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CALCAREOUS NANNOPLANKTON OF THE UPPER EOCENE AND THE LOWER OLIGOCENE OF ORAVSKÁ VRCHOVINA HIGHLANDS

(Figs. 4, Pls. VIII)

Abstract: The work deals with biostratigraphy of Oravská vrchovina highlands solved on the basis of calcareous nannoplankton. Relatively bad preservation and small species diversity of the calcareous nannoplankton refers to sedimentation in deep basin (in oligolytic zone, in accordance with N. Schneidermann, 1977). Species composition of assemblage proves the Upper Eocene till the Lower Oligocene age of series of strata. Nannoplankton assemblages could be placed to nannoplankton zones NP 19, NP 20, NP 21 and correlated with 5 and 6 pollen spectrum.

Резюме: Работа занимается биостратиграфией Оравской возвышенности решенной на основе известкового нанопланктона. Относительно плохое сохранение и малое видовое разнообразие известкового нанопланктона указывает на седиментацию в глубокой котловине (в олиголытической зоне, согласно Н. Шнайдерману, 1977). Видовой состав сообщества доказывает верхнеэоценовый по нижнеолигоценовый возраст свит пластов. Нанопланктонные сообщества могли быть включены в нанопланктонные зоны NP 19, NP 20, NP 21 и коррелированы с 5 и 6 пыльцевым спектром.

Introduction

When doing geological mapping of the broader environs of Komjatná and Žaškov (in the geomorphological sense of Oravská vrchovina of its subunit Choč furrow and of Veľká Fatra of its subunit Šípska Fatra — according to E. Mazúr, M. Lukniš, 1978) — it was possible to determine the lithofacies characteristic of evolution of the intracarpathian Palaeogene in overlying stratum of Mesozoic complexes: basal transgressive lithofacies (carbonate conglomerates, breccias and sandstones, bioclastic and biogenic limestones), claystone lithofacies (claystones s. s. and claystones of the menilite type), flysch lithofacies (ratio of claystones to sandstones from 2 : 1 to 1 : 2). (See Fig. 1).

When solving stratigraphy the main stress was laid on palaeontologic contents, besides taking into consideration the lithofacial evolution. The whole territory is extremely poor on the fossil residues. Positive results were obtained with nannoflora (nannoplankton and palynomorphs).

Stratigraphy of the basal transgressive lithofacies was solved by E. Köhler. On the basis of ascertained species of big foraminifera: *Nummulites perforatus* (Monfort), *Nummulites puschi* D'Archiac, *Nummulites striatus minor* D'Archiac et Haime, *Alveolina elongata* D'Orbigny, *Alveolina boscii* Defrance, *Orbitolites complanatus* Lamarck, *Assilina exponens* (Sowerby), *Fabiania cassis* Silvestri he places this lithofacies to the Middle Eocene — the Upper Lutetian (oral report).

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Stratigraphy of the both overlying lithofacies is solved by means of calcareous nannoplankton and palynomorphs. The subject of this work is biostratigraphic analysis of calcareous nannoplankton assemblages obtained from the studied area.

Biostratigraphy

Seven samples from claystone lithofacies rocks were taken for the study of calcareous nannoplankton. Four samples with most abundant representation of nannoflora were studied using scanning electron microscope — JSM — U_3 (see Fig. 2). This is question of calcareous claystones of grey to grey-yellow

