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ZAPADNÉ KARPATY

SÉRIA

paleontológia 9

GEOLOGICKÝ ÚSTAV DIONÝZA ŠTÚRA, BRATISLAVA 1984

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Západné Karpaty, sér. paleontológia, 9. P. 7—11, Geol. Úst. D. Štúra, Bratislava, 1984

Viera Kantorová

PROLOGUE

Prologue on occasion of opening of the 18th European Micropaleontological Colloquy

Micropaleontology, especially Small Foraminifera Micropaleontology has a relatively short tradition in Slovakia.

We started building the first Micropaleontological laboratory in 1945 at the Dionýz Štúr Institute of Geology, then named State Institute of Geology.

The second one was established at the Comenius University soon after (1947).

The first research program was biostratigraphy based upon foraminifers. Lacking in equipment and literature, the first results were modest but very useful for economic geology (coal, salt, oil).

The Slovak territory being dominated by the West Carpathians has a complicated geological structure. As well its microfossiliferous marine sediments are of very different origin belonging to various stratigraphic and tectonic units, as the Carpathian Flysch zone, Klippen Belt, Central Carpathian Mesozoic, Intracarpathian Tertiary, Mesozoic and the Tertiary of the Slovak part of the Vienna Basin, the Tertiary of the Danube region, of the South Slovakian basin and East Slovakia, the Permo-Carboniferous and Jurassic of the Spiš-Gemer Ore Mountains and the Slovak Karst region.

Until 1945 they were paid very little attention from the view of micropaleontology, although their neighbouring regions are classical domains of foraminiferal micropaleontology, such as the Vienna Basin in Austria, the Pannonian Basin in Hungary, the Carpathian flysch in Poland, the Moravian Tertiary and the Bohemian Cretaceous in the western part of Czechoslovakia.

Only few researches concerning our territory were occasionally performed up to the end of the second World War. The main of them are to be mentioned:

Large foraminifers and radiolarians have been known and investigated already since more than one hundred years ago.

Nummulites have been noticed in the papers of D. Štúr (1858, 1859, 1868) and described by G. Stache (1867), H. Wolf (1868), L. Lóczy (1877), M. Hantken (1877), Ph. de la Harpe (1926), B. Dornay (1916), F. Bieda (1931, 1957) and M. de Cizancourt (published in 1948).

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Radiolarian Jurassic jaspers and Neocomian limestones from the Klippen Belt of the Orava region had been already known to D. RÜST (1885) and later to R. HOJNOS (1916) and J. HEITZER (1930).

The first report on small foraminifers was given by A. LIEBUS and R. J. SCHUBERT (1902) from an uncertain Klippen Belt locality near Gbelany at Žilina.

Further mention of the Klippen Belt foraminifers comes from R. NOTH (1912) and later from L. MAJZON (1943); they both dealt with Carpathian Cretaceous Foraminifera only partly concerning the eastern part of our territory.

Small Foraminifera microfauna from the brickyard Devínska Nová Ves — a Badenian locality near Bratislava (Vienna Basin) was described by F. TOULA (1915, preliminary report in 1900). To this locality led also our today's pre-Colloquy trip.

The earliest touch on small Foraminifera of South Slovakian Tertiary sediments bordering the Hungarian Pannonian Basin belongs to I. GAÁL (1905). Diatoms from this deposits were described in a well known Monography by J. PANTOCSEK (1886—1892).

The work of Hungarian geologists was shortly resumed during the Second World War, this territory being for that period under Hungarian government. Micropaleontological observations are included in the papers of S. JASKÓ (1940), L. MAJZON (1941—42) and some others.

All microfossils mentioned above were studied in washed up or otherwise destroyed samples, that is to say loosen from the rock.

West Carpathian Mesozoic foraminifers, radiolarian ond other microfossils were studied also in thin sections (D. ANDRUSOV—J. KOUTEK 1927, D. ANDRUSOV 1950), as well as radiolarites from the Paleozoic and Jurassic of the Spiš-Gemer Ore Mountains (P. ROZLOZSNIK 1935, J. ŠUF — FR. ULRICH 1933, D. ANDRUSOV 1937).

Micropaleontological research of the South Slovakian Tertiary was the first task of the newly founded Micropaleontological laboratory at Dionýz Štúr Institute of Geology in 1945. So the investigation of Miocene and Oligocene foraminifers started.

Since 1946 numerous drilling cores and outcrops samples were and still are controlled by the modern micropaleontological methods by the Dionýz Štúr Institute staff, University staff, some workers of the Slovak Academy of Sciences, Coal and Oil prospecting micropaleontological laboratories.

With the increase of educated — mostly self educated — research staff the knowledge of the past life and paleoecology of our small part of the world has greatly improved.

At that moment, the sedimentary rocks deposited on Slovak territory in different stratigraphic and tectonic units mentioned before, are known enough from various micropaleontological points of view.

Microfauna — as foraminifers, ostracods, radiolarian, sponges, bryozoan and microflora — as calcareous nannoflora, pollen, acritarchs, alga, diatoms and other microscopical faunal remains (mainly conodonts) and floral remains, proved to be of great value for stratigraphy.

Our next days field excursion tending to the Klippen Belt of the Váh river valley

and some from there not distant Eocene and Lower Miocene outcrops will demonstrate the work done.

About biostratigraphy, micropaleontological results as well as other important geological problems of the given region you will be informed at exposures by competent workers.

As a representative of the oldest generation of recent Slovak micropaleontologists I would like to express my immense pleasure in the fact that the knowlege about our country in various fields of Micropaleontology has grown up to such an extent that we are able to present it to such outstanding scientists as are the participants of this Colloquy.

I felt myself highly honoured that I could welcome you in the name of all Slovak micropaleontologists.

Have a nice stay in our country!

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Jozef Salaj—Ondrej Samuel

Microbiostratigraphical division of West-Carpathian Mesozoic and Paleogene

6 text-figs., 30Pls. (I—XXX) Slovak summary

Abstract. In the paper the authors present a synoptic survey of microbiostratigraphic investigation of the Mesozoic and Paleogene of the West Carpathians. On the basis of the latest investigations up to present biozonal subdivision of the Triassic, Cretaceous and Paleogene is getting more precise.

Lower Trias

In the West Carpathians the Lower and maybe also the Upper "Seissian" are transgressive (detrital) and insufficient for the inner-stratigraphical study.

In the Slovak Karst is a different situation: in the overlier of Permian sediments there is a variegated sandstone-schistose sequence with the species *Pseudomonotis* sp. and *Claraia clarae* (EMMR) ranged by K. Balogh (1950) to the Seissian (= Griesbachian — Lower Dienerian; sensu G. Pisa 1974), and by J. Bystrický (1964) to higher parts of the "Seissian" up to the lowermost "Campilian" (= Upper Dienerian — Spatian). In contrast to that the Campilian is represented by schists with a level of Gastropod oolites in their lower part. The lower part of the sequence contains abundant Lower Campilian fauna (J. Bystrický 1964; J. Bystrický — A. Biely 1966, p. 47); the upper part corresponds to the biozone *Tirolites cassianus* (J. Bystrický 1974).

Biozone *Arenovidalina chialingchiangensis* (partial-range zone)

From the view of microbiostratigraphy, the biozone *Arenovidalina chialingchiangensis* (J. Salaj 1978) may be distinguished in the Lower Trias of the West Carpathians. It has the character of a regional partial-range biozone. Its lower boundary cannot be defined exactly because of unfavourable facies conditions. The upper boundary is defined by the first appearances of the Anisian species *Meandrospira insolita* (Ho) and *Meandrospira deformata* Salaj.

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In tethyd areas (Turkey, L. ZANINETTI — Z. DAGER 1978; Iran, P. BROENNIMANN — L. ZANINETTI — F. BOZORGNIA 1972; L. ZANINETTI — P. BROENNIMANN 1974; the Alps, V. RESCH (1979) the Lower "Seissian" formation is characterized by the species *Cyclogyra mahajeri* BROENNIMANN, ZANINETTI et BOZORGNIA, and *Rectocornuspira kalhori* BROENNIMANN, ZANINETTI et BOZORGNIA.

Subzone *Meandrospira cheni* (interval-range zone)

The upper layers of the "Seissian" to the Lowermost "Campilian" are characterized by the interval-range subzone *Meandrospira cheni*. Its lower boundary cannot be defined exactly whereas the upper boundary is defined by the first appearance of the genus *Meandrospira pusilla* (HO).

The subzone was determined on the basis of microfauna from the Gemeric locality Honce — red oolite limestones of the Lowermost "Campilian" (Smithian) indicated by the species *Naticella costata Muenst.* and *Myophoria laeviga* ALB. (J. SALAJ — A. BIELY — J. BYSTRICKÝ 1967 b) and from the same level of the locality Rakovnica as well as from the Nízke Tatry Mts. (the confluence of the Čierny Váh r. and the Šuňavský potok brook; beds containing *Myophoria costata* ZENK.).

Meandrospira pusilla (HO) found by W. RESCH (1979) in a gastropod oolite from South-Tirolian Dolomites corresponds to the species *Meandrospira cheni* (HO).

Subzone *Meandrospira pusilla* (interval-range zone)

J. SALAJ (1.c.) distinguished the zone *Meandrospira pusilla* in the upper part of the biozone *Arenovidalina chialingchiangensis*. It has the character of an interval-range subzone and is indicative of the Upper Campilian. The lower boundary is defined by the first appearance of the species *Meandrospira pusilla* (HO), the upper one — by the first appearance of *Meandrospira insolita* (HO), the upper one — by the first appearance of *Meandrospira insolita* (HO), and *Meandrospira deformata*.

Microfauna of the Subzone Meandrospira pusilla originates from the "Upper-Campilian" beds (Spatian) containing *Tirolites* sp., from a rail-road cut between Červená skala and Švermová (J. SALAJ — A. BIELY — J. BYSTRICKÝ 1967 a, b).

Anisian

Biozone *Meandrospira insolita* (interval-range zone)

The Lower Anisian zone *Meandrospira insolita* was originally defined by J. SALAJ (1969a) in the Slovak Karst. It is associated with the environment of more-or-less normal salinity. There the Guttenstein limestones with very scarce foraminifers deposited. Besides scarce *Meandrospira insolita*, and *Tolypammina gregaria* WENDT and *Calcitornella* div. sp. there are quite abundant *Meandrospira deformata* SALAJ. The lower boundary of the biozone is characterized by the first appearances of *Meandrospira insolita* (HO) and *M. deformata* SALAJ. The upper boundary is defined

by the first appearance of *Meandrospira dinarica* KOCHANSKY — DEVIDÉ et PANTIĆ. Foraminiferal assemblages of this zone are generally poor in the Carpathian region.

The described zone was paleontologically proved on more localities in the lower parts of Gutenstein limestones around Drienok (cf. J. SALAJ — A. BIELY 1967), on the basement of Middle-Anisian-Pelsonian limestones in the Brezovské Karpaty Mts. (N of Dobrá Voda; cf. J. SALAJ — A. BIELY — J. BYSTRICKÝ 1967) and in the lower part of Gutenstein limestones in the profile Hurtovec (sample MK-21), studied by J. MELLO from the lithofacies viewpoint. According to the existing lithostratigraphical data the lower part of the Gutenstein limestones generally corresponds to the Lower Anisian. So it is in accordance with E. TRIFONOVA (1972b) who also found *Meandrospira insolita* (Ho) in the Lower Anisian.

Biozone *Meandrospira deformata* (interval-range zone)

Although sedimentation in the Slovak Karst proceeded in an environment of more-or-less normal salinity (zone *Meandrospira insolita*), the Lower Anisian Gutenstein limestones deposites on extensive shallows in other parts of the West Carpathians (M. MIŠÍK 1972). In some areas, mainly in marginal (Tatric) parts and in the area corresponding to the original sedimentation zone of the Krížna, and partly of the Choč tectonic unit (J. SALAJ — M. POLÁK 1978) a hypersaline environment formed. Such environment (known also from the Lower Anisian of the Opole Silesia: the Gogolin beds of the German Muschelkalk) is characterized by *Meandrospira deformata* SALAJ. J. GŁAZEK — J. TRAMMER — K. ZAWIDZKA (1973) determined the zone *Meandrospira deformata,* fully accepted by J. SALAJ — M. POLÁK (1978) also for hypersaline environment of the Lower Anisian in the Tatroveporicum. The zone is coeval to the zone *Meandrospira insolita.*

Zone *Meandrospira dinarica* (interval-range zone)

The lower boundary of the zone is characterized by the first appearance of *Meandrospira dinarica* KOCHANSKY — DEVIDÉ et PANTIĆ. The upper boundary is determined (cf. J. SALAJ 1969a) by the first appearance of *Pilammina densa* PANTIĆ. The described zone (like the next successive zone *Pilammina densa*) or assemblages of foraminifers with the species *Meandrospira dinarica* KOCHANSKY — DEVIDÉ et PANTIĆ et *Pilammina densa* PANTIĆ were generally accepted for the division of the Anisian, for example in the Dinarides (S. PANTIĆ 1965, 1967; V. KOCHANSKY — DEVIDÉ — S. PANTIĆ 1966) in the Alps (L. KOEHN — L. ZANINETTI 1969; I. PREMOLI SILVA 1971), in Balkan (E. TRIFONOVA — G. ČATALOV 1975, E. TRIFONOVA 1978a) and in the Opole Silesia (J. GŁAZEK — J. TRAMMER — K. ZAWIDZKA 1973). According to our opinion the differences in opinions about stratigraphical range of both biozones are due to different vertical diapason of the species characteristic for the two biozones. The difference was obviously caused by different paleoecological conditions in various areas. If we take in consideration that the species *Meandrospira dinarica* KOCHANSKY — DEVIDÉ et PANTIĆ developed from *Meandrospira insolita*

(Ho) on the Lower/Middle Anisian boundary, then our corrections of the opinion about its distribution in the Middle to Upper Anisian are in a full agreement with the opinions of other authors (O. Jendrejáková 1973; J. Głazek — J. Trammer — K. Zawidzka 1973; E. Trifonova 1978a; A. Baud — L. Zaninetti — P. Broennimann 1971; L. Zaninetti — P. Broennimann — A. Baud 1972a, b). I. Premoli-Silva (1971) mentioned presumable occurrences of the species in the Lower Anisian and she regards the Lower-Anisian species *Meandrospira insolita* (Ho) as a probable synonym of the species *M. dinarica* Kochansky—Devidé et Pantić. L. Zaninetti — Z. Dagger (1978; p. 100) found the species in the Lower Anisian of Turkey (the *Kocaeli peninsula).* They extended the range of the species *M. dinarica* Kochansky-—Devidé et Pantić and Ranged there also forms with less whorls. We regard the species as an independent taxon (= *M. insolita).* The authors mentioned admit that the species *M. dinarica* Kochansky —Devidé et Pantić developed from the species *M. pusilla* (Ho). We regard it as an ancestral form of the above mentioned polemic taxon *M. insolita* (Ho). The authors mentioned write: "Preliminarily we can say that some specimens of the Upper Anisian differ in their morphology from the oldest representatives of *Meandrospira dinarica.* A large test with plentiful whorls (L. Zaninetti — P. Broennimann — A. Baud 1972a, pl. 7, fig. 1) could really correspond to an advanced evolutionary stage of the species.". So the authors actually admit the existence of two morphologically different forms (from different stratigraphic levels) within the species *Meandrospira dinarica* Kochansky-Devidé et Pantić. In this way L. Zaninetti — Z. Dagger (1978) explain why the primitive forms of the species *Meandrospira dinarica* Kochansky-Devidé et Pantić (according to our opinion *M. insolita* Ho) appear earlier in Turkey than in the Alpine-Carpathian region, in the Dinarides and in Balkan. According to the opinion of the quoted authors, the different stratigraphical range of the species under discussion may also be caused by gradual migration of benthic foraminifers from eastern tethyd provinces westward.

Biozone *Pilammina densa* (acma-zone)

The zone was described for the first time and modified by J. Salaj (1976, 1978) and J. Salaj — K. Borza — O. Samuel (1983) in the West Carpathians. Basing upon data by K. Borza (1970) who found the species *Pilammina densa* Pantić in the Lower Anisian, J. Salaj (1979) correlated the described zone (as a total-range zone) to the entire Anisian. Since stratigraphic position of the locality described by K. Borza (1.c.) is problematic (cf. Głazek — J. Trammer — K. Zawidzka 1973; J. Hanáček 1976) it should be revised. This is why we change the zone *Pilammina densa* to the *Acma* zone. Its lower boundary is determined by the first appearance of *Pilammina densa* Pantić in the West Carpathians whereas the upper boundary is characterized by the first appearance of *Pilamminella gemerica* and by extinction of the species *Pilammina densa* Pantić and *Pilamminella grandis* (Salaj). There are contradictory opinions about the species *Pilammina (Glomospira) densa* Pantić. L. Zaninetti — Z. Dagger (1978) recorded it in the Lower Anisian (Egean) of the

Kocaeli peninsula where the platform type limestones deposited in that time. Higher up the species and *P. grandis* SALAJ are absent because of intense paleogeographic changes (formation of pelagic facies). Besides the above mentioned problematic occurrence the species *Pilammina densa* PANTIĆ is present in the Middle to the Upper Pelsonian and Illyrian in our country. In the vicinity of Silická Brezová (Slovak Karst) the lower boundary of the occurrence was determined in the middle part of the Steinalm limestones by the *Pilammina densa* PANTIĆ together with *Physoporella pauciforata sulcata* BYSTRICKÝ (sample SB—I, 11; profile Brezová studied by J. MELLO). From the overlier of the above species plentiful conodonts were found, corresponding to the Upper Pelsonian zone *Nicoraella kockelle* (G. KALISKÁ 1980).

Biozone *Permodiscus pragsoides* (interval-range zone)

Formerly the zone was determined by J. SALAJ (1978) in the Lower Ladinian. On the basis of the latest data its stratigraphic position is only Upper Illyrian. It is also evidenced by the occurrence of the species *Permodiscus pragsoides* OBERHAUSER in an assemblage with *Pilammina densa* PANTIĆ together with *Diplopora annulatissima* and *Diplopora annulata* in the Strážovské hory Mts. (J. HANÁČEK 1976). According to this interpretation the described zone partly alternating with the zone *Pilammina densa* may eventually be distinguished as a subzone within the zone *Pilammina densa* (J. SALAJ — K. BORZA — O. SAMUEL, 1983).

The species *Permodiscus pragsoides* OBERHAUSER in the West Carpathians occurs sporadically in association with the species *Pilammina densa* PANTIĆ or without it. Interesting is its mass occurrence in the Upper Anisian of the Dinarides (P. BROENNIMANN — J. P. CADET — L. ZANINETTI 1973).

The lower boundary of the zone is defined by the first appearance of the species *Permodiscus pragsoides* OBERHAUSER and the upper boundary is determined by extinction of *Pilamminella densa* PANTIĆ and *Pilamminella grandis* (SALAJ) and the first appearance of the species *Pilamminella gemerica* (SALAJ).

Ladinian

In the Ladinian J. SALAJ (1979) distinguished the zone *Pilamminella gemerica* (s.1.) with two subzones: *Pilamminella gemerica* (s.s.) and *Angulodiscus gaschei praegaschei* (Tab. 1).

Biozone *Pilaminella gemerica* (interval-range zone)

The lower boundary of the biozone is determined by the first appearance of the species *Pilamminella gemerica* (SALAJ), the upper one by *Pilamminella kuthani* (SALAJ) and *Angulodiscus gaschei gaschei* KOEHN-ZANINETTI et BROENNIMANN. The described zone is correlated to the Fassanian and the Longobardian.

Tab. 1 Microstratigraphic subdivision of the West Carpathians Triassic on the basis of the Foraminifers.

		STAGE		ZONES	
TRIASSIC	UPPER	RHAETIAN (s.l.)	RHAETIAN (s.s.)	Triasina hantkeni - TRZ	
			SEVATIAN	Angulodiscus pokornyi - A. friedli - IRZ	
		NORIAN	ALAUNIAN	Semiinvoluta clari - IRZ	
			LACIAN		
		CARNIAN	TUVALIAN		
			JULIAN	Pilamminella kuthani - IRZ	Rakusia oberhauseri - IRSZ
			„KORDEVOLIAN"		Lamelliconus procerus - TRSZ
	MIDDLE	LADINIAN	LONGOBARDIAN	Pilamminella gemerica (s.l.) IRZ	Angulodiscus gaschei praegaschei - IRSZ
			FASSANIAN		Pilamminella gemerica - s.s. - IRSZ
		ANISIAN	ILLYRIAN	Permodiscus pragsoides - IRZ	
				Pilammina densa - AZ	
			PELSONIAN	Meandrospira dinarica - IRZ	
			BITHYNIAN	Meandrospira insolita - IRZ	Meandrospira deformata - IRZ
			AEGEAN		
	LOWER	SPATIAN		Arenovidalina chialingchiangensis - PRZ	Meandrospira pusilla - IRSZ
		NAMALIAN	SMITHIAN		Meandrospira cheni - PRSZ
			DIENERIAN		
		GRIESBACHIAN	ELESMERIAN		
			GANGETIAN		

Subzone *Pilamminella gemerica* s. s. (interval-range subzone)

Its lower boundary is defined by the first appearance of *Pilamminella gemerica* and by the extinction of *Pilamminella grandis* (SALAJ). The upper boundary is determined by the first appearance of *Angulodiscus gaschei praegaschei* KOEHN-ZANINETTI. The foraminiferal assemblage of the subzone consists mostly of *Permodiscus pragsoides* OBERHAUSER, *P. oscillensis* (OBERHAUSER), *P. planidiscoides* OBERHAUSER and *Pilamminella gemerica* (SALAJ). It is ranged to the Fassanian. With respect to zonation of conodonts it may correspond to the zone *Gondolella mombergensis* (sensu K. BUDUROV — E. TRIFONOVA 1974). We prefer this zone (H. KOZUR 1972) to the zone *Gladigondolella tethydis*, since the index species of this zone (*G. tethydis*) HUCKRIEDE (also occurs in the Illyrian (cf. R. MOCK 1971; A. GAŹDZICKI — O. E. OTT 1977).

Subzone *Angulodiscus gaschei praegaschei* (interval-range subzone)

Its lower boundary is characterized by the first appearance of *Angulodiscus gaschei praegaschei* KOEHN-ZANINETTI. The upper boundary is determined by the first appearance of the species *Pilamminella kuthani* (SALAJ).

Index species of this subzone *Angulodiscus gaschei praegaschei* KOEHN- ZANINETTI, *Pilamminella gemerica* (SALAJ) pass even to the Carnian where the species *Pilamminella gemerica* (SALAJ) extinguishes. Their occurrence in the Carnian (mainly in the Cordevolian) was evidenced by diplopores *Andrusoporella duplicata* (PIA) whose first appearanced were generally recorded in the Cordevolian (J. BYSTRICKÝ et al. 1973).

The relation of this subzone to the Longobardian in the West Carpathians was evidenced on more localities. On a locality 1200 m E of Silická Brezová, studied in detail by K. BORZA (1973), together with the assemblage indicative of the described subzone also *Teutloporella herculea* (STOPP.) occurs in Wetterstein limestones.

As regards the foraminiferal assemblage of the described biozone, many samples from the Gemericum (for example loc. Budikovany), contain — besides *Permodiscus pragsoides* OBERHAUSER — also other species of subfamily *Permodiscinae* SALAJ — SAMUEL — BORZA: *Aulotortus oscillens* (OBERHAUSER), *Lamelliconus eomesozoicus* (OBERHAUSER), *Angulodiscus gaschei praegaschei* KOEHN-ZANINETTI together with *Pilamminella gemerica* (SALAJ) which is particularly abundant.

Upper Trias

Carnian

Biozone *Pilamminella kuthani* (interval-range zone)

The Carnian of the West Carpathians mostly contains macrofauna and Dasycladacea. Generally, Carnian sediments are quite rich in microfauna (cf. J. SALAJ — A.

BIELY — J. BYSTRICKÝ 1967b, Pl. 2; J. SALAJ — A. BIELY 1967, O. JENDREJÁKOVÁ 1973). In 1969 (a) J. SALAJ determined the biozone *Pilamminella kuthani*. Its lower boundary is determined by the first appearance of *Pilamminella kuthani* (SALAJ) and *Angulodiscus gaschei gaschei* KOEHN-ZANINETTI et BROENNIMANN: The upper boundary is characterized by the disappearance of *Pilamminella kuthani* (SALAJ) and by the first appearance of *Semiinvoluta clari* KRISTAN. According to O. JENDREJÁKOVÁ (1973) in the Lower and Middle Carnian also *Pilamminella* (= *Pilammina*) *gemerica* (SALAJ) is very frequent. *Lamelliconus procerus* (LIEBUS) occurs sporadically in the Lower — Middle Carnian of the Gemericum. We distinguish subzones *Lamelliconus procerus* and *Rakusia oberhauseri* in the described zone.

Subzone *Lamelliconus procerus* (total-range subzone)

The lower and upper boundaries are determined by *Lamelliconus procerus* (LIEBUS).

In connection with the determination of the lower boundary of the subzone *Lamelliconus procerus* and with the first appearance of the genus *Lamelliconus* PILLER 1978 it is to be mentioned that high-spiral coiled representatives of the species *Lamelliconus procerus* (LIEBUS) and *Lamelliconus multispirus* (OBERHAUSER) in the West Carpathians occurred in the Cordevolian whereas in Bulgaria *lamelliconus procerus* (LIEBUS) and other species of the genus *Lamelliconus occurred* all over the Longobardian.

Subzone *Rakusia oberhauseri* (interval-range subzone)

The Upper Carnian (Tuvalian) in the West Carpathians was first characterized by the subzone *Aulotortus broennimanni* (J. SALAJ 1969a) and then by the zone *Aulotortus sinuous* (J.SALAJ 1978). The use of the two synonymous zones met some difficulties because the index species *Aulotortus sinuosus* WEYNSCHENK appeared for the first time much earlier, namely in the course of the Ladinian. This is why we do not use the zone. According to personal information by O. JENDREJÁKOVÁ, in the Upper Carnian the species *Rakusia oberhauseri* SALAJ appeared, regarded by J. SALAJ (1969a, 1978) as the index species of the Norian zone *Rakusia oberhauseri*. In one case we found the species together with *Pilamminella kuthani* (SALAJ). For this reason we range this zone to the Upper Carnian (Tuvalian) as the interval-range subzone. Its lower boundary is determined by the first appearance of *Rakusia oberhauseri* SALAJ. *Pilamminella kuthani* (SALAJ) also occurs in this zone. The upper boundary is characterized by the first appearance of *Semiinvoluta clari* KRISTAN.

Recently E. JABLONSKÝ (1973), K. BORZA — O. SAMUEL (1977a, b; 1978), O. SAMUEL — J. SALAJ — K. BORZA (1981) described a very interesting group from the Carnian of the West Carpathians. The group *Paratintinnina* BORZA et SAMUEL, *Amphorella* BORZA et SAMUEL, *Spiriamphorella* BORZA et SAMUEL, *Urnulinella* BORZA et SAMUEL, *Pseudocucurbita* BORZA et SAMUEL, *Parophthalmidium* SAMUEL et BORZA, *Cucurbita* JABLONSKY was described from the view of stratigraphy, taxonomy and phylogeny. So far it is ranged either to incertae sedis or its systematic position is described differently. It is sure that some of representatives of the group are

foraminifers, others are related to Fungi. Most taxa described as *Paratintinnina* BORZA et SAMUEL, *Pseudocucurbita* BORZA et SAMUEL, *Amphorella* BORZA et SAMUEL (partim), *Urnulinella* BORZA et SAMUEL occur in shallow-water and near-reef sediments (see SALAJ — BORZA — SAMUEL 1983).

Norian

The division of the Norian and the Rhaetian is understood in the sense of J. WIEDMANN (1974), J. WIEDMANN — F. FABRICIUS — L. KRYSTYN — J. REITHNER et M. ULRICHS (1979) and E. KRISTAN-TOLLMANN — A. TOLLMANN et A. HAMEDANI (1979).

So the Lacian is understood as the Lower Norian and the Alaunian as the Upper Norian. The Sevatian (zone *Rhabdoceras suessi*), so far understood as the Upper Norian is now regarded as the Lower Rhaetian, whereas the zone *Christoceras marshi* representing the Rhaetian, corresponds now to the Upper Rhaetian.

The Lacian and the Lower Alaunian are in the facies of light massive (Furmanec) limestones, containing more-or-less current species of foraminifers (J. BYSTRICKÝ et col. 1973, p. 74—75) of the subfamily *Permodiscinae* SALAJ. Significant species are *Rakusia oberhauseri* SALAJ and *Pilamminella* (= *Glomospira*) cf. *kuthani* (SALAJ).

Biozone *Rakusia oberhauseri* (total-range zone)

According to the existing data on the upper part of the Tisovec (Upper Carnian) and the Furmanec (Norian) limestones within the total-range zone *Rakusia oberhauseri*, our microbiostratigraphical study can be based upon the following types of foraminiferal assemblages:

a) *Rakusia oberhauseri* SALAJ and *Pilamminella kuthani* (SALAJ) without *Triasina oberhauseri* KOEHN-ZANINETTI et BROENNIMANN and *Semiinvoluta clari* KRISTAN would only be characteristic of the Tuvalian (= partial-range zone *Rakusia oberhauseri*);

b) *Rakusia oberhauseri* SALAJ, *Pilamminella* cf. *kuthani* (SALAJ) and *Semiinvoluta clari* KRISTAN would already determine the Lacian — Lower Alaunian. The Lower Norian form *Pilamminella* cf. *kuthani* (SALAJ) differs in its greater size and more whorls from *Pilamminella kuthani* (SALAJ) differing only in the Carnian;

c) *Rakusia oberhauseri* SALAJ with the species *Semiinvoluta clari* KRISTAN, eventually also with *Triasina oberhauseri* KOEHN-ZANINETTI et BROENNIMANN without *Pilamminella* cf. *kuthani* (SALAJ) already within the zone *Angulodiscus pokornyi* and *Angulodiscus friedli* could characterize the Upper Alaunian — Lower Sevatian (= lower part of the Lower Rhaetian).

The species *Triasina oberhauseri* KOEHN-ZANINETTI et BROENNIMANN and *Rakusia oberhauseri* SALAJ were found in lower parts of the banks of light- and dark-grey massive Furmanec limestones of the Stratenská hornatina Mts. (localities Geravy, Suchý vrch) with *Halorella amphitona* (BRONN)., *Thecosmilia defilippi* (STOPPANI) a. o. J. BYSTRICKÝ et col. (1973, p. 63) found also rich foraminiferal assemblages at these and other localities of the Stratenská hornatina Mts.

Biozone *Semiinvoluta clari* (interval-range zone)

This zone corresponds to the Lacian and the Alaunian, i. e. to the entire Norian. It is characteristic first of all of the lagoonal facies of hauptdolomite. We studied it mainly in the Choč nappe of the Nízke Tatry Mts. (road cut at Hyby). The biozone defined by J. SALAJ (1969) is characterized by the first appearance of *Semiinvoluta clari* KRISTAN. Its upper boundary is determined by the first appearance of the species *Angulodiscus pokornyi* SALAJ, *Angulodiscus friedli* KRISTAN-TOLLMANN. A foraminiferal assemblage with *Semiinvoluta clari* and *Triasina oberhauseri* together with *Angulodiscus friedli* KRISTAN-TOLLMANN and *Angulodiscus pokornyi* SALAJ come from the lower part of the Dachstein limestones (loc. Veľká Lúka and Červená skala) with *Neomegalodus complanatus* (GUEMBEL).

Because *Triasina oberhauseri* KOEHN-ZANINETTI has not been occurring together with *Semiinvoluta clari* KRISTAN since its first appearance but only later, we abandon the zone *Semiinvoluta clari — Triasina oberhauseri* defined by J. SALAJ (1978 and keep to the zone *Semiinvoluta clari* defined by J. SALAJ (1969a) as the interval-range zone.

Among the most significant works on microbiostratigraphy of the Rhaetian is a work by E. KRISTAN-TOLLMANN (1964a, c) where the Lower Rhaetian is characterized by a foraminiferal assemblage with *Angulodiscus* (= *Glomospirella*) *friedli* KRISTAN, and the Upper Rhaetian by a foraminiferal assemblage with *Triasina hantkeni* MAJZON. There is unique assemblage of free foraminifers from the Zlambach marls (1964c). The first work mentioned served as a basis for the zonal division of the Rhaetian in the West Carpathians where J. SALAJ (1969a) distinguished and then modified (J. SALAJ 1978) two biozones.

Biozone *Angulodiscus pokornyi — Angulodiscus friedli*
(interval-range zone)

The zone resulted from the combination of two zones described by J. SALAJ (1969a): the Upper Norian zone *Angulodiscus pokornyi* and the Lower Rhaetian zone *"Glomospirella" friedli.* The zone is also mentioned by A. GAŻDZICKI (1974), only in a different stratigraphical sense from J. SALAJ (1978); Uppermost Norian — Lower Rhaetian). As a total-range zone it corresponds to the uppermost Alaunian and the entire Rhaetian. In this zone also *Triasina oberhauseri* KOEHN-ZANINETTI appears.

The foraminiferal assemblage of this zone occurs in the Furmanec (= Sevatian) limestones at the loc. Bleskový prameň spring, known for plentiful macrofauna and microfauna (O. JENDREJÁKOVÁ 1970, J. BYSTRICKÝ 1975, A. GAŻDZICKI — H. KOZUR — R. MOCK (1979). The most part of the formation belongs evidently to the zone *Angulodiscus pokornyi — Angulodiscus friedli.* There are, however, some difficulties in zonal division of this locality. It is because the facies represents a deeper type. So *Angulodiscus friedli* KRISTAN and *Angulodiscus pokornyi* SALAJ, characteristic of the lagoonal environment have not been found there. Besides foraminifers recorded by J. BYSTRICKÝ et col. (1973, p. 55) and O. JENDREJÁKOVÁ (1970) the significant

species of miliolid foraminifers are represented there by *Quinqueloculina nucleiformis* KRISTAN-TOLLMANN. In the uppermost layers of this formation (dark-grey organodetrital limestones) ranged to the zone *Rhabdoceras suessi* the species *Triasina hantkeni* MAJZON appears for the first time.

In the Muráň plateau the Upper Alaunian (halorite level p. p.) and the Lower Rhaetian (Sevatian) in the facies of Dachstein limestones represented by biomicrites and biosparites or oosparites, is characterized by foraminifers of the biozone *Angulodiscus pokornyi* — *Angulodiscus friedli* (localities Veľká lúka, Červená skala — Muráň plateau).

The biozone was also determined in the Choč nappe of the Nízke Tatry Mts. on the locality Hyby (a rail road cut).

Biozone *Triasina hantkeni* (total-range zone)

In the sense of J. SALAJ (1978) the biozone would correspond to the uppermost part of the Lower Rhaetian — Upper Rhaetian. Its lower and upper boundaries are defined by vertical distribution of species of *Triasina hantkeni* MAJZON. According to A. GAŻDZICKI (1974, 1978a, b) this zone should not extend to the uppermost parts of the Rhaetian. We regard this opinion acceptable only for the Tatricum and the Fatricum (D. ANDRUSOV — O. FUSÁN — J. BYSTRICKÝ 1973). The local absence of this species in the Uppermost Rhaetian may be caused by changed ecological conditions indicative of the onset of detrital sedimentation associated with the Lower Lias.

Jurassic

The Jurassic in the West Carpathians is the least investigated formation from microbiostratigraphic and taxonomic viewpoint, as it is prevailingly built up of carbonate facies, which are usually poor in microfacies, mainly foraminifers.

Jurassic sediments are found practically in all tectonic units of the West Carpathians (D. ANDRUSOV 1959; M. MAHEĽ in T. BUDAY et al. 1967).

As a consequence of break of sedimentation in the Upper Triassic, the Jurassic in the Inner Carpathians is prevailingly transgressive (compare D. ANDRUSOV, 1959). Its oldest members are developed in the facies of the Gresten beds or crinoidal, abundantly detrital limestones. This type of facies is very poor in microfossils; especially foraminifers, or is without fossils. So far as foraminifers are found, they are usually represented by so far nearer not identified forms of the genus Lenticulina. In the lowermost Jurassic from stratigraphically important forms the species Involutina liassica is found, which is usually bound to the facies of crinoidal or organo-detrital limestones.

In places with gradual transition of sedimentation from the Triassic to the Jurassic we put the boundary between these formations according to first appearance of the species *Ophthalmidium leischneri* (KRISTAN-TOLLMANN) and *Involutina liassica* (JONES), see Tab. 2.

Tab. 2 Vertical range of the important microfossils in the Jurassic of the West Carpathians

Microfossils \ Age	RHAETIAN	HETTANGIAN	SINEMURIAN	PLEISBACHIAN	LOTHARINGIAN	TOARCIAN	AALENIAN	BAJOSIAN	BATHONIAN	CALLOVIAN	OXFORDIAN	KIMMERIDGIAN	TITHONIAN	BERRIASIAN
Angulodiscus friedli (Krist.-Tollm.)	—													
Triasina hantkeni Majzon	—													
Involutina liassica (Jones)		—	—	—	—	—								
Ophthalmidium leischneri (Krist.-Tollm.)	—													
Marginulina aff. prima d' Orbigny		—	- - -											
Lingulina gr. tenera Bornemann		—	- - -											
Vidalina mastana Farinaci			—	- - -										
Ostracoda div. sp.				—			—							
Frondicularia sulcata Bornemann						—								
Nodosaria metensis Terguem						—								
Spirillina imfima (Strikland)						—	—							
Filaments (Lamelibranchiata)						—	—	—	—	—				
Polskanella oxfordiana (Grigelis)											—	- -		
Conoglobigerina dagestanica (Morozova)											—	- -		
Alveosepta aff. jaccardi (Schrodt.)												—	—	
Alveosepta aff. powersi (Redmond)												—	—	
Pseudocyclammina lituus (Yokoyama)												—	—	
Clypeina jurassica Favre												—	—	—
Coscinoconus alpinus (Leupold)												—	—	—
Coscinoconus elongatus (Leupold)												—	—	
Saccocoma (Lombardia) angulata Brönnimann												—	—	
Sacoccoma (Lombardia) arachnoidea Brönnimann												—	—	
Sacoccoma (Eotrix) alpina Colom Y form													—	—
Crassicolaria intermedia Durand Delga													—	—
Calpionella alpina grandis Doben														—
Calpionella alpina cadischi														—
Tintinnopsella carpathica (Murg. et Filip)-primitive form														- -
Tintinnopsella carpathica (Murg. et Filipescu)														—
Calpionella elliptica Cadisch														—
Tintinopsella oblonga (Cadisch, in Boller)														—

Among facies mostly wide-spread in the Lower and Middle Jurassic marls and marly limestones, mainly of "Fleckenmergel" type belong. Besides the last mentioned type of facies in the Klippen Belt, moreover, Posidonia, Supraposidonia and Opalinus beds are developed, in which foraminifers are relatively most abundant, mainly represented by forms of the family Nodosaridae. V. SCHEIBNEROVÁ (1968) described the association of foraminifers from the Opalinus beds of the western part of the Klippen Belt, whereas A. BEGAN — V. GAŠPARIKOVÁ — J. SALAJ (in A. BEGAN et al. 1983, p. 68) from the "Fleckenmergel" facies.

Lower Cretaceous

Lower Cretaceous sediments in the West Carpathians have an extensive areal distribution in all principal tectonic units.

In central units the single lithofacies (J. SALAJ and O. SAMUEL 1966, p. 21, 24), mainly the marly lithofacies contain considerably recrystallized microfauna and some parts are devoid of macrofauna and microfauna. Limestone bed sequences (Berriasian-Barremian) in the „biancone" facies not only in the Central Carpathians but also in the Manín and the Klippen Belts are dated mostly according to calpionelles, cadosines and stomiospheres studied most thoroughly by K. BORZA (1969, 1980). The Barremian-Aptian in the Urgonian limestone facies are dated on the basis of orbitolines (D. ANDRUSOV 1959, O. SAMUEL — K. BORZA — E. KÖHLER 1978). The limestone-marly bed sequences of the Aptian-Lower Albian age and the Upper Albian flysch facies extending to the Cenomanian in the Central Carpathians and to the Turonian in the Vysoké Tatry Mts. are best dated on the basis of foraminifers. Younger bed sequences are not preserved there.

Lower and Middle Cretaceous sediments are tectonically disturbed to a considerable extent in the West Carpathians. In spite of a great attention paid to stratigraphy of Lower Cretaceous sediments in the present (K. BORZA — V. GAŠPARIKOVÁ — J. MICHALÍK — Z. VAŠÍČEK 1980, J. MICHALÍK — Z. VAŠÍČEK 1979) their microbiostratigraphical division based on foraminifers is not accomplished. So the existing stratigraphic data are only preliminary. The Berriasian is dated — besides macrofauna — on the basis of calpionelles. Scarce foraminifers, mainly lenticulines are mostly known from thin sections.

The Valanginian. Marly strata of the bottom complex of spotty limestones (Trstie, Podskalie) contain the following significant species: *Conorboides hofkeri* (BARTENSTEIN et BRAND), *Conorboides valendisensis* (BARTENSTEIN et BRAND), *Epistomina* (*E.*) *fursenkovi* MJATLIUK and *Epistomina* (*E.*) *ornata* (ROEMER) [= *Conorboides hofkeri* — *E.* (*B*). *ornata* Assemblage Zone, see Tab. 3]. Upper Valanginian marls (Trstie) contain the species: *L.* (*L*) *ouachensis* (SIGAL), *Lenticulina* (*Lenticulina*) *eichenbergi* BARTENSTEIN et BRAND, *L.* (*Lenticulina*) *guttata* TEN DAM and *Lingulina* loryi (BERTHELIN) [*Lenticulina* (*L.*) *ouachensis* — *L.* (*L.*) *eichenbergi* Assemblage Zone].

The Hauterivian. In marly layers of the Lower Hauterivian limestone complex [*L.* (*M.*) *djaffaensis* — *Haplophragmoides nana* Assemblage Zone] were the following

Tab. 3

Age \ Area		MICROBIOSTRATIGRAPHIC ZONATION OF THE LOWER CRETACEOUS OF THE WEST CARPATHIANS IN SLOVAKIA	
APTIAN	Clans.	Hedbergella rohri I. Z.	Epistomina (Brotzenia) charlottae I.S.Z
			Discorbis wassoewizi I.S.Z
	Garg.	Biglobigerinella barri I. Z.	
	Bedoul	Pl. (Globigerinelloides) algeriana - Epistomina (Br.) spinulifera polypioides A. Z.	
		Pl. (Globigerinelloides) ferreolensis - Conorotalites aptiensis A. Z.	
BARREMIAN	Upper	Conorotalites bartensteini intercedens - Epistomina (Brotzenia) spinulifera A.Z.	
		Conorotalites bartensteini bartensteini - Hedbergella sigali A. Z.	
	Lower	Epistomina (Brotzenia) hechti - Hedbergella sigali A. Z.	
		Hedbergella sigali - Lingulogavelinella sigmoicosta barremiana A. Z.	
HAUTERIVIAN	Upper	Caucasella hoterivica - Lingulogavelinella sigmoicosta sigmoicosta A. Z.	
	Lower	Lenticulina (Marginulinopsis) djaffaensis - Haplophragmoides nana A. Z.	
VALANGINIAN	Upper	Lenticulina (Lenticulina) ouachensis - Lenticulina (Lenticulina) eichenbergi A. Z.	
	Lower	Conorboides hofkeri - Epistomina (Epistomina) ornata A. Z.	
BERRIASIAN		Tintinnopsella carpathica - Calpionella elliptica P.R.Z	

index species: *Lenticulina* (*Marginulinopsis*) *djaffaensis* (SIGAL), *Epistomina* (*Hoeglundina*) *caracola* (ROEMER), *Haplophragmoides nana* (ORBIGNY), *Verneuilinoides neocomiensis* (MJATLIUK), *Vaginulina gaultina* BERTHELIN, *Vaginulina recta* REUSS and *Frondicularia* aff. *inversa* REUSS. The Upper Hauterivian [= *Caucasella hoterivica* — *Lingulogavelinella sigmoicosta sigmoicosta* Assemblage Zone] contains also abundant planktic foraminifers: *Hedbergella infracretacea* (GLAESSNER) and *Caucasella hoterivica* (SUBBOTINA). Among benthic foraminifers significant is *Lingulogavelinella sigmoicosta sigmoicosta*.

The Barremian. In the course of the Lower Barremian the index species *Lingulogavelinella sigmoicosta barremiana* BETTENSTAEDT) and *Hedbergella sigali* MOULLADE appear, and in the higher part of the Lower Barremian also *Epistomina* (*Brotzenia*) *hechti*. In the Upper Barremian are *Conorotalites bartensteini bartensteini* (BETTENSTAEDT). In the top parts of the Barremian are *Conorotalites bartensteini intercedens* (BETTENSTAEDT) and *Epistomina* (*Brotzenia*) *spinulifera* (REUSS). In the Upper Barremian of the Klipenn Belt are also planktic foraminifers represented by *Clavihedbergella subcretacea* (TAPPAN), *Hedbergella sigali* (MOULLADE) and *Hedbergella seminolensis* (HAARLTON). No representatives of the genera *Schackoina* and *Leupoldina* have so far not been found in the Uppermost Barremian and Aptian of the West Carpathians. Subdivision of the Barremian is presented in the Table 3.

The Aptian. The base of the Aptian is defined by the occurrence of foraminifers — the species *Planomalina* (*Globigerinelloides*) *ferreolensis* (MOULLADE) and later on by *Planomalina* (*Globigerinelloides*) *algeriana* regarded by J. SALAJ and O. SAMUEL (1966) as the index species of the Lower Aptian zone of the same name. Benthic foraminifers in the West Carpathians occur from the base of the Aptian and are represented by *Conorotalites bartensteini aptiensis* (BETTENSTAEDT), higher up also by *Planomalina* (*Gls.*) *algeriana* (CUSHMAN et TEN DAM) and *E.* (*Brotzenia*) *spinulifera polypioides* (EICHENBERG).

The Upper Aptian (Gargasian) is characterized mainly by *Bioglobigerina barri* BOLLI, LOEBLICH et TAPPAN (see Tab. 3).

The Uppermost Gargasian and Clansayesian in the West Carpathians like in the Tunisian Atlas are characterized by the species *Hedbergella rohri* BOLLI (in the sense of J. SALAJ and O. SAMUEL 1966, J. SALAJ 1976, 1980; A.—L. MAAMOURI and J. SALAJ 1978 denoted as *Hedbergella roberti* (GANDOLFI), syn. aj. *Ticinella bejaouensis* SIGAL) — the index species of the zone formerly defined by H. BOLLI 1959 as the zone *Praeglobotruncana rohri* or by J. SALAJ and O. SAMUEL (1966) as the zone *Hedbergella roberti*. In the lower part of the thus modified interval zone *Hedbergella rohri* (representative of the Upper Gargasian and Clansayesian) is the species *Discorbis wassoevizii* DJAFFAROV et Agalarova — the index species of the interval subzone of the same name, defined in the West Carpathians by J. Salaj et O. Samuel (1966). The Upper part of the Hedbergella rohri Zone is characterized by the species E. (B. charlottae — the index species of the interval subzone of the same name (J. SALAJ — O. SAMUEL 1966, see Tab. 3).

The Albian. The Aptian/Albian boundary is defined by the species *Ticinella roberti* (GANDOLFI) in the sense of REICHEL 1950, and by the index species of planktic

Tab. 4

Age		MICROBIOSTRATIGRAPHIC ZONATION OF THE MIDDLE AND UPPER CRETACEOUS ON THE BASIS OF PLANKTONIC FORAMINIFERS (GLOBOTRUNCANIDAE AND HETEROHELICIDAE) after J. Salaj & O. Samuel, 1983	
MAASTRICHTIAN	UPPER	Abathomphalus mayaroensis Zone	Racemiguembelina varians Zone
		Rugotruncana gansseri Zone	
	LOWER	Globotruncana falsostuarti Zone	Gublerina cuvillieri Zone
CAMPANIAN	UPPER	Globotruncanella havanensis Zone	Gublerina reniformis Zone
		Globotruncana calcarata Zone	
		Globotruncana arca rugosa Zone	
	LOWER	Globotruncana arca arca Zone	Ventilabrella glabrata Zone
SANTONIAN	UPPER	Globotruncana manaurensis - - Globotruncana elevata Zone	Ventilabrella alpina Zone
	MIDDLE	Dicarinella carinata Zone	Ventilabrella decoratissima Subzone
	LOWER		Sigalia carpathica Subzone
CONIACIAN	UPPER	Dicarinella concavata Zone	Sigalia deflaensis Subzone
	MIDDLE		Globotruncanella praehavanensis Subzone
	LOWER		Helvetoglobotruncana cachensis - - Marginotruncana angusticarinata Subzone
TURONIAN	UPPER	Marginotruncana schneegansi Zone	Dicarinella renzi Subzone
			Whiteinella inornata - Falsotruncana maslakovae Subzone
	MIDDLE	Helvetoglobotruncana helvetrica Zone	Caronita turona Subzone
			Dicarinella biconvexa Subzone
	LOWER		Dicarinella oraviensis trigona Subzone
		Dicarinella imbricata s.l. Zone	Dicarinella hagni Subzone
			Dicarinella imbricata s.s. Subzone
CENOMANIAN	UPPER	Rotalipora cushmani Zone	Rotalipora turonica Subzone
			Rotalipora montsalvensis Subzone
	MIDDLE	Thalmanninella appennica s.l. Zone	Pseudoticinella bicarinata Subzone
	LOWER		Thalmanninella evoluta Subzone
			Thalmanninella deeckei Subzone
			Thalmanninella appenninica s.s. Subzone
		Thalmanninella brotzeni Zone	
ALBIAN	UPPER	Whiteinella gandolfii Zone	
		Thalmanninella ticinensis Zone	
	MIDDLE	Thalmanninella subticinensis Zone	
	LOWER	Ticinella roberti Zone	

zone of the same name (I. R. Z.) as well as by the species *Haplophragmoides nonioninoides* (REUSS) which is the index species of a benthic zone (I. R. Z.) of the same name.

Both zones are characteristic of the Lower Albian. The planktic zone is characteristic of the Czorsztyn and the Manín Units. They represent though, a shallow-water environment, but the pelagic component is still large there. In the Czorsztyn Unit the Albian — although transgressive — is represented by pelagic variegated marls containing mostly (90%) the species *Ticinella roberti* (GANDOLFI sensu REICHEL) like in the Manín Unit.

The deep-sea sedimentation in the Lower Albian proceeded in the Central Carpathians in the Klape Unit s. l. with dominant benthic foraminifers., mainly the index species of the zone *Haplophragmoides nonioninoides* (REUSS).

In the Middle and Upper Albian of practically all tectonic units of the West Carpathians dominant are planktic foraminifers represented by the zones *Thalmanninella ticinensis subticinensis* and *Thalmanninella ticinensis ticinensis* (Tab. 4) The Uppermost Albian up to the base of the Cenomanian is characterized by the zone *Whiteinella gandolfii* defined by V. GAŠPARIKOVÁ et J. SALAJ (1984). It corresponds to the original, in the West Carpathians defined zone *Rotundina stephani* (J. SALAJ) et O. SAMUEL 1966).

Upper Cretaceous

The Upper Cretaceous in the West Carpathians developed in essentially two basical facies types. The first type is represented by flysch sequences with variable ratio of pelitic component to the psammitic; it has greater areal extent and occurs mainly in the Outer Flysch Belt, less in the Klippen Belt and in the Inner-Carpathian units. The second type is represented by a marly facies, especially in the Klippen Belt. The flysch sequences — in contrast to facies of the marly type — are poorer in fossils and in planktonic components. The two facies types are very poor in macrofossils or fossilless. To biostratigraphy of Upper Cretaceous sediments is based on foraminifers. Researches based on nannoplankton (J. SALAJ — V. GAŠPARIKOVÁ 1979, 1983) also seem prospective (Tab. 5).

A very significant foraminiferal group is represented by planktic foraminifers enabling biostratigraphical parallelization over greater distance. It is evidenced by correlation of Carpathian and Tunisian Cretaceous which contains besides foraminifers also macrofauna with a significant orthostratigraphic group — ammonites. Since the first determination of regional biozones in the Carpathians, based on planktic foraminifers (cf. J. SALAJ — O. SAMUEL 1966) further valuable factographic material has been collected also out of the Carpathians, so we present further aspects of the relation of the defined biozones to chronostratigraphic units with a particular emphasis on index species of the individual foraminiferal biozones and on chronostratigraphic units within the Upper Cretaceous (Tab. 4).

Cenomanian

Thalmanninella brotzeni (interval biozone)

The biozone was defined almost simultaneously by R. LEHMANN (1966) and J. SALAJ — O. SAMUEL (1966). Its lower boundary is characterized by the F. A. (first appearance) of the species *Thalmanninella brotzeni* SIGAL. According to J. SALAJ — O. SAMUEL (1966) and J. SIGAL (1967) the species appears immediately above the base of the Lower Cenomanian, according to R. LEHMANN (1962) later. On the hypostratotype the index form of the biozone appears in the Lower Cenomanian, i. e. in the ammonite biozone *Mantelliceras martinpreyi* and so the original conception of the Carpathian biozone is reasoned. The upper boundary of the biozone *Thalmanninella brotzeni* is defined by the F. A. of *Thalmanninella appenninica* (RENZ). The biozone comprises foraminiferal assemblages, still without typical forms of the species *Thalmanninella appenninica appenninica* (RENZ) and with sudden abundant occurrence of *Th. brotzeni* SIGAL. Especially in pelagic sediments of the Klippen Belt and the Manín Unit — like on the Tunisian Cenomanian hypostratotype — this form dominates markedly over other species and sometimes forms 50—90% of the total amount of specimens. There are also *Hedbergella brittonensis* (LOEBLICH et TAPPAN) and *Schackoina cenomana* GANDOLFI. The biozone also contains *Planomalina* (*Planomalina*) *buxtorfi* (GANDOLFI) whereas typical forms of the preceding biozone are less frequent and some extinguish. The described biozone is correlated to the lower part of the Lower Cenomanian — in contrast to R. LEHMANN (1966) who correlated it to the Middle Cenomanian.

Thalmanninella appenninica appenninica (interval-Range Biozone s. l.)

For the first time it was defined as the lower Rotalipora zone (cf. F. DALBIEZ 1955 and H. M. BOLLI 1957), i. e. as the zone *Rotalipora appenninica appenninica*. It corresponds to the upper part of the Lower Cenomanian up to the lower part to the Middle Cenomanian (cf. J. SALAJ — O. SAMUEL 1966, 1977, 1979, M. STURM 1969).

We understand the species *Thalmanninella appenninica* (RENZ) as the type species (holotype), determined for the first time by P. MARIE (1948; *Globotruncana appenninica* n. sp., in O. RENZ 1936, p. 14, Fig. 2, section left).

In the foraminiferal assemblage of the described biozone the species *Thalmanninella appenninica appenninica* (RENZ) dominates. Sometimes it represents 50—70 % of the total number of specimens. Present are also *Th. appenninica balernaensis* (GANDOLFI) and *Schackoina cenomana* (SCHACKO). Almost simultaneously *Hedbergella portsdownensis* (WILIAMS et MITCHEL), *H. brittonensis* LOEBLICH et TAPPAN and *Praeglobotruncana delrioensis* (PLUMMER) appear. They characterize the lower boundary of the described biozone. Somewhat later appear *Th. globotruncanoides* (SIGAL), *Thalmanninella deeckei* (FRANKE), *Thalmanninella evoluta* (SIGAL) and *Pseudoticinella bicarinata* (SAMUEL et SALAJ). The occurrence of

Tab. 5

Age		MICROBIOSTRATIGRAPHIC SUBDIVISION OF THE MIDDLE AND UPPER CRETACEOUS OF THE WEST CARPATHIANS ON THE BASIS OF PLANCTIC FORAMINIFERS AND NANNOPLANKTON after V. Gašparikova & J. Salaj, 1983		
MAASTRICHTIAN	UPPER	Abathomphalus mayaroensis Zone		Nephrolithus frequens Zone
		Rugotruncana gansseri Zone		Lithraphidites quadratus Zone
	LOWER	Globotruncana falsostuarti Zone		Tetralithus trifidus Zone
CAMPANIAN	UPPER	Globotruncanella havanensis Zone		Tetralithus aculeus Zone
		Globotruncana calcarata Zone		
		Globotruncana arca rugosa Zone		
	LOWER	Globotruncana arca arca Zone		Broinsonia parca Zone
SANTONIAN	UPPER	Dicarinella carinata Zone	Globotruncana manaurensis Glbtr. elevata Subzone	Tetralithus obscurus Zone
	MIDDLE		Ventilabrella decoratissima Subzone	
	LOWER		Sigalia carpathica Subzone	
CONIACIAN	UPPER	Dicarinella concavata Zone	Sigalia deflaensis Subzone	Micula decussata Zone
	MIDDLE		Globotruncanella praehavanensis Subzone	Marthasterites furcatus Zone
	LOWER		Helvetoglbtr. cachensis Margtr. angusticarinata Subzone	
TURONIAN	UPPER	Marginotruncana schneegansi Zone	Dicarinella renzi Subzone	Eiffelithus eximius Zone
			Whiteinella inornata Falsotruncana maslakovae Subz.	
	MIDDLE	Helvetoglobotr. helvetica Zone	Caronita turona Subzone	Tetralithus pyramidus Zone
			Dicarinella biconvexa Subzone	
			Dicarinella oraviensis trigona Subzone	
	LOWER	Dicarinella imbricata s.l. Zone	Dicarinella hagni Subzone	Gartnerago obliquum Zone
			Dicarinella imbricata s.s. Subz.	
CENOMANIAN	UPPER	Rotalipora cushmani Zone	Rotalipora turonica Subzone	
			Rotalipora montsalvensis Subzone	
	MIDDLE	Thalmanninella appenninica s.l. Zone	Pseudoticinella bicarinata Subzone	
			Thalmanninella evoluta Subzone	
			Thalmanninella deeckei Subzone	Eiffelithus turriseiffeli Zone
	LOWER		Thalmanninella appenninica s.s. Subzone	
		Thalmanninella brotzeni Zone		
ALBIAN	UPPER	Whiteinella gandolfii Zone		
		Thalmanninella ticinensis Zone		Podorhabdus albianus Zone
	MIDDLE	Thalmanninella subticinensis Zone		Praediscosphaera cretacea Zone
	LOWER	Ticinella roberti Zone		Parhabdolithus angustus Zone

Thalmanninella deeckei (FRANKE) and *Thalmanninella evoluta* (SIGAL) culminates in higher parts of the biozone *Thalmanninella appenninica*. The upper boundary of the biozone is determined by the F. A. of representatives of *Rotalipora* ex gr. *cushmani cushmani* (MORROW). The biozone is ranged to the upper part of the Lower Cenomanian and to the lower part of the Middle Cenomanian. It is well characterized by ammonites. Its lower part on the locality Dj. Ech. Chama (Tunisia, cf. G. CASTANY 1951, J. M. MASSIN—J. SALAJ 1970) and on the Cenomanian hypostratotype loc. Dj. Fguira Salah) are characterized by ammonites of the zone *Mantelliceras mantelli*. The top part of the zone *Thalmanninella appenninica* on the loc. Dj. Fguira Salah and in SE France (cf. B. PORTHAULT — G. THOMEL — O. de VILLOUTREYS 1966) are characterized by ammonites of the zone *Acanthoceras rhotomagense*.

The fact that the biozone *Thalmanninella appenninica* represents a long time interval and is characterized by more index forms, enables us to divide it into several subzones (A. BEGAN — J. HAŠKO — J. SALAJ — O. SAMUEL 1978):

a) *Thalmanninella appenninica Interval*-Range Biosubzone s. s. represents a part of biozone *Thalmanninella appenninica* s. l. The base of the subzone is characterized by the F. A. of *Thalmanninella appenninica appenninica* (RENZ) and its upper boundary by the F. A. of *Thalmanninella deeckei* (FRANKE). Significant species of the subzone are *Thalmanninella appenninica* (RENZ), *Th. globotruncanoides* (SIGAL), *Th. brotzeni* SIGAL and *Praeglobotruncana delrioensis* (PLUMMER).

b) *Thalmanninella deeckei* interval-range biosubzone. Its lower boundary is defined by the F. A. of *Thalmanninella deeckei* (FRANKE) and the upper by the F. A. of *Thalmanninella evoluta* (SIGAL). Besides *Thalmanninella appenninica* (RENZ), *Thalmanninella deeckei* (FRANKE), *Thalmanninella appenninica gandolfii* LUTERBACHER et PREMOLI SILVA also *Thalmanninella globotruncanoides* (SIGAL) and *Praeglobotruncana marginaculeata* (LOEBLICH et TAPPAN) are frequent.

c) *Thalmanninella evoluta* interval-range biosubzone. Its lower boundary is characterized by the F. A. of *Thalmanninella evoluta* (SIGAL) and its upper boundary by the F. A. of *Pseudoticinella bicarinata* (SAMUEL—SALAJ). Besides *Thalmanninella evoluta* (SIGAL) the subzone also contains frequent *Thalmanninella brotzeni* SIGAL. *Thalmanninella globotruncanoides* SIGAL and *Thalmanninella deeckei* (FRANKE) and the F. A. of *Praeglobotruncana gibba* KLAUS and *Praeglobotruncana indica* (JACOB et SASTRI).

The described subzone is well developed mostly in flysch facies of the Manín Unit (V. GAŠPARIKOVÁ — J. SALAJ 1985) where it is thicker than in the marlstone facies. *Thalmanninella evoluta* SIGAL is dominant there and passes abundantly (like in Tunisia; J. SALAJ 1980) also in the zone *Rotalipora cushmani*. The species is sometimes erroneously described as *Rotalipora montsalvensis* (MORNOD) without a distinct carina. *Rotalipora montsalvensis* (MORNOD) occurs in the West Carpathians (like in Tunisia) contemporaneously with the species *R. cushmani* (MORROW). Contradictory interpretation of the age diapason of *Thalmanninella evoluta* SIGAL and *Rotalipora montsalvensis* (MORNOD) is frequently caused by contradictory approaches to the respective taxa.

d) *Pseudoticinella bicarinata* interval-range biosubzone, defined for the first time by J. SALAJ (1974a) and J. SALAJ — J. P. BELLIER (1976). Its lower boundary is

characterized by the F. A. of *Pseudoticinella bicarinata* (SAMUEL — SALAJ) (= *Pseudoticinella biconvexa* LONGORIA) and the upper boundary by the F. A. of *Rotalipora montsalvensis* (MORNOD).

It is a very narrow subzone because the species *Pseudoticinella bicarinata* (SAMUEL et SALAJ) acquires very quicky characteristic features of the taxon *Rotalipora montsalvensis* (MORNOD).

Besides scarce *Pseudoticinella bicarinata* SAMUEL et SALAJ most frequent are *Thalmanninella evoluta* (SIGAL), *Praeglobotruncana gibba* (KLAUS), *Thalmanninella deeckei* (FRANKE) and *Praeglobotruncana indica* (JACOB et SASTRI).

Since J.—P. BELLIER (1983) did not found the species *Pseudoticinella* (= *Rotalipora*) *bicarinata* SAMUEL et SALAJ in his Tunisian material, he did not use it for the determination of the respective biozone. It is perhaps the reason why he is doubtful about the genetic relation of the taxon to *Rotalipora montsalvensis* (MORNOD) when he writes (L. C., p. 47): "Le problème par l'origine de ces formes rejoint celui de la position phylétique des *Rotalipores*, la souche de *Rotalipora montsalvensis* demeurent très énigmatique. SALAJ et SAMUEL (1966, p. 176) envisagent une relation *Rotalipora bicarinata* SAMUEL et SALAJ — *Rotalipora montsalvensis;* ces auteurs étant les seuls à avoir distingué l'espèce bicarinata, jusqu' à présent, cette relation reste donc très artificielle". Here it should be noticed that *Pseudoticinella* is regarded as the ancestral form of *R. montsalvensis* (MORNOD). *Pseudoticinella biconvexa* (LONGORIA 1973) has on some chambers two fine pustulose carinae like the species *Pseudoticinella bicarinata* (SAMUEL et SALAJ 1962). We already mentioned the fact in 1977 (J. SALAJ — O. SAMUEL 1977) and so we regard the taxon described by J. F. LONGORIA (l. c.) as synonymous to *P. bicarinata* (SAMUEL et SALAJ 1962).

J. F. LONGORIA — M. A. GAMPER (1974) assume that the genus *Pseudoticinella* LONGORIA 1973 developed from *Thalmanninella* SIGAL 1948. The inverted development seems improbable to us because of markedly different morphology of the two genera. According to our former studies (cf. J. SALAJ — O. SAMUEL 1966) and present results the lineage of the genus *Pseudoticinella* LONGORIA is *Hedbergella* BROENNIMANN et BROWN 1956 → *Ticinella* REICHEL 1950 → *Pseudoticinella* LONGORIA 1973. The latter, represented mainly by the species Pseudoticinella bicarinata (SAMUEL et SALAJ 1962) is regarded as ancestral form of *Rotalipora montsalvensis* (MORNOD 1950) — *R. turonica* BROTZEN 1942 on the basis of gradual basical morphological changes. This our interpretation is different from the former generally accepted lineage (P. BROENNIMANN — N. K. JR. BROWN 1956) of the genera *Hedbergella* BROENNIMANN et BROWN 1956 → *Ticinella* REICHEL 1949 → *Thalmanninella* SIGAL 1948. Because of substantial differences in their phylogeny we do not regard the genera *Thalmanninella* and *Rotalipora* as synonymous (F. ROBASZINSKI — M. CARON 1979) but as independent taxa (cf. J. SALAJ — O. SAMUEL 1966). This is also the opinion of J. F. LONGORIA — M. A. CAMPER (1974), who wrote: "Thalmanninella has infralaminal accessory apertures formed at the edge of the long portici; while in Rotalipora the apertures are secondary connecting directly into the chamber. It seems important to make a clear distinction between this two types of structures and its apertures since it is quite probable that they were used for different function during the life of the cell. Furthermore, Thalmanninella develops on

imperforate coverplate which is lacking in Rotalipora". It follows that the authors regard the infralaminal accessory apertures which are secondarily connecting directly to the chamber as a significand distinctive morphologic character of the genus *Rotalipora*. So they supported the opinion of J. SALAJ (1962, p. 259): "Beim Studium der Gattung *Rotalipora* BROTZEN 1942 ist es uns gelungen Individuen (*Rotalipora* aff. *cushmani*) festzustellen, bei welchen alle Kamern auf der Veretsalseite 2 gegeneinander liegende intraumbilicale Mündungen besitzen. Zwischen einzelnen Kamern sind grosse zwischensuturale Räume, welche die Entwicklung von zwei Mündugen ermöglichen".

