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BIOSTRATIGRAPHY OF THE MAASTRICHTIAN TO PALEOCENE DISTAL FLYSCH SEDIMENTS OF THE RAČA UNIT IN THE UZGRUŇ SECTION (MAGURA GROUP OF NAPPES, CZECH REPUBLIC)

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Abstract: Late Maastrichtian to Paleocene distal flysch sediments of the Rača Unit (Outer Flysch Carpathians) at the Uzgruň section provided a relatively rich fossil record (foraminifers, radiolarians, calcareous nannofossils). The Upper Maastrichtian can be subdivided into three calcareous nannofossil zones and the Paleocene assigned to one agglutinated foraminiferal zone. Some prospective new marker species of agglutinated foraminifers for subdivision of the Maastrichtian–Paleocene are discussed. The well preserved (pyritized) radiolarian fauna has brought interesting data on the radiolarian biostratigraphy. The integrated microbiostratigraphy approach enabled us to find the Cretaceous/Tertiary transition in a continuous flysch sequence of one partial outcrop. The transition is characterized by an increase in the frequency of coarser turbidite intervals and disappearance of calcareous sediments. The nannofossils show the influence of both Boreal and Tethyan bioprovince on the Magura depositional area.

Key words: Western Carpathians, Magura Flysch, Cretaceous/Tertiary boundary, lithostratigraphy, biostratigraphy, calcareous nannofossils, Radiolaria, Foraminifera.

Introduction

The biostratigraphy in the Magura group of nappes of the Carpathian Flysch Belt is limited by usually missing or poorly preserved calcareous micro- and nannofossils especially in the Cretaceous to Lower Eocene sediments. In the unnamed brook near the Uzgruň settlement Pesl & Švábenická (1988) found calcareous nannofossils of CC 25 and CC 26 nannozones in the Soláň Formation. This find proved for the first time in Moravia the Cretaceous (Late Maastrichtian) age within the Soláň Formation.

Švábenická et al. (1997) studied the Uzgruň section in more detail. The rich fossil content of the flysch sediments makes the Uzgruň section important for the biostratigraphy of the Soláň Formation. The turbidite calcareous claystones contained abundant calcareous nannofossils and sporadic planktonic foraminifers. Non-calcareous hemipelagic claystones contained medium to high diversity assemblages of autochthonous agglutinated foraminifers with stratigraphically important rzehakinids. In addition, well preserved (pyritized) radiolarians were found in several layers of claystones (both turbidite and hemipelagic) below the Cretaceous/Paleocene boundary.

This paper presents the biostratigraphy of the section based on foraminifers (M. Bubík), radiolarians (M. Bąk) and calcareous nannofossils (L. Švábenická) integrated to achieve a more precise subdivision of the Upper Maastrichtian-Paleocene sediments of the Magura Flysch.

Studied section

The Uzgruň section is represented by several isolated outcrops situated along the unnamed brook (Fig. 1) NNE of the

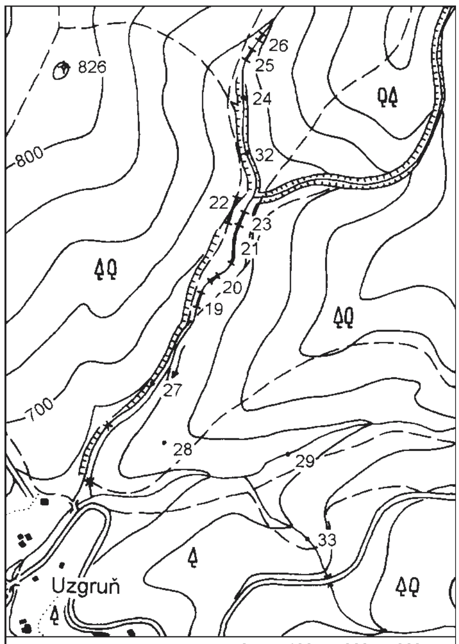

Fig. 1. Uzgruň section: situation of studied outcrops.

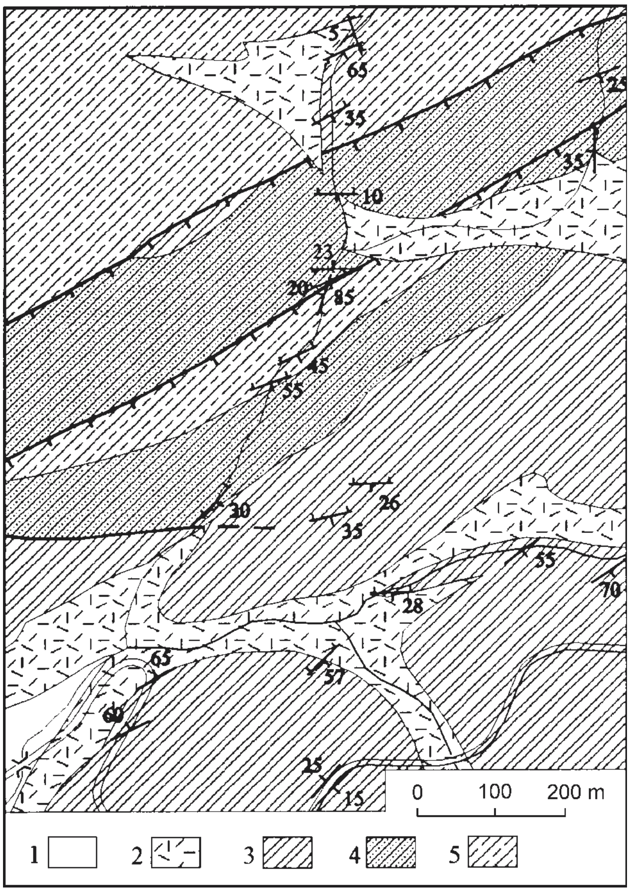

Fig. 2. Geological map of the area around the Uzgruň section: Quarternary: 1 — fluvial sediments (aluvium), 2 — deluvio-fluvial and slope sediments; Rača Unit: 3 — Beloveža Formation (Paleocene-Eocene), 4 — Soláň Formation (Paleocene), 5 — Soláň Formation (Senonian).

Uzgruň settlement (on the road from Velké Karlovice to Makov close to the Slovak border). The brook generally follows the strike of the belt consisting mostly of thin bedded flysch of the Soláň Formation (Fig. 2) with a high claystone/sandstone ratio. The succession of strata within the belt is disturbed by faults and folds as evident from measurements and biostratigraphic results. Nevertheless, the strikes of beds between 40^o and 90^o predominate.

The thin-bedded flysch consists predominantly of dark grey calcareous silty claystones and grey-green non-calcareous claystones with thin intercalations of dark grey silty sandstones and siltstones. Banks of grey and green-grey fine-grained sandstones 10 to 40 cm occur less frequently. In places grey marlstones to marly claystones occur at the base of rhythms. The Paleocene part of the formation is barren of calcareous claystones and marlstones. On the other hand, thicker sandstone beds (up to 1.35 m at maximum) seem to be more frequent.

From the sedimentological point of view, the non-complete turbidite rhythms usually consist of Te, Td-e and Tc-e members (sensu Bouma 1962) in the Maastrichtian and Td-e, Tc-e and Tb-d in the Paleocene (compare Fig. 3). In the Maastrichtian, turbidite rhythms beginning with the Te interval represent about 50 % of all turbidites, while in the Paleocene they amount to no more than 20 %. Hemipelagites (non-calcareous claystones) are regularly present between the turbidites. A lack of calcium carbonate and purely agglutinated foraminiferal fauna in the hemipelagites indicate the conditions below the CCD. Such features are evidence of very distal turbidite sedimentation probably on a lower fan-bottom plain transition.

Description of studied points:

No. 19. Low cuts along both banks of the brook exposing the slightly folded thin-bedded flysch sequence with predominance of hemipelagic grey-green non-calcareous claystones. In the lower part of the sequence, thin intercalations of dark grey calcareous silty claystones and less frequently grey pelocarbonates are present. The upper part is completely non-calcareous. A few banks of grey fine-grained calcareous sandstone (40 cm thick at maximum) representing the Tb and Tc intervals are visible. Samples 19A–19G (see Fig. 3) and 19 (in the stratigraphically highest accessible level). Soláň Formation.

No. 20. Small outcrops in the bed and both banks of the brook. Thin-bedded flysch sequence with alternating grey, dark-grey and green-grey non-calcareous and calcareous claystones, fine-grained sandstones (Tc) and more frequent grey pelocarbonates. Samples (in subsequence from the oldest) 20B, 20, 20A. Soláň Formation.

No. 21. Small outcrops in both banks of the brook. In the left bank the thin-bedded flysch consisting of claystones and fine-grained sandstones includes a thick bed of dark grey fine-grained unsorted silty sandstone and microconglomerate with silty matrix (mudflow body). In the right bank the thin-bedded flysch sequence deformed by flexure is cut by the brook in a 3.5 m high outcrop. The sequence consists of dark-grey calcareous and green-grey non-calcareous claystones alternating with thin layers of fine-grained sandstones and rarely marlstones (samples 21A, 21B). Upstream, a long right cut-bank over 4 m high shows a similar flysch sequence (sample 21C, see Fig. 3). The thin banks of grey, yellowish weathered marlstones are more frequent. Soláň Formation.

No. 22. Low road-cut in slope debris and slope loams. In places the debris contain red brown non-calcareous claystones of the Beloveža Formation, transported by gravity process from the slope.

No. 23. Rocky cascade about 7 m high formed by concentration of thick coarse- to fine-grained sandstone banks 0.6 to 1.35 m thick strongly disturbed by faults. Thin grey claystone and dark-grey silty claystone intercalations (both non-calcareous) were observed in the highest part of the sequence in the right bank (sample 23). Soláň Formation.

No. 24. Small outcrop in the right bank of the brook, mostly covered by debris. The thin-bedded flysch sequence consists predominantly of green-grey black-grey mostly non-calcareous claystones (both turbidite and hemipelagite). Limonitized fine-grained sandstones occur in thin (1–3 cm, exceptionally 10 cm) layers. Samples 24A, 24B. Soláň Formation.

No. 25. Poorly exposed outcrops in the bed and right bank of the brook covered by debris. Several sandstone banks parallel to the brook are accompanied by green-grey non-calcareous claystone (sample 25D), dark grey calcareous claystone (25C) and light grey mottled marl and grey marly limestone (25A, 25B). Soláň Formation.