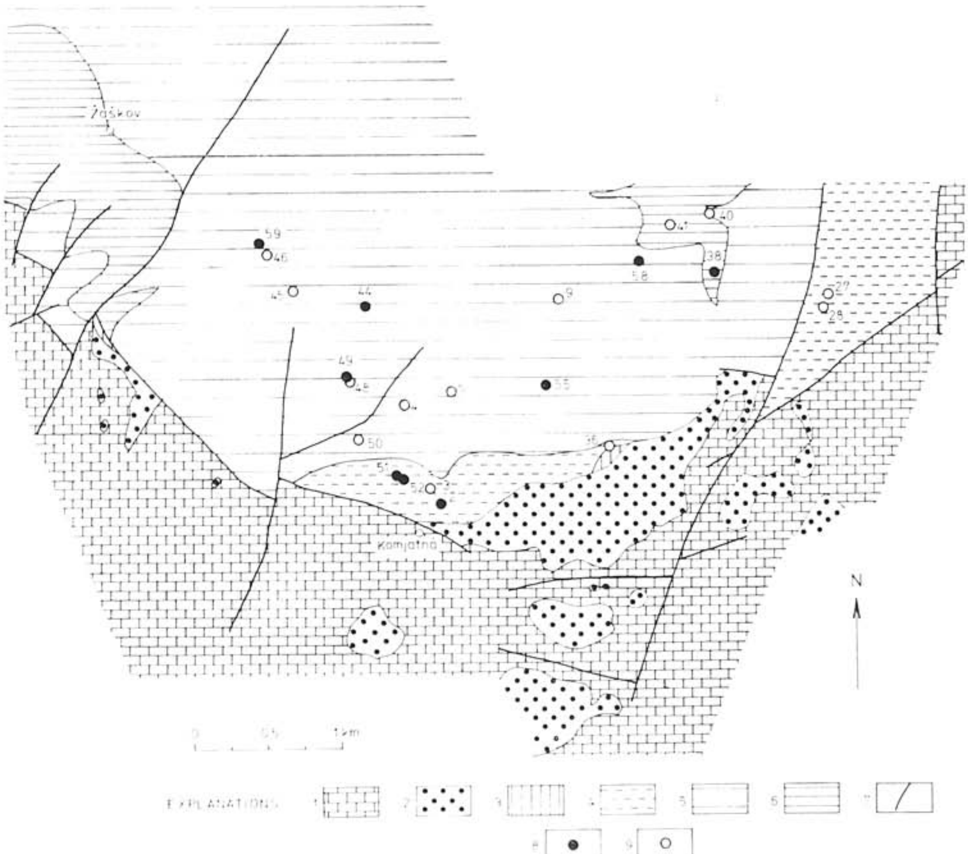


Fig. 1. Geological map of the broader environs of Komjatná and Žaškov (compiled by M. Peterčáková, 1981) with indication of sampling.
Explanations: 1. Mesozoic (Choč nappe — the Middle Triassic, Krížna nappe — the Upper Jura — the Middle Cretaceous); 2. basal transgressive lithofacies — the Upper Lutetian; 3. strata of menilite type — Priabonian (?); 4. claystone lithofacies — Priabonian; 5. flysch lithofacies — the Upper Priabonian — the Lower Oligocene; 6. flysch lithofacies (prevalence of claystones) — the Upper Priabonian — the Lower Oligocene; 7. faults; 8. the samples studied by JSM-U_3; 9. the taken samples

Lithofacies	claystone				flysch					
Sample number	2	51	52	52'	38	44	49	55	58	59
Coccolithus eopelagicus	○		○	○	○			○	○	○
Coccolithus pelagicus	○	○	○	○	○	○	○	○	○	○
Ericsoniella subdisticha		○								
Cyclicargolithus floridanus	○	○			○			○		
Cycloccolithus formosus	○	○	○	○	○	○	○	○	○	○
Dictyococcites cf. daviesi	○									
Dictyococcites bisectus	○		○	○	○	○	○		○	
Dictyococcites ornatus						○				
Reticulofenestra umbilica		○				○		○		○
Transversopontis obliquipons	○									
Isthmolithus recurvus	○									
Discoaster barbadiensis	○			○			○			○
Discoaster deflandrei	○									
Discoaster cf. tani										○
Discoaster saipanensis	○				○		○		○	
Discoaster cf. sublodoensis									○	
Coronocyclus serratus				○						

Fig. 2. Representation of calcareous nannoplankton in the samples studied by SEM.

colour, leaflet, schistose and conchoidal cleavage. They have frequent coating of Fe and Mn oxides, as well as laminae of carbonaceous detritus on divisional planes. From claystones the assemblage of calcareous nannoplankton was obtained, being represented by the following species: *Coccolithus eopelagicus, Coccolithus pelagicus, Ericsoniella subdisticha, Cyclicargolithus floridanus, Cyclococcolithus formosus, Dictyococcites cf. daviesi, Dictyococcites bisectus, Reticulofenestra umbilica, Transversopontis obliquipons, Isthmolithus recurvus, Discoaster barbadiensis, Discoaster deflandrei, Discoaster saipanensis* and *Coronocyclus serratus.*

The found assemblages are characterized by frequent occurrence of genera *Coccolithus* and *Cyclococcolithus. Coccolithus pelagicus* and *Cyclococcolithus formosus* are in absolute majority. The occurrence of genus *Isthmolithus recurvus* is of stratigraphic importance.

On the basis of qualitative species analysis the assemblage of calcareous nannoplankton obtained from the claystone lithofacies sediments could be placed to the middle part of the Upper Eocene — the Middle Priabonian.

In the sense of standard zonation of E. Martini (1971) NP 19 — *Isthmolithus recurvus* biozone is in question.

		Priabonian		Lower Oligocene	
	NP	NP 19	NP 20	NP 21	NP
Coccolithus eopelagicus	13				25
Coccolithus pelagicus	10				R
Ericsoniella subdisticha	?				
Cyclicargolithus floridanus	15				NN (?)
Cyclococcolithus formosus	12				22
Dictyococcites cf. daviesi	1			?	(?)
Dictyococcites bisectus	16				25
Dictyococcites ornatus	?				24
Reticulofenestra umbilica	15				22
Transversopontis obliquipons	17				
Isthmolithus recurvus					22
Discoaster barbadiensis	11				
Discoaster deflandrei	12				25
Discoaster cf. tani	16				23
Discoaster saipanensis	16				
Discoaster cf. sublodoensis		redeposited			
Coronocyclus serratus					

Fig. 3. Stratigraphic range of determined species of calcareous nannoplankton (according to E. Martini, 1971).

Fifteen samples were taken from flysch lithofacies rocks, six of them were examined by means of SEM. The obtained assemblage is represented by species: *Coccolithus eopelagicus, Coccolithus pelagicus, Cyclicargolithus floridanus, Cyclococcolithus formosus, Dictyococcites bisectus, Dictyococcites ornatus, Reticulofenestra umbilica, Discoaster barbadiensis, Discoaster cf. tani, Discoaster saipanensis, Discoaster cf. sublodoensis.*

Determined assemblages are characterized also by frequent occurrence of genera *Coccolithus (Coccolithus pelagicus)* and *Cyclococcolithus (Cyclococcolithus formosus)*. Also the species *Reticulofenestra umbilica* and *Dictyococcites bisectus* could be marked as species of more abundant occurrence.

