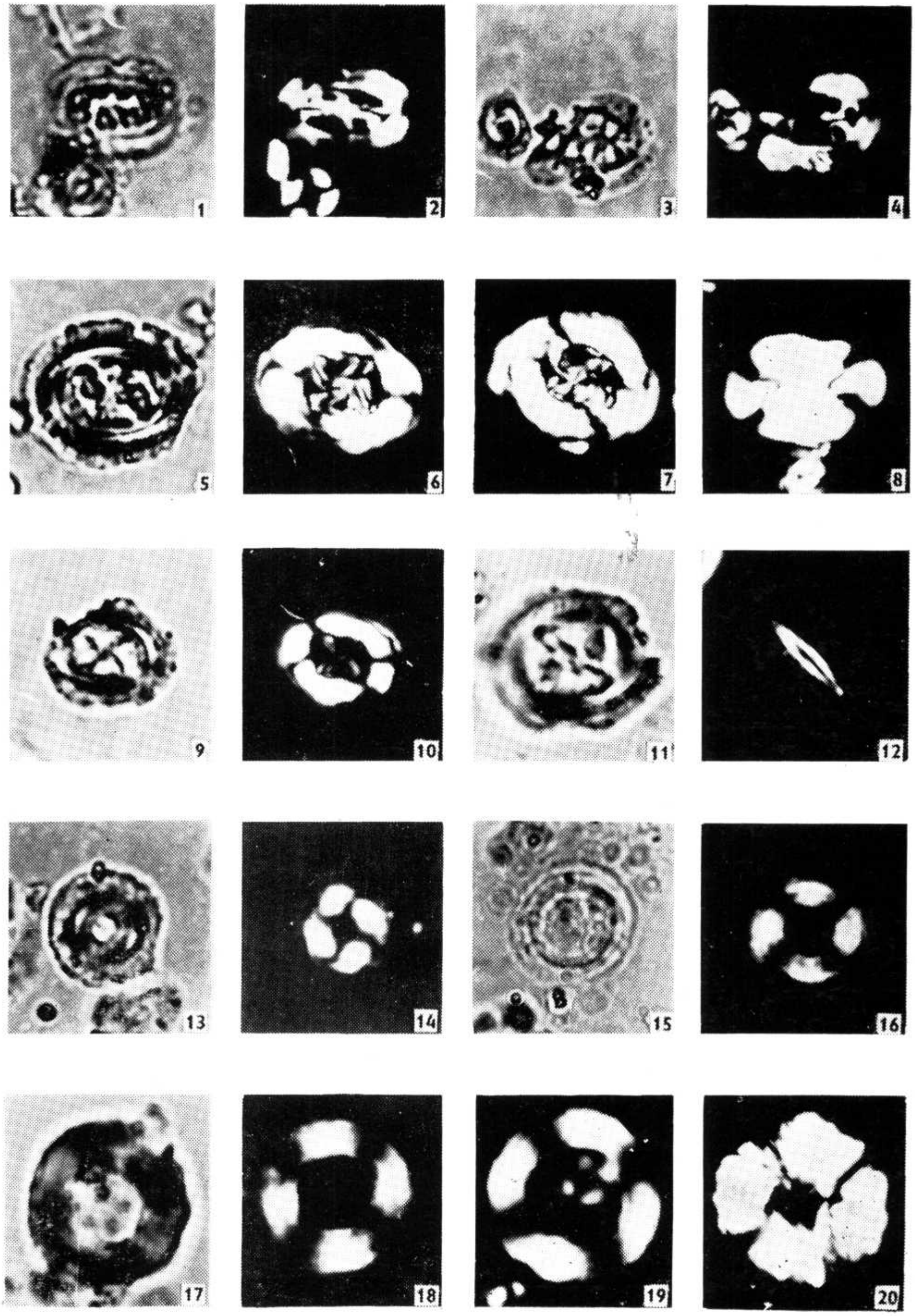
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