No. 26. Right cut-bank exposing thin-bedded flysch sequence (Fig. 3) in subhorizontal position. The calcareous claystones (Te) of dark grey and less frequently green-grey and brown-grey colours predominate over thin layers (1 cm) of silty sandstones. Three thin banks of grey, yellowish weathered marlstone occur in

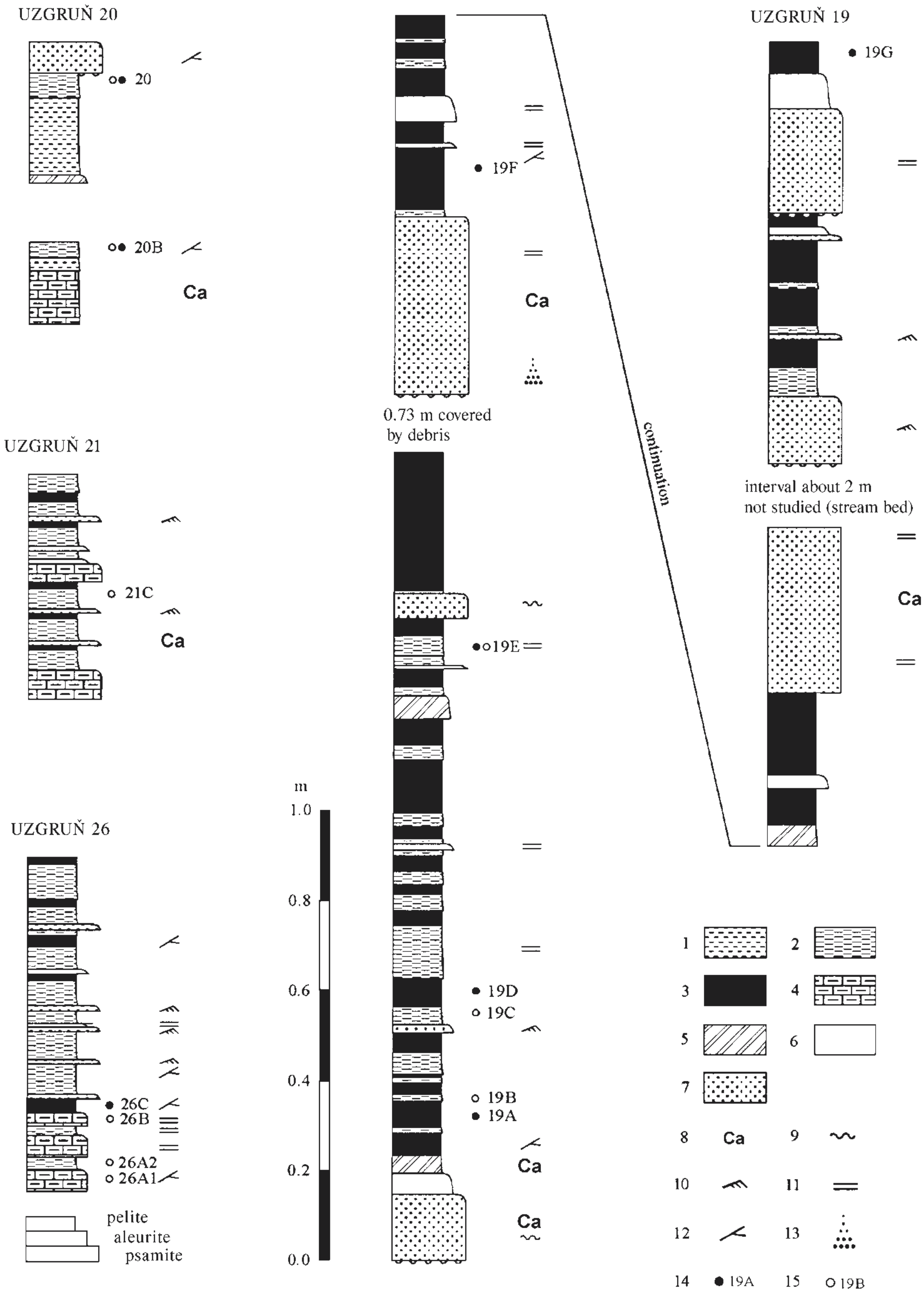

Fig. 3. Uzgruň section: lithology and sedimentology of the selected outcrops. ***Lithology:*** 1 — non-calcareous turbidite claystones, 2 — calcareous turbidite claystones, 3 — non-calcareus hemipelagic claystones and clays, 4 — marly limestones and marlstones, 5 — pelocarbonates, 6 — turbidite siltstones, 7 — sandstones; ***Explanation of marks:*** 8 — calcareous, 9 — convolute lamination, 10 — ripples, 11 — parallel lamination, 12 — Chondrites sp., 13 — graded bedding, 14 — samples for foraminifers, 15 — samples for nannofossils.

the lower third of the exposed sequence. Samples 26A1, 26A2, 26B, 26C. Soláň Formation.

No. 27. Outcrop in the left bank of the brook covered by debris. The poorly exposed thin-bedded flysch sequence consists of alternation of green-grey non-calcareous silty claystones and siltstones and dark grey fine-grained sandstones (up to 14 cm thick). Sample 27. Soláň Formation.

No. 28. Slope loam with debris of sandstones and red-brown non-calcareous claystones in the track-cut on the spur of ridge. Sample 28. Beloveža Formation.

No. 29. Left cut-bank of another unnamed brook 4.5 m high and over 8 m long. The well exposed thin bedded flysch sequence consists of grey-green non-calcareous siltstones (predominating), silty claystones and dark grey silty sandstones with cubic disintegration. Sample 29. Beloveža Formation.

No. 32. Small (2.3 m high) right cut-bank of the brook exposing the thin to medium bedded completely non-calcareous flysch sequence. The sequence consists of green-grey fine-grained sandstones (up to 0.4 m thick), green-grey, less frequently black-grey and grey claystones and silty claystones (Te and hemipelagites) and dark-grey siltstones and silty sandstones. Sample 32. Soláň Formation.

No. 33. Poor outcrop (?debris) in the left bank of a branch of the unnamed brook. Below the slope loam, weathered red-brown non-calcareous silty claystones of the Beloveža Formation were observed. Agglutinated foraminifers give evidence of Middle Eocene age (Cyclammina amplectens Zone).

Foraminifers

From the Uzgruň section 19 samples were taken for foraminifers, mostly from hemipelagic claystones (Table 1). The samples were weighed and washed on 0.063 mm sieves. The taxonomic concept of determined taxa and description of species named in open nomenclature (numbered species) is consistent with the study by Bubík (1995). For the determination of stratigraphically important rzehakinids, the biometric method based on length/width ratio and the involution index was applied (Bubík, in preparation).

The calcareous silty claystones (turbidite Te interval) studied in three samples provided rare calcareous benthos, as well as agglutinated benthos and only one test of the planktonic species *Abathomphalus mayaroensis* Bolli. Nevertheless, the find of this species is stratigraphically very important giving evidence of the Late Maastrichtian A. mayaroensis Zone.

The attention was focused on agglutinated benthos from hemipelagic claystones (see Fig. 4), which was abundant in all samples and probably represents autochthonous fauna.

The interval higher Lower Campanian–Maastrichtian is equivalent to Hormosina (= Caudammina) gigantea Zone sensu Geroch & Nowak (1984). In the Uzgruň section *Caudammina gigantea* (Geroch) is completely missing and the closely related *C. ovulum* (Grzybowski) is also unusually rare. The absence of *C. gigantea* is reported also in some formations of the same age from the Bílé Karpaty Unit (Bubík 1995). On the other hand, the frequent occurrence of *C. gigantea* is known in the Soláň Formation at some other localities in the Rača Unit. The occurrence of this species is probably limited by an unknown paleoenvironmental factor. A more detail subdivision of the Campanian–Maastrichtian interval based on the agglutinated foraminifers and useful in inter-regional correlation remains problematic.

Rzehakina fissistomata (Grzybowski) is the most important agglutinated species for biostratigraphy in the studied section. The first occurrence of this species defines the base of the Paleocene and the base of the Rzehakina fissistomata Zone sensu Geroch & Nowak (1984). In the Uzgruň section *R. fissistomata* occurs in the completely non-calcareous part of the formation, where nannofossil biostratigraphy cannot be applied. At the point No. 19 the first occurrence of this species was observed in sample 19G above the last intercalation of calcareous claystone (sample 19E) which provided Late Maastrichtian nannofossils and *Abathomphalus mayaroensis* (Fig. 3).

"*Trochammina*" sp. 4 was reported from the Lower Paleocene of the Bílé Karpaty Unit (Bubík 1995). This species is very rare, what limits its potential use in biostratigraphy. In the Uzgruň section this species occurs in the non-calcareous

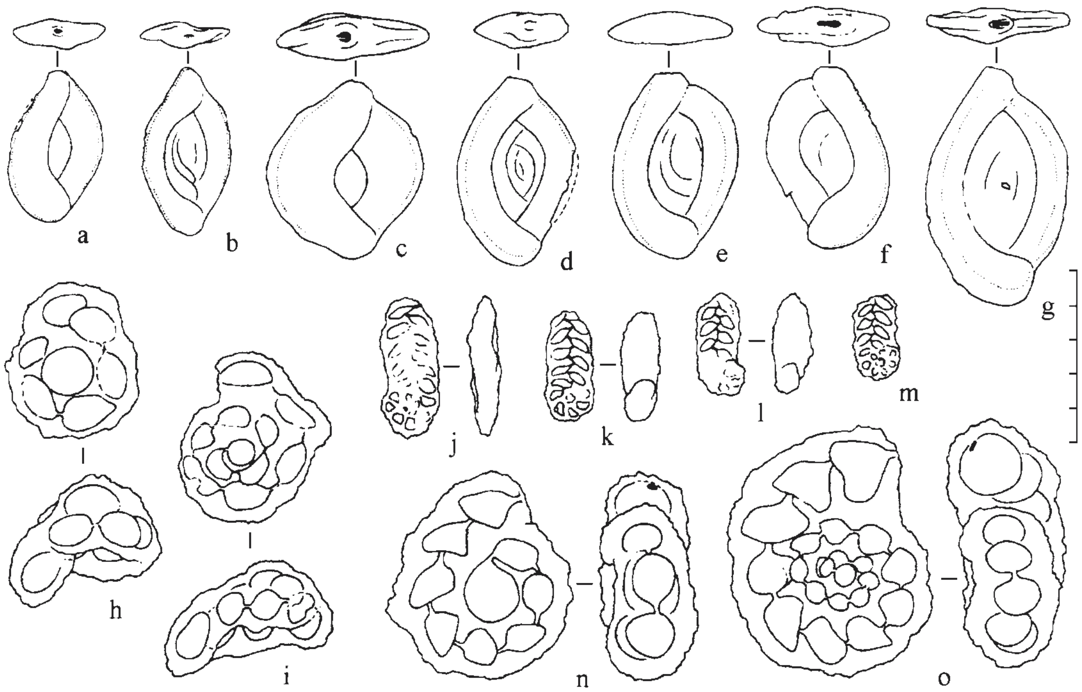

Fig. 4. Stratigraphically important agglutinated foraminifers from the Uzgruň section. **a** — *Rzehakina epigona* (Rz.), sample 19F, **b** — *Rzehakina minima* Cush. & Renz, sample 19 F, **c** — *Rzehakina lata* Cush. & Jarv., sample 19, **d–g** — *Rzehakina fissistomata* (Grzyb.), sample 19G, **h** — "*Trochammina*" cf. sp. 4, sample 19A, **i** — "*Trochammina*" sp. 4, sample 27, **j–m** — *Spiroplectammina* sp. 1, j — sample 19G, k-m — sample 22, **n–o** — *Bulbobaculites fontinensis* (Terquem), sample 29, h-o in transparency; lenght of bar 0.5 mm.