Assemblage of calcareous nannoplankton obtained from flysch lithofacies rocks on the basis of its species taxonomic analysis could be placed to the Upper Eocene — the most upper Priabonian till the Lower Oligocene.

Following zones are concerned:

NP 20 *Sphenolithus pseudoradians*

NP 21 *"Ericsonia" subdisticha*

Also species *Dictyococcites ornatus* was obtained from the samples of this lithofacies, its occurrence is given by C. Müller (1970) in zones NP 23 and

SERIES	STAGE	LITHOFACIES	ASSEMBLAGES OF FORAMINIFERS	CALCAREOUS NANNOPLANKTON: standard biozones /E. Martini, 1971/		CALCAREOUS NANNOPLANKTON: ascertained more significant species	SPORES AND POLLEN-GRAINS: spectrums /P. Snopková, 1977/	SPORES AND POLLEN-GRAINS: ascertained more significant species
OLIGOCENE	Lower	FLYSCH		NP 21	„ERICSONIA" SUBDISTICHA	Ericsoniella subdisticha Cyclicargolithus floridanus Dictyococcites ornatus Transversopontis obliquipons	PS_6	Arecipites granulatus Sciadopityspollenites quintus Caryapollenites simplex Polyatriopollenites stellatus Trivestibulopollenites betuloides Boehlensipollis hohli Arecipites cf. wiesaensis Alnipollenites verus Monocolpopollenites tranquillus
EOCENE	Priabonian	FLYSCH / CLAYSTONE		NP 20	SPHENOLITHUS PSEUDORADIANS	Cyclococcolithus formosus Dictyococcites daviesi D. bisectus Reticulofenestra umbilica Discoaster barbadiensis D. saipanensis		
		CLAYSTONE		NP 19	ISTHMOLITHUS RECURVUS	Isthmolithus recurvus Dictyococcites daviesi D. bisectus Discoaster barbadiensis D. saipanensis	PS_5	Compositiopollenites rhizophorus Cupanieidites minimus Cicatricosisporites dorogensis Plicapollis pseudoexcelsus Alnipollenites verus Monocolpopollenites tranquillus Cupuliferoidaepollenites liblarensis
				NP 18	CHIASMOLITHUS OAMARUENSIS	unascertained		
				NP 17	DISCOASTER SAIPANENSIS	unascertained		
	Upper Lutetian	BASAL	Nummulites perforatus N. puschi, N. anomalus N. striatus minor Alveolina elongata Orbitolites complanatus Assilina exponens Fabiania cassis Gyroidinella carpathica Sphaerogypsina globula					

Fig. 4. Lithologic-biostratigraphic correlative table (M. Peterčáková, 1981).

NP 24 (the Middle Oligocene). On the basis of our ascertainment we may deduce that they occur already in zone NP 21, or NP 20 (?). (See Fig. 3).

Besides the calcareous nannoplankton the spores and pollen-grains were obtained from the samples of Oravská vrchovina highlands, on the basis of which it was possible to correlate nannoplankton bizones with pollen spectrums being determined in the West Carpathians by S. Snopková (1977). (See Fig. 4). Spores and pollen-grains typical of pollen spectrum were found in samples from which the assemblage of nannoflora corresponding to zone NP 19 and lower part of zone NP 20 was obtained. In the samples, in which the species belonging to upper part of zone NP 20 and zone NP 21 were determined, palynomorphs first occurrence of which was described by P. Snopková (in P. Gross — E. Köhler et al., 1980) and W. Krutzsch (1962) from sediments of the Lower Oligocene, or the Middle Oligocene *(Boehlensipollis hohli, Arecipites wiesensis)* were ascertained. They characterize the pollen spectrum 6.

Preservation

N. Schneidermann (1977) deals with selective dissolution of recent coccoliths in the Atlantic Ocean. On the basis of state of preservation of the tests he subdivides "the compensation zone", i.e. the zone in which solution of $CaCO_3$ occurs, into 5 zones:

1. Alytic, which occurs 3500 m or more above the CCCD (= calcium carbonate compensation depth — area where the total solution of calcareous nannoplankton occurs) and preservation of tests is good.

2. Eolytic — occuring 3000 m above the CCCD in which initial dissolution of less resistant tests occurs.

3. Oligolytic, which in low geographic latitudes occurs at depths of 4400 m — 5500 m. Its upper boundary corresponds with lysocline which gives the level of rapid increase in the rate of dissolution of planktonic foraminifera and calcareous nannoplankton assemblages. In the lower part of this zone certain parts of more resistant species are soluble, e.g. the proximal shield of *Coccolithina leptopora* and *Coccolithus pelagicus.* Planktonic foraminifera disappear at the base of the zone. In higher geographic latitudes increased rates of solution occur at shallower depths.

4. Mesolytic zone is the lowest part of the compensation zone and immediately overlies the CCCD. Mostly only distal shields of solution-resistant forms (e.g. *Coccolithus pelagicus)* are preserved.

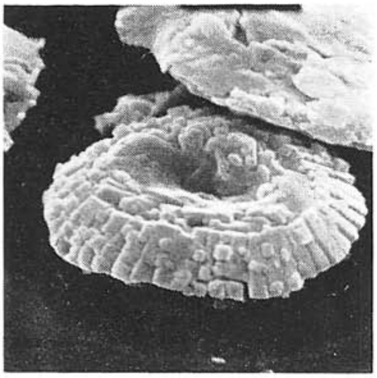
5. Hololytic zone occurs below the CCCD and there is no one form preserved in it.