In accordance with the quoted opinion we range to *Rotalipora* BROTZEN 1942 only the species *Rotalipora gigantea* LEHMANN, *Rotalipora montsalvensis* (MORNOD) and *Rotalipora turonica* (BROTZEN) which developed from the preceding species. So our former opinion (A. BEGAN — J. HAŠKO — J. SALAJ — O. SAMUEL 1976; J. SALAJ — O. SAMUEL 1977; J. SALAJ 1980) that *Rotalipora globotruncanoides* SIGAL is the ancestral form of *Rotalipora turonica* (BROTZEN) is to be revised in the above sense.

We still do not know the origin of the species *Rotalipora cushmani* (MORROW) which developed from *Rotalipora evoluta* (SIGAL). It is likely that the two species originate from a species of the genus *Pseudoticinella* LONGORIA 1973).

If the phylogenetic relation of these species to a species of the genus *Thalmanninella* SIGAL will be proved, then the genus *Rotalipora* BROTZEN 1942 is to be regarded as polyphyletic.

Rotalipora cushmani, s. l. (total-range biozone)

The biozone was for the first time defined by A. M. BORSETTI (1962) as the zone *Rotalipora cushmani*, by J. SALAJ — O. SAMUEL (1966) as the zone *Rotalipora* ex gr. *cushmani*. J. SALAJ (1976) modified it to the zone *Rotalipora cushmani* s. l.

Its lower boundary is determined by the F. A. of *Rotalipora cushmani* (MORROW) and the upper by the F. A. of *Dicarinella imbricata* (MORNOD) and by sudden total extinction of rotalipores in the *Metoicoceras geslinianum* Zone ROBASZYNSKI et al. 1982).

The described biozone forms another successive microstratigraphic zone in the Cenomanian owing to representatives of the typical species (or subspecies) of the biozone, dominating over the others. Some forms even occur in monoassemblages in the marly facies of the Klippen and Manín Belts which enables us to distinguish two subzones:

Rotalipora montsalvensis and *Rotalipora turonica-subbiozones*

a) *Rotalipora montsalvensis* interval range biosubzone was defined for the first time by J. SALAJ — O. SAMUEL (1966) as *Rotalipora cushmani montsalvensis*, representing the lower part of biozone *Rotalipora cushmani* (cf. also J. M. MASSIN — J. SALAJ 1970, J.-P. BELLIER, 1971, 1983). Its range is the same as that of the index species. Its lower boundary is characterized by the F. A. of *Rotalipora montsalvensis* (MORNOD) and *Rotalipora cushmani* (MORROW); the upper boundary by *Rotalipora turonica* BROTZEN. In the subzone *Rotalipora montsalvensis* dominant is *Rotalipora*

montsalvensis (MORNOD). Together with *Epistomina* (*Brotzenia*) *postdorsoplana* (VASILENKO), *Anomalina* (*Gavelinella*) *berthelini* KELLER, *Rotalipora montsalvensis minor* (MORNOD) and *Praeglobotruncana marginaculeata* (LOEBLICH et TAPPAN) it characterizes the subzone. With respect to the data on vertical distribution of some more significant species and to superposition, we range the subzone to the upper part of the Middle Cenomanian.

On the Tunisian Cenomanian hypostratotype — on the basis of ammonites — the subzone is ranged to the upper parts of the amonite zone Acanthoceras rotomagense representing the top parts of the Middle Cenomanian and to the lower parts of the zone *Calycoceras naviculare* which already correspond to the Upper Cenomanian. The data on the occurrence of *Rotalipora montsalvensis* (cf. B. PORTHAULT 1969) in the uppermost part of the Lower Cenomanian (ammonite zone Mantelliceras mantelli) in SE France seem unreliable to us. We think that it is *Thalmanninella evoluta* (SIGAL) to which *Rotalipora montsalvensis* (MORNOD) shows greatest affinity. This opinion is also supported by the fact that no *Rotalipora montsalvensis* (MORNOD) was found on several Tunisian localities in the zone *Mantelliceras mantelli.*

b) Subzone *Rotalipora turonica* (total-range subzone) was defined for the first time by J. SALAJ — O. SAMUEL 1966) as subzone *Rotalipora cushmani* (cf. also J. M. MASSIN — J. SALAJ 1970; J.-P. BELLIER 1983).

The lower boundary is characterized by disparition of *Rotalipora montsalvensis* (MONROD) and by the F. A. of *Rotalipora turonica* BROTZEN, the upper by the F. A. of *Dicarinella imbricata* (MORNOD) and by sudden extinction of rotalipores. The foraminiferal assemblage of the biozone consists most frequently of *Rotalipora cushmani* (MORROW), *R. turonica* BROTZEN, *Schackoina multispinata* (CUSHMAN et WICKENDEN), *Schackoina gandolfi* REICHEL and typical forms of the species *Thalmanninella reicheli* (MORNOD). The last species belongs together with *Rotalipora cushmani* (MORROW) and *Rotalipora turonica* BROTZEN among the most frequent species (60—90 %) of the subzone. *Praeglobotruncanes* like *Praeglobotruncana marginaculeata* (LOEBLICH et TAPPAN), *Pr. gibba* KLAUS and PR. *delrioensis* (LOEBLICH et TAPPAN) are quite frequent but they extinguish gradually in the course of the biozone.

To accomplish stratigraphy, it is to be mentioned that in the flysch facies of the Cenomanian in the Manín Unit there are besides assemblages of small foraminifers also assemblages of orbitolines (*Orbitolina concava* LAMARCK, *O. conica* ARCHIAC, *O. mammilata* ARCHIAC, *O. plana* (ARCHIAC). Basing on a work by M. NEUMANN (1963) the sediments containig the orbitolines are ranged to the Lower Cenomanian — in contrast to the existing interpretation (J. SALAJ — O. SAMUEL 1966, p. 40). Planktic foraminifers occur very scarcely with orbitoline assemblages; dominant are species of a wider stratigraphical range and this is why it is difficult to correlate them mutually.

Since the orbitoline assemblage on the Cenomanian stratotype (characterized by ammonites) also occurs in the upper part of the Lower Cenomanian (cf. M. NEUMANN — P. JUIGNET — J. LOUAIL — P. MOREAU 1974, p. 7), we correlate the sediments containing orbitolines to the planktic biozone *Thalmanninella appenninica* (upper

part of the Lower Cenomanian — Lower part of the Middle Cenomanian) in spite of the fact that no planktic foraminifers are known on the Lower — Middle Cenomanian stratotype.

Cenomanian/Turonian boundary

In our attempts for parallelization of the described subzone with the international chronostratigraphical scale we met the problem of occurrence of such species of planktic foraminifers which could have been suitable index forms for the determination of the Cenomanian/Turonian boundary. Many authors divided the Upper Cenomanian from the Turonian mostly on the basis of species *Helvetoglobotruncana helvetica* (BOLLI), *Dicarinella imbricata* (MORNOD), *Dicarinella renzi* GANDOLFI or *Caronita sigali* (REICHEL) and in epicontinental facies mainly *Gl.* ex gr. *linneiana* (ORBIGNY) which were expected to have had appeared on the Cenomanian/Turonian boundary. In this sense also the Cenomanian/Turonian boundary in the West Carpathians was interpreted.

The following researches showed that at least in the tethyd region these species appeared for the first time not at the base of the Turonian but in the upper part in the first or the second Inoceramian zone of the Turonian (cf. F. DALBIEZ 1956, J. KLAUS 1959, 1960). Both authors also found rotalipores common in the Upper Cenomanian — in the lower part of the Lower Turonian.

M. CONRAD (1978, pp. 66—67), R. DELOFFRE (1978, p. 80) and B. PORTHAULT (1978, p. 184) mention the existence of *Rotalipores* in the basal Turonian, namely in the *Mammites nodosoides* zone with *Fagesia supertes* (KOSSMAT) J. PHILIP — M. NEUMANN — P. PORTHAULT — P. JUIGNET 1978).

With respect to this fact our subzone Rotalipora turonica would also represent the lowest part of the Lower Turonian — as it was interpreted before.

In the correlation of the biozone Rotalipora cushmani to the chronostratigraphic scale also the latest results of F. ROBASZYNSKI et al. (1982) must be considered. They did not found *R. cushmani* (MORROW) in the type region and according to them this species does not occur even in the Uppermost Cenomanian. So the biozone *R. cushmani* would not extend to the Cenomanian/Turonian boundary. This is partly denied by the fact, that planktic foraminifers are scarce since the Uppermost Cenomanian and the Lower Turonian consist of shallow-water sediments with hiatuses.

Turonian

Dicarinella imbricata (interval-range biozone)

The zone was for the first time defined by J. SALAJ — O. SAMUEL (1966). Its base is characterized by the F. A. of the species *Dicarinella imbricata* (MORNOD), its upper boundary — by the F. A. of *Helvetoglobotruncana helvetica* (BOLLI) and *Dicarinella oraviensis trigona* (SCHEIBNEROVÁ).

Besides planktic and benthic foraminifers there are also frequent radiolarians in the biozone (J. SALAJ — O. SAMUEL 1977).

In the lower part of the Lower Turonian (besides the base), represented by the zone Dicarinella imbricata, J. SALAJ — V. GAŠPARIKOVÁ (1983) distinguished two subzones:

a) *Dicarinella imbricata* s. s. interval-range biosubzone. Its lower boundary is determined by extinction of rotalipores and conical praeglobotruncanes. The upper boundary is characterized by the F. A. of *Dicarinella hagni* (SCHEIBNEROVÁ).

b) *Dicarinella hagni* interval-range biosubzone. Its lower boundary is defined by the F. A. of *Dicarinella hagni* (SCHEIBNEROVÁ) and the upper boundary by the F. A. of *Helvetoglobotruncana helvetica* (BOLLI).

Besides plentiful *Dicarinella hagni* (SCHEIBNEROVÁ) there is also *Dicarinella turonica* (SAMUEL et SALAJ) — a transitional form between *Dicarinella hagni* (SCHEIBNEROVÁ) and *Dicarinella trigona* (SCHEIBNEROVÁ). J. SALAJ — V. GAŠPARIKOVÁ (1985) correlate the biozone *Dicarinella imbricata* to the Lower Turonian zone *Whiteinella gigantea — Dicarinella imbricata* defined on the hypostratotype of the Turonian (Dj. Fguira Salah) as the zone *Rotundina cretacea — Praeglobotruncana imbricata* (J. SALAJ 1970, 1980).

Biozone *Helvetoglobotruncana helvetica* (interval-range zone)

The biozone was formerly defined by J. SIGAL (1952, 1955) and F. DALBIEZ (1955) as the zone *Globotruncana helvetica*. Its range was the same as that of the index species. Later on V. SCHEIBNEROVÁ (1958) denoted the zone as *Praeglobotruncana helvetica* and J. SALAJ (1970) as the zone *Helvetoglobotruncana helvetica*. Its lower boundary is determined by the F. A. of *Helvetoglobotruncana helvetica* (BOLLI) and the upper by the F. A. of *Marginotruncana schneegansi* SIGAL.

The biozone *Helvetoglobotruncana helvetica* is in the tethyd region above the zone *Whiteinella gigantea — Dicarinella imbricata* or above the zone *Dicarinella imbricata* in areas representing the N margin of the tethyd region.

In boreal regions no typical biozone of *Helvetoglobotruncana helvetica* is known. The species *H. helvetica* (BOLLI) only occurred sporadically if at all. The zone has not been identified so far on the Turonian stratotype (cf. J. P. BELLIER 1968, 1971) in spite of isolated finds of *Helvetoglobotruncana helvetica* (F. ROBASZYNSKI et al. 1982), nor in the entire Parisian Basin.

The absence of the species or its sporadical finds in these areas are due to unfavourable ecologic conditions proving both the paleogeographical differentiation and different evolution of microfauna in the tethyd and boreal regions.

a) *Dicarinella trigona* interval-range biosubzone was defined by J. SALAJ — O. SAMUEL (1966) as the lower part of the biozone Helvetoglobotruncana helvetica. The lower boundary is determined by the F. A. of *Helvetoglobotruncana helvetica* (BOLLI) and *Dicarinella trigona* (SCHEIBNEROVÁ) whereas the upper boundary is characterized by the F. A. of *Dicarinella biconvexa* (SAMUEL et SALAJ).

The species *Dicarinella oraviensis oraviensis* (SCHEIBNEROVÁ) and *Dicarinella oraviensis trigona* (SCHEIBNEROVÁ) can in no case be regarded as a morphotype of

Praeglobotruncana gibba KLAUS — as done by F. ROBASZYNSKI — M. CARON (1979). The type species *Dicarinella algeriana* CARON 1966 as well as *Praeglobotruncana marginaculeata* (LOEBLICH et TAPPAN), *Praeglobotruncana stephani stephani* (GANDOLFI) and *Praeglobotruncana stephani gibba* KLAUS described by M. CARON (1966, p. 84, pl. 2) are synonymous to *Dicarinella oraviensis oraviensis* (SCHEIBNEROVÁ). According to our opinion, specimens of the species *Dicarinella algeriana* (CARON) depicted by FR. ROBASZYNSKI — M. CARON (1979, p. 59, pl. 50, fig. 1—2), are transitional forms between *Dicarinella imbricata* (MORNOD) and *Dicarinella oraviensis* (SCHEIBNEROVÁ).

The species *Dicarinella trigona* (SCHEIBNEROVÁ) is plentiful in this subzone. Typical forms of this species occur almost simultaneously with *Helvetoglobotruncana helvetica* (BOLLI), and together with *Globorotalites hangensis* VASILENKO they characterize the lower boundary of the subzone. *Globorotalites hangensis* VASILENKO was not only in assemblages of the subzone but also in other subzone of the biozone *Helvetoglobotruncana helvetica*.

The author of the type species (V. P. VASILENKO 1961) ascribed it a very narrow vertical range — he only found it in one zone (*Globorotalites hangensis*). Age: the lower part of the Middle Turonian.

b) *Dicarinella biconvexa* (interval-range biosubzone was defined for the first time by J. SALAJ — O. SAMUEL (1966) as the upper part of the biozone Helvetoglobotruncana helvetica, later on J. SALAJ (1970) denoted it as only the middle part of the biozone.

Its lower boundary is determined by the F. A. of *Dicarinella biconvexa* (SAMUEL et SALAJ) and the upper by the F. A. *Caronita turona* (OLBERTZ).

Subzone *Dicarinella biconvexa* is characterized by a sudden reduction or disappearance of *Dicarinella* ex gr. *oraviensis* (SCHEIBNEROVÁ) with its optimal occurrence in the preceding subzone. *Dicarinella biconvexa biconvexa* (SAMUEL et SALAJ). *D. biconvexa gigantea* (SAMUEL et SALAJ) and *Marginotruncana marginata* (REUSS) appear for the first time here. Radiolarians and benthic agglutinate foraminifers are also present. We presume that the subzone represents the middle part of the Middle Turonian.

The species *Dicarinella biconvexa biconvexa* (SAMUEL et SALAJ) and *Dicarinella biconvexa gigantea* (SAMUEL et SALAJ) developed from the species *Dicarinella hagni* SCHEIBNEROVÁ. In contrast to the above mentioned species this one is less arched and the last chamber from the ventral side makes an angle to 44° with the coiling plane. The angle is 45—90° on *Dicarinella biconvexa gigantea* (SAMUEL et SALAJ).

Since all the species mentioned belong to one phylogenetic group (A. BEGAN — J. HAŠKO — J. SALAJ — O. SAMUEL 1976) which developed from *Dicarinella imbricata* (MORNOD), we propose to use the trinomic nomenclature also for the species *Dicarinella hagni* (*Dicarinella biconvexa hagni* SCHEIBNEROVÁ) which is in a good agreement with the priority principle.

c) *Caronicta turona* interval-range biosubzone. On the hypostratotype and parahypostratotype of the Turonian (cf. J. SALAJ 1974, 1978a, b) it was determined for the first time as the zone *Globotruncana sigali* (cf. E. A. PESSAGNO 1969, R. G. DOUGLAS 1969, F. T. BARR — O. S. HAMMUDA 1971). Its lower boundary is defined

by the F. A. of *Caronita turona* (OLBERTZ) and *Marginotruncana schneegansi* (SIGAL).

The subzone corresponds to the top parts of the Middle Turonian up to the base of the Upper Turonian (cf. J. SALAJ 1974a).

As for the species *Dicarinella renzi* (GANDOLFI) it is to be noticed that J. SALAJ — O. SAMUEL 1966 described the species *Dicarinella* (= *Globotruncana*) *renzi* GANDOLFI in accordance with the rules of zoology. So in synonymy the first specimen depicted by R. GANDOLFI (1942) was regarded as specimen of the above mentioned taxon. Other depicted specimens (arched types) were included in synonymy of the species *Dicarinella* (= *Globotruncana*) *coldreriensis* (GANDOLFI). We did so in accordance with R. GANDOLFI (1957) who also ranged his arched forms of *Dicarinella* (= *Globotruncana*) *renzi* GANDOLFI 1942 to the newly defined species *Globotruncana coldreriensis* GANDOLFI 1957 and the form depicted by himself in 1942 in Tab. III, Fig. 1 was denoted as holotype. And so he codified the species *"Globotruncana coldreriensis"* without respect of the fact that the chamber with the arched form *"Globotruncana renzi"* was denoted as holotype. This is why we cannot accept the change made by M. CARON (1966) who denoted the arched form as the holotype of the species *"Globotruncana renzi"* and abolished validity of the species *Globotruncana coldreriensis* (cf. F. ROBASZYNSKI — M. CARON 1979). It is in contradiction to the rules of international zoological code. M. CARON was aware of it (see p. 78, 79). The specimen denoted by us as holotype of the species *Dicarinella renzi* (GANDOLFI) is — according to M. CARON — poorly preserved "... cette première forme illustrè est trop mal conservée..." and its ultimate chamber is underdeveloped. In our opinion the species still can be defined exactly. Two different taxa are also proved by the studies of other authors who determined two new taxa for the specimens with characters typical of *Dicarinella renzi* (GANDOLFI). The new taxa are denoted as *Dicarinella sigmocostata* (SCHEIBNEROVÁ 1963) and *Dicarinella paraconcavata* (PORTHAULT 1970). The latter was also accepted by F. ROBASZYNSKI — M. CARON (1979). On the basis of the rules of zoological nomenclature the two species are to be regarded as synonymous to *Dicarinella renzi* (GANDOLFI) emend. SALAJ et SAMUEL 1966).

As for the relation of the planktic zone *Marginotruncana schneegansi*, we correlate it to the benthic zone *Stensioeina praeexsculpta*. The species *Stensioeina praeexsculpta* (KELLER) appeared at the base of the zone *Marginotruncana schneegansi*. The Upper boundary corresponding to the Turonian/Coniacian boundary is defined by the F. A. of *Stensioeina exsculpta* (REUSS).

Later on the subzone was also defined in the West Carpathians and divided from the upper part of the subzone *Dicarinella biconvexa* (J. SALAJ — O. SAMUEL 1977; J. SALAJ — V. GAŠPARIKOVÁ 1979, 1983).

In Tunisia and in the West Carpathians the species *Caronita turona turona* (OLBERTZ) and *Caronita turona sigali* (REICHEL) — one-keel forms — appear in the upper part of the biozone *Helvetoglobotruncana helvetica*.

In subzone Dicarinella biconvexa on the hypostratotype of the tethyd biogeoprovince and in the West Carpathians the well preserved material contained transitional forms between the species *Dicarinella biconvexa biconvexa* (SAMUEL et SALAJ) and

Caronita turona sigali (REICHEL). We distinguished the forms as an independent taxon *Dicarinella* (= *Praeglobotruncana*) *fusani* (J. SALAJ — O. SAMUEL 1977).

The planktic biozone *Helvetoglobotruncana helvetica* corresponds to the benthic zone *Globorotalites hangensis* found in the western part of the Klippen Belt. It was defined for the first time by N. N. VASILENKO (1961) in the Lower Turonian of Mangyšlak.

Marginotruncana schneegansi interval-range biozone

It was described for the first time by F. DALBIEZ (1955) as *Globotruncana schneegansi* and J. SALAJ (1978b) denominated it as the zone *Marginotruncana schneegansi.*

Its lower boundary is characterized by the F. A. of *Marginotruncana schneegansi* (SIGAL) and by the extinction of *Helvetoglobotruncana helvetica* (BOLLI). The upper boundary is determined by the F. A. of *Dicarinella concavata* (BROTZEN) and *Dicarinella angusticarinata* (GANDOLFI).

The biozone consists mostly of foraminifers: *Marginotruncana schneegansi* (SIGAL). *Dicarinella coldreriensis* (GANDOLFI), *Triplasia murchisoni* REUSS, *Tritaxia pyramidata* REUSS, *Gaudryina subserrata* VASILENKO, *Stensioeina praeexsculpta* (KELLER), *Stensioeina pokornyi* SCHEIBNEROVÁ, *Anomalia* (*Valvulineria*) *moniliformis* (REUSS), *Gaudryina pyramidata* CUSHMAN, *Spiroplectammina praelorya* REUSS, *Tappannina costifera* CUSHMAN, *T. eouvigeriniformis* (KELLER) and *Eouvigerina serrata* (CHAPMAN).

As regards the planoconvex form of *Dicarinella renzi* (GANDOLFI sensu SALAJ et SAMUEL), we presumed (1966) that its F. A. were in the Upper Turonian but the new investigations on profiles prove that the F. A. of the planoconvex type are in the top part of the Turonian (see J. SALAJ 1980, p. 77). It is more frequent in the Coniacian together with *Marginotruncana angusticarinata* (GANDOLFI) as proved on the hypostratotype of the Coniacian whose base is also characterized by echinoids.

a) *Whiteinella inornata — Falsotruncana maslakovae* interval-range biosubzone was defined by J. SALAJ — V. GAŠPARIKOVÁ (1983) as the lower part of the interval-range zone *Marginotruncana schneegansi* for Tunisia and for the West Carpathians. Its lower boundary is defined by the F. A. of *Marginotruncana schneegansi* (SIGAL) and by the extinction of *Helvetoglobotruncana helvetica* (BOLLI). Foraminiferal assemblages of this subzone comprise mainly *Dicarinella carpathica* (SCHEIBNEROVÁ). *Whiteinella inornata* (BOLLI), *Falsotruncana maslakovae* CARON, *Marginotruncana schneegansi* (SIGAL) and *M. marginata* (REUSS).

b) *Dicarinella renzi* interval-range biosubzone was defined by J. SALAJ — V. GAŠPARIKOVÁ (1983) as the upper part of the biozone *Marginotruncana schneegansi.* Its lower boundary is characterized by the F. A. of *Dicarinella renzi* (GANDOLFI) sensu J. SALAJ — O. SAMUEL (1966), the upper by the F. A. of *Marginotruncana angusticarinata* (GANDOLFI) and *Dicarinella concavata* (BROTZEN).

The foraminiferal assemblage of the subzone comprises mostly: *Marginotruncana schneegansi* SIGAL, *Marginotruncana marginata* (REUSS), *Marginotruncana undulata* (LEHMANN), *Marginotruncana coronata* (BOLLI), *Dicarinella renzi* (GANDOLFI) sensu J. SALAJ — O. SAMUEL (l. c) and *Dicarinella coldreriensis* (GANDOLFI).

Turonian/Coniacian boundary

It is impossible to determine the Turonian/Coniacian boundary in typical regions, because the Upper Turonian in Tourrains is in neritic facies without characteristic fossils (cf. J. P. BELLIER 1971), P. P. DONZE — B. PORTHAULT — G. THOMEL — O. de VILLOUTREYS 1970, F. ROBASZYNSKI et al. 1982) and the breaks in sedimentation are associated with formation of "hard-grounds" (G. LECOINTRE 1959).

As regards the Coniacian from the Cognac region, it is divided from the underlying units by erosion boundary (cf. P. DONZE — B. PORTHAULT — G. THOMEL —O. DE VILLOUTREYS 1970, p. 94). So in the West Carpathians we determine the Turonian/ Coniacian boundary according to criteria concerning Turonian and Coniacian hypostratotypes in Tunisia.

Coniacian

Formerly the Coniacian in the West Carpathians was defined by J. SALAJ — O. SAMUEL (1966) by the zone *Marginotruncana* (*Globotruncana*) *angusticarinata*. A later detailed division of the Tunisian Coniacian by J. SALAJ (1970, 1975) was after a slight modification successfully applied in the West Carpathians (J. SALAJ — O. SAMUEL 1979, J. SALAJ — V. GAŠPARIKOVÁ 1979, 1983).

Biozone *Dicarinella concavata* (interval-range zone) corresponds to the whole Coniacian. Its base is defined by the F. A. of *Dicarinella concavata* (BROTZEN) and *Marginotruncana angusticarinata* (GANDOLFI), the upper part by the F. A. of *Sigalia carpathica* SALAJ et SAMUEL.

The biozone *Dicarinella concavata* is practically identic with the Coniacian. According to J. SALAJ (1970, 1974a, b; 1980) *D. concavata* (BROTZEN) appears at the base of the Coniacian on a hypostratotype in Tunisia. This also confirms the opinion of I. de KLASZ (1961) about the F. A. of this species at the base of the Coniacian.

a) *Helvetoglobotruncana cachensis* — *Marginotruncana angusticarinata* (interval-range biozone) corresponds to the lower part of the above mentioned zone *Dicarinella concavata* (Lower Coniacian).

Its upper boundary is determined by the F. A. of *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ. In the foraminiferal assemblage of this subzone dominant are *Marginotruncana angusticarinata* (GANDOLFI), *Helvetoglobotruncana cachensis* (DOUGLAS), *Dicarinella concavata* BROTZEN) and *D. asymmetrica* (SIGAL). Frequent are also species passing there over from the Upper Turonian subzone *Dicarinella renzi*.

b) *Globotruncanella praehavanensis* interval-range biozone. The lower and upper boundaries of this subzone are characterized by the F. A. of *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ, *Sigalia deflaensis* (SIGAL).Most frequent is *Globotruncana desioi* GANDOLFI. Among benthic species are frequent *Neoflabellina suturalis* (CUSHMAN) and *Lenticulina* (*Marginulina*) *gosae* (REUSS). It is stratigraphically correlated to the Middle Coniacian.

c) *Sigalia deflaensis* interval biosubzone (= Upper Coniacian) was defined for the first time by J. SALAJ — O. SAMUEL (1966). Its lower boundary is determined by the F. A. of *Sigalia deflaensis* (SIGAL) and the upper by the F. A. of *Sigalia carpathica* SALAJ et SAMUEL. Since *Sigalia carpathica* SALAJ et SAMUEL occurs only beginning from the base of the Santonian, the subzone is to be restricted to the uppermost Coniacian as it is proved on the profile proposed for Coniacian and Santonian hypostratotypes where the Coniacian/Santonian boundary is well defined also by macrofauna (J. SALAJ 1974).

The Coniacian planktic zone *Dicarinella concavata* may well be correlated to the benthic biozone *Anomalina* (*Pseudovalvulineria*) *praeinfrasantonica*, defined by V. P. VASILENKO (1961). This species was also found in Tunisia. Among other benthic foraminifers in the Coniacian of the West Carpathians are mainly *Globorotalites michelianus* (d'ORBIGNY), *Globorotalites multiseptus* (BROTZEN), *Parella whitei* BROTZEN, *Eponides concinnus* BROTZEN and *Stensioeina granulata* OLBERTZ which occurs in abundance from the base of the Coniacian in the West Carpathians and in Tunisia as well. It is the index species of the benthic biozone *Stensioeina exsculpta* (J. SALAJ — O. SAMUEL 1979) equivalent to the planktic zone *Dicarinella concavata*.

Its lower boundary is defined by the F. A. of *Stensioeina exsculpta gracilis* (BROTZEN),

Santonian

The Santonian was formerly defined by the zone *"Globotruncana" concavata* (cf. F. DALBIEZ 1956, R. LEHMANN 1962), later on the zone *Globotruncana elevata* (E. J. VAN HINTE 1965).

Since *Dicarinella concavata* (BROTZEN) appears from the base of the Coniacian and *Globotruncana elevata* (BROTZEN) from the Upper Santonian (with its optimal occurrence in the Campanian), they cannot be used as index species for the definition of the Santonian.

The Lower-Middle Santonian of the West Carpathians is characterized by the zone *Dicarinella concavata carinata* defined for the first time by J. SALAJ (1970) in Tunisia. Its lower boundary is characterized by the F. A. of *Sigalia carpathica* SALAJ et SAMUEL, since no globotruncanes appeared on the Coniacian/Santonian boundary. Its upper boundary is characterized by the F. A. of *Globotruncana manaurensis* GANDOLFI.

In the Lower-Middle Santonian of the West Carpathians an auxiliary zonation may be used on the basis of planktic foraminifers of the family *Heterohelicidae*.

Sigalia carpathica (interval-range biozone)

The biozone represents the Lower Santonian. It is characterized by the F. A. of *Sigalia carpathica* SALAJ et SAMUEL. The upper boundary of the biozone is determined by the F. A. of *Ventilabrella decoratissima* DE KLASZ. The biozone actually

corresponds to the older biozone *"Globotruncana" concavata carinata* defined in Tunis (cf. J. SALAJ l. c.) and is correlable to the biozone *"Globotruncana" concavata*, determined by J. SIGAL (1955), only it partly overlaps the lower part of the biozone *ventilabrella decoratissima*, formerly defined in the Slovak West Carpathians by J. SALAJ — O. SAMUEL (1966) as a subzone of the biozone *Sigalia carpatica*.

The biozone *"Globotruncana" concavata carinata* in the sense of A. POSTUMA (1962) corresponds to the Upper Santonian.

Ventilabrella decoratissima (interval-range biozone)

It corresponds to the lower part of the Middle Santonian. Its lower boundary is determined by the F. A. of the species *Ventilabrella decoratissima* DE KLASZ.

Its upper boundary is characterized by the F. A. of *Globotruncana fornicata manaurensis* (cf. J. SALAJ — O. SAMUEL 1966, J. SALAJ — V. GAŠPARIKOVÁ 1979). The species *Ventilabrella decoratissima* DE KLASZ is the index form not only for the Middle but also for the Upper Santonian. In the upper part of the Middle Santonian and in the Upper Santonian the species occurs in an assemblage with *Globotruncana fornicata manaurensis* GANDOLFI. In the Upper Santonian also *Ventilabrella bipartita* DE KLASZ, *ventilabrella alpina* DE KLASZ and *Globotruncana elevata* (BROTZEN) appear.

The uppermost Lower Santonian and the Upper Santonian are defined by the zone *Globotruncana manaurensis — Globotruncana elevata* (interval-range biozone).

It was determined by J. SALAJ — O. SAMUEL (1979). Formerly it was defined by R. GANDOLFI 1957, J. SALAJ 1969 and J. SALAJ — O. SAMUEL 1979 as the zone *Globotruncana fornicata manaurensis*. It corresponds to the uppermost part of the Middle Santonian and the entire Upper Santonian. The lower boundary of this partly modified zone is defined by the F. A. of *Globotruncana manaurensis* GANDOLFI and *Globotruncana elevata elevata* (BROTZEN), the upper by the F. A. of *Globotruncana arca arca* (CUSHMAN). Thus defined, the biozone may be parallelized to the zone *Globotruncana fornicata* of H. M. BOLLI (1957).

The most significant species of the biozone are: *Globotruncana elevata elevata* (BROTZEN), *Globotruncana elevata stuartiformis* DALBIEZ, *Anomalina* (*Gavelinella*) *pseudoexcolata* (KALININ), *Stensioeina exsculpta* (REUSS), *Ventilabrella alpina* DE KLASZ and *Ventilabrella bipartita* DE KLASZ. The species *Sigalia carpatica* SALAJ et SAMUEL is scarce and extinguishes very quickly, especially in the upper part of the biozone.

The auxiliary heterohelicid biozone *Ventilabrella alpina* corresponds to the zone *Globotruncana manaurensis — Globotruncana elevata*. The lower boundary of the auxiliary zone is determined by the F. A. of *Ventilabrella alpina* DE KLASZ, the upper boundary — by the F. A. of *Ventilabrella glabrata* CUSHMAN which begins at the base of the Campanian with the species *Globotruncana arca* (CUSHMAN).

In the Santonian — like in the Coniacian — some benthic foraminifers are significant for microbiostratigraphical division. Following is the division of the Santonian (J. SALAJ — O. SAMUEL 1979):

Stensioeina exsculpta gracilis (interval-range biozone)

Its lower boundary is determined by the F. A. of *Stensioeina exsculpta gracilis* (BROTZEN)). The upper boundary of the biozone and the base of the Campanian are characterized by the F. A. of *Stensioeina pommerana* BROTZEN.

In the biozone *Stensioeina exsculpta gracilis* the following subzones (interval-range zones) have been distinguished:

a) Subzone *Neoflabellina gibbera — Hoeglundina fovosoides* (interval-range zone). It was denoted as subzone *Neoflabellina gibbera* (J. SALAJ — O. SAMUEL 1966). It represents the Lower Santonian i. e. zone *Sigalia carpatica*. Its lower boundary is defined by the F. A. of *Neoflabellina gibbera* (WEDEKIND) and *Hoeglundina favosoides* (EGGER), the upper by the F. A. of *Gavelinella stelligera* (MARIE). The upper boundary is more-or-less identic with the lower boundary of the planktic zone *Ventilabrella decoratissima*.

Gavelinella infrasantonica MJATLIUK is a particularly significant benthic species in the Lower and Middle Santonian. So the zone *Anomalina (Gavelinella) infrasantonica*, defined by V. P. VASILENKO (1961), is well correlable to the biozone *Sigalia carpatica* and biozone *Ventilabrella decoratissima*.

Another significant Lower Santonian — Middle Santonian species is *Daviesina minuscula* (HOFKER). Its F. A. are already in the base of the Lower Santonian in the Brezová Group. It seems that it is identic with the species from the Santonian stratotype and denoted as *Daviesina* sp. (M. SÉRONIE — VIVIEN 1972). V. KOCH (1973) regards it as index species for the Lower Santonian zone *Daviesina minuscula* only. So the species is characteristic not o only of the Middle but also of the Lower Santonian. The absence of the species in the Lower Santonian of the German Cretaceous may best be explained by unfavourable or bathymetric conditions.

b) Subzone *Gavelinella stelligera* (interval-range zone). Its lower boundary is defined by the F. A. of *Gavelinella stelligera* (MARIE), the upper by the F. A. of *Gavelinella pseudoexcolata*. The subzone corresponds to the planktic zone *Ventilabrella decoratissima* and to the lower part of the Upper Santonian zone *Globotruncana manaurensis — Globotruncana elevata — Ventilabrella alpina*.

c) Subzone *Gavelinella pseudoexcolata* (interval-subzone). It is a subzone defined by the authors in 1966. It is also known from the German Cretaceous (W. KOCH 1973).

Its lower boundary is determined by the F. A. of *Gavelinella pseudoexcolata* (KALININ), the upper (which is identic with the base of the Campanian) is determined on the basis of the F. A. of *Stensioeina pommerana* BROTZEN.

The subzone is well correlable to the upper part of the biozone *Globotruncana fornicata manaurensis — Globotruncana elevata*.

The species *Bolivinoides strigillatus* CHAPMAN is a good index species of the Upper Santonian. It appears for the first time together with *Gavelinella pseudoexcolata* (KALININ).

The Santonian/Campanian boundary in the West Carpathians is mainly characterized by the F. A. of *Globotruncana arca* (CUSHMAN) and *Neoflabellina rugosa rugosa* (D'ORBIGNY).

Campanian

Globotruncana arca (interval-range biozone)

The biozone was defined in the Tethyd region. The authors (1966) defined it for the first time in the West Carpathians. Its lower boundary is characterized by the F. A. — of *Globotruncana arca rugosa* (MARIE) — sensu J. SALAJ — O. SAMUEL (l. c.). Beginning with the base of the Campanian the heterohelicid foraminifers *Ventilabrella eggeri* CUSHMAN and *ventilabrella glabrata* CUSHMAN started appearing (= *Ventilabrella glabrata* Interval Biozone). Benthic foraminifers are represented by *Neoflabellina rugosa* (D'ORBIGNY) which also started appearing in the base of the Campanian. It is stratigraphically correlated to the Lower Campanian.

Globotruncana arca rugosa (interval-range biozone)

It is Upper Campanian biozone (cf. J. SALAJ — O. SAMUEL 1966). Its lower boundary is characterized by the F. A. of *Globotruncana arca rugosa* (MARIE) — sensu J. SALAJ — O. SAMUEL (l. c.), the upper by the F. A. of *Globotruncana falsostuarti* (SIGAL). The zone is restricted to the flysch facies. In marly facies an independent total-range zone *Globotruncana calcarata* (cf. J. SALAJ — J. KYSELA — V. GAŠPARIKOVÁ — A. BEGAN 1978) may be distinguished. Then the biozone *Globotruncana arca rugosa* has a narrower stratigraphic range.

The species *Globotruncana ventricosa* (WHITE) and *Globotruncana obliqua* HERM are significant for the middle and upper parts of the biozone *Globotruncana arca rugosa*. *Heterohelicides* are represented by *Pseudotextularia elegans* RZEHAK and *Gublerina reniformis* (MARIE) (syn. *Gublerina acuta* KLASZ and *Gublerina acuta robusta* KLASZ (= *Gublerina reniformis* Interval Biozone).

Benthic foraminifers in the lower part of the biozone *Globotruncana arca rugosa* are represented by *Bolivinoides decoratus decoratus* and in the upper part of the biozone *Globotruncana arca rugosa* (or in biozone *Globotruncana calcarata*) by *Bolivinoides draco miliaris* HILTERMANN et KOCH. They are index forms of the respective benthic zones.

In the Upper Campanian and Maastrichtian of the West Carpathians is an extensive facies of orbitoid limestones rich in orbitoid foraminifers. They are in the flysch facies (Upper Campanian — Maastrichtian), represented mainly by the Jarmuta Formation (E. KÖHLER 1960, 1962; J. SALAJ 1960, 1961; J. SALAJ — A. BEGAN 1963, J. SALAJ — O. SAMUEL 1963, 1966, A. BEGAN — K. BORZA — E. KÖHLER — O. SAMUEL 1977).

With respect to correlation with benthic zones the lower part of the zone *Globotruncana arca rugosa* corresponds to the interval-range zone *Bolivinoides decoratus* whereas the upper part of the zone *Globotruncana arca rugosa* and the zone *Globotruncana calcarata* correspond to the benthic interval-range zone *Bolivinoides draco miliaris*.

Maastrichtian

Globotruncana falsostuarti (interval-range biozone)

It was defined by J. SALAJ — O. SAMUEL (1966). At the base it is characterized by the F. A. of *Globotruncana falsostuarti* SIGAL and its upper boundary by the F. A. of *Globotruncana gansseri* BOLLI and *Racemiguembelina fructicosa* (EGGER). Heterohelicid foraminifers are represented by *Gublerina cuvillieri* KIKOINE (= *Gublerina cuvillieri* I. R. Z.). It is stratigraphically ranged to the Lower Maastrichtian.

Biozone Racemiguembelina varians s. l. (total-range zone) J. SALAJ — O. SAMUEL 1966, J. SALAJ — V. GAŠPARIKOVÁ 1979) corresponds to H. BOLLI'S (1957) zones *Globotruncana gansseri* and *Abanthomphalus mayaroensis.* In the sense of H. Bolli (1957) we regard it as subzone of the Carpathian biozone *Racemiguembelina varians* (cf. J. SALAJ — O. SAMUEL 1966, J. SALAJ — V. GAŠPARIKOVÁ 1979). It corresponds to the Upper Campanian.

Significant benthic foraminifers in the lower part of the zone *Globotruncana falsostuarti* are mostly represented by *Bolivinoides draco* (MARSSON) and *Neoflabellina praereticulata* HILTERMANN.

In the upper part of the zone *Globotruncana falsostuarti* and in the zones *Globotruncana gansseri* and *Abanthomphalus mayaroensis* are *Neoflabellina reticulata* (REUSS) and *Bolivinoides giganteus* HILTERMANN et KOCH.

Paleogene

In the researches in Paleogene sediments of the West Carpathians in Slovakia two principially different types of foraminiferal assemblages were distinguished. The first type is represented by agglutinate foraminifers. They are mostly in the area of the outer (Krosno s. l.) and the inner (Magura) sedimentation zones. The second type is represented by planktic foraminiferal assemblages, occurring mostly in the "periklippen" and Inner-Carpathian Paleogene and the non-flysch Buda Paleogene. In the Dukla and Magura units planktic foraminifers are only sporadical in some formations. They are more frequent only in the so-called globigerina marls (the Šešor horizon) where they form complete monoassemblages.

Because of their particular stratigraphic significance, planktic foraminifers were paid particular attention in the past three decades. Many specialists performed phylogenetic and taxonomic studies, but particularly significant are synthetizing works by N. N. SUBBOTINA (1953, H. M. BOLLI (1957 b, b), A. R. LOEBLICH — H. TAPPAN (1957), W. H. BLOW — F. T. BANNER (in EAMENS et coll. 1962), V. G. MOROZOVA (1960, 1961), H. LUTERBACHER (1966) W. A. BERGGREN (1966), M. B. CITA (1968), W. H. BLOW (1969), J. A. POSTUMA (1971), O. SAMUEL (1972a, b, c), a. o. The most comprehensive scheme of the division of the Paleogene, based on planktic foraminifers was presented by H. M. BOLLI (l. c.). He distinguished 16

successive zones in the Paleogene, and after some modifications they are still used as basis of standard zonation in the Mediterranean zone. Formerly in the West Carpathians 11 successive zones were distinguished (including Lower Oligocene; cf. O. SAMUEL 1965, 1972; O. SAMUEL — J. SALAJ 1968). They partly agree with BOLLI'S zones. Bolli's zonation cannot be fully applied on the West Carpathians because of the specific character of flysch sediments. The common occurrences of several species enable a generally reliable correlation of the extent of Carpathian zones to the extent of Bolli's zones or to regional zonation of other authors. The Carpathian regional zonal scheme is very similar to the general scheme of J. A. POSTUMA (1971) who distinguished 14 zones in the Paleocene and Eocene. He thus considered some corrections made by H. M. Bolli — M. B. CITA (1960), mainly in the division of the Lower Eocene.

At present the opinions on biozonal division of the Paleogene are almost in agreement with one another. There are 17 biozones (P_1—P_{17}; G. BIGNOT — C. CAVELIER 1981) distinguished in the Paleocene and Eocene with four subzones within P_1 (P_{1a-d}) and two subzones within the biozone P_3 (P_{3a-b}); see Tab. 6.

Biozone P1

In 1978 J. SALAJ — J. KYSELA — V. GAŠPARIKOVÁ — A. BEGAN distinguished the biozone *Globigerina taurica — Globoconusa daubjergensis* in the Danian around the Hradisko B. M. The biozone was originally defined by J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVÁ (1976) and it is a modification of the zone Globigerina eugubina (H. P. LUTERBACHER — I. PREMOLI SILVA 1964) and of the zone *Globigerina taurica* (G. MOROZOVA 1960). Its thickness is about 20 cm. The foraminiferal assemblage of this zone is represented by the species *"Globigerina" taurica* MOROZOVA, *"G." eobulloides* MOROZOVA, *"G." tetragona* MOROZOVA, *"G." pentagona* MOROZOVA, *"G." sabina* LUTERBACHER et PREMOLI SILVA, *"G." eugubina* LUTERBACHER et PREMOLI SILVA, *"G." minutula* LUTERBACHER et PREMOLI SILVA, *"G." fringa* SUBBOTINA, *Globoconusa daubjergensis* (BRÖNNIMANN), *Guembelitria irregularis* MOROZOVA, *Chiloguembelina vilcoxensis* (CUSHMAN et PONTON), *Chiloguembelina crinita* (GLAESSNER) and *Woodringina claytonensis* LOEBLICH et TAPPAN.

At the base of the Danian, calcareous nannoplankton assemblages represent the zone *Markalius inversus* NP_1 corresponding to the oldest foraminiferal zone of the Danian, *Globigerina taurica — Globoconusa daubjergensis*. The zone Markalius inversus, defined by E. MARTINI (1970), represents the interval between the L. A. of the species *Arkhangelskiella cymbiformis* and other Cretaceous species and the F. A. of *Cruciplacolithus tenuis*. H. P. MOHLER et W. W. HAY (1967) define the lower boundary of this zone by the F. A. of the species Biantolithus sparsus. This species was not among the studied material. The species *Arkhangelskiella cymbiformis* and other Upper Cretaceous species were found in this zone and in overlying zones. They are redeposited forms.

The zone Markalius inversus is best characterized by the mass occurrence of the species *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI and *Thoracosphaera operculata* BRAMLETTE et MARTINI.

Tab. 6 Microbiostratigraphic zonation of the West Carpathians Paleogene and its correlation with standard scheme of generale zonation.

STAGE			GENERALE ZONATION (by G. Bignot et C. Cavelier, 1981)		REGIONALE ZONATION (by O. Samuel et J. Salaj)
OLIGOCENE	Upper		P 22 Globigerina angulisuturalis		Globigerina angulisuturalis
			P 21 Globigerina angulisuturalis / Globorotalia opima opima		Globigerina opima opima
	Lower		P 20 Globigerina ampliapertura		Globigerina ampliapertura
			P 19 Globigerina sellii / Pseudohastigerina barbadiensis		Globigerina postcretacea
			P 18 Globigerina tapuriensis		
EOCENE	PRIABONIAN	Upper	P 17 Globigerina gortanii / Globorotalia centralis	Turborotalia cerroazulensis	Globigerina officinalis
		Mid.	P 16 Cribrohantkenina inflata		
		Low.	P 15 Globigerinatheka semiinvoluta		Globigerinatheka semiinvoluta
	LUTETIAN	Upper	P 14 Truncorotaloides rohri		Truncorotaloides rohri
			P 13 Orbulinoides beckmanni		
			P 12 Morozovella lehneri		
		Lower	P 11 Globigerinatheka subconglobata		Globigerinatheka subconglobata
			P 10 Hantkenina aragonensis		Turborotalia (A.) densa
	CUISIAN		P 9 Acarinina pentacamerata		
	YPRESIAN		P 8 Morozovella aragonensis		Morozovella aragonensis
			P 7 Morozovella formosa		Morozovella formosa
PALEOCENE	ILERDIAN		P 6 Morozovella subbotinae		Morozovella subbotina
			P 5 Morozovella velascoensis		Morozovella velascoensis
	THANETIAN		P 4 Planorotalites pseudomenardii		Planorotalites pseudomenardii
			P 3b Planorotalites pusilla		Planorotalites pussila
			P 3a Morozovella angulata		Morozovella angulata
	MONTIAN		P 2 Morozovella uncinata		T. (A.) praecursoria uncinata s.l.
					Globoconusa kozlowskii
	DANIAN s.l.	DANIAN s.s.	P 1d Subbotina trinidadensis		Turborotalia (A.) inconstans
					Planorotalites compressa
			P 1b/c Subbotina pseudobulloides		Subbotina pseudobulloides
			P 1a „Globigerina" eugubina		G. taurica – Gn. daubjergensis

The overlying foraminiferal zone *Globigerina trinidadensis* formerly defined by H. M. BOLLI (1957) is interpreted here in modification by J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA (1976) with the following subzones.

a) Subzone *Subbotina pseudobulloides*. It was originally determined by H. GLINTZBOECKEL (in A. JAUZEIN 1795) and defined by M. MEIJER (1969). Most frequent are species *Subbotina pseudobulloides* (PLUMMER), *S. triloculinoides* (PLUMMER), *"Globigerina" danica* BANG, *Subbotina trinidadensis* (BOLLI), emend. SALAJ (J. SALAJ 1974), *Globoconusa daubjergensis* (BRÖNNIMANN), *Chiloguembelina trinidadensis* (CUSHMAN et RENZ), *Chiloguembelina midwayensis* (CUSHMAN) and *Chiloguembelina crinita* (GLAESSNER).

b) Subzone Planorotalites* compressa. It was originally determined by. O. SAMUEL (1965) and O. SAMUEL et J. SALAJ (1968) as the Zone *Globigerina compressa*. Here it is interpreted according to the definition by M. MEIJER (1969) and J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA (1976). Most plentiful are species: *Subbotina pseudobulloides* (PLUMMER), *Planorotalites compressa* (PLUMMER), *Subbotina triloculinoides* (PLUMMER), *S. varianta* (SUBBOTINA) and *chiloguembelines*, represented by: *Chiloguembelina morsei* (KLINE), *Chiloguembelina trinidadensis* (CUSHMAN et RENZ) and *Chiloguembelina wilcoxensis* (CUSHMAN et PONTON).

Biozone P2

c) Subzone *Turborotalia (A.) inconstans*. It was defined for the first time by N. N. SUBBOTINA (1953) from the Caucasian Elburgan Formation, and redefined by J. SALAJ (1974). Its lower boundary is characterized by F. A. of *Turborotalia (A.) inconstans* (SUBBOTINA) and the upper one by F. A. of *Globoconusa kozlowskii* (BROTZEN et POŻARYSKA).

The foraminiferal assemblage of this subzone is extremely rich, represented mainly by *Turborotalia (A.) inconstans inconstans* (SUBBOTINA), *T. (A.) inconstans trinidadensis* (BOLLI) emend. SALAJ, *Subbotina pseudobulloides* PLUMMER, *S. triloculinoides* (PLUMMER), *Planorotalites compressa* (PLUMMER), *Subbotina varianta* (SUBBOTINA), *S. edita* (SUBBOTINA) and *Globoconusa daubjergensis* (BRÖNNIMANN).

The nannoplankton Zone *Cruciplacolithus tenuis* NP_2 corresponds to lower parts of Zone *Subbotina trinidadensis*, i. e. to subzone *Subbotina pseudobulloides* partly to subzone *Planorotalites compressa*. The Zone was defined by E. MARTINI (1970) as an interval between F. A. of *Cruciplacolithus tenuis* and F. A. of *Chiasmolithus danicus*.

Assemblages of this zone are mainly represented by *Cruciplacolithus tenuis* (STRADNER HAY et MOHLER, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Thoracosphaera operculata* BRAMLETTE et MARTINI and scarce resedimented Cretaceous forms.

* One of us (J. S.) uses the generic designation Planorotalia

Zone *Chiasmolithus danicus* NP_3 — E. MARTINI (1970) is the uppermost Danian zone. It represents the interval between F. A. of *Chiasmolithus danicus* and F. A. of *Ellipsolithus macellus*. The Zone corresponds to the upper part of Subzone *Planorotalites compressa* and to the uppermost Danian subzone — Subzone *Morozovella inconstans*.

Assemblages are represented mainly by *Chiasmolithus danicus* (BROTZEN) HAY et MOHLER, *Coccolithus cavus* HAY et MOHLER, *Zygodiscus sigmoides* BRAMLETTE et SULLIVAN, *Lophodolithus* sp. and by forms characteristic of the underlying zone.

The mentioned zones and subzones correspond to the Danian s. l. and are comparable to the Danian hypostratotype, defined in Tunisia (J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA 1976). In contrast to the Danian stratotype there are also the basal part of the Zone *Globigerina taurica — Globoconusa daubjergensis* and Subzone *Turborotalia (A.) inconstans*. They are absent in the stratotype because of its transgressive and regressive (erosive) character.

The Danian Formation in the area of Hradisko is best documented by fauna among all formations in the West Carpathians. The Danian and a continuous sedimentation between the Cretaceous and the Paleogene (J. SALAJ 1960 a; O. SAMUEL — J. SALAJ 1961) are present in the area of Dolná Polianka (Myjavská pahorkatina) but after the revision of Danian foraminiferal assemblages it is not possible to characterized the top part of the Zone *Subbotina trinidadensis*, i. e. Subzone *Turborotalia (A.) inconstans*. Perhaps it is lithologically represented by the facies of sheety organogenic Paleocene coralline limestones.

In the overlier of Subzone *Turborotalia (A.)* inconstans are foraminifers of Zone *Globoconusa kozlowskii*, originally defined by J. SALAJ (1974) on the Paleocene hypostratotype proposed as the stratotype of the marine Tethyd Paleocene. This zone is correlated to the Lower Montian (J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA 1976), since *Globoconusa kozlowskii* (BROTZEN — POŻARYSKA) was also found on the Montian stratotype.

Foraminiferal assemblage of Zone *Globoconusa kozlowskii* — found in several samples — is particularly rich in benthic and planktic foraminifers and in nannoplankton. It is mostly represented by *Globoconusa kozlowskii* (BROTZEN et POŻARYSKA), *Subbotina trivialis* (SUBBOTINA), *Subbotina triloculinoides* (PLUMMER), *Subbotina pseudobulloides* PLUMMER, *Subbotina varianta* SUBBOTINA, *Planorotalites compressa* (PLUMMER), *Turborotalia (A.) inconstans inconstans* (SUBBOTINA), *Subbotina trinidadensis* (BOLLI) emend. SALAJ and *Subbotina spiralis* (BOLLI).

The following zone, originally documented by O. SAMUEL — K. BORZA — E. KÖHLER (1972) and denoted as Zone *Turborotalia (Acarinina) inconstans praecursoria* (O. SAMUEL — J. SALAJ 1968) was re-named by J. SALAJ (1974) to Zone *Turborotalia (Acarinina) praecursoria uncinata* s. l. for taxonomic and phylogenetic raisons, and so is it interpreted here (J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA 1976). The lower part of this zone contains — besides above mentioned foraminifers from the preceding zone — also *Turborotalia (A.) praecursoria uncinata* (BOLLI), and in its upper part also *Turb. (A.) praecursoria* (MOROZOVA).

Nannoplankton Zone *Ellipsolithus macellus* NP_4 was defined by E. MARTINI (1970) as the interval between F. A. of *Ellipsolithus macellus* and F. A. of

Fasciculithus tympaniformis. In its range the zone corresponds to two foraminiferal zones *Globoconusa kozlowskii* and *Turborotalia (A.) praecursoria uncinata* s. l.

In the upper part of Zone *Ellipsolithus macellus* s. l., at the level of the base of Zone *Turborotalia (Acarinina) praecursoria uncinata* s. l., F. A. of *Toweius craticulus* was recorded. It enabled us to distinguish a new subzone *Toweius craticulus* in the Zone *Ellipsolithus macellus* s. l. The new subzone is related to foraminiferal zone *Turborotalia (A.) praecursoria uncinata.* The lower boundary of the subzone is characterized by F. A. of *Toweius craticulus.* Its upper boundary is identic with the upper boundary of Zone *Ellipsolithus macellus* s. l.

Is assemblages representing Zone *Ellipsolithus macellus* s. s. are the following main species: *Ellipsolithus macellus* (BRAMLETTE et SULLIVAN) SULLIVAN, *Neochiastozygus concinnus* (MARTINI) PERCH-NIELSEN, *Cruciplacolithus subrotundus* PERCH-NIELSEN, *Ericsonia subpertusa* HAY et MOHLER, ? *Toweius* sp. and species occurring in underlying zones.

The Subzone *Toweius craticulus* contained all species of Zone *Ellipsolithus macellus,* and the species *Toweius craticulus* HAY et MOHLER characterizing the subzone.

Biozone P3a

Zone *Morozovella angulata,* originally defined by V. P. ALIMARINA (1963) as *Globorotalia angulata,* is also present here. In the West Carpathians it was included in Zone *Planorotalites pusilla* (O. SAMUEL — J. SALAJ 1968). The use of terms Zone *Morozovella angulata* and Zone *Planorotalites pusilla* is reasoned in works by A. von HILLEBRANDT (1965), H. M. BOLLI (1966), J. SALAJ — K. POŻARYSKA — J. SZCZECHUROVA (1976) a. o. Foraminiferal assemblage of this zone consists mostly of *Morozovella angulata angulata* (WHITE), *Turborotalia (A.) praecursoria praecursoria* (MOROZOVA), *Turborotalia (Acarinina) intermedia* (SUBBOTINA), *T. (A.) esnaensis* LE ROY and *Subbotina triloculinoides* (PLUMMER).

There also is a relation between the lower part of this zone and a nannoplankton zone *Fasciculithus tympaniformis* NP_5 — W. W., HAY — H. P. MOHLER (1967) corresponding to zone *Morozovella angulata* and to a great part of the Middle Paleocene Zone *Planorotalites pusilla pusilla.* It represents the interval between F. A. of *Fasciculithus tympaniformis* and F. A. of *Heliolithus kleinpelli.*

The assemblages consist mostly of species representative of the underlying zone *Ellipsolithus macellus,* and of the species *Fasciculithus tampaniformis* HAY et MOHLER which is better developed in upper parts of the zone.

Biozone P3b

Following is the Zone *Planorotalites pusilla pusilla.* This zone is here interpreted according to the definition by H. M. BOLLI — W. A. KRASHENINNIKOV (1974) and it is particularly rich in planktic, benthic-agglutinated and calcareous foraminifers. Among planktic foraminifers dominant are *Planorotalites pusilla pusilla* BOLLI, *Morozovella aequa* (CUSHMAN et RENZ), *Subbotina finlayi* (BRÖNNIMANN), *Subbotina*

triloculinoides (PLUMMER), *Turborotalia* (*Acarinina*) *intermedia* (SUBBOTINA), *Turborotalia* (*Acarinina*) *esnaensis* (LE ROY), *Turborotalia* (*Acarinina*) *tadjikistanensis* (BYKOVA), *Morozovella angulata angulata* (WHITE), *Morozovella abundocamerata* (BOLLI).

In accordance with D. PAJAUD — J. C. PLAZIAT (1972) we correlate the first zone of larger foraminifers with *Operculina heberti* and *Discocyclina seunesi* (cf. O. SAMUEL — K. BORZA — E. KÖHLER 1972) to the Lower Thanetian (Lower Landenian in the sense of J. SALAJ et al.) and to the Zone *Planorotalites pusilla pusilla*. This is proved by the fact, that the first zone of larger Paleocene foraminifers is in the overlier of the Zone *Morozovella angulata* (sandy marls with layers or organogenic reef limestones without larger foraminifers — Hričovské Podhradie, exposure at house No. 12, cf. O. SAMUEL — K. BORZA — E. KÖHLER 1972), and by the studied profile (between Hradisko and Na Skale elev. point) of operculina sandstones with *Operculina heberti* in marls containing *Planorotalites pusilla pusilla* and in the overlier of marls with *Morozovella angulata*.

It is evident that larger foraminifers in the Hričov-Žilina Paleogene formation appear at the base of the Landenian* and are absent in the Montian. Then the Montian/Landenian s. l. boundary should be between Zone *Morozovella angulata* and Zone *Planorotalites pusilla* as it was proposed between hypostratotypes of the Montian s. l. and Landenian s. l. in Tunisia (J. SALAJ — K. POŻARYSKA — J. SZCECHURA 1976).

The boundary between the planktic foraminiferal zones *Planorotalites pusilla pusilla* and *Planorotalites pseudomenardii* is represented by the nanoplankton zone *Heliolithus kleinpelli* — NP_6. H. P. MOHLER — W. W. HAY (1967) defined it as the interval between F. A. of *Heliolithus kleinpelli* and F. A. of *Discoaster gemmeus*. Assemblages of this zone are represented mainly by *Heliolithus kleinpelli* SULLIVAN, *Coccolithus cavus* HAY et MOHLER, *Cruciplacolithus subrotundus* PERCH- NIELSEN, *Toweius craticulus* HAY et MOHLER, *Zygodiscus sigmoides* BRAMLETTE et SULLIVAN.

Biozones P4—5

Further successive zones (correlated with Middle and Upper Landenian by J. SALAJ et al., l c.) are zones *Planorotalites pseudomenardii* and *Morozovella velascoensis*. They are difficult to delimitate in the area of Hradisko and in the West Carpathians generally because of considerable shallowing. We can only prove that immediately above Zone *Planorotalites pusilla pusilla* are scarce *Morozovella marginodentata* (SUBBOTINA), *Planorotalites pseudomenardii* (BOLLI) and *Morozovella aequa* (CUSHMAN et RENZ). It is evident that it is the lower part of Zone *Planorotalites pseudomenardii*, originally defined by H. M. BOLLI (1957) as Zone *Globorotalia pseudomenardii*. Its upper part is poor in planktic foraminifers and contains scarce resedimented Upper Senonian microfauna.

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* O. SAMUEL — K. BORZA — E. KÖHLER (1972) use Thanetian in chronostratigraphic classification of Paleocene in contrast to J. SALAJ (and coauthors, l. c.) prefering Landenian to Thanetian.

In this zone are rich nannoplankton zones *Discoaster gemmeus* NP_7, *Heliolithus riedeli* NP_8 and base of Zone *Discoaster multiradiatus* NP_9.

Zone *Discoaster gemmeus* defined by W. W. HAY (1964) terminates with F. A. of Heliolithus riedeli. It is represented mainly by: *Discoaster gemmeus* STRADNER, *Discoaster* cf. *trinus* STRADNER, *Discoaster* sp., *Coccolithus cavus* HAY et MOHER, *Neochiastozygus concinnus* (MARTINI) PERCH-NIELSEN, *Fasciculithus tympaniformis* HAY et MOHLER, *Heliolithus kleinpelli* SULLIVAN. It corresponds to the lower part of Zone *Planorotalites pseudomenardii.*

The overlying Zone *Heliolithus riedeli* corresponds to upper parts of Zone *Planorotalites pseudomenardii.* It is defined by M. N. BRAMLETTE — F. R. SULLIVAN (1961) as the interval between F. A. of *Heliolithus riedeli* and F. A. of *Discoaster multiradiatus.* Assemblages of this zone are represented by *Coccolithus cavus* HAY et MOHLER, *Heliolithus riedeli* BRAMLETTE et SULLIVAN, *Heliolithus kleinpelli* SULLIVAN, *Chiasmolithus consuetus* (BRAMLETTE et SULLIVAN) HAY et MOHLER, *Chiasmolithus bidens* (BRAMLETTE et MARTINI) HAY et MOHLER, *Discoaster gemmeus* STRADNER.

Zone *Discoaster multiradiatus* represents the uppermost part of the zone *Planorotalia pseudomenardii* and a considerable part of the next Zone *Morozovella velascoensis.* This zone, defined by M. N. BRAMLETTE — F. R. SULLIVAN (1961), commences with F. A. of *Discoaster multiradiatus* and terminates with F. A. of *Marthasterites contortus.* Assemblages consist mostly of *Discoaster multiradiatus* BRAMLETTE-RIEDEL, *Coccolithus cavus* HAY et MOHLER, *Chiasmolithus consuetus* (BRAMLETTE et SULLIVAN) HAY et MOHLER, *Neochiastozygus concinnus* (MARTINI) PERCH-NIELSEN, *Discoaster gemmeus* STRADNER, *Discoaster nobilis* MARTINY, *Discoaster splendidus* MARTINI.

The upper part of the Landenian (in sense of J. SALAJ) up to the base of the Illerdian corresponds to Zone *Morozovella velascoensis* defined by H. M. BOLLI (1957). Foraminiferal assemblages comprise atypical species and *Morozovella velascoensis* (CUSHMAN), *M. aequa* (CUSHMAN et RENZ), *M. occlusa* LOEBLICH et TAPPAN a *M. acuta* TOULMIN. *Planorotalites pseudomenardii* (BOLLI) is already absent in this zone.

Zone P6

Zone P_6 — *Morozovella subbotinae* is known in the entire periklippen area and in the Myjava Group. In its "Acarinina" component it shows many characters in common with preceding zone. It differs from the preceding zone in absence of some significant species like *Morozovella velascoensis* (CUSHMAN), *Planorotalites pseudomenardii* (BOLLI) and *Morozovella aragonensis* (NUTTAL), *M.* ex gr. *formosa* (BOLLI) appearing in the next successive zone. It also differs from the preceding zone in new forms of *Morozovella subbotinae subbotinae* (MOROZOVA), *M. subbotinae marginodenta* (SUBBOTINA), *Morozovella simulatilis* (SCHWAGER), and *Globigerina eocaena* GÜMBEL in the uppermost part.

Zone *M. subbotinae* has many characters in common with H. BOLLI's Zone *M. rex.* We regard them as synchronous zones.

N. N. SUBBOTINA (1953, 1960a) ranges Zone "*Gr. marginodentata*" to Upper Paleocene. Also A. HILLEBRANDT (1962, p. 156) described many forms, including *G. aequa marginodentata* (= *M. subbotinae marginodentata* in our interpretation) and *Gr. aequa — simulatilis* from a typical Illerdian locality. The lower boundary of occurrences of the above species is above biozone *Morozovella velascoensis*. Its upper part ranges to Lower Illerdian. So the Zone *M. subbotinae* corresponds to Illerdian. It is in accordance with data on a typical Illerdian locality (cf. M. B. CITA, 1968; Pl. I). There are contradictions in opinions about its upper border. According to results of investigation in Northern Italy the planktic foraminifers of this zone occur with larger foraminifers indicative of Lower Cuisian (fide K. GOHRBANDT, 1963). Materials from Colloquy on Eocene held in 1968 show that Zone Alveolina trempina and Nummulites involutus (cf. H. SCHAUB 1968) corresponds to Upper Illerdian. M. B. CITA (1968; Pl. I) correlates the zone to the lower part of H. BOLLI's Zone *Gr. formosa formosa* without having revised his former opinion. Because of contradictory opinions about chronostratigraphic position of Illerdian and Cuisian the problem of the relation of the upper boundary of Zone *Gr. subbotinae* to these stages remains unsolved. Here we interpret it in the same way as in 1968 (O. SAMUEL — J. SALAJ; O. SAMUEL — K. BORZA — E. KÖHLER 1972).