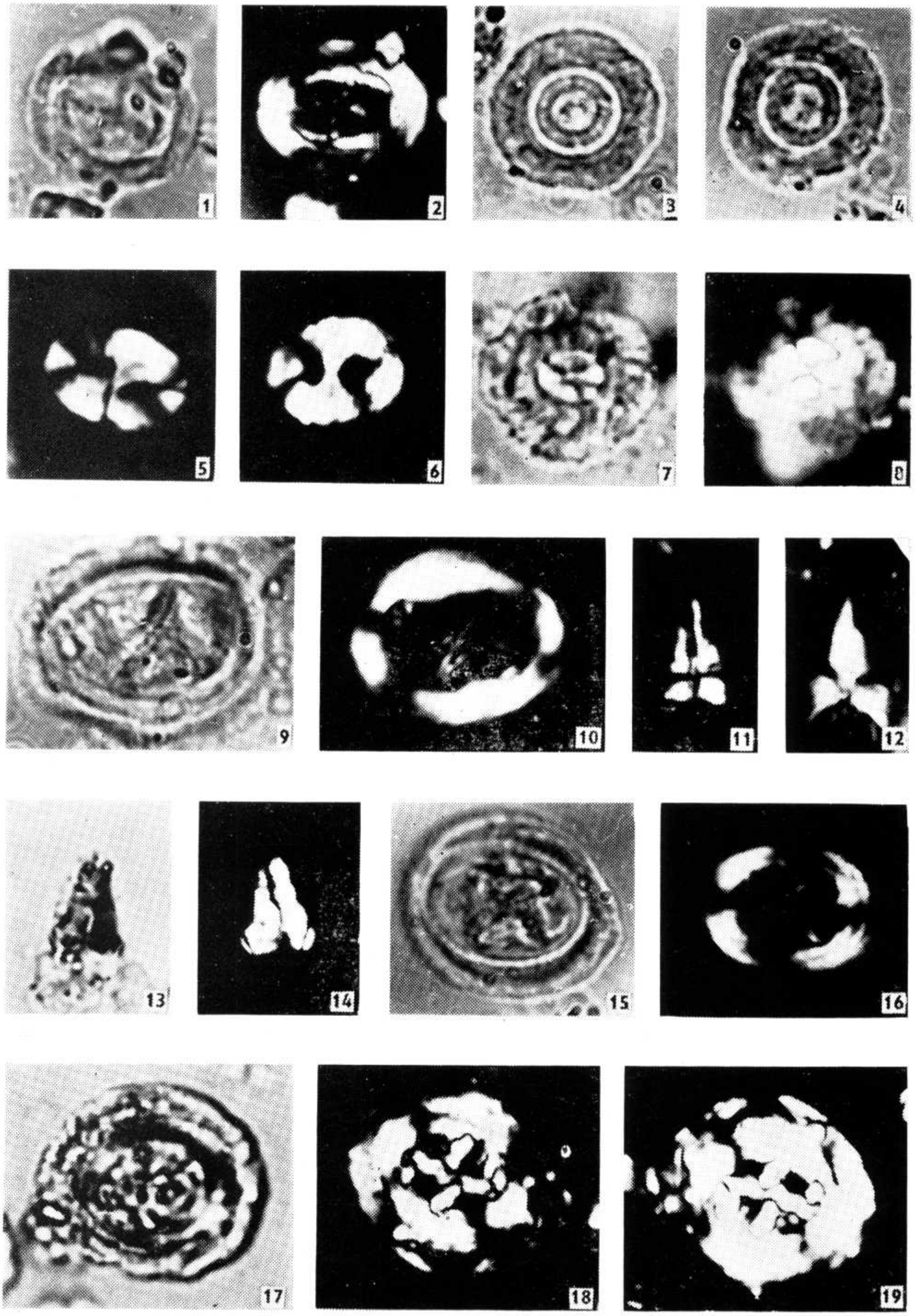
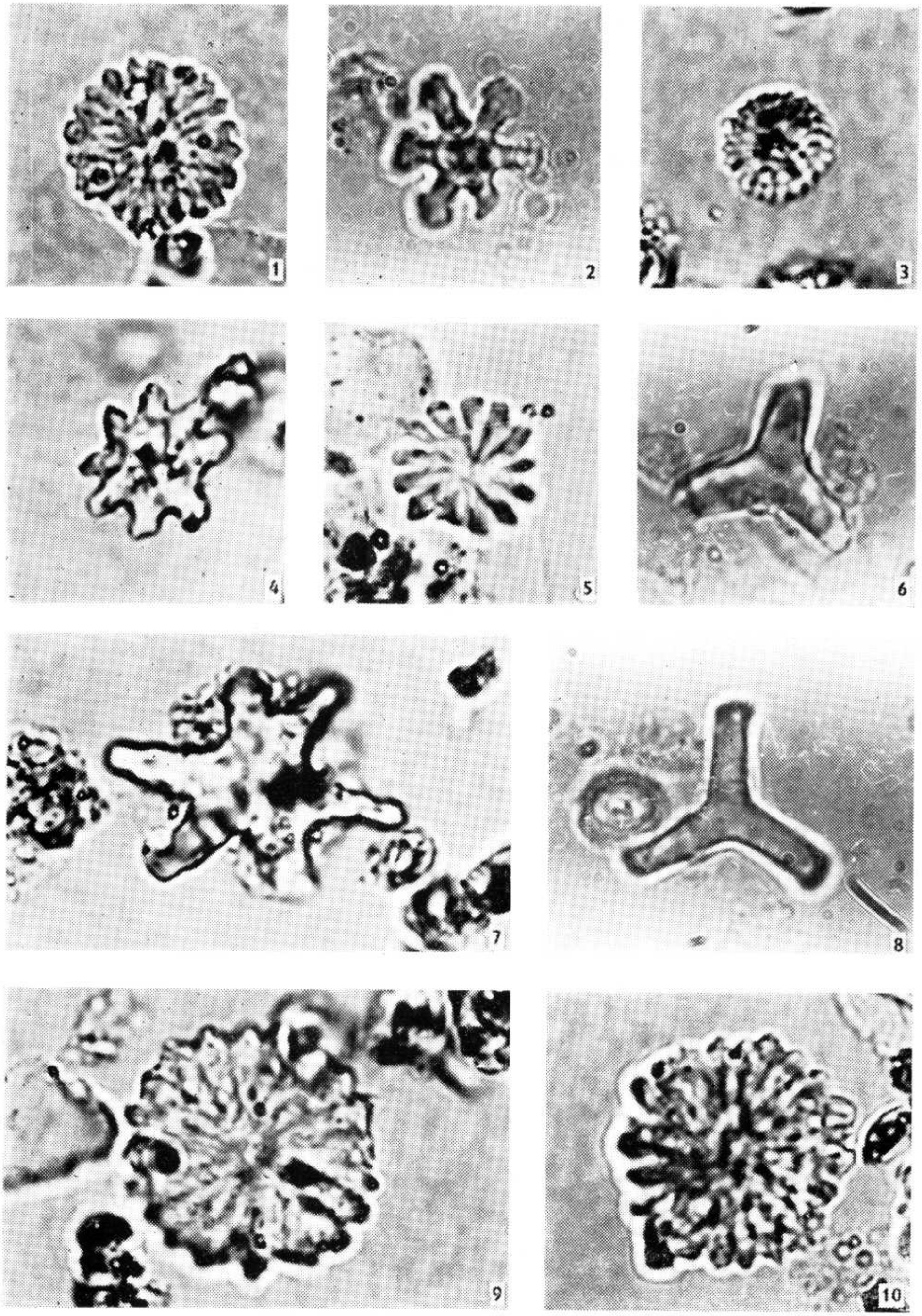
Pl. X