Species composition of the obtained assemblage, its preservation and absence of planktonic foraminifera indicate the lower part of oligolytic zone.

But this recent model can't be applied on the past because of the frequent oscillation of the CCCD, which is dependent on the factors which have been changed in the course of past geological periods, e.g. temperature, pressure, physical and chemical properties of water, rate of $CaCO_3$ production etc.

The results were obtained from equatorial region, i.e. from low latitudes. Due to the fact that waters in higher latitudes are cooler, richer in CO_2, the solvent ability of $CaCO_3$ is increasing. So the CCCD should occur at lower

Plate I



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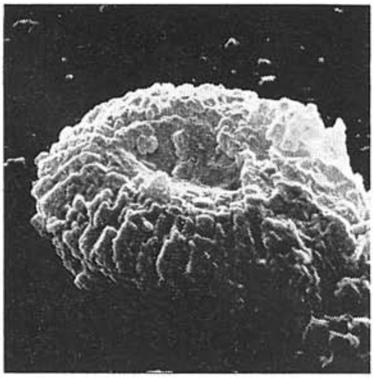

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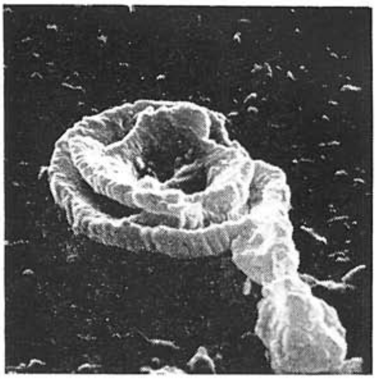

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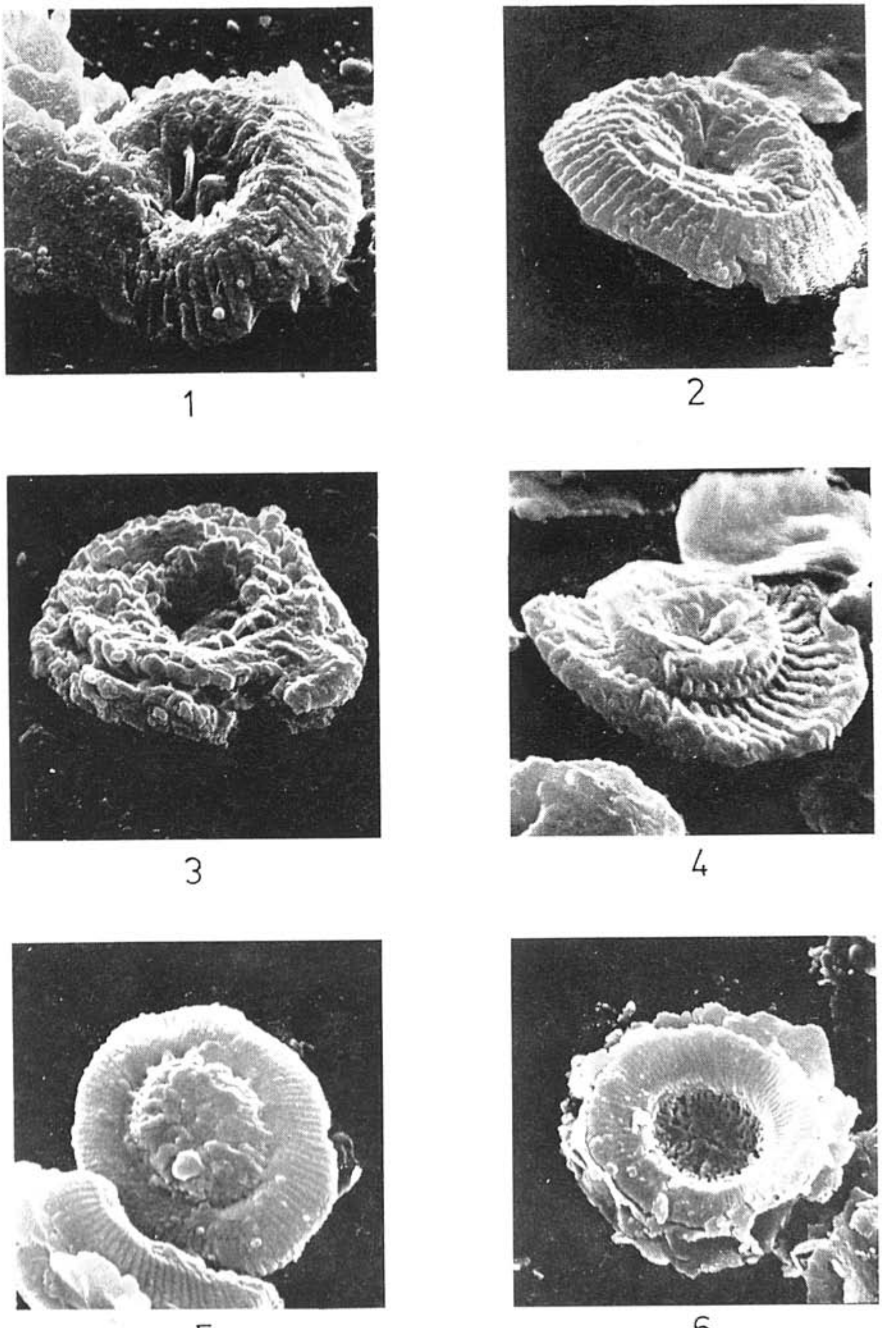
Plate II