flysch sequence at point No. 27 of probably Paleocene age. A similar form (megalosphaeric specimen) was found at point No. 19 in sample 19A below the last calcareous intercalations containing Maastrichtian nannofossils, that is in the uppermost Maastrichtian close to the C/T boundary.

Another potential marker species *Spiroplectammina* sp. 1 sensu Bubík (1995) is very rare in the Paleocene of the Soláň and Beloveža formations. Dating of its first appearance still has to be made more precise. Thit is complicated by its occurrence in non-calcareous formations without nannofossil calibration.

In the probably youngest studied Paleocene strata of the Uzgruň section (point No. 29, Beloveža Formation) *Bulbobaculites fontinensis* (Terquem) appears. Although occurrence of this species is reported in Carpathian Flysch already from the Lower Cretaceous (Geroch 1966), an identical form (see Geroch 1960) has been observed from the Eocene. It will also be necessary to precisely date the first occurrence of this species.

Radiolaria

Three samples taken originally for foraminifers (20B, 20, 19D) contained abundant pyritized radiolarian fauna (see Pl. I). The best preserved forms have been recovered in sample 19D. Specimens in the samples 20 and 20B are also pyritized but unrecognizable.

The recognized low-latitude radiolarian association is dominated by Nassellaria belonging to the genera *Theocapsomma, Gongylothorax, Cryptamphorella, Siphocampe, Rhopalosyringium, Myllocercion, Eostichomitra, Stichomitra, Dictyomitra, Amphipyndax* and *Cryptocapsa.* Common and characteristic species are *Cryptocapsa asymmetros* Foreman, *Dictyomitra lamellicostata* (Foreman), *D. multicostata* Zittel, *Theocapsomma teren* Foreman, *T. comys* Foreman, *T.* aff. *comys* Foreman, *Gongylothorax verbeeki* (Tan), *Siphocampe daseia* (Foreman), *S. bassilis* (Foreman), *Rhopalosyringium magnificum* Campbell & Clark, *Amphipyndax pseudoconulus* (Pessagno), *A. tylotus* Foreman, *Stichomitra stocki* (Campbell & Clark), *S. bertrandi* Cayeux, *Eostichomitra asymbatos* (Foreman), *Cryptamphorella conara* (Foreman), *Myllocercion acineton* Foreman and *Dictyodedalus cretaceus* (Taketani) and *Afens liriodes* Riedel & Sanfilipo.

Spumellaria are less common in the association investigated. They are represented by the genera *Pseudoaulophacus, Patellula, Praeconocaryomma* and *Orbiculiforma*. The most characteristic species are *Pseudoaulophacus floresensis* Pessagno and *Orbiculiforma renillaeformis* Pessagno.

Upper Cretaceous Radiolaria have been studied previously by many authors (Campbell & Clark 1944; Foreman 1968, 1975, 1977; Petrushevskaya & Kozlova 1972; Moore 1973; Riedel & Sanfilippo 1974; Pessagno 1976; Empson-Morin 1981; Sanfilippo & Riedel 1985; Ling & Lazarus 1990; Vishnevskaya 1993). Some of them proposed radiolarian biozonation for the Campanian–Danian interval (Moore 1973; Hollis 1993), but well-documented sections containing Upper Cretaceous to Paleocene deposits with known calcareous plankton for biostratigraphic control are rare (Strong et al. 1995; Keller et al. 1997).

The assemblage investigated can be correlated with the Late Campanian to Maastrichtian Amphipyndax tylotus Zone of Foreman (1977) on the basis of the presence of the index species and *A. liriodes* which co-occur with *Siphocampe bassilis, S. daseia, E. asymbatos, Cryptocapsa asymmetros, Theocapsomma teren* and *T. comys*, described also by Foreman (1968) from Upper Maastrichtian deposits of California.

The assemblage can also be correlated with the Theocapsomma comys Zone of Riedel & Sanfilippo (1974) of approximately Maastrichtian age, on the basis of co-occurrence of the index species with *E. asymbatos, Stichomitra stocki, A. liriodes* and *Amphipyndax pseudoconulus*.

The presence of *Orbiculiforma renillaeformis* together with the above mentioned radiolarian species allow the correlation with Maastrichtian Orbiculiforma renillaeformis Interval Zone proposed by Pessagno (1976) for the California the Coast Ranges.

The comparison of our radiolarian fauna with the above mentioned zonal schemes allows us to date it as Maastrichtian, but does not give the precise position of the Cretaceous/Tertiary (C/T) boundary within the profile investigated. This problem can be discussed on the basis of the radiolarian zonation proposed by Hollis (1993) for the latest Cretaceous to late Paleocene deposits from the New Zealand region and also by Keller et al. (1997) from Equador. Hollis (1993) proposed the Lithomelissa ?hoplites Zone for the Late Campanian to the latest Maastrichtian interval, on the basis of high-intermediate latitude radiolarian fauna. Although the index species is lacking in our assemblage, it corresponds to this zone by the presence of *O. renillaeformis, A. stocki, M. acineton, E. asymbatos* and *D. multicostata*. Moreover *L. ?hoplites* appears near the base of the A. tylotus Zone and was recommended by Foreman (1977) for use in the region where *A. tylotus* is absent. Hollis (1993) defined the top of this zone as the first appearance of *Amphisphaera aotea* Hollis and placed it at the C/T boundary. According to this author, *A. aotea* co-occurs with the above mentioned species and also with those de-

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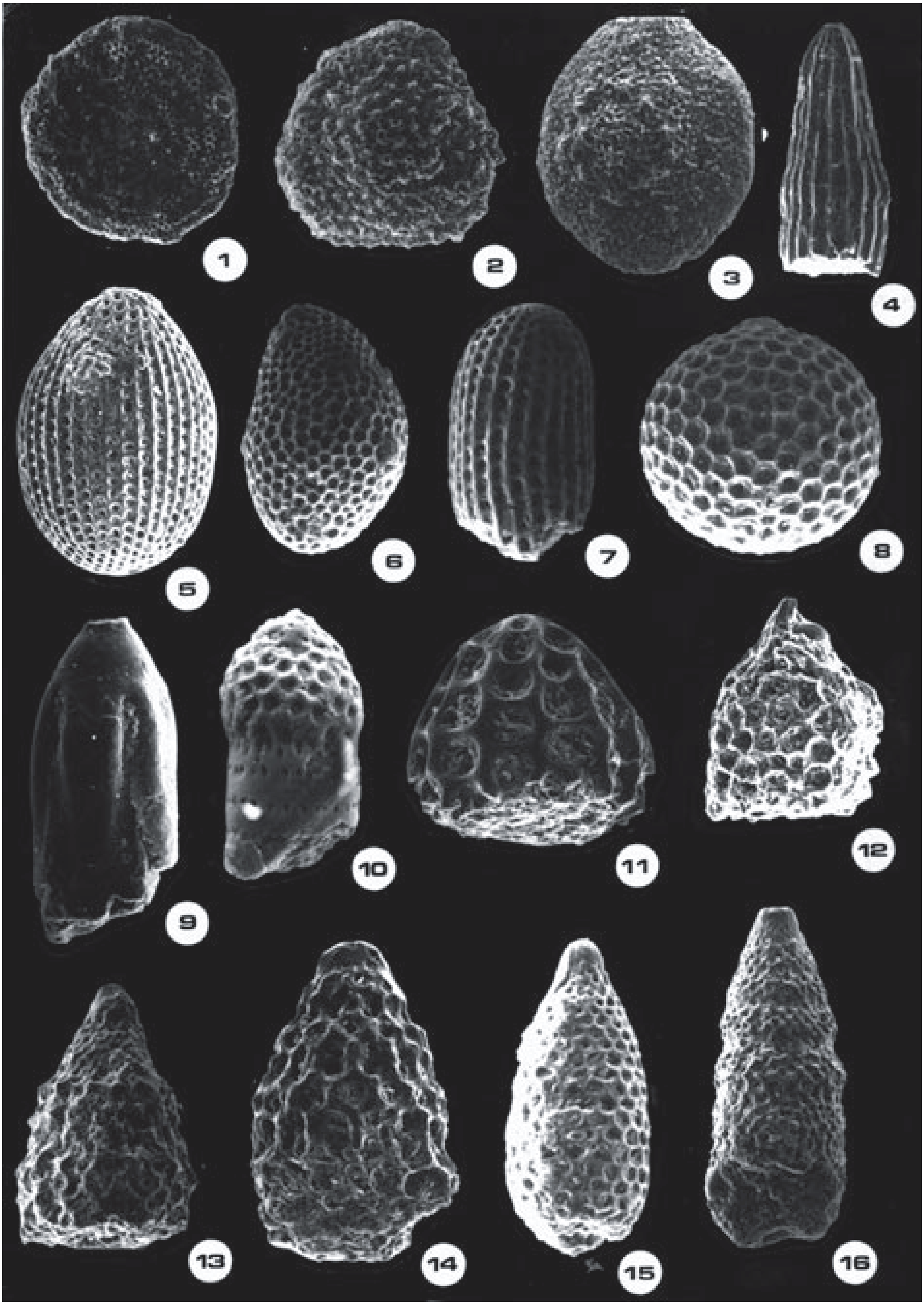
Plate I: Fig. 1 — *Flustrella ruesti* (Campbell & Clark), U715, ×150. **Fig. 2** — *Pseudoaulophacus floresensis* Pessagno, U755, ×150. **Fig. 3** — *Patellula planoconvexa* (Pessagno), U676, ×150. **Fig. 4** — *Dictyomitra multicostata* Zittel, U167, ×150. **Fig. 5** — *Theocapsomma teren* Foreman, U322, ×300. **Fig. 6** — *Cryptocapsa asymmetros* Foreman, U710, ×300. **Fig. 7** — *Theocapsomma comys* Foreman, U672, ×300. **Fig. 8** — *Gongylothorax verbeeki* (Tan), U162, ×300. **Fig. 9** — *Afens liriodes* Riedel & Sanfilippo, U251, ×200. **Fig. 10** — *Siphocampe daseia* (Foreman), U736, ×300. **Fig. 11** — *Theocapsomma* aff. *comys* Foreman, U456, ×500. **Fig. 12** — *Rhopalosyringium magnificum* Campbell & Clark, U330, ×300. **Fig. 13** — *Amphipyndax pseudoconulus* (Pessagno), U279, ×300. **Fig. 14** — *Dictyodedalus cretaceus* (Taketani), U470, ×500. **Fig. 15** — *Stichomitra stocki* (Campbell & Clark), U388, ×250. **Fig. 16** — *Stichomitra bertrandi* Cayeux, U238, ×175. All specimens from the sample 19D. Microphotographs M. Bąk.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scribed by Foreman (1968) from the Upper Maastrichtian and unzoned transitional interval, which have their last occurrence in the Lower Paleocene.