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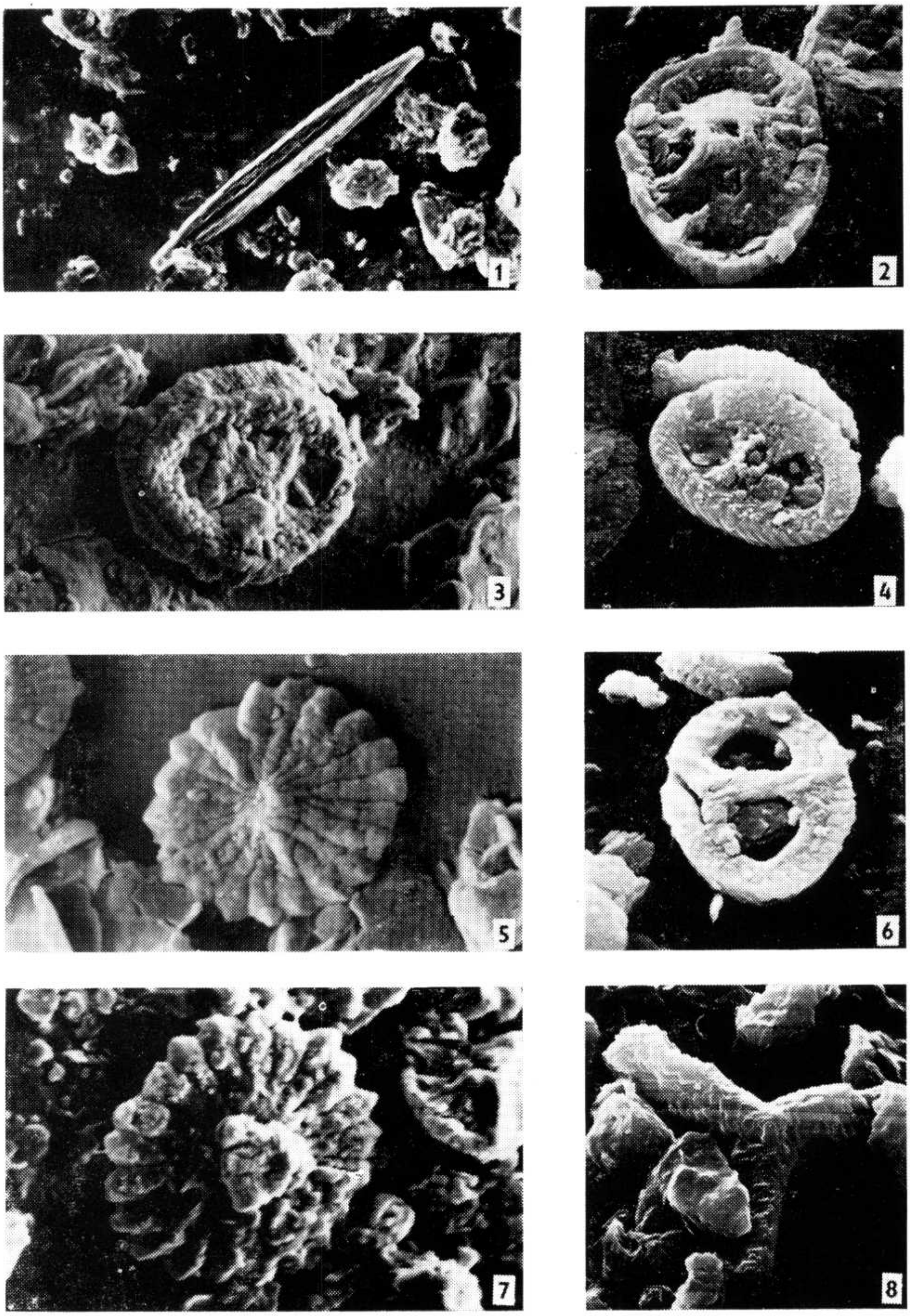
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v hlubokovodním prostředí pod karbonátovou kompenzační hladinou CCD. V těchto sedimentech jsou naopak relativně bohatá společenstva aglutinovaných foraminier s vyšší druhovou diverzitou a širším stratigrafickým rozsahem, velmi vzácně se vyskytuje plankton.