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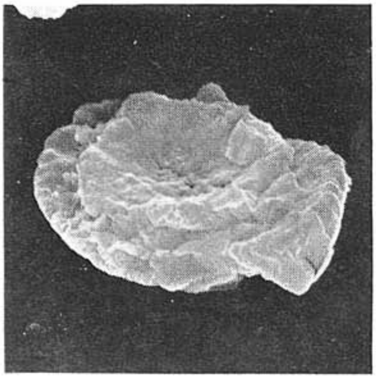

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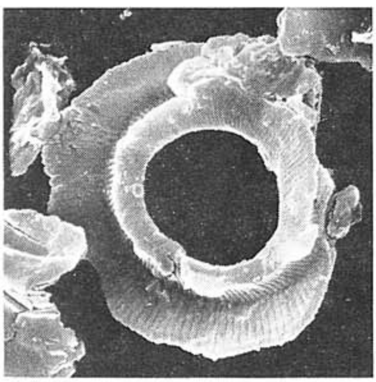

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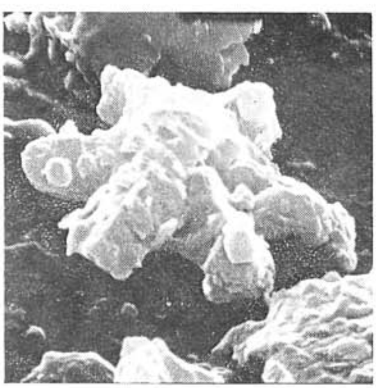

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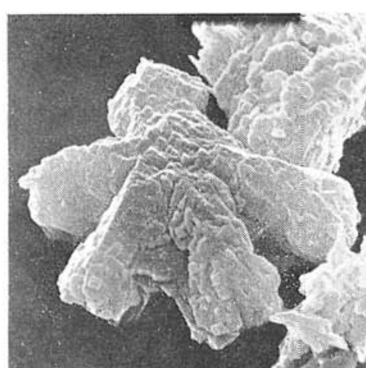

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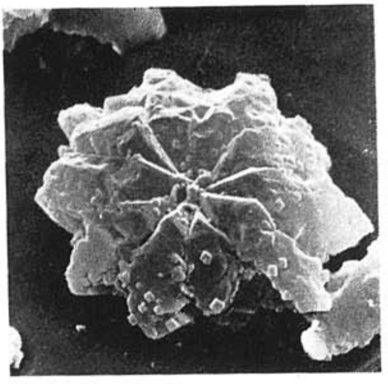
Plate IV



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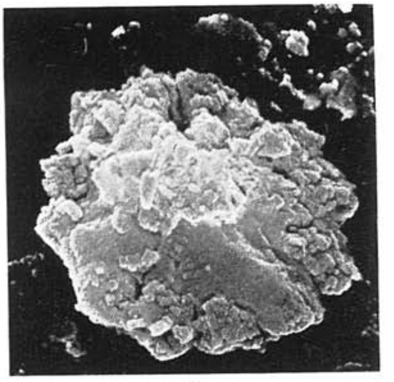

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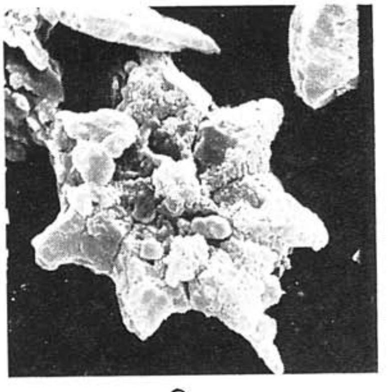

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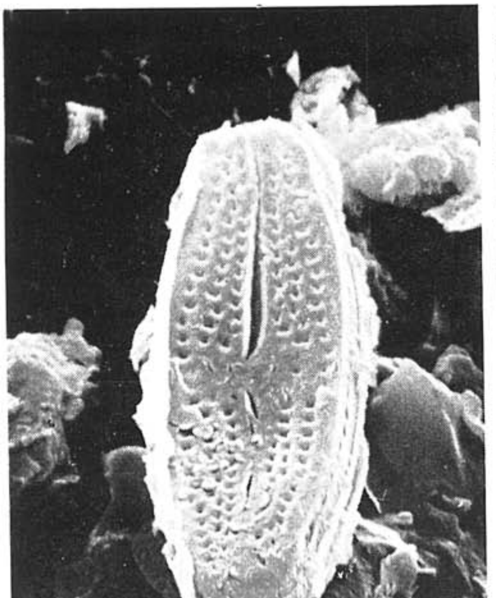

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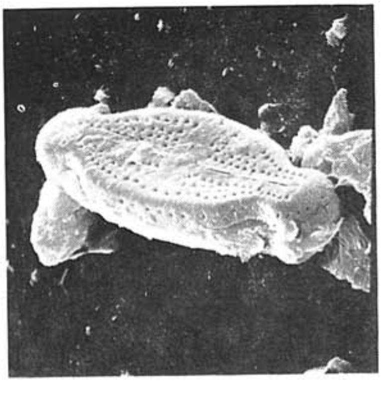