Moreover, the C/T is marked by changes in radiolarian composition from Nassellaria to Spumellaria dominance. The radiolarian fauna composition in our assemblage is dominated by Nassellaria and also lacking *A. aotea*. Those facts may prove its Cretaceous age, although an Early Paleocene age cannot be excluded (compare Fig. 5).

Calcareous nannofossils

Samples were taken from turbidite calcareous claystones (flysch interval Te sensu Bouma 1962). Smear slides for nannofossil study were prepared using the standard method of decantation, the samples were inspected in the light microscope at 1000× magnification. Biostratigraphic data were correlated with the standard nannoplankton CC zones by Sissingh (1977) and Perch-Nielsen (1985). The data concerning province appurtenance of nannofossil species were interpreted mainly according to Wind (1979), Watkins (1992) and Burnett (pers. comm.).

The rich assemblages of moderate to poorly preserved nannofossils with relatively high species diversity contained typical Maastrichtian species, such as *Arkhangelskiella cymbiformis* (specimens of *A. cymbiformis* var. W and var. N sensu Varol 1989 pre-

Plate II: Figs. 1–4 — *Ceratolithoides kamptneri* Bramlette & Martini, sample 26A1. **Figs. 5, 6** — *Ceratolithoides aculeus* (Stradner) Prins & Sissingh, sample 26A1. **Figs. 7, 8** — *Micula decussata* Vekshina, sample 21. **Figs. 9, 10** — *Micula concava* (Stradner) Bukry, sample 20B. **Figs. 11, 12, 14** — *Micula murus* (Martini) Bukry. Fig. 11 — sample 20. Figs. 14, 15 — sample 26A2. **Fig. 13** — *Micula swastica* Stradner & Steinmetz, sample 26A1. **Fig. 15** — *Micula murus-prinsii,* sample 20B. **Figs. 16–18** — *Micula prinsii* Perch-Nielsen, sample 20B. **Figs. 19, 20** — *Lithraphidites quadratus* Bramlette & Martini, sample 20B. **Figs. 21, 22** — *Biscutum constans* (Górka 1957) Black 1967, sample 21. **Figs. 23, 24** — *Cribrocorona gallica* (Stradner) Perch-Nielsen, sample 26A2. **Figs. 25, 26, 31, 32** — *Cribrosphaerella ehrenbergii* (Arkhangelsky) Deflandre. Figs. 25, 26 — sample 26A2. Figs. 31, 32 — sample 26A1. **Figs. 27–30** — *Nephrolithus frequens* Górka. Figs. 27, 28 — sample 21. Figs. 29, 30 — sample 20B. **Figs. 33, 34** — ?*Cribrosphaerella daniae* Perch-Nielsen, sample 26A2. **Figs. 35, 36, 39–42** — *Arkhangelskiella cymbiformis* Vekshina. Figs. 35, 36 — var. N, sample 26A1. Figs. 39, 40 — var. W, sample 21. Figs. 41, 42 — var. W, sample 26A1. **Figs. 37, 38** — *Cribrosphaerella* sp. cf. *?C. daniae* (fragment of a large specimen), sample 26A2. Microphotographs L. Švábenická, magnification ×2000.

Table 1: Foraminiferal distribution in the Uzgruň section. (**r** — rare, **c** — common, **d** — dominant, **cf.** — species determination uncertain).

Solaň Formation														Beloveža F.			Lithostratigraphy
Maastrichtian								Paleocene									Age
26 C	25 D	24 A	21 B	20 B	20	19 A	19 D	19 E	19 G	19	27	23	32	22	28	29	UZGRUŇ SECTION
								r									*Abathomphalus mayaroensis* (Bolli)
						cf.			r							r	*Ammodiscus bornemanni* (Reuss)
	r		cf.	r		r	cf.		r	r	r		r	r	r	r	*Ammodiscus cretaceus* (Reuss)
		r	r										r	r			*Ammodiscus glabratus* (Cushman&Jarvis)
cf.											cf.						*Ammodiscus infimus* Franke
r	r	r		r	cf.	r	r		cf.		c	r	r	r	r	r	*Ammodiscus planus* Loeblich
r	r	r				r			r	cf.		r	r	r		r	*Ammodiscus tenuissimus* Grzybowski
					r				r	r	r	r					*Ammolagena clavata* (Jones & Parker)
	r	r	r		r	r	r		r	r	r	r		r	c	c	*Ammosphaeroidina pseudopauciloculata* (Myatl.)
						r	r	r	r						r		*Arenobulimina* sp.,juv.
							r										*Aschemocella grandis* (Grzybowski)
						cf.											*Aschemocella subnodosiformis* (Grzybowski)
r				r							r					r	*Aschemocella* sp.
	r	r	r				r		r		cf.					r	*Bathysiphon gerochi* Myatlyuk
																r	*Bulbobaculites fontinensis* (Terquem)
												cf.	r				*Buzasina pacifica* (Krasheninnikov)
r	r	r	r	r	r	cf.			r	c		r	c	c	r	r	*Caudammina excelsa* (Dylazanka)
					r					r	cf.	r		r			*Caudammina ovuloides* (Grzybowski)
r	r	r		r	r					r		r	r	c			*Caudammina ovulum* (Grzybowski)
r										cf.	cf.	r	r	r			*Caudammina? velascoensis* (Cushman)
													r				*Cystammina* sp.
r		r		r					r	r	r		r		d	r	*Glomospira charoides* (Jones & Parker)
r		r															*Glomospira diffundens* (Cushman&Renz)
												cf.		r			*Glomospira gaultina* (Berthelin)
	r								r						r	r	*Glomospira glomerata* (Grzybowski)
				r			r		r				r	r	r	r	*Glomospira gordialis* (Jones&Parker)
	r	r	r	r	r	r				r	r	r	r	r	cf.		*Glomospira irregularis* (Grzybowski)
	r								r		r		cf.			r	*Glomospira serpens* (Grzybowski)
											r	cf.					*Glomospira* sp. 1
	r	r		r	r	cf.		cf.		r			r	r	r		*Glomospirella grzybowskii* (Jurkiewicz)
						cf.			cf.			r		r			*Haplophragmoides horridus* (Grzybowski)
r	r																*Haplophragmoides suborbicularis* (Grzybowski)
															r	r	*Haplophragmoides walteri* (Grzybowski)
					cf.												*Haplophragmoides* sp. 1
													r			r	*Haplophragmoides* sp. 2
										cf.		cf.				cf.	*Haplophragmoides* sp. 3
						cf.				r	cf.						*Haplophragmoides* sp. 5
r										r	cf.		c	r	cf.	r	*Hyperammina nuda* Subbotina
	r	r	r		r		r			r	r	r		r			*Kalamopsis grzybowskii* (Dylazanka)
cf.	r	r							r				r				*Karrerulina coniformis* (Grzybowski)
		r								c	r			r	r		*Karrerulina conversa* (Grzybowski)
r		r			r								r	r			*Karrerulina horrida* (Myatluyuk)
																c	*Karrerulina tenuis* (Grzybowski)
c	r	r	d	r	c	r	c	d	r	c	r	r	r	c	r	r	*Nothia* sp.
r	r	r	cf.	r		r	r		r	r	r		r				*Nothia? latissima* (Grzybowski)
								r									*Nuttallides* sp.
				cf.								cf.	cf.				*Paratrochamminoides acervulatus* (Grzybowski)
			cf.		r	cf.					r			r		cf.	*Paratrochamminoides contortus* (Grzybowski)
r			cf.						cf.					cf.		r	*Paratrochamminoides deformis* (Grzybowski)
					cf	cf.	r		r	r						r	*Paratrochamminoides heteromorphus* (Grzybow.)
cf.		r		r		r	cf.			r		r	r			r	*Paratrochamminoides mitratus* (Grzybowski)
r	r	r	r	r	r	r		r	r		r	r			cf.		*Paratrochamminoides olszewskii* (Grzybowski)
					cf.												*Paratrochamminoides uviformis* (Grzybowski)
			cf.		r		r		r		r	r	r			r	*Paratrochamminoides* sp.1
											r						*Plectorecurvoides parvus* Krasheninnikov
																c	*Psammosphaera fusca* Schulze
						r											*Psammosphaera irregularis* (Grzybowski)
r	r	r	r	r			cf.	r			r	r	r		r	r	*Psammosphaera* sp. 2
r						cf.	cf.							r	r		*Recurvoidella lamella* (Grzybowski)
cf.		r	r		.	cf.			r		cf.				r		*Recurvoides anormis* Myatlyuk
															r		*Recurvoides* cf. *gerochi* Pflaumann
						cf.		cf.							cf.		*Recurvoides immane* (Grzybowski)
		r			r					r			r	r			*Recurvoides nucleolus* (Grzybowski)
						cf.					cf.						*Recurvoides pentacameratus* Krasheninnikov
	cf.																*Recurvoides* aff. *primus* Myatlyuk
				cf.	r			cf.	r	cf.	r			r			*Recurvoides pseudosymmetricus* Krasheninn.
														r	cf.		*Recurvoides recurvoidimiformis* (Neagu & Tocor.)
													r	cf.	r	cf.	*Recurvoides walteri* (Grzybowski)
				r					cf								*Recurvoides* sp. 2
										cf.					r		*Recurvoides* sp. 3
cf.			cf.						r						r		*Recurvoides* sp. 5
						r											*Recurvoides?* sp. 6
														r		r	*Reophax duplex* Grzybowski
	r	r	r	r		cf.	r									r	*Reophax pilulifer* Brady
			r	r			r	r			r						*Remesella varians* (Glaessner)
				r						r	c		cf	r	cf.	r	*Rhabdammina cylindrica* Glaessner
r	r	r	r		r		r	r	r	r	r	r	d	r	r	r	*"Rhizammina"* sp.
							r	r	r	r							*Rzehakina epigona* (Rzehak)
									r	r		r	r				*Rzehakina fissistomata* (Grzybowski)
						r				r	r						*Rzehakina lata* Cushman & Jarvis
r	cf.					r			r	r			r				*Rzehakina minima* Cushman & Renz
c	r	r	r	r	r	r	r		r	r	r	r	c	r	r		*Saccammina placenta* (Grzybowski)