One of us (J. SALAJ et al. 1978) denoted a successive zone above Zone NP_5 — *Morozovella velascoensis* as *"Globorotalia" edgari* defined by I. PREMOLI SILVA — H. M. BOLLI (1973). The zone is regarded as equivalent to biozone *Globorotalia simulatilis* defined by J. SALAJ in 1969 in Tunisia. O. SAMUEL prefers the term *Morozovella subbotinae* for this zone because of dominant *Morozovella* ex gr. *subbotinae* in the zone of the same name and for its frequency in regional extent, and for its parallelization with the international standard biozonation (P_6).

Biozones P7—8

Zones *Morozovella formosa — M. aragonensis*. The species *Morozovella formosa formosa* (BOLLI) occurs sporadically in the West Carpathians and it is difficult to delimitate the biozone P_7 *Morozovella formosa*. Assemblages from the overlier of biozone *Morozovella subbotinae* show many characters in common with those in zone NP_7 — *M. formosa* and in zone NP_8 — *M. aragonensis*. Among currently occurring forms of "globigerinas" are *Subbotina linaperta* (FINLAY), *Globigerina* ex gr. *yeguaensis* WEINZIERL et APPLIN, *G. eocaena* GÜMBEL. Later on *G. inaequispira* SUBBOTINA, *G. turgida* FINLAY appear scarcely or more frequently.

Among "Globorotalia" quite frequent is *Morozovella simulatilis* (SCHWAGER). New forms are *M.* ex gr. *formosa* (BOLLI), *M. aragonensis* (NUTTALL) and later on *M. aragonensis crater* (FINLAY).

Among "Globorotalia" quite frequent is *Morozovella simulatilis* (SCHWAGER). New forms are *M.* ex gr. *formosa* (BOLLI), *M. aragonensis* (NUTTALL) and later on *M. aragonensis crater* (FINLAY).

The "Acarinina" component is mainly represented by *T. (A.) primitiva* (FINLAY), whereas the species *T. (A.) acarinata* (SUBBOTINA), *T. (A.) intermedia* (SUBBOTINA), *T. (A.) wilcoxensis* (CUSHMAN et PONTON), *T. (A.) graveli* BRÖNNIMANN do not surpass boundaries of Zone *Morozovella frontosa — M. aragonensis*.

Biozones P9—10

Biozones P_9 and P_{10} (*Acarinina pentacamerata — Hantkenina aragonensis*). The species *T. (A.) pentacamerata* (SUBBOTINA) has so far been found in the West Carpathians only with the species denoted as *T. (A.) crassata densa* (CUSHMAN). There are differences in interpretation of the boundaries of occurrences of this species. Most authors place its F. A. on the Lower (Cuisian) Middle (Lutetian) Eocene boundary. In the West Carpathians the species is one of the most frequent forms in populations occurring in the overlier of Zone *Globorotalia formosa — G. aragonensis.* For this region the assemblages including *T. (A.) crassata densa* are regarded as an independent regional biozone.

Since the species *T. (A.) pentacamerata* and *T. (A.) crassata densa* started appearing in the top part of the Lower Eocene, it is possible that the lower part of our biozone *T. (A.) crassata densa* represents also the time interval corresponding to the biozone P_9 — *Acarinina pentacamerata.* This is, however, not confirmed with respect to correlation between foraminifers and nannoplankton.

If our assumption is confirmed, then the Carpathian biozone may represent Zones P_9 and P_{10}. Its upper part corresponds to the next biozone P_{11}.

Biozone P11

Biozone P_{11} — *Globigerinatheca subconglobata.* It was not distinguished as an independent zone before, since the nominal species was never too frequent, although it occurred currently. At the original definition of biozone *T. (A.) crassata densa* it was correlated with the Lower Lutetian. The latest researches show, however, that assemblages with *G. subconglobata* (SCHUTSKAYA) and *Morozovella lensiformis carpatica* SAMUEL do not appear at the level of Biozone NP_{10} but only higher up in connection with biozone NP_{11}. So the Carpathian biozone *T. (A.) crassata densa* is reduced to the first biozone of the Middle Eocene. It may correspond to Zone P_{10} — *Hantkenina aragonensis.*

Biozones P12—14

Carpathian biozone *Truncorotaloides rohri* is corresponding to the Zones P_{12}—P_{14}. It is still not divided exactly because the forms necessary for detailed biozonation are missing in the Carpathian region. According to larger foraminifers and nannoplankton our zone corresponds to the Upper Lutetian, to Zones P_{12}—P_{14}. Interestingly, the standard biozonal scale may be applied on the southern epicontinental (Buda) Paleogene formations most extensive in Hungary.

Zone P15

Zone P_{15} was formerly denoted as Biozone *Globigerapsis index* by the authors in the Carpathians. It is well correlable to the standard zone P_{15} — *Globigerinatheca*

semiinvoluta. On the basis of larger foraminifers and nannoplankton it is correlated with the lower part of the Upper Eocene (Priabonian).

Zone P16—17

In the Carpathians the Zones P_{16} and P_{17} are represented by the regional biozone *Globigerina officinalis*. Nominal species of this biozone together with *Globigerina* ex gr. *praebulloides* BLOW belong to the described biozones. On the basis of larger foraminifers and nannoplankton (cf. P. GROSS — E. KÖHLER et al. 1980) the Carpathian biozone (*Globigerina officinalis*) is correlated with the upper part of the Upper Eocene (Priabonian).

As regards parallelization with standard biozonation for the Mediterranean zone, it shows most characters in common with Zones P_{16} and P_{17} — *Turborotalia cerroazulensis*. It is practically impossible to divide the zone into the lower (P_{16}) — *Cribrohantkenina inflata* Zone and the upper (P_{17}) — *Globigerina gortanii* (*Turborotalia centralis*) Zone, since the species characteristic of Zone P_{16} do not occur in the Carpathian biogeoprovince.

Biozone P18

Carpathian biozone *Globigerina officinalis* corresponds to Zone P_{18} and partly to Zone P_{19}. The biozone is characterized mainly by *Globigerina officinalis* SUBBOTINA and by scare *Globigerina postcretacea* Mjatliuk, *G. liverovskae* (BYKOVA), *G. pseudoedita* SUBBOTINA, *Chiloguembelina gracillima* (ANDREAE). The Carpathian biozone has so far not been parallelized with nannoplankton biozonation.

It is likely that because of interrupted sedimentation biozones P_{19}—P_{20} do not occur anymore in the Inner-Carpathian Paleogene and in the Magura Unit. They are known in the Outer Flysch Belt and in Southern Slovakia.

Explanations: AZ = Acma Zone, IRZ = Interval-Range Zone, PRZ = Partial-Range Zone, TRZ = Total-Range Zone. F. A. = First Apparition.

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Jozef Salaj — Ondrej Samuel

Mikrobiostratigrafické členenie mezozoika a paleogénu Západných Karpát

Resumé

Autori v predloženej práci predkladajú súčasný stav názorov na mikrobiostratigrafické členenie mezozoických a paleogénnych sedimentov Západných Karpát Slovenska, hlavne na základe foraminifer, v kriede a paleogéne predovšetkým planktonických.

Z mikrobiostratigrafického hľadiska Západné Karpaty predstavujú jednu z klasických oblastí, v ktorej vôbec po prvý raz vo svete bola vypracovaná schéma zonálneho členenia triasu podľa foraminifer. Prvý náčrt foraminiferových biozón podal J. SALAJ (1969a), ktoré najprv sám, neskôr v spoluautorstve (J. SALAJ — K. BORZA — O. SAMUEL 1983) modifikoval (porov. tab. 1). V tejto súvislosti treba poznamenať, že v posledne citovanej práci je determinovaných asi 300 taxónov s aspektom na ich stratigrafickú hodnotu.

Po mikrobiostratigrafickej stránke najmenej rozpracovaným útvarom v Karpatoch je jura. Z foraminifer bolo doteraz opísaných iba niekoľko taxónov. Pre vrchnú juru a spodnú kriedu osobitný význam majú tintinoidné mikrofosílie, o poznanie ktorých sa u nás pričinil hlavne K. BORZA (l. c).

V súvise s mikrozonálnym členením kriedy (Tab. 3, 4, 5) sa upresňujú niektoré taxonomické problémy, a tým aj ich stratigrafická hodnota, hlavne niektorých biozón vo vzťahu ku chronostratigrafickým jednotkám.

Výskumy v posledných rokoch nám umožnili podrobnejšie nielen rozčleniť niektoré paleogénne biozóny, ale ich aj presnejšie paralelizovať so štandardnou biozonálnou stupnicou (porov. tab. 6).

Explanations of Plates I — XXX

Plate I

1 *Ammodiscus cretaceous* (REUSS) × 100
Považská Bystrica, sample no Sj. 495, Žadovec formation (lower part) of the Manín Unit. *Dicarinella concavata* Zone.

2 *Ammodiscus cretaceous* (REUSS) × 60
Považská Bystrica, sample no Sj. 495.

3 *Rhabdammina* cf. *cylindrica* GLAESSNER × 60
Hrabovka, sample no Sj. 19, transgressive marls of the Middle Coniacian of the Klape Unit. *Globotruncanella praehavanensis* Subzone.

4, 5 *Spiroplectammina baudouiniana* (d'ORBIGNY) ×90, ×100
Brezová pod Bradlom, sample no Sj. 633, Hurbanová dolina formation. *Sigalia carpathica* Zone.

6 *Spiroplectammina* aff. *laevis* (ROEMER) × 115
Považská Bystrica, sample no Sj. 495

7, 8, 10, 11 *Marssonella oxycona* (REUSS) ×60, × 60, × 70, × 90
7, 10, 11 — Brezová pod Bradlom, sample no Sj. 633; 8 — Považská Bystrica, sample no Sj. 919, Žadovec formation (upper part) of the Manín Unit. *Globotruncana manaurensis* — *Globotruncana elevata* Zone.

9. *Marssonella turris* (d'ORBIGNY) × 90
Považská Bystrica, sample no Sj. 919.

Plate II

1, 2, 3, 5, 6 *Marssonella oxycona* (REUSS × 50, × 80, × 130, × 80, × 80
1, 2, 3-Hrabovka, sample no Sj. 19, transgressive marls of the Middle Coniacian of the Klape Unit. *Globotruncanella praehavanensis* Subzone; 5-Brezová pod Bradlom, sample no Sj. R-45, Čtvertnik marls member of the Upper Coniacian. *Sigalia deflaensis* Subzone; 6-Brezová pod Bradlom, sample no Sj. 635, Hurbanová dolina formation. *Sigalia carpathica* Zone.

4 *Marssonella trochus* (d'ORBIGNY) × 150
Brezová pod Bradlom, sample no Sj. 635.
7 *Dorothia pupa* (REUSS) × 90
Brezová pod Bradlom, sample no Sj. 153, Hurbanová dolina formation. *Globotruncana manaurensis — Globotruncana elevata* Zone.
8, 9 *Dorothia gradata* (BERTHELIN) × 80
Brezová pod Bradlom, 8 — sample no Sj. 633; 9 — sample no Sj. 635, Hurbanová dolina formation. *Sigalia carpathica* Zone.
10, 11, 12 *Textularia agglutinans* d'ORBIGNY × 60, × 50, × 60,
Považská Bystrica, sample no Sj. 495, Žadovec formation. *Helvetoglobotruncana cachensis — Marginotruncana angusticarinata* Subzone (lower part of the *Dicarinella concavata* Zone).

Plate III
1 *Spiroplectammina flexuosa* (REUSS) × 50
Považská Bystrica, sample no Sj. 495. *Dicarinella concavata* Zone.
2 *Spiroplectinata* sp. × 60
Hrabovka, sample no Sj. 19. *Globotruncanella praehavanensis* Subzone.
3 *Pseudospiroplectinata compressiusculla* (CUSHMAN) × 70
Považská Bystrica, sample no Sj. 919. *Globotruncana manaurensis-Globotruncana elevata* Zone.
4,5 *Gaudryina laevigata* FRANKE × 60, × 50
Brezová pod Bradlom, sample no Sj. 633. *Sigalia carpathica* Zone.
6 *Gaudryina crassa* MARSSON × 110
Považská Bystrica, sample no Sj. 919.
7 *Gaudryina nanushukensis* TAPPAN × 80
Brezová pod Bradlom, sample no Sj. 633. *Sigalia carpathica* Zone.
8 *Gaudryina* aff. *pseudoserrata* CUSHMAN × 75
Brezová pod Bradlom, sample no Sj. 633.
9 *Textularia foeda* REUSS × 130
Považská Bystrica, sample no Sj. 495.
10, 11 *Clavulinoides* aff. *gaultinuss* (MOROZOVA) × 60, × 100
Považská Bystrica, sample no Sj. 919
12 *Ataxophragmium* aff. *subhaericum* (REUSS) × 100
Považská Bystrica, sample no Sj. 495

Plate IV
1, 2, 3 *Tritaxia dubia* (REUSS) × 60, × 60, × 80
1, 2-Brezová pod Bradlom, sample no Sj. 635. *Sigalia carpathica* Zone; 3-Brezová pod Bradlom, sample no Sj. 153. *Globotruncana manaurensis-Globotruncana elevata* Zone.
4 *Reussella szajnochae praecursor* KNIPSCHER et KLASZ × 90
Považská Bystrica, sample no Sj. 919. *Globotruncana manaurensis-Globotruncana elevata* Zone.
5, 6 *Ataxophragmium subsphaericum* (REUSS) × 200
Považská Bystrica, sample no Sj. 495. *Dicarinella concavata* Zone.
7 *Valvoreussella bronni* (REUSS) × 90
Považská Bystrica, sample no Sj. 919.
8 Ataxophragmium ovoideum (MARIE) × 200
Považská Bystrica, sample no Sj. 495
9 *Spirophthalmidium cretaceum* (REUSS) × 150
Hrabovka, sample no Sj. 19. *Globotruncanella praehavanensis* Subzone.
10, 11 *Sigmoilina* aff. *antiqua* (FRANKE) × 70, × 80
Brezová pod Bradlom, sample no Sj. R-45. *Sigalia deflaensis* Subzone.
12 *Miliammina* aff. *bisobscura* (BROTZEN) × 175
Brezová pod Bradlom, sample no Sj. 633.

Plate V
1, 2, 3 *Gaudryina pyramidata* CUSHMAN × 70, × 80, × 75
Hrabovka, sample no Sj. 19

4, 5 *Gaudryina cretacea* (KARRER) × 60, × 70
4-Hrabovka, sample no Sj. 19; 5-Brezová pod Bradlom, sample no Sj. R-45. *Sigalia deflaensis* Subzone.
6 *Gaudryina supracretacea* HOFKER × 60
Hrabovka, sample no Sj. 19.
7, 8 *Gaudryina cretacea* (KARRER) × 70, × 50
Hrabovka, sample no Sj. 19
11 *Tritaxia tricarinata* (REUSS) × 50
Brezová pod Bradlom, sample no Sj. R-45. *Sigalia deflaensis* Subzone.
9, 10, 12 *Gaudryina rugosa* d'ORBIGNY × 70, × 70, × 90
Hrabovka, sample no Sj. 19

Plate VI
1 *Haplophragmoides chapmani* CRESPIN × 70
Belušské Slatiny, sample no Sj. 573, Praznov formation. *Rotalipora turonica* Subzone.
2 *Ammobaculites fisheri* CRESPIN× 130
Lednické Rovné, sample no Sj. 167. *Rotalipora montsalvensis* Zone.
3 *Spiroplectammina baudouiniana* (d'ORBIGNY) × 70
Lednické Rovné, sample no Sj. 167.
4 *Marssonella oxycona* (REUSS) × 90
Belušské Slatiny, sample no Sj. 573.
5 *Ataxophragmium* cf. *ruthenicum* (REUSS) × 100
Újazd, sample no Sj. 35. *Thalmaninella deeckei* Subzone.
6 *Ataxophragmium puschi* (REUSS) × 90
Újazd, sample no Sj. 35
7 *Spiroplectammina flexuosa* (REUSS) × 60
Belušské Slatiny, sample no Sj. 573.
8 *Dorothia pupa* (REUSS) × 50
Belušské Slatiny, sample no Sj. 573.
9 *Textularia foeda* (REUSS) × 70
Lednické Rovné, sample no Sj. 168. *Thalmanninella deeckei* Subzone.
10 *Clavulinoides gaulthinus* (MOROZOVA) × 50
Lednické Rovné, sample no Sj. 167. *Rotalipora montsalvensis* Zone.
11 *Clavulinoides* sp. × 55
Belušské Slatiny, sample no Sj. 573.
12 *Clavulinoides gaultinus* (MOROZOVA) × 50
Brodno, sample no Sj. 12. *Rotalipora turonica* Subzone.

Plate VII
1 *Lenticulina* (*Lenticulina*) sp. × 50
Brezová pod Bradlom, sample no Sj. 153. *Globotruncana manaurensis-Globotruncana elevata* Zone.
2 *Lenticulina* (*Lenticulina*) aff. *comptoni* (SOWERBY) × 70
Brezová pod Bradlom, sample no Sj. 153.
3 *Lenticulina* (*Saracenaria*) *jarvisi* (BROTZEN) × 90
Brezová pod Bradlom, sample no Sj. 153.
4, 5 *Lenticulina* (*Lenticulina*) *secans* (REUSS) × 50, × 110
4-Brezová pod Bradlom, sample no Sj. 633. *Sigalia carpathica* Zone; 5-Považská Bystrica, sample no Sj. 495. *Dicarinella concavata* Zone.
6 *Lenticulina* (*Lenticulina*) aff. *secans* (REUSS) × 170
Považská Bystrica, sample no Sj. 495.
7 *Lenticulina* (*Lenticulina*) sp. × 110
Považská Bystrica, sample no Sj. 495.
8 *Lenticulina* (*Planularia*) *liebusi* (BROTZEN) × 60
Brezová pod Bradlom, sample no Sj. R-45

9 *Lenticulina (Marginulina) gosae* (REUSS) × 32
Brezová pod Bradlom, sample no Sj. 635.
10, 11, 12 *Lenticulina (Saracenaria) trilobata* (d'ORBIGNY) × 40, × 50, × 40
Brezová pod Bradlom, sample no Sj. 633.
13 *Lenticulina (Vaginulina) lata* HOFKER × 40
Brezová pod Bradlom, sample no Sj. 633.

Plate VIII
1 *Nodosaria* sp. × 50
Brezová pod Bradlom, sample no Sj. 635.
2 *Dentalina reussi* NEUGEBOREN × 50
Brezová pod Bradlom, sample no Sj. R-45
3 *Pyrulina cylindroides* (ROEMER) × 140
Považská Bystrica, sample no Sj. 495.
4 *Dentalina distincta* REUSS × 150
Považská Bystrica, sample no Sj. 495.
5 *Dentalina* sp. × 50
Brezová pod Bradlom, sample no Sj. R-45
6 *Nodosaria* aff. *monile* REUSS × 100
Hrabovka, sample no Sj. 19
7 *Dentalina legumen* REUSS × 60
Považská Bystrica, sample no Sj. 495.
8 *Frondicularia* sp. × 50
Brezová pod Bradlom, sample no Sj. 635.
9 *Frondicularia sagittula* VAN DEN BROCK × 40
Brezová pod Bradlom, sample no Sj. 635.
10, 11, 13 *Pleurostomella reussi* BERTHELIN × 50 × 30, × 30
Hrabovka, sample no Sj. 19.
12 *Elipsonodosaria* sp. × 60
Hrabovka, sample no Sj. 19
14 *Pleurostomella subnodosa* REUSS × 50
Hrabovka, sample no Sj. 19
15, 16 *Rectoglandulina* aff. *kirschneri* TAPPAN × 50, × 140
Hrabovka, sample no Sj. 19.
17 *Neoflabellina gibbera* (WEDEKIND) × 50
Brezová pod Bradlom, sample no Sj. 635.

Plate IX
1 *Stenosioeina praeexsculpta* (KELLER) × 100
Hrabovka, sample no Sj. 19.
2, 4 *Stensioeina exsculpta gracilis* BROTZEN × 100, × 140
Brezová pod Bradlom, sample no Sj. 633.
3 *Stensioeina granulata* (OLBERTZ) × 90
Brezová pod Bradlom, sample no Sj. 633.
5, 6 *Stensioeina exsculpta exsculpta* (REUSS) × 175, × 140
Považská Bystrica, sample no Sj. 495.
7, 11 *Stensioeina exsculpta exsculpta* (REUSS) × 90, × 100
Hrabovka, sample no Sj. 19.
8, 9 *Stensioeina exsculpta exsculpta* (REUSS) × 140, × 125
Považská Bystrica, sample no Sj. 495.
10 *Stensioeina exsculpta exsculpta* (REUSS) × 130
Brezová pod Bradlom, sample no Sj. R-45.
11 *Stensioeina praeexsculpta* (KELLER) × 150
Hrabovka, sample no Sj. 19.

Plate X

1, 2, 3 *Stensioeina exsculpta exsculpta* (REUSS) × 100, × 100, × 90
Brezová pod Bradlom, sample no Sj. 153.

4 *Stensioeina exsculpta asper* HOFKER × 100
Brezová pod Bradlom, sample no Sj. 153.

5, 6, 7, 8 *Epistomina* (*Hoeglundina*) *favosoides* (EGGER) × 60, × 70, × 80, × 60
Brezová pod Bradlom, sample no Sj. 635.

9, 10 *Daviesina minuscula* (HOFKER) × 80
Brezová pod Bradlom, sample no Sj. 635.

11 *Epistomina* (*Brotzenia*) *postdorzoplana* (VASILENKO) × 50
Hrabovka, sample no Sj. 19.

12, 13 *Eponides* sp. × 120, × 140
Považská Bystrica, sample no Sj. 495.

Plate XI

1, 2 *Stensioeina exsculpta gracilis* BROTZEN × 100
Brezová pod Bradlom, sample no Sj. 153.

3 *Stensioeina exsculpta exsculpta* (REUSS) × 150
Považská Bystrica, sample no Sj. 495.

4 *Pseudovalvulineria moniliformis* (REUSS) × 115
Považská Bystrica, sample no Sj. 495.

5 *Gyroidinoides nitida* (REUSS) × 125
Považská Bystrica, sample no Sj. 495

6, 12 *Anomalina* (*Anomalina*) *stelligera* (MARIE) × 140, × 150
Brezová pod Bradlom, sample no Sj. 153.

7, 8, 9 *Praebulimina ventricosa* (BROTZEN) × 175, × 130, × 200
Považská Bystrica, sample no Sj. 495.

10, 11 *Anomalina* (*Gavelinella*) *pseudoexcolata* (KALININ) × 80, × 90
Brezová pod Bradlom, sample no Sj. 153.

Plate XII

1, 2 *Eponides* sp. × 120
Považská Bystrica, sample no Sj. 495.

3 *Valvulineria lenticula* (REUSS) × 150
Považská Bystrica, sample no Sj. 495.

4, 5, 6 *Anomalina* (*Anomalina*) *infrasantonica* BALAKHMATOVA × 60, × 80, × 100
Brezová pod Bradlom sample no Sj. 153.

7, 8 *Anomalina* (*Anomalina*) *praeinfrasantonica* MJATLIUK, × 60, × 200
Brezová pod Bradlom, sample no Sj. R-45.

9 *Anomalina* (*Anomalina*) *praeinfrasantonica* MJATLIUK × 90
Brezová pod Bradlom, sample no Sj. 633.

10 *Globorotalites michelianus* (d'ORBIGNY) × 100
Brezová pod Bradlom, sample no Sj. R-45.

11, 12 *Gyroidinoides tendami* (SCHIJFSMA) × 100, × 100
Brezová pod Bradlom, sample no Sj. 153.

Plate XIII

1, 2, 3 *Anomalina* (*Anomalina*) *infrasantonica* BALAKHMATOVA × 90, × 90, × 100
Brezová pod Bradlom, sample no Sj. 153.

4 *Anomalina* (*Anomalina*) sp. × 80
Brezová pod Bradlom, sample no Sj. R-45.

5, 8, 9 *Gyroidinoides depressa* (ALTH) × 80, × 90, × 90
Brezová pod Bradlom, sample no Sj. R-45.

6 *Anomalina* (*Anomalina*) *umbilicatula* MJATLIUK, × 100
Brezová pod Bradlom, sample no Sj. 635.

7 *Gyroidinoides globosa* (HAGENOW) × 120
Brezová pod Bradlom, sample no Sj. 153
10 *Anomalina* (*Anomalina*) *infrasantonica* (*Balakhmatova*) × 70
Hrabovka, sample no Sj. 19.
11, 12 *Anomalina* (*Anomalina*) *stelligera* (MARIE) × 150
Brezová pod Bradlom, sample no Sj. 153.

Plate XIV
1, 2, 3 *Heterohelix striata* (EHRENBERG) × 130, × 130, × 150
1, 2-Brezová pod Bradlom, sample no Sj. R-45, 3-Hrabovka, sample no Sj. 19.
4 *Sigalia deflaensis* (SIGAL) × 140
Brezová pod Bradlom, sample no Sj. 635. *Sigalia carpathica* Zone.
5, 6, 7, 8 *Sigalia carpathica* SALAJ et SAMUEL × 90, × 120, × 120, × 60
5, 6, 7-Brezová pod Bradlom, sample no Sj. 635; 8-Považská Bystrica, sample no Sj. 919.
9 *Sigalia* aff. *carpathica* SALAJ et SAMUEL × 110
Považská Bystrica, sample no Sj. 919.
10, 11, 12 *Ventilabrella decoratissima* de KLASZ × 100, × 85, × 90
Považská Bystrica, sample no Sj. 919.

Plate XV
1, 2 *Hedbergella brittonensis* LOEBLICH et TAPPAN × 120, × 500
Újazd, sample no Sj. 35. *Thalmanninella deeckei* Subzone.
3 *Hedbergella portsdownensis* (WILLIAMS et MITCHELL) × 150
Lednické Rovné, sample no Sj. 168. *Thalmaninnella deeckei* Subzone.
4 *Hedbergella brittonensis* LOEBLICH et TAPPAN × 250
Lednické Rovné, sample no Sj. 168.
5 *Hedbergella planispira* (TAPPAN) × 200
Lednické Rovné, sample no Sj. 168.
6 *Hedbergella planispira* (TAPPAN) × 200
Lednické Rovné, sample no Sj. 168
7 *Hedbergella planispira* (TAPPAN) × 200
Lednické Rovné, sample no Sj. 168.
8 *Hedbergella brittonensis* LOEBLICH et TAPPAN × 250
Lednické Rovné, sample no Sj. 168.
9 *Hedbergella portsdownensis* (WILIAMS et MITSCHELL) × 180
Lednické Rovné, sample no Sj. 168.
10 *Hedbergella planispira* (TAPPAN) × 200
Lednické Rovné, sample no Sj. 168.

Plate XVI
1 *Hedbergella delrioensis* (CARSEY) × 200
Újazd, sample no Sj. 35.
2 *Hedbergella brittoensis* LOEBLICH et TAPPAN × 150
Újazd, sample no Sj. 35.
3 *Clavihedbergella amalilis* (LOEBLICH et TAPPAN) × 150
Újazd, sample no Sj. 35.
4 *Clavihedbergella amalilis* (LOEBLICH et TAPPAN) × 150
Újazd, sample no Sj. 35.
5 *Clavihedbergella amalilis* (LOEBLICH et TAPPAN) × 200
Újazd, sample no Sj. 35.
6 *Clavihedbergella amalilis* (LOEBLICH et TAPPAN) × 150
Újazd, sample no Sj. 35.
7 *Hedbergella delrioensis* (CARSEY) × 180
Újazd, sample no Sj. 35.
8 *Globigerinelloides aegleformis* (MOREMAN) × 225
Újazd, sample no Sj. 35.

9 *Hedbergella brittoensis* LOEBLICH et TAPPAN × 200
Újazd, sample no Sj. 35.
10 *Hedbergella brittoensis* LOEBLICH et TAPPAN × 200
Újazd, sample no Sj. 35
11 *Hedbergella planispira* (TAPPAN) × 250
Újazd, sample no Sj. 35.
12 *Hedbergella brittoensis* LOEBLICH et TAPPAN ×
Újazd, sample no Sj. 35.

Plate XVII
1, 2, 3 *Thalmanninella subticinensis* GANDOLFI × 90, × 90, × 100
Červený Kameň, sample no Sj. 168/11. *Thalmanninella subticinensis* Zone.
4, 5, 6 *Rotalipora montsalvensis* (MONROD) × 50, × 70, × 160
Vršatecké podhradie, sample no Sj. 4. Cenomanian of the Drietoma development. *Rotalipora montsalvensis* Zone.
7 *Thalmanninella appenninica* (REUSS) × 60
Lednické Rovné, sample no Sj. 168. *Thalmanninella deeckei* Subzone.
8 *Thalmanninella appenninica* (REUSS) × 60
Újazd, sample no Sj. 35.
9 *Thalmanninella globotruncanoides* SIGAL × 80
Újazd, sample no Sj. 35. *Thalmanninella deeckei* Subzone.
10 *Thalmanninella deeckei* (FRANKE) × 90
Újazd, sample no 35.
11 *Thalmanninella reicheli* (MONROD) × 120
Vršatecké Podhradie, sample no Sj. 4.
12 *Rotalipora turonica* BROTZEN × 70
Belušské Slatiny, sample no Sj. 573. *Rotalipora turonica* Subzone.

Plate XVIII
1, 2 *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ × 80, × 70
Považská Bystrica, sample no Sj. 919.
3 *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ × 100
Hrabovka, sample no Sj. 19.
4, 7 *Helvetoglobotruncana cachensis* (DOUGLAS) × 70 × 80
Hrabovka, sample no Sj. 19.
5 *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ × 60
Hrabovka, sample no Sj. 19.
6 *Hedbergella* sp. × 200
Hrabovka, sample no Sj. 19.
8, 9 *Helvetoglobotruncana cachensis* (DOUGLAS) × 130
Považská Bystrica, sample no Sj. 495.
10, 11, 12 *Hedbergella* sp. × 200 × 200, × 170
Hrabovka, sample no Sj. 19.

Plate XIX
1, 2, 3 *Dicarinella primitiva* (DALBIEZ) × 90, × 100, × 90
Brezová pod Bradlom, sample no Sj. 635.
4 *Dicarinella concavata* (BROTZEN) × 90
Brezová pod Bradlom, sample no Sj. 635.
5, 6 *Dicarinella primitiva* (DALBIEZ) × 50
Hrabovka, sample no Sj. 19.
7 *Globotruncana elevata stuartiformis* (DALBIEZ) × 70
Považská Bystrica, sample no Sj. 919.
8 *Marginotruncana coronata* (BOLLI) × 55
Považská Bystrica, sample no Sj. 919.

9 *Globotruncana elevata elevata* (BROTZEN) × 60
Považská Bystrica, sample no Sj. 919.
10, 11 *Globotruncana elevata elevata* (BROTZEN) × 70
Brezová pod Bradlom, sample no Sj. 153.
12 *Globotruncana elevata elevata* (BROTZEN) × 50
Považská Bystrica, sample no Sj. 919.

Plate XX
1, 2 *Dicarinella coldreriensis* GANDOLFI × 60
Hrabovka, sample no Sj. 19.
3 *Marginotruncana angusticarinata* GANDOLFI × 60
Hrabovka, sample no Sj. 19.
4 *Globotruncana manaurensis* GANDOLFI × 150
Považská Bystrica, sample no Sj. 919.
5 *Globotruncana desioi* GANDOLFI × 50
Považská Bystrica, sample no Sj. 919.
6 *Dicarinella coldreriensis* GANDOLFI × 90
Brezová pod Bradlom, sample no Sj. R-45.
7 *Marginotruncana coronata* (BOLLI) × 80
Považská Bystrica, sample no Sj. 919.
8 *Globotruncana manaurensis* GANDOLFI × 80
Považská Bystrica, sample no Sj. 919.
9 *Globotruncana* aff. *linneiana* (d'ORBIGNY) × 50
Považská Bystrica, sample no Sj. 919.
10 *Marginotruncana angusticarinata* (GANDOLFI) × 50
Považská Bystrica, sample no Sj. 919.
11 *Globotruncana tricarinata* (QUEREAU) × 40
Hrabovka, sample no Sj. 19.
12 *Globotruncana tricarinata* (QUEREAU) × 50
Považská Bystrica, sample no Sj. 919.
13 *Globotruncana desioi* GANDOLFI × 50
Považská Bystrica, sample no Sj. 919.

Plate XXI
1, 2 *Marginotruncana coronata* (BOLLI) × 50
Brezová pod Bradlom, sample no Sj. R-45.
3 *Marginotruncana coronata* (BOLLI) × 40
Hrabovka, sample no Sj. 19.
4 *Helvetoglobotruncana cachensis* (DOUGLAS) × 110
Hrabovka, sample no Sj. 19.
5 *Globotruncana desioi* GANDOLFI × 70
Brezová pod Bradlom, sample no Sj. R-45.
7 *Globotruncana manaurensis* GANDOLFI × 60
Brezová pod Bradlom, sample no Sj. 153.
8 *Globotruncana tricarinata* (QUEREAU) × 90
Považská Bystrica, sample no Sj. 495.
9 *Globotruncana desioi* GANDOLFI × 80
Brezová pod Bradlom, sample no Sj. 633.
10 *Marginotruncana coronata* (BOLLI) × 120
Brezová pod Bradlom, sample no Sj. 633.
11 *Globotruncana desioi* GANDOLFI × 60
Brezová pod Bradlom, sample no Sj. 635.
12 *Marginotruncana coronata* (BOLLI) × 60
Brezová pod Bradlom, sample no Sj. 635.

Plate XXII

1, 4 *Globotruncana desioi* GANDOLFI × 60, × 70
Hrabovka, sample no Sj. 19.

2, 3 *Marginotruncana angusticarinata* (GANDOLFI) × 50, × 60
Hrabovka, sample no Sj. 19.

5, 6 *Marginotruncana coronata* (BOLLI) × 60
Brezová pod Bradlom, sample no Sj. R-45.

7 *Globotruncanella praehavanensis* SALAJ et GAŠPARIKOVÁ × 80
Hrabovka, sample no Sj. 19.

8 *Globotruncana desioi* GANDOLFI × 80
Brezová pod Bradlom, sample no Sj. R-45.

9 *Globotruncana desioi* GANDOLFI × 60
Brezová pod Bradlom, sample no Sj. 635.

10 *Globotruncana bulloides* (VOGLER) × 150
Hrabovka, sample no Sj. 19.

11, 12 *Marginotruncana coronata* (BOLLI) × 50
Hrabovka, sample no Sj. 19.

Plate XXIII

1 *Globigerina gnaucki* BLOW et BANNER
Ľubietová, borehole P-4, 37—39 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 300 ×

2 *Globigerina gnaucki* BLOW et BANNER
Ľubietová, borehole P-4, 59,5 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 120 ×

3 *Globigerina gnaucki* BLOW et BANNER
Ľubietová, borehole P-4, 59, 5 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 14), 120 ×

Plate XXIV

1—2 *Globigerina officinalis* SUBBOTINA
Ľubietová, borehole P-4, 35—36 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 120 x.

3 *Globigerina praebulloides leroy* BLOW et BANNER Ľubietová, borehole P-4, 35—36 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 120 x.

4 *Globigerina danvillensis* HOWE et WALLACE
Ľubietova, borehole P-8, 46—47 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 150 ×.

Plate XXV

1—2 *Globigerina eocaena* GÜMBEL
Ľubietová, borehole P-R, 51—52 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 140 ×

3—4 *Globigerina eocaena* GÜMBEL
Ľubietová, borehole P-4, 51—52 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 140 × (Fig. 3), 300 × (Fig. 4)

Plate XXVI

1 *Globigerina boweri* BOLLI
Žilina, borehole V-1, 9—10 m; Podtatra group (Huty formation): *Truncorotaloides rohri* Zone (= P 12—14); 200 ×

2 *Globigerina eocaena compacta* SUBBOTINA
Ľubietová, borehole P-4, 59,4 m; Podtatra group (uppermost part); *Globigerina officinalis* Zone (= P 17), 200 ×

3—4 *Globigerina boweri* BOLLI
Žilina, borehole V—1, 9—10 m, Podtatra group (Huty, formation); *Truncorotaloides rohri* Zone (= P 12—14), 150 × (Fig. 3), 300 × (Fig. 4)

Plate XXVII
1—2 *Turborotalia (Acarinina) rugosoaculeata* (SUBBOTINA)
Žilina, borehole V-12, 115 m; Podtatra group (Zuberec formation); *Globigerinatheka semiinvoluta* Zone (= P 15), 150 × (Fig. 1), 320 × (Fig. 2)
3 *Turborotalia (Acarinina) rugosoaculeata* (SUBBOTINA)
Žilina, borehole V-12, 95 m; Podtatra group (Zuberec formation); *Globigerinatheka semiinvoluta* Zone (= P 15), 150 ×

Plate XXVIII
1 *Globigerinatheca index* (FINLAY)
Štúrovo, borehole Čenkov-2, 150 m; *Truncorotaloides rohri* Zone (= P 12—14), 100 ×
2—4 *Globigerinatheca globosa* SAMUEL
Štúrovo, borehole Čenkov-2, 110 m, non-Flysch (Buda) development); *Truncorotaloides rohri* Zone (= P 12—14), 100 ×

Plate XXIX
1—2 *Globigerina linaperta* FINLAY
Žilina, borehole V-1, 25 m; Podtatra group (Huty formation); *Truncorotaloides rohri* Zone (= P 12—14), 100 ×
3—4 *Globigerina boweri* BOLLI
Myjava, Brezová group/*Truncorotaloides rohri* Zone (= P 12—14), 100 ×

Pl. XXX
1—3 *Turborotalia (Acarinina) rotundimarginata* (SUBBOTINA)
Žilina, borehole V-12, 5 m; Podtatra group (Biely potok formation); *Globigerinatheca semiinvoluta* Zone (= P 15), 150 ×
4—6 *Globorotalia aff. reissi* LOEBLICH et TAPPAN Podhoroď, Klippen belt; *Morozovella velascoensis* Zone (P 5), 120 ×

Západné Karpaty, sér. paleontológia, 9, P. 73—86, Geol. Úst. D. Štúra, Bratislava, 1984

Viera Gašpariková

Cretaceous nannoplankton zones of the West Carpathians

4 text-figs., 6 Pls. (XXXI—XXXVI), Slovak summary

Abstract. Nannoplanktic Cretaceous zones of the West Carpathians were determined on the basis of calcareous nannoplankton studied in the Krížna nad Manín units of the Strážovské vrchy Mts., in the Klippen Belt in the Czorsztyn and Kysuca Units and in the Myjavská pahorkatina upland.

In the Lower Cretaceous studied were only assemblages characteristic of the Valanginian, Hauterivian and Barremian. The zones were distinguished from the Aptian to the Maastrichtian or Danian. There are 18 zones, each being characterized by the first appearance of the respective species. They are zones with the character of interval zones.

Nannoplanktic zones in the Cenomanian-Coniacian time interval were correlated to zones determined in the Mediterranean region. There are almost the same zones in this stratigraphic range in the West Carpathians and in the Mediterranean region, only they are somewhat late in the West Carpathians.

In the past two decades nannoplankton was significant for biozonation of the Cretaceous. Cretaceous nannoplankton zones were determined by many authors in various parts of the world: P. Čepek et W. W. Hay (1969), H. Manivit (1971, 1977), H. Thierstein (1971, 1973, 1976), T. Worlsley (1971), M. E. Hill (1976), J. Verbeek (1976), W. Sissingh (1977), K. Perch-Nielsen (1977, 1979). They did, however, not formed a standard scale like in the Tertiary because of considerably variegated facies and the character of single regions.

The determination of nannoplankton zones in the Cretaceous of the West Carpathians was based upon the existing foraminiferal zones determined by J. Salaj et O. Samuel (1966, 1977), J. Salaj et V. Gašpariková (1979) and J. Salaj in V. Gašpariková et J. Salaj (1982).

In the Lower Cretaceous so far only assemblages characteristic of the individual stages have been distinguished. The zones, characterized by the first appearances of index species were determined from the Aptian to the Maastrichtian or Danian.

The Lower and Middle Cretaceous calcareous nannoplankton was only found in the Krížna and the Manín units in the Strážovské vrchy Mts. Together with ammonites, brachiopods, foraminifers and calpionelles the nannoplankton enabled stratigraphical division of the region.

The Neocomian nannoplankton was studied in the Krížna unit in two groups: the deep-sea Zliechov Group and the shallow-water Belá Group, but there were no

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substantial differences in the composition of assemblages. The facies of grey marlstones, marly limestones and schists contained Valanginian, Hauterivian, Barremian and Aptian assemblages.

In both groups the highest members of the Krížna unit consist of a flyschoid to flysch formation of schists and marlstones. The formation contained nannoplankton zones characteristic of the Lower, Middle Albian to the Lower Cenomanian.

In the Manín unit forming a continuous belt along the inner margin of the Klippen Belt, is a thick Albian-Cenomanian flysch formation. It was studied in the NW part of the Strážovské vrchy Mts. in the profile Tŕstie — Horný Lieskov — Slopná containing abundant nannoplankton and foraminifers from the Lower Albian to the Upper Cenomanian (V. GAŠPARIKOVÁ et J. SALAJ 1982). Less abundant assemblages were found in the SW part of the Strážovské vrchy Mts. where the Manín unit extends to the Central Carpathians (loc. Dobrá, Trenčianske Teplice, Soblahov).

The Middle- and Upper Cretaceous nannoplankton was studied also in the Klippen Belt in the Kysuca and the Czorsztyn Groups.

Middle Cretaceous assemblages were determined in a marly facies of the Kysuca Group in a wider vicinity of Žilina in the Aptian — Turonian stratigraphic range. In some formations containing plentiful planktic foraminifers was also calcareous nannoplankton. It concerns the Koňhora Formation — Aptian, the Tissal Formation — Albian, the Lalinok Formation — Cenomanian, the Kysuca Formation — Lower Turonian, the Snežnica Formation — Middle and Upper Turonian.

Upper Cretaceous nannoplankton zones from the Coniacian to the Maastrichtian were distinguished in the Czorsztyn Group in variegated marls of the Púchov type.

Upper Cretaceous assemblages were also studied in the Myjavská pahorkatina upland. A. BEGAN — J. HANÁČEK — J. MELLO — J. SALAJ (1982) basing on lithofacies and stratigraphic differences determined three facies: the southern Bradlo facies, the transitional Stará Turá facies and the northern Surovín facies. Most plentiful assemblages were in the southern transgressive facies. Marly and flyschoid formation represent the Upper Coniacian to the Upper Campanian and the variegated Lower Campanian marls are lithologically similar to the Púchov marls (couches rouges facies). Detailed correlation study was enabled by rich foraminiferal and calcareous nannoplankton assemblages.

Continuous sedimentation between the Cretaceous and the Paleogene in the West Carpathians has so far been best proved in the Manín unit at the locality Hradisko, W of Žilina, by J. SALAJ — J. KYSELA — V. GAŠPARIKOVÁ — A. BEGAN (1978). In the marly facies sedimentation continued from the Maastrichtian to the Lower Eocene. Rich foraminiferal and nannoplankton assemblages represent the Upper Maastrichtian, the entire Paleocene and the Lower Eocene, i. e. Danian s. l., Montian s. l., Landenian s. l., Illerdian.

Lower Cretaceous

The Valanginian is represented by grey marlstones, partly by schistose and marly limestones.

The assemblages contain plentiful representatives of the genus *Ellipsagelosphaera*, namely the species *Ellipsagelosphaera* ex. gr. *britannica* (STRADNER) PERCH-NIELSEN, *Ellipsagelosphaera coronata* (GARTNER) BLACK, *Ellipsagelosphaera keftalrempti* GRÜN, *Ellipsagelosphaera ovata* (BUKRY) BLACK, *Biscutum constans* (GORKA) BLACK, *Cyclagelosphaera margereli* NOËL, *Cyclagelosphaera rotaclypeata* BUKRY, *Diazomatolithus* sp., cf. *D. subbeticus* GRÜN, ? *Markalius ellipticus* GRÜN,

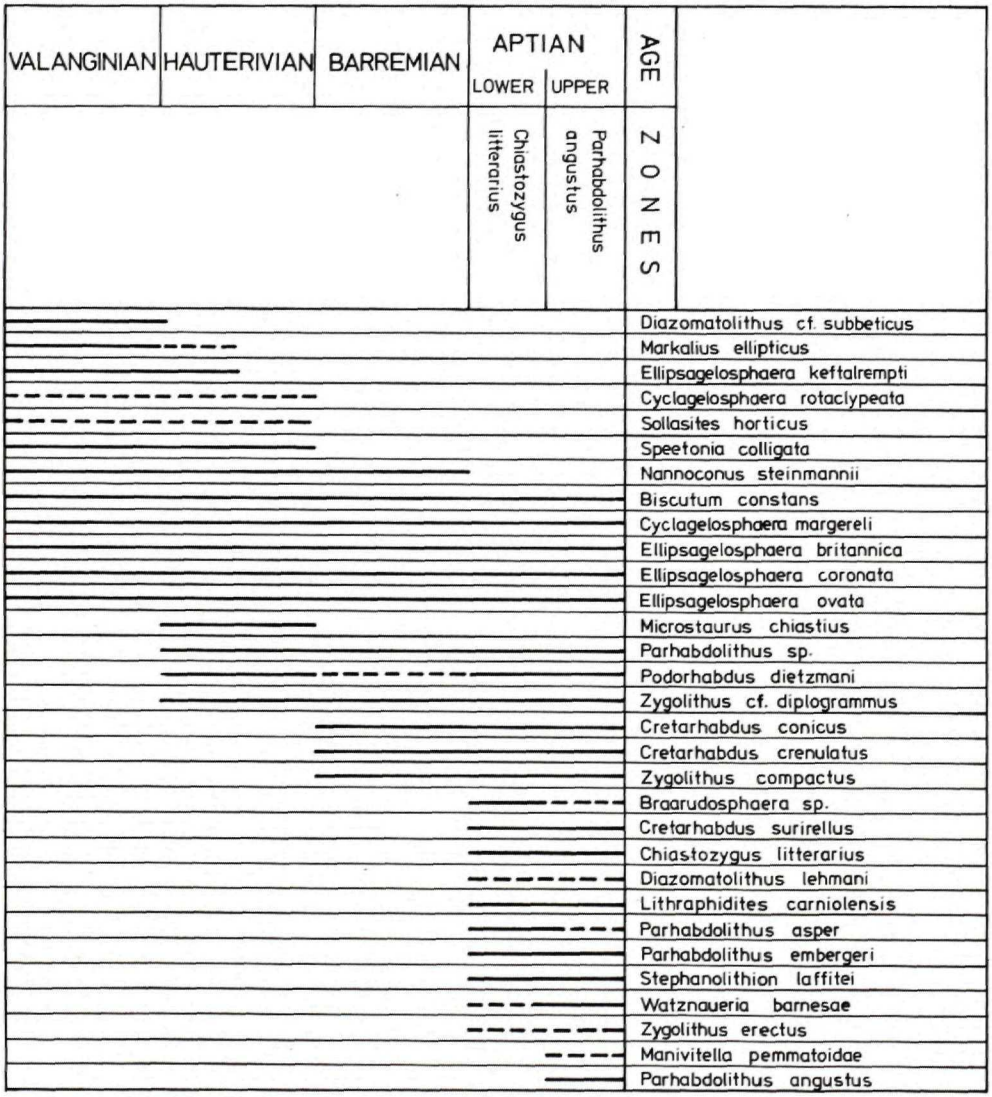


Fig. 1 Vertical distribution of calcareous nannoplankton in Lower Cretaceous of West Carpathians

Sollasites cf. *horticus* (STRADNER, ADAMIKER et MARESCH) BLACK, *Speetonia* cf. *colligata* BLACK, *Nannoconus* ex gr. *steinmanni* KAMPTNER.

The species *Ellipsagelosphaera* has a narrower stratigraphical range — up to the Upper Hauterivian. According to W. GRÜN — F. ALLEMANN (1975) the stratigraphical range of *Diazomatolithus* sp. cf. *D. subbeticus* is Upper Tithonian — Valanginian and the upper boundary of the occurrence of *Marcalius ellipticus* is the Lower Hauterivian.

There are no substantial lithological differences between the Valanginian and Hauterivian. The latter is rich in microorganisms; nannoplankton is correlable to foraminifers. The composition of assemblages is similar like in the Valanginian: most frequent are representatives of the genus *Ellipsagelosphaera*, the species *Podorhabdus dietzmani* (REINHARDT) REINHARDT and *Parhabdolithus* sp.; significant is also *Microstaurus chiastius* (WORSLEY) GRÜN whose stratigraphical range is Berriasian — Hauterivian. In the Hauterivian the genus *Zygolithus* — *Zygolithus* sp. cf. *Z. diplogrammus* DEFLANDRE appears.

The Barremian is represented by a sequence of grey marly limestones, marly schists and marls. The assemblages contain less representatives of the genus *Ellipsagelosphaera*; the species *Ellipsagelosphaera keftalrempti* extinguishes. The species *Cretarhabdus conicus* BRAMLETTE et MARTINI appears; *Zygolithus* ex. gr. *compactus* BUKRY and *Zygolithus* cf. *diplogrammus* DEFLANDRE are quite frequent.

The Aptian is represented by a sequence of dark-grey marls and marly schists, higher up by massive limestones. On the basis of plentiful nannoplankton assemblages two zones were distinguished in the Aptian.

The zone *Chiastozygus litterarius* (H. THIERSTEIN 1971) is the lowest nannoplankton zone distinguished so far in the West Carpathians. It is characterized by the first occurrence of *Chiastozygus litterarius* (GORKA) MANIVIT.

The assemblages contain abundant species *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cretarhabdus surirellus* (DEFLANDRE) REINHARDT, *Zygolithus diplogrammus* DEFLANDRE, *Zygolithus erectus* DEFLANDRE, scarcer *Ellipsagelosphaera coronata* (GARTNER) BLACK, *Elipsagelosphaera ovata* (BUKRY) BLACK, *Diazomatolithus lehmani* NOËL, *Lithraphidites carniolensis* DEFLANDRE, *Parhabdolithus asper* (STRADNER) REINHARDT, *Parhabdolithus embergeri* (NOËL) STRADNER, *Stephanolithion laffitei* NOËL, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN. In the West Carpathians the zone corresponds to the Lower Aptian. It is overlain by the zone *Parhabdolithus angustus* (H. MANIVIT 1971) characterized by the F. A. of *Parhabdolithus angustus* (STRADNER) STRADNER. The assemblages have the same composition as in the underlying zone.

The zone corresponds to the Upper Aptian and extends to the Lower Albian.

Middle Cretaceous

The Middle Cretaceous (Albian, Cenomanian, Turonian) assemblages were studied in the Kysuca Group of the Klippen Belt, and in the Krížna and Manín units of the Strážovské vrchy Mts.

The Albian is represented by dark-grey limestones, marls and marly Lower Albian schists with a small sandy admixture. Calcareous sandstones increase toward the overlier and the sequence gets the flysch character. Most part of the flysch formation

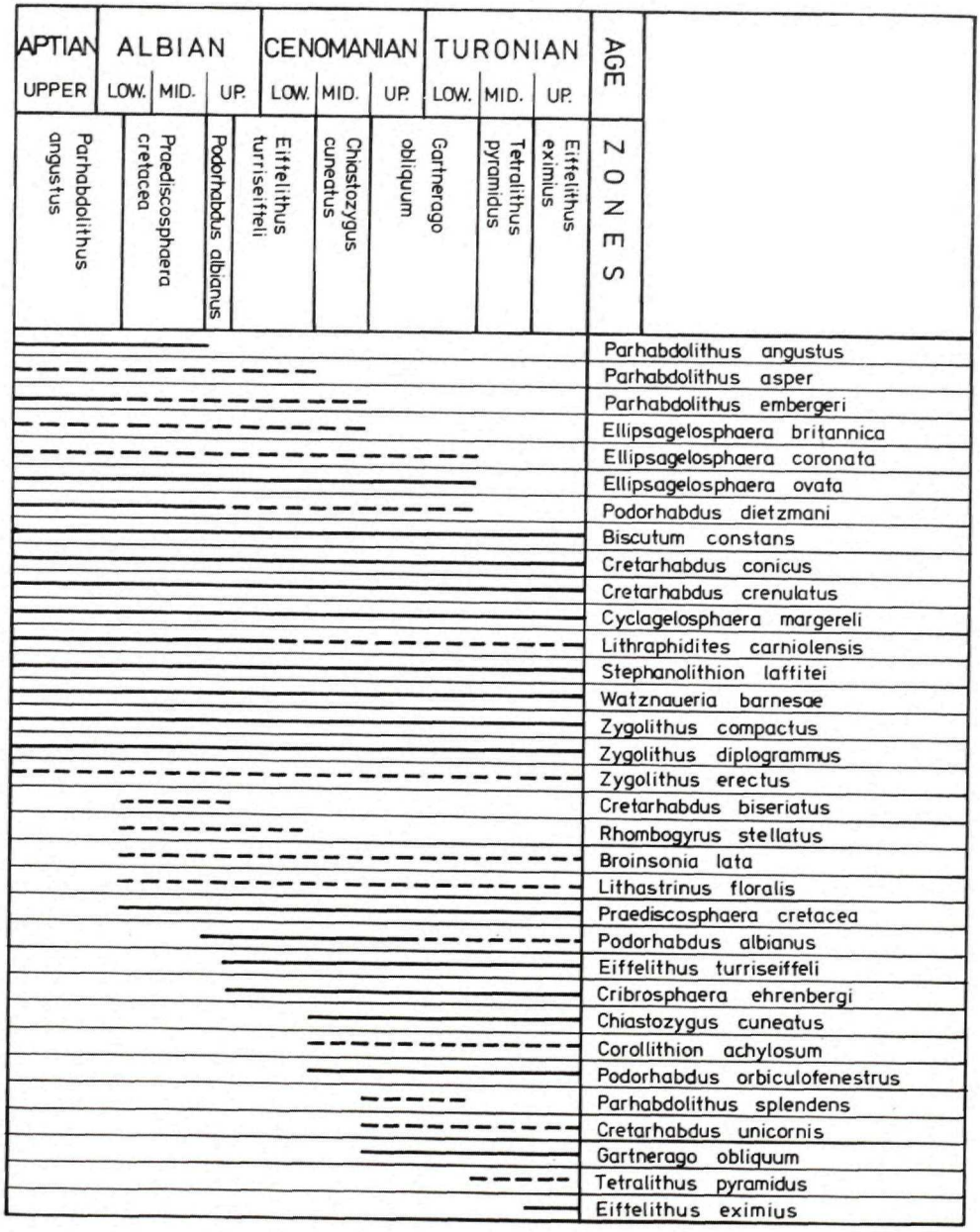


Fig. 2 Vertical distribution of calcareous nannoplankton in Middle Cretaceous of West Carpathians

in the Krížna unit is Middle Albian — Lower Cenomanian. In the Manín unit the Middle and Upper Cenomanian have the flysch character as well as Turonian sediments of the Kysuca Group of the Klippen Belt, represented by variegated marly schists and sheety calcareous sandstones (the Kysuca and Snežnica Members).

On the basis of rich nannoplankton assemblages the following zones were distinguished in the Middle Cretaceous:

Zone *Praediscosphaera cretacea* (H. THIERSTEIN 1971) characterized by the F. A. of *Prediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER. The assemblages mostly contain: *Cretarhabdus biseriatus* FORCHHEIMER, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Parhabdolithus asper* (STRADNER) REINHARDT, *Parhabdolithus angustus* (STRADNER) STRADNER, *Zygolithus compactus* BUKRY, *Zygolithus diplogrammus* DEFLANDRE, *Zygolithus erectus* DEFLANDRE, *Lithastrinus floralis* STRADNER, *Rhombogyrus stellatus* BLACK, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, and scare *Ellipsagelosphaera britannica* (STRADNER) PERCH-NIELSEN, *Ellipsagelosphaera ovata* (BUKRY) BLACK. There are also the F. A. of *Broinsonia lata* (NOËL) NOËL.

The zone represents the upper part of the Lower Albian, the Middle Albian, and corresponds to foraminiferal zones *Ticinella roberti* and *Thalmanninella ticinensis subticinensis.*

Zone *Podorhabdus albianus* (M. E. HILL 1976) is characterized by the F. A. of *Podorhabdus albianus* BLACK. The assemblages have a similar composition like in the underlying zone, with scarce representatives of the genus *Ellipsagelosphaera.* The zone represents the lower part of the Upper Albian and corresponds to the foraminiferal zone *Thalmanninella ticinensis ticinensis.*

Zone *Eiffelithus turriseiffeli* (H. THIERSTEIN 1971) is characterized by the F. A. of *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT. The assemblages contain plentiful representatives of the genus *Cretarhabdus* and *Zygolithus*, the species *Broinsonia lata* (NOËL) NOËL, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Podorhabdus albianus* BLACK, *Podorhabdus dietzmanni* (REINHARDT), REINHARDT, *Prediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Parhabdolithus asper* (STRADNER) MANIVIT and *Parhabdolithus embergeri* (NOËL) STRADNER are scarce.

The zone *Eiffelithus turriseiffeli* corresponds to the upper part of the Albian and to the Lower Cenomanian in relation to foraminiferal zones *Whiteinella gandolfi, Thalmanninella brotzeni* and the lower part of the zone *Thalmanninella appenninica* s. l.

Zone *Chiastozygus cuneatus* (P. ČEPEK et W. HAY 1969) is characterized by the F. A. of *Chiastozygus cuneatus* (LYULEVA) ČEPEK et HAY. The assemblages contain *Corollithion achylosum* (STOVER) THIERSTEIN, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cribroshpaera ehrenbergi* ARKHANGELSKIJ, *Eiffelithus turriseiffeli* (DEFLANDRE), REINHADRT, *Chiastozygus litterarius* (GORKA) MANIVIT, *Podorhabdus albianus* BLACK, *Podorhabdus orbiculofenestrus* (GARTNER) THIERSTEIN, *Prediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Zygolithus compactus* BUKRY, *Zygolithus diplogrammus* DEFLANDRE, *Zygolithus erectus* DEFLANDRE.

The zone represents the Middle Cenomanian and corresponds to the upper part of the zone *Thalmanninella appenninica* s. l.

Zone *Gartnerago obliquum* (H. MANIVIT 1971) is characterized by the F. A. of *Gartnerago obliquum* (STRADNER) REINHARDT. The composition of assemblages is similar to those in the underlying zone.

The zone represents the Upper Cenomanian and Lower Turonian and corresponds to the foraminiferal zone *Rotalipora cushmani* and extends to the zone *Helvetoglobotruncana helvetica.*

Zone *Tetralithus pyramidus* (P. ČEPEK et W. W. HAY 1969) is characterized by the F. A. of *Tetralithus pyramidus* GARDET. The assemblages are similar to those in the Lower Turonian zone *Gartnerago obliquum,* with frequent *Gartnerago obliquum.* The zone represents the Middle Turonian and corresponds to the zone *Helvetoglobotruncana helvetica.*

Zone *Eiffelithus eximius* (H. MANIVIT et al. 1977) is characterized by the F. A. of *Eiffelithus eximius* (STOVER) PERCH-NIELSEN. The assemblages contain mostly: *Biscutum constans* (GORKA) MANIVIT, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Cyclagelosphaera margereli* NOËL, *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT, *Gartnerago obliquum* (STRADNER) REINHARDT, *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Zygolithus compactus* BUKRY. The zone *Eiffelithus eximius* represents the Upper Turonian and corresponds to the foraminiferal zone *Marginotruncana schneegansi.*

Upper Cretaceous

In the Upper Cretaceous (Coniacian, Santonian, Campanian, Maastrichtian), calcareous nannoplankton was studied in a marly facies, in the Czorsztyn Group of the Klippen Belt and in the Myjavská pahorkatina upland. On the basis of plentiful assemblages the following zones were distinguished:

Zone *Marthasterites furcatus* (P. ČEPEK et W. W. HAY 1969) is characterized by the F. A. of *Marthasterites furcatus* DEFLANDRE. The assemblages comprise *Biscutum constans* (GORKA) MANIVIT, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cretarhabdus unicornis* STOVER, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Cyclagelosphaera margereli* NOËL, *Eiffelithus eximius* (STOVER) PERCH-NIELSEN, *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT, *Gartnerago obliquum* (STRADNER) REINHARDT, *Chiastozygus cuneatus* (LYUĽEVA) ČEPEK et HAY, *Lithastrinus floralis* STRADNER, *Loxolithus armilla* (BLACK et BARNES) NOËL, *Markalius circumradiatus* (STOVER) PERCH-NIELSEN, *Micula decussata* VEKSHINA, *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Stephanolithion laffitei* NOËL, *Tranolithus orionatus* (REINHARDT) REINHARDT, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Zygolithus compactus* BUKRY, *Zygolithus diplogrammus* DEFLANDRE and new species *Cylindralithus biarcus* BUKRY, *Cylindralithus serratus* BRAMLETTE et MARTINI, *Tranolithus exiguus* STOVER, *Zygolithus bussoni* NOËL.

The zone *Marthasterites furcatus* represents almost the entire Coniacian, extends to the Upper Coniacian and corresponds to the zone *Dicarinella concavata.*

Zone *Micula decussata* (H. MANIVIT 1971) is characterized by the F. A. of *Micula decussata* VEKSHINA. The assemblages have the same character as those in the underlying zone. The species *Marthasterites furcatus* has not been found.

The zone is associated with the subzone *Sigalia deflaensis* and *Sigalia carpatica,* i. e. to the Coniacian/Santonian boundary.

Zone *Tetralithus obscurus* (H. THIERSTEIN 1976) is characterized by the F. A. of *Tetralithus obscurus* DEFLANDRE. The assemblages are rich and their composition is similar to those of Coniacian assemblages. The species *Cyclagelosphaera margereli* NOËL, *Chiastozygus cuneatus* (LYULEVA) ČEPEK et HAY and *Tetralithus pyramidus* GARDET are most frequent.

The zone represents the Middle and Upper Santonian and corresponds to subzones *Ventilabrella alpina.*

Zone *Broinsonia parca* (D. BUKRY 1974) is characterized by the F. A. of *Broinsonia parca* (STRADNER) BUKRY. The assemblages contain *Ahmuellerella octoradiata* (GORKA) REINHARDT, *Bipodorhabdus tesselatus* NOËL, *Biscutum constants* (GORKA) BLACK, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Cribrosphaera hilli* (BLACK), REINHARDT, *Cylindralithus* cf. *biarcus* BUKRY, *Cylindralithus serratus* BRAMLETTE et MARTINI, *Eiffelithus eximius* (STOVER) PERCH-NIELSEN, *Gartnerago obliquum* (STRADNER) REINHARDT, *Heliolithus anceps* NOËL, *Lithastrinus floralis* STRADNER, *Lucianorhabdus cayeuxi* DEFLANDRE, *Markalius circumradiatus* (STOVER) PERCH-NIELSEN, *Micula decussata* VEKSHINA, *Prediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Prediscosphaera spinosa* (BRAMLETTE et MARTINI) GARTNER, *Tranolithus exiguus* STOVER, *Zygolithus bussoni* NOËL, *Zygolithus diplogrammus* DEFLANDRE. The species *Ahmuellerella octoradiata, Bipodorhabdus tesselatus, Cribrosphaera hilli, Heliolithus anceps, Lucianorhabdus cayeuxi, Prediscosphaera spinosa,* appear for the first time in the zone.