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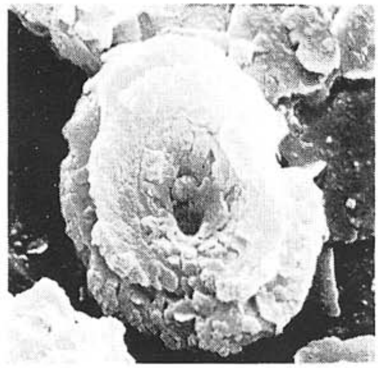

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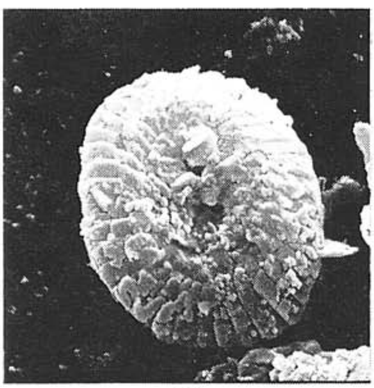

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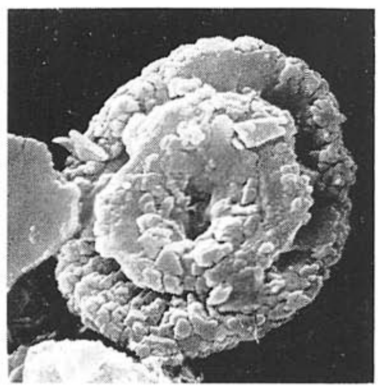

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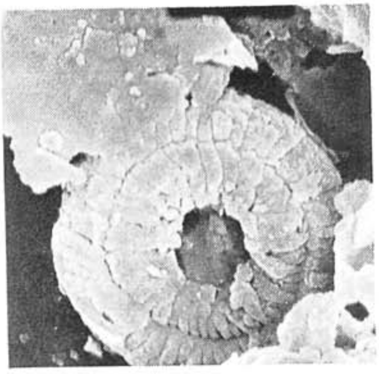

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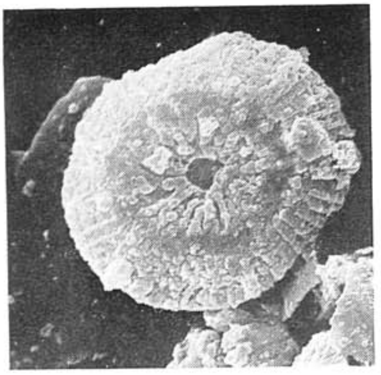

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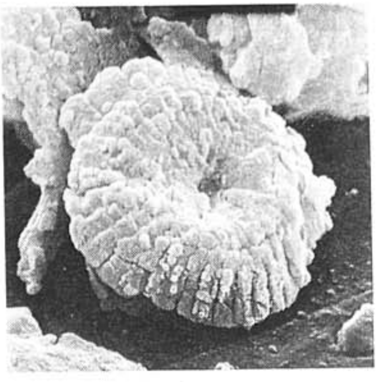

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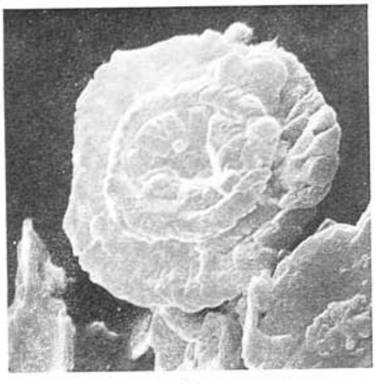

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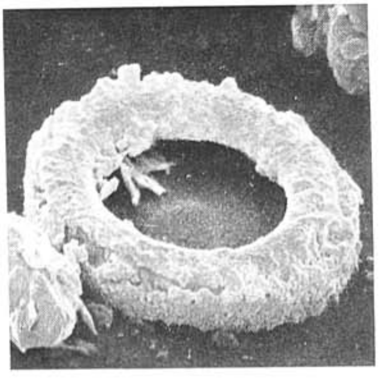

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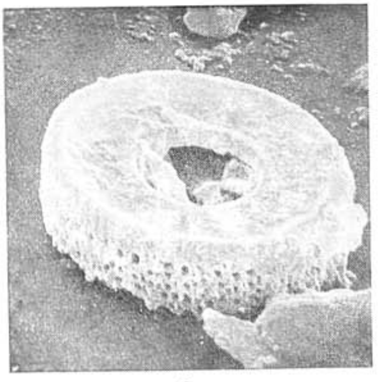

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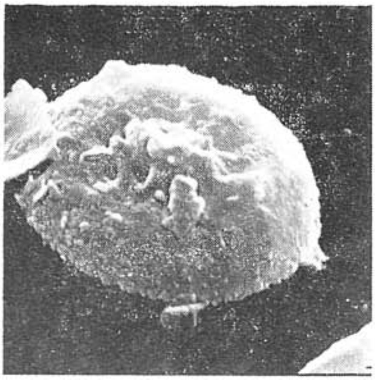

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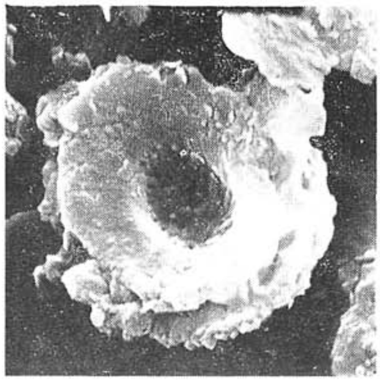