Continuation of Table 1

Solaň Formation														Beloveža F.			Lithostratigraphy
Maastrichian								Paleocene									Age
26 C	25 D	24 A	21 B	20 B	20	19 A	19 D	19 E	19 G	19	27	23	32	22	28	29	UZGRUŇ SECTION
		r		r		cf.	r		r								*Sphaerammina gerochi* Hanzlikova
cf																	*Spiroplectammina dentata* (Alth)
							r	cf.								r	*Spiroplectammina spectabilis* (Grzybowski)
										r			r	r			*Spiroplectammina* sp. 1
		cf.			r									r	r		*Subreophax pseudoscalaria* Samuel
r						r			cf.							cf.	*Subreophax scalaria* (Grzybowski)
r		r				cf.	cf.					r		r	cf.		*Subreophax splendidus* (Grzybowski)
r	r	r			r	r	r		r	r			r	r	r	r	*Thalmannammina gerochi* (Hanzlikova)
r		r	r			r						r		r	r	r	*Thalmannammina* ex gr. *gerochi* (Hanzlikova)
														r			*Thalmannammina meandertornata* Neagu & Tocor.
cf.													r			r	*Thalmannammina subturbinata* (Grzybowski)
					r								cf.				*Thurammina papillata* Brady
						r			r								*"Trochammina" quadriloba* Grzybowski
						cf.				r	cf.	r					*Trochammina* sp. 3
						cf.					r						*"Trochammina"* sp. 4
	r	r				cf.								r			*Trochamminoides ammonoides* (Grzybowski)
r		r		r	r				r	r	r		r	cf.	r		*Trochamminoides dubius* (Grzybowski)
												r	r				*Trochamminoides folius* (Grzybowski)
				r						r	r						*Trochamminoides* cf. *proteus* (Karrer)
																r	*Trochamminoides* cf. *septatus* (Grzybowski)
													r				*Trochamminoides subcoronatus* (Grzybowski)
	cf.													r		r	*Trochamminoides vermetiformis* (Grzybowski)
											r	cf.	r	r	r		*Trochamminoides variolarius* (Grzybowski)
r																	*Turritellella reversa* Bubik

vail), *Cribrosphaerella daniae, Lithraphidites quadratus*, *Ceratolithoides kamptneri, Ahmuellerella regularis* etc. (Table 2).

Three distinct biostratigraphic intervals within the Upper Maastrichtian can be recognized in the section. The first one is documented by the presence of *Micula murus* (Pl. II, Figs. 11, 12, 14) which give evidence for the CC 25c Zone, the second one is characterized by *Nephrolithus frequens* (Pl. II, Figs. 27–30), the nominate species of the CC 26 Zone and the third one by the presence of *Micula prinsii* (Pl. II, Figs. 16–18) which allowed correlation even with the uppermost part of this stage (Perch-Nielsen 1985; Seyve 1990).

The nannofossil assemblages yielded the so called "survivor species" that pass C/T boundary and survive into the Tertiary, such as *Markalius apertus, M. inversus, Zeugrhabdothus sigmoides, Cyclagelosphaera reinhardtii, Neocrepidolithus cohenii, N. fossus, Braarudosphaera bigelowii, Thoracosphaera* sp. (sensu Pospichal 1991, Burnett pers. comm.). Moreover, the extremely rare occurrence of *Biantholithus sparsus* was recorded in two samples of the Uzgruň section (see Table 2 and Pl. III: Figs. 7, 8).

The first occurrence of *Biantholithus sparsus* is mostly mentioned at the base of the Paleocene (Martini 1971; Perch-Nielsen 1985) or it is even used as a marker for the base of this period (Seyve 1990; Watkins 1992; Ivanov & Stoykova 1994 and others). Romein & Smit (1981) emended Biantholithus sparsus Zone (described by Perch-Nielsen 1971) with a note that the name-giving species is extremely rare or even absent in the sediments and that the lowermost part of this zone is characterized by high frequencies of the long-ranging species

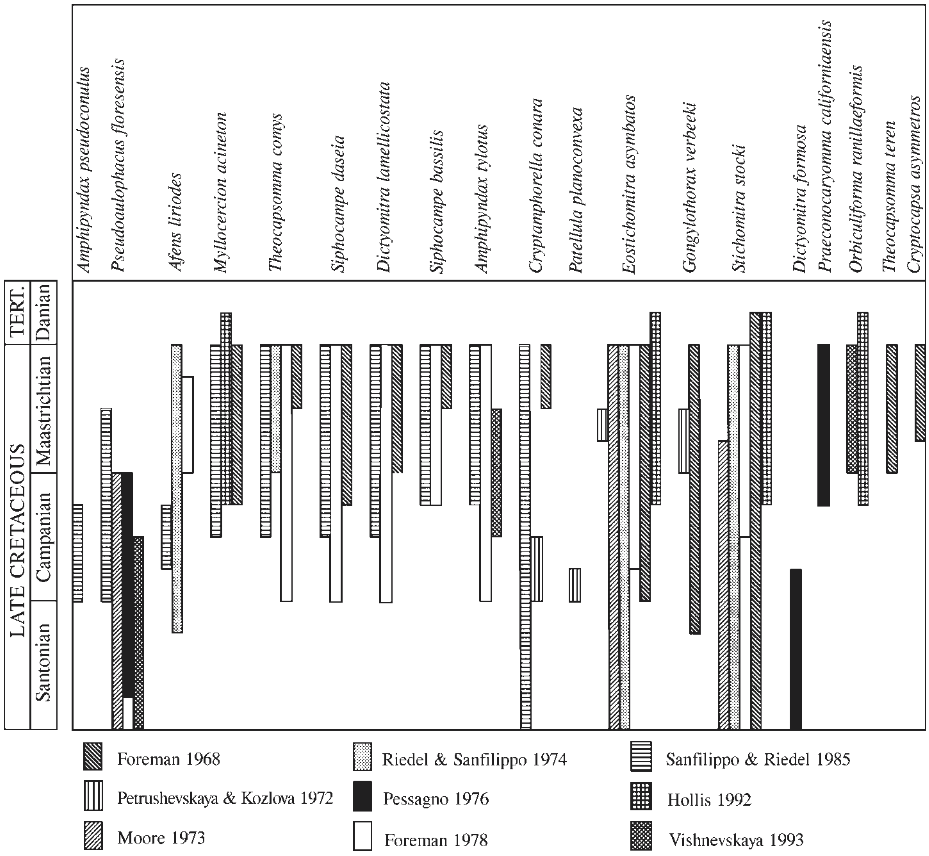


Fig. 5. Comparison of Upper Cretaceous to lower Paleocene radiolarian ranges reported by previous authors.

Table 2: Calcareous nannofossils distribution and their relative abundances in the Uzgruň section.