Vápnité nanofosilie nacházíme: 1. ve vápnitých i velmi slabě vápnitých sedimentech turbiditní fáze flyšového rytmu T_d, kde můžeme právem předpokládat vliv suspenze redeponovaného materiálu, 2. ve vápnitých jílovcích klidové fáze flyšového rytmu T_e nad hladinou CCD, kde došlo k dlouhotrvající depozici pelagického materiálu.

Известковый нанопланктон во флишевых осадочных породах белокарпатской единицы (Западные Карпаты)

Флишевые осадочные породы внешнего развития белокарпатской единицы (яворинская и своднинцкая свиты) в смысле Страника и др. (Stránik et al. 1986) содержат известковые мельчайшие ископаемые организмы, по которым можно определить относительный возраст горных пород с точностью от ярусов до зон.

В яворинской свите (кампанского до маастрихтского возраста) выделено 7 нанопланктонных зон, соответствующих частично стандартным нанопланктонным зонам в смысле Сиссинга (Sissingh 1977). В палеогене применено в полном обьеме классическое разделение на зоны в смысле Мартини (Martini 1971) в диапазоне от NP 1–2 до NP 11 (т.е. от нижнего палеогена до нижней части нижнего эоцена).

В представленной работе приводятся определения установленных нанопланктонных зон меловой системы и систематический обзор (в т.ч. также изображения) меловых и палеогеновых видов известкового нанопланктона, встречаемых в белокарпатской единице.

Přeložil A. Kříž