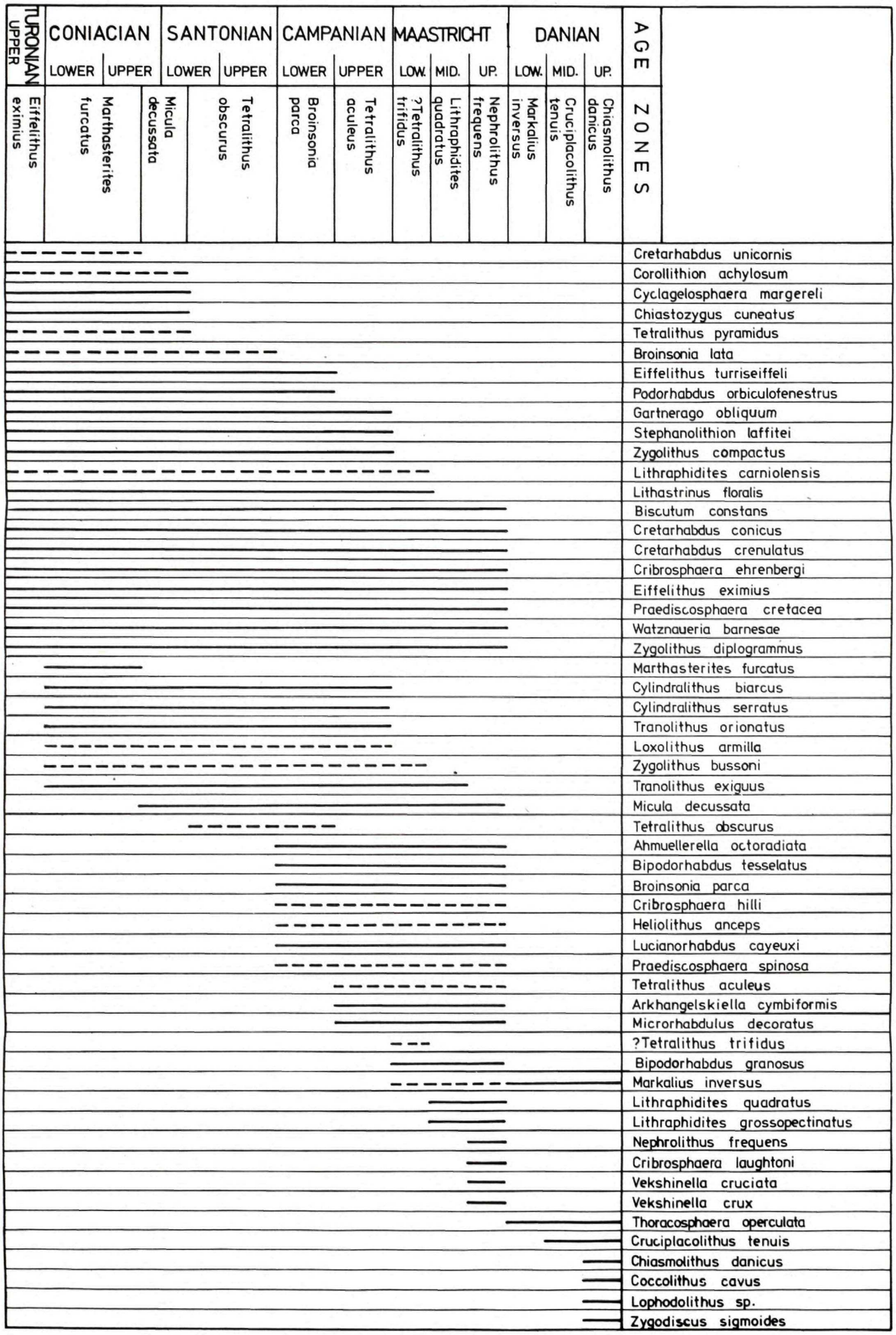
The zone represents the Lower Campanian in relation to the foraminiferal zone *Globotruncana arca arca.*

Zone *Tetralithus aculeus* (P. ČEPEK et W. W. HAY 1969) is characterized by the F. A. of *Tetralithus aculeus* (STRADNER) GARTNER. The assemblages have a similar composition like those in the Lower Campanian, *Arkhangelskiella cymbiformis* VEKSHINA, *Microrhabdulus decoratus* DEFLANDRE and *Zygolithus crucifer* NOËL, appear for the first time, some other species extinguish, like *Tranolithus orionatus* (REINHARDT) REINHARDT, *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT and *Tetralithus obscurus* DEFLANDRE.

The zone *Tetralithus aculeus* represents the Upper Campanian and corresponds to the foraminiferal zone *Globotruncana arca rugosa.*

Zone *Tetralithus trifidus* (D. BUKRY 1974) was only determined on the basis of scare problematic occurrences of *Tetralithus trifidus* (STRADNER) BUKRY. The assemblages differ in their composition from those in the underlying zone, but the index species of the overlying zone *Lithrapidites quadratus* only apper in higher parts. The assemblages contain mostly *Ahmuellerella octoradiata* (GORKA) REIN-

Fig. 3 Vertical distribution of calcareous nannoplankton in Middle Cretaceous of West Carpathians



HARDT, *Arkhangelskiella cymbiformis* VEKSHINA, *Bipodorhabdus granosus* (REINHARDT) NOËL a *Bipodorhabdus tesselatus* NOËL, *Broinsonia parca* (STRADNER) BUKRY, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Cylindralithus serratus* BRAMLETTE et MARTINI, *Lucianorhabdus cayeuxi* DEFLANDRE, *Markalius circumradiatus* (STOVER) PERCH-NIELSEN, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Micula decussata* VEKSHINA, *Prediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Prediscosphaera spinosa* (BRAMLETTE et MARTINI) GARTNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Tetralithus aculeus* (STRADNER) GARTNER, *Zygolithus bussoni* NOËL, *Zygolithus diplogrammus* DEFLANDRE. Significant species are mainly *Bipodorhabdus granosus, Bipodorhabdus tesselatus* and *Cylindralithus serratus.* The species *Gartnerago obliquum* was not found.

The zone *Tetralithus trifidus* represents the Lower Maastrichtian in the West Carpathians. It corresponds to the foraminiferal zone *Globotruncana falsostuarti.*

Zone *Lithraphidites quadratus* (P. ČEPEK et W. W. HAY 1969) is characterized by

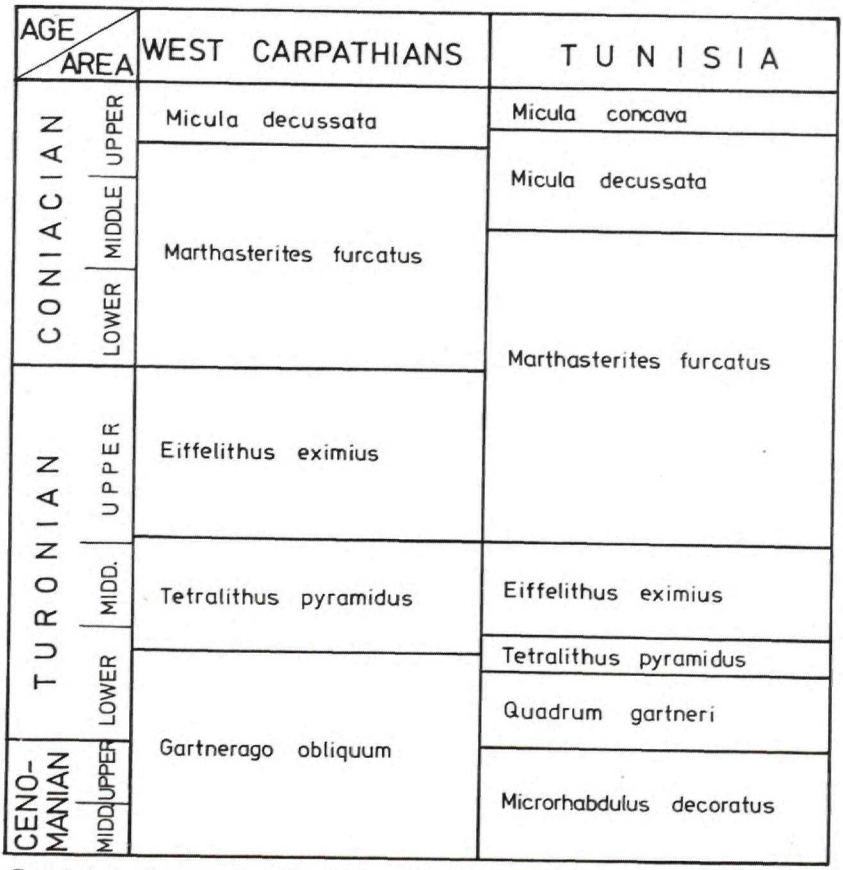


Fig. 4 Correlation of nannoplankton zones in West Carpathians and in Tunisia (Cenomanian — Coniacian)

the F. A. of *Lithraphidites quadratus* BRAMLETTE et MARTINI. The character of assemblages is similar to those in the underlying zone. A new species *Lithraphidites grossopectinatus* BUKRY appears, and *Tetralithus aculeus*(STRADNER) GARTNER disappears. The zone *Lithraphidites quadratus* represents the Middle Maastrichtian and corresponds to the lower part of the foraminiferal zone *Racemiguembelina varians varians* s. l.

Zone *Nephrolithus frequens* (P. ČEPEK et W. W. HAY 1969) is characterized by the F. A. of *Nephrolithus frequens* GORKA. The rich assemblages contain *Ahmuellerella octoradiata* (GORKA) REINHARDT, *Arkhangelskiella cymbiformis* VEKSHINA, *Cretarhabdus conicus* BRAMLETTE et MARTINI, *Cretarhabdus crenulatus* BRAMLETTE et MARTINI, *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, *Cribrosphaera laughtoni* (BLACK) BUKRY, *Eiffelithus eximius* (STOVER) PERCH-NIELSEN, *Lithraphidites quadratus* BRAMLETTE et MARTINI, *Lithraphidites grossopectinatus* BUKRY, *Micula decussata* VEKSHINA, *Nephrolithus frequens* GORKA, *Podorhabdus* sp., *Vekshinella cruciata* (NOËL) SHAFIK et STRADNER, *Vekshinella crux* (DEFLANDRE) SHAFIK et STRADNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Watznaueria biporta* BUKRY, *Zygodiscus spiralis* BRAMLETTE et MARTINI.

The species *Micula murus* and *Micula prinsii*, significant for the Uppermost Maastrichtian of the Mediterranean area were not found in the West Carpathians.

This zone represents there the uppermost Maastrichtian zone, and corresponds to the higher part of the foraminiferal zone *Racemiguembelina varians varians* s. l., i. e. to the subzone *Racemiguembelina varians varians* s. s. and *Abatomphalus mayaroensis*.

In the immediate overlier of the uppermost Maastrichtian zone *Nephrolithus frequens*, the first Paleogene zone NP_1 was found.

Zone *Markalius inversus* NP_1 (E. MARTINI 1971) is the first Paleocene zone defined as an interval between the L. A. of *Arkhangielskiella cymbiformis* and of other Cretaceous species, and the F. A. of *Cruciplacolithus tenuis*. In the West Carpathians the zone is characterized by mass occurrences of *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI and of *Thoracosphaera operculata* BRAMLETTE et MARTINI. It represents the lowermost zone of the Danian and corresponds to the foraminiferal zone *Globigerina taurica — Globoconusa daubjergensis*.

Zone *Cruciplacolithus tenuis* NP_2 (E. MARTINI 1971) is the interval between the F. A. of *Cruciplacolithus tenuis* and the F. A. of *Chiasmolithus danicus*. The assemblages mostly consist of *Cruciplacolithus tenuis* (STRADNER) HAY et MOHLER, *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, *Thoracosphaera operculata* BRAMLETTE et MARTINI and scarce resedimented Cretaceous forms.

The zone represents the Middle Danian and corresponds to the foraminiferal subzone *Globigerina pseudobulloides* and partly to the subzone *Planorotalia compressa*.

Zone *Chiasmolithus danicus* NP_3 (E. MARTINI 1971) is the interval between the F. A. of *Chiasmolithus danicus* and the F. A. of *Ellipsolithus macellus*. The assemblages contain *Coccolithus cavus* HAY et MOHLER, *Chiasmolithus danicus* (BROTZEN) HAY et MOHLER, *Lophodolithus* sp., *Zygodiscus sigmoides* BRAMLETTE et SULLIVAN and forms present in the underlying zones.

It is the uppermost Danian zone corresponding to the higher part of the subzone *Planorotalia compressa* and to the subzone *Turborotalia* (*Acarinina*) *inconstans*.

Notes on correlation. Nannoplankton zones of the West Carpathian Cretaceous were correlated — in the Cenomanian-Coniacian interval — to the zones of the Mediterranean area in Tunisia on the locality Dj. Fguira Salah — V. GAŠPARIKOVÁ (1976, 1978), J. SALAJ (1980), J. SALAJ — V. GAŠPARIKOVÁ (1982).

Detailed examinations of assemblages show that the Middle-Upper Cenomanian and the Lower Turonian are represented by the zone *Gartnerago obliquum* in the West Carpathians; in Tunisia the Cenomanian is characterized by the zone *Microrhabdulus decoratus*, and the Lower Turonian by the zone *Quadrum gartneri*. All zones determined in Tunisia in the range from the Middle Turonian to the Upper Coniacian were also found in the West Carpathians, only there they appeared later. For example the zone *Marthasterites furcatus* is a very conspicuous, sharply delimitated zone of the Coniacian in the West Carpathians and in other regions. In Tunisia it commenced already in the Upper Turonian and links with the foraminiferal zone *Marginotruncana schneegansi*.

Correlation studies in two distant areas of Tethys — the northern and the southern — in a short time interval result in interesting paleoecological and paleogeographical questions.

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Viera Gašpariková

Nanoplanktónové zóny kriedy Západných Karpát

Resumé anglického textu

Nanoplanktónové zóny kriedy Západných Karpát boli stanovené na základe štúdií vápnitého nanoplanktónu v krížňanskej a manínskej jednotke Strážovských vrchov, v bradlovom pásme — v čorstynskej i kysuckej jednotke, ako i v Myjavskej pahorkatine.

V spodnej kriede boli vytypované zatiaľ len spoločenstvá, ktoré charakterizujú valangin, hoteriv a barém, zóny boli vyčlenené od aptu po mástricht, resp. po dán. Celkove bolo vyčlenených 18 zón, každá zóna je charakterizovaná prvým výskytom uvedeného druhu.

Nanoplanktónové zóny v časovom intervale cenoman — koňak boli korelované so zónami vyčlenenými v mediteránnej oblasti. Zistilo sa, že v tomto stratigrafickom rozpätí v Západných Karpatoch i v mediterárnnej oblasti sú vyvinuté takmer tie isté zóny, v Západných Karpatoch nastupujú oneskorene.

Práca je doplnená v texte tabuľkami, ktoré vyjadrujú vertikálne rozšírenie vápnitého nanoplanktónu v spodnej, strednej a vrchnej kriede. Ďalej je pripojená korelačná tabuľka a niekoľko tabúl s významnými druhmi.

Explanations of plates

Plate XXXI

1 *Corrolithion achylosum* (STOVER) THIERSTEIN, distálna strana, 5000 ×, Lalinok, N° 353/76, vrchný cenoman.
2 *Podorhabdus orbiculofenestrus* (GARTNER) THIERSTEIN, proximálna strana, 9000 ×, Čavoj, N° 249/75, vrchný alb.
3 *Cretarhabdus* ex gr. *crenulatus* BRAMLETTE et MARTINI, distálna strana, 5000 ×, Hradisko, N° KPK—1/75, vrchný maastricht.
4 *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, 4500 ×, Horný Moštenec, N° 495/77, spodný kampan.
5 *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT, distálna strana, 8000 ×, Snežnica N° 397/76, vrchný turón.
6 *Parhabdolithus* ex gr. *asper* (STRADNER) MANIVIT, proximálna strana, 3500 ×, Vranie N° 523/77, vrchný turón.

Plate XXXII

1 *Eiffelithus eximius* (STRADNER) PERCH-NIELSEN, proximálna strana, 4500 ×, Horné Sŕnie, N° 441/74, koniak.
2 *Gartnerago obliquum* (STRADNER) REINHARDT, distálna strana, 5000 ×, Hatné, N° 43/74, santón.
3 *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, proximálna strana, 5000 ×, Horný Moštenec, N° 495/77, spodný kampan.
4 *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, proximálna strana, 5000 × Snežnica, N° 397/76, vrchný turón.
5 *Zygolithus compactus* BUKRY, proximálna strana, 5000 ×, Horné Sŕnie, N° 441/74, koniak.
6 *Chiastozygus cuneatus* (LYULEVA) ČEPEK et HAY, distálna strana, 5000 ×, Horné Sŕnie, N° 441/74, koniak.

Plate XXXIII

1 *Micula decussata* VEKSHINA, 4500 ×, Horný Moštenec, N° 494/77 spodný kampan.
2 *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, proximálna strana, 10 000 ×, Pont du Fahs, N° 680, vrchný kampan.
3 *Marthasterites furcatus* (DEFLANDRE) DEFLANDRE, 5000 ×, Terchová, N° 516/76, koniak.
4 *Tranolithus exiguus* STRADNER, distálna strana, 5000 ×, Hatné, č. 43, santón
5 *Marthasterites furcatus* (DEFLANDRE) DEFLANDRE 10 000 ×, Pont du Fahs, N° 667, vrchný turón.

Plate XXXIV

1 *Bipodorhabdus tesselatus* NOËL, distálna strana, 10 000 ×, Dolný Hričov, N° 36/73 spodný maastricht.
2 *Broinsonia parca* (STRADNER) BUKRY, proximálna strana, 400 ×, Horný Moštenec, N° 494/77, spodný kampan.
3 *Cribrosphaera ehrenbergi* ARKHANGELSKIJ, proximálna strana, 5000 ×, Koňhora, spodný kampan.
4 *Bipodorhabdus granulatus* (REINHARDT) NOËL distálna strana, Dolný Hričov, N° 36/73, spodný maastricht.

Plate XXXV

1 *Nephrolithus frequens* GORKA, distálna strana, 9000 ×, Hradisko, N° KPK-1/75 vrchný maastricht.
2 *Cribrosphaera laughtoni* (BLACK) BUKRY, proximálna strana, 5000 ×, Hradisko, N° KPK-1/75, vrchný maastricht.
3 *Ahmuellerella octoradiata* (GORKA) REINHARDT, distálna strana, 6000 ×, Hradisko, N° KPK-1/75, vrchný maastricht.
4 *Arkhangelskiella cymbiformis* VEKSHINA distálna strana, 3500 ×, Hradisko, N° KPK-1/75, vrchný maastricht.
5 *Arkhangelskiella cymbiformis* VEKSHINA proximálna strana, 4000 ×, Hradisko, N° KPK-1/75, vrchný maastricht
6 *Lithraphidites quadratus* BRAMLETTE et MARTINI 4500 ×, Hradisko, N° KPK-1/75, vrchný maastricht.

Plate XXXVI

1 *Chiasmolithus danicus* (BROTZEN) HAY et MOHLER, distálna strana, 6000 ×, Hradisko, N° KP-3/75, vrchný dán.

2 *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, distálna strana, 5000 ×, Hradisko, N° KPK-2/75, spodný dán.

3 *Cruciplacolithus tenuis* (STRADNER) HAY et MOHLER proximálna strana, 5000 ×, Hradisko, N° KPK-4/75, stredný dán.

5 *Thoracosphaera operculata* BRAMLETTE et MARTINI, 2500 x, Hradisko, N° KPK-2/75, spodný dán.

6 *Markalius inversus* (DEFLANDRE) BRAMLETTE et MARTINI, proximálna strana, 12 000 ×, Hradisko, N° KPK-2/75, spodný dán.

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Middle Eocene calcareous nannoplankton in West Carpathians (around Žilina)

8 Pls. (XXXVII—XLIV), Slovak summary)

Abstract. Presented are results of study of calcareous nannoplankton from a profile of Middle Eocene variegated flysch sediments from the area W of Žilina (loc. Hradisko). Samples from ten places contained rich thanatocenoses, with conspicuous traces after selective dissolution and secondary calcite overgrowths. The species composition and the manner of preservation indicate a warm pelagic biotope and sedimentation at a great depth, most likely in the eolithic zone. Assemblages of the subzone *Discoaster bifax* (sensu D. BUKRY 1973) were studied for stratigraphy.

Introduction

The profile of variegated flysch sediments W of Žilina belongs among localities chosen for the 18th European Colloquy on Micropaleontology. It is on the SW slope of the loc. Hradisko and now it is ranged to the Manín unit (J. SALAJ et al. 1978). Samples from the study of foraminifers and calcareous nannoplankton were taken from brown-red calcareous pelites, namely from 10 points distant 5 m from each other. All samples were positive and the examination of nannoplankton resulted in stratigraphical and ecological data as well as information on the sedimentation and diagenetic conditions.

Characteristic of nannoplankton thanatocenoses from individual points

The points are marked with C-C 9. Point C is in a dig-in, 12 m left of the profile, perpendicular to point C 3.

Point C — In a very rich nannoplankton the species *Discoaster barbadiensis* is most frequent. Less frequent are *Cyclococcolithus formosus, Coccolithus pelagicus* and *Discoaster saipanensis.* Other species are scarce. Species diversity of the assemblage is low.

Point C 1 — The sample contained the poorest thanatocenosis of the whole profile. More frequent are only *Coccolithus pelagicus* and *Cyclococcolithus formosus.*

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Species found on studied localities and their relative occurrence

Species	C	C1	C2	C3	C4	C5	C6	C7	C8	C9
Coccolithus eopelagicus (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN	1	1	1	1	1	1	1	1	1	1
Coccolithus pelagicus (WALLICH) SCHILLER	3	3	5	5	5	4	4	4	4	4
Cyclococcolithus formosus KAMPTNER	4	3	5	5	4	5	4	4	5	4
Chiasmolithus grandis (BRAM. et RIED.) HAY, MOH. et WADE	1	1	3	4	5	1	1	1	1	
Discoaster barbadiensis TAN SIN HOK	5	1	5	2	2	5	5	4	3	3
Discoaster cf. *deflandrei* BRAMLETTE et RIEDEL	1	1	1	1	1	1	1	1		
Discoaster nonaradiatus KLUMPP	1		1			1				
Discoaster saipanensis BRAMLETTE et RIEDEL	3	1	3	2	1		1	1	1	1
Discoaster cf. *sublodoensis* BRAMLETTE et SULLIVAN	1	1				1		1		
Discoaster wemmelensis ACHUTHAN et STRADNER	1	1	1	1			1		1	
Nannotetrina cf. *cristata* (MARTINI) PERCH-NIELSEN	1		1	1	1			1	1	1
Reticulofenestra umbilica (LEVIN) MARTINI et RITZKÓWSKI	1	1	1	1	1	1	1	1	1	1
Zygrhablithus bijugatus (DEFLANDRE) DEFLANDRE	1									
Discoaster tani BRAMLETTE et RIEDEL	1	1								
Discoaster lodoensis BRAMLETTE et RIEDEL	1		1	1	1	1	5	5	1	1
Cyclicargolithus floridanus (ROTH et HAY) BURKY	1	1	1		1			1	1	
Discoaster binodosus MARTINI			1	1	1					
Nannotetrina fulgens (STRADNER) ACHTUTHAN et STRADNER			1	2	2					
Chiasmolithus sp.			1	1				1	1	
Cycloplacolithella sp.			1	1	1	1		1	1	
Discoaster mirus Deflandre				1		1	1			
Chiasmolithus gigas (BRAMLETTE et SULLIVAN) HAY, MOHLER et WADE				1				1		
Discoaster bifax BUKRY		1	1	1			1		1	

Numerals 1—5 mean relative occurrence of individual species
1 — scarce occurrence, 5 — mass occurrence.

Point C 2 — In a very rich thanatocenosis are masss occurrences of *Discoaster barbadiensis, Coccolithus pelagicus* and *Cyclococcolithus formosus.* Frequent are also *Discoaster saipanensis* and *Chiasmolithus grandis.* Other species occur sporadically.

Point C 3 — The sample contained rich nannofloral species like in the preceding one, only there are quantity changes. *Discoaster barbadiensis* and *Discoaste saipanensis* are less frequent whereas *Chiasmolithus grandis* is dominant and *Nannotetrina fulgens* is also quite frequent.

Point C 4 — Except slight qualitative changes, the quantity is the same. *Coccolithus pelagicus, Cyclococcolithus formosus* and *Chiasmolithus grandis* dominate.

Point C 5 — Marked quantity change. In a rich, poorly preserved thanatocenosis dominant are again *Discoaster barbadiensis* and large asterolites of *Discoaster* cf. *lodoensis.* They are infrequent in other assemblages. *Coccolithus pelagicus* and *Cyclococcolithus formosus* are frequent, *Chiasmolithus grandis* is scarce.

Point C 6 — Nannoflora of this sample is the same as in sample C 5.

Point C 7 — Plentiful nannoflora differs from the preceding in complete disappearance of *Discoaster* cf. *lodoensis.* The amount of other species is approximately the same.

Point C 8 — *Cyclococcolithus formosus* is dominant. *Coccolithus pelagicus* is also frequent. *Discoaster barbadiensis* is less frequent. Other species are scarce.

Point C 9 — Nannoflora is somewhat poorer than in the preceding sample. Most frequent are *Coccolithus pelagicus* and *Cyclococcolithus formosus. Discoaster barbadiens* is less frequent. Species diversity is low.

Preservation

Coccolith assemblages from sediments slightly damaged by erosion, are comparatively well preserved. They comprise mostly representatives of the genera *Coccolithus, Cyclococcolithus, Discoaster* and locally *Chiasmolithus.* All the genera are highly resistant to dissolution in undersaturated waters. Destruction of nannoplankton assemblages is due to chemical activity of two types: a) selective dissolution during sedimentation and residence in sea sediments. At the dissolution less resistant forms dissolved partly or completely and damaged the more resistant. Traces of dissolution are damaged lamellae of rings, particularly on the proximal disc, or the absence of the inner ring and complete dissolution of grills of *Reticulofenestra,* and scarcely isolated placcolite discs; b) growth of secondary calcite on rays of discoasters. All discoasters in the studied thanatocenoses have on their rays a variably thick layer of secondary calcite which covers partly or fully their diagnostic characters. In asterolites with branched rays or with lateral knolls on rays the calcite prevents species determination (e. g. *Discoaster binodosus, Discoaster mirus, Discoaster deflandrei*). Asterolites with straight, simple rays have secondary calcite along their rays so that the rays get even 3 times thicker (S. W. Wise, Jr. 1973) which also can cause erroneous species determination (*Discoaster barbadiensis, Discoaster saipanensis, Discoaster sublodoensis, Discoaster bifax* a. o.).

Thanatocenoses from weathered beds are erosion-damaged by waters infiltrating from the surface. Secondary calcite surfaces on asterolites are covered with etched pits. Lamellae of both discs of placcolites are etched mostly along edges. Since the assemblages come from flysch sediments, destruction traces may also be caused by turbidity current transport of sediments.

Ecology

All the studied thanatocenoses are rests of pelagic assemblages. It is proved by the species composition of nannoflora, by the absence of pericoastal genera (*Helicosphaera, Discolithina, Braarudosphaera,* a. o.). Quantitative relations of the genus *Discoaster* to the genus *Chiasmolithus* are indicative of high temperature of the sea water by biocenoses of points C and C 2. The sea water was gradually cooling towards points C 3 and C 4. Assemblages from other points are indicative of warm oceanic water. Low temperature of samples from points C 3 and C 4 need not indicate climatic cooling it may result from local penetration of cool water in these places in some periods (currents).

The low diversity of nannoplankton assemblage, atypical of warm-water facies, is indicative of a deep sedimentation area with selective dissolution during sedimentation and with increasing dominance of highly resistant forms (*Coccolithus, Cyclococcolithus, Discoaster*). According to researches in Atlantic the sediments of the Eolithic zone representing the upper part of the compensation zone contain only about 40 % of living population (N. SCHNEIDERMANN 1977).

Stratigraphical range

All thanatocenoses contain autochthonous and redeposited species. Most frequent are species extending from the Lower Eocene to the Upper Eocene or Oligocene. Stratigraphical range of the studied sequences may be based on species with a narrow stratigraphical range, i. e. the youngest component of thanatocenoses, like *Reticulofenestra umbilica, Nannotetrina fulgens, Discoaster wemmelensis, Discoaster bifax* and *Discoaster saipanensis.*

Reticulofenestra umbilica — Basing on the F. A. of this species D. BUKRY and M. N. BRAMLETTE (1970) distinguished the biozone *Reticulofenestra umbilica* — CP 14 representing the upper part of the Middle Eocene. E. MARTINI (1971) found the F. A. of this species in the lower part of the biozone NP 15 — *Chiphragmalithus alatus* (= *Nannotetrina fulgens*). So the assemblages cannot be older than the biozone NP 15.

Nannotetrina fulgens — The F. A. of this species characterizes the lower boundary of the biozone NP 15. It disappears in the lower part of the overlying biozone NP 16 — *Discoaster tani* nodifer.

Discoaster wemmelensis — The species is characteristic of biozones NP 14 — *Discoaster sublodensis* and NP 15.

Discoaster bifax — It is the stratigraphically most valuable species for us. It is associated with the subzone *Discoaster bifax* — CP 14a which is the lower part of the biozone *Reticulofenestra umbilica* — CP 14 (BUKRY 1973).

Discoaster saipanensis — According to E. MARTINI (1971) the species appeared for the first time in the upper part of the biozone NP 16. According to data in literature (J. P. BECKMANN et al. 1981) it already had appeared in the biozone NP 14. No such early occurrences are known from the West Carpathians and asterolites from the biozone NP 14 may actually be representatives of *Discoaster sublodoensis* with broken end of rays. If we admit the presence of this species in the entire biozone NP 16, then the studied thanatocenoses are to be ranged to the lower part of the biozone NP 16 — *Discoaster tani* nodifer according to the zonation by E. MARTINI (1971) or to the subzone *Discoaster bifax* CP 14a according to the zonation by D. BUKRY (1973).

E. MARTINI 1971	NP 14	NP 15	NP 16	NP 17
D. BUKRY 1973		*Reticul. umbilica* PC 14		
		D. bifax	*D. saipanensis*	
Reticulofenestra umbilica		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
Nannotetrina fulgens		xxxxxxxxxxxxxxxxxx		
Discoaster wemmelensis	xxxxxxxxxxxxxxxx			
Discoaster bifax		xxxxxxxxxxxx		
Discoaster saipanensis		-----	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	

REMARKS TO THE SPECIES

Coccolithus eopelagicus (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN

Pl. XXXVII, Fig. 3, 4, 5

1954 *Tremalithus eopelagicus* BRAMLETTE and RIEDEL, n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigrahpic value of *Discoaster* etc., p. 392, pl. 39, fig. 2a, b.

1961 *Coccolithus eopelagicus* (BRAMLETTE and RIEDEL) — M. N. BRAMLETTE, F. R. SULLIVAN: Coccolithophorids and related nannoplankton etc., p. 141.

There are scarce occurrences of the species in all thanatocenoses. It is highly resistant. Both discs show effects of selective dissolution. Specimens from weathered sediments show markedly etched outer edges of lamellae, forming the discs and the central area (Fig. 3).

Coccolithus pelagicus (WALLICH) SCHILLER

Pl. XXXVII, Fig. 1, 2, 6, 7

1877 *Coccosphaera pelagica* WALLICH — G. C. WALLICH: Observations on the coccosphaera etc., p. 348, pl. 17, fig. 1

1930 *Coccolithus pelagicus* (WALLICH) SCHILLER — J. SCHILLER in L. RABENHORSTS Kryptogamenflora etc., p. 91, fig. 246.

The species belongs to the richest group in the whole profile owing to its high resistance. Partially damaged placcoliths may be results of etching and of mechanical activity which is very likely as regards flysch sediments.

Cyclococcolithus formosus KAMPTNER

Pl. XXXVIII, Fig. 2, 3, 4; Pl. XLIV, Fig. 8

1963 *Cyclococcolithus formosus* nov. spec. — E. KAMPTNER: Coccolithineen Skeletreste etc., p. 163, pl. 2, fig. 8, text — fig. 20

1966 *Cyclococcolithus lusitanicus* (BLACK) — W. W. HAY, H. P. MOHLER, M. E. WADE: Calcareous nannofossils etc., p. 390, pl. 7, fig. 3—6.

1971 *Cyclococcolithina formosa* (KAMPTNER WILCOXON — J. A. WILCOXON: *Cyclococcolithina* WILCOXON, nom. nov. etc., p. 390, pl. 7, fig. 3, 6.

It is the most frequent species in the studied thanatocenoses. In spite of its high restivity its placcoliths are variably preserved (well preserved to isolated discs). Strongly damaged specimens might have been redeposited from older sediments. Specimens from weathered layers have typically etched lamellae like the species *Coccolithus eopelagicus* (Pl. XXXVII, Fig. 2).

Chiasmolithus grandis (BRAMLETTE et RIEDEL) HAY, MOHLER et WADE

Pl. XXXIX, Fig. 1, 2

1954 *Coccolithus grandis* BRAMLETTE et RIEDEL, n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc., p. 391, pl. 38, fig. 19.

1966 *Chiasmolithus grandis* — W. W. HAY, H. P. MOHLER, M. E. WADE: Calcareous nannofossils etc., p. 388.

Large, easily identifiable placcoliths are well preserved, with almost intact cross bridges and usually dissolved grills. The species is frequent in 3 assemblages (points C 2, C 3, C 4). The negative relation of this species to discoasters is evident on all specimens.

Chiasmolithus gigas (BRAMLETTE et SULLIVAN) HAY, MOHLER et WADE

1961 *Coccolithus gigas* BRAMLETTE et SULLIVAN, new spec. — M. N. BRAMLETTE, F. R. SULLIVAN: Coccolithophorids and related nannoplankton etc., p. 140, pl. 1, fig. 7 a—d.

1966 *Chiasmolithus gigas* — W. W. HAY, H. P. MOHLER, M. E. WADE: Calcareous nannofossils etc. p. 388.

The species was only found in 2 assemblages (points C 3, C 7) in slide preparates. Very scarce specimens showed partly or completely destroyed cross bridges. The

species is associated to the biozone NP 15 and it is evidently redeposited in the studied sediments.

Reticulofenestra umbilica (LEVIN) MARTINI et RITZKOWSKI

Pl. XXXIX, Fig. 3, 4, 5

1965 *Coccolithus umbilicus* LEVIN n. sp. — H. L. LEVIN: Coccolithophoridae and related etc. P. 264, pl. 4, fig. 2

1968 *Reticulofenestra umbilica* (LEVIN) nov. comb. — E. MARTINI, S. RITZKOWSKI: Was ist das etc., p. 20, pl. 1, fig. 11,

The species is scarce in all thanatocenoses. Placcoliths are variably damaged (destroyed central grill in all specimens, variably corroded disc margins, destruction of both discs).

Cyclicargolithus floridanus (ROTH et HAY) BUKRY

Pl. XXXVIII, Fig. 6

1967 *Coccolithus floridanus* ROTH et HAY, n. sp. — W. W. HAY, et al.: Calcareous nannoplankton zonation etc., p. 445, pl. 6, fig. 1—4.

1967 *Cyclococcolithus neogammation* BRAMLETTE et WILCOXON, n. sp. — M. N. BRAMLETTE, I. A. WILCOXON: Middle Tertiary nannoplankton etc., p. 104, pl. 1, fig. 1—3, pl. 4, fig. 3, 5.

1970 *Cyclococcolithus floridanus* (ROTH et HAY) n. comb. — P. A. ROTH: Oligocene calcareous nannoplankton etc., p. 854, pl. 5, fig. 6.

The species is scarce in most thanatocenoses. Placcoliths are quite well preserved. Proximal discs are more damaged than distal. They are always connected.

Cyclothella sp.

Pl. XXXVIII, Fig. 5

Circular placcoliths with a large central aperture, a narrow distal disc reminding of the species *Coronocyclus prionion* (DEFLANDRE et FERT) STRADNER occurred scarcely in almost all assemblages.

Discoaster barbadiensis TAN SIN HOK

Pl. XLIII, Fig. 1, 2, 3, 5

1927 *Discoaster Barbadiensis* nov. spec. typ — TAN SIN HOK: Over de samenstelling etc., p. 119, pl. 2, fig. 3, 4.

1954 *Discoaster barbadiensis* TAN, sens. emend. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc. p. 389, pl. 39, fig. 5a, b.

The species occurs in all thanatocenoses and belongs among the most frequent forms of the whole profile. Besides typical specimens there are also transitional

forms to the species *Discoaster saipanensis* BRAMLETTE et RIEDEL with less rays (9) whose ends form a lesser angle than those of typical specimens (Pl. XLIII, Fig. 4). All asteroliths have secondary calcite on rays. On some specimens the calcite surfaces are etched in small pits, most likely by surface waters penetrating into exposed Paleogene sediments (Pl. XLIII, fig. 1,5).

Discoaster bifax BUKRY

Pl. XL, Fig. 7, 8

1971 *Discoaster bifax* n. sp. — D. BUKRY: Cenozoic calcareous nannofossils etc., p. 313, pl. 3, fig. 6—11.

Small asteroliths of this species occur scarcely but they are well preserved. Secondary calcite forms euhedral crystal surfaces on rays. Diagnostic characters are not covered, only the asterolith gets thicker.

Discoaster binodosus MARTINI

Pl. XLI, Fig. 5; Pl. XLII, Fig. 6

1958 *Discoaster binodosus binodosus* n. ssp. — E. MARTINI: Discoasteriden und verwandte Formen etc., p. 361, pl. 4 fig. 18 a, b.

Scarce asteroliths are strongly recrystallized and mechanically damaged. Secondary calcite covers diagnostic characters almost completely. According to the way of preservation they are allochthonous in thanatocenoses.

Discoaster deflandrei BRAMLETTE et RIEDEL

Pl. XLI, Fig. 3, 4

1954 *Discoaster deflandrei* BRAMLETTE et RIEDEL n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc., p. 399, pl. 39, fig. 6, text — fig. 1.

With the exception of points C 8 and C 9 the species is present scarcely in all thanatocenoses. Asteroliths are covered with a thick layer of secondary calcite which in extreme cases covers the bifurcated ends of rays. So the rays become elongated heart-shaped (Pl. XLI, Fig. 3). *Discoaster trinus* described by Stradner and depicted 6-rayed asteroliths of *Discoaster colleti* (PAREJAS) BERSIER are recrystallized specimens of *Discoaster deflandrei* (1961; p. 79, Pl. 13, fig. 1, 2; Pl. 14, fig. 1, 2).

Discoaster mirus DEFLANDRE

Pl. XLI, Fig. 1, 2

1952 *Discoaster mirus* n. sp. — G. DEFLANDRE in P. P. GRASSE, p. 465, fig. 326.

Scarce specimens of this species are covered with a thick layer of secondary calcite. Species determination is only possible according to the number of rays (more than 6) and their narrow heart-like shape.

Discoaster nonaradiatus KLUMPP

Pl. XLI, Fig. 6

1953 *Discoaster nonaradiatus* n. sp. — B. KLUMPP: Beitrag zur Kenntniss etc., p. 383, fig. 3/5.
1953 *Discoaster heptaradiatus* n. sp. var. — B. KLUMP: Ibidem. p. 383, Pl. 16, fig. 5
1953 *Agalmatoaster septemradiatus* n. sp. B. KLUMMP: Ibidem, p. 384, Pl. 16, fig. 7, 8, text-fig. 4, 1.

Scarce, usually 8-rayed asteroliths resemble the form denoted by B. KKLUMPP as *Agalmatoaster septemradiatus* (1953, text — fig. 4, 1). The specimens are quite large. Secondary calcite caused the heart-like shape of rays like in discoasters with bifurcated ray ends. Their original shape is approximately preserved.

Discoaster saipanensis BRAMLETTE et RIEDEL

Pl. XLIII, Fig. 4; Pl. XLIV, Fig. 5

1954 *Discoaster saipanensis* BRAMLETTE et RIEDEL n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc., p. 398, Pl. 39, fig. 4.

The 5—8-rayed asteroliths with simple rays cannot be exactly determined because of poor preservation. All specimens show the same types of chemical and diagenetic changes as *Discoaster barbadiensis*, namely growth of secondary euhedral crystal surfaces on rays, and some also etched pits on the surfaces. These phenomena cover diagnostic characters and it is impossible to say with sure that they represent *Discoaster saipanensis* or *Discoaster sublodoensis* with damaged ray ends or large specimens of *Discoaster lodoensis*.

Discoaster cf. *tani* BRAMLETTE et RIEDEL

Pl. XLII, Fig. 6

1954 *Discoaster tani* BRAMLETTE et RIEDEL n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc., p. 397, Pl. 39, fig. 1.

5—6-rayed asteroliths with longer, narrower, non-widened rays are ranged to this species. Since all such forms have rays covered with secondary calcite hiding diagnostic characters, they may also comprise asteroliths of narrow-rayed species with broken bifurcated ends of rays.

Discoaster wemmelensis ACHUTHAN et STRADNER

Pl. XL, Fig. 1—6, Pl. XLIV, Fig. 8b

1969 *Discoaster wemmelensis* nov. spec. — M. W. ACHUTHAN, H. STRADNER: Calcareous nannoplankton etc., p. 5, Pl. 4, fig. 3, 4, text-fig. 2.

Scarce on most localities. Asteroliths are mostly well preserved. Secondary calcite did not changed their outlook but caused unusually large size of some specimens. (See Fig. 6 in Plate XL and Fig. 8 in Plate XLIV).

Discoaster cf. *lodoensis* BRAMLETTE et RIEDEL

Pl. XLIV, Fig. 1, 2, 3, 4, 6, 7

1954 *Discoaster lodoensis* BRAMLETTE et RIEDEL, n. sp. — M. N. BRAMLETTE, W. R. RIEDEL: Stratigraphic value etc.

Almost all studied sequences contain massive, 5—8-rayed asteroliths covered with a thick layer of secondary calcite. Exact species determination is not possible, although according to size and number of rays the asterolith might be ranged to the species Discoaster lodoensis. According to some authors the secondary calcite may enlarge the size of asteroliths even three times (D. BUKRY 1971, S. W. WISE 1973). But the large, strongly damaged specimens from points C 5 and C 6 evidently belong to *Discoaster lodoensis.* Their preservation and the species composition of thanatocenoses are indicative of their redeposition from older sediments.

Conclusion

Calcareous nannoplankton from the studied profile represents an assemblage of warm pelagic sea water. According to the degree of preservation, species diversity and character of sediments the assemblage deposited in an Eolithic zone. During sedimentation and early diagenesis, less resistant species dissolved partly or completely and resistant forms, mainly discoasters got covered with secondary calcite.

The nannoflora is stratigraphically ranged to the subzone *Discoaster bifax* representing the lower part of the biozone *Reticulofenestra umbilica* CP 14 according to D. BUKRY (1973) or the interval between the upper part of the biozone NP 15 *Nannotetrina alata* and the lower part of the biozone NP 16 *Discoaster tani* nodifer according to E. MARTINI (1971).

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Vápnitý nanoplanktón stredného eocénu Západných Karpát

Resumé anglického textu

V práci sú uvedené výsledky štúdia vápnitého nanoplanktónu z profilu strednoeocénnymi pestrými flyšovými sedimentmi z oblasti na z. od Žiliny (lok. Hradisko). Vzorky odobraté z 10 polôh poskytli bohaté tanatocenózy s výraznými stopami po selektívnom rozpúšťaní a sekundárnom kalcitovom narastaní. Z druhového zloženia a spôsobu zachovania nanoflóry možno usudzovať na teplý pelagický biotop a sedimentáciu vo veľkej hĺbke. Stratigraficky boli študované spoločenstvá zaradené do podzóny *Discoaster bifax* v zmysle G. BUKRYHO (1973).

Explanations to Plates XXXVII—XLIV

Plate XXXVII
1, 2, 6, 7 *Coccolithus pelagicus* (WALLICH) SCHILLER. Magn. 5500×, 5000×, 5000×, 5000×.
3, 4, 5 *Coccolithus eopelagicus* (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN. Fig. 3 placolith corroded by permeating waters. Magn. 6000×, 4000×, 4500×.

Plate XXXVIII
1 Isolated disc of *Cyclococcolithus formosus* KAMPTNER. Magn. 5000×.
2, 3, 4 *Cyclococcolithus formosus* KAMPTNER. Variably damaged placoliths. Magn. 9000×, 4000×, 5000×.
5 *Cyclolithella* sp. Magn. 4500×.
6 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY. Magn. 4500×.

Plate XXXIX
1, 2 *Chiasmolithus grandis* (BRAMLETTE et RIEDEL) HAY, MOHLER et WADE. Magn. 7000×, 3750×.
3, 4, 5 *Reticulofenestra umbilica* (LEVIN) MARTINI et RITZKOWSKI. All specimens have completely destroyed central grill. Magn. 5000×, 4500× 5000×.

Plate XL
1—6 *Discoaster wemmelensis* ACHUTHAN et STRADNER. Magn. 5000×, 5000×, 5000×, 5000×, 4500×.
7, 8 *Discoaster bifax* BUKRY. Magn. 5000×, 5000×.

Plate XLI
1, 2 *Discoaster mirus* DEFLANDRE, Intensely overgrowth asteroliths. Layer of secondary calcite changed shape of rays to cordate. Magn. 4000×, 3500×.

3, 4 *Discoaster deflandrei* BRAMLETTE et RIEDEL. Variably recrystallized asteroliths. The more intensely overgrowth specimen on Fig. 3 has already cordate rays. Magn. 3000×, 4000×.

5 *Discoaster binodosus* MARTINI. Secondary calcite covers almost completely the lateral knots. Magn. 4500×.

6 *Discoaster nonaradiatus* KLUMPP. Magn. 4500×.

7, 8 *Discoaster saipanensis* BRAMLETTE et RIEDEL. Magn. 4000×, 3500×.

Plate XLII

1—8 Intensely recrystallized discoasters. Secondary calcite layer covered diagnostic characters. Fig. 4 Probably *Discoaster binodosus* MARTINI, Fig. 6 probably *Discoaster tani* BRAMLETTE et RIEDEL. Magn. 4000×, 4000×, 5000×, 4000×, 4000×, 4000×, 5000×, 3000×.

Plate XLIII

1, 2, 3, 5 *Discoaster barbadiensis* TAN SIN HOK. On specimens 1 and 5 secondary calcite is etched by surface waters. Magn. 8000×, 4500×, 4500×, 4000×.

4 *Discoaster saipanensis* BRAMLETTE et RIEDEL. Hollows on asterolith are traces after post-overgrowth dissolution. Magn. 9000×.

Plate XLIV

1—4, 6, 7 *Discoaster* cf. *lodoensis* BRAMLETTE et RIEDEL. All asteroliths are intensely damaged. Magn. 4500×, 5000×, 4500×, 4000×, 4000×, 4000×.

5 *Discoaster saipanensis* BRAMLETTE et RIEDEL. Magn. 5000×.

8 *Cyclococcolithus formosus* KAMPTNER a *Discoaster wemmelensis* ACHUTHAN et STRADNER. Magn. 4000×.

All photographs were made on scanning electron microscope JSM U3 in D. Štúr Institute of Geology in Bratislava. Operators: K. Šebor and M. Švec.

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Lower Miocene calcareous nannoflora of the West Carpathians

10 Pls. (XLV—LIV), Slovak summary

Abstract. Presented are results of the study of calcareous nannoflora (by scanning-electron microscopy) from Lower Miocene sediments of the West Carpathians. Calcareous nannoplankton of the studied localities is well correlable with nannoflora of biozones NN 2 — *Discoaster druggi* and NN 4 — *Helicosphaera ampliaperta* (according to zonation by E. MARTINI 1971). The sediments under study are ranged to the regional stages Eggenburgian and Karpathian.

We studied Lower Miocene marine sediments from surficial and drilling materials from the areas of Central Považie and the Trenčianska kotlina depression (loc. Trenčín, Soblahov), the Bánovská kotlina depression (loc. Dežerice, Krásna Ves, Kostolné Mítice, Rožňová Neporadza, Horné Motešice, Horňany, Podlužany), the Handlovská kotlina d. (loc. Veľká Čausa), the Ipeľská kotlina d. (loc. Pôtor), the Cerová vrchovina highland (loc. Hostice) and from the East-Slovakian lowland (loc. Hlinné) for the purpose of the study of calcareous nannoplankton.

Geological research in the Trenčianska kotlina d. was performed by more authors. Recently T. BUDAY (1956), M. MAHEĽ et col. (1962) published results of the study of Lower Miocene sediments in the area. E. BRESTENSKÁ (in J. KYSELA 1978), basing on foraminifers and ostracods, ranged the sediments from a wider vicinity of localities Trenčín and Soblahov to the Eggenburgian. They were studied for calcareous nannoflora. (Samples were taken from pelitic intercalations of basal conglomerates of boreholes ST-9 6 m, VT 16 10,5 m, VT-17 12,8 m and from surficial material denoted as Trenčín-1, Trenčín-south, and Soblahov-1). Nannoassemblages from all samples were poor, poorly preserved, and contained mainly:

Coccolithus eopelagicus (BRAMLETTE et RIEDEL), BRAMLETTE et SULLIVAN
Coccolithus pelagicus (WALLICH) SCHILLER
Cyclicargolithus floridanus (ROTH et HAY) BUKRY
and scarce specimens of *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON.

The area of the Bánovská kotlina depression was investigated by many authors: J. GAŠPARIK 1953, M. MAHEĽ 1953. M. MAHEĽ et al. 1962, J. SENEŠ — E. BRESTENSKÁ

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1965. Paleontological investigations of some localities were performed by M. VAŇOVÁ 1955, 1957. Molluscan fauna was studied by A. ONDREJIČKOVÁ 1971, 1976. The comprehensive geological and biostratigraphical interpretation of the area was presented by E. BRESTENSKÁ 1976. She distinguished there the Eggenburgian and the Karpathian on the basis of foraminifers and ostracods.

The Eggenburgian commences with carbonate conglomerates passing through sandstones into overlying schliers.

Eggenburgian sediments from the facies of carbonatic conglomerates did not contain calcareous nannoflora. Examined were samples from a surficial exposure Kostolné Mítice, borehole DB-15, loc. Horňany, depth 979,4 m.

The Eggenburgian in the facies of schlier sediments contains poor recrystallized nannoflora, somewhat richer than in the Trenčianska kotlina depression. The nannoassemblages contain:

Coccolithus eopelagicus (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN
Coronocyclus nitescens (KAMPTNER) BRAMLETTE et WILCOXON
Helicosphaera ampliaperta (BRAMLETTE et WILCOXON) BUKRY
Helicosphaera carteri (WALLICH) KAMPTNER
Pontosphaera multipora (KAMPTNER) ROTH
Reticulofenestra bisecta (HAY, MOHLER et WADE) ROTH
Reticulofenestra excavata LEHOTAYOVÁ
Reticulofenestra pseudoumbilica (GARTNER) GARTNER
Spenolithus moriformis (BRONNIMANN et STRADNER) BRAMLETTE et WILCOXON

Nannoassemblages composed of these taxa, were in samples from surficial exposures of the localities Krásna Ves, Horné Motešice, Rožňová Neporadza.

Calcareous nannoplankton of Eggenburgian sediments of the loc. Podlužany (borehole DB-9, depth 57,58 m), and loc. Horňany (borehole DB-15, depth 815,10—819,20 m) also contains:

Cyclococcolithus formosus KAMPTNER
Discoaster adamanteus BRAMLETTE et WILCOXON
Discoaster aulakos GARTNER
Sphenolithus cf. *belemnos* BRAMLETTE et WILCOXON

As for calcareous nannoflora, the regional stage Eggenburgian is well characterized by the species:

Helicosphaera ampliaperta (BRAMLETTE et WILCOXON) BUKRY
Reticulofenestra excavata LEHOTAYOVÁ
Sphenolithus cf. *belemnos* BRAMLETTE et WILCOXON

Calcareous nannoflora of the regional stage Karpathian from the area of the Bánovská kotlina depression was still poorer than Eggenburgian nannoflora. Most samples contained only scarce *Coccolithus pelagicus* (WALLICH) SCHILLER, *Helicosphaera carteri* (WALLICH) KAMPTNER.

Richter assemblages were only in samples from a surficial exposure of the loc. Dežerice and in sediments from the same locality from the borehole DB-10 (161—162 m). I determined the following species:

Coccolithus eopelagicus (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN
Coccolithus pelagicus (WALLICH) SCHILLER
Coronosphaera mediteranea (LOHMANN) GAARDER
Cyclococcolithus rotula KAMPTNER
Cyclicargolithus floridanus (ROTH et HAY) BUKRY
Helicosphaera carteri (WALLICH), KAMPTNER
Pontosphaera multipora (KAMPTNER), ROTH
Reticulofenestra bisecta HAY—MOHLER—WADE
Reticulofenestra pseudoumbilica (GARTNER) GARTNER
Diatomaceae

The samples from the surficial exposure of the loc. Rožňové Mítice contained assemblages with the following species:

Braarudosphaera bigelovi (GRAN-BRAARUD) DEFLANDRE
Reticulofenestra excavata LEHOTAYOVÁ
Reticulofenestra minuta ROTH
Helicosphaera ampliaperta (BRAMLETTE et WILCOXON) BUKRY
Helicosphaera intermedia MARTINI
Holodiscolithus macroporus (DEFLANDRE) ROTH and
Sphenolithus moriformus(BRÖNNIMANN et STRADNER) BRAMLETTE et WILCOXON

Karpathian calcareous nannoflora comprising the above taxa, was also in pelites from the boreholes DB-7 (loc. Podlužany, depth 148,50—104,8 m) and DB-15 (loc. Horňany, depth 112,5—26,7 m).

The Lower Miocene of the Handlovská kotlina depression was studied most thoroughly by V. ČECHOVIČ et col. (J. GAŠPARIK, J. SENEŠ, M. VÁŇOVÁ, F. BIEDA, T. ŚMIGIELSKA, R. LEHOTAYOVÁ, M. MARKOVÁ a. o.) in 1959. The marly and sandy clays and sands contain brackish and marine microassemblages, characterizing the Lower Miocene — Eggenburgian in a belt between the village Veľká Čausa on the south and the village Brezany on the west.

V. GAŠPARIKOVÁ (1970) recorded the Lower Miocene (Eggenburgian) also in the Hornonitrianska kotlina (depression) in the line Nová Lehota — Podhradie — Nováky. The beds were not studied for calcareous nannoflora.

Brackish Eggenburgian beds in the area of Veľká Čausa, drilled by boreholes ČČ-2 (depth 49,0—5,4 m), ČČ-3 (depth 287,0—257,0 m) and ČČ-4 (depth 28—6 m) did not contain calcareous nannoplankton.

Micaceous grey-green clays with marine foraminifers contained rich calcareous assemblages (loc. Veľká Čausa, borehole ČČ-3, depth 237,0—237,60; 226,20—226,30 m; 205,00—205,20 m).

In well preserved nannoassemblages the following taxa dominated:
Coccolithus eopelagicus (BRAMLETTE-RIEDEL) BRAMLETTE et SULLIVAN
Coccolithus pelagicus (WALLICH) SCHILLER
Cyclicargolithus floridanus (ROTH et HAY) BUKRY
Cyclococcolithus leptoporus (MURRAY et BLACKMAN) KAMPTNER
Discoaster deflandrei BRAMLETTE et RIEDEL

Helicosphaera ampliaperta BRAMLETTE et WILCOXON
Helicosphaera carteri (WALLICH) KAMPTNER
Microrhabdulus decoratus DEFLANDRE
Pontosphaera multipora (KAMPTNER) ROTH
Reticulofenestra bisecta (HAY, MOHLER WADE) ROTH
Reticulofenestra excavata LEHOTAYOVA
Reticulofenestra minuta ROTH
Reticulofenestra umbilica (LEVIN) MARTINI et RITZKOWSKI
Reticulofenestra sp.

Geologic structure of the Ipeľská kotlina depression was studied by many authors (T. BUDAY 1938, V. ČECHOVIČ 1948b, 1952b, J. SENEŠ 1956 a. o.). The most thorough investigations were performed by D. VASS and a collective of authors-specialists in 1979. According to their results the Eggenburgian sediments of the Ipeľská kotlina depression only preserved in the form of denudation relicts in the southern part of the depression in the vicinity of Slovenské Ďarmoty, south of Želovce up to Kováčovce and near Bušince.

The analyzed samples from these surficial exposures were not suitable for the study of calcareous nannoflora and did not enable biostratigraphical correlations to nannoassemblages of the regional stage Eggenburgian. It is the same with sediments of the Ottnangian in the area under study.

Karpathian beds are in the W and S parts of the Ipeľská kotlina depression. D. VASS (1979) divided the Karpathian sediments to brackish (hyposaline) and marine. The two facies are above each other in the most part of the Ipeľská kotlina depression. Brackish beds represented by the so-called rzehakia beds (oncophora beds, V. ČECHOVIČ 1948) are down, they are overlain by the marine Krtíš sandy beds and higher up are marly sea clays and aleurites (schlier). For the study of calcareous nannoflora most suitable were schlier- and schlier-sandy beds cropping out NNE of Bušince, E of the localities Pôtor, Dolné Strháre and SE of Modrý Kameň.

The best preserved and richest Karpathian calcareous nannoflora was in samples from the vicinity of Pôtor (borehole M-2, depth 22—21 m). The nannoassemblage is represented by the species:

Coccolithus eopelagicus (BRAMLETTE-RIEDEL) BRAMLETTE et SULLIVAN
Coccolithus pelagicus (WALLICH) SCHILLER
Cyclicargolithus floridanus (ROTH et HAY) BUKRY
Cyclococcolithus rotula (KAMPTNER) KAMPTNER
Discoaster sp.
Helicosphaera ampliaperta BRAMLETTE et WILCOXON
Helicosphaera carteri (WALLICH) KAMPTNER
Pontosphaera multipora (KAMPTNER) ROTH
Reticulofenestra excavata LEHOTAYOVÁ
Reticulofenestra pseudoumbilica (GARTNER) GARTNER
Syracosphaera sp.
Thoracosphaera heimi (LOHMANN) KAMPTNER
Umbilicosphaera jafari MÜLLER

In the Rimavská kotlina depression M. VÁŇOVÁ (1959) recorded Lower Miocene (Aquitanian) sediments in basal detrital conglomerates containing molluscs in a wider vicinity of Šafárikovo, and later A. PAPP (1960) and M. VÁŇOVÁ (1975), basing upon miogypsines from Bretka. No other Lower Miocene (Eggenburgian — Karpathian) sediments were found in this area.

The Eggenburgian sediments were, revealed in the adjacent Cerová vrchovina highland. Detailed geological investigations were performed there by D. VASS — M. ELEČKO (1982). They distinguished there a preliminary lithostratigraphic unit of the Fiľakovo formation (grey disintegrating calcareous schlier-like sandstones).

The formation is in the whole Cerová vrchovina highland and it contains sporadical marine fauna. Its Eggenburgian age was proved by foraminifers (V. KANTOROVÁ 1980) and calcareous nannoflora (R. LEHOTAYOVÁ 1980).

D. VASS — M. ELEČKO distinguished other informal lithostratigraphic units in the eastern part of the Cerová vrchovina highland, namely: the Jálov beds (bedded sandstones), the Abiriňa beds (coarse-grained sandstones with glauconite).

The monotonous sandy sediments in the Cerová vrchovina highland were not quite suitable for the study of calcareous nannoplankton. Most-samples were fossilless or contained poorly preserved indeterminable nannofossil fragments (samples from surficial exposures in the vicinity of Hostice: H-13, H-13b, H-15, H-42, H-92, H-97 a. o.).

Repeated analyses of some samples showed that they contained richer assemblages suitable for stratigraphical dating (samples H-65, H-80, H-88, H-208). Following are significant assemblages:

Coccolithus eopelagicus (BRAMLETTE et RIEDEL) BRAMLETTE et SULLIVAN
Coccolithus pelagicus (WALLICH) SCHILLER
Cyclicargolithus floridanus (ROTH et HAY) BUKRY
Discoaster aulakos GARTNER
Discoaster druggi BRAMLETTE et WILCOXON
Helicosphaera ampliaperta BRAMLETTE et WILCOXON
Helicosphaera carteri (WALLICH) KAMPTNER
Pontosphaera multipora (KAMPTNER) ROTH
Reticulofenestra excavata LEHOTAYOVÁ
Reticulofenestra lockeri MÜLLER
Reticulofenestra pseudoumbilica (GARTNER) GARTNER
Triquetrorhabdulus sp. (fragment)

For the determination of biostratigraphic competence of the nannoassemblages and for their parallelization to Eggenburgian fauna most significant were the species *Discoaster druggi* BRAMLETTE et WILCOXON as the index taxon of the biozone NN 2 *Discoaster druggi* coeval to the Eggenburgian in Central Paratethys, and *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, *Reticulofenestra excavata* LEHOTAYOVÁ appearing for the first time at the base of the biozone NN 2 and with the last occurrences within the Lower Miocene.

Calcareous nannoflora of the East-Slovakian lowland was not studied systematically. The samples taken during geological mapping of the East-Slovakian Neogene

(J. SENEŠ 1954) were analyzed by myself for a comparison to Lower Miocene fauna of the Karpathian.

The samples from the locality Hlinné (grey fine-grained marls of surficial exposures Sš-74, Sš-73) contained poor nannoassemblages with dominant *Coccolithus pelagicus* (WALLICH) SCHILLER and scarce fragments of *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY.

Conclusion

This is a presentation of the results of the study of Lower Miocene nannoplankton in single areas of the West Carpathians.

In the studied area in the Lower Miocene it is possible to distinguish — besides the biozone NN-1 *Triquestrorhabdulus carinatus* (it is not yet defined exactly because we are not sure about the Paleogene/Neogene boundary) — also the biozones NN-2 *Discoaster druggi* and NN-4 *Helicosphaera ampliaperta* (according to standard zonation by E. MARTINI 1970).

If the two determined biozones are applied to the regional stages of Central Paratethys, then the Lower Miocene sediments in the studied areas of the West Carpathians can be ranged to the regional stages Eggenburgian and Karpathian.

Eggenburgian calcareous nannoplankton (biozone NN-2 *Discoaster druggi*) in the Trenčianska kotlina depression is represented by partly preserved poor nannoassemblages. Only sporadical occurrence of the species *Helicosphaera ampliaperta* in samples from the loc. Trenčín-1, Soblahov-1, enabled correlation to Eggenburgian nannoflora of the Bánovská kotlina (depression). The nannoflora comprises *Reticulofenestra excavata* and index species characteristic of the biozone NN-2 *Discoaster druggi*. The species *Reticulofenestra excavata* is equally significant as *Helicosphaera ampliaperta* for the Eggenburgian nannoassemblages because they both appear for the first time in the biozone NN-2 and for the last time within the Lower Miocene. The two taxa are stratigraphically significant for Lower Miocene sediments of many areas in Central Paratethys.

Nannoassemblages of marine sediments of the Handlovská kotlina depression (loc. V. Čausa) differ from the Eggenburgian nannoassemblages of the Bánovská kotlina depression only in the absence of *Discoaster druggi*. Nannoplankton of sediments of the Cerová vrchovina highland (wider vicinity of the loc. Hostice) is well preserved and contains also *Helicosphaera ampliaperta* and *Reticulofenestra excavata*.

Eggenburgian nannoassemblages in the mentioned West-Carpathian areas are well correlable to Eggenburgian nannoflora of the sedimentation area of South Moravia (the Křepice beds of the Pouzdřany Unit and the Šakvice beds of the Ždánice Unit — J. KRHOVSKÝ 1981) and of Rumania (E. MARTINI et C. LEBENSON 1971).

As I have already mentioned in the studied West Carpathian (the Bánovská kotlina, borehole DB-15, depth 577,0 m) areas the Ottnangian sediments may be coeval to the lower part of the biozone NN-4 *Helicosphaera ampliaperta*. Since the

sediments represent a freshwater facies, they cannot be studied for calcareous nannoflora.

Karpathian calcareous nannoflora (the upper part of the biozone NN-4 *Helicosphaera ampliaperta*) in most samples is poor, monotonous, with dominant *Coccolithus pelagicus* (the Bánovská kotlina: borehole DB-15, depth 68—69 m) the Ipeľská kotlina: loc. Bušince; the East-Slovakian lowland, loc. Hlinné). Rich assemblages from Karpathian Lower Miocene sediments of the Bánovská kotlina, i. e. from grey sandy marls from the surficial exposure on the loc. Dežerice and from drill material of loc. Dežerice, Podlužany, Horňany. The best preserved and most abundant calcareous Karpathian nannoflora is in sediments of the Ipeľská kotlina depression (loc. Pôtor).

Poor Karpathian nannoassemblages of our areas may well be parallelized to nannoassemblages of Karpathian Lower Miocene sediments from the foredeep in Moravia. V. Molčíková (1978) found in Karpathian nannoassemblages only specimens of the species *Coccolithus pelagicus* in samples from surficial exposures of localities Šatov, Vlasatice, Malešovice and from boreholes HV-105, loc. Nová Ves, Nitkovice-2, Nitkovice-3,

E. Martini—C. Müller (1973) found poor Karpathian nannoassemblages in the North-Sea Basin in Germany. Nannofloral assemblages of the Reinbeckian — a possible equivalent of our Karpathian are also poor.

E. Martini — C. Müller (1975) studied calcareous nannoflora from the uppermost levels of the Karpathian on Austrian localities (Laa 18, Wagna). Basing on occurrences of *Sphenolithus heteromorphus* and *Helicosphaera ampliaperta*, they ranged the studied levels to the lower part of the nannoplanktic zone NN-5 *Sphenolithus heteromorphus*.

V. Molčíková (1981) regards the Karpathian nannoassemblages from some hydrogeological boreholes in the SW part of the Carpathian Foredeep in Moravia as coeval to the lower part of the biozone NN-5 *Sphenolithus heteromorphus*. M. Horváth and A. Nagymarossy (1978) recorded similar nannoflora in Hungary (Garáb shlier, Mátra Mts.).

In the studied areas of the West Carpathians no assemblages of calcareous nannoflora characteristic of the top levels of the Karpathian have been found so far. Neither among foraminifers there was any species significant for these levels, like *Globigerinoides sicanus* Stefan (personal communication by E. Brestenská, V. Kantorová). I explain it by the fact, that the uppermost members of the Karpathian in the studied area of the West Carpathians, which should correspond to the lower part of the biozone NN-5 *Sphenolithus heteromorphus* did not develop in our area or were denuded off.

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Ružena Lehotayová

Vápnitá nanoflóra spodného miocénu Západných Karpát

Resumé anglického textu

Práca prináša výsledky štúdia vápnitej nanoflóry (metódou riadkovacej elektrónovej mikroskopie) morských spodnomiocénnych sedimentov jednotlivých oblastí Západných Karpát. Boli skúmané sedimenty Trenčianskej kotliny, Bánovskej, Handlovskej, Ipeľskej, Cerovej vrchoviny a Východoslovenskej nížiny.

Na základe analýz vápnitej nanoflóry sa dá v predmetnom území Západných Karpát v spodnom miocéne vymedziť biozóna NN-2 *Discoaster druggi* a NN-4 *Helicosphaera ampliaperta* (v zmysle štandardnej zonácie E. MAARTINI 1970). Spodnomiocénne sedimenty v skúmaných oblastiach zodpovedajú regionálnym stupňom egenburgu a karpatu.

Nanoasociácie egenburgu sa dajú paralelizovať nielen v rámci našich oblastí, ale navzájom s nanoflórou egenburgu z územia južnej Moravy — J. KRHOVSKÝ (1981), Rumunska (E. MARTINI — C. LEBERSON 1971, sedimenty zodpovedajúce vekovému ekvivalentu spodnej časti) nanoplanktónovej biozóny NN-4 *Helicosphaera ampliaperta* sú v oblastiach Západných Karpát vyvinuté v sladkovodnom vývoji a ako také neboli vhodné k štúdiu vápnitej nanoflóry.