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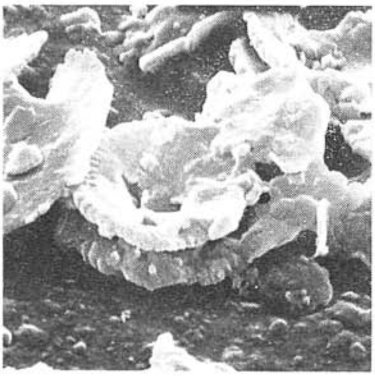

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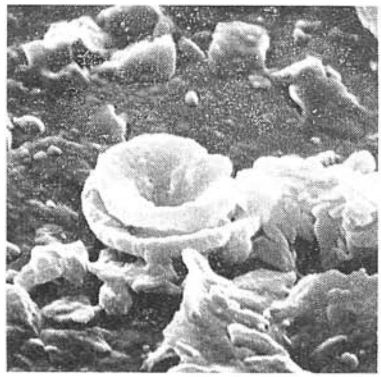

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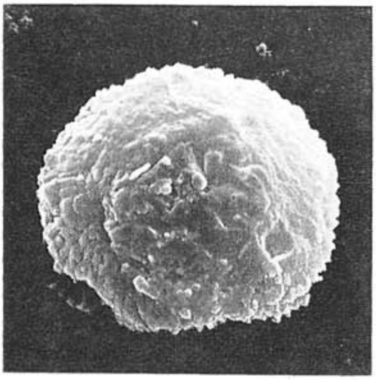

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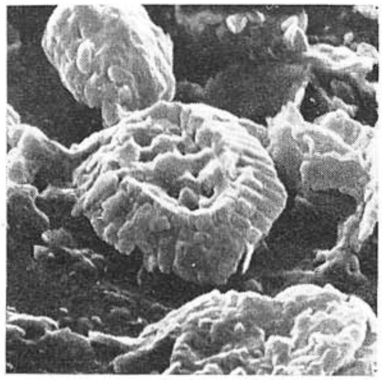

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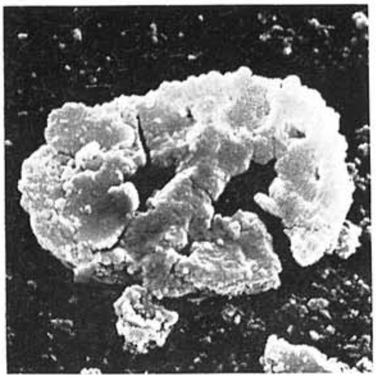
Plate VIII



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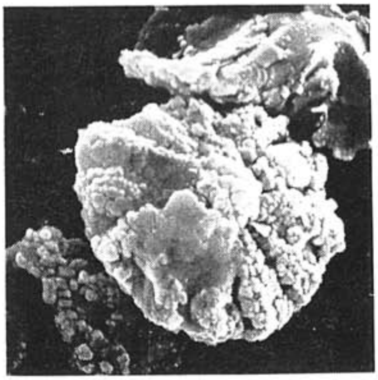

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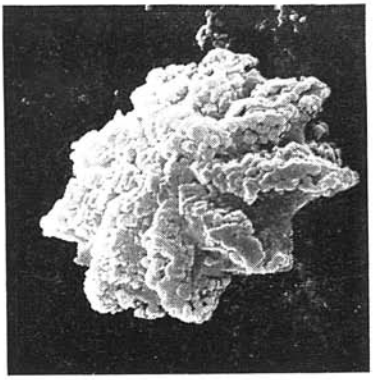

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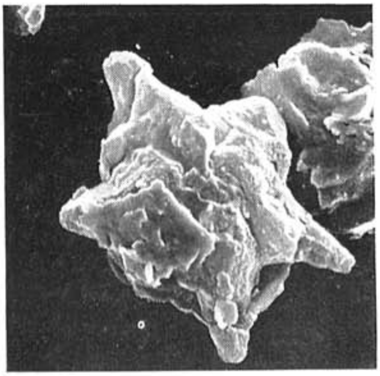

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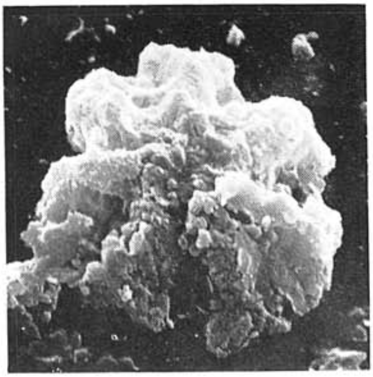

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Plate I

Figs. 1—4. *Coccolithus pelagicus* (Wallich) Schiller, distal view, x 4500.
Figs. 5—6. *Cyclicargolithus floridanus* (Roth et Hay) Bukry, proximal view, x 5000.

Plate II

Figs. 1—2. *Cyclococcolithus formosus* Kamptner, distal view, x 4000.
Figs. 3—4. *Cyclococcolithus formosus* Kamptner, proximal view, x 4000.
Fig. 5. *Dictyococcites ornatus* (Müller) Bystrická, distal view, x 5000.
Fig. 6. *Dictyococcites ornatus* (Müller) Bystrická, proximal view, x 4000.