Late Maastrichtian																Age
CC25c			CC26													zones Sissingh (1977), Perch-Nielsen (1985)
M. murus			N. frequens						M. prinsii							local zones
26 A1	26 A2	26 B	25 A	25 B	25 C	24 B	21	21 C	20	20 A	20 B	19 B	19 C	19 E	*1	UZGRUŇ SECTION
A	R	P	P	R	R	P	R	A	A	A	R	P	P	P		relative sample abundance
c	c	f	f	c	c	x	c	c	c	c	c	c	f	f		*Arkhangelskiella cymbiformis*
.	.	.	.	.	.		f			.	.		.			*Biscutum constans*
.	f	.	.	f	f		f	.	f	f	c					*Chiastozygus litterarius*
f	f	.			f		f	f	f	.	f	.	.			*Cretarhabdus conicus*
c	c	f	f	c	c		c	c	c	c	c	c	c	f		*Micula decussata*
f	f	.		f	f		f	f	.	.	f					*Placozygus fibuliformis*
c	c	f	f	c	c	f	c	c	c	c	c	f	f	f		*Prediscosphaera cretacea*
		.		.	.		.		.		.	.	.	.		*Thoracosphaera* sp.
c	c	c	f	f	c	f	f	f		f		f	f			*Watznaueria barnesae*
f	f			.				f		.	.					*Ahmuellerella regularis*
®	®			®						®				®		*Aspidolithus parcus constrictus*
	®															*Axopodorhabdus albianus*
	.															*Amphizygus brooksii*
	.			f	f		.	f	f	.	f				H	*Biscutum coronum*
f	f				.										L	*Ceratolithoides aculeus*
.	f			.	.										L	*Ceratolithoides kamptneri*
	.			.												*Corollithion exiguum*
	®															*?Corollithion kennedyi*
f	f		f	f	f		f	f	f	f	f		.	.		*Cribrosphaerella ehrenbergii*
.	.						.									*Cribrocorona gallica*
	.				.		.		.	.						*Cyclagelosphaera reinhardtii*
	®						®			®		®				*Eiffellithus eximius*
f	f		f	c	f		f	f	f	f	c		.			*Eiffellithus gorkae*
.	f		.	.	.		f	.	.	f	f					*Eiffellithus turriseiffelii*
.	.			.	.			.	.	.	.					*Ellipsagelosphaera britannica*
	®				®											*Eprolithus floralis*
f	f				f		.	f	f		f					*Gartnerago obliquum*
.	.				.								.			*Glaukolithus compactus*
®	®															*Glaukolithus diplogrammus*
f	f			f			.				.					*Lithraphidites carniolensis*
f	f			f	f		.	.		f	f				L	*Lithraphidites quadratus*
.	.			.							.					*Microrhabdulus attenuatus*
.	f			f	f		.		.	.	f	.	.			*Microrhabdulus decoratus*
f	f		.	.					.	.	f		.		L	*Micula murus*
.	.			.	.						.					*Placozygus sigmoides*
	.			.			x	x	f	c	c	.		x		*Prediscosphaera grandis*
.	c						f		c							*Prediscosphaera majungae*
	c			.	c					.	.					*Prediscosphaera ponticula*
.	.			.	.		.	.		.	.	.				*Prediscosphaera spinosa*
	.															*Quadrum gartneri*
	.						.									*Quadrum gartneri-gothicum*
	®														L	*Quadrum trifidum*
.	f			f	f		f	f		.	f		.			*Retacapsa schizobrachiata*
.				.	.		.		.							*Retacapsa madingleyensis*
f	f				f					.	.					*Rhagodiscus angustus*
				.	.		.									*Rhagodiscus asper*
	®				®		®					®				*Reinhardtites anthophorus*
	®			®	®	®	®	®		®	®				H	*Reinhardtites levis*
	.															*Staurolithites mielnicensis*
		.					.									*Staurolithites crux*
f	f		f	f	f		f	f	.	f	f		.			*Retacapsa crenulata*
	®			®			®	®			®					*Tranolithus phacelosus*
	.			.							.					*Watznaueria biporta*
.	.									.	.					*Zeugrhabdothus embergerii*
	.				.		.									*Manivitella pemmatoidea*
.	.						.									*Thoracosphaera* sp.
.	.			.	.		.	.								*Braarudosphaera bigelowii*
.			.	f	c		c	f	f		f	.			H	*Kamptnerius magnificus*
.				.	.											*Broinsonia* sp.
.	.			.			.		.	.	.					*Eiffellithus parallelus*
				.	f											*Biscutum dissimilis*
				.	.		.	.		.	.				H	*Ahmuellerella octoradiata*
					.		.			.						*Cyclagelosphaera margerelii*
			.		.		.	.	.	.	.	.	.	.		*Calculites obscurus*
			.	.	.		.									*Helicolithus trabeculatus* < 7m
			.	.	.		.	.	.	.		.	.		H	*Lucianorhabdus cayeuxii*
					.			.	.	.	.	.		.		*Lucianorhabdus inflatus*
				.	.			.	.	.	.					*Markalius inversus*
					.		f	f			f				H	*Nephrolithus frequens*
				f	.		.	.			.				H	*Prediscosphaera stoveri*
					.											*Vagalapilla matalosa*
					.											*Zeugrhabdotus theta*
				.			.				.					*Markalius apertus*
				f			.			.	f			.		*Micula concava*

Continuation of Table 2

Late Maastrichtian																Age
CC25c			CC26													zones Sissingh (1977), Perch-Nielsen (1985)
M. murus			N. frequens						M. prinsii							local zones
26 A1	26 A2	26 B	25 A	25 B	25 C	24 B	21	21 C	20	20 A	20 B	19 B	19 C	19 E	*1	UZGRUŇ SECTION
A	R	P	P	R	R	P	R	A	A	A	R	P	P	P		relative sample abundance
				.			.			.						*Neocrepidolithus dirimosus*
				.												*Ottavianus giannus*
				.			.			.	.					*Prediscosphaera arkhangelskyi*
	.						.		.		.					*?Corollithion madagaskarensis*
								.								*Biscutum boletum*
							.	.	.		.					*Micula swastica*
.	.						x			.					H	*?Cribrosphaerella daniae*
	.			.			.			.	.					*Tranolithus minimus*
							.		.							*Biantholithus sparsus*
											.					*Dodekapodorhabdus noeliae*
										.	f					*Micula prinsii*
											.					*Tranolithus gabalus*
											.					*Staurolithites aachena*
									.							*Neocrepidolithus fossus*
										.						*Haqius circumradiatus*
										.					H	*Monomarginatus quaternarius*
												.				*Orastrum campanensis*

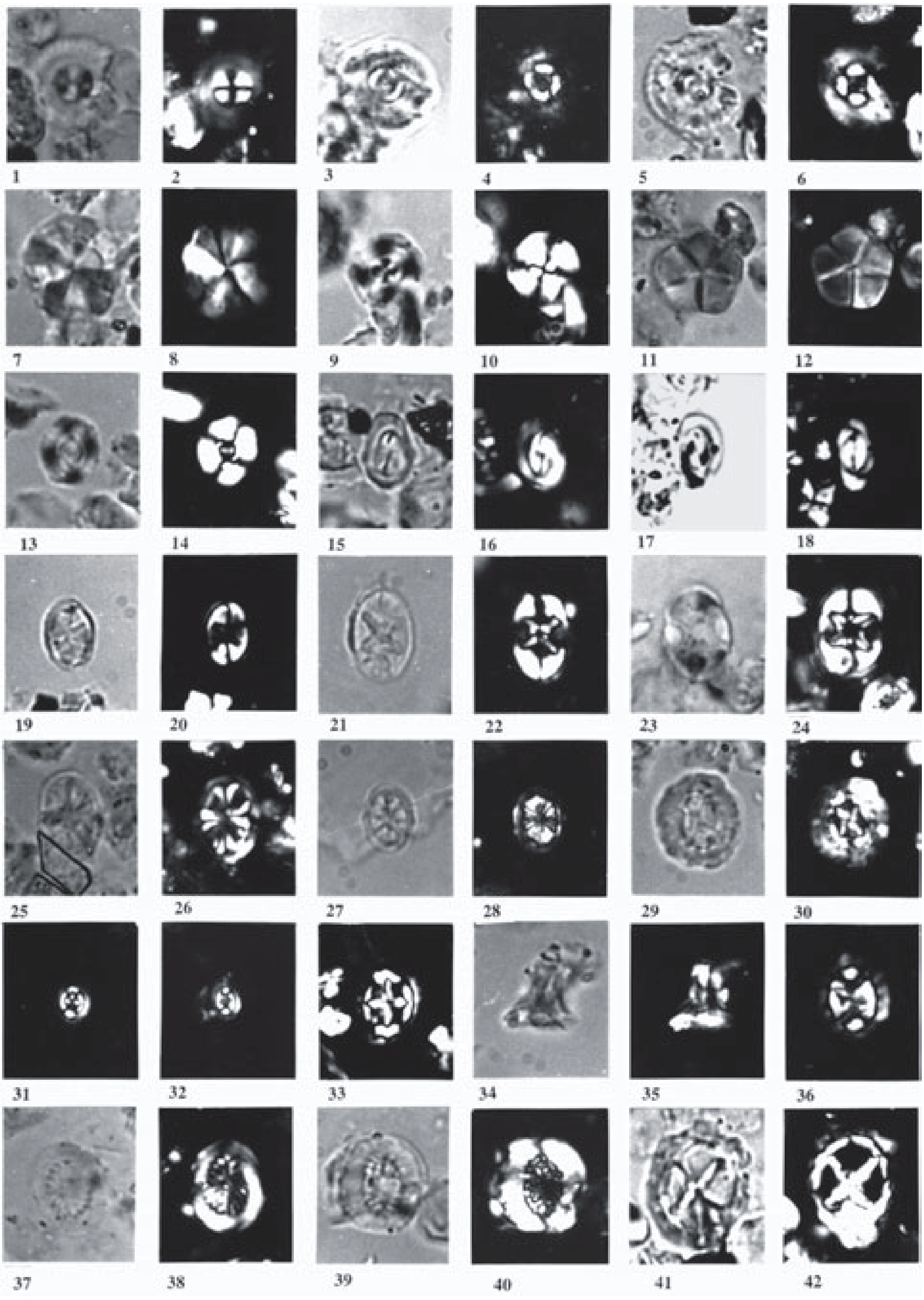
Explanations to Table 2:

*1 — nannofossil province appurtenance (after Wind 1979; Watkins 1992 and Burnett, pers. comm.): **L** — low-latitude species confirmed in warm waters (tropical areas), **H** — high-latitude species confirmed in cold waters (Boreal/Austral areas)

relative nannofossil abundance: **c** — common (> 5 specimens per one field of view), **f** — few (> 5 specimens per ten fields of view), **.** — rare (< 5 specimens per ten fields of view), **x** — fragments, ® — reworked

relative sample abundance: **A** — abundant (> 20 specimens per one field of view), **R** — rare (20–2 specimens per one field of view), **P** — poor (< 2 specimens per one field of view).