Vápnitá nanoflóra karpatu (vrchná časť biozóny NN-4 *Helicosphaera ampliaperta*) je tiež väčšinou chudobná. Výnimku tvorí Bánovská kotlina, lokalita Dežerice a Ipeľská kotlina, lokalita Pôtor.

Chudobné spoločenstvá karpatu korelujeme s nanoflórou spodnomiocénnych sedimentov karpatu z predhlbne na Morave (V. MOLČÍKOVÁ 1978), ďalej s chudobnými nanospoločenstvami severomoravskej panvy Nemecka (E. MARTINI — C. MÜLLER 1973). Bohaté nanoasociácie karpatu sedimentov (hydrogeologických vrtov) jz. časti karpatskej predhlbne na Morave M. MOLČÍKOVÁ (1981) považuje za vekový ekvivalent spodnej časti biozóny NN-5 *Sphenolithus heteromorphus*.

Zo skúmaných oblastí Západných Karpát sme doteraz nezistili sedimenty s vápnitou nanoflórou, ktorá by zodpovedala vekovému ekvivalentu spodnej časti biozóny NN-5 *Sphenolithus heteromorphus*. Najvyššie členy karpatu sa na našom území nevyvinuli alebo boli denudované.

Explanations of Plates XLV—LIV

Explanations to scanning-electron micrographs of calcareous nannoflora of the Lower Miocene in the West Carpathians

Plate XLV

1 *Reticulofenestra excavata* LEHOTAYOVÁ, loc. Veľká Čausa (borehole ČČ-3, depth 237, 0—237,6 m), prox. side, magn. 9000×.

2 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, loc. Veľká Čausa (borehole ČČ-3, depth 237,0—237,6 m) prox. side, magn. 5000×.

3 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Veľká Čausa (borehole ČČ-3, depth 237,0—237,6 m), distal side, magn. 5000×.
4 *Reticulofenestra excavata* LEHOTAYOVÁ, loc. Veľká Čausa, borehole ČČ-3, depth 237,0—237,6 m, distal side, magn. 10.000×.

Plate XLVI
1 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Trenčín-1, prox. side, magn. 5000×.
2 *Helicosphaera* sp., loc. Trenčín-1, prox. side, magn. 2500×.
3 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Trenčín-1, distal side, magn. 4500×.
4 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Trenčín-1, prox. side, 5000×.
5 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, loc. Trenčín-1, prox. side, magn. 4000×.
6 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Trenčín-1, prox. side, magn. 5000×.

Plate XLVII
1 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Krásna Ves, prox. side, magn. 5000×.
2 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Krásna Ves, distal side, magn. 5000×.
3 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Krásna Ves, prox. side, magn. 5000×.
4 *Coronocyclus mitescents* (KAMPTNER) BRAMLETTE et WILCOXON, loc. Krásna Ves, prox. side, magn. 5000×.
5 *Reticulofenestra bisecta* (HAY, MOHLER, WADE) ROTH, loc. Krásna Ves, prox. side, magn. 4500×.
6 *Reticulofenestra excavata* LEHOTAYOVÁ, loc. Krásna Ves, distal side, magn. 5000x.

Plate XLVIII
1 *Braarudosphaera bigelowi* (GRAN et BRAARUD) DEFLANDRE, loc. Podlužany (borehole DB-9, depth 57—58 m), prox. side, magn. 5000x.
2 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Podlužany, (borehole DB-9, depth 57—58 m), distal side, magn. 10.000×.
3 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, loc. Podlužany (borehole DB-9, depth 57—58 m), distal side, magn. 5000×.
4 *Discoaster adamanteus* BRAMLETTE et WILCOXON, loc. Podlužany (borehole DB-9, depth 57—58 m), distal side, magn. 5000×.
5 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Podlužany (borehole DB-9, depth 57—58 m), distal et prox. side, magn. 2500×.

Plate XLIX
1 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Radzovce (R-51), prox. side, magn. 7500×.
2 *Discoaster druggi* BRAMLETTE et WILXOCON, loc. Hostice (H-65), prox. side, magn. 5000×.
3 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Hostice (H-81), prox. side, magn. 35.000×.
4 *Helicosphaera carteri* (WALLICH) KAMPTNER, loc. Hostice (H-42), prox. side, magn. 45.000×.
5 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, loc. Hostice (H-88) prox. side, magn. 5000×.

Plate L
1 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice, prox. side, magn. 16.000×.
2 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice (borehole DB-10, depth 161—162 m), lateral side, magn. 10.000×.
3 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice, prox. side, magn. 9000×.
4 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice, prox. side, magn. 10.000×.

Plate LI
1 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice, distal side, magn. 8×.
2 *Coronosphaera mediteranea* (LOHMANN) GAARDER, loc. Dežerice, distal side, magn. 10.000×.
3 *Reticulofenestra bisecta* (HAY, MOHLER, WADE) ROTH, loc. Dežerice, prox. side, magn. 3000×.
4 *Reticulofenestra pseudoumbilica* (GARTNER) GARTNER, loc. Dežerice, prox. side, magn. 5000×.
5 *Cyclococcolithus rotula* (KAMPTNER) KAMPTNER, loc. Dežerice, prox. side, magn. 4500×.
6 Fragment *diatomaceae*, loc. Dežerice, magn. 5000×.

Plate LII

1 *Helicosphaera carteri* (WALLICH) KAMPTNER, loc. Dežerice, prox. side, magn. 9000×.
2 *Helicosphaera carteri* (WALLICH) KAMPTNER, loc. Dežerice, distal side, magn. 5000×.
3 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Dežerice, magn. 5000×.
4 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Dežerice, magn. 5000×.
5 *Coccolithus pelagicus* (WALLICH) SCHILLER, coccosphere, loc. Dežerice, magn. 4000×.

Plate LIII

1 *Reticulofenestra excavata* LEHOTAYOVÁ, loc. Pôtor (borehole M-2, depth 21—22 m), distal side, magn. 9000×.
2 *Coccolithus pelagicus* (WALLICH) SCHILLER, loc. Pôtor (borehole M-2, depth 21—22 m), prox. side, magn. 5000×.
3 *Cyclicargolithus floridanus* (ROTH et HAY) BUKRY, loc. Pôtor (borehole M-2, depth 21—22 m), prox. side, magn. 4500×.
4 *Pontosphaera multipora* (KAMPTNER) ROTH, loc. Pôtor (borehole M-2, depth 21—22 m), prox. side, magn. 4500×.
5 *Helicosphaera ampliaperta* BRAMLETTE et WILCOXON, loc. Pôtor (borehole M-2, depth 21—22 m), distal side, magn. 5000×.

Plate LIV

1 *Reticulofenestra pseudoumbilica* (GARTNER) GARTNER, loc. Pôtor (borehole M-2, depth 21—22 m), prox. side, magn. 10.000×.
2 *Thoracosphaera heimi* (LOHMANN) KAMPTNER a detail of test-wall structure, loc. Pôtor (borehole M-2, depth 21—22 m), magn. 5000×.
3 *Cyclococcolithus rotula* (KAMPTNER) KAMPTNER, loc. Pôtor (borehole M-2, depth 21—22 m), magn. 14.000×.
4 *Thoracosphaera heimi* (LOHMANN) KAMPTNER loc. Pôtor (borehole M-2, depth 21—22 m), magn. 7000×.
5 *Pontosphaera multipora* (KAMPTNER) ROTH, loc. Pôtor (borehole M-2, depth 21—22 m), distal side, magn. 5000×.

Západné Karpaty, sér. paleontológia, 9, P. 111—130, Geol. Úst. D. Štúra, Bratislava, 1984

Eva Planderová

Sporomorphs and Plankton of the Karpathian from the Locality Dežerice

1 text-fig., 11 Pls. (LV—LXV), Slovak summary

Abstract. From the locality Dežerice I investigated several samples from the profile in the road cut behind the village (map 1). As to lithology there are grey calcareous inbedded marls with variable aleuritic admixture and sandy lamination on bedding planes. For palynological investigation I took samples from the whole profile, also vertically from various positions. I established that the samples richest in sporomorphs are found in the lower part of the outcrop in layers with carbonized remnants of plants. The higher layers were much poorer in sporomorphs or contained marine plankton of dinoflagellates and algae only. The age of the studied beds is Karpathian.

The village Dežerice is in Western Slovakia, 6 km NW of Bánovce n/Bebravou. The studied profile is in a road cut, 0,5 km NW of Dežerice.

I have examined samples from the profile (map 1) for the purposes of palynological characteristic of marls from Dežerice.

From the view of lithology they are grey stratified calcareous marls with variable aleuritic admixture and sandy lamination on their bedding planes. In the lower part of the exposure are dark-grey layers containing carbonized plant remains (Brestenská, Guide-book of the 6th European Colloquy on Micropaleontology).

On the basis of microfauna (Brestenská 1983) and nannoflora (Lehotayová 1983) the marls from Dežerice are ranged to the Karpathian, i. e. the Zones N 7—8 (Blow) and NN-1 (Martini).

The samples for palynological examination were taken from the whole profile and from different layers in vertical sense. The samples with the greatest content of sporomorphs are from the lower part of the exposure from layers with carbonized plant remains. Higher layers are poorer in sporomorphs or contain sea plankton: dinoflagellates and dasycladaceans. This may be indicative of sea deepening or of transgression during the deposition of marls from the lower parts upwards.

Following are systematical ranging and morphological description of taxa of sea plankton, spores of Spermophyta and pollen of seed plants.

Morphological characteristic is in accordance with modern works by Krutzsch 1962, 1967, 1970, 1971, Nagy 1969, Thomson et Pflug 1953, Potonié 1960, Thiele-Pfeiffer 1979.

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Systematical ranging of sporomorphs is based on the botanical system whose application on the Tertiary is well reasoned and desirable with respect to paleoecological evaluation.

Systematical part

CHLOROPHYTA

Pterospermellaceas

Pteraspermella EISENACK 1972

Type species *Pterospermella aureolata* (COOKSON, — EISENACK 1958) EISENACK 1972 = *Pterospermopsis aureolata* COOKSON, EISENACK 1958.

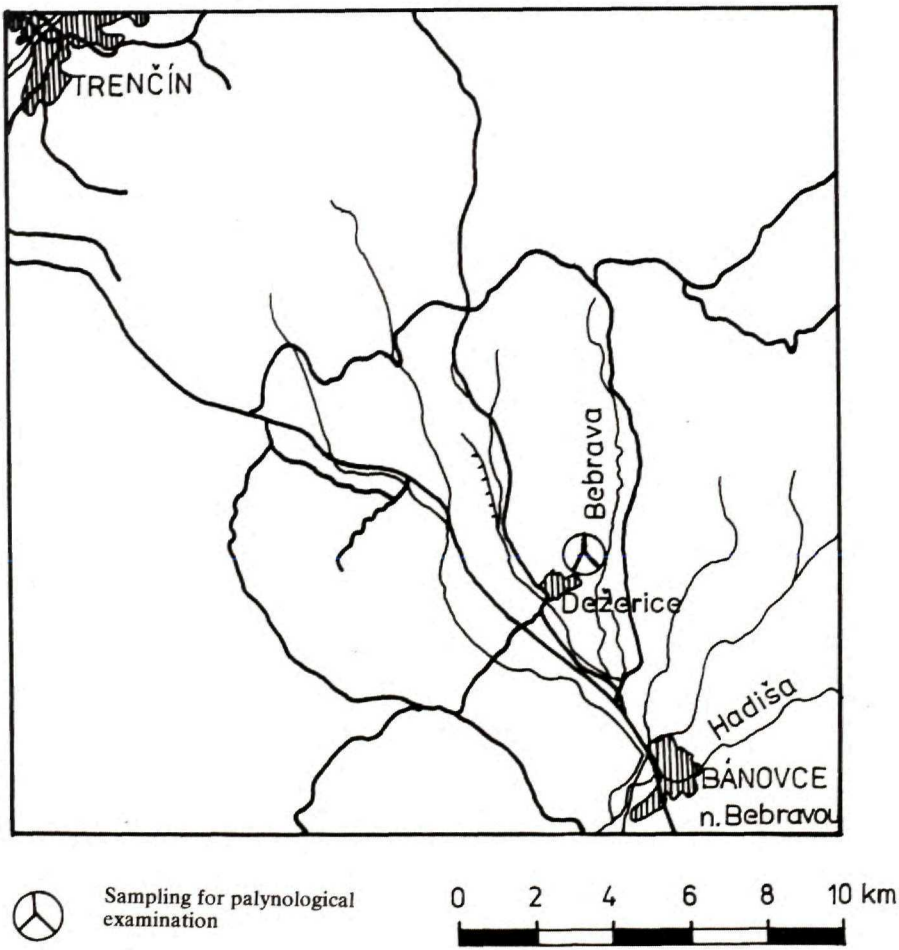

Fig. 1 Map of localities of sediments from area of Dežerice

***Pterospermella harti* (SARJEANT 1960) (EISENACK 1973)**

Pl. LV, Fig. 1

1960: SARJEANT, W. A. S.: *Pterospermopsis harti*. S. 102, Pl. 14, fig. 16, abb. 3.

Description: The capsula and the whole microplankton body are circular. The body size is 60—65 μ. Radial folds on the membrane are darker but not dark brown like on *P. barbarae* (GORKA) Eis., and smaller.

Occurrence: The species occurs in the Cretaceous, Paleogene — Lower Miocene. It is scarce in our material.

Tasmanaceae
Pleurozonaria WETZEL 1933

Type genus *Pleurozonaria globulus* WETZEL 1933

***Pleurozonaria concinna* (COOKSON et MANUM 1960) MÄDLER 1968**

Pl. LV, Fig. 2, 3, Pl. LVI, Fig. 2—3, Pl. LVIII, Fig. 5

1960: *Crassosphaera concinna* COOKSON et MANUM s. 6 (nou vidi).
1968: *Pleurozonaria concinna* (COOKSON — MANUM) n. comb. MÄDLER.

Description: A round body, ranging from 80 to 100 μ in size. The body wall is 3—4 μ thick. The whole body is covered with conical hexagonal projections.

Occurrence: The species is widely spread all over the Tertiary. SNOPKOVA (1981) found the species in the Upper Eocene — Oligocene in the area around Štúrovo. It is quite frequent in our material.

***Pleurozonaria* sp.**

Pl. LVI, Fig. 1

REMARK: The species is similar to *P. concina* (COOKSON et MANUM) MÄDLER 1965, only the exine thickness is greater — 6 μ. It is scarce in the studied material.

Tithodiscus NOREM 1955

***Tithodiscus* sp.**

Pl. LVIII, Fig. 1, 2; Pl. LVI, Fig. 4, 6

Description: The circular body has the average size of 70 μ. The exine

thickness is 4—5 μ. The exine consists of tiny tubes aligned tightly next to one another. Beneath them is another dark irregular layer composed of thin tubes. The specimen cannot be ranged to the known species. It is quite frequent.

Occurrence: In the Tertiary the whole genus is present. It is not in the Upper Miocene.

PTERIDOPHYTA

Lycopsida
Lycopodiaceae
Verrucingulatisporites KEDVES 1961

Type genus *Verrucingulatisporites verrucatus* KEDVES 1961

Verrucingulatisporites granus granus W. KR. 1967

Pl. LX, Fig. 5

1967: *Verrucingulatisporites granus granus* W. KRUTZSCH Pl. 44, Fig. 1—11.

Description: A trilete spore, 30 μ in size, with conspicuous granulate sculpture and undulated cingulum.

Occurrence: Its occurrence ranges from the Upper Oligocene to the Lower Miocene. In the Miocene of Central Paratethys it is absent in younger stages. It is scarce in our material.

PTEROPSIDA

Ophioglassales
Leiotriletes (NAUM. 1937) **R. POT. KR.** 1954

Genotypus *L. sphaerotriangulus* (LOOSE 1932), R. POT. KREMP 1954.

Leiotriletes triangulus (MÜRR. PF.. 1962 ex KR. 1959) W. KR. 1962

Pl. LIX, Fig. 1

1962: *Leiotriletes triangulus* W. KRUTZSCH Pl. 5, figs 11—13.

Description: A rounded triangular spore with a distinct Y-mark occupying 5/5 of the spore body without thorus. Size: up to 35 μ.

Occurrence: W. KRUTZSCH 1962 found it in Lower Miocene cyrene beds and brown-coal seams. The species is scarce in our material.

***Leiotriletes adriennis* R. Pot. Gell) Kr. 1959 *pseudomaximus* (Th. Pf. 1953), Kr. 1962**

Pl. LIX, Fig. 2—3

1962: *Leiotriletes adriennis* W. Krutzsch Pl. I, Fig. 1.

Description: A rounded triangular spore. Size: 65—70 μ. A frequently open Y-mark occupies 1/3 of the body.

Occurrence: Lower-Middle Eocene brown-coal basins, cyrene marls. In our country the species occurs in the Lower to Middle Miocene.

Polypodiaceoisporites R. Pot. 1956

Type genus *Polypodiaceoisporites speciosus* (R. Pot. 1934 b) R. Pot. 1956

***Polypodiaceoisporites gracillimus* Nagy 1963**

Pl. LX, Fig. 7

1963: *Polypodiaceoisporites gracillimus* Nagy E. Pl. 1, figs 3—6.

Description: A trilete spore with a smooth cingulum ranging in size to 35 μ. Fine, distinctly verrucate structure extends into the cingulum.

Occurrence: Generally Lower Miocene. Scarce in our material.

Microfoveolatisporites W. Kr.1962

Type genus *Microfoveolatisporites tuemmlitzensis* W. Kr. 1962

***Microfoveolatisporites tuemmlitzensis* W. Kr. 1962**

Pl. LIX, Fig. 7

1962: *Microfoveolatisporites tuemmlitzensis* W. Krutzsch Pl. 22, figs 1—3.

Description: A circular spore with Y-mark occupying 4/5 of the body. The structure is microfoveolate. Size: 45 μ.

Occurrence: W. Kr. (1962) found it in the Lower Miocene. It is scarce in our material.

Punctatisporites Kr. 1969 b.

Type genus *Punctatisporites punctatus* (Ibr. 1932) Ibrahim 1933

Punctatisporites cf. *tannendorfensis* W. Kr. 1962

Pl. LX, Fig. 3—4

1962: *Punctatisporites tanndorfensis* W. Krutzsch Pl. 16, figs 1—6.

Description: An almost circular spore with the Y-mark occupying 2/3 of the spore body. The Y-mark is thick, dark. The spore ranges up to 100 μ in size.

Remark: There are differences in size and thickness of exine between our species and *P. tanndorfensis*. Our species ranges to 100 μ in average size and *P. tanndorfensis* only to 65 μ. The exine of our species is thin-walled when compared to the thick dark exine of *P. tanndorfensis*.

Occurrence: *P. tanndorfensis* occurs in the Lower Miocene (W. Krutzsch 1962). Our species is scarce in the material under study.

Toroisporis Kr. 1959

Type genus *Toroisporis torus* (Pf. 1953) Krutzsch 1959

Toroisporis teupitzensis Kr. *medioris* W. Kr. 1962

Pl. LIX, Fig. 5—6

1962: *Toroisporis teupitzensis* W. Krutzsch Pl. 33, figs 1—12.

Description: A rounded triangular spore. Size: 30—35 μ. The Y-mark occupies 5/5 of the spore body. The thorus around the Y-mark is dark, distinct, smooth.

Occurrence: Krutzsch (1962) found it in the Lower-Middle Miocene. Our species occurs in the Lower-Middle Miocene as well. It is scarce on the locality under study.

GYMNOSPERMAE

Coniferopsida

Abietaceae

Pityosporites Seward 1914

Type genus *Pityosporites antarcticus* Seward 1914

Pityosporites labdacus (R. Pot. 1931) Th. et Pf. 1953

Pl. LXI, Fig. 4—6; Pl. LXII, Fig. 1,5

1953: *Pityosporites labdacus* Thomson-Pflug Pl. 5, figs 60—62.

Description: The species is characterized by smaller air sacs fitted to the pollen body by a narrowed base.

Occurrence : The species found in Central Paratethys was denoted as *Pinus* type *silvestris*. It occurred from the Middle Miocene to the Upper Pliocene. It was quite frequent on the studied locality.

Pityosporites alatus (R. Pot 1931 b) Th. Pf. 1953

Pl. LXII, Fig. 2

1953: *Pityosporites alatus* Thomson-Pflug, Pl. 5, figs, 63, 65, 66.

Description : The species is characterized by air sacs fitted to the pollen grain by a wide base.

Occurrence : The species found in Central Paratethys was denoted as *Pinus* type *Haploxylon*. It was frequent in the Lower-Middle Miocene, less frequent in the Upper Miocene and Pliocene. It was plentiful on the locality studied.

Pityosporites pristinipollinius (Trav. 1955) W. Kr. 1971

Pl. LXI, Fig. 7

1971: *Pityosporites pristinipollinius* W. Krutzsch, Pl. 11, figs. 1—11

Description : Bisaccate pollen grains ranging from 70 to 75 μ in size. Air sacs are fitted by a wide base to the elliptic body.

Occurrence : According to Krutzsch 1971 it occurs in the Oligocene-Lower Miocene. It is scarce in our material.

Inaperturopollenites Thoms. Pflug 1953

Type genus *Inaperturopollenites dubius* (R. Pot. Ven) Th. Pf. 1953

Inaperturopollenites verrupapillatus Trevisan 1967

Pl. LXI, Fig. 1—2

1967: *Inaperturopollenites verrupapillatus*, Trevisan, Pl. 6, figs. 9a—c.

Description : A pollen grain with a small ligula and fine verrucate structure.

Remark : Its botanical competence is *Taxaceae* or *Taxodiaceae* families.

Occurrence : According to Krutzsch 1971 it occurs all over the Miocene. It is present in a low percent in our material.

Angiospermae

Juglandales

Type genus *Caryapollenites* Raatz (1937) Raatz 1938 ex Potonié 1960

Caryapollenites simplex RAATZ 1938 p. 19 fig. 6 in R. POTONIÉ 1960 Synopsis part III p. 123.

Caryapollenites simplex (R. POT. 1934) R. POT. 1960

Pl. LXIII, Fig. 10—12, 15; Pl. LXIV, Fig. 1—2

1962: *Caryapollenites simplex* R. POTONIÉ, Pl. 7, fig. 162.

Description: Subtriporate pollen grains with three pores. Size: around 40 μ. Circular pores are in subequatorial position. The exine is smooth, double-walled, with secondary triangular folds.

Remark: The Lower Miocene species are smaller than the Upper Miocene and the Pliocene species ranging up to 50—55 μ in size.

Occurrence: The entire Tertiary. Smaller forms occur in the Paleogene. It is most frequent in the Miocene.

Momipites WODEHOUSE 1933

Type genus *Momipites coryloides* WODEHOUSE 1933 fig. 43

Momipites punctatus (R. POT. 1931) NAGY 1969

Pl. LXII, Fig. 8—9

1969: *Momipites punctatus* NAGY E., Pl. LIV, figs. 9—10.

Description: Convex triangular pollen grains with a thin, double-walled exine. Size: to 35 μ. The exine is infragranulate, the atrium is small, the labrum and the anulus as well.

Occurrence: NAGY (1969) found the species in the Middle Miocene and in the Sarmatian. In Central Paratethys it is most frequent in the Middle Miocene, and perhaps redeposited in the Pliocene. It is quite plentiful on the locality Dežerice.

Platycaryapollenites NAGY E. 1969

Type genus *Platycaryapollenites miocaenicus* NAGY E. 1969 pl. LIII, figs. 25—26

Platycaryapollenites miocaenicus NAGY 1969

Pl. LXIII, Fig. 5—6

Description: Triatrioporate pollen grains. Size: 20—22 μ. The exine is thin, double-walled. Pores have no anulus, no labrum, only a small atrium. Characteristic are 2—3 ribbon-like folds.

Occurrence : NAGY (1969) found the species in the Ottnangian. Its first Miocene occurrence in our country is in the Karpathian on the locality Dežerice.

Engelhardtioidites (R. POT. TH. THIAG 1950) R. POT. 1960

Type genus *Engelhardtioidites microcoryphaeus* (POT.) POT. 1960

***Engelhardtioidites microcoryphaeus* (R. POT. 1931)**

Pl. LXIII, Fig. 7—8

1931: *Pollenites microcoryphaeus* R. POT. fig. 13
1960: *Engelhardtioidites microcoryphaeus* POT. 1931 Pl. 7, fig. 148, 149.

Description : Triporate pollen grains with a thin exine. Size: 22—25 μ. The structure of the exine is fine granulate. The exine walls are slightly convex.

Occurrence : The species is plentiful in the Lower and Middle Miocene. NAGY (1969) found it in the Badenian and Lower Miocene. STUCHLIK (1964) found plentiful occurrences in Rypin in the Lower, Middle and Upper Miocene. The species is also frequent in the Miocene, especially Lower and Middle Miocene of Central Paratethys. It is likely to be redeposited in the Pliocene. It is very frequent on the locality Dežerice.

Remark : It belongs to the genus *Engelhardtia*.

Subtriporopollenites PF. TH. 1953

Type genus *Subtriporopollenites anulatus* PF. TH. 1953, Pl. 9, fig. 49

***Subtriporopollenites* sp.**

Pl. LXIII, Fig. 13

Description : A subtriporate grain. Size: to 15 μ. Pores are small, subequatorially arranged. The structure is microfoveolate. Foveolate openings are aligned in rows. The specimen differs from the described species in size and structure.

Occurrence : Its occurrence is scarce at the locality under study.

Plicatopollis W. KR. 1962

Type genus *Plicatopollis plicatus* (POT. KR. 1962)

***Plicatopollis plicatus* (R. POT. 1934) W. KR. 1962**

Pl. LXII, Fig. 3—4

1962: *Plicatopollis plicatus* (R. POT.) n. comb. W. KRUTZSCH p. 277.

Description: An almost circular grain. Size: 30 μ. It has 3—4 pores with an atrium, a small labrum and an indistinct anulus. The exine is 2—3-walled, with granulate structure and ribbon-like folds.

Remark: KRUTZSCH (1962) and NAGY (1969), range it to the family *Juglandaceae.*

Occurrence: scarce in Dežerice marls.

Triporopollenites PFLUG THOMSON 1953

Type genus *Triporopollenites coryloides* PF. TH. 1953

***Triporopollenites* sp. 1**

Pl. LXIII, Fig. 1

1953: *Triporopollenites coryloides* THOMSON-PFLUG, Pl. 9 figs. 20—24

Description: A triangular pollen grain with smooth walls and slight indications of convexity or concavity. Size: 18 μ. Pores are small, without anulus. The exine is smooth, thin, infragranulate.

Remark: It differs from the genus *Engelhardtioidites* in size, pores and structure. STUCHLIK (1964) described a similar pollen grain as a species of the genus *Myrtus* (Pl. XV, Fig. 18). The recent species have different internal structure of pollen grains.

Occurrence: Scarce in the studied material.

Betulaceae

Carpinuspollenites THIERG. 1938

Type genus *Carpinus? pollenites granifer megagranifer* R. POT.

Remark: According to POTONIÉ 1960 the described genus is not valid. NAGY 1969 described *Carpinuspollenites* with the species name taken over from THOMSON-PFLUG 1953 and the genus name from THIERGART (1938).

***Carpinuspollenites carpinoides* (PF. 1953) NAGY 1969**

Pl. LXII, Fig. 6

1969: *Carpinuspollenites carpinoides* (PF.) NAGY E. Pl. LII, fig. 8.

Description: Polyporate pollen grains. Size: 30—50 μ. Shape: almost round. Pores have anulus and labrum.

Occurrence: The whole Miocene. Scarce on the locality Dežerice.

MALVALES

Malvaceae

Intratriporopollenites PF. TH. 1953

Type genus *Intratriporopollenites instructus* (R. POT. VEN) PFLUG et THOMSON 1953
Pl. 10, fig. 21

***Intratriporopollenites insculptus* MAI 1961**

Pl. LXIV, Fig. 3—4

Description: Intratriporate pollen grains. Size: 34 μ. Shape: almost circular. Pores: small, narrow. Anulus around pores is smooth, dark. Structure: micro-reticulate.

Occurrence: plentiful in the Oligocene-Pliocene; quite frequent in our material.

Botanical competence: family *Tiliaceae*. THIELE-PFEIFFER (1979) range it to subfamily *Brownownoidae* perhaps to the species *Brownownia alata*. In the recent the species lives in tropical and subtropical parts of Southeastern Asia.

Nyssaceae

Nyssapollenites THIEGART 1938 ex POTONIÉ 1960

Type genus *Nyssapollenites pseudocruciatus* (POT.) THIERG. 1938, Pl. I, fig. 10
Pollenites pseudocruciatus POT. 1931 pl. fig. 10 illustrated in POTONIÉ 1934, p. 61, pl. 2, fig. 30

***Nyssapollenites kruschi* (R. POT.) ssp. *contortus* (PF. TH. 1953) NAGY 1969**

Pl. LXV, Fig. 10, 11

1953: *Tricolporopollenites kruschi* THOMSON PFLUG Pl. XIII, figs. 34—38.
1969: *Nyssapollenites kruschi* (R. POT.) ssp. *contortus* Th. Pf. NAGY p. 177.

Description: Tricolporate pollen grains. Size: 35—40 μ. Structure: infragranulate. Pores are large, circular, open. The sculpture is infrarugulate.

Occurrence: plentiful in the Tertiary. It is paleoecologically significant.

Botanical competence: Family *Nyssaceae* and perhaps also *Mastixiaceae*.

Anacardiaceae

Tricolporopollenites PFLUG THOMSON 1953

Type genus *Tricolporopollenites dolium* R. POT. 1934 Pl. 12, fig. 114—117

***Tricolporopollenites pseudocingulum*, (R. Pot. 1931) Th. Pflug 1953**
Pl. LXV, Fig. 1—2

1953: *Tricolporopollenites pseudocingulum* (R. Pot.) Thomson, Pflug Pl. 12, figs. 96—111.

Description: Tricolporate pollen grains of typical rhomboidal shape, widened in the centre of the body in polar position. Size: 35 × 25 μ. Pores are circular, large, the structure infragranulate. The exine is thin, double-walled, infrabaculate.

Occurrence: The species is frequent in the Oligocene, especially in the Middle Miocene.

Remark: It is ranged to the family *Anacardiaceae*, perhaps it belongs to the genus *Rhus*. According to Thiele-Pfeiffer (1979) the species extinguished at the end of the Miocene and cannot be compared to the recent species.

Fagaceae

***Tricolporopollenites microhenrici* (R. Pot. 1931) W. Kr. 1961**
Pl. LXV, Fig. 16

Description: Tricolporate pollen grains. Size: 25—28 μ. Oval in polar position. The exine is three-walled, infrabaculate, the structure granulate.

Occurrence: The species is frequent in the Eocene-Pliocene in the area of Paratethys. It is quite frequent in our material.

Botanical competence: The pollen grains are ranged to the family *Fagaceae*. A comparison to recent species of the genus *Quercus* shows morphological analogy to the species *T. microhenrici*.

***Tricolporopollenites cingulum* R. Pot. subsp. *fusus* (R. Pot.) Pf. Th. 1953**
Pl. LXV, Fig. 9

1953: *Tricolporopollenites cingulum*, Thomson, Pflug, Pl. 12, figs. 15—27.

Description: Ellipsoid tricolporate pollen grains with infrabaculate or infrarugulate structure. Size: 25 μ. Pores are small circular. Colpae are distinct, the exine is double-walled, infrabaculate.

Occurrence: very frequent in the Early Tertiary. Scarce in the Lower Miocene — Badenian. Botanical competence unknown.

***Tricolporopollenites cingulum* (R. Pot. 1931) Th. Pf. 1953 ssp. *oviformis* (R. Pot. 1931) Th. Pf. 1953**

Pl. LXIV, Fig. 10

1953: *Tricolporopollenites cingulum* (R. POT.) TH. PF. ssp *oviformis* (R. POT. THOMSON PFLUG. Pl. 12, figs. 42—49.

Description: Tricolporate pollen grains ranging to 20 μ in size. Shape: oval to rounded oval. The exine is double-walled, thin, pores are small, circular.

Occurrence: It is present in the entire Tertiary, especially in the Middle-Upper Miocene. It is rather infrequent in our material.

Botanical competence: It is likely to belong to the family *Fagaceae*. THOMSON-PFLUG (1953) range it among pollen of the genus *Castanea*.

Tricolporopollenites cf. *villensis* (THOMS) THOMSON PFLUG 1953

Pl. LXV, Fig. 13

1953 *Tricolporopollenites villensis* (THOMS.) THOMSON, PFLUG Pl. 12, figs. 5—14

Description: Pollen grains are tricolporate, oval or elliptical, with larger, circular pores. Size: 28—30μ.

Occurrence: THOMSON-PFLUG 1953 found it in the Middle Tertiary. It is all over the Miocene in Central Paratethys.

Botanical competence: It is ranged to the family *Fagaceae*.

Tricolporopollenites sp.

Pl. LXV, Fig. 12

Description: Tricolporate pollen grains. Shape: elongated oval. Size: 35 × 35 μ. In its shape it resembles the genus *Parthenocissus* but it has different structure and size of the germinal apparatus. The structure of the exine is granulate; pores small, colpae dark, distinct.

Occurrence: scarce in Karpathian Dežerice marls.

Tricolporopollenites minimus NAGY 1960

Pl. LXV, Fig. 17

1969: *Tricolporopollenites minimus* NAGY E. Pl. III, figs. 22—24

Description: Tricolporate pollen grains. Size: to 17 μ. Shape: oval or rounded oval. Distinct pores and colpae. The exine is double-walled, dark.

Occurrence: NAGY (1969) found the species in the Middle Miocene of Hungary. The first poor occurrence in our country was recorded at Dežerice.

Cornaceae

Tricolporopollenites satzveyensis **PFLUG in THOMSON PFLUG 1953**

Pl. LXV, Fig. 7—8

1953: *Tricolporopollenites satzveyensis* THOMSON, PFLUG, Pl. 13, figs. 10—13.

Description: Tricolporate grains. Size: 30 μ. Shape: oval or elliptical. Large, distinct pores, dark-brown, 3—14 μ, wide colpae. The structure is foveolate. The pollen grain show characteristic structure and is well defined as to species.

Occurrence: In the Paleogene, in the Lower and Middle Miocene — according to THIELE-PFEIFFER (1979).

Botanical competence: It is ranged to the family *Cornaceae.*

Simarubaceae

Tricolporopollenites pacatus **PFLUG in TH. PF. 1953**

Pl. LXV, Fig. 4

1953: *Tricolporopollenites pacatus* THOMSON, PFLUG Pl. 12, figs. 118—121.

Description: Tricolporate pollen grains. Size: 25—30 μ. Shape: rounded triangular. Colpae are darker than the exine, pores are small, narrow (1,5 μ), the exine is finely granulate.

Occurrence: the Tertiary.

Botanical competence: The species belongs to the family *Simarubaceae*, perhaps the genus *Ailanthus* — according to THOMSON and PFLUG (1953). It is scarce on the locality Dežerice.

Aquifoliaceae

Ilexpollenites THIERGART 1937 ex POTONIÉ 1960

Type genus *Ilexpollenites illiacus* POTONIÉ 1960

Pollenites illiacus POTONIÉ 1931 d, 7. BRAUNK v. 30 p. 556, fig. 5

Ilexpollenites illiacus **POT. 1960**

Pl. LXIV, Fig. 5—8, 11

1960: *Ilexpollenites illiacus* R. POTONIÉ p. 99.

Description: Tricolporate pollen grains. Size: 35—40 μ. Clavate structure is

typical of the species. Clavae are 3—4μ wide at the top. They are fitted to the exine base by a narrow (2—3 μ) neck. Pores are small, circular.

Occurrence: In the Tertiary, mainly in the Miocene. It is quite frequent in our material.

Botanical competence: It belongs to the family *Aquifoliaceae*, genus *Ilex*.

***Illexpollenites margaritatus* (R. Pot. 1931a) Thierg. 1937 ex Potonié 1960**
Pl. LXIV, Fig. 9

Ilexpollenites margaritatus R. POTONIÉ p. 99.

Description: Tricolporate pollen grains. Size: about 25 μ. Clavate structure of the exine is finer than that of the species I. illiacus.

Occurrence: In the Tertiary — Pliocene. Scarce in our material.

Botanical competence: the family *Aquifoliaceae*, genus *Ilex*.

Sterculiaceae

Reevesiapollis Krutzsch 1970

Type genus *Reevesia triangulus* (Mam.) Krutzsch 1970 Pl. 5, fig. 19—35.

***Reevesiapollis triangulus* (Mamczar 1960) Krutzsch 1970**
Pl. LXII, Fig. 7

Description: Four-porate pollen grains with characteristic structure. Size: 25—30 μ. Reticulate structure, thin exine. Pores are large, circular.

Botanical competence: The species belongs to the family *Sterculiaceae*.

Occurrence: mainly in the Miocene, in warm climatic phases. Scarce in the Dežerice marls.

Porocolpopollenites Pflug 1953

Type genus *Porocolpopollenites vestibuliformis* Pf. in Thomson Pflug 1953 Pl. 10, fig. 122.

***Porocolpopollenites* sp.**
Pl. LXIII, Fig. 2

Description: Triporate pollen grains of triangular shape. A narrow long colpa is running out of each pore. It is smaller (17 μ in average) than other species described. Openings of the foveloate structure are aligned in rows.

Occurrence: scarce in the material under study.

Botanical competence unknown.

Myricipites WODEHOUSE 1933

Type genus *Myricipites dubius* WODEHOUSE, Bull. Torey Botanical Club. v. 60, p. 505.

***Myricipites* cf. *rurensis* (PF. TH. 1953) NAGY 1969**

Pl. LXIII, Fig. 9

1969: *Myricipites rurensis* (PF. TH.) NAGY E., Pl. LIII, fig. 27.

Description: Triatrioporate pollen grains. Size: 25 μ. Pores have anulus, labrum and atrium. There are many dark folds on the exine. The species corresponds to the genus described by WODEHOUSE (1933) by its size.

Occurrence: The species occurring in the Miocene are larger than 28 μ. In our material it is scarce, although it is plentiful in the whole Miocene.

Lythraceae

Lythraceaepollenites THIELE-PFEIFFER 1979

Type genus *Lythraceaepollenites bavaricus* THIELE-PFEIFFER 1979 Pl. 16, fig. 1—10.

***Lythraceaepollenites bavaricus* THIELE-PFEIFFER 1979**

Pl. LXV, Fig. 6

Description: Tricolporate pollen grains. Size: 22 μ. The exine is thick with its wall composed of several layers. Pores are circular, the structure is intrabaculate or rugulate.

Occurrence: In Bavaria it was only found in the Miocene (THIELE-PFEIFFER 1979); in our material it is scarce.

Botanical competence: the family *Lythraceae*, perhaps genus *Lawsonia* (THIELE-PFEIFFER 1979).

Sapotaceae

Tetracolporopollenites PFLUG in THOMSON PFLUG 1953

Type genus *Tetracolporopollenites sapotoides* (PF. TH. 1953) Pl. 15, Fig. 6—7

***Tetracolporopollenites microrhombus* PFLUG in THOMSON 1953**

Pl. LXV, Fig. 3

1953: *Tetracolporopollenites microrhombus* THOMSON-PFLUG, Pl. 15, figs. 22—25.

Description : Tetracolporate pollen grains. They have the form of a double cup, i. e. extremely broadened in the central part and narrowing toward the poles. Size: 30 μ. The exine is thick, double-walled, smooth. The sculpture is distinctly granulate.

Occurrence : mainly in the Paleogene, in the Lower Miocene only.

Botanical competence : the family *Sapotaceae*.

Tetracolporopollenites microrhombus **(PFLUG in TH. PF. 1953) subsp. minor n. subsp.**

Pl. LXV, Fig. 18

Description: Tetracolporate rhomboidal pollen grains. Size: 18—20 μ. Distinct circular pores, 1,5 μ wide. Colpae are thick, dark. The structure is granulate to foveolate.

Occurrence : scarce in studied sediments of the locality Dežerice.

Conclusion

The spore-pollen pattern resulting from the examination of about 10 samples from the exposure at Dežerice indicates possible correlation of Karpathian flora so far studied from the area of Central Paratethys (PLANDEROVÁ 1967 in Chronostratigraphie und Neostratotypen). The pollen spectrum is characterized by plentiful sea plankton, pollen of coniferous plants and of angiosperms. Spores of spermophytes are poorest but they contain about 15 % of flora of the whole pollen spectrum composition. I have already mentioned that the samples studied come from the base of the exposure and that there is a mixed assemblage of spores, pollen, dinoflagellates and algae. The algae represent plankton of the sea- or brackish environment.

Higher levels of the same profile contained a monoassemblage of planktonic forms and very scarce sporomorphs. The paleoecological-paleogeographical reconstruction shows that in the course of the deposition of marls from the underlier to the overlier a transgression proceeded and the former lagoonal or coastal environment changes gradually into a deep-sea environment or distant from the coast. The composition of sporomorphs is indicative of a warm subtropical climate with *Taxodiaceae-Nyssaceae-Mastixiceae* with predominant plentiful xerophilous and thermophilous pollen of the genus *Engelhardtia* and woody plants of the genus *Platycarya*. Plentiful coniferous plants represent woody plants in higher areas. Herbal elements are absent in pollen spectra. On the basis of the composition of sporomorphs the sediments under study may be ranged to the microfloristic zone MF-3 (PLANDEROVÁ 1978).

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Sporomorfy a planktón karpatského stupňa z lokality Dežerice

Resumé anglického textu

Spóropeľový obraz získaný spracovaním asi desiatich vzoriek z odkryvu v Dežericiach poukazuje na možnosť korelácie karpatskej flóry už doteraz spracovanej z oblasti centrálnej paratetýdy (E. PLANDEROVÁ 1967 in Chronostratigraphie und Neostratotypen). Peľové spektrum sa vyznačuje bohatým výskytom morského planktónu, peľových zŕn ihličnatých i krytosemenných rastlín. Najchudobnejšie sú zastúpené spóry výtrusných, ale aj tie obsahujú asi 15 % celkového zloženia mikroflóry. V profile odkryvu som zistila, že na báze, odkiaľ pochádzajú skúmané vzorky, je zmiešané spoločenstvo spór, peľových zŕn dinoflagelát a rias, z ktorých posledné patria do planktónu v morskom alebo brakickom prostredí.

Vyššie horizonty odoberané z toho istého profilu obsahovali monospoločenstvo planktonických foriem a sporomorfy sa tam vyskytli v minimálnom množstve. Paleoekologicko-paleogeografickou rekonštrukciou som usúdila, že v priebehu ukladania slieňov od podložia do nadložia dochádzalo k transgresii a pôvodne lagunárne alebo pobrežné prostredie sa postupne stávalo hlbokomorským alebo aspoň vzdialeným od pobrežia. Na základe zloženia sporomorf usudzujeme na teplú, subtropickú klímu s vyvinutým močiarom *Taxodiaceae-Nyssaceae-Mastixiceae*, s prevahou hojných a relatívne sucho-teplomilných peľových zŕn rodu *Engelhardtia* a drevín rodu *Platycarya*. Ihličnany, ktoré sú hojne zastúpené, reprezentujú tiež dreviny na vyvýšených terénoch. Bylinná zložka nie je v peľových spektrách zastúpená vôbec. Podľa celkového zloženia sporomorf môžeme skúmané sedimenty zaradiť do mikrofloristickej zóny MF-3 (PLANDEROVÁ 1978).

Explanations to Plates LV—LXV

magn. 1000×
magn. 500× (fig. n.×)

Plate LV
1 *Pterospermella harti.* (SARJEANT) EIS
2—3 *Pleurozonaria concinna* (COOKSON MANUM) MÄDLER
4—5 Plankton incertae sedis

Plate LVI
1 *Pleurozonaria* sp.
2—3, 5 *Pleurozonaria concinna* (COOKSON MANUM) MÄDLER
4, 6 *Tithodiscus* sp.

Plate LVII
1—2 *Leiosphaeridia* sp.
3, 4 Plankton incertae sedis

Plate LVIII
1—2 *Leiosphaeridia* sp.
3—4 Plankton incertae sedis
5 *Pleurozonaria* cf. *concinna* (COOKSON MANUM) MÄDLER
6 *Leisphaeridia* sp.

Plate LIX
1 *Leiotriletes triangulus* (MÜRR. PF. ex KR. R. POT. GELL.) KR.
2—3 *Leiotriletes adriensis pseudomaximus* (TH. PF.) KR.
4 *Intrapunctatisporites* sp.
5—6 *Toroisporis teupitzensis* W. KR. *medioris* W. KR.
7 *Microfovealatisporites tuemlitzensis* W. KR.

Plate LX
1—2 *Leisphaeridia* sp.
3—4 *Punctatisporites* cf. *tannendorfensis* W. KR.
5 *Verrucingulatisporites granus granus* W. KR.
6 *Toroisporis* sp.
7 *Polypodiaceoisporites gracillimus* NAGY

Plate LXI
1—2 *Inaperturopollenites verrupapilatus* TREVISAN
3 *Inaperturopollenites* sp.
4—6 *Pityosporites labdacus* (R. POT) TH. PF.
7 *Pityosporites pristinipollinius* (TRAV.) W. KR.

Plate LXII
1 *Pityosporites labdacus* (R. POT.) TH. PF.
2 *Pityosporites alatus* (R. POT) TH. PF.
3—4 *Plicatopollis plicatus* W. KR.
5 *Pityosporites labdacus* (R. POT.) TH. PF.
6 *Carpinuspollenites carpinoides* (PF.) NAGY
7 *Reevesiapollis triangulus* W. KR.
8—9 *Momipites punctatus* (R. POT.) NAGY

Plate LXIII
1 *Triporopollenites* sp. 1
2 *Porocolpopollenites* sp.
3 *Platycaryapollenites* sp.
4 *Platycaryapollenites* sp.
5—6 *Platycaryapollenites miocaenicus* NAGY
7—8 *Engelhardtioidites microcoryphaeus* (R. POT.) R. POT.
9 *Myricipites* cf. *rurensis* (PF. TH.) NAGY
10—12, 15 *Caryapollenites simplex* (R. POT.) R. POT.
13 *Subtriporopollenites* sp.
14 *Caryapollenites* sp.

Plate LXIV
1—2 *Caryapollenites simplex* (R. POT.) R. POT.
3 *Intratriporopollenites insculptus* MAI
4 *Intratriporopollenites insculptus* photo SEM magn. 3000×
5—7 *Ilexpollenites illiacus* R. POT.
8—11 *Ilexpollenites illiacus* R. POT.
9 *Ilexpollenites margaritatus* (R. POT.) POT.
10 *Tricolporopollenites cingulum* ssp. *oviformis* (R. POT.) PF. TH.

Plate LXV
1—2 *Tricolporopollenites pseudocingulum* (R. POT.) TH. PF.
3 *Tetracolporopollenites microrhombus* PT. in TH. PT.
4 *Tricolporopollenites pacatus* PFLUG in TH. PF.
5 *Tricolporopollenites cingulum fusus* (R. POT.) TH. PF.
6 *Lithraceaepollenites bavaricus* THIELE-PFEIFFER
7—8 *Tricolporopollenites satzveyensis* PF. in Th-PF.
9 *Tricolporopollenites cingulum* (R. POT.) *fusus* (R. POT.) PF. TH.
10, 11 *Nyssapollenites kruschi* R. POT. ssp. *contortus* (PF. TH.) NAGY
12 *Tricolporopollenites* sp.
13 *Tricolporopollenites* cf. *villensis* (TH.) PF. TH.
14—15 cf. *Sambucus*
16 *Tricolporopollenites microhenrici* (R. POT.) W. KR.
17 *Tetracolporopollenites minimus* NAGY
18 *Tetracolporopollenites microrhombus* PF. in TH. PF. f. *minor* n. f. ssp.

Západné Karpaty, sér. palentológia, 9, P. 131—134, Geol. Úst. D. Štúra, Bratislava, 1984

Eva Planderová

Palynological evolution of Pannonian sediments from the West Carpathians

2 text-fig., 3 Pls. (LXVI—LXVIII), Slovak summary

Abstract. For the purpose of palynological characteristic of Pannonian sediments studied were samples ranged to the Pannonian of the basis of ostracods. In the pollen spectrum the pollen of Class Angiospermae dominated. They were rich in herbal species (Graminae, Compositae, Umbeliferae, Artemisia) indicative of a dry climate with vegetation of steppe character.

Microfloristic characteristic of the Pannonian sediments is based on the evaluation of two exploratory boreholes: N- 7 (248—284 m) near Vozokany and N- 8 (170—208 m) near Rohožník, in the area of the town Nitra (fig. 1) Regarding lithology, grey sandy clays alternate with sands and clays containing carbonized plant remains (fig. 2). These freshwater sediments contain ostracods determined by E. Brestenská.

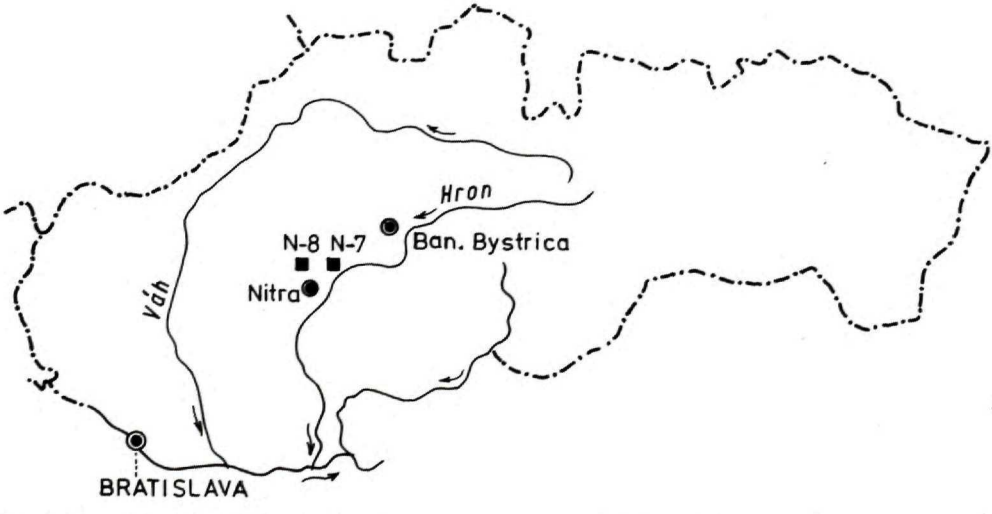

Fig. 1 Map of localities of Pannonian sediments sampled for palynological examination

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Microfloristic characteristic of the sediments is as follows: Spores of *Spermophyta* are less frequent in the Pannonian than in the Upper Sarmatian. They are mostly represented by the species *Leiotriletes microlepidoides* W. Kr., *Laevigatosporites haardti* Pf. Th., *Baculatisporites quintus* Pf. Th., *Baculatisporites nanus nanus* W. Kr., *Stereisporites stereoides stereoides* (R. Pot. Ven) Th. Pf., *Stereisporites magnoides* W. Kr., *Retitriletes pseudoclavatus* W. Kr., *Retitriletes reticuloides reticuloides* W. Kr., *Retitriletes annotinoides* W. Kr., *Selaginella* sp.

From the view of botany the spores are representative of *Spermophyta*, mostly of the classes *Pteridophyta, Lycopsida, Equisetopsida*. Among *Gymnospermae* most frequent were pollen of the species *Pinus silvestris* and a group of *Pinus Haploxylon, Picea* sp., *Tsugaepollenites* (R. Pot.) R. Pot. et Ven., *Tsugaepollenites viridifluminipites* Wood., *Cedrus* sp., *Taxodiceaepollenites* sp., *Inaperturopollenites magnus* (R. Pot. et Ven.) Pf. Th., *Sequoiapollenites polymorphosus* Thierg., *Cupressaccae* div. sp. and species of the genus *Ephedra*. *Angiospermae* were most frequent both in species and in genera, especially the pollen of *Betulaepollenites betuloides* (Pf.) Nagy, *Alnipollenites verus* R. Pot., *Myricipites rurensis* (Pf. Th.) Nagy., *Pterocaryapollenites stellatus* (R. Pot. et Ven.) Thierg., *Carpinuspollenites carpinoides* (Pf.) Nagy., *Juglanspollenites verus* Raatz., *Intratriporopollenites cordataeformis* (Wolff.) Mai, *Triporopollenites coryloides* Pf., *Quercoidites microhenrici* R. Pot., *Quercoides robur* — type., *Quercoidites petrea* — type.

Faguspollenites div. sp., *Salixipollenites* div. sp., *various herb* species, especially

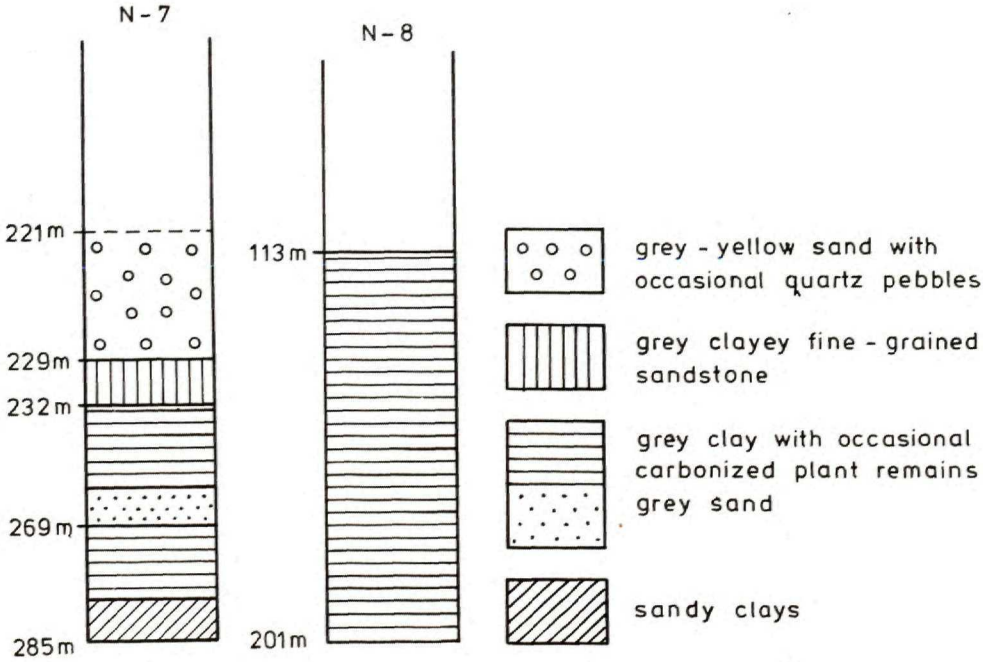

Fig. 2 Schematic profile of sediments of boreholes N-7 and N-8

grasses of the artificial species *Graminidites media* (COOKSON) R. POT., dominate over woody plants. Other herb species comprise: *Chenopodipollenites multiplex* WEYL. et PF. *Compositoipollenites cirsioides* sp. *Umbeliferae* sp., *Ericipites* sp. *Typha* sp., and others ranged to NAP.

The described microflora is indicative of steppe-forest vegetation partly of moderate highlands or mountain regions with spruces and sequoias in studied localities.

Marshes were reduced in that time, and the flora (*Typha*) was indicative of closed lakes with freshwater plankton species *Crassosphaera concinna* COOKSON et MORNEM) surrounded by steppe meadows with scarce woody plants of the above mentioned character. Pollen of coniferous woody plants — except pines (*Pinus* div. sp.) might have been blown from more distant areas. The representatives of the genus *Ephedra* are dry substratus. The same is proved by grass pollen and herb pollen, especially of the genus *Artemisia* dominant over the others.

A comparison between the Pannonian and the Sarmatian flora (E. PLANDEROVÁ 1972) shows a gradual change of vegetation from the rich subtropical to the steppe vegetation impoverished in many species of woody plants and especially of *Spermophyta* and sponges demanding humid substratum. So already at the end of the Sarmatian and the Pannonian there must have been arid, mild warm climate with vegetation limited both in genera and in species, in our region. In the Pontian (E. PLANDEROVÁ 1972) the vegetation is richer in species than in the Pannonian, although subtropical vegetation is not represented anymore.

A comparison to palyonological data from Hungary (E. NAGY 1958) shows indications of a warmer climate affected by the near sea. The character of microflora was also influenced by a warmer and more humid climate than in our country.

Conclusion

The results of the study of Pannonian microflora are as follows:

1. The character of microflora in the area of Central Paratethys in the Pannonian time was determined.
2. Herbal, and especially grass types dominate in microflora over woody plants which were prevalent in the Sarmatian time. Percentage of thermophilous and hydrophilous woody plants decreased and slope woody plants and coniferous of higher areas increased.
3. Paleoecological study showed that the climate got more arid, hydrophilous marshes of *Taxodiaceae* — *Myricaceae Nyssaceae* types changed into closed lakes.
4. Correlation with Pannonian spore-pollen spectra from Hungary showed different climatic conditions in the West Carpathians and also different flora. The Pannonian flora in Hungary (E. NAGY 1958) was still rich in hydrophilous subtropical species — in contrast to our flora.

References

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PLANDEROVÁ, E. 1972: Pliocene sporomorphs from the West Carpathians mountains and their stratigraphic interpretation. Geol. Práce, Správy 59, Geol. Úst. D. Štúra, Bratislava, 209—283.

Eva Planderová

Palinologický vývoj panónskych sedimentov zo Západných Karpát

Resumé anglického textu

Pre palinologickú charakteristiku panónskych sedimentov autorka vyhodnotila vzorky, ktoré boli zaradené do tohto stupňa na základe ostrakódovej fauny. Zistilo sa, že v peľovom spektre prevládajú peľové zrná triedy *Angiospermae* najbohatšie na bylinné druhy (*Graminae, Compositae, Umbeliferae, Artemisia*), ktoré indikujú suchšiu klímu so stepným charakterom vegetácie.

Explanations to Plates LXVI—LXVIII

Plate LXVI

1 *Stereisporites stereoides* (R. POT. VEN.) TH. PF. magn. 1000×
4 *Stereisporites stereoides* (R. POT. VEN) TH. PF. SEM magn. 2800×
2 *Retitriletes annotinoides* W. KR. magn. 1000×
3, 5 *Retitriletes annotinoides* W. KR. SEM magn. 2800×
6 *Retitriletes annotinoides* W. KR. SEM det. magn. 6000×

Plate LXVII

1—2 *Pinus silvestris* type; magn. 1000×
3 *Pinus haploxylon* type; magn. 1000×
4—5 *Pinus haploxylon* type; SEM magn. 1200×
6 *Picea* sp. magn. 800×
7 *Ephedra* cf. *distachya* magn. 2000×

Plate LXVIII

1—2 *Alnipollenites verus* R. POT. magn. 1000×
3 *Juglanspollenites verus* RAATZ; magn. 1000×
8 *Juglanspollenites verus* RAATZ; SEM magn. 1500×
4 *Ulmipollenites undulosus* WOLFF; magn. 1000×
5 *Ulmipollenites undulosus* WOLFF; SEM magn. 2000×
6 *Quercoidites* sp., magn. 1000×
7 *Caryapollenites simplex* (R. POT.), R. POT. magn. 1000×
9 *Compositoipollenites* sp., magn. 1000×
10 *Graminidites media* (COOKSON) R. POT., magn. 1000×
11 *Chenopodipollenites multiplex* (WEYL. POT.) W. KR. magn. 1000×
12 *Jusiaeapollenites champlainensis* (TRAVERSE) NAGY; magn. 1000×

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Paulína Snopková

Lower Devonian palynomorphs from Drnava Formation of Gelnica Group in Spišsko-gemerské rudohorie Mts. (West Carpathians)

1 text-fig., 6 Pls. (LXIX-LXXIV), Slovak summary

Abstract: The author presents morphological description of palynomorphs from phyllite and lydite samples from 15 profiles of the Drnava Formation in the Gelnica Group (Spišsko-gemerské rudohorie ore mountains). Described are 11 species of the group *"Acritarcha"* and 21 species of trilete spores. Most of them are most frequent in the Lower Devonian.

Introduction

I present systematic description of palynomorphs from lydites and phyllites of the Drnava Formation. The Drnava Formation is the youngest stratigraphical-lithological member of the Gelnica Group. Lithological and petrographical research in the Drnava Formation of the Gelnica Group (L. Snopko — A. Vozárová 1981) showed distinct signs of rhytmical sedimentation on its sedimentary members.

In lower parts of larger sedimentary rhythms a complex of lithofacies of coarse-grained quartzs sandstones dominates. In central parts dominant are laminated phyllites passing gradually in sediments with hidden bedding. They form upper parts of rhythmical sedimentation. Lydites occur in all lithofacies; they are, however, most frequent in fine laminated phyllites and graphitic phyllites (J. Ilavský 1953: J. Ilavský — G. Kupčo — P. Snopková 1985).

The formation was denoted with its name for the first time by O. Fusán (1963) on the basis of his own and A. Klinec's (1958) work. Although the present opinion about lithology and volcanism of the formation is not quite modern, it is based on early data by M. Kuthan (1950), (the Drnava and the Uhorná series). Then the bed complexes were defined for the first time and served as basis for further study of the formations in the Gelnica Group. The results of investigations in this area were published by A. Klinec (1958, 1959), M. Máška (1956), J. Ilavský (1953), L. Snopko (1967), J. Šuf (1932), P. Grecula (1965, 1970), D. Onačila (1978).

Palynological research of the Drnava Formation was performed on samples from 15 profiles, mainly from lydite levels and from dark fine-grained phyllites (Fig. 1). Most researches were performed at Drnava — Pipítka, Malá Pipítka, Smolnícke Mýto, Smolník, Beckengrund, Smolnícka Huta. Detailed geological cross sections

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are in works by L. SNOPKO — A. VOZÁROVÁ (1981). P. SNOPKOVÁ (1979) and J. ILAVSKÝ — G. KUPČO — P. SNOPKOVÁ (1985) presented palynomorph assemblages from samples from the studied cross sections, and their stratigraphic range as a basis for the age determination of the Drnava Formation. Here I present only palynomorphs with certain morphological characters (they are poorly preserved because of epimetamorphosis) enabling me to describe the palynomorphs. I described 11 representatives of the group *"Acritarcha"* and 21 species of trilete spores. They are the first palynomorphs found in the Drnava Formation. On the basis of the palynomorphs the formation is ranged to the Lower Devonian.

Systematical range and description of the palynomorphs are based on works by C. DOWNIE — W. EVITT — V. A. S. SARJEANT (1963), F. H. CRAMER (1964, 1973), F. MARTIN (1968, 1973), R. RAUCHER (1973), A. MOREAU — BENOIT (1974, 1976, 1980), E. V. TSCHIBRIKOVA (1972, 1977), K. C. ALLEN (1965), J. B. RICHARDSON (1965), J. B. RICHARDSON — T. R. LISTER (1969), E. P. LANNINGER (1968), D. C. MC GREGOR (1973, 1977).

Palynological description

ACRITARCHA EVITT, 1963

Acanthomorphitae DOWNIE, EVIT et SARJEANT, 1963

Baltisphaeridium (EISENACK 1958) emend STAPLIN, JANSONIUS — POCOCK 1965

Type species *Baltisphaeridium longispinosum* EISENACK 1959

cf. *Baltisphaeridium guillermi* CRAMER 1984

Pl. LXIX, Fig. 1

1964: *Baltisphaeridium guillermi* n. sp. — CRAMER, Pl. IV. Fig. 10, p. 294—295.

Description: The body is oval. Hollow, about 4 μ long projections are running out of the body in almost equal distance from one another. Some less conspicuous projections have rose-like ends like on the species *Baltisphaeridium guillermi* CRAMER. The described specimen is highly corroded. According to the shape of its test and hollow projections it may be ranged to the species *B. guillermi.*

Occurrence: Scarce; localities: Smolnícka Huta, Ober der Kirche, sample 636/79.

Stratigraphical range: Middle Siegen — Ems, NW Spain (F. CRAMER 1964).

Micrhystridium DEFLANDRE 1937 emend DEFLANDRE-EISENACK-SARJEANT 1963

Type species *Micrhystridium inconspicuum* (DEFLANDRE, 1935)

? *Micrhystridium raspa* CRAMER, 1964

Pl. LXIX, Fig. 9

1964: *Baltisphaeridium raspa* n. sp. — CRAMER; Pl. IV, Fig. 1, 2, 3, p. 301
1965: *Micrhystridium raspa* — DEFLANDRE et DEFLANDRE RIGAUD, p. 402.
1968: *Micrhystridium raspa* (CRAMER) DEFLANDRE et DEFLANDRE - RIGAUD - MARTIN, Pl. III, Fig. 145, 146, 157; Pl. V, Fig. 241, 242; Pl. VIII, Fig. 377, 384, p. 77.

Description: The body is circular. Size 15 μ. Projections are 3—5 μ long. Fifteen of them are visible under optical microscope.

Remark: The specimen described has the size, shape and length of projections of the original species. It is poorly preserved, dark, the projections are inconspicuous. It may perhaps be ranged to *B. raspa* (CRAMER 1964) DEFLANDRE et DEFLANDRE — RIGAUD 1965.

Occurrence: Scarce on the confluent of Veľký and Malý Beckengrund, sample 500/79, 8a.

Stratigraphical range: Upper Silurian, Lower Devonian of NW Spain (F. CRAMER 1964), Ordovician, Silurian of Belgium (F. MARTIN 1968).

? *Micrhystridium lapellum* LOEBLICH — WICANDER 1976

Pl. LXIX, Fig. 10

1976: *Micrhystridium lapellum* LOEBLICH et WICANDER n. sp. — LOEBLICH, ALFRED R. and WICANDER, E. REED; Pl. 6, Fig. 3, p. 18.

Description: The test is oval. Size: 18 μ. Small (1—1,5 μ) projections, slightly widened at their base, pointed at their ends. There are 12 visible projections. The test surface, is corroded. Under dark graphitic coat are 4—5 μ large mish-like ornaments.