Plate III

Fig. 1. *Dictyococcites bisectus* (Hay, Mohler et Wade) Bukry et Percival, proximal view, x 4000.
Fig. 2. *Dictyococcites bisectus* (Hay, Mohler et Wade) Bukry et Percival, distal view, x 4500.
Fig. 3. *Reticulofenestra umbilica* (Levin) Martini et Ritzkovski, proximal view, x 3500.
Fig. 4. *Reticulofenestra umbilica* (Levin), Martini et Ritzkovski, distal view, x 3500.
Fig. 5. *Discoaster cf. tani* Bramlette et Riedel, distal view, x 5000.
Fig. 6. *Discoaster deflandrei* Bramlette et Riedel, distal view, x 4000.

Plate IV

Figs. 1—2. *Discoaster barbadiensis* Tan Sin Hok, x 3500.
Fig. 3. *Discoaster saipanensis* Bramlette et Riedel, x 2500.
Fig. 4. *Achnanthes sp.*, x 4500.
Fig. 5. *Achnanthes sp.*, x 2750.

Plate V

Figs. 1, 6. *Coccolithus eopelagicus* (Bramlette et Riedel) Bramlette et Sullivan, distal view, x 4000.
Fig. 2. *Coccolithus eopelagicus* (Bramlette et Riedel) Bramlette et Sullivan, proximal view, x 4000.
Fig. 3. *Coccolithus pelagicus* (Wallich) Schiller, distal view, x 4500.
Fig. 4. *Cyclococcolithus formusus* Kamptner, proximal view, x 4500.
Fig. 5. *Coccolithus eopelagicus* (Bramlette et Riedel) Bramlette et Sullivan, distal view, x 2250.

Plate VI

Figs. 1, 3. *Cyclococcolithus formusus* Kamptner, distal view, x 4500.
Fig. 2. *Cyclococcolithus formusus* Kamptner, distal view, x 3500.
Fig. 4. *Cyclococcolithus formusus* Kamptner, proximal view, x 4500.
Fig. 5. *Coronocyclus serratus* Hay, Mohler et Wade, x 3750.
Fig. 6. *Melosira scala* (Ehrb.) Ralfs, x 4000.

Plate VII

Fig. 1. *Dictyococcites daviesi* (Haq) Perch — Nielsen, distal view, x 5000.
Fig. 2. *Dictyococcites daviesi* (Haq) Perch — Nielsen, proximal view, x 4500.
Figs. 3—4. *Cyclicargolithus floridanus* (Roth et Hay) Bukry, proximal view, x 5000.
Fig. 5. *Dictyococcites bisectus* (Hay, Mohler et Wade) Bukry et Percival, distal view, x 5000.
Fig. 6. *Ericsoniella subdisticha* (Roth et Hay) Krhovský, distal view, x 3500.

Plate VIII

Fig. 1. *Transversopontis obliquipons* (Deflandre) Hay, Mohler et Wade, x 3000.
Fig. 2. *Isthmolithus recurvus* Deflandre, distal view, x 5000.
Figs. 3—4. *Discoaster barbadiensis* TanSinHok, x 5000.
Fig. 5. *Discoaster cf. sublodoensis* Bramlette et Riedel, x 4000.
Fig. 6. *Discoaster deflandrei* Bramlette et Riedel, x 3750.

depths. Absence of the forms typical of warm waters, or their small representation (genus *Discoaster)* as well as absence of forms typical of cold waters (genus *Chiasmolithus)* and small species diversity is not a consequence of climatic conditions, but it is a result of higher solution of tests connected with increasing marine depth, whereby the solution of tests during sedimentation plays an importat role.

Conclusion

In the Upper Lutetian marine transgression on various stratigraphic members of Choč and Krížna nappes occurred during simultaneous origination of basal transgressive lithofacies rocks. After settlement of sediments of this lithofacies, expressive subsidence of ocean floor occurred which was reflected in great facies change. In the Middle Priabonian the sediments of claystone lithofacies began to settle. After the settlement of monotonous claystone series of strata, origination of sediments of turbidity current, i.e. flysch lithofacies rocks occurred in the Upper Priabonian till the Lower Oligocene. Sedimentary cycle was completed by the Lower Oligocene, though we can't exclude the possibility that on the flysch lithofacies rocks, sediments of Biely Potok sandstones type lay originally on flysch lithofacies rocks, which were desintegrated in post-palaeogene period.

The obtained assemblage of calcareous nannoplankton proves the Upper Eocene till the Lower Oligocene age of the studied series of strata. In accordance with E. Martini (1971) it was possible to class it into the three nannoplankton zones:

$$\left.\begin{array}{l}\text{zone NP 19 — } \textit{Isthmolithus recurvus} \\ \text{zone NP 20 — } \textit{Sphenolithus pseudoradians}\end{array}\right\} \text{ the Upper Eocene}$$

zone NP 21 — "*Ericsonia*" *subdisticha* — the Lower Oligocene

These biozones could be correlated with 5 and 6 pollen spectrum according to P. Snopková (1977).

Small species diversity of calcareous nannoplankton refers to sedimentation at deep depths where an important role is played by selective dissolution of skeleton ultrastructure, or less resistant tests and diagenetic effects which are dependent on lithology of rock.

Translated by O. Mišániová

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