Plate III: Figs. 1, 2 — *Markalius inversus* (Deflandre) Bramlette & Martini, sample 20B. **Figs. 3–6** — *Markalius apertus* Perch-Nielsen. Figs. 3, 4 — sample 21. Figs. 5, 6 — sample 20B. **Figs. 7, 8** — *Biantholithus sparsus* Bramlette & Martini, sample 21. **Figs. 9, 10** — *Cyclagelosphaera reinhardtii* (Perch-Nielsen) Romein, sample 21. **Figs. 11, 12** — *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre, sample 26A2. **Figs. 13, 14** — *Ellipsagelosphaera britannica* (Stradner) Perch-Nielsen, sample 20B. **Figs. 15–18 —** *Neocrepidolithus dirimosus* (Perch-Nielsen) Perch-Nielsen. Figs. 15, 16 — sample 21A. Figs. 17, 18 — sample 21. **Figs. 19–20** — *Eiffellithus gorkae* Reinhardt, sample 21. **Figs. 21, 22** — *Eiffellithus turriseiffelii* (Deflandre) Reinhardt, sample 20B. **Figs. 23, 24** — *Eiffellithus parallelus* Perch-Nielsen, sample 20B. **Figs. 25, 26** — *Ahmuellerella octoradiata* (Górka) Reinhardt, sample 21. **Figs. 27, 28** — *Ahmuellerella regularis* (Górka) Reinhardt & Górka, sample 20B. **Figs. 29, 30** — *Prediscosphaera cretacea* (Arkhangelsky) Gartner, sample 26A2. **Figs. 31, 32** — *Prediscosphaera stoveri* (Perch-Nielsen) Shafik & Stradner, sample 20B. **Fig. 33** — *Prediscosphaera arkhangelskyi* (Reinhardt) Perch-Nielsen, sample 20B. **Figs. 34–36** — *Prediscosphaera majungae* Perch-Nielsen, sample 21. Figs. 34, 35 — lateral view of specimen. **Figs. 37, 38** — *Cretarhabdus conicus* Bramlette & Martini, sample 20B. **Figs. 39, 40** — *Retacapsa madingleyensis* (Black) Black, sample 21A1. **Figs. 41, 42** — *Prediscosphaera grandis* Perch-Nielsen, sample 20B. Microphotographs by L. Švábenická, magnification ×2000.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Braarudosphaera bigelowii and/or *Thoracosphaera operculata*. Nevertheless, they marked *B. sparsus* with a question mark already in the uppermost Maastrichtian within the Micula prinsii Zone (l.c., p. 297, fig. 1).

The appearance of *Biantholithus sparsus* in the uppermost Maastrichtian, i.e. already below the C/T boundary is mentioned in further works. Van Heck & Prins (1987) noticed that *B. sparsus* "has been observed on rare occasions in assemblages which are otherwise Maastrichtian" (l.c., p. 295). Pospichal & Wise (1990, p. 470, Table 2) recorded this species in the Late Maastrichtian within the Cribrosphaerella daniae Subzone from the Weddell Sea off Eastern Antarctica. Pospichal & Bralower (1992 — see table 1, p. 741) reported the isolated occurrence of *B. sparsus* in the uppermost Maastrichtian sediments of the Northwest Australian Margin. Burnett (pers. comm.) considered *B. sparsus* with a question mark to be a so called "survivor Cretaceous taxon".

In the Uzgruň section it also cannot be used as a marker of the Paleocene age for following reasons: 1. No enrichment is evident in "blooming species", such as *B. bigelowii*, *Thoracosphaera* sp. and *C. reinhardtii* (sensu Seyve 1990); 2. No occurrence of Paleocene species s.s. (such as representatives of genera *Cruciplacolithus*, *Prinsius* etc.) was observed.

The thanatocoenoses are completed by reworked nannofossils (up to 5 %) mostly from the Campanian sediments, including: 1. species with occurrences known only in the Campanian–Early Maastrichtian interval, such as *Aspidolithus parcus constrictus*, *Ceratolithoides arcuatus*, *Quadrum trifidum* and *Reinhardtites levis*, 2. species with their last known occurrence within the Late Campanian, i.e. *Eiffellithus eximius*, *Glaukolithus diplogrammus* and *Reinhardtites anthophorus*. Moreover, there were also rare reworked nannofossils of the Cenomanian age: *Corrolithion kennedyi* and *Axopodorhabdus albianus*.

Discussion

Thin-bedded flysch with frequent clayey turbidites and hemipelagites deposited below the CCD is usually termed distal flysch. Such sedimentation can be expected on continental rise to bottom plain transition in the abyssal zone in terms of recent oceanic morphology. The autochthonous assemblages of agglutinated foraminifers from hemipelagic claystones of the Soláň and Beloveža formations in Uzgruň can be assigned to the flysch-type DWAF biofacies and paleobathymetric zone of lower slope (1500 to more than 2500 m paleodepth) sensu Kuhnt et al. (1989). In fact the absolute paleodepths of sedimentation in Carpathian Flysch basins are difficult to estimate, because the CCD has changed with time.

As stated above, the calcareous sediments common in the Maastrichtian disappear in the Paleocene. This fact corresponds well with the decrease in carbonate production at the Cretaceous/Tertiary (C/T) boundary worldwide. For example this trend is clearly visible in the C/T sections in the "Gossau" facies of the Eastern Alps.

Another trend — the relative increase in frequency of coarser turbidite intervals in the Paleocene as shown above — can be explained by worldwide sea-level fall at the C/T boundary.

In the Uzgruň section, common occurrences of high- and low-latitude nannofossils were observed in the Late Maastrichtian showing the influence of both the Boreal and Tethyan bioprovinces. With regard to the presence of Campanian reworked material, attention was focussed on the species with distributions known only in the Maastrichtian. Assemblages contain *Micula murus* and *Lithraphidites quadratus* which are supposed to be low-latitude (Mediterranean/Tethyan) species. On the other hand, *Nephrolithus frequens* which prefers cold waters was also present in these sediments. Moreover, the abundance of *Arkhangelskiella cymbiformis*, the presence of *Prediscosphaera stoveri*, *Biscutum coronum, B. boletum*, *Cribrosphaerella daniae*, *Monomarginatus quaternarius* etc. may also be regarded as feature of the Boreal/Austral bioprovince (Wise 1983; Watkins 1992).

In the flysch sediments, a complete C/T boundary section using nannofossils was described by de Kaenelet al. (1989) in the Gurnigel Flysch of the Swiss Alps and by Sinnyovsky & Stoykova (1995) in the Emine Flysch in Bulgaria. In these section a nannofossil record through the C/T boundary was also obtained from the turbidite claystones. In addition, the boundary at the former section was proved by the presence of the Ir-anomaly.

In the Uzgruň section the C/T boundary sediments are probably present at the outcrop point No. 19 (Fig. 3) in continuous thin-bedded flysch sequence. Unfortunately, the nannofossil record is preserved only in the lower part of the outcrop. The highest turbidite calcareous level (sample 19E) provided only Maastrichtian nannofossils. Sample 19G taken approximately 5.6 m above sample 19E yielded *Rzehakina fissistomata,* which already proves the Paleocene. The C/T boundary can be expected within this 5.6 m thick sequence not studied in detail. The youngest nannofossil in sample 19E are considered to be synsedimentary redepositions documenting the age of turbidite sedimentation. This is also supported by a radiolarian assemblage of the Amphipyndax tylotus Zone found only 75 cm below the sample 19D. The sample was taken from hemipelagite, that is autochthonous sediment. The radiolarian assemblage is interpreted as probably Maastrichtian in age.

To complete the integrated microbiostratigraphy, there is still a chance to search for a dinocyst fossil record which could be preserved in the dark layers through this 5.6 m thick interval. The iridium anomaly may also be preserved as the hemipelagite/turbidite ratio is relatively high (30 % of the given thickness are hemipelagites).

Conclusions

The Uzgruň section provides the possibility to study the biostratigraphy of the Late Maastrichtian to Paleocene distal flysch facies (deposited below the CCD) of the Rača Unit (Outer Flysch Carpathians).

The rich fossil content (foraminifers, radiolarians, calcareous nannofossils) enabled succesful application of the integrated microbiostratigraphy approach to subdivision of these sediments (see Figs. 6, 7). Although the single fossil groups themselves did not enable subdivision of the given strati-

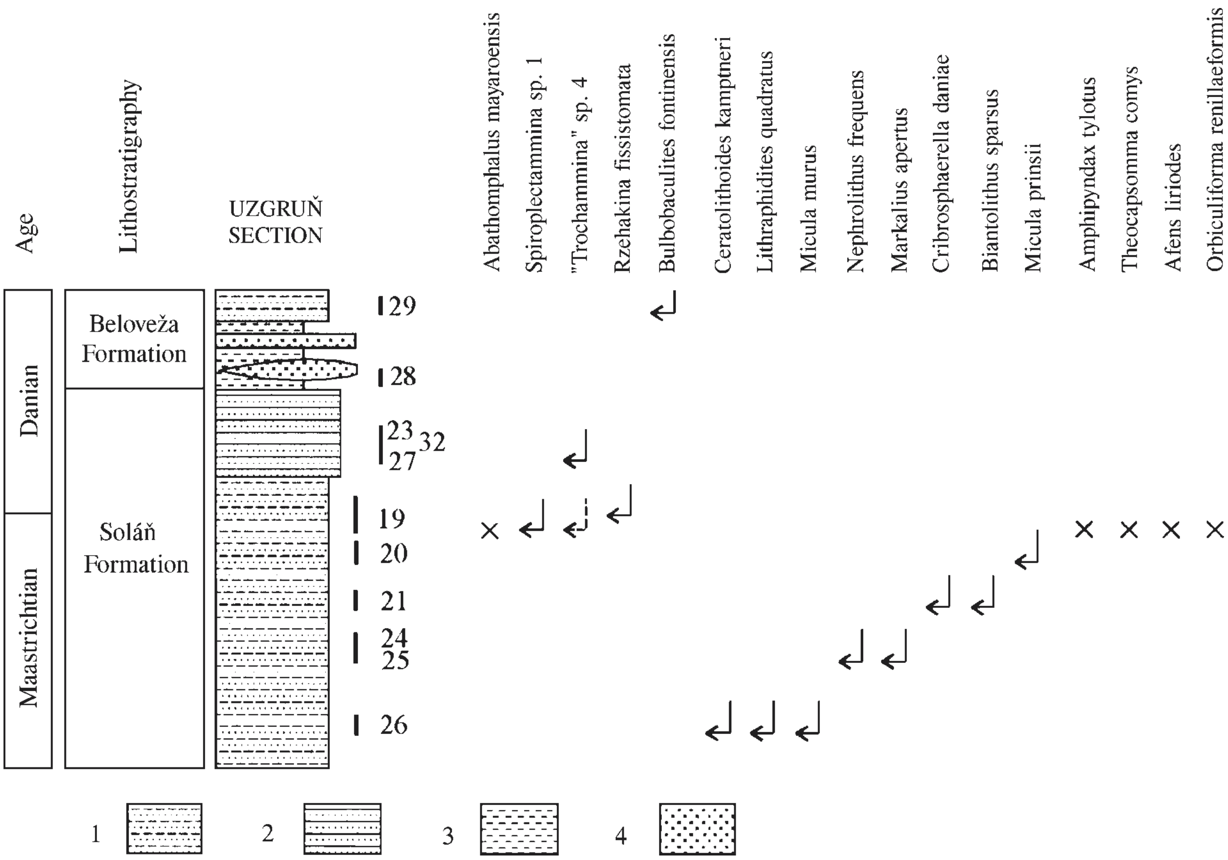

Fig. 6. Distribution of stratigraphically important micro- and nannofossils in the Upper Maastrichtian–Paleocene of the Uzgruň section. Lithology of idealized section: 1 — thin-bedded flysch (claystones/sandstones ratio > 1), 2 — predominantly medium-bedded flysch (claystones/sandstones ratio = 1), 3 — claystones and siltstones, 4 — thick beds of coarse-grained sandstones.