Remark: The species may belong to *M. lapellum* LOEBLICH — WICANDER but they only have the same size and shape of projections, other characters cannot be identified because of poor preservation.

Occurrence: Scarce; loc. Smolnícka Huta, Ober der Kirche, sample 635/79.

Stratigraphical range: Upper Gedin, Oklahoma, U.S.A.

Polygonomorphitae DOWNIE — EVITT — SARJEANT 1963
Veryhachium DEUNFF, 1954

Type species *Veryhachium trisulum* (DEUNFF 1951)

Veryhachium cf. *helenae* CRAMER, 1964

Pl. LXIX, Fig. 3, 4

1964: *Veryhachium helenae* n. sp. — CRAMER, Pl. XIII, Fig. 10, 11, 12; text-figure 30, 14, 16; p. 313.

Description: Size 20 μ. The central body is triangular. On its corners are 3 about 5 μ long projections, slightly bifurcated on their ends (Pl. XXXIX, Fig. 3). The specimen on Fig. 3 has only 1 projection preserved and that on Fig. 4 has 2 complete projections. The surface is coated with graphite. There are fine hairs visible on margins.

Remark: The specimens have the body shape, size of the body and of projections like the original species.

Occurrence: Scarce; confluent of Veľký and Malý Beckengrund; sample 500/79, 8a.

Stratigraphical range: F. CRAMER (1964) found the species in the Lower Devonian (Siegen — Ems).

cf. *Veryhachium valientae* CRAMER, 1964

Pl. LXIX, Fig. 2

1964: *Veryhachium valientae* n. sp. — CRAMER; Pl. XII, Fig. 3, 4, 6, text.-figure 28, 7, 8, 9, p. 311.

Description: The body is quadrangular. Size: about 30 μ. Projections are extensions of walls of the quadrangle. Two well preserved projections are hollow in the visible parts. The surface of the central body is highly corroded.

Remark: The specimen depicted in Pl. LXIX, Fig. 2 may correspond to *V. valiente* CRAMER with its shape, position of projections and size.

Occurrence: Scarce; loc. Smolnícka Huta, sample 636/79.

Stratigraphical range: Upper Ludlowian — Ems (F. CRAMER 1964).

Veryhachium cf. *minutum* DOWNIE 1958

Pl. LXIX, Fig. 5, 6

1958 *Veryhachium minutum* n. sp. — DOWNIE; Pl. 17, Fig. 4, p. 334.

Description: The central body is quadrangular. Projections run out of the corners of the quadrangle. Size: 5—6 μ. General size: about 10 μ. There is a small slot in the middle of the body. The specimen depicted in Pl. LXIX, Fig. 5 is from thin-section, that in Fig. 6 was obtained by maceration.

Remark: The specimens correspond to the original species by their size and shape. Formerly the species only occurred in the Ordovician, partly in the Silurian. It might have been redeposited in the studied material.

Occurrence: Scarce; loc. Smolnícka Huta, sample 636/79; Uhorná — Kotlinec, Veľký Beckengrund, 488/79.

Stratigraphical range: Upper Tremadocian in England; Lower Tremadocian, ? Arening in Belgium (F. MARTIN 1968).

Sphaeromorphitae Downie — Ewitt — Sarjeant 1963
Synsphaeridium Eisenack, 1965

***Synsphaeridium* cf. *sorediforme* (Timofeev 1959).**

Pl. LXIX, Fig. 7, 8

1959: *Protoleiosphaeridium sorediforme* n. sp. — Timofeev; Pl. 1, Fig. 25, p. 26.
1974: *Synsphaeridium* cf. *sorediforme* (Timofeev 1959) — Moreau — Benoit, Pl. 6, Fig. 13, 14; p. 117—117.

Description: Globular forms. Size: 5—6 μ. They are in clusters. The form depicted in Pl. LXIX, Fig. 8 has four cells, in Fig. 7 six cells.

Remark: Forms occurring in the studied sediments correspond to specimens found by A. Moreau-Benoit (1974) in the Silurian of the Armoric Massif (Pl. 6, Fig. 13, 14).

Occurrence: Scarce; loc. Uhorná — Kotlinec, Veľký Beckengrund, sample 2 b, 487/79.

Stratigraphical range: Silurian — Sahara (A. Combasz 1967), France — Armoric Massif (A. Moreau-Benoit 1974).

Herkomorphitae Downie — Ewitt — Sarjeant, 1963
Cymatiosphaera O. Wetzel 1933 emend Deflandre 1954

Type species *Cymatiosphaera rachiata* O. Wetzel 1933

***Cymatiosphaera* cf. *pavimenta* Deflandre, 1954**

Pl. LXIX, Fig. 11

1945: *Micrhystridium pavimentum* Deflandre — Deflandre; Pl. 3, Fig. 20, 21, p. 68 (non vidi).
1954: *Cymatiosphaera pavimenta* — Deflandre, p. 257—258.
1968: *Cymatiosphaera pavimenta* (Deflandre) Deflandre-Martin; Pl. VI, Fig. 296, p. 136.
1976: *Cymatiosphaera* cf. *pavimenta* (Deflandre 1944) — Deunff; Pl. 14, Fig. 9, 10; p. 69.

Description: The test is circular. Size: 14 μ. On the surface are distinct polygonal areas (5 μ). Columns connecting septa which form a fringe around the test body, are not preserved.

Remark: The species with distinct polygonal areas on the test surface and with the corroded rim corresponds to the species found by J. Deunff (1976) in the Upper Silurian of Montagne Noire.

Occurrence: Scarce, loc. Smolnícka Huta, sample 636/79.

? *Cymatiosphaera multisepta* DEUNFF, 1955

Pl. LXIX, Fig. 12

1955: *Cymatiosphaera multisepta* n. sp. — DEUNFF; text. Fig. 23; p. 147
1968: *Cymatiosphaera multisepta* DEUNFF — MARTIN; Pl. II; Fig. 91, 92; Pl. VIII; Fig. 381, p. 135.

Description: The test is circular. Size 10—12 μ. The test is dark, so the polygonal areas and rib-like septa on the periphery of the central body are indistinct.

Remark: The specimen depicted in Pl. LXIX, Fig. 12 may belong to *C. multisepta* DEUNFF. according to its size, shape, indistinct septa and polygonal areas.

Occurrence: Cross section Drnava — Pipítka: phyllites, sample I/1/76.

Brochopsophosphaera SCHEPELEVA 1962

Brochopsophosphaera cf. *diligens* var. *parva* TSCHIBR. 1972

Pl. LXIX, Fig. 13, 14

1972: *Brochopsophosphaera diligens* var. *parva* sp. nov. et var. nov. — TCHIBRIKOVA; Pl. Fig. 8—9, p. 171.

Description: The size of test is 15—20 μ. The shape is semiglobular. Tests are dark. Visible are small (or 1,0—2,0 μ) pentagonal and hexagonal sculptural elements.

Remarks: The specimen depicted in Pl. XIX, Fig. 13 differs from the original in irregularly waved tests margins. Their size and sculptural elements are the same.

Occurrence: Regular; loc. Smolnícka Huta, Ober der Kirche, sample 635/79, Uhorná — Kotlinec, Veľký Beckengrund, sample 487/79.

Stratigraphical range: Silurian — Lower Devonian (E. V. TSCHIBRIKOVA 1972, 1977).

Dictyopsophosphaera, NAUMOVA, 1964

cf. *Dictyopsophosphaera polygonia* (STAPL.) TSCHIBR., 1972

Pl. LXIX, Fig. 15

1961: *Dictyotidium polygonium* sp. nov. — STAPLIN; Pl. 49; Fig. 14; p. 417.
1972: *Dictyopsophosphaera polygonia* (STAPLIN) comb.-nov. — TSCHIBRIKOVA; Pl. XV, Fig. 11, 12, p. 177—178.

Description: Semioval tests have the size of 15—25 μ. Reticulate sculpture is distinct on both specimens. The oval shape is disturbed by corrosion.

Occurrence: 2 specimens, loc. Smolník — Markscheidergrund, sample 1996/78, occurrence 3, sample 1b, lydites, cross section Drnava — Pipítka, dark phyllites.

SPORITES H. POTONIÉ 1893
Triletes (REINSCH. 1881) POTONIÉ et KREMP 1954
Azonotriletes LUBER 1935
Laevigati (BENIE et KINDSTON 1886) POTONIÉ et KREMP 1954
Leiotriletes (NAUMOVA 1937) POTONIÉ et KREMP 1954
Type species *Leiotriletes sphaerotriangulatus* (LOOSE) POT. et KREMP 1954

Leiotriletes cf. _simplex_ NAUMOVA 1953
Pl. LXIX, Fig — 17

1953: *Leiotriletes simplex* sp. n. — NAUMOVA, Pl. 1, Fig. 2, p. 21.
1974: *Leiotriletes* sp. — GHERASI — VISARION — ZIMERMANN JORDAN, Pl. II, Fig. 11, p.
1976: *Leiotriletes* cf. *simplex* NAUMOVA 1953 — MOREAU-BENOIT, Pl. 4, Fig. 7, 8, p. 29.

Description: A trilete miospore; triplanar; size 32 μ. The surface is dark, only a small exposed part indicates intrapunctate sculpture. The Y-mark is not visible.
Remarks: The miospore is larger than the original species. It is identic with miospores of synonymy, only it is poorly preserved.
Occurrence: Scarce; loc. Smolník — Kotlinec, sample 2003/78, lydites.
Stratigraphical range: Silurian — Tertiary.

Punctatisporites (IBR. 1933) POTONIÉ et KREMP 1954
Type species *Punctatisporites punctatus* IBRAHIM 1933

Punctatisporites cf. _solidus_ (NAUMOVA 1953)
Pl. LXX, Fig. 5

1953: *Trachytriletes solidus* NAUM. — NAUMOVA, Pl. 18, Fig. 10, p. 121
1974: *Punctatisporites solidus* (NAUMOVA 1953) — MOREAU — BENOIT, Pl. 11, Fig. 15, p. 164.

Description: Oval spore, depressed on sides. Size: 42 μ. The Y-mark is thin, extending almost to the margin of the wall of spore. The surface is tightly punctate. The dots look like small fovae. The spore is well preserved.
Remark: The spore belongs most likely to *Punctatisporites solidus* NAUM. It is larger than the original species. It is analogous to the species found by A. MOREAU-BENOIT (1974) in the Lower Devonian of the Armoric Massif.
Occurrence: Scarce; loc. Smolník — Markscheidergrund, occur. 3, sample 1998/78, Smolník — Beckenhöhe, sample 1993/78, lydites.
Stratigraphical range: Silurian, Devonian, Carboniferous-Permian, S. N. NAUMOVA (1953), Upper Silurian — Lower Devonian, France (R. RAUCHER 1969, A. MOREAU-BENOIT 1974).

Retusotriletes (NAUMOVA) STREEL 1964

Type species *Retusotriletes simplex* NAUMOVA 1953

***Retusotriletes* cf. *divulgatus* TSCHIBRIKOVA var. *plicatus* TSCHIBRIKOVA 1972**

Pl. LXX, Fig. 1

1972: *Retusotriletes divulgatus* TSCHIBRIKOVA var. *plicatus* TSCHIBR. var.-nov.-TSCHIBRIKOVA, Pl. 3, Fig. 3—8, p. 114—115.

Description: A circular-triangular spore. Size: 58 μ. The spore surface is covered with small (0,5—1,0 μ) spines. The Y-mark is thin and occupies about 3/4 of the exine. The rays are bifurcated on their ends. Characteristic folds on the surface of exine are indistinct on the depicted specimen.

Occurrence: Scarce, loc. Smolník, Kompas II—III, sample 2001/78.

Stratigraphical range: E. V. TSCHIBRIKOVA (1972) found the species in the Lower Eifel in South Ural, scarcely in the Lower Devonian.

***Retusotriletes* cf. *insperatus* var. *gracilis* TSCHIBRIKOVA 1972**

Pl. LXIX, Fig. 18, Pl. LXX, Fig. 6

1972: *Retusotriletes insperatus* var. *gracilis* TSCHIBR. sp. et var. nov. — TSCHIBRIKOVA; Pl. 4, Fig. 7, 8, p. 122—123.

Description: Oval shape. Size: 30—35 μ. Thickness: 1 μ. The exine surface is covered with short spines (1 μ). Sculptural elements look as small dense reticules. The Y-mark is distinct.

Remark: The described spore differs from the original species in being smaller.

Occurrence: Scarce; locality Smolník — Beckenhöhe III, occurrence 4, sample 1a, 1999/78, lydites; cross section Drnava — Pipítka, sample I/13/76, phyllites.

Stratigraphical range: ? Middle (scarcely Lower) Devonian (E. V. TSCHIBRIKOVA 1972).

Apiculati (BENIE et KINDSTON) POTONIÉ 1956

***Apiculiretusispora* STREEL 1964 emend. STREEL 1967**

Type species *Apiculatasporites brandtii* STREEL 1964

? *Apiculiretusispora cherata* RICH. — LIST. 1969

Pl. LXXI, Fig. 3, 4, 5

1969: *Apiculiretusispora cherata* sp. nov. — RICHARDSON — LISTER; Pl. 37, Fig. 13—14, p. 219.
1980: *Apiculiretusispora cherata* RICHARDSON-LISTER 1969, MOREAU-BENOIT, Pl. 7, Fig. 14, p. 65.

Description: The test is oval to triangular. Size: 32—45 μ. The exine surface is

covered with 1—3μ large spines. They are arranged in circles on the exine surface. The spines are 0,5—1,5 μ wide at their base. The Y-mark is distinct, the rays are straight with contact areas on their ends. The spores are partly damaged.

Remark: Miospores found in lydites, differ from the species in synonymy in less distinct spines (perhaps because of corrosion).

Occurrence: Scarce; loc. Smolnícka Huta — Ober der Kirche, sample 634/79, lydites; Smolník — Kompas II—III, sample 2001/78.

Stratigraphical range: Lower Devonian in England, South Wales; Lower Devonian — Armoric Massif — Bodennec in France, Upper Gedin — Siegen — Armoric Massif (A. MOREAU-BENOIT 1980).

Dibolisporites RICHARDSON 1965

Type species *Dibolisporites echinaceus* (EISENACK) RICHARDSON 1965

***Dibolisporites* cf. *quebecensis* MC. GREGOR 1973**

Pl. LXXI, Fig. 7—8

1973: *Dibolisporites quebecensis* n. sp. — MC. GREGOR; Pl. 3, Fig. 11 a 14—16, p. 32—33.

Description: The spore is oval to triangular. Size: 25—30 μ. The trilete mark of the spore is well visible on Pl. XXI, Fig. 8; it occupies about 3/4 of the spore body. The spore on Fig. 7, Pl. LXXI shows distinct sculptural elements (dense sticks and spines) also on the margin of the spore exine. The Y-mark is inconspicuous.

Remark: The specimens depicted in Fig. 7—8. Pl. LXXI differ from the original species because they are partly damaged. Their size and sculptural elements correspond to those of the holotype.

Occurrence: Scarce; loc. Uhorná — Kotlinec, Veľký Beckengrund, loc. Smolník — Kompas II—III, sample 2001/78, Nr. 250/28.

Stratigraphical range: Lower Devonian (Ems), East Gaspé — Canada (D. C. MC. GREGOR 1973).

***Dibolisporites* cf. *eifeliensis* (LANNINGER) MC GREGOR 1973**

Pl. LXXI, Fig. 9

1968 *Anapiculatisporites eifeliensis* sp. nov. — LANNINGER; Pl. 22, Fig. 11, p. 124
1973: *Dibolisporites eifeliensis* (LANNINGER) n. comb. — MC GREGOR; Pl. 3, Fig. 17—22 and 26, p. 31.

Occurrence: Scarce, loc. Smolník — Kompas I, II, III, sample 2000/78, No. 249/78.

Stratigraphical range: Devonian (Ems — Eifel), the Gaspé Formation, East Canada (D. C. MC. GREGOR 1973), Lower Devonian (Ems), LM-Eifel (E. P. LANNINGER 1968), the Armoric massif (Lower Ems), (A. MOREAU-BENOIT 1976).

Verrucosisporites (IBRAHIM 1933) SMITH et BUTTERWORTH 1967

Type species *Verrucosisporites verrucosus* (IBRAHIM) IBRAHIM 1932

Verrucosisporites ? polygonalis **LANNINGER 1968**

Pl. LXX, Fig. 2

1968: *Verrucosisporites polygonalis* sp. nov. — LANNINGER; Pl. 22, Fig. 19, p. 128.
1973: *Verrucosisporites ? polygonalis* LANNINGER - MC GREGOR; Pl. 4, Fig. 16, 17, 19; p. 25, 26; p. 37—38.

Description: A trilete spore. Size: 48 μ. The spore is oval-triangular. The papillae are so dense that they form a polygonal reticle. The Y-mark and the characteristic "tectum" are indistinct. In the middle of the spore they are partly covered with graphitic coat.

Remark: The spore differs from the original species described by E. P. LANNINGER (1968) in its smaller size and in the indistinct tectum around the Y-mark. Sculptural elements and the shape of the spore correspond to those of the original species and to species found by D. C. MC GREGOR (1973) in the Lower Devonian (Ems) in East Canada.

Occurrence: Scarce; loc. Smolník — Beckenhöhe, occurrence 2, sample 1993/78.

Stratigraphical range: Lower Devonian — Lower Ems (loc. Eifel), Lower Devonian (Ems) of East Canada.

Bullatisporites ALLEN 1965

Type species *Bullatisporites bullatus* ALLEN 1965

cf. Bullatisporites bullatus **ALLEN 1965**

Pl. LXXIII, Fig. 1

1965: *Bullatisporites bullatus* sp. nov. ALLEN, Pl. 96, Fig. 5—7, p. 703.

Description: An oval trilete spore, with a distinct trilete mark. Its rays are straight, bifurcated on the ends like in the genus Retusotriletes. The surface is covered with small spines, about 1 μ high. On the surface are (most likely secondary) knobs (2—5 μ in size) which partly cover the primary spinose sculpture. Size: 80 μ. A fold on the distal end of the spore is also covered with knobs.

Remark: With its oval shope, spinose sculpture and the course of the Y-mark the spore corresponds to the holotype, only its knobs are larger.

Occurrence: Scarce; cross section Linkeš — Pipítka, sample I—III — 27/77, lydites.

Stratigraphical range: Siegen-Eifel-Spitzbergs (K. C. ALLEN 1965).

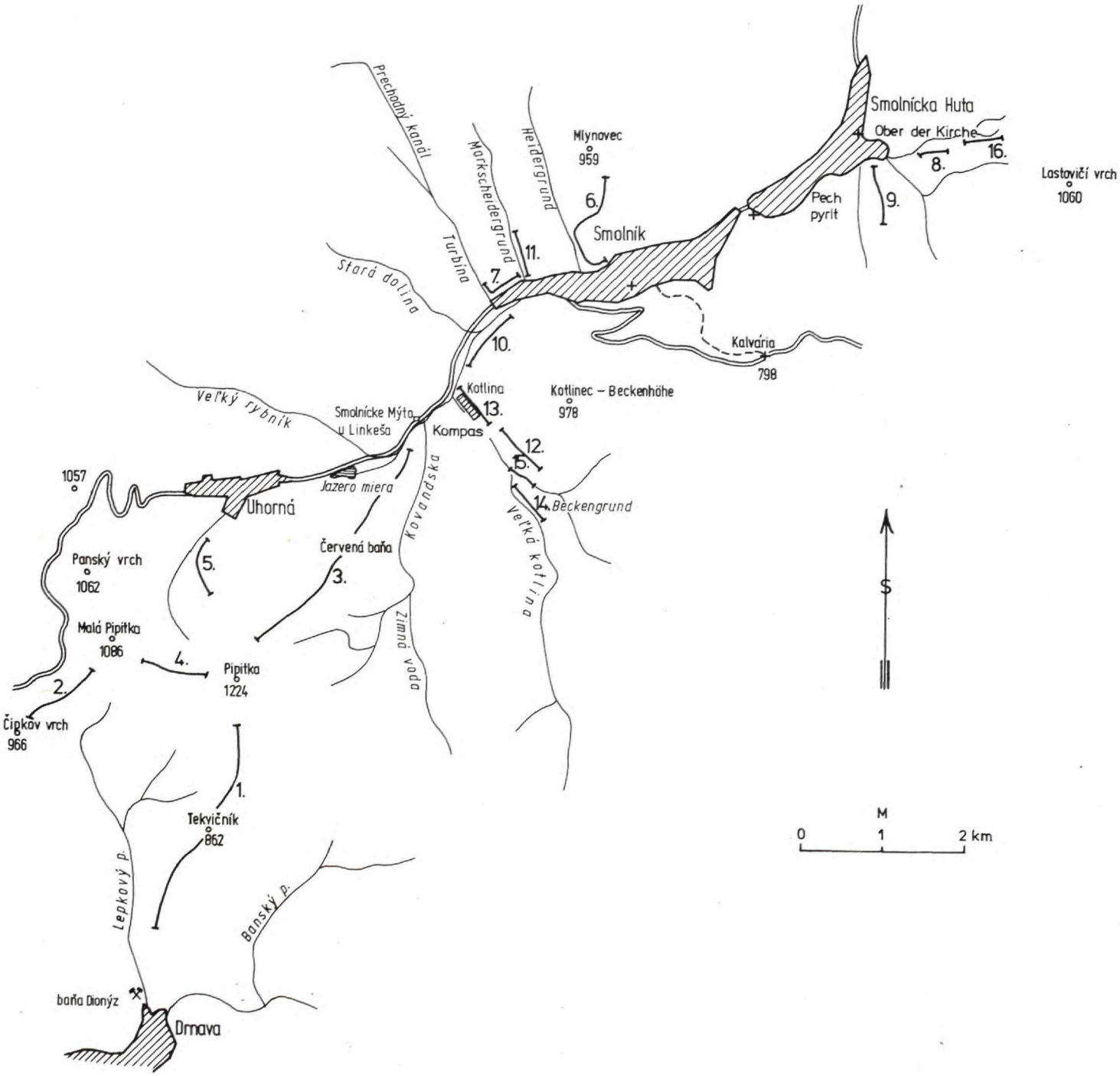

Fig. 1 Profiles and boreholes studied by palynological methods

Acanthotriletes (NAUMOVA) POTONIÉ et KREMP 1954

Type species *Acanthotriletes ciliatus* (KNOX) POTONIÉ et KREMP 1954

Acanthotriletes parvispinosus **NAUM. var. *rotundus* TSCHIBRIKOVA 1972**

Pl. LXX, Fig. 8

1973: *Acanthotriletes parvispinosus* NAUM. var. *rotundus* TSCHIBRIKOVA, var. nov. — TSCHIBRIKOVA; Pl. 1, Fig. 7; p. 94—95.

Description: The round spores range to 17 μ in size. The exine thickness is about 1 μ. The surface of the exine is covered with short spines. They are equilateral and range to 0,5—1,0 μ in length and height. The trilete mark is thin, distinct. The rays extend almost to the periphery of the exine. The rays are bifurcated on ends.

Remark: With their shape, sculptural elements and size the spores correspond to the original species.

Occurrence: Scarce; loc. Smolnícka Huta, sample 637/79; loc. at the confluent of Veľký and Malý Beckengrund, No. 500/79.

Stratigraphical range: Lower Devonian — Chlebodarskaja suite (E. V. TSCHIBRIKOVA 1972).

Acanthotriletes* aff. *denticulatus **NAUMOVA 2**

Pl. LXXI, Fig. 1

1953: *Acanthotriletes denticulatus* NAUM. sp. nov. NAUMOVA; Pl. V, Fig. 33, p. 49.

Description: A circular-triangular spore. Size: 20 μ. The exine is covered with dense small spines (0,5—1,5 μ). They extend behind the exine margins and are there even 1—1,5 μ. They have the form of an equilateral triangle. From the Y-mark only one straight ray is visible. A half of the exine is covered with graphitic coat.

Remark: Our specimen differs from the species depicted on Pl. I, Fig. 6, p. 94, by E. V. TSCHIBRIKOVA (1971) in spines extending behind the spore margins, being less dense and longer. The Y-mark is not visible.

Occurrence: Scarce; loc. Smolník — Markscheidergrund, sample 1 d, No. 1998/78, No. 247/78.

Stratigraphical range: Lower Devonian (West Bakshiria E. V. TSCHIBRIKOVA 1972).

Murornati POTONIÉ et KREMP 1954

Dictyotriletes (NAUMOVA 1953) POTONIÉ et KREMP 1954

Type species *Dictyotriletes mediareticulatus* IBRAHIM 1933

Dictyotriletes cf. *peculiaris* Tschibrikova 1972

Pl. LXX, Fig. 9, 10

1971: *Dictyotriletes peculiaris* n. sp. — Tschibriková, Nadler, Pl. I, Fig. 11—16, p. 131.
1972: *Dictyotriletes peculiaris* Tschibriková — Tschibriková Pl. II, Fig. 6—10, p. 106.

Description: An oval spore. Size: 14—16 μ. The exine is about 1,0 thick, with dense reticular elements giving it a dentate appearance with a widened base (0,1 μ; Pl. XL, Fig. 9), the Y-mark is indistinct. It is only on spore depicted in Pl. LXX, Fig. 9.

Remark: The species from the Drnava Formation correspond in their sculptural elements, size and shape to the species found by E. V. Tschibrikova (1972), Pl. II, Fig. 6—10, p. 106 in the Lower Devonian of West Bashkiria. They differ only in less distinct Y-mark and inconspicuous "area" on one of the rays of the Y-mark, and in smaller reticles.

Occurrence: Scarce; loc. Smolnícka Huta — Ober der Kirche, sample 664/79.

Stratigraphical range: Lower Devonian — West Bashkiria, Ems — Spitzbergs, Canada.

Camptotriletes Naumova 1939 ex Potonié et Kremp 1954

Type species *Camptotriletes corrugatus* (Ibrahim) Potonié et Kremp 1954

cf. *Camptotriletes dubius* Mc Gregor 1973

Pl. LXX, Fig. 7

1973: *Camptotriletes dubius* n. sp. — Mc Gregor, Pl. V, Fig. 9—11, 13—14, p. 42.

Description: The spore is oval — triangular. The exine is about 2 μ thick. The spore is covered with conical sculptural elements. They are partly connected in a reticle. Inside every reticle and in interstices a baculate structure is visible. The Y-mark is indistinct because of dark surface. The rays are straight and extend to the equator. The size of spore is 25 μ.

Remark: The spore is well preserved. With its size, shape and sculptural elements it corresponds to the original species.

Occurrence: Scarce; dark phyllites, cross section Drnava — Pipítka, sample I/13/76.

Stratigraphical range: Lower Devonian (Ems), Canada — Battery Point Formation (D. C. Mc Gregor 1973).

Emphanisporites Mc Gregor 1961

Type species *Emphanisporites rotatus* Mc Gregor 1961

cf. *Emphanisporites minutus* ALLEN 1965
Pl. LXXI, Fig. 6

1965: *Emphanisporites minutus* sp. nov. — ALLEN, Pl. 97, Fig. 20, p. 709.

Description: Trilete oval spore, partly depressed on sides. The trilete mark is indistinct, the rays are straight. The exine is 2—3 μ thick, infragranulate. On the proximal surface are about 15—25 radial ribs, 0,5—1 μ wide. They are partly corroded toward the centre of the spore. Size: around 23 μ.

Remark: The spore agrees in its morphological characters with the holotype, only it is partly corroded.

Occurrence: Scarce; cross section Drnava — Pipítka, sample I/13/76, dark phyllites.

Stratigraphical range: Gedin-Lower, Spitzbergs (K. C. ALLEN).

cf. *Emphanisporites*
Pl. LXXI, Fig. 10—11

Description: The spore is oval, with the exine 2 μ thick. The surface is graphitized; the margins are exposed and show ribs and the spinose sculpture. Other morphological signs are covered. Size: about 39 μ.

Remark: The spores are dark; their exposed sculptural elements and radial ribs are indicative of the genus Emphanisporites.

Occurrence: Scarce; cross-section Drnava — Pipítka, sample 1/12/76, dark phyllites.

Perinotriletes ERDTMAN 1947
Perotriletes (ERDTMANN) COUPER, 1953
Type species *Perotriletes granulatus* COUPER, 1953

cf. *Perotriletes microbaculatus* var. *attenuatus* RICH.-LIST. 1969
Pl. LXX, Fig. 3—4

1969: *Perotriletes microbaculatus* var. *attenuatus* var. nov. — RICHARDSON-LISTER, Pl. 39, Fig. 12—13, p. 227.

Description: Circular perotrilete spores with distinct trilete Y-mark and straight rays. "The contact area" is indistinct. The spore surface is covered with small baculae and coni. The "perine" and the exine are tightly connected. Size: 35—40 μ.

Remark: The described spores are well preserved. The spore depicted on Pl. LXX, Fig. 3 has a partly corroded surface. In their diagnostic characters they correspond to the holotype.

Occurrence: Scarce; cross section Drnava — Pipítka; sample 1/12/76, dark phyllites; loc. Smolník — Kompas II—III, lydites, 2001/78.

Stratigraphical range: Lower Devonian — Gedin (J. B. RICHARDSON — T. R. LISTER 1969).

Cingulicavati SMITH — BUTTERWORTH 1967

Camptozonotriletes STAPLIN 1960

Type species *Camptozonotriletes vermiculatus* STAPLIN 1960

cf. *Camptozonotriletes caperatus* MC. GREGOR 1973

Pl. LXXIII, Fig. 2

1973: *Camptozonotriletes caperatus* n. sp. — MC. GREGOR, Pl. 7, Fig. 1—2, p. 52, 53.

Description: An oval-triangular trilete, zonate-camerate spore. The central body is circular, about 50 μ in size. The body is covered with papillae, either pointed or rounded. The basical sculpture beneath the papillae is punctate. It also extends to the zone and there it is very dense. The zone is 20—25μ wide. The zone is characterized by septum-like elements distant from one another about 10 μ. They are well visible on the proximal side. The trilete mark is indistinct because of the dense papillate sculpture. The size of the spore is 98—100 μ.

Remarks: The spore differs from the original species in a smaller central body and a somewhat wider zone. The zone margins are partly depressed. The spore is well preserved. It is not graphitized.

Occurrence: Scarce; light-grey phyllites, loc. Smolník — town, cliff No. 3.

Stratigraphical range: Lower Devonian (Ems) — Canada (York River, Battery Point Formation).

Patinati BUTTERWORTH et WILLIAMS 1958

Samarisporites RICHARDSON 1964

Type species *Samarisporites* (*Cristatisporites*) *orcadensis* (RICH. 1960) RICHARDSON 1964

cf. *Samarisporites inusitatus* ALLEN 1965

Pl. LXXI, Fig. 12

1965: *Samarisporites inusitatus* sp. nov. — ALLEN, Pl. 99, Fig. 7—9, p. 717.
1974: *Samarisporites inusitatus* ALLEN-MOREAU — BENOIT, Pl. 14, Fig. 6, p. 198.

Description: An oval-triangular trilete spore. Size: 60 μ. The size of the central

area: 45 μ, of the zone 15 μ. Sculptural elements (fine "coni") are well visible, dense and form an incomplete reticulum.

Remark: The depicted spore is partly graphitized; mainly the surface of the central area is dark and the trilete mark so distinct on *Samarisporites inusitatus* ALLEN, is not visible. The zone is partly damaged. It is likely that according to its shape, size and sculptural elements the spore belongs to *Samarisporites inusitatus* ALLEN.

Occurrence: Scarce, loc. Smolník — Beckenhöhe, occur. 2, sample 3a, 1993/78, lydites.

Stratigraphical range: Upper Givet — Spitzbergs, Central Dicksonland (K. C. ALLEN 1965), Middle Frasnian — France P. TAUGOURDEAU 1969), Upper Siegen — Ems — Armoric Massif (A. MOREAU-BENOIT 1974).

Monopseudosacciti SMITH et BUTTERWORTH 1967
Grandispora HOFFMEISTER STAPLIN, and MALLOY 1955

Type species *Grandispora spinosa* HOFFMEISTER STAPLIN, and MALLOY 1955

***Grandispora* cf. *inculta* ALLEN 1965**

Pl. LXXII, Fig. 1

1965: *Grandispora inculta* sp. nov. — ALLEN, Pl. 103, Fig. 7—9, p. 734
1974: *Grandispora inculta* ALLEN 1965 — MOREAU-BENOIT, Pl. 14, Fig. 7, p. 199.

Description: A circular trilete spore, with distinctly delimitated central body and zone. Size of central body: 55 μ: width of zone: 25 μ; size of spore: around 85 μ. The trilete mark is indistinct; the rays overlap the body diameter. The exine is covered with minor dense grains. The central body has an oval rim which is like to be secondary, formed by depression. The zone margin is partly damaged.

Remark: The spore is quite well preserved. It is ranged to *Grandispora inculta* ALLEN on the basis of the shape of body and zone, sculptural elements and indistinct Y-mark.

Occurrence: Scarce; dark phyllites, sample I/12/76, cross section Drnava — Pipítka.

Stratigraphical range: Givet-Spitzbergs (K. C. ALLEN 1965), Middle Siegen — Ems — Armoric Massif (A. MOREAU-BENOIT 1974).

Rhabdosporites RICHARDSON 1960

Type species *Rhabdosparites langi* (EISENACK) RICHARDSON

cf. *Rhabdosporites parvulus* RICHARDSON 1965

Pl. LXXII, Fig. 2

1964: *Rhabdosporites parvulus* sp. nov. — RICHARDSON, Pl. 93, Fig. 5—6, p. 588.
1974: *Rhabdosparites parvulus* 1965 — MOREAU-BENOIT, Pl. 15, Fig. 4, p. 202.

Description: A trilete spore composed of the central body 55—70 μ large, and the zone damaged by metamorphosis. It is preserved in fragments, 15—25 μ wide. The size of the spore is about 95 μ. The trilete mark is well visible. Its rays are straight and extend to the body margins. The original sculpture of the spore body and of the zone is indistinct. Exposed parts show baculate to clavate sculpture.

Remark: The described specimen is damaged by metamorphosis. The trilete mark is well preserved, as well as the delimitation of the central body and the course of the zone. Sculptural elements are partly visible.

Occurrence: Scarce; light-grey phyllites, loc. Smolník-town, cliff No. 3, sample 3 b.

Stratigraphical range: Upper Eifel and Givet — NE Scotland (J. B. RICHARDSON 1965), Givet-Belgium (K. M. LELE et M. STREEL 1969), Ems in France — Armoric Massif (A. MOREAU-BENOIT 1974).

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Spodnodevónske palinomorfy z drnavského súvrstvia gelnickej skupiny Spišsko-gemerského rudohoria

Resumé anglického textu

V predloženej práci sa zaoberám morfologickým opisom palinomorf z drnavského súvrstvia gelnickej skupiny Spišsko-gemerského rudohoria. Na základe opísaných 31 druhov a ich stratigrafického diapazónu som zistila, že palinomorfy nájdené v spodnejších častiach drnavského súvrstvia (na lokalite Smolnícka Huta, Smolník), sú rozšírené v spodnom devóne (gedin—siegen). Vyššie ležiace súvrstvie, ktoré sa vyskytuje na lokalitách od Smolníckeho Mýta na juh (v území od Beckengrundu, Pipítka až Drnava), majú okrem druhov typických pre spodný devón aj početnejšie druhy, ktoré umožňujú zaradiť vyššie časti drnavského súvrstvia do vrchnej časti spodného devónu (ems). Uvedené výsledky boli kontrolované aj histogramami početnosti, poukazujúce na koncentráciu palinomorf v siegene až emse.

Na základe doterajších geologických výskumov bola v oblasti gemerika O. FUSÁNOM—M. MÁŠKOM—V. ZOUBKOM (1955) stanovená spišská fáza. Autori vychádzali z predpokladu, že sedimentácia gelnickej skupiny sa ukončila silúrom a nadložný sedimentačný cyklus rakoveckej skupiny sa začína devónom. Podľa uvedeného názoru spišská fáza by zapadala do mladokaledónskeho vrásnenia. Avšak z vyššie uvedenej palinologickej analýzy vyplýva, že najvyššie (drnavské) súvrstvie gelnickej skupiny patrí už k spodnému devónu. V dôsledku tejto skutočnosti je nutné posunúť aj tzv. spišskú fázu vyššie. Do

úvahy prichádza mladšia fáza vrásnenia, spojená s ranobretónskymi tektonickými pochodmi. Túto skutočnosť by potvrdzovali aj palinologické výsledky z vrtu Blhovce (FV—1). (južné Slovensko, oblasť Šafárikova). V tomto vrte v podloží terciérnych sedimentov bol identifikovaný vek metasedimentov na stredný až vrchný devón (givet—frasen). Ich koreláciou so staropaleozoickými horninami gemerika (P. SNOPKOVÁ — Š. BAJANÍK 1979) sú metasedimenty z vrtu FV-1 najpravdepodobnejšie stratigrafickým ekvivalentom metasedimentov rakoveckej skupiny. Poukazujú na to aj paleontologické a palinologické výsledky z vrtu Zelený Háj (ZH-1, Podunajská nížina), kde z vápencov bol stanovený strednodevónsky vek (A. BIELY — A. KULLMANOVÁ 1979), z lyditov taktiež stredný devón (P. SNOPKOVÁ 1979). Stredný a vrchný devón bol zistený aj v pohoriach Szendrö a Uppony (K. BALOGH 1964, K. BALOGH — L. KÖRÖSSY 1974), kde je obzvlášť výrazná karbonátová sedimentácia v stredných častiach súvrstvia.

Vek sedimentov rakoveckej skupiny sa doposiaľ nepodarilo palinologicky preukázať, hoci zo severnej časti gemerika bol odobraný väčší počet vzoriek. Vrchná hranica sedimentov rakoveckej skupiny je doložená vo valúnovom materiáli sedimentov dobšinskej skupiny. V ochtinskom súvrství na lokalite Ochtiná sa zistilo, že vrásnivo-metamorfné pochody, ktoré postihli sedimenty rakoveckej skupiny, sú pred visénom (H. KOZÚR — R. MOCK, — H. MOSTLER 1976), teda sedimenty rakoveckej skupiny sú staršie ako bretónske vrásnivo-metamorfné pochody.

Explanations to Plates LXIX—LXXIV
(microphotographs are magnified 1000×)

Plate LXIX

1 cf. *Baltisphaeridium guillermi* CRAMER, loc. Smolnícka Huta — Ober der Kirche, lydites, inv. No. 635/79
2 cf. *Veryhachium valientae* CRAMER, loc. Smolnícka Huta, lydites, inv. No. 636/79
3—4 *Veryhachium* cf. *helenae* CRAMER, loc. Smolnícka Huta — Ober der Kirche, lydites, inv. No. 635/79, Smolnícka Huta, lydites, inv. No. 636/79
5—6 cf. *Veryhachium minutum* DOWNIE, loc. Smolník-Markscheidergrund, lydites, occur. 3, sample 1 d, inv. No. 247/78, loc. Smolnícka Huta, lydites, inv. No. 636/79
7—8 *Synsphaeridium cf. sorediforme* TIMOFEEV, loc. Uhorná — Kotlinec — Veľký Beckengrund, graphitic phyllites, sample No. 2b, inv. No. 487/79
9 ? *Micrhystridium raspa* (CRAMER) DEFLANDRE et DEFLANDRE — RIGAUD, loc. confluent of Veľký and Malý Beckengrund, lydites, sample No. 8a, inv. No. 500/79
10 cf. *Micrhystridium lapellum* LOEBLICH et WICANDER, loc. Smolnícka Huta — Ober der Kirche, lydites, V 4467/79, inv. No. 635/79
11 *Cymatiosphaera* cf. *pavimenta* (DEFLANDRE), DEFLANDRE, loc. Smolnícka Huta, lydites, inv. No. 636/79
12 cf. *Cymatiosphaera multisepta* DEUNFF, cross section Drnava — Pipítka, sample I/1/76, dark lydites
13—14 *Brochopsophosphaera* cf. *diligens* var. *parva* TSCHIBRIKOVA, loc. Uhorná — Kotlinec, Veľký Beckengrund, graphitic phyllites, sample 2b, inv. No. 487/79
15 cf. *Dictyopsophosphaera polygonia* (STAPLIN) TSCHIBRIKOVA, cross section Drnava — Pipítka, sample I/1/76, dark lydites, loc. Smolník — Markscheidergrund, occur. 3, sample 1b, lydites 1996/78, Inv. No. 245/78
16 cf. *Dictyopsophosphaera*, cross section Linkeš — Pipítka, sample 2 III/26/77, dark lydites
17 *Leiotriletes* cf. *simplex* NAUMOVA, loc. Smolník — Kotlinec, occur. 8, 2003/78, inv. No. 252/78, dark phyllites
18 *Retusotriletes* cf. *insperatus* var. *gracilis* TSCHIBRIKOVA, loc. Smolník — Beckenhöhe, occur. 4, sample 1a, 1999/78, inv. No. 248/78, lydites.

Plate LXX

1 *Retusotriletes* cf. *divulgatus* TSCHIBRIKOVA var. *plicatus* TSCHIBRIKOVA, loc. Smolník, Kompas II—III, sample 2001/78, inv. No. 250/78, lydites
2 *Verrucosisporites* ? *polygonalis* LANNINGER, loc. Smolník — Beckenhöhe, occur. 2, sample 3a, 1993/78, inv. No. 242/78, lydites

3—4 cf. *Perotriletes microbaculatus* var. *attenuatus* RICHARDSON — LISTER, cross section Drnava — Pipítka, sample I/1/76, dark lydites, loc. Smolník — Kompas II—III,2001/78, inv. No. 250/78, lydites
5 *Punctatisporites* cf. *solidus* NAUMOVA, cross section Drnava — Pipítka, sample I/12/76, dark lydites
6 cf. *Retusotriletes insperatus* var. *gracilis* TSCHIBRIKOVA, cross section Drnava — Pipítka, sample I/13/76, dark phyllites
7 cf. *Camptotriletes dubius* MC GREGOR, cross section Drnava — Pipítka, sample I/13/76, dark lydites
8 *Acanthotriletes parvispinosus* NAUMOVA var. *rotundus* TSCHIBRIKOVA, loc. Smolnícka Huta, inv. No. 637/79, lydites
9 *Dictyotriletes* cf. *peculiaris* TSCHIBRIKOVA, cross section Linkeš — Pipítka, sample 2 III—26/77, lydites
10 *Dictyotriletes peculiaris* TSCHIBRIKOVA, cross section Drnava — Pipítka, sample I/13/76, dark lydites

Plate LXXI
1 *Acanthotriletes* aff. *denticulatus* NAUMOVA, loc. Smolník — Markscheidergrund, occur. 3, sample Id, 1998/79, inv. No. 247/78
2 cf.*Acanthotriletes parvispinosus* NAUMOVA cross section Drnava — Pipítka, sample I/13/76, dark phyllites
3—4 ? *Apiculiretusispora cherata* RICHARDSON — LISTER, loc. Smolník — Kompas II-III, sample No. 2601/78, inv. No. 250/78

5 cf. *Apiculiretusispora cherata* RICHARDSON-LISTER, loc. Smolnícka Huta — Ober der Kirche, inv. No. 684/79, lydites
6 cf. *Emphanisporites minutus* ALLEN, cross section Drnava — Pipítka, sample I/13/76, dark lydites
7 *Dibolisporites* cf. *quebecensis* MC GREGOR, cross section Drnava — Pipítka, sample I/16/76, dark phyllites
8 cf. *Dibolisporites quebecensis* MC GREGOR, loc. Uhorná — Kotlinec, Veľký Beckengrund, sample 2c, inv. No. 488/78, graphitic phyllites
9 *Dibolisporites* cf *seifeliensis* (LANNINGER) MC GREGOR, loc. Smolník — Kompas I-III, 2000/78, inv. No. 249/78, lydites
10—11 cf. *Emphanisporites*, cross section Drnava — Pipítka, sample I/12/76, dark phyllites
12 cf. *Samarisporites inusitatus* ALLEN, loc. Smolník — Beckenhöhe, occur. 2, sample 3a, 1993/78, lydites

Plate LXXII
1 *Grandispora* cf. *inculta* ALLEN, cross section Drnava — Pipítka, sample I/12/76, dark phyllites
2 cf. *Rhabdosparites parvulus* RICHARDSON, loc. Smolník-town, cliff No. 3, sample 3b, light-grey phyllites

Plate LXXIII
1 cf.*Bullatisporites bullatus* ALLEN, cross section Linkeš — Pipítka, sample I—III — 27/77, dark phyllites
2 cf. *Camptozonotriletes caperatus* MC GREGOR, loc. Smolník-town, cliff No. 3, light-grey phyllites

Plate LXXIV
1—3 Structural kerogen, cross section Drnava — Pipítka,
4 Undetermined globular body, cross section Drnava — Pipítka
5 Structural kerogen, cross section Drnava — Pipítka

Západné Karpaty, sér. paleontológia, 9, P. 155—164, Geol. Úst. D. Štúra, Bratislava, 1984

Jarmila Papšová — Ľudovít Gaál

Conodonts from Pelsonian-Cordevolian basinal limestones of Choč and Silica nappes

3 text-fig., 4 Pls. (LXXV—LXXVIII), Slovak summary

Abstract. The authors present characteristic and comparison of Conodont assemblages from facies of basinal limestones of the Choč and the Silica nappes in the Nízke Tatry Mts. and the Slovenské rudohorie ore mountains (localities Zámostie and Hrušovo). The microfacies pattern of the Reifling or Nádaska limestones of the studied localities is indicative of a depositional environment with a slightly deepened sea floor of the shelf area.

Introduction

Thorough study of the character and distribution of Mesozoic basinal sediments is significant for reconstruction of depositional area and for interpretation of distribution of large tectonic units. The study of conodont macrofauna is one of the most suitable methods of reliable correlation and determination of stratigraphic range of basinal limestones. It is, however, necessary to study more cross sections. This is the initial work on this problem in the area of study. We chose two cross sections in limestones of the Choč and the Silica nappes on the localities Zámostie and Hrušovo in the Nízke Tatry Mts. and in the Slovenské rudohorie ore mountains.

Locality Zámostie

It is in the southern part of the Nízke Tatry Mts., NW of the village Dubová, on the right side of a deep-cut valley toward Štefánka (B. M. 499.1) and extends about 50 m higher into the valley in the road bent on the left side (Fig. 2).

In the cross section is a complex of the Reifling limestones of the Biely Váh Group of the Choč nappe (A. Biely 1960, A. Biely — O. Miko 1978) which was the main topic of our study. In the basement of the Reifling limestone complex is a thick dolomite complex. The limestones are overlain by the Lunz Member.

The cross section represents one of stratigraphically complete sequences of the Choč nappe. It was already studied by several geologists (J. Papšová 1980, J.

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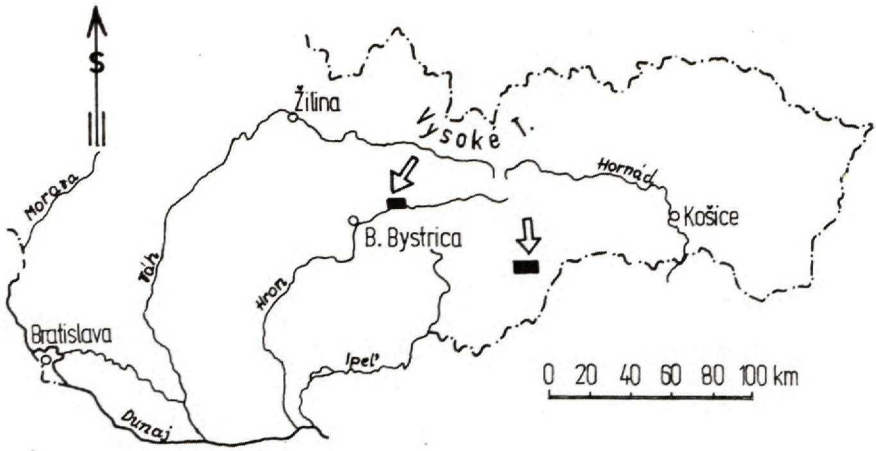

Fig. 1 Sketch map of conodont localities Zámostie and Hrušovo (Choč and Silica nappes).

PAPŠOVÁ — J. PEVNÝ 1982, J. PAPŠOVÁ in O. JENDREJÁKOVÁ et al. 1981). The results are complemented and precised.

Biostratigraphic characteristic of the cross section

Dominant are three lithotypes:

1. Dark organodetrial limestones (sample 0 — microsparite, the so-called "black formation" in the sense of J. MICHALÍK 1979 in O. JENDREJÁKOVÁ et al. 1981) containing plentiful organisms of various animal groups, mainly benthic organisms (*Bivalvia, Gastropoda, Brachiopoda*) and remains of echinoderms, fish, less juvenile stages of ammonites, foraminifers (the assemblage with *Pilammina densa* PANTIČ — K. BORZA 1970), holothurians, ostracods, a. o. Among conodonts are plentiful: *Neospathodus kockeli* TATGE, *Gondolella bulgarica* (BUDUROV et STEFANOV), *G. hanbulogi* (SUDAR et BUDUROV). They are indicative of the Pelsonian age.

2. Dark-grey organodetrital limestones (sample 2) "ash-grey" clastic limestones" (J. MICHALÍK in O. JENDREJÁKOVÁ et al. 1981) with similar plentiful macro- and microfauna with Bivalvia dominant. Microfacies of the complex is biomicrosparite with intraclasts (packstone; bioclasts and intraclasts are close to one another with a narrow sparite part between them), or echinoderm biomicrosparite with unrounded or partly rounded bioclasts of echinoderm columnalia in the upper part. There are also profiles of foraminifers, shells of bivalves and globochetes, as well as scarce pellets. Conodonts are represented by *Gondolella constricta* MOSHER et CLARK, *G. cornuta* (BUDUROV et STEFANOV), *G. hanbulogi* (SUDAR et BUDUROV) with frequent ramiform specimens, and indicate the Pelsonian — Illyrian to Illyrian boundary. The lack of Pelsonian forms is rather indicative of the Illyrian age, the zone "constricta A".

3. Grey sheety limestones with frequent cherty concretion or cherts in size of

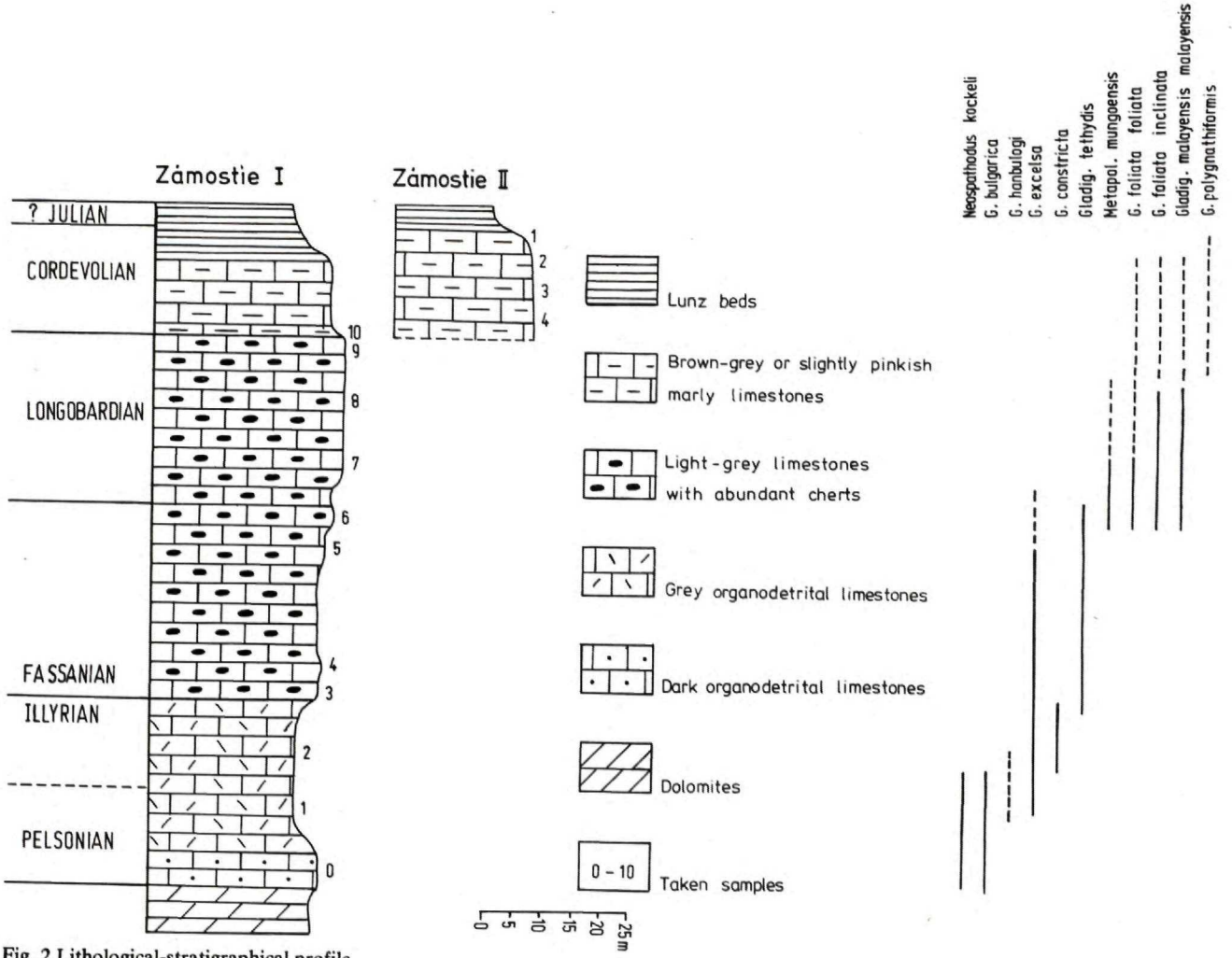

Fig. 2 Lithological-stratigraphical profile

small peas (samples 3—9, 4—1), a classic type of the Reifling limestone (A. BIELY 1960) containing many sessile foraminifers (O. JENDREJÁKOVÁ et al. 1981). Macrofossils are absent here, holothurians and Fungi decrease in amount and radiolarians increase.

Microfacies of the lower part of the complex (sample 3—4) is biomicrosparite with lamellibranchiates. Bivalves are thinwalled ("filaments"); the sample 4 contains detritus of bivalvian shells of the type "shell hash". Segments of echinoderms, foraminifers and isolated globochetes occur sporadically.

Conodonts are more frequent than in the two underlying levels. Frequent are *Gondolella excelsa* (MOSHER), *G. cornuta* (BUDUROV et STEFANOV), scarce *Gladigondolella tethydis* (HUCKRIEDE), *Gondolella constricta* MOSHER et CLARK and scarce *G. pseudolonga* MIETTO, KOVÁCS et KOZUR. *G. excelsa* is less frequent here than in the Silica nappe. Only immature specimens were preserved. Mature specimens are characterized by a high carina. In the lineage *G. excelsa* — *G. foliata foliata* (S. KOVÁCS in print) are frequent transitions to *G. foliata foliata* (BUDUROV). The species *G. constricta* is stable in its form. The age is Illyrian — Lower Ladinian. In microfacies pattern of the overlying part (samples 5—6—7—8) pelmicrosparite dominates; in some places pelsparite. The matrix is micritic. The sediment is poorly sorted (packstone or wackestone with pellets or bioclasts of bivalves, frequently filaments), isolated ostracods and globochetes. The amount of conodonts decreases for some time, among old species only *Gladigondolella tethydis* survives and stratigraphically younger species like *Gondolella foliata foliata* (BUDUROV), *G. foliata inclinata* KOVÁCS (quite frequent), *Gladigondolella malayensis malayensis* NOGAMI and *Metapolygnathus mungoensis* (DIEBEL) (scarce) appear. The conodonts are indicative of the Longobardian age of the limestone complex.

Microfacies of the next part of the complex in vertical section (sample 9) is biomicrite to biopelmicrite, in places with filaments and globochetes. Cherts consist of microcrystalline SiO_2. On the margins of concretions they are also pressed in the limestone matter or are in fragments or nests. The conodont assemblage is unchanged.

The overlying limestones (samplex 10, 4—1) under microscope appear as biomicrosparite (packstone) with plentiful shells of bivalves of variable size, and frequently also with filaments. Ostracods and profiles of gastropods are sporadical. In some places frequent are profiles of spherical organisms (*Calcisphaera*) and sporadical pellets.

In this level scarce (*Gladigondolella tethydis* (HUCKRIEDE) in fragments, *Gondolella foliata inclinata* KOVÁCS, stratigraphically significant form *G. polygnathiformis* BUDUROV et STEFANOV (indicative of Upper Triassic age of the formation, Cordevolian), *Gladigondolella malayensis malayensis* NOGAMI, and in some beds (sample 2) ramiform conodonts appear again. This is the only bed with *Irinella canalifera* (KRISTAN—TOLLMANN), mostly known from the Carnian (for example R. MOCK 1973). The conodont assemblages occur together with frequent sessile species of foraminifers, less frequent echinoderms and holothurians.

The bed sequence of the carbonate complex terminates with filament biomicrite containing sporadical *Globochetes*, profiles of sponge spicules, without conodonts.

A quite different ophthalminian foraminiferal assemblage appears which might indicate a stratigraphic change (O. JENDREJÁKOVÁ et al. 1981).

Locality Hrušovo

The locality is in the southern part of the Slovenské rudohorie ore mountains (Železnické predhorie foothills) on the western margin of the Drienčany karst, 10 km NNE of Rimavská Sobota (Fig. 3). The studied cross section runs through clints of Triassic limestones along the eastern periphery of the village Hrušovo, on the western slope of the limestone high. Middle Triassic limestones of the area are ranged to the Španie Pole syncline (in the sense of M. MAHEĽ 1954) of the Silica nappe. The syncline is in the form of a carbonate block thrust over plastic Lower Triassic schistose formations. The carbonate sequence of the area was thoroughly studied by Ľ. GAÁL (1982). He also examined conodonts. The base of the carbonates consists of Gutenstein limestones overlain by an almost continuous sequence up to the Upper Norian.

Biostratigraphical characteristic of the cross section

The cross section commences with Steinalm limestones passing into basinal limestones toward the overlier (Nádaska and Reifling limestones). The sequence of basinal limestones terminates with a complex of lightgrey Wetterstein limestones.

Steinalm limestones

Nine samples were taken from the cross section for thin sections; one of them for conodont microfauna. The limestones are light-grey, partly pinkish, and represent shallow-water sedimentation of a calm environment. Higher up is a layer of grey fine-grained limestones with scarce conodont microfauna.

Microfacies of Steinalm limestones of the studied cross section is mostly microsparite with frequent pellets, occasional pelsparite or pelmicrite. Microscopical pattern is inhomogeneous with frequent clusters of micrite, pelmicrite and sparite nests among them. According to DUNHAM'S (1962) classification it represents packstone. Intraclasts were only in one layer — there it was intrasparite or intrapelsparite. Bioclasts occur in incontinuous horizons. They are represented by shells of bivalves, foraminifers (in sample 1/70 are frequent meandrospires), less frequent bioclasts of dasycladaceans, rests of echinoderms, ostracods and globochetes.

Poorly preserved conodonts were only in a darker layer (sample 1/100). There were several samples of ramiform conodonts of the genus Neohindeodella.

Nádaska limestones

The approximately 40—50 m thick complex consists of variegated Nádaska limestones; in its upper part are also light-grey limestones without conodonts. The Nádaska

limestones are grey, grey-black, red, pinkish or brownish, frequently changing colour. Their basal part commences with accumulation of bivalves but it was only found under microscope (sample 2/1). There is detritus of lamellibranchiate shell of the type "shell hash". The main part of the Nádaska limestones consists of typical wackestone; biomicrite, microsparite, pelmicrite, biopelmicrite, in places comprising bioclasts of bivalves, globochetes, less frequent ostracods, foraminifers. Microfacies change also within one thin section.

Microscopical pattern of light-grey facies in the upper part of the complex does not differ substantially from typical Nádaska limestones, frequent are only sparite nests among micrite clusters.

In some places the Nádaska limestones contain plentiful conodont microfauna. At the base are fragments of gondolelles with high carina and rather narrow platform. They may be fragments of juvenile specimens of *Gondolella* cf. excelsa (Mosher). They occur with fragments of *Gondolella* cf. *hanbulogi* (SUDAR et BUDUROV). Well developed specimens of *Gondolella excelsa* together with *Gladigondolella tethydis* (HUCKRIEDE) occur in the whole length of the Nádaska limestone complex. In the lower part of the complex is also *Gondolella constricta* MOSHER et CLARK which disappears beginning with the sample 2/44 (the first quarter of the cross section. The specimens of the type *"G. mombergensis"* have a narrow platform and partly

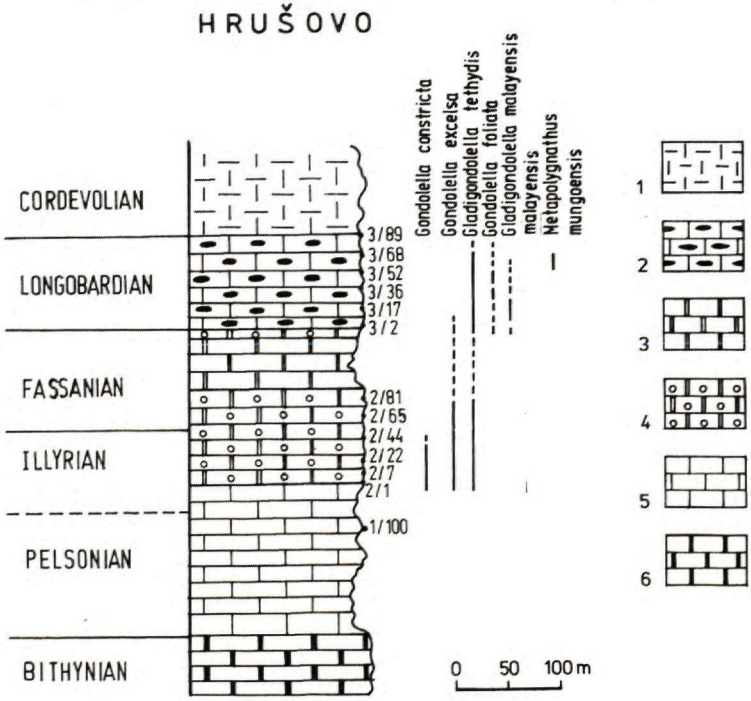

Fig. 3 Lithological-stratigraphical profile
1 — Wetterstein limestones, 2— Reifling limestones, 3 — Light-grey limestones in the complex of Nádaska limestones, 4 — Nádaska limestones, 5 — Steinalm Limestones, 6 — Gutenstein limestones.

rounded back part. Teeth are only partly grown together, carina is somewhat higher on some, mainly juvenile forma. After having recovered more specimens, we regard also the two specimens depicted by Ľ. GAÁL (1982) in Pl. XI, Fig. 4—6 as *G. constricta*, and not *G. mombergensis*.

The problem of the age of the lower part of the Nádaska limestone complex is not solved reliably. The lower boundary of all species mentioned may extend to the Uppermost Pelsonian (the upper part of the zone with *Balatonites balatonicus* — in the sense of S. KOVÁCS — H. KOZUR 1980). The upper part of the Nádaska limestones without *Gondolella constricta* is indicative most likely of the Uppermost Fassanian — the zone "*Protrachyceras curionii*". They do not surpass the upper boundary of the zone, since in their overlier — in the Reifling limestones — already the Longobardian species (*Gladigondolella malayensis malayensis* NOGAMI, *Gondolella foliata foliata* (BUDUROV) appear. They are absent in the Nádaska limestones.

Reifling limestones

They are represented by a complex of dark-grey slab-like limestones with scarce (out of the cross section) cherts, in the overlier of the Nádaska limestones.

From microfacies view most frequent is pelmicrite or biopelmicrite, occasional small nests of sparite. Micrite is concentrated in clusters. Bioclasts consist mostly of bivalves (also filaments), globochetes, ostracods, less frequently foraminifers, *Aeolisaccus* sp., profiles of sponge spicules.

Conodonts from Reifling limestones of the cross section were studied from six samples. *Gladigondolella tethydis* (HUCKRIEDE) is present almost in the whole length of the limestones. Poorly preserved *Gondolella* cf. *excelsa* (MOSHER) occurred only in the sample 3/17.

Two samples from the lower part of the complex (3/2 and 3/17) contained *Gladigondolella malayensis malayensis* NOGAMI or *G.* cf. *malayensis malayensis* NOGAMI. They were not in the upper part of the complex. On the base of Reifling limestones (sample 3/2) appeared thicker fragments of the back part of the platform of the type "*Gondolella navicula*".

In the whole length of the cross section of Reifling limestones occur forms close to the species *Gondolella foliata foliata* (BUDUROV) or its fragments. *G.* aff. *foliata foliata*, present in the sample 3/89 (= RS 526, by Ľ. GAÁL 1982, p. 34) is most likely a hyperadult specimen. The sample 3/36 contained 1 specimen of microproblematic *Irinella canalifera* (KRISTAN — TOLLMANN). Higher parts of the Reifling limestone complex are poor in conodonts. The sample 3/68 contains only ramiform types; the sample 3/89 contains *Metapolygnathus mungoensis* (DIEBEL). All samples contain assemblages of fish teeth and scales, sponge spicules and sclerites of holothurians.

The presence of *Gladigondolella malayensis malayensis* and its absence in the underlying Nádaska limestones indicate that the lower boundary of the Reifling limestones of the cross section does not extend lower than the base of the Longobardian. This is also indicated by fragments of *G. foliata foliata*.

The upper boundary of the Reifling limestones is still not clear. The absence of *G. polygnathiformis* BUDUROV et STEFANOV indicates that it does not surpass the Upper Longobardian. The Upper Longobardian age of the uppermost part of Reifling

limestones (zone *Protrachyceras archelaus*) is proved-besides *Metapolygnathus mungoensis* (sample 3/89) — also by *Metapolygnathus mostleri* (KOZUR) out of the cross section line (Ľ. GAÁL 1982).

Conclusions

The authors compared two profiles of basinal limestones of the Silica nappe and the Choč nappe. The comparison resulted in the following conclusions:

The conodont microfauna proved Pelsonian-Cordevolian basinal sedimentation in the Biely Váh facies of the Choč nappe. The limestones are overlain by the Lunz beds from which no conodonts have been recovered so far. We do not regard basinal sediments as deep-sea (geosynclinal) sediments. The deposited near the zone of the reach of sea waves. It is indicated by frequent finds of bivalves with thicker walls and by frequent intraclasts and bioclasts bound by sparite. Except the top part of the cross section with biomicrite to biopelmicrite microfacies representative of deepening of the area and beginning of sedimentation of the Lunz beds, the most part of the cross section consists of poorly sorted sediment (packstone or wackstone) with frequent pellets and bioclasts of bivalves.

According to the conodont microfauna and character of microfacies the basinal sedimentation commenced with the Nádaska limestones, most likely in the Illyrian. Indications of slight deepening of the area appear in the Steinalm limestone complex with a layer of darker limestones with micrite microfacies.

According to the latest results, in some parts of the Silica nappe the lower boundary of the Nádaska and also of the Reifling limestones extends to the Pelsonian (R. MOCK 1980, Ľ. GAÁL — J. MELLO 1983). Basinal sedimentation lasts to the end of the Longobardian. Out of the facies area of Slovenská skala (in the sense of Ľ. GAÁL — J. MELLO 1983) it represents the highest stratigraphical level of Reifling limestones, so far known in the Silica nappe.

According to microfacies pattern, basinal limestones of the Silica nappe do not originate in a deep-sea environment but represent a slight deepening of the sea floor of the shelf zone. They are overlain by shallow-water Wetterstein limestones of the carbonate platform. In the cross sections we found the following main differences in conodont assemblages:

In the Choč nappe all 15 samples taken were positive in conodonts and various macro- and microfossils. All specimens were well preserved. Microfauna from the Silica nappe was secondarily damaged, preserved in fragments, 14 samples from 27 were sterile.

In the cross section Zámostie and in other studied cross sections (J. PAPŠOVÁ in J. VOZÁR 1982), *Gladigondolella tethydis* or its associated ramiform elements appear in the zone *Aplococeras avisianus* (Lower Fassanian in the sense of H. KOZUR 1980; Upper Illyrian in the sense of L. KRYSTYN 1980) in an assemblage with *Gondolella pseudolonga* MIETTO, KOVÁCS et KOZUR. *G. tethydis* occurs sporadically. In the cross section Hrušovo the species *G. tethydis* appears in the Illyrian. It is more frequent here than in the cross section Zámostie. As a rule, it occurs in an assemblage with *Gondolella excelsa* and *G. constricta*.

Analysis of *G. excelsa* shows differences in quality and quantity. *G. excelsa* is much more frequent in the cross section Hrušovo of the Silica nappe than in the cross section Zámostie in the Choč nappe. Well preserved adult specimens are mainly in the Nádaska limestones. Their presence in the Longobardian Reifling limestones is not unambiguosly proved. In the Longobardian of both cross sections they are replaced by *G. foliata foliata* which is partly transitional In the cross section Hrušovo it is associated with G. tethydis and in the cross section Zámostie it always occurs above the level containing *G. tethydis.*

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Explanations to Plates LXXV—LXXVIII

Plate LXXV

1 *Neospathodus kockeli* TATGE — Zámostie I.2/79, Pelsonian; 50×.
2 *Gondolella bulgarica* (BUDUROV et STEFANOV) — Zámostie I. 0/82, Pelsonian; 80×.
3—4 *Gondolella hanbulogi* (SUDAR et BUDUROV) — Zámostie I. 0/82, Pelsonian; 50×.
5 *Gondolella constricta* MOSHER et CLARK — Zámostie I. 3/80, Fassanian; 75×.
6 *Gondolella excelsa* (MOSHER) juv. — Zámostie I. 0/82, Pelsonian; 140×.

7 *Gladigondolella tethydis* (HUCKRIEDE) — Zámostie I. 4/80, Fassanian; 90×.
8 *Gladigondolella tethydis* (HUCKRIEDE) — Zámostie I. 6/80, Fassanian; 50×.
9—10 *Metapolygnathus mostleri* KOZUR — Zámostie I. 7/79, Longobardian; 9—140×, 10—130×.

Plate LXXVI
1—2 *Gondolella foliata inclinata* KOVÁCS — Zámostie I. 7/80, Longobardian; 100×.
3 *Gondolella foliata inclinata* KOVÁCS — Zámostie I. 10/80, Cordevolian; 50×.
4 *Gondolella foliata foliata* (BUDUROV) — Zámostie I. 9/80, Longobardian; 50×.
5—7 *Gondolella foliata inclinata* KOVÁCS — Zámostie II. 4/80, Cordevolian; 5—6 — 90×, 7 — 80×.
8—11 *Gladigondolella malayensis malayensis* NOGAMI — Hrušovo 3/17, Longobardian; 8—10 — 50×, 11—60×.

Plate LXXVII
1 *Neohindeodella* sp. — Hrušovo 1/100, Pelsonian; 50×.
2 *Gondolella* cf. *excelsa* (MOSHER) juv. — Hrušovo 2/1, Illyrian; 130×.
3 *Hindeodella* sp. — Hrušovo, 2/22, Illyrian; 50×.
4 *Gondolella excelsa* (MOSHER), — Hrušovo 2/44, Illyrian; 40×.
5 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/1, Illyrian; 60×.
6 *Gladigondolella tethydis* (HUCKRIEDE) — Hrušovo 2/22, Illirian; 60×.
7 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/22, Illyrian; 40×.
8 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/22, Illyrian; 40×.
9 *Gondolella excelsa* (MOSHER) — Hrušovo 2/22, Illyrian; 50×.
10 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/22, Illyrian; 40×.
11 *Gondolella excelsa* (MOSHER) — Hrušovo 2/22, Illyrian; 50×.
12 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/44, Illyrian; 70×.
13 *Gondolella constricta* MOSHER et CLARK — Hrušovo 2/44, Illyrian; 70×.

Plate LXXVIII
1 *Gladigondolella tethydis* (HUCKRIEDE) — Hrušovo 2/22, Illyrian; 30×.
2 *Gondolella excelsa* (MOSHER) — Hrušovo 2/44, Illyrian; 30×.
3 *Gladigondolella tethydis* (HUCKRIEDE) juv. — Hrušovo 2/44, Illyrian; 75×.
4 *Gondolella constricta* MOSHER et CLARK, juv. — Hrušovo 2/44, Illyrian; 100×.
5 *Neohindeodella triassica triasica* (TATGE) — Hrušovo 2/65, Fassanian; 60×.
6 *Dydimodella alternata* (MOSHER) — Hrušovo 2/65, Fassanian; 70×.
7—8 *Gondolella ecxelsa* (MOSHER) — Hrušovo 2/81, Fassanian; 100×.
9—11 *Gondolella* cf. *foliata* (BUDUROV) — Hrušovo 3/2, Longobardian; 50×.
10 *Gladigondolella tethydis* (HUCKRIEDE), — Hrušovo 3/17, Longobardian; 40×.
12—14 *Gondolella* cf. *excelsa* (MOSHER) — Hrušovo 3/17, Longobardian; 70×.
13 *Metapolygnathus mungoensis* (DIEBEL) — Hrušovo 3/89 = RS—526, Longobardian; 70×.

Jarmila Papšová — Ľudovít Gaál

Konodonty z panvových vápencov pelsónu až kordevolu chočského a silického príkrovu

Resumé anglického textu

V predloženej práci boli spracované dva profily panvových vápencov chočského a silického príkrovu, z ktorých môžeme vyvodiť nasledovné:

V bielovážskom vývoji chočského príkrovu bola konodontovou faunou potvrdená panvová sedimentácia od pelsónu po kordevol s nedostatočne vytriedenými sedimentmi, často s pelitmi a bioklastami lastúrnikov.

V silickom príkrove na základe konodontovej mikrofauny a charakteru mikrofácií bola potvrdená panvová sedimentácia od ilýru do konca longobardu. Študované vápence majú tiež panvový vývoj, hoci predstavujú len mierne prehĺbenie morského dna šelfovej zóny.

Západné Karpaty, sér. paleontológia, 9, P. 165—172, Geol. Úst. D. Štúra, Bratislava, 1984

Jozef Pevný

Conodonts and holothurian sclerites of the Strážov nappe north of Mojtín

2 text-fig., 2 Pls. (LXXIX—LXXX), Slovak summary

Abstract. In the presented paper are described Middle Triassic conodonts and holothurians from the area north of Mojtín, from Schreyeralm type limestones underlying the Wetterstein limestones at the base of the Strážov nappe in the Strážovské vrchy mts. The conodont species *Gondolella excelsa* (MOSHER) and *Gondolella constricta* MOSHER — CLARK and holothurian species *Theelia undata* MOSTLER, *Acanthotheelia spinosa* FRIZZELL — EXLINE, *Kuehnites spiniperforatus* (ZAWIDZKA), *Tetravirga perforata* MOSTLER, *Priscopedatus staurocumitoides* MOSTLER indicate an Illyrian age.

In the area north of Mojtín in the Strážovské vrchy mts. a strip of Schreyeralm type limestones occurs, in which an assemblage of conodonts and holothurian sclerites was found at several places. The limestones of Schreyeralm type are found at the base of the Strážov nappe, underlying the Wetterstein limestones. They are yellowish, pinkish, brownish, compact limestones, in places with nodules. Mapping was carried out by J. HANÁČEK (1976) and M. MAHEĽ (1983) in this area. In the studied area geological investigations were performed by M. KRIVÝ, to whom the author is thankful for introduction to the localities. The assemblage of conodonts and holothurian sclerites points to a Middle Triassic, Illyrian age. Together with conodonts and holothurian sclerites fish teeth and scales, sponge spicules and calcified ostracodes were found.

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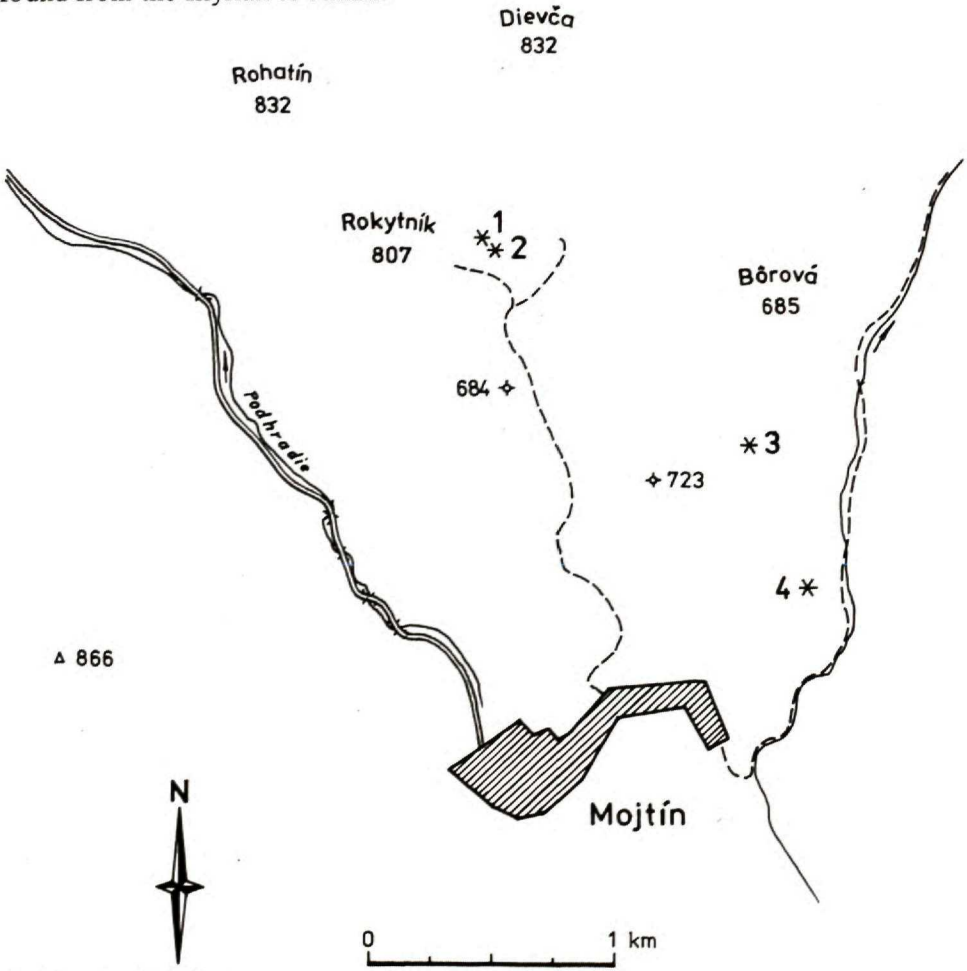
Localities and their fauna

1. Eastern slope of Rokytník, 230 m north of elev. p. 703, brownish limestones underlying the Wetterstein limestones.

Conodonts: *Gondolella excelsa* (MOSHER), *Gondolella constricta* MOSHER — CLARK, *Gondolella* sp., *Prioniodina venusta* (HUCKRIEDE), *Didymodella alternata* (MOSHER), *Ozarkodina tortilis* TATGE, *Enantiognathus ziegleri* (DIEBEL), *Hindeodella* (*Metaprioniodus*) *suevica* (TATGE), *Prioniodina* (*Cypridodella*) *muelleri* (TATGE).

The presence of the platform species *Gondolella excelsa* (MOSHER), *Gondolella constricta* MOSHER — CLARK points to an Illyrian age, the compound conodont species *Prioniodina venusta* (HUCKRIEDE) and *Didymodella alternata* (MOSHER) are found from the Illyrian to Julian.



Sketch-map of localities

Holothurian sclerites: *Theelia immisorbicula* MOSTLER, *Theelia undata* MOSTLER, *Acanthotheelia spinosa* FRIZZELL — EXLINE, *Tetravirga perforata* MOSTLER, *Priscopedatus staurocumitoides* MOSTLER, *Achistrum* sp. These species indicate the Illyrian.

Besides that fish teeth, calcified ostracodes, crinoid stems are found here.

2. 500 m west of elev. p. 684, greyishwhite to yellowish compact limestones.

From conodonts *Gondolella* sp. and *Prioniodina* (*Cypridodella*) *muelleri* (TATGE) were determined. They are ranging from the Scythian to Norian.

From holothurian sclerites *Theelia* undata MOSTLER, *Acanthotheelia spinosa* FRIZZELL — EXLINE, *Kuehnites spiniperforatus* (ZAWIDZKA), *Priscopedatus staurocumitoides* MOSTLER, *Achistrum* sp. were found, indicating an Illyrian age.

Fish teeth, ostracodes, sponge spicules are also present here.

3. 500 m east of elev. k. 684, strip of light-pink limestones.

From conodonts *Gondondolella excelsa* (MOSHER), *Gondolella constricta* MOSHER — CLARK, *Prioniodina venusta* (HUCKRIEDE), *Lonchodina posterognathus* (MOSHER), *Prioniodina* (*Cypridodella*) *muelleri* (TATGE), *Hindeodella* (*Metaprioniodus*) *suevica* (TATGE), *Enantiognathus ziegleri* (DIEBEL) were determined.

The presence of platform species *Gondolella excelsa* (MOSHER), *Gondolella constricta* MOSHER — CLARK indicates an Illyrian, age the compound conodont species *Prioniodina venusta* (HUCKRIEDE) and *Lonchodina posterognathus* (MOSHER) are ranging from the Illyrian to Julian.

From holothurian sclerites *Theelia undata* MOSTLER, *Acanthotheelia spinosa* FRIZZELL — EXLINE, *Priscopedatus tyrolensis* MOSTLER, *Tetravirga perforata* MOSTLER, *Eocaudina subhexagona* GUTSCHICK; CANIS — BRILL, *Calclamra* sp., were determined, indicating an Illyrian age.

There are also fish teeth, forms similar to scolecodonts and sponge spicules.

4. 600 m east of elev. p. 723, west of mill Uhliská, thin-platy, compact, pinkish, yellowish, buff limestones.

From conodonts *Prioniodina venusta* (HUCKRIEDE) was determined, ranging from the Illyrian to Julian; from holothurian sclerites *Theelia undata* MOSTLER and *Priscopedatus triassicus* MOSTLER, pointing to an Illyrian age.

Systematic part

CONODONTA

Gondolella STAUFFER — PLUMMER, 1932

Type species *Gondolella elegantula* STAUFFER — PLUMMER, 1932, Upper Carboniferous, North America.

***Gondolella excelsa* (MOSHER 1968)**

Pl. LXXIX, Figs. 1—3, 8, 9, 13, 14

1965 *Gondolella navicula* HUCKRIEDE, K. BUDUROV — S. STEFANOV, tab. 2, fig. 5—7, 9, non fig. 1—4, 8, 10, 11; non tab. 3, fig. 1—2, 8—13

1965 *Gondolella navicula* HUCKRIEDE — L. C. MOSHER — D. L. CLARK, tab. 66, fig. 14, 16, non fig. 10, 17—21.

1968 *Paragondolella excelsa* — L. C. MOSHER, p. 938—939, tab. 118 fig. 1—8.

1972 *Gondolella excelsa* (MOSHER) — H. KOZUR — H. MOSTLER, tab. 3, fig. 1, 2

1976 *Paragondolella excelsa* MOSHER — WANG CHENG — YUAN — WANG ZHI — HAU, p. 405, tab. 5, fig. 1—5, 16.

1979 *Neogondolella excelsa* (MOSHER), P. MIETTO — M. PETRONI, p. 9, tab. 1, fig. 2.

1982 *Gondolella excelsa* (MOSHER) — L. GAÁL, tab. 11, fig 1—3.

Remarks: 6 specimens. The platform is broad, at the posterior end rounded off, greatest width in one third from the posterior end, in the anterior third markedly narrowing. The carina is high, the denticles are highest and most distinct at the anterior margin, toward the posterior margin fusing, not reaching the platform margin. At the aboral side is an elevated keel, not very broad, the pit is medium large, in one fourth from the posterior margin. At one specimen the posterior margin of keel is deformed, notched, with a lobe projecting to the left behind the pit.

Stratigraphic and geographic range: Upper Pelsonian to Lower Longobardian, most abundant in the Illyrian in the Nothern and Southern Alps, Balkans, Turkey, Tibet, in North America (Nevada) in the lowermost Carnian; in the West Carpathians, in the Pelsonian to Illyrian — Jazovčie, Jasenie, Illyrian — Markovica, Ilavka, Predhorie, Beckov, Trstená near Rajec, Malinô Brdo, Liptovská Revúca, Zámostie, Jasenie, Gombasek, Bérc.

Gondolella constricta MOSHER — CLARK, 1965

Pl. LXXIX, Figs. 5—6, 12

1965 *Gondolella constricta* — L. C. MOSHER — D. L. CLARK, p. 560, tab. 65, fig. 11, 14, 15, 18, 19, 21, 22, 24, 25.

1966 *Gondolella constricta* — D. L. CLARK — L. C. MOSHER, p. 390, tab. 47, Fig. 1—3, 5, 6.

1976 *Neogondolella constricta* MOSHER et CLARK — WANG CHENG-YUAN — WANG ZHI — HAU, p. 407, Tab. 4, Fig. 8—13.

Remarks: 4 specimens. The platform is narrow, broadest in one third to half from the posterior end, toward the anterior end gradually narrowing, constricted in the posterior part. The carina is higher than usually in *Gondolella constricta*, the denticles are fused, at one younger specimen more discrete. On the aboral side is a largely raised and narrow keel with a quite large and elongated pit at the posterior end.

Stratigraphic and geographic range: Upper Pelsonian to Fassanian in the Northern Alps, Balkans, Hungary, Upper Anisian in North America; in the West Carpathians, in the Illyrian to Pelsonian — Jazovčie, Illyrian — Markovica, Predhorie, Trstená near Rajec, Liptovská Revúca, Zámostie, Jasenie, Ráztoka.

Gondolella sp.

Pl. LXXIX, Figs. 10, 11

Remarks: 2 specimens, incompletely preserved with broad platform, straight

posterior margin, oral side descending posteriorly with low carina, the denticles not reaching the platform margin, one denticle remains free. On the aboral side is a very broad, flat keel, with small pit.

HOLOTHURIOIDEA

Theelia SCHLUMBERGER 1890

Type species *Chirodota undulata* SCHLUMBERGER, Eocene, France.

Theelia undata **MOSTLER**

Pl. LXXIX, Fig. 11

1968 *Theelia undata n. sp.* — *H.* MOSTLER, p. 30, tab. 5, fig. 5
1968 *Theelia undata* MOSTLER — P. SPECKMANN, p. 206, text-tab. 3, fig. 2.
1970 *Theelia undata* MOSTLER — S. A. STEFANOV, p. 47, tab. 1, fig. 19
1978 *Theelia undata* MOSTLER — A. GAŹDZICKI — H. KOZUR, R. MOCK, J. TRAMMER, p. 364, tab. 51, fig. 89, tab. 52, fig. 1.

Remarks: 4 specimens. The outer margin is very undulate. Over every spoke interarea the margin is highly convex, above every spoke deepened. The central portion is relatively small. The spokes are widening to the margin, number of spokes 7—10.

Theelia serta SPECKMANN is probably a younger synonym of *Theelia undata* MOSTLER.

Stratigraphic and geographic range: Anisian to Cordevolian, most often in the Illyrian, in the Northern Alps, Balkans, Turkey; in the West Carpathians — Trstená near Rajec, Markovica, Ilavka, Beckov, Malinô Brdo, Liptovská Revúca, Liptovská Osada, Zámostie, Jasenie, Predajná, Ráztoka.

Acanthotheelia FRIZZELL — EXLINE, 1955

Type species *Acanthotheelia spinosa* FRIZZELL — EXLINE, Triassic, Southern Alps.

Acanthotheelia spinosa **FRIZZELL — EXLINE, 1954**

Pl. LXXX, Fig. 5, 10, 12

1954 *Acanthotheelia spinosa* FRIZZELL and EXLINE, new species, p. 112, tab. 6, fig. 7—8.
1968 *Acanthotheelia spinosa* FRIZZELL — EXLINE, H. MOSTLER, p. 25, tab. 4, fig. 6, tab. 6, fig. 1.
1968 *Acanthotheelia spinosa* FRIZZELL — EXLINE, P. SPECKMANN, p. 213, text-tab. 4, fig. 5, 6, text-tab. 5, fig. 1—2, 4—5.
1970 *Acanthotheelia spinosa* FRIZZELL — EXLINE, S. A. STEFANOV, p. 45, tab. 1, fig. 13.
1978 *Acanthotheelia spinosa* FRIZZELL — EXLINE, A. GAŹDICKI, H. KOZUR, R. MOCK, J. TRAMMER, p. 360, tab. 49, fig. 2, 3.

Remarks: 6 specimens. Small star-shaped sclerite with 7—9 spokes. The spines are above the spoke interareas. Sometimes above the spokes circular perforations are in the margin. The central portion is large.

Stratigraphic and geographic range: Illyrian to Cordevolian in the Alps, Hungary, Dinarides, Balkans, Turkey; West Carpathians: Beckov, Markovica, Malinô Brdo, Liptovská Osada, Zámostie, Jasenie.

Conclusion

Although the stratigraphic range of the mentioned assemblage of conodonts and holothurian sclerites reaches higher than the Illyrian, from platform conodonts *Gondolella constricta* MOSHER — CLARK reaches the Fassanian, *Gondolella excelsa* (MOSHER) the Lower Longobardian, from holothurian sclerites *Theelia undata* MOSTLER and *Acanthotheelia spinosa* FRIZZELL — EXLINE reach the Cordevolian, I consider the age of the mentioned localities as Illyrian, corresponding to the excelsa Zone in the sense of the division of S. KOVÁCS — H. KOZUR (1980), because *Gladigondolella tethydis* (HUCKRIEDE) indicating the *Aplococeras avisianus* Zone, Lower Fassanian in the sense of S. KOVÁCS — H, KOZUR, is still not present here. Macrofauna has not been found in the mentioned Schreyeralm type limestones at the described localities.

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Jozef Pevný

Konodonty a sklerity holotúrií strážovského príkrovu severne od Mojtína

Resumé anglického textu

V severnom okolí Mojtína v Strážovských vrchoch vystupuje pruh vápencov schreyeralmského typu, v ktorých sa na niekoľkých miestach našlo spoločenstvo konodontov a skleritov holotúrií. Vápence schreyeralmského typu sa vyskytujú na báze strážovského príkrovu v podloží wettersteinských vápencov. Sú to žltkasté, ružovkasté, hnedasté, celistvé vápence, miestami s hľuzami. Mapovacie práce robili v tejto oblasti: J. HANÁČEK (1976) a M. MAHEĽ (1983). Geologický výskum tu robil M. Krivý, ktorému je autor vďačný za uvedenie na lokality. Spoločenstvo konodontov a skleritov holotúrií je strednotriasové, ilýrskeho veku. Pochádza zo štyroch lokalít: 1. východný svah Rokytníka, 230 m severne od k. 730; 2500 m západne od k. 684; 3 . 500 m východne od k. 684; 4 . 600 m východne od k. 723, z. od mlyna Uhliská. Spolu s konodontmi a skleritmi holotúrií sa našli zuby rýb, šupiny rýb, osteokriny, ihlice hubiek a kalcifikované ostrakódy.

Z konodontov boli určené platničkovité druhy *Gondolella exselsa* (MOSHER), *Gondolella constricta* MOSHER-CLARK, *Gondolella* sp., ozúbkované druhy *Prioniodina* (*Cypridodella*) *venusta* (HUCKRIEDE), *Prioniodina* (*Cypridodella*) *muelleri* (TATGE), *Didymodella alternata* (MOSHER), *Lonchodina posterognathus* (MOSHER), *Ozarkodina tortilis* TATGE, *Enantiognathus ziegleri* (DIEBEL), *Hindeodella* (*Metaprioniodus*) *suevica* (TATGE). Z holotúrií sa našli *Theelia immisorbicula* MOSTLER, *Theelia undata* MOSTLER, *Acanthotheelia spinosa* FRIZZELL- EXLINE, *Kuehnites spiniperforatus* (ZAWIDZKA), *Tetravirga perforata* MOSTLER, *Priscopedatus staurocumitoides* MOSTLER, *Priscopedatus tyrolensis* MOSTLER, *Priscopedatus triassicus* MOSTLER, *Eocaudina subhexagona* GUTSCHICK; CANIS — BRILL, *Achistrum* sp., *Calclamna* sp.

Stratigrafické rozpätie platničkovitých konodontov *Gondolella excelsa* (MOSHER) je vrchný pelsón až spodný longobard, *Gondolella constricta* MOSHER — CLARK vrchný pelsón až fasan, ozúbkovaných konodontov *Prioniodina* (*Cypridodella*) *venusta* (HUCKRIEDE), *Didymodella alternata* (MOSHER), *Lonchodina posterognathus* (MOSHER) je ilýr až jul, skleritov holotúrií *Acanthotheelia spinosa* (FRIZZELL — EXLINE a *Theelia undata* MOSTLER ilýr až kordevol. Napriek tomu pokladám vek uvedených asociácií konodontov a skleritov holotúrií za ilýrsky, zodpovedajúci zóne *excelsa* v zmysle členenia S. KOVÁCSA — H. KOZURA (1980) preto, lebo sa tu nevyskytuje *Gladigondolella tethydis* (HUCKRIEDE), ktorá by už poukazovala na prítomnosť zóny *Aplococeras avisianus* — spodný fasan v zmysle S. KOVÁCSA — H. KOZURA. Makrofauna sa na uvedených lokalitách nenašla.

Explanations to Plates LXXIX—LXXXX

Plate LXXIX

1 *Gondolella excelsa* (MOSHER), Illyrian, aboral-lateral view, locality 3, 80×.
2 *Gondolella excelsa* (MOSHER), Illyrian, lateral view, locality 3, 110×.
3 *Gondolella excelsa* (MOSHER), Illyrian, oral view, locality 3, 70×.
4 *Gondolella constricta* MOSHER — CLARK, young form, Illyrian, lateral view, locality 1, 75×.
5 *Gondolella constricta* MOSHER — CLARK, lateral view, Illyrian, locality 1, 50×.
6 *Gondolella constricta* MOSHER — CLARK, lateral view, Illyrian, locality 1, 75×.
7 *Prioniodina* (*Cypridodella*) *muelleri* (TATGE), Illyrian, locality 1, 100×.
8 *Gondolella excelsa* (MOSHER), oral side, Illyrian, locality 1, 70×.
9 *Gondolella excelsa* (MOSHER), oral side. Illyrian, locality 1, 60×.
10 *Gondolella* sp., aboral side, Illyrian, locality 1, 50×.
11 *Gondolella* sp., oral side, Illyrian, locality 2, 50×.
12 *Gondolella constricta* MOSHER — CLARK, aboral side, Illyrian, locality 1, 90×.
13 *Gondolella excelsa* (MOSHER), aboral side, Illyrian, locality 1, 75×.
14 *Gondolella excelsa* (MOSHER), aboral side, detail, deformed posterior end of keel, Illyrian, locality 3, 250×.

Plate LXXXX

1 *Enantiognathus ziegleri* (DIEBEL), Illyrian, locality 3, 90×.
2 *Prioniodina* (*Cypridodella*) *muelleri* (TATGE), Illyrian, locality 3, 120×.
3 *Prioniodina venusta* (HUCKRIEDE), Illyrian, locality 3, 100×.
4 *Lonchodina posterognathus* (MOSHER), Illyrian, locality 3, 60×.
5 *Acanthotheelia spinosa* FRIZZELL — EXLINE, Illyrian, locality 2, 100×.
6 *Calclamna* sp., Illyrian, locality 3, 100×.
7 *Tetravirga perforata* MOSTLER, Illyrian, locality 1, 50×.
8 *Kuehnites spiniperforatus* (ZAWIDZKA), Illyrian, locality 2, 100×.
9 *Priscopedatus tyrolensis* MOSTLER, Illyrian, locality 3, 100×.
10 *Acanthotheelia spinosa* FRIZZELL — EXLINE, Illyrian, locality 2, 100×.
11 *Theelia undata* MOSTLER, Illyrian, locality 1, 150×.
12 *Acanthotheelia spinosa* FRIZZELL — EXLINE, Illyrian, locality 1, 150×.

Photo by K. Šebor
The material is deposited in the collections of the Dionýz Štúr Institute of Geology in Bratislava.

Západné Karpaty, sér. paleontológia, 9, P. 173—178, Geol. Úst. D. Štúra, Bratislava, 1984

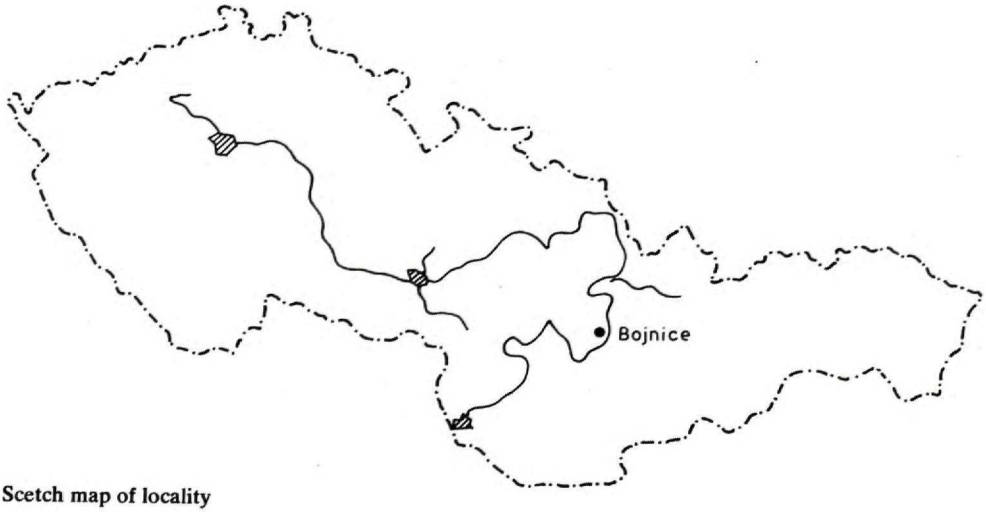
Margita Vaňová

Remarks on Discocyclina andrusovi Cizancourt 1948 emend (ČSSR, Bojnice)

1 text-fig., 2 Pls. (LXXXI—LXXXII), Slovak summary

Abstract. In 1948 M. DE CIZANCOURT found a new species in samples from the Bojnice spa and denoted it as *Discocyclina andrusovi*. The description did not comprise characteristic of the equatorial section of the forms A, B, and the Plates were imperfect in print. Here the complementary paleontological description is presented with diagnostic values measured on original material of M. DE CIZANCOURT.

In 1948 M. DE CIZANCOURT published results of evaluation of larger foraminifers she had obtained from D. ANDRUSOV, in the article, "Nummulitidae et Orbitoidae de l'éocène de Bojnice — les Bains près Prievidza, Carpathes Slovaques. The assemblage comprised plentiful nummulites, assilines, scarce discocyclines and a specimen of the species *Actinocyclina radians*. Nummulites were represented by *Nummulites millecaput* BOUBÉE, *Nummulites gallensis* (HEIM) and *Nummulites striatus* (BRUGU-



Scetch map of locality

RNDR. M. VAŇOVÁ, CSC., Geologický ústav Dionýza Štúra, Bratislava.

IÈRE), assilines were represented by *Assilina exponens* (SOWERBY). Among discocyclines besides *Discocyclina nummulitica* (GÜMBEL), *Discocyclina varians* (KAUFMANN), M. DE CIZANCOURT found a new species and denoted it as *Discocyclina andrusovi.* Because of the lack of suitable material of form A she gave the test dimensions, the ratio of diameter and test thickness, the size of granules and number of lateral chambers. She did not describe equatorial section. As for the axial section, she gave number of series of lateral chambers and their height. The description of the form B comprises data on test dimensions, the ratio of diameter and test thickness, size of granules; the description of axial section comprises number of series of lateral chambers, height of lateral chambers and height of equatorial layer. According to the axial section she compared the specimens of form A to *Discocyclina* aff. *varians* (KAUFMANN) in P. BRÖNNIMANN (1940). Because of their similarity she proposed to range specimens from Forte San Felice to *Discocyclina andrusovi* CIZANCOURT..

Later on *Discocyclina andrusovi* CIZANCOURT was mentioned by other auhtors. In 1953 J. SCHWEIGHAUSER ranged to this species small discocyclines with distinct umbo and granules surrounded by 5—6 lateral chambers. The dimensions of protoconch of the embryonal apparatus of the eulepidine — trybliolepidine type were $0.15 - 0.24 \times 0.14 - 0.24$ mm. The cross diameter of the deuteroconch (CC) varied within 0.22—0.41 mm. In periembryonal chambers were two main auxiliary chambers. 0—2 interauxiliary chambers, 25—33 adauxiliary chambers. In internal rings the chambers were hexagonal; radial arrangement was replaced by wavy bend. In most cases it ended in the damaged parts of the test where anular arrangement began as a rule. He does not regard P. BRÖNNIMANN'S specimens *Discocyclina* aff. *varians* (KAUFFMANN) as identic with *Discocyclina andrusovi* CIZANCOURT. According to him they are closer to *Discocyclina papayracea* (BOUBÉE).

M. NEUMANN (1958) says in connection with *Discocyclina* aff. *varians* (KAUFMANN) from Forte San Felice, that M. DE CIZANCOURT presented her new species in depictions of low quality. M. NEUMANN regards the species as nonvalid because M. DE CIZANCORUT characterized it by indistinct differences from *Discocyclina varians* (KAUFMANN).

E. KÖHLER (1967) distinguishing the species *Discocyclina varians* (KAUFMANN) from other species also mentioned the species *Discocyclina andrusovi* CIZANCOURT. He said that its description was incomplete and its name in literature comprises various forms. He found specimens of the species in material from the original locality at Bojnice. Their test was thicker, with a distinct umbo lip and a large embryonal apparatus.

This brief information on the history of *Discocyclina andrusovi* CIZANCOURT shows the necessity to complete its paleontological description.

Several years ago E. KÖHLER gave me original material of M. DE CIZANCOURT. It consisted of two free specimens (differing in size and form of test), a specimen polished to get equatorial section, a specimen polished to get axial section, a rather thick thin section of the form A, a rather thick thin section of the form B. Both thin sections show rock inclusions. To complete the description I close a smaller free specimen with a distinct umbo (syntype 1) and thin sections of equatorial section of forms A (syntype 2) and B (syntype 3).

Discocyclina andrusovi CIZANCOURT 1948

Form A
Pl. LXXXI

1948 *Discocyclina (Discocyclina) Andrusovi* sp. nov., Forme A—M. DE CIZANCOURT: Nummulitidae et Orbitoidae etc., p. 52—54, Pl. 8, fig. 21, Pl. 9, fig. 29 (non Pl. 7, fig. 15, Pl. 9, fig. 26).

Syntypes: Material M. DE CIZANCOURT; Syntype 1: free specimen (pl. LXXXI, fig. 1—2), Syntype 2: thin section equatorial section (pl. LXXXI, fig. 3—5).

Type level: Upper Lutetian

Type locality: Bojnice spa

Denomination: After the outstanding geologist Academician D. ANDRUSOV

Diagnosis: Discocycline of medium size, with distinct umbo and broad lip. Several larger granules with many lateral chambers are on umbo. A small protoconch, quite a large deuteroconch.

Test description: The test is described according to a free specimen (Pl. LXXXI, fig. 1—2). A distinct umbo passes abruptly into a wider lip with partly waved margin. Umbo diameter: 2.24 mm. There are about ten granules (0.165—0.280 mm) on the umbo. The granules are surrounded by 9—13 lateral chambers, 0.036—0.084 mm in size. Granules on umbo are 0.070—0.090 mm distant from one another. Among larger granules are smaller ones (about 0.070 in size). They are surrounded by 8—9 lateral chambers. They get smaller on the transition of umbo to lip. They are less distinct on the lip. The test diameter is 5.8 mm, the test thickness 2.2 mm.

Equatorial section: It is described according to thin section Pl. LXXXI, fig. 3—5). A small overgrown rock grain near the embryonal apparatus prevents exact determination of the eulepidine or umbilicolepidine type of the embryonal apparatus. Protoconch is small. Its cross diameter (AA) is 0.204 mm, the longitudinal diameter of protoconch (BB) is 0.235 mm. The deuteroconch is markedly larger, its cross diameter (CC) is 0.812 mm. The main diameter (MD) is smaller — 0.613 mm.

The type of arrangement of chambers in the initial cycles is not distinct. Number of periembryonal chambers cannot be determined exactly because one of rock enclosures in the test partly extended to the embryonal apparatus. There are about 26 periembryonal chambers on 2/3 of deuteroconch periphery. The chambers are rectangular. Their height is variable; it is greater than their width. The lower chambers have dimensions 0.022 × 0.042 mm; the higher 0.039 × 0.067 mm. Periauxiliary chambers behind them are lower. They are rectangular as well, their height is greater than width: 0.028 × 0.059 mm. Their height increases toward periphery — as shown by their dimensions 0.02 × 0.07 mm. Equatorial section is characterized by sudden increase or decrease in the height of cycles and their tapering out.

Description of parts of test is based on the way of measurements by J. SCHWEIGHAUSER (1953).

Axial section: I can only describe axial section of one specimen (Pl. LXXXII, fig. 2). Its test shape is different from that of the free specimen and its umbo is less distinct and passes gradually into lip. The lip is narrower, with a less sharp margin. Specimens depicted in Pl. 7, fig. 15 and Pl. 9, fig. 26 by M. DE CIZANCOURT have the same shape. I think they belong to other species. So I do not present detailed description of axial section of my specimen and denote it only *Discocyclina* sp.

Form B

Pl. LXXXII

1948 *Discocyclina (Discocyclina) Andrusovi* sp. nov., forme B — M. DE CIZANCOURT: Nummulitidae et Orbitoidae etc., p. 54, Pl. 8, fig. 21, Pl. 9, fig. 22, textfig. 1.

Syntype: Material of M. DE CIZANCOURT; Syntype 3: thin section, equatorial section (Pl. LXXXII, fig. 1).

Type locality: Bojnice spa

Diagnosis: The test diameter is approx. 18 mm; granules in the middle are larger than on periphery (taken over from M. DE CIZANCOURT), chambers rectangular, vertically elongated. They get larger toward periphery of test. They are arranged in regular cycles. The cycles are tapering out, waved.

Test description: I have only one thin section of equatorial section, so I can only give approximate test dimensions (11.5 mm).

Equatorial section: The thin section is not sufficiently thin in the area of embryonal apparatus, so the apparatus, the shape and number of periembryonal chambers cannot be observed. Chambers are rectangular in the whole equatorial section. Their height increases from the middle of the test; the individual cycles show variable height. They are tapering out, and partly waved. Chambers in inner cycles have the dimensions 0.017 × 0.031 mm, 0.048 × 0.048 mm, in cycles in the middle of the test 0.036 × 0.048 mm, 0.034 × 0.076 mm, and in cycles on test periphery 0.031 × 0.042 mm, 0.031 × 0.090 mm.

Remarks on comparison: The test of A form of *Discocyclina andrusovi* CIZANCOURT has medium size, large umbo passing abruptly into a wide lip with sharp margin. Granules on umbo are rather large, surrounded by 9—13 small lateral chambers. The equatorial section is characterized by eulipidine embryonal apparatus with smal protoconch and large deuteroconch, many periembryonal chambers, rectangular chambers with their height greater than width. The chambers are arranged in irregular cycles. Euqatorial section of form B is characterized by rectangular chambers, elongated vertically and arranged in irregular, variably tapering out cycles. Because of its large embryonal apparatus and a small test of form A it can hardly be compared to specimens described in the past. It is most resemblant to *Discocyclina nummulitica* (GÜMBEL) described by M. NEUMANN (1958). Only our specimen has a smaller test, more lateral chambers around granules, a larger embryonal apparatus and more periembryonal chambers.

A comparison between *Discocyclina andrusovi* CIZANCOURT and the specimens of *Discocyclina* aff. *varians* (KAUFMANN) described by P. BRÖNNIMANN (1940) shows

their similarity. But the specimens from Forte San Felice are larger and have distinct dense granules on their lip. In equatorial section the cross diameter of deuteroconch is somewhat greater. A comparison of specimens of *Discocyclina andrusovi* CIZANCOURT described by J. SCHWEIGHAUSER (1953) to specimens from Bojnice spa shows that the former have a smaller umbo, half so many lateral chambers around granules on umbo, a smaller embryonal apparatus, hexagonal chambers in initial rings and radially arranged chambers in the inner part of test. So they cannot be regarded identic with *Discocyclina andrusovi* CIZANCOURT.

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Explanations to Plates LXXXI—LXXXII

Plate LXXXI

1—5 *Discocyclina andrusovi* CIZANCOURT; 1—2 A form, syntype 1, Bojnice spa, 1 — surface × 13.6, 2 — lateral view × 10,5; 3—5 A form, syntype 2, Bojnice spa, both sides of the thin section of the equatorial section, 3 — × 13.5, 4 — × 14,4, 5 — × 24.6.

Plate LXXXII

1 *Discocyclina andrusovi* CIZANCOURT, B form, syntype 3, Bojnice spa, equatorial section × 12.

2 *Discocyclina* sp., axial section, determined by M. DE CIZANCOURT as *Discocyclina andrusovi* sp. nov., × 10.

Photo by M. Vaňová

Margita Vaňová

Niekoľko poznámok k druhu Discocyclina andrusovi CIZANCOURT 1948 emend. (ČSSR Bojnice)

Resumé anglického textu

M. DE CIZANCOURTOVA v roku 1948 hodnotila veľké foraminifery, ktoré obdržala od D. ANDRUSOVA z viacerých lokalít z kúpeľov Bojnice. Zistila tu druhy *Nummulites millecaput* BOUBÉE, *Nummulites gallensis* (HEIM), *Nummulites striatus* (BRUGUIÈRE), *Assilina exponens* (SOWERBY), *Discocyclina nummulitica* (GÜMBEL), *Discocyclina varians* (KAUFMANN) a nový druh diskocyklíny, ktorý pomenovala *Discocyclina andrusovi*. Pri jeho opise u formy A uviedla rozmery schránky, pomer priemeru a hrúbky schránky, veľkosť granúl a počet laterálnych komôrok. Na axiálnom reze uviedla počet vrstiev laterálnych komôrok a výšku laterálnych komôrok. V opise formy B nachádzame údaje o rozmeroch schránky, o pomere priemeru a hrúbky schránky, veľkosti granúl, v axiálnom reze o počte vrstiev laterálnych komôrok, o výške laterálnych komôrok a výške ekvatoriálnej vrstvy. Podľa vzhľadu axiálneho rezu exempláre formy A prirovnala k exemplárom *Discocyclina* aff. *varians* (KAUFMANN) z práce P. BRÖNNIMANNA. Na základe ich podobnosti uviedla, že by exempláre z Forte San Felice mali byť priradené ku druhu *Discocylina andrusovi* CIZANCOURT. K tomuto druhu priradil J. SCHWEIGHAUSER v roku 1953 drobné diskocyklíny s výrazným umbom a 5—6 laterálnymi komôrkami. M. NEUMANN (1958) považuje druh *Discocyclina andrusovi* CIZANCOURT za neplatný. E. KÖHLER (1967) o druhu *Discocyclina andrusovi* uviedol, že bol nedokonale opísaný a v literatúre pod jeho názvom sú zahrnuté rozličné formy. Exempláre, ktoré z pôvodnej lokality videl, mali hrubšiu schránku s markantným umbom a golierom, ako i veľkým embryonálnym aparátom.

Z uvedeného stručného prehľadu o histórii druhu *Discocyclina andrusovi* CIZANCOURT sa javí potreba doplniť jeho paleontologicky opis.

Pred niekoľkými rokmi som obdržala od E. KÖHLERA originálny materiál M. DE CIZANCOURT. Z neho k doplňujúcemu paleontologickému opisu som vybrala menší voľný exemplár s výrazným umbom (tab. LXXXI, obr. 1—2) a výbrusy ekvátoriálnych rezov formy A (tab. LXXXI, obr. 3—4) a B (tab. LXXXII, obr. 1).

Charakteristickým znakom druhu *Discocyclina andrusovi* CIZANCOURT u formy A je schránka stredných rozmerov s veľkým výrazným umbom, ktoré prudko prechádza do širokého goliera s ostrým okrajom. Na umbe sú pomerne veľké granuly obklopené 9—13 drobnými bočnými komôrkami. Pre ekvatoriálny rez je typický embryonálny aparát s malou protokonchou a veľkou deuterokonchou, vysoký počet periembryonálnych komôrok a pravouhlý tvar do výšky pretiahnutých komôrok, usporiadaných v nepravidelných cykloch. Pre formu B na ekvatoriálnom reze sú charakteristické pravouhlé, do výšky pretiahnuté komôrky, usporiadané v nepravidelných rôzne sa vykliňujúcich cykloch.

Pre pomerne veľký embryonálny aparát a malú schránku u formy A môžeme ho ťažko prirovnávať k exemplárom opísaným v minulosti. Najviac pripomína druh *Discocyclina nummulitica* (GÜMBEL) uvádzaný v práci M. NEUMANNOVEJ (1958). Líši sa od neho menšími rozmermi schránky, väčším počtom laterálnych komôrok okolo granúl, trochu väčším embryonálnym aparátom a vyšším počtom periembryonálnych komôrok..

Ak porovnáme druh *Discocyclina andrusovi* CIZANCOURT s exemplármi *Discocyclina* aff. *varians* (KAUFMANN) opísanými v práci P. BRÖNNIMANNA (1940), zistíme, že sú si na prvý pohľad podobné. Exempláre z Forte San Felice majú však väčšie schránky, dobre viditeľné, husto uložené granuly na golieri. V ekvatoriálnom reze majú o málo väčší priečny priemer deuterokonchy.

Ak prirovnáme exempláre druhu *Discocyclina andrusovi* z práce J. SCHWEIGHAUSERA (1953) k exemplárom z Bojníc zistíme, že majú menšie umbo, polovičný počet bočných komôrok okolo granúl na umbe, menší embryonálny aparát, hexagonálne komôrky v prvých prstencoch a lúčovité usporiadanie komôrok vo vnútornej časti schránky. Na základe týchto odlišných znakov nemôžu byť považované za totožné s druhom *Discocyclina andrusovi* CIZANCOURT.

Západné Karpaty, sér. paleontológia, 9, P. 179—186, Geol. Úst. D. Štúra, Bratislava, 1984

Jan Řehánek

Colomisphaera modica n. sp. and Stomiosphaera leporis n. sp. from sandy- glauconite autochthonous Mesozoic series on SE slopes of Bohemian Massif (Turonian — Lower Senonian, South Moravia, ČSSR)

2 text-figs. 2 Pls. (LXXXIII—LXXXIV), Czech summary

Abstract. Two new species of microorganisms (incertae sedis), namely *Colomisphaera modica* n. sp. and *Stomiosphaera leporis* n. sp. are described from a profile of a sandy-glauconite series of the autochthonous Mesozoic on SE slopes of the Bohemian Massif in the basement of the Foredeep and of the Outer Flysch Belt of the West Carpathians. In the biozonal aspect the new taxa represent a significant part of microfossil association in Upper Cretaceous sediments testified by drilling in the basement of external Carpathian units in South Moravia.

Introduction

In systematic microfacies study of Upper Cretaceous sediments of the Bohemian Massif autochthonous Mesozoic, denoted as the so-called sandy-glauconite series (J. Řehánek 1978), two new microorganism species were determined by the thin-section method. So far they have not been described in detail in literature. They have radial wall structure of spherical calcite tests and on the basis of detail microscopical study are ranged to the genera *Colomisphaera* Nowak, 1968 and *Stomiosphaera* Wanner, 1940 (incertae sedis). For a detail micrometrical characteristic of described forms, besides common parameters of tests, like Dt (test diameter) and Tw (wall thickness), also the coefficient Dt/Tw was selected. It is numerically expressible (cf. I. Nagy 1966) for individual species of described microorganisms with single-layered walls.

Foraminifers quoted in association with newly described species of incertae sedis were determined by E. Hanzlíková (1977) and M. Holzknecht (1978). Other species of microfossils were determined by the author of this article.

Regional position of studied drilling localities is in Figs. 1, 2.

RNDr. J. Řehánek, Geologicko-chemické středisko, Moravské naftové doly, koncern. podnik, Sadová 4, 695 30 Hodonín

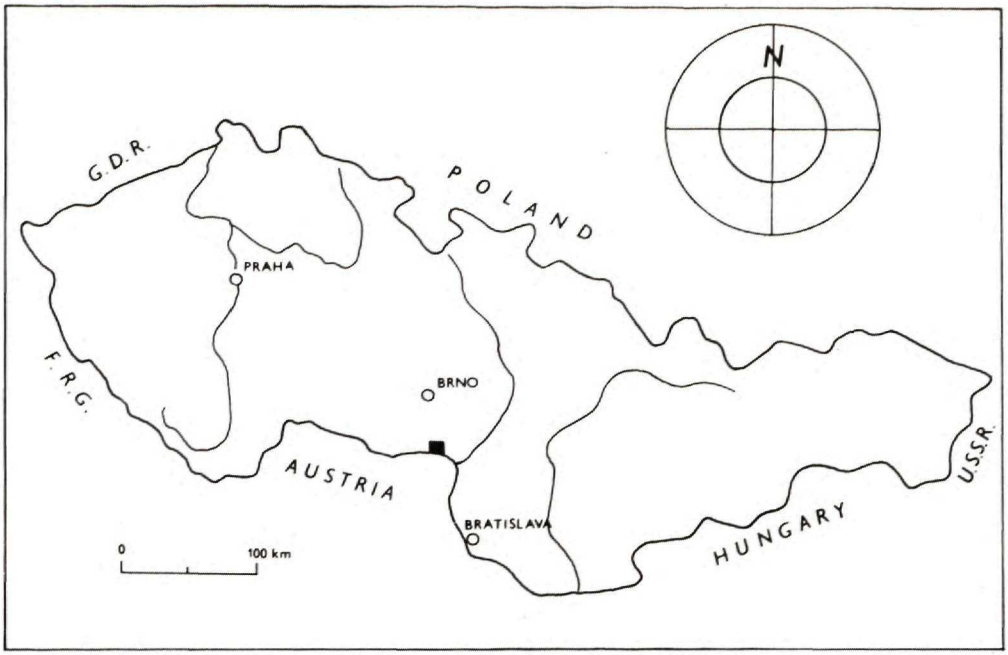

Fig. 1 Localization of area under study (black rectangle).

Colomisphaera Nowak, 1968

***Colomisphaera modica* n. sp.**

Pl. LXXXIII, Fig. 1—6

Holotype: The specimen depicted in Pl. LXXXIII, Fig. 1, 2, in the repository of MND (oil mines) Hodonín. Thin section 6197, coordinates x-50. 8, y-3. 2 (Table of parameters, specimen 3).

Denomination: From lat. modicus — of medium size.

Type level: Turonian — Lower Senonian.

Type locality: Sandy-glauconitic pithonellous marlstone in the borehole Strachotín 2, depth 1694—1697 m.

Material: 5 specimens in thin-section samples (3 specimens from borehole Strachotín 2, 2 specimens from borehole Mikulov 2).

Diagnostic characters: A spherical, unicamerate test with single-layered wall consisting of thin, short, radially arranged calcite crystals.

Description: A spherical test with single-layered wall composed of thin, short, radially arranged calcite crystals. The inner margin of test is straight, the outer is partly uneven. Under penetrating light the test is light grey, under falling light it is milk-white. Calcite individuals in the wall extinct unconformably at crossed nicols.

Axial cross was not seen in any case. The chamber is filled with secondary calcite or pyrite. Test aperture was not observed on any section studied. The test diameter ranges from 47.5 to 61.5 μm, wall thickness is 4 μm.

Dimensions of holotype: Test diameter 58 μm, wall thickness 4 μm.

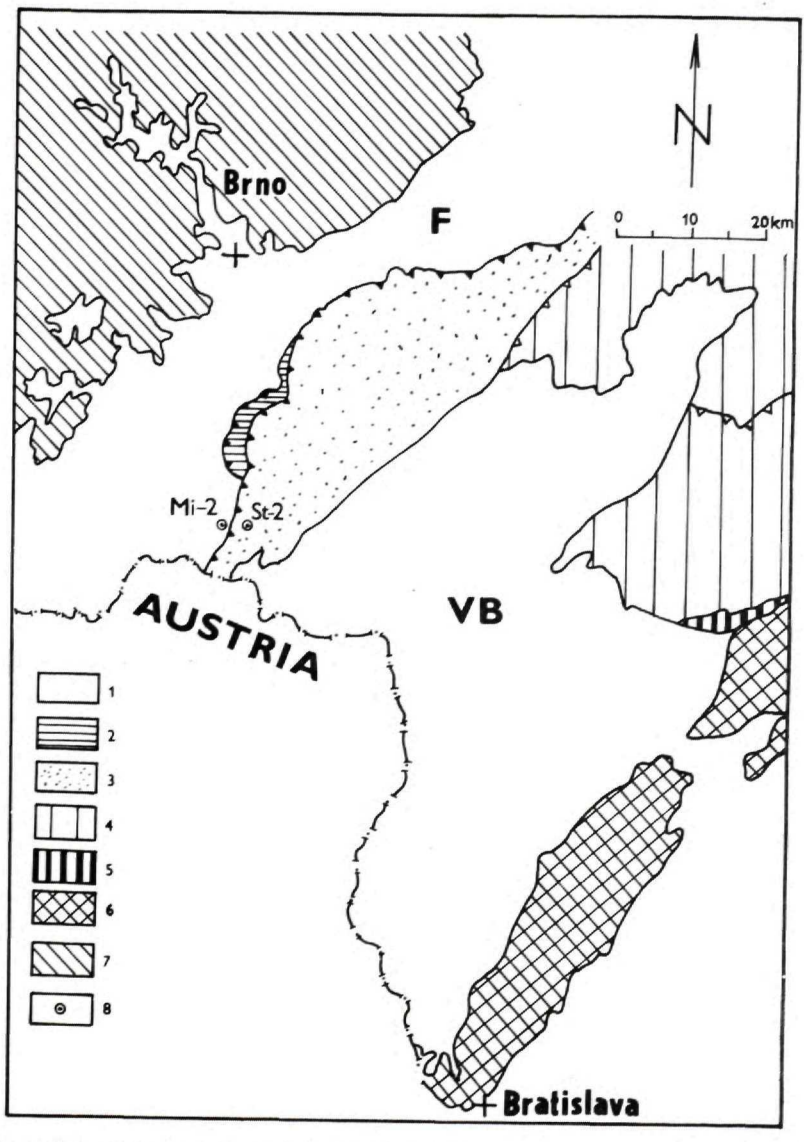

Fig. 2 Schematic geological and tectonical map of area under study; position of boreholes Mikulov 2 and Strachotín 2. Explanations: 1 — Neogene of Carpathian Foredeep (F) and Vienna Basin (VB), 2, 3, 4, — Carpathian Flysch Belt (2-Pouzdřany Unit, 3 — Subsilesian — Ždánice Unit, 4 — Magura Unit), 5 — Klippen Belt, 6 — Inner West Carpathians, 7 — Bohemian Massif, 8 — drilling locality

Stratigraphical range: *Colomisphaera modica* n. sp. occurs scarcely in sandy-glauconite series of autochthonous Mesozoic on SE slopes of the Bohemian Massif (Turonian-Lower Senonian) in the basement of the Foredeep and of the Outer Flysch Belt in South Moravia, in pithonellous marlstone microfacies and in microfacies of spongy claystones in association with *Pithonella ovalis* (KAUFMANN), *Pithonella multicava* BORZA, *Calcisphaerula innominata* BONET, *Cadosina fusca* WANNER, *Colomisphaera varia* ŘEHÁNEK, *Stomiosphaera leporis* n. sp., with radiolarians, silicisponges, with *Hedbergella* gr. *deflandrini* PORTHAULT, *H. delrioensis* CARSEY, *Heterohelix globulosa* (EHRENBERG), *Praeglobotruncana* cf. *turbinata* REICHEL, *P. crassa* BOLLI, *P.* cf. *helvetica* BOLLI, *Globigerinelloides aspera* (EHRENBERG), *Globotruncana imbricata* MORNOD, *Arenobulimina presli* REUSS, *Pernerina* cf. *depressa* PERNER, *Gavelinella* sp., *Bolivina* sp., a. o.

Differentiation: Under penetrating light the general character of sections of *Colomisphaera modica* n. sp. reminds of some formerly presented forms of calcisphaeres. The described species differs from *Colomisphaera fibrata* (NAGY, 1966) in greater test diameters, constant wall width and in stratigraphic position. It differs from *C. tenuis* (NAGY 1966) in a finer wall structure, in the character of outer periphery and in generally greater test parameters, as well as in stratigraphical range. *C. modica* n. sp. differs from *C. pieniniensis* (BORZA 1969) mainly in smaller test diameter and in stratigraphical position.

Remark: The ratio of the minimal and maximal measured values of test diameters and wall thicknesses (Dt/Tw) may be used as an auxiliary differentiation criterium. As for the newly described species *Colomisphaera modica* n. sp. the ratio (Dt/Tw) is 11.875—15.375, as for the holotype it is 14.500. With *C. fibrata* (NAGY) the ratio (Dt/Tw) ranges from 8.00 to 8.85, with the holotype of *C. tenuis* (NAGY) it is 13.60 (for details see I. NAGY 1966, p. 94, Tab. 2). The ratio (Dt/Tw) of *C. pieniniensis* — a form presented for the first time in three specimens by K. BORZA (1969, p. 56) from the West Carpathian Klippen Belt — ranges from 15.750 to 16.666.

Stomiosphaera WANNER, 1940

***Stomiosphaera leporis* n. sp.**

Pl. LXXXIV, Fig. 1—8

Holotype: The specimen depicted in Pl. LXXXIV, Fig. 1—3, in the collection of Petrographical Dept. of the Geological-chemical Centre at MND, Hodonín; thin section 6131/1; coordinates: x – 53.3, – 14.6 (Table of parameters, specimen 13).

Denomination: According to Lat. leporis — fine.

Type level: Turonian — Lower Senonian.

Type locality: Sandy glauconitic spongy claystone in the borehole Mikulov 2, depth 1290 m.

Material: 13 specimens in thin sections from borehole Mikulov 2.

Diagnostic characters: A spherical or slightly oval test with single-layered wall. The wall is porous, composed of extremely fine, regular, radial calcite fibres. Only one section (Pl. LXXXIV, Fig. 4) showed wall fibres slightly oblique to the test surface. The internal margin of the wall is straight or almost straight, the external one is partly uneven. The chamber is filled with secondary calcite or pyrite. No section showed test aperture. In penetrating light the sections of individual specimens are yellowbrown, in falling light they are light grey. At crossed nicols a distinct dark axial extinction was observed (Pl. LXXXIV, Fig. 3). Test diameters range from 58—74.5 μm, wall thickness from 6 to 7 μm.

Holotype dimensions: Test diameter — 74.5 μm, wall thickness 6.5 μm.

Stratigraphical range: The sandy-glauconite series of autochthonous Mesozoic on SE slopes of the Bohemian Massif (Turonian — Lower Senonian); microfacies of spongy claystones, in association with *Colomisphaera modica* n. sp., *Colomisphaera varia* ŘEHÁNEK, *Cadosina fusca* WANNER, *Globigerinelloides aspera* (EHRENBERG), *Heterohelix globulosa* (EHRENBERG), *Globotruncana* gr. *stuarti* (LAPPAR.), *Hedbergella* gr. *monmouthensis* (OLSSON), fragments of *Bolivina* sp., *Dentalina* sp., with silicisponges, radiolarians, echinoderm segments and spines, small fragments of bivalves.

Table of parameters of described species (values in μm)

No.	Thin section	Coordinates		Dt	Tw	Dt/Tw
		x	y			
1.	5568	49.0	2.8	47.5	4	11.875
2.	6196	62.6	9.6	47.5	4	11.875
3.	6197	50.8	3.2	58.0	4	14.500
4.	6131/1	56.7	12.5	61.5	4	15.375
5.	6131/1	55.5	14.8	47.5	4	11.875
6.	6131/1	56.7	10.9	61.5	7	8.785
7.	6131/1	55.7	13.8	58.0	7	8.285
8.	6131/1	55.3	13.0	58.0	7	8.285
9.	6131/1	54.8	14.5	68.5	7	9.785
10.	6131/1	54.6	11.3	72.0	7	10.285
11.	6131/1	53.9	13.4	61.5	6.5	9.461
12.	6131/1	53.2	10.8	58.0	6	9.666
13.	6131/1	53.3	14.6	74.5	6.5	11.461
14.	6131/1	52.3	13.8	65.0	6	10.833
15.	6131/1	51.8	9.3	68.0	7	9.714
16.	6131/1	51.6	15.0	61.5	6	10.250
17.	6131/1	50.9	11.0	61.5	7	8.785
18.	6131/2	50.6	16.0	58.0	7	8.285

Order numbers 1—5 *Colomisphaera modica* n. sp.: 1—3 borehole Strachotín 2, depth 1694—97 m (1 — the interval of 0.2—0.3 m, 2 — the interval of 1.2—1.3 m, 3 — the interval of 1.7—1.8 m); 4—5 borehole Mikulov 2, depth 1290 m.

Order numbers 6—18 *Stomiosphaera leporis* n. sp.: all specimens from borehole Mikulov 2, depth 1290 m.

Differentiation: In its colour and shape of some tests *Stomiosphaera leporis* n. sp. resembles some specimens of *Colomisphaera vogleri* (BORZA). There are substantial differences in porous structure of wall, in the absence of apertures and in the characteristic extinction with axial cross of the newly described species, and in stratigraphical range.

Remark: Additional micrometric characteristic represented by the ratio of measured Dt/Tw values may be numerically expressed within the range of values 8.285—11.461 for the species *Stomiosphaera leporis* n. sp.

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Jan Řehánek

Colomisphaera modica n. sp. a Stomiosphaera leporis n. sp. z písčito-glaukonitové serie autochtonního mesozoika jihovýchodních svahů Českého masívu (turon — spodní senon, jižní Morava, ČSSR)

Resumé anglického textu

Při mikrofaciálním a biozonálním výzkumu vrtně ověřených sedimentů svrchní křídy autochtonního mesozoika Českého masívu na jižní Moravě byly výbrusovou metodou popsány dva nové, v literatuře doposud neuváděné druhy mikroorganismů s radiální stavbou stěny kalcitových schránek. Na základě mikroskopických popisů řadíme studované exempláře do okruhu rodů *Colomisphaera* NOWAK, 1968 a *Stomiosphaera* WANNER, 1940 (incertae sedis).

Colomisphaera modica n. sp. (tab. LXXXIII, obr. 1—6) má jednokomůrkovitou, sférickou kalcitovou schránku s jednovrstevnou stěnou, kterou tvoří radiálně uspořádané kalcitové krystalky. V procházejícím světle jsou výbrusové řezy schránek popisovaného druhu světle šedé, v dopadajícím světle mléčně bělavé, při zkřížených nikolech zháší kalcitová individua stěny nesouhlasně, bez osového kříže. Ústí schránek nebylo pozorováno. Mikrometrickou charakteristiku nově popisovaného druhu uvádíme v anglickém

textu práce. Colomisphaera modica n. sp. představuje formu se sporadickým vystupováním v mikrofacii spongiových jílovců a v mikrofacii pithonelových slínovců svrchní křídy mesozoika jihovýchodních svahů Českého masívu (turon — spodní senon).

Stomiosphaera leporis n. sp. (tab. LXXXIV, obr. 1—8) má jednokomůrkovitou, kulovitou nebo mírně oválnou kalcitovou schránku s jednovrstevnou stěnou, která je složená velmi jemnými, stejnoměrnými, radiálně orientovanými kalcitovými vlákny. Ústí schránek nebylo pozorováno. V procházejícím světle jsou řezy schránek žlutohnědé, v dopadajícím světle šedé, při zkřížených nikolech pozorujeme vždy osový kříž. Mikrometrická charakteristika druhu je uvedena v anglickém textu práce. Stomiosphaera leporis n. sp. je vcelku nepočetnou složkou mikrofosilní asociace tzv. spongiových jílovců svrchní křídy mesozoika jihovýchodních svahů Českého masívu (turon — spodní senon).

Explanations to Plates LXXXIII—LXXXIV

Plate LXXXIII

1—6 *Colomisphaera modica* n. sp. All photographs are from sandy-glauconite series of autochthonous Mesozoic on SE slopes of Bohemian Massif.

1—4, 6 Microfacies of pithonellous marlstones from borehole Strachotín 2, depth 1694—1697 m.

1—2 (holotype), interval 1.70 m, thin section 6197, Fig. 1 magn. 378×, Fig. 2 magn. 850×,

3—4 interval 1.20 m, thin section 6196, Fig. 3 magn. 378×, Fig. 4 magn. 850×.

6 interval 0.20 m, thin section 5568, magn. 378×.

5 Microfacies of spongy claystones from borehole Mikulov 2, depth 1290 m, thin section 6131/1, magn. 378×.

6 shows a specimen slightly depressed, damaged. All photographs are made at//N.

Plate LXXXIV

1—8 *Stomiosphaera leporis* n. sp. All photographs are from sandy-glauconite series of autochthonous Mesozoic of Bohemian Massif, microfacies of spongy claystones in borehole Mikulov 2, depth 1290 m.

1—3 (holotype), thin section 6131/1, Fig. 1, 3 magn. 378×, Fig. 2 magn. 850×.

4—7 thin section 6131/1, magn. 378×

8 thin section 6131/2, magn. 378×.

Photographs 1—2, 4—8 are made at / /N, photograph 3 at XN.

Photographed by J. Řehánek

Západné Karpaty, sér. paleontológia, 9, P. 187—194, Geol. Úst. D. Štúra, Bratislava, 1984

Miroslav Plička

The Upper Cretaceous Ichnofossil Dactylodiscus beskidensis Ślączka 1971 from Zubří (Moravskoslezské Beskydy Mts., Czechoslovakia)

8 text-fig., 4 Pls. (LXXXV—LXXXVII), Czeh summary

Abstract. Detailed studies of "medusa-like" impressions at top surfaces of sandstones of the Istebné Member in the Moravskoslezské Beskydy Mts. in Czechoslovakia and in Polish Beskydy Mts. (Inner-Carpathian flysch, Upper Cretaceous of the Silesian nappe) showed that they were not impressions of medusae — as formerly presumed by some authors — but the impressions of cudgel-shaped spines of regular *Echinodermata*, most likely belonging to the order *Cidaroida*.

Diameter of circular impressions ranges from 1 to 5 cm. The impressions occur together with minor pits, most likely caused by spines of echinoderms as well.

Systematical description

ECHINODERMATA Klein 1734

Echinoidea Düben et Koren 1846

INCERTAE SEDIS

Dactylodiscus Ślączka 1971

Dactylodiscus beskidensis Ślączka 1971

Pl. LXXXV—LXXXVIII, Fig. 1—8

A. Ślączka (1971) introduced the term *Dactylodiscus beskidensis* for circular impressions found at top surfaces of sandstones of the Istebna Member on the locality Łazy near Roźnóv in the Carpathian Flysch in the Polish territory. The author studied 18 samples and assumed that the impressions were from medusae. B. Zahálka (1957) had the same opinion. He found the impressions earlier on the locality at Zubří and I had them to my disposal in addition to my own finds.

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I studied 27 samples (fragments) of rocks with impressions from the Istebna Member on the Czechoslovak territory. Diameter of the impressions ranges from 1 to 5 cm. The information presented by A. ŚLĄCZKA (1971) is to be complemented by the following data:

Since the surfaces of sandstone fragments represent actually the bedding joints, it is difficult to say exactly which is the top surface and which the bottom one. Decisive are conspicuous depressions with the diameter of 0.5—4 mm on the bed surface of the sandstone. In analogy with thin tabular sandstones of the Godula Member with depressions and openings on the bed surface, caused by the same organism (*Echinodermata*) or by sea fish looking for food on the surface of the sea floor (*Pisces*) (M. PLIČKA 1982), always on the top surface (negative epirelief) and with the corresponding projections (positive hyporelief) on the lower bed surface, we may presume that depressions on the bed surface of sandstone fragments of the Istebna Member characterize the top surface and we also can orientate the circular radial impressions, concave (negative epirelief) on the top surface of sandstones.

Cudgel-like projections are at the outer periphery of the impression depressed in the form of a dimple (see photographs in Pl. LXXXVI, Fig. 4, Pl. LXXXVII, Fig. 5 and text-fig. 4). The triangular shape of the projection is identic with the shape of

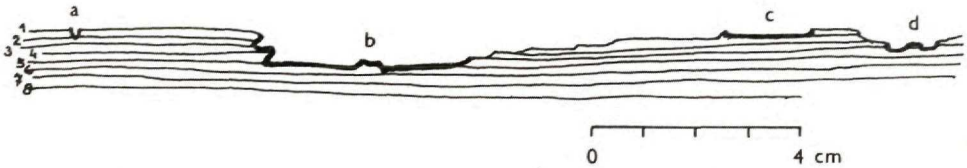
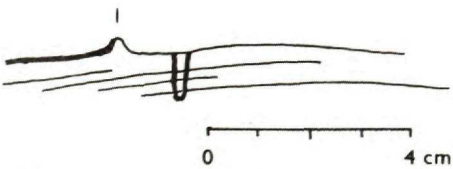


Fig. 1 Schematic illustration of chronologically and spatially distinguishable impressions in fine-grained, microlaminated sandstone. a — opening after spine of echinoderm, b — impression after organism, its depth is greater than that of c, its bottom surface is identic with that of d, but it is younger. 1 — top surface, 2 — 8 bedding joints. Impressions and openings are made more distinct.



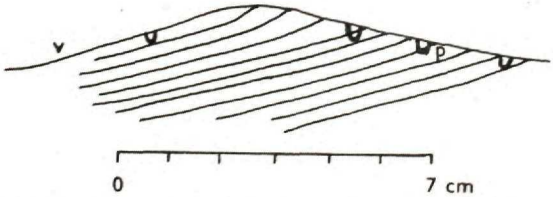


Fig. 2 Schematic sketch of cross section through sandstone with a half impression. A distinct elevation at the periphery of the impression (1). Near the impression is an opening 10 mm long, 3 mm wide, crossed by vertical rock fracture. Microlamination is gently waved. The impression and the opening are made more distinct.

Fig. 3 Openings on uneven sandstone surface on bed surface (v) and on the surface crossing the top laminae (p) prove that the uneven surface was partly washed and levelled by water stream (Scheme according to sample 16).

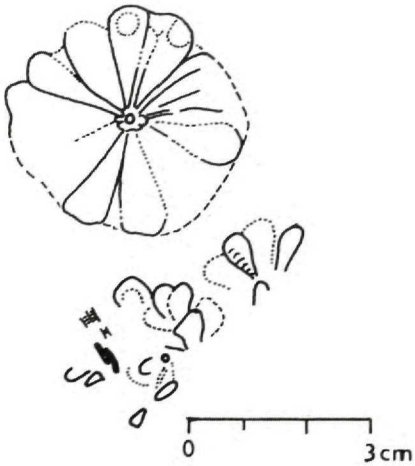
secondary rays of regular echinoderms of the family *Cidaroida* (cf. TH. MORTENSEN, (1928, Fig. 19, p. 72). Usually it is difficult to say whether there are two narrow cudgel- shaped projections, each one with a dimple at its end, or whether it is one broad triangular projection with one longitudinal elevation in its central part and two dimples at the end of the cudgel (see Fig. 4 in text).

Like on Polish samples, also our samples show fine vertical grooves on some cudgel-shaped projections looking at internal structure as segmenting (cf. Fig. 5 in text).

On most samples the impressions are somewhat depressed in the rock. In the wall resulting from depression of the organism into the sandy basement of the sea floor are impressions of ends of the cudgel-shaped elements. The wall is oblique to steeply inclined to the surface of impressions. Pl. LXXXV, Fig. 5, Pl. LXXXVI, Fig. 4, Pl. LXXXVII, Fig. 1, 6, Pl. LXXXVIII, Fig. 5, and Fig. 1 and 6 in text).

At the upper periphery of the impression is a rampart indicating that the sea animal was depressed in the bottom of the basement (Fig. 1 in text, Fig. 3 and 5 in Pl. LXXXV, Fig. 6 in Pl. LXXXVII).

The sample in Pl. LVII, Fig. 3 is a link between circular radial impressions and dimples (openings) on bed surface. Its central part and indications of radial structure



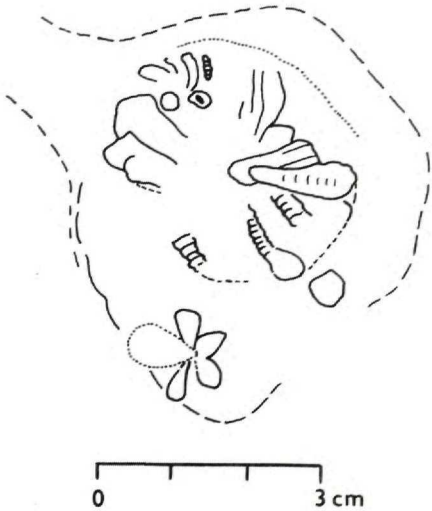


Fig. 4 *Dactylodiscus beskidensis* ŚLĄCZKA 1971, impression on the top surface of sandstone. A very nice impression of organism with a central part (oral aperture?) from which radial cudgel-shaped projections run out. Near the impression are traces after remains of organism and oval dimples. The projections have depressions on their ends. (Sample 22).

Fig. 5 *Dactylodiscus beskidensis* ŚLĄCZKA 1971, an impression with vertical grooving on cudgel-like projections. Some of them have distinct lateral projections. The grooving and fine metamery may represent the internal structure of the cudgel-like projections (sample 19).

are vague, but striking in marginal delimitation in the form of dimples and openings after the ends of cudgel-shaped projections. The organism only touched the sea floor with its spinose projections but did not settled and left only the trace after projections.

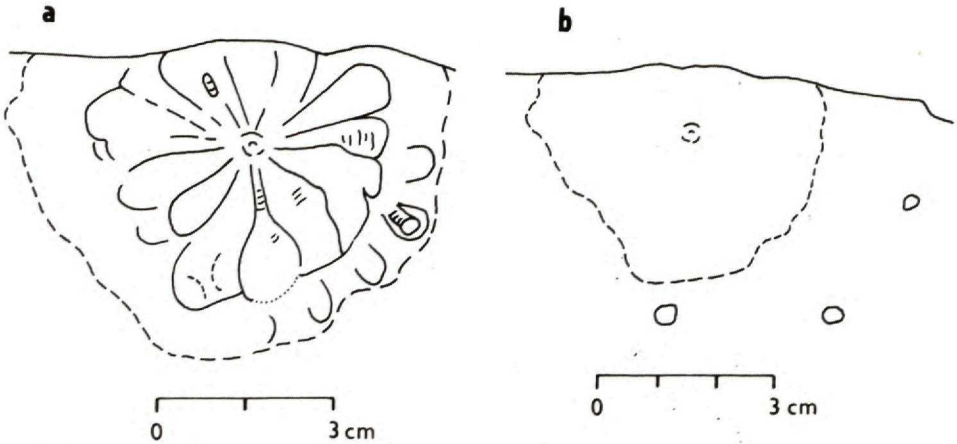


Fig. 6 *Dactylodiscus beskidensis* ŚLĄCZKA 1971, the impression is in the top surface of sandstone 6 mm. It forms a slight elevation with impressions of other higher cudgel-shaped projections. Out of the impression are three circular openings, 2,2 and 3 mm in diameter (sample 5).

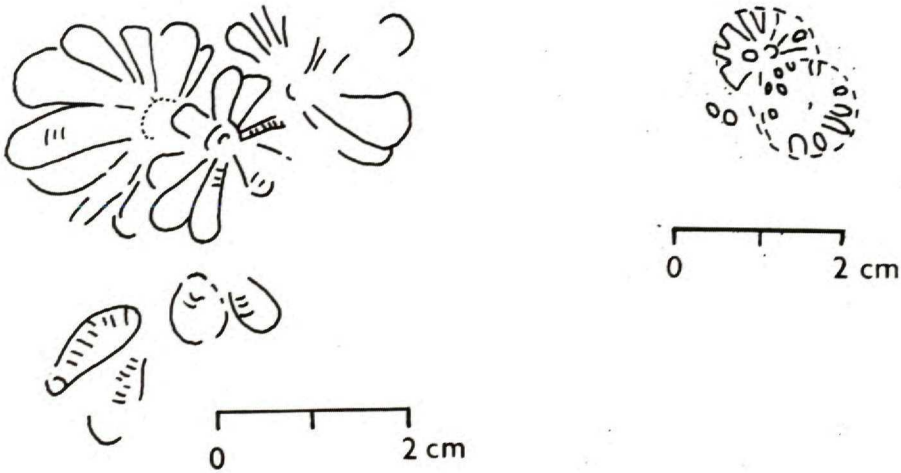


Fig. 7 *Dactylodiscus beskidensis* ŚLĄCZKA 1971 ; impressions on the top surface of sandstone. In one place are impressions of several isolated cudgel-shaped projections. Circular impressions overlap one another in places.The largest impression is depressed intensely in the rock (sample 2).

Fig. 8 *Dactylodiscus beskidensis* ŚLĄCZKA 1971, a double impression 1.5 cm in diameter with distinct dimples at its periphery. Perhaps the organism migrated a little (sample 12).

Also some openings on the surface of sandstone indicate that the projections touched the sandy sea floor in the time when the organism was partly transported by water stream (Pl. LXXXVIII, Fig. 6). A small elevation and unidirectional prolongation of the traces indicate orientated movements of the animal floating and touching the sea floor.

It is interesting that the ends of cudgel-shaped projections are thrusted in sand from side (Fig. 1b in text) not only with their bottom part but partly also with their higher parts. This enabled the organism to fit firmly to the sea floor (e. g. the recent echinoderm *Heterocentrotus mammilatus* from the Indian Ocean (W. Crome et al. 1969). The lateral thrust of the end of cudgel-shaped projection in sand (sandstone) is visible on many samples, particularly when the organism is depressed deeper in the sea floor.

Besides complete circular radial impressions some samples showed disturbed radial structure and nearness of projections without central orientation (Pl. LXXXV, Fig. 4). Some samples even show impressions of single projections out of the circular impressions (Fig. 7 in text). Sample 18 shows isolated cudgel-shaped impressions in a distance over 15 cm from the nearest circular radial impression.

Conclusion

Circular radial impressions on the surface and inside the top part of the sandstone layer of the Istebna Member represent impressions of oral parts of regular echinoderms, most likely order *Cidaroida* Duncan, 1889 (*Echinodermata* Klein 1734, class *Echinoidea* Düben et Koren 1946). Cudgel-shaped projections running out radially from the central part of the impression, and other terminal impressions of cudgel-shaped projections out of the periphery of the impression, higher up above the impression and isolated impressions of single cudgel-shaped projections represent impressions of cudgel-like spines of echinoderms.

Scarce openings and traces on the top surfaces of sandstones, usually 2—5 mm in diameter, are traces after spines of echinoderms moving on the sea floor.

The term *Dactylodiscus beskidensis* Ślączka 1971 introduced by the Polish author A. Ślączka (1971) for the radial impressions is valid. It also concerns isolated impressions of cudgel-like spines with their shape identic with that of impressions which are a part of the radial impression. The term cannot be unambiguously applied for the single "sharp" openings on the surface of the Istebna and Godula sandstones from which they are known.

The impressions *Dactylodiscus beskidensis* Ślączka 1971 cannot be regarded as impressions of medusae. The same concerns similar impressions *Belitsia casteri* Nikolov — Shopov 1967 from the Lower Cretaceous flysch in Bulgaria (T. Nikolov — V. Shopov 1967). First of all it is necessary to respect the natural law of the animal realm: quintuple articulation is characteristic of Echinodermata, quadruple of medusae. The medusal origin of the genera *Dactylodiscus* Ślączka 1971 and *Belitsia* Nicolov — Shopov 1967 is denied by the fact, that deep impressions of cudgel-shaped projections in the sandy sea floor could not be made by the soft, jelly-like body of a medusa, but only by hard, calcareous spines of echinoderms.

It will be necessary to revise the systematical range of similar forms ranked among impressions of medusae (H. J. HARRINGTON and R. C. MOORE, 1956: *Protomedusae, Trachylinida*). It follows, that also Lower Jurassic impressions from Germany, denoted by W. HÄNTZSCHEL (1970) as "Jurassic" medusae or star-like ichnofossils?" (W. HÄNTZSCHEL 1970, p. 12, Fig. a, b, c) are actually impressions of oral part of echinoderms with distinctly impressed single teeth on the bottom side of aristotle lantern. The quintuple structure is quite distinct.

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Miroslav Plička

Ichnofosilie Dactylodiscus beskidensis Ślączka 1971 ze svrchní křídy u Zubří (Moravskoslezské Beskydy), Československo

V roce 1956 uvedl B. ZAHÁLKA (1957) ve Věstníku ÚÚG článek o nálezu medusovité formy v pískovci istebňanských vrstev (svrchní křída) u Zubří nedaleko Rožnova pod Radhoštěm. Při studiu použil 15 vzorků. V r. 1967 jsem navázal na studii prof. B. ZAHÁLKY. Kromě nově nalezených vzorků jsem měl k dispozici i materiál po prof. B. ZAHÁLKOVI. Celkem jsem zpracoval 27 vzorků.

V poslední době byly tyto otisky studovány v istebňanských vrstvách také na území Polska (A. ŚLĄCZKA 1964, 1967, 1971), kde byl pro ně zaveden rodový i druhový název *Dactylodiscus beskidensis* ŚLĄCZKA 1971. Jak B. ZAHÁLKA (1957) tak také A. ŚLĄCZKA (1964, 1967, 1971) spojovali jejich vznik s medusami. Studium našich vzorků po srovnání se vzorky polskými, které se s nimi naprosto shodují ukázalo, že se nejedná o otisky medus, ale o otisky mořských ježovek.

Za pomoc při získávání a zajišťování odborné literatury k této problematice a rovněž za odborné rady z oboru *Echinodermat*, s nimiž otisky spojuji, děkují Doc. Dr. V. KALABISOVI, který se podrobně studiem Echinodermat zabýval (V. KALABIS 1949).

Z geologického hlediska je výskyt otisků vázán na nejsvrchnější část pískovce istebňanských vrstev, vystupujícího v nejspodnějším pískovcovém pásmu. Otisky se vyskytují jen v šedozeleném jemnozrnném pískovci, jemně laminovaném. Průměr otisků se pohybuje od 1 do 5ti cm. V těsné blízkosti otisků se často objevují dolíkovité vpichy.

Kromě poznatků, které uvádí A. ŚLĄCZKA (1971) je třeba doplnit tato další zjištění, závažná pro vysvětlení původu vzniku otisků:

Otisky jsou výhradně na povrchu pískovcových lavic nebo při vrstevních spárách i uvnitř pískovců. Materiál je pro možnost uchování a vzniku otisku měkkého rosolovitého těla medusy značně hrubý.

Otisk v pískovci je vyhlazený, detailně modelovaný. Zvláště je nápadné zaklínění konce kyjovitých výběžků z boku do pískovce (viz obr. 1 v textu). Tento způsob zaklínění a přichycení na mořském dně je znám u recentních ježovek řádu *Cidaroida* DUNCAN 1889.

Skoro u všech otisků je patrné zahloubení organizmu do písčitého podkladu. Tento jev je rovněž znám u recentních ježovek řádu *Cidaroida* (W. CROME et al. 1969).

Ve stěně jamky s otiskem, jejíž hloubka se pohybuje od dvou do pěti milimetrů jsou znatelné otisky konce výše položených kyjovitých výběžků.

U některých vzorků pozorujeme překrývání otisků (až tři otisky v těsné blízkosti), jak je tomu například u vzorku č. 2 (tab. LXXXV, obr. 2 a obr. 7 v textu). Po jedinci, který se buď přemístil nebo zahynul se usadil jiný, menší jedinec.

Vzorek č. 12, zachycený na fotografii na tab. LXXXVII, obr. 3 je velmi pádným dokladem toho, že se jedná o otisky pevných kyjovitých ostnů ježovek. Spojitost mezi povrchovými vpichy a stopami po jednotlivých ostnech a kruhovitým radiálním otiskem je zde velmi zřejmá.

Stavba radiálních otisků neodpovídá ani počtem výběžků ani jejich tvarem výběžkům medusovitého těla. U medus je totiž tělo stavěno dle čísla 4. A. ŚLĄCZKA (1971) uvádí pro diagnozu druhu *Dactylodiscus beskidensis* pět paprskovitých laloků.

Závěrem je možno říci, že kruhovité radiální otisky na povrchu i uvnitř nejsvrchnější části pískovcové polohy istebňanských vrstev pocházejí od otisků orální části regulárních ježovek, pravděpodobně řádu *Cidaroida* DUNCAN, 1889. Kyjovité výběžky, vybíhající radiálně od středové části otisku a další koncové otisky kyjovitých výběžků vně obvodu otisku výše nad otiskem a izolované otisky jednotlivých kyjovitých tvarů jsou otisky kyjovitých ostnů mořských ježovek.

Ojedinělé vpichy a stopy na svrchní vrstevní ploše pískovců o průměru obyčejně 2—5 mm pocházejí od konce ostnů ježovek, pohybujících se po mořském dně.

Rodový i druhový název *Dactylodiscus beskidensis* ŚLĄCZKA 1971, který pro tyto radiální paprsčité otisky uvedl do literatury A. ŚLĄCZKA (1971) je platný. Týká se to i ojedinělých otisků kyjovitých ostnů, tvarově se shodujících s těmi, které jsou součástí radiálního otisku.

Otisky *Dactylodiscus beskidensis* ŚLĄCZKA 1971 nelze považovat za otisky medus. Hluboké a výrazné zaklínění kyjovitých výběžků do písčitého mořského dna nemohlo způsobit měkké, rosolovité tělo medusy, ale tvrdé vápnité ostny ježovek.

Explanations to Plates LXXXV—LXXXVIII

Plate LXXXV—LXXXVIII

Dactylodiscus beskidensis ŚLĄCZKA 1971, Istebné Member (Upper Cretaceous) of the Godula nappe, 1.5 km W of Zubří near Rožnov pod Radhoštěm. Samples marked with K (Doc. Dr. V. KALABIS) are from the property of the late Prof. Dr. B. ZAHÁLKA.

Plate LXXXV
1 sample 1K (presented by B. ZAHÁLKA, 1957 in Pl. 1, Fig. 3);
2 sample 2K;
3 sample 3k;
4 sample 4K;
5 sample 5K;
6 sample 8K;

Plate LXXXVI
1 sample 6K (presented by B. ZAHÁLKA, 1957, in Pl. 1, Fig. 1);
2 sample 7K;
3 sample 9K;
4 sample 10K (presented by B. ZAHÁLKA, 1957 in Pl. 1, Fig. 2);
5 sample 15;
6 sample 14K;

Plate LXXXVII
1 sample 16;
2 sample 17;
3 sample 12K;
4 sample 13K;
5 sample 11K;
6 sample 18K;

Plate LXXXVIII
1 sample 23 (health centre in Zubří);
2 sample 20;
3 sample 21;
4 sample 22;
5 sample 24, (health centre in Zubří);
6 sample 26

Západné Karpaty, sér. paleontológia, 9, P. 195—200, Geol. Úst. D. Štúra, Bratislava, 1984

Miroslav Plička

Two new Fossil Traces in Inner-Carpathian Paleogene in Slovakia (Czechoslovakia)

4 Pls (LXXXIX—XCII), Czech summary

Abstract. The author describes two new fossil traces *Agrichnium incompositum* n. sp. and *Cumulusichnium incertum* n. ichnogen n. sp., found in the Inner Carpathian Paleogene in the Liptovská kotlina (basin), NE of Liptovský Mikuláš. The fossil traces are on undersurfaces of sandstones in the form of positive hyporelief. New generic and species names were selected for one fossil trace, the new species for the other one.

Introduction

In connexion with geological and paleontological data on the Liptovská kotlina basin (P. Gross 1979, P. Gross — E. Köhler et al. 1980) the study of fossil traces began in this area in 1978 within the researches performed by ÚÚG. My attention to the localities of fossil traces was called by Dr. P. Gross who has done thorough geological research in thin region. The localities comprised also Liptovský Ondrej where the newly described fossil traces were found. For this I offer my heartiest thanks to Dr. Gross.

The newly described fossil traces come from an outcrop of Paleogene beds in a claystone facies (claystone-sandstone facies on the locality) of the Middle-Upper Eocene age. In the debris in the left bank of a brook and in its bed 8 fragments of laminated sandstones were found in 1980. The newly described traces were on the undersurface (positive hyporelief).

Systematic description

Ichnogenus Agrichnium Pfeiffer, 1968

Description: Groups of small subparallel smooth furrows of unequal moderate length (W. Häntzschel 1975, W 36, W 38, fig. 22).

Stratigraphical range: Devonian, "Nereitenquartzite", Eocene — Inner Carpathian Paleogene.

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***Agrichnium incompositum* n. ichnosp.**

Pl. LXXXIX, Fig. 1, 2; Pl. XC, Fig. 1, 2

Holotype: Sample 74/1 (Pl. I, Fig. 2), in the collection of ÚÚG.

Type level: Claystone to claystone-sandstone facies of Paleogene beds (Upper Lutetian — Upper Eocene), Inner Carpathian Paleogene.

Type locality: Liptovský Ondrej, the right bank of the brook near a bridge at the upper end of the village.

Denomination: from Lat. "incompositus" (the traces run in all directions on the sandstone undersurface).

Material: 8 sandstone fragments. Holotype (sample 74/1) is irregular-shaped, with dimensions 31 × 16 × 3.5 cm.

Description: Fine fibrous tubular traces partly curved or almost straight are on the sandstone undersurface. They are running in all directions and overlap one another on their contacts. During the horizontal movement on the clayey surface of the sea floor the organism was slightly submerging or emerging, forming so cylindrical traces narrowed at their ends on the undersurfaces of the sandstone. In places there are great accumulations of traces.

Remark: The newly found trace resembles Agrichnium fimbriatum (Ludwig) in its form and size and differs from it in its disordered unoriented course on the under-surface of the sandstone, whereas *Agrichnium fimbriatum* (Ludwig) is characterized by subparallel course of traces (Pfeiffer) 1968, p. 671, Pl. III, Fig. 4, 5).

Sediment: The fossil trace Agrichnium incompositum n. sp. is on the undersurface of the green-grey, noncalcareous, fine-grained sandstone with Fe, Mn — coats on cleavage planes. The sandstone undersurface with the newly found traces is greyish.

Association: On some sandstone fragments from the studied locality were traces of the genus *Beloraphe* Fuchs 1895 and *Planolites* Nicholson 1873 and another newly found fossil trace of *Cumulusichnium incertum* n. ichnogen, n. sp. which is also described here.

On undersurface of sandstones from the studied localities are many carbonatized plant remains and also some mechanoglyphs.

Origin: Fine vermicular forms are likely to originate from small sea worms moving on the surface of the muddy sea floor and slightly pressing in the floor. In places of greater accumulations of the fine cylindrical forms may also be remnants of extinct worms.

Stratigraphical range: Inner Carpathian Paleogene in the claystone to claystone-sandstone facies (Upper Lutetian — Upper Eocene). Locality Liptovský Ondrej, 6 km NE of Liptovský Mikuláš. Some of the newly described traces were also found in the Godula Member (Cretaceous) of the Silesian nappe in Moravia (Outer Carpathian Flysch).

***Ichnogenus Cumulusichnium* n. ichnogen.**

Type species *Cumulusichnium incertum* n. sp.

Denomination: Lat. cumulus = accumulated, heaped.

Diagnosis: Accumulated, irregular arched forms with fine internal hill-like dissection (positive hyporelief).

Stratigraphical range: Inner Carpathian Paleogene (Upper Lutetian — Upper Eocene).

***Cumulusichnium incertum* n. ichnosp.**

Pl. XCI, Pl. XCII, Fig. 1, 2

Holotype: Sample 74/9, in collection of ÚÚG.

Type level: Claystone to claystone-sandstone facies of Paleogene beds (Upper Lutetian — Upper Eocene), Inner Carpathian Paleogene.

Type locality: Liptovský Ondrej, right bank of brook at bridge on the upper end of the village.

Denomination: Lat. "incertus" — uncertain, problematic.

Material: One sample of laminated sandstone; dimensions: 45 × 20 × 3 cm.

Diagnosis: Accumulated, gently arched forms with fine internal hill-like dissection (positive hyporelief).

Description: On the entire undersurface of the sandstone are distinct accumulated projections with fine hill-like inner dissection. They are arranged in an approximate arc. The size of projections ranges from 0.5 to 6 mm, the diameter of the arc with projection is 3—4 cm. Out of the arcs the projections are isolated, arranged irregularly (Pl. XCI, Pl. XCII, Fig. 1, 2).

Sediment: Green-grey, extremely fine-grained calcareous sandstone, partly micaceous, slightly convolute. The undersurface with the newly described traces is light-greyish.

Association: As in the preceding newly found fossil trace. Near the trace are straight or partly bent, 1.5 mm wide cylindrical traces, ranging up to 7 cm in length which were newly found in the vicinity of Poprad and described as *Popradichnium erraticum* n. ichnogen. n. sp. (M. Plička, in print).

Origin: Depressions in the clayey surface of the sea floor resulted most likely from the activity of sea organisms moving on the floor. The arc-like arrangement of traces resulted most likely from the activity of the organism's extremities in a close circle around the place of its temporary stay.

Stratigraphical range: Middle-Upper Eocene, Inner Carpathian Paleogene in the sandstone- to claystone-sandstone facies; locality Liptovský Ondrej, NE of Liptovský Mikuláš.

Ecology and paleoecology

Fine cylindrical traces *Agrichnium incompositum* n. ichnosp. originating most probably from sea worms cannot unambiguously prove the depth conditions in the former sedimentation basin in the place of their occurrence. The latest data on

marine fauna show that sea worms are considerably adaptable as regards depth conditions. Some species of the family *Maldanidae* like *Maldane sarsi* MALMGREN, *Asychis biceps* (M. SARS) and *Praxillura longissima* ARVIDSON live both in the shallow water environment at the sea coast and at great depths to several thousands of metres (F. DAHL 1971).

As regards the second fossil trace *Cumulusichnium incertum* n. ichnogen n. sp. we cannot unambiguously determine the depth of the sedimentation environment. The conditions for the development and the activity of sea organisms on the sea floor were extremely favourable in the area of the studied fossil traces as indicated by great accumulations and varied assemblages. They are indicative of a shallow-water environment.

Current- and drag marks

Among mechanoglyphs on undersurfaces of sandstone fragments were current- and drag marks. Almost all samples with the trace *Agrichnium incompositum* n. ichnosp. showed indications of current marks. They did, however, not influence the course of small cylindrical forms. One sample had also a distinct drag mark running at a sharp angle to current marks. The drag mark did not influence fine cylindrical traces on undersurface of sandstone. The orientation of the second fossil trace is not influenced by the current marks.

Conclusion

The two new fossil traces are from the claystone facies of the Inner Carpathian Paleogene in the Liptovská kotlina basin. There are more sandstones with platy parting on the locality Liptovský Ondrej where the traces were found on their undersurfaces (positive hyporelief).

The trace *Agrichnium incompositum* n. ichnosp. is characterized by accumulating fine cylindrical forms, very similar to finds from the German Devonian (H. PFEIFFER 1968). It is likely that the greater accumulations of the traces represent body imprints of worms suddenly buried under sandy material and killed. A considerable time span of their occurrence (Devonian — Paleogene) is indicative of their extremely slow evolution.

The second trace resulted most likely from the activity of sea organisms in the place of their temporary stay on the sea floor. Both fossil traces are results of activity of sea organisms living on the clayey sea floor. Conditions for the development and activity of sea organisms on the sea floor were particularly favourable in that time and place. It is proved by great local accumulations of fossil traces, mostly fine, and their varied assemblage. These facts are indicative of a shallow-water environment.

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Miroslav Plička

Dvě nové fosilní stopy ve vnitrokarpatském paleogénu na Slovensku

V návaznosti na práce zaměřené na geologický a paleontologický výzkum Liptovské kotliny (P. GROSS 1979, P. GROSS — E. KÖHLER et al., 1980) bylo zahájeno v r. 1978 i studium fosilních stop v uvedené oblasti v rámci prací Ústředního ústavu geologického Praha, pobočka Brno. K lokalitám, na které mne předem upozornil DR. P. GROSS, který oblast geologicky zpracovával, patří i lokalita Liptovský Ondrej, na níž byly zjištěny dvě nové fosilní stopy.

Na uvedené lokalitě vycházejí na povrch vrstvy vnitrokarpatského paleogénu v jílovcovém až jílovcovo-pískovcovém vývoji (eocén střední — svrchní) a to v pravém břehu a korytě potoka u můstku, při horním konci obce. Ze sutě bylo získáno 9 vzorků destičkovitých pískovců s nově zjištěnými fosilními stopami (positivní hyporelief).

Stopa *Agrichnium incompositum* n. ichnosp. se vyznačuje nahromaděním jemných válečkovitých tvarů, probíhajících na spodní vrstevní ploše pískovce všemi směry, velmi blízkých nálezům z devonu Německa (H. PFEIFFER 1968). Není vyloučeno, že v místě většího nahromadění válečkovitých tvarů se jedná o tělní otisky červů, náhle zasypaných písčitým materiálem a uhynulých (Tab. LXXXIX, tab. XC, obr. 1, 2).

Stopa *Cumulusichnium incertum* n. ichnogen, n. sp. (Tab. XCI, Tab. XCII, obr. 1, 2) představuje nahloučené, místy poněkud obloukovitě nepravidelně uspořádané kopečkovité tvary s dalším jemnějším vnitřním kopečkovitým členěním (positivní hyporelief). Prohlubeninky na jílovitém mořském dně vznikly pravděpodobně činností mořských organizmů, pohybujících se na jeho povrchu. Obloukovité uspořádání stop mohlo být vyvoláno činností jejich končetin v těsném okruhu místa dočasného pobytu.

Kromě dvou nově uvedených fosilních stop byly na studované lokalitě zjištěny ještě fosilní stopy náležející rodu *Beloraphe* FUCHS 1895, *Planolites* NICHOLSON 1873 a další nová fosilní stopa *Popradichnium erraticum* n. ichnogen n. sp., zjištěná v okolí Popradu (M. PLIČKA, v tisku).

Podmínky pro rozvoj a činnost mořských organizmů na mořském dně byly v uvedeném prostoru a čase mimořádně příznivé. Svědčí o tom značné lokální nahromadění fosilních stop, většinou velmi jemných a jejich pestrá asociace. Tyto okolnosti by nasvědčovaly spíše pro mělkovodnější prostředí.

Vysvětlivky k tabulkám LXXXIX—XCII
(Foto M. Plička)

Tab. LXXXIX

1 *Agrichnium incompositum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/3, kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

2 *Agrichnium incompositum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/1 (holotyp), kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

Tab. XC

1 *Agrichnium incompositum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/7, kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

2 *Agrichnium incompositum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/2, kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

Tab. XCI

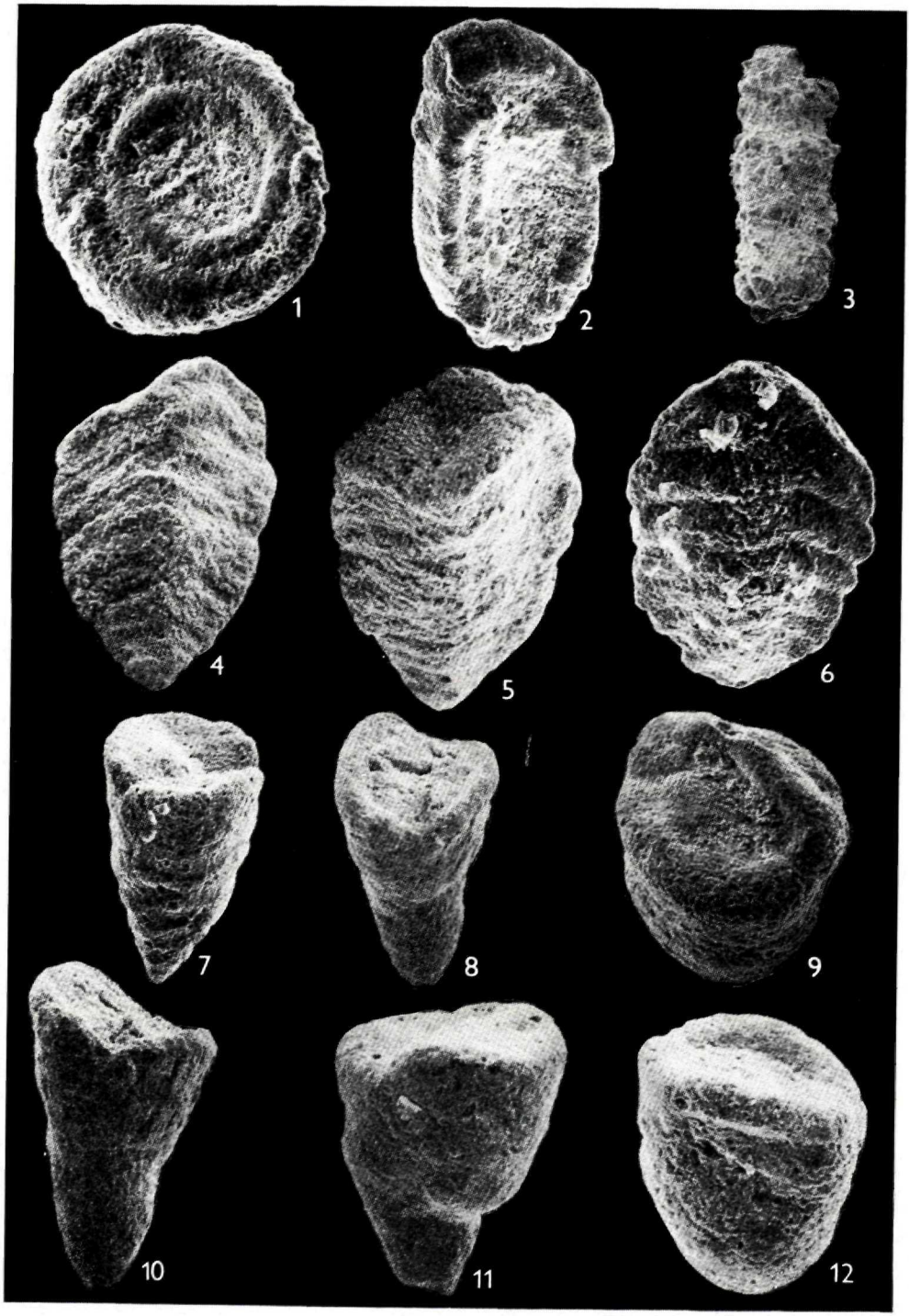
1 *Cumulusichnium incertum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/9 (holotyp), kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

Tab. XCII

1 *Cumulusichnium incertum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/9 (detail), kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

2 *Cumulusichnium incertum* n. sp. na spodní vrstevní ploše tabulkovitého pískovce (vnitrokarpatský paleogén, eocén střední — svrchní). Vzorek č. 74/9 (detail), kolekce uložena na Ústředním ústavě geologickém, pobočka Brno.

PHOTOGRAPHS
I—XCII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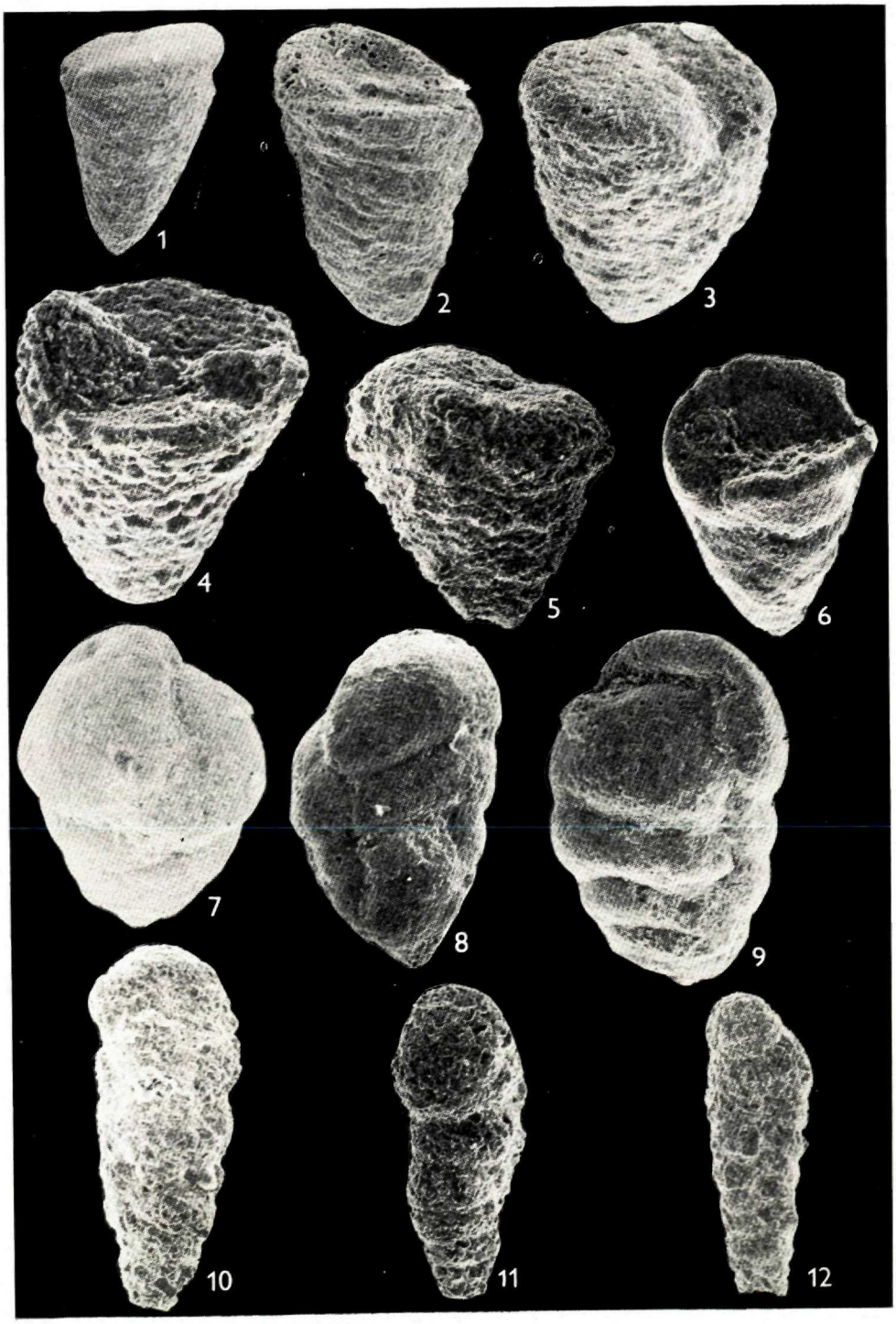
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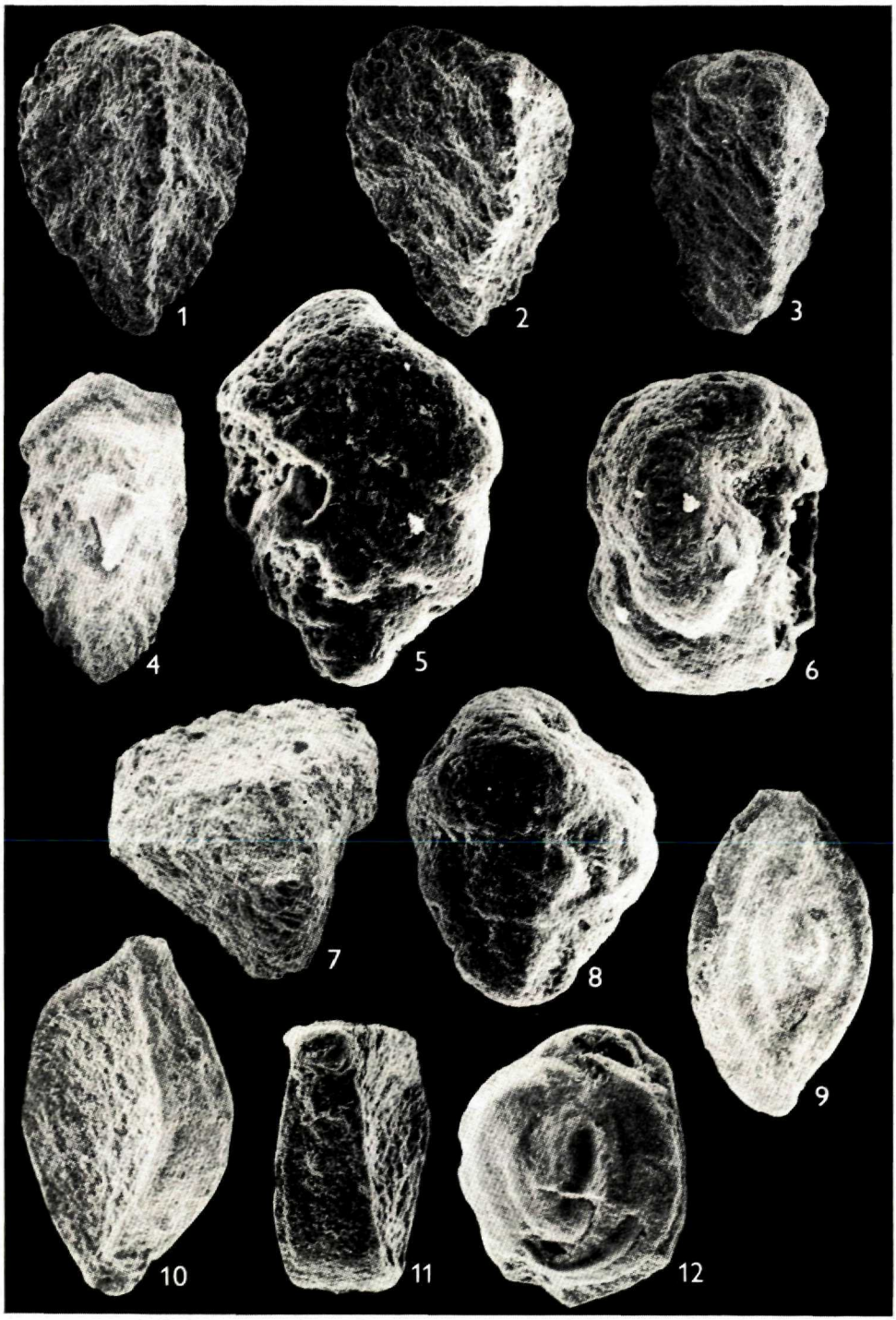
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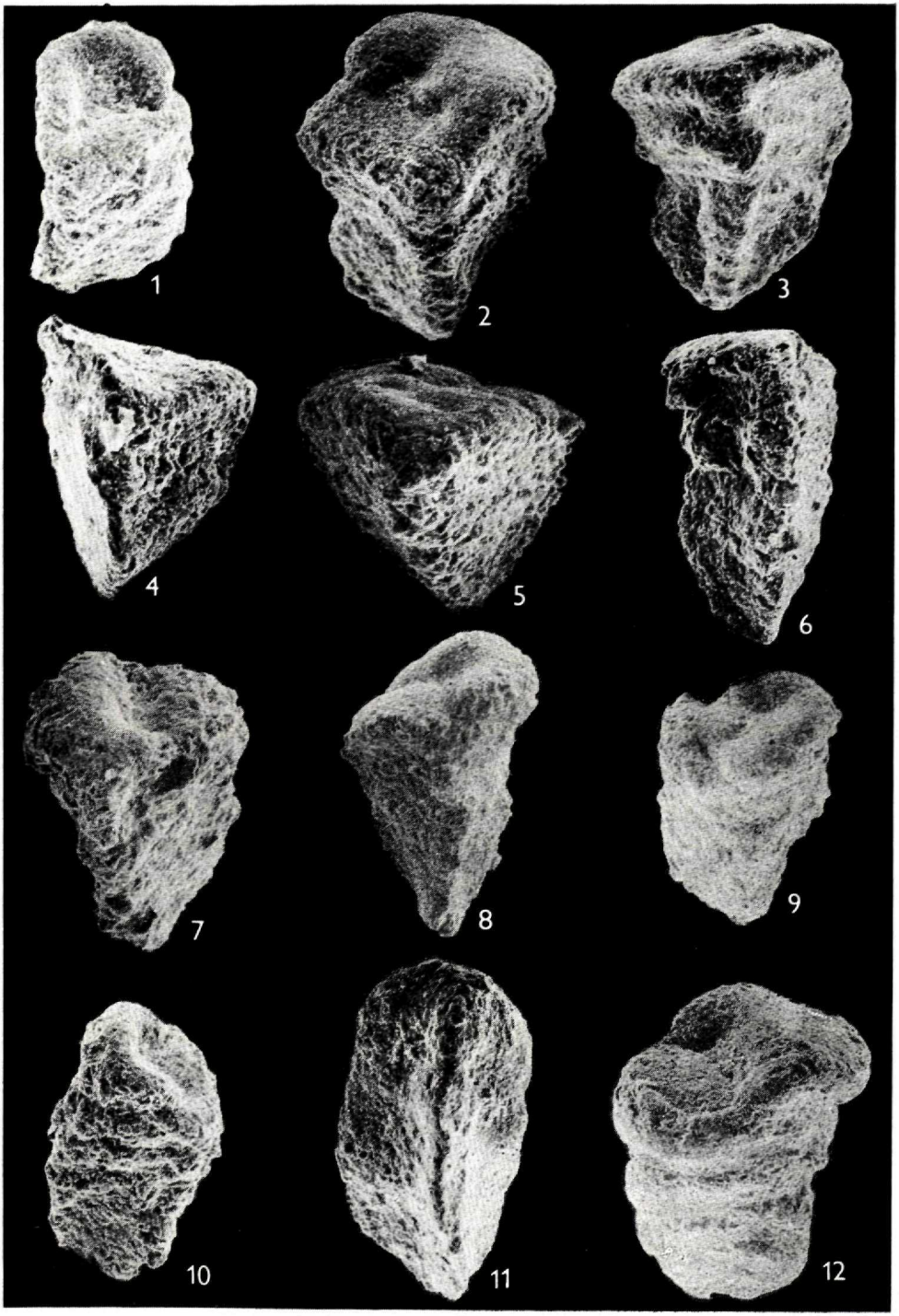
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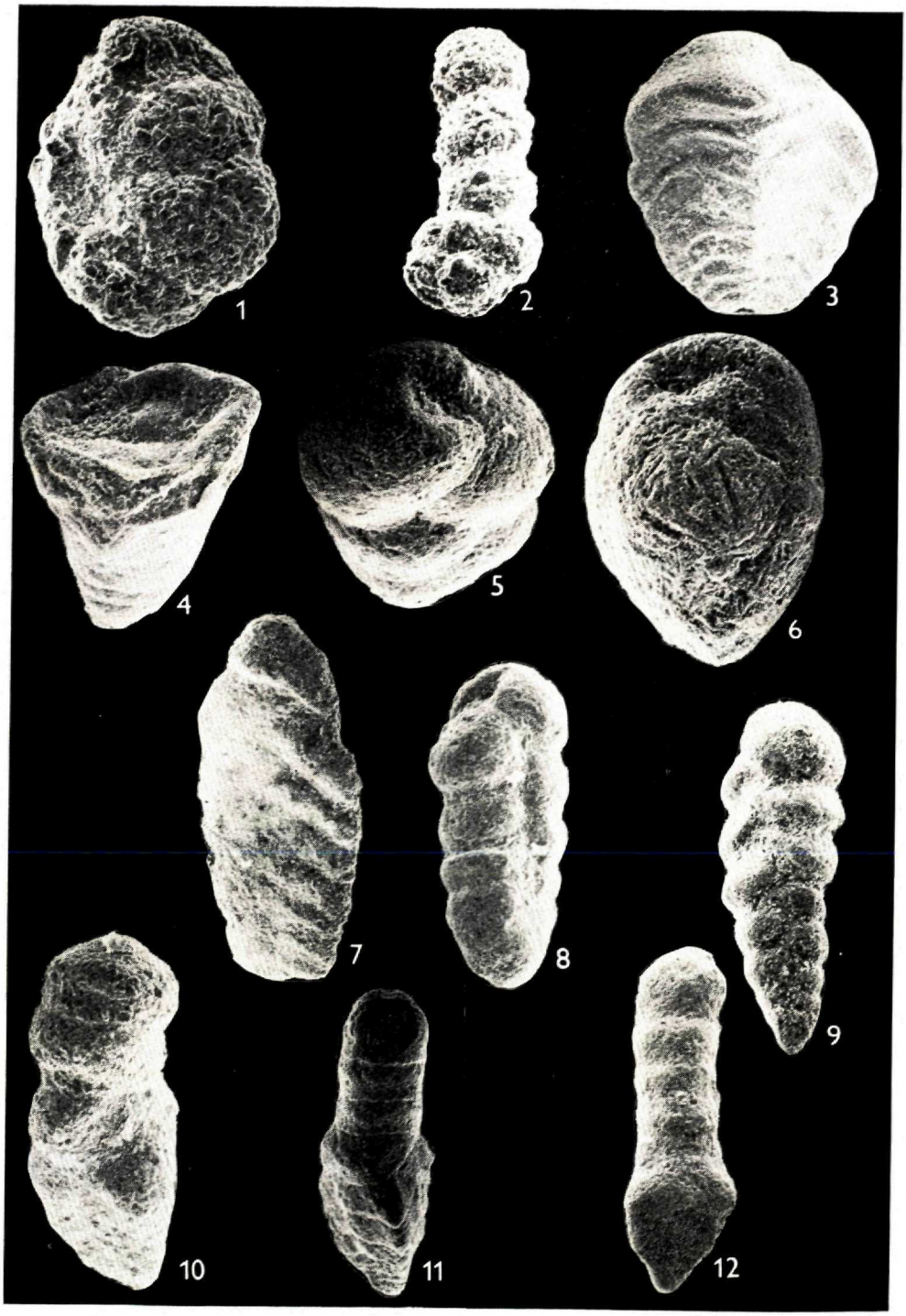
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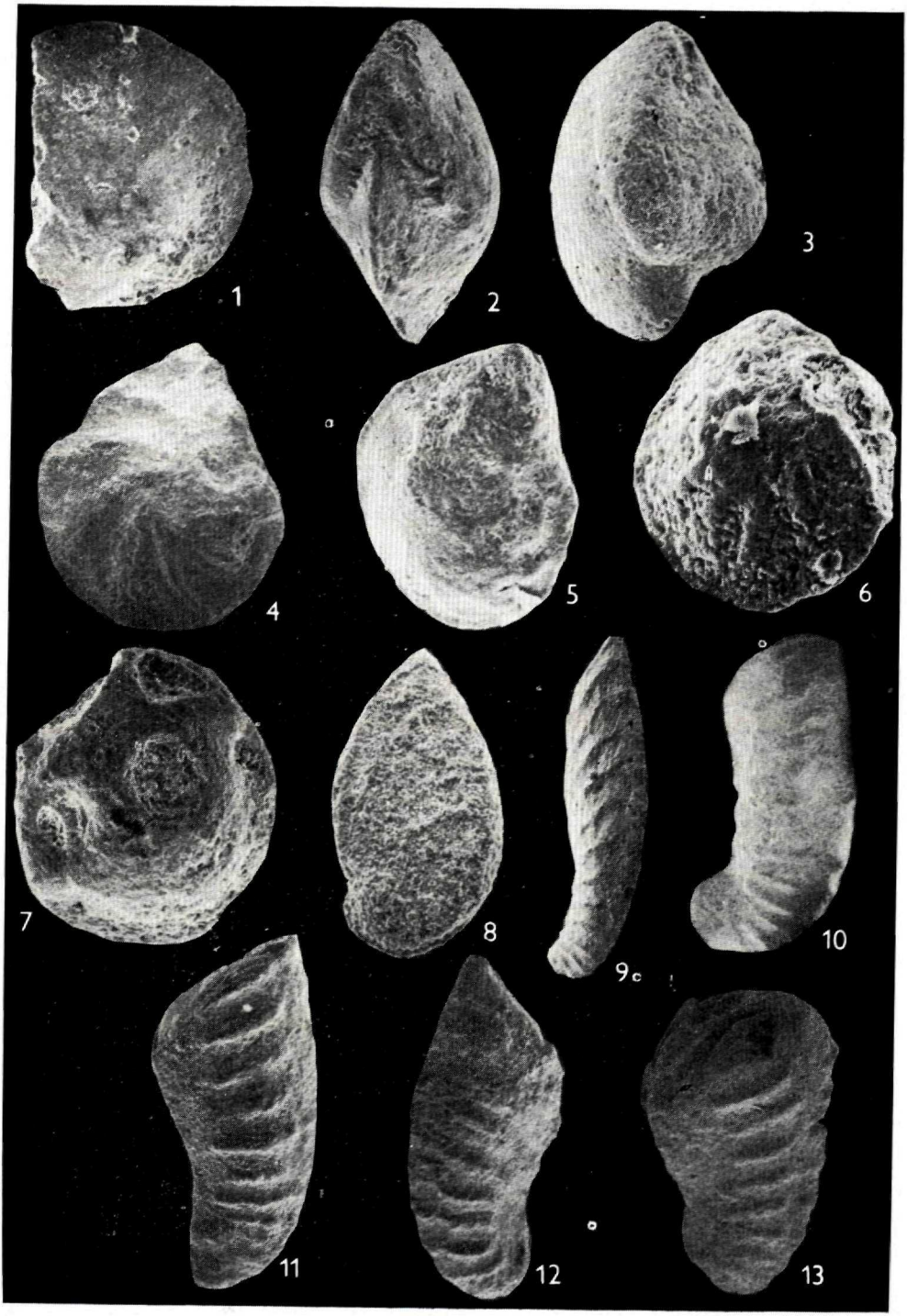
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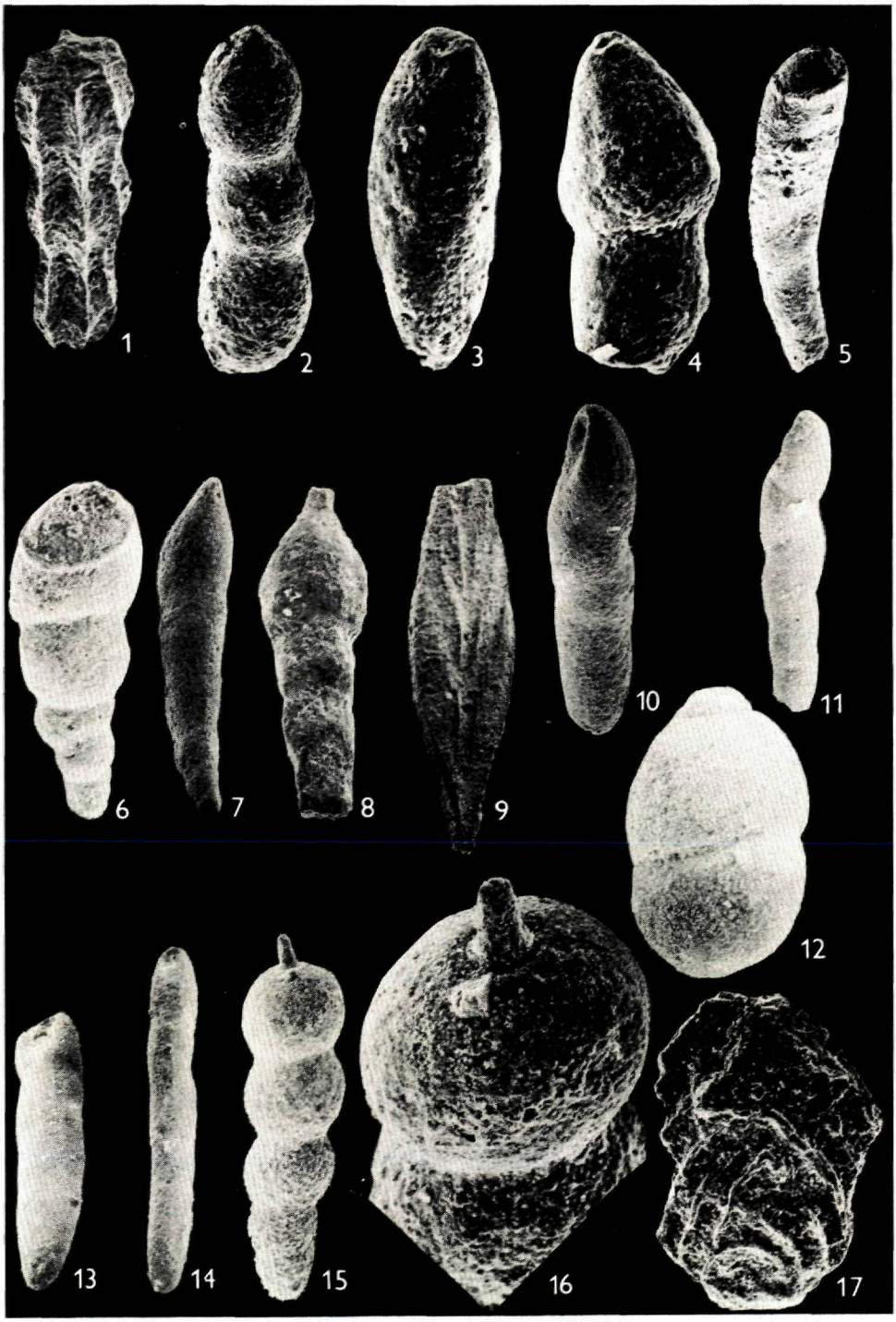
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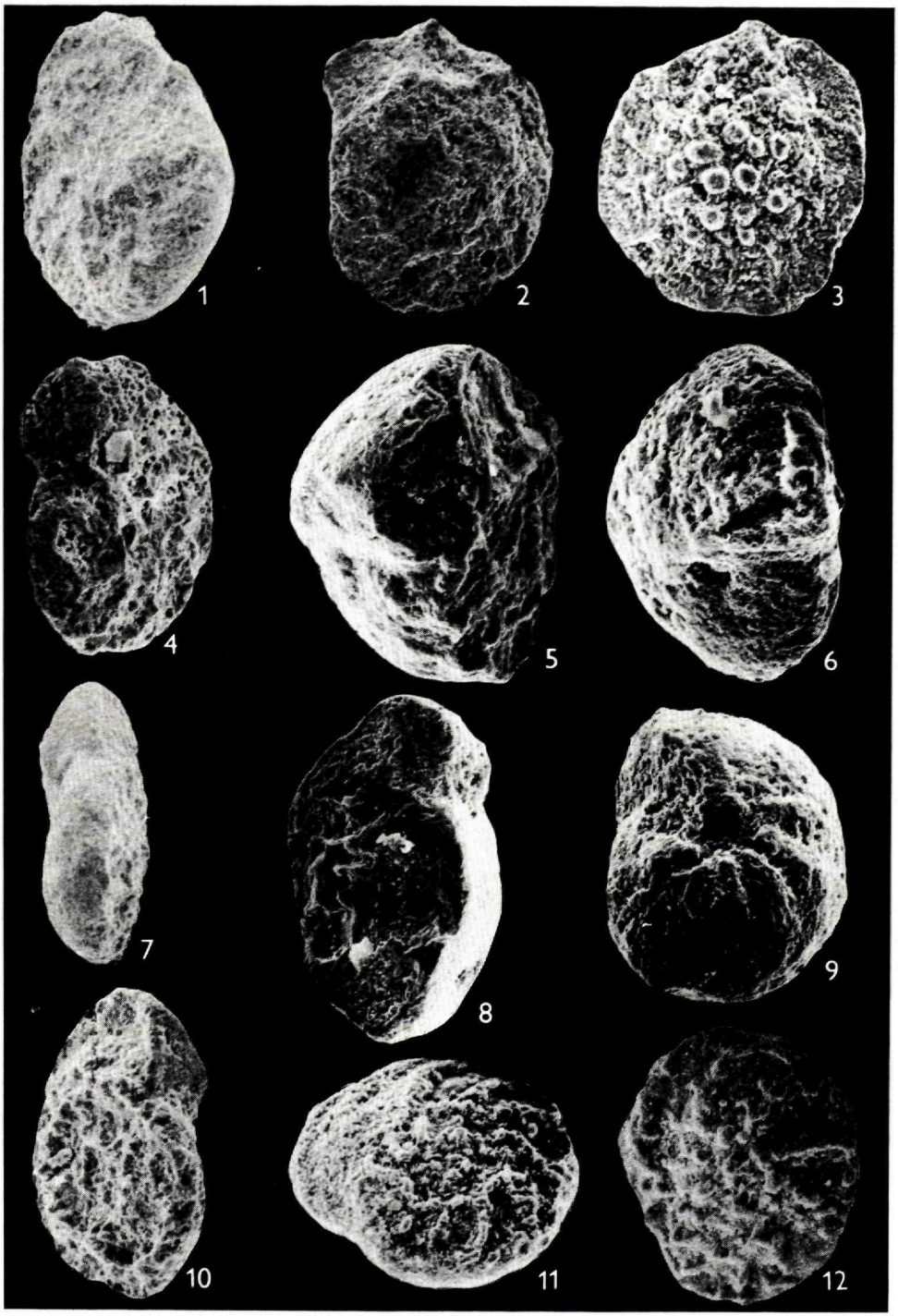
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