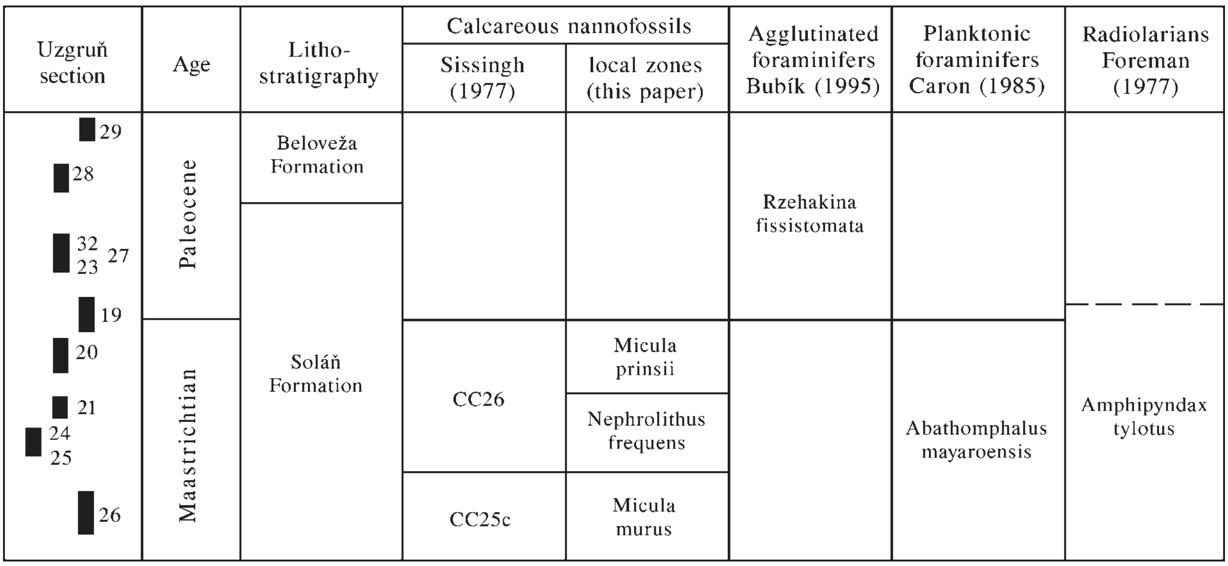

Fig. 7. Stratigraphic correlation zonal chart of the Maastrichtian to Paleocene sediments of the Uzgruň section.

graphic interval, integrated microbiostratigraphy enabled to definition of three nannozones within the Upper Maastrichtian and one agglutinated foraminiferal zone through Paleocene with prospective subdivision based on potential new marker species. There is no disproportion between the results from single fossil groups in the studied section.

The Uzgruň section also provided interesting data on the radiolarian biostratigraphy considering the fact, that well-documented sections across the Upper Cretaceous to Paleocene deposits with biostratigraphic control are very rare.

The nannofossils show the influence of both the Boreal and Tethyan bioprovinces on the Magura depositional area.

Integrated microbiostratigraphy enabled us to find the Cretaceous/Tertiary (C/T) boundary in one partial outcrop of the Uzgruň section. Two trends were observed on the C/T transition: 1. increase in frequency of coarser turbidite intervals; 2. disappearance of calcareous turbidite claystones. There is a potential opportunity for precise determination of the C/T boundary using palynology (dinocysts) and geochemistry (iridium anomaly).

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Appendix 1

Calcareous nannofossil species considered in this report, in alphabetical order of the Species epithets

Cretaceous

Staurolithites aachena Bukry 1969
Ceratolithoides aculeus (Stradner 1961) Prins & Sissingh in Sissingh 1977
Axopodorhabdus albianus (Black 1967) Wind & Wise in Wise & Wind 1977
Retacapsa schizobrachiata (Gartner 1968) Grün in Grün & Allemann 1975
Rhagodiscus angustus (Stradner 1963) Reinhardt 1971
Reinhardtites anthophorus (Deflandre 1959) Perch-Nielsen 1968
Prediscosphaera arkhangelskyi (Reinhardt 1965) Perch-Nielsen 1984
Rhagodiscus asper (Stradner 1963) Reinhardt 1967
Microrhabdulus attenuatus (Deflandre 1959) Deflandre 1963
Watznaueria barnesae (Black in Black & Barnes 1959) Perch-Nielsen 1968
Watznaueria biporta Bukry 1969
Biscutum boletum Wind & Wise in Wise & Wind 1977
Ellipsagelosphaera britannica (Stradner 1963) Perch-Nielsen 1968
Amphizygus brooksii Bukry 1969
Orastrum campanensis (Čepek 1970) Wind & Wise in Wise & Wind 1977
Lithraphidites carniolensis Deflandre 1963
Lucianorhabdus cayeuxii Deflandre 1959
Haqius circumradiatus (Stover 1966) Roth 1978
Glaukolithus compactus (Bukry 1969) Perch-Nielsen 1984
Micula concava (Stradner in Martini & Stradner 1960) Bukry1969
Cretarhabdus conicus Bramlette & Martini 1964
Biscutum constans (Górka 1957) Black 1967
Biscutum coronum Wind & Wise in Wise & Wind 1977
Prediscosphaera cretacea (Arkhangelsky 1912) Gartner 1968
Retacapsa crenulata (Bramlette & Martini 1964) Grün in Grün & Allemann 1975
Staurolithites crux (Deflandre & Fert in Deflandre 1954) Caratini 1963
Arkhangelskiella cymbiformis Vekshina 1959
?Cribrosphaerella daniae Perch-Nielsen 1973
Microrhabdulus decoratus Deflandre 1959
Micula decussata Vekshina 1959
Glaukolithus diplogrammus (Deflandre in Deflandre & Fert 1954) Reinhardt 1964
Biscutum dissimilis Wind & Wise in Wise & Wind 1977
Cribrosphaerella ehrenbergii (Arkhangelsky 1912) Deflandre in Piveteau 1952
Zeugrhabdothus embergeri (Noël 1959) Perch-Nielsen 1984
Corollithion exiguum Stradner 1961
Eiffellithus eximius (Stover 1966) Perch-Nielsen 1968
Placozygus fibuliformis (Reinhardt 1964) Hoffmann 1970
Eprolithus floralis (Stradner 1962) Stover 1966
Neocrepidolithus fossus Romein 1979
Nephrolithus frequens Górka 1957
Tranolithus gabalus Stover 1966
Cribrocorona gallica (Stradner 1963) Perch-Nielsen 1973
Quadrum gartneri Prins & Perch-Nielsen in Manivit et al. 1977
Ottavianus giannus Risatti 1973
Eiffellithus gorkae Reinhardt 1965
Prediscosphaera grandis Perch-Nielsen 1973
Lucianorhabdus inflatus Perch-Nielsen & Feinberg in Perch-Nielsen 1984
Ceratolithoides kamptneri Bramlette & Martini 1964
?Corollithion kennedyi Crux 1981
Reinhardtites levis Prins & Sissingh in Sissingh 1977
Chiastozygus litterarius (Górka 1957) Manivit 1971
?Corollithion madagaskarensis Perch-Nielsen 1973
Retacapsa madingleyensis (Black 1973) Black 1975
Kamptnerius magnificus Deflandre 1959
Prediscosphaera majungae Perch-Nielsen 1973
Cyclagelosphaera margerelii Noël 1965
Vagalapilla matalosa (Stover 1966) Thierstein 1973
Staurolithites mielnicensis (Górka 1957) Perch-Nielsen 1968
Tranolithus minimus (Bukry 1969) Perch-Nielsen 1984
Micula murus (Martini 1961) Bukry 1973
Dodekapodorhabdus noeliae Perch-Nielsen 1968
Gartnerago obliquum (Stradner 1963) Reinhardt 1970
Calculites obscurus (Deflandre 1959) Prins & Sissingh in Sissingh 1977
Amhuellerella octoradiata (Górka 1957) Reinhardt 1966
Eiffellithus parallelus Perch-Nielsen 1973
Aspidolithus parcus constrictus (Hattner et al. 1980) Perch-Nielsen 1984
Manivitella pemmatoidea (Deflandre in Manivit 1965) Thierstein 1971
Tranolithus phacelosus Stover 1966
Prediscosphaera ponticula Bukry 1969
Micula prinsii Perch-Nielsen 1979
Lithraphidites quadratus Bramlette & Martini 1964
Monomarginatus quaternarius Wind & Wise in Wise & Wind 1977
Ahmuellerella regularis (Górka 1957) Reinhardt & Górka 1967
Cyclagelosphaera reinhardtii (Perch-Nielsen 1968) Romein 1977
Prediscosphaera spinosa (Bramlette & Martini 1964) Gartner 1968
Prediscosphaera stoveri (Perch-Nielsen 1968) Shafik & Stradner 1971
Micula swastica Stradner & Steinmetz 1984
Zeugrhabdotus theta (Black in Black & Barnes 1959) Black 1973
Helicolithus trabeculatus (Górka 1957) Verbeek 1977
Quadrum trifidum (Stradner in Stradner & Papp 1961) Prins & Perch-Nielsen in Manivit et al. 1977
Eiffellithus turriseiffelii (Deflandre in Deflandre & Fert 1954) Reinhardt 1965

Survivors

Markalius apertus Perch-Nielsen 1979
Braarudosphaera bigelowii (Gran & Braarud 1935) Deflandre 1947
Neocrepidolithus dirimosus (Perch-Nielsen 1979) Perch-Nielsen 1981

Markalius inversus (Deflandre 1954) Bramlette & Martini 1964
Cyclagelosphaera margerelii Noël 1965
Cyclagelosphaera reinhardtii (Perch-Nielsen 1968) Romein 1977
Placozygus sigmoides (Bramlette & Sullivan 1961) Romein 1979
Thoracosphaera sp.
Biantholithus sparsus Bramlette & Martini 1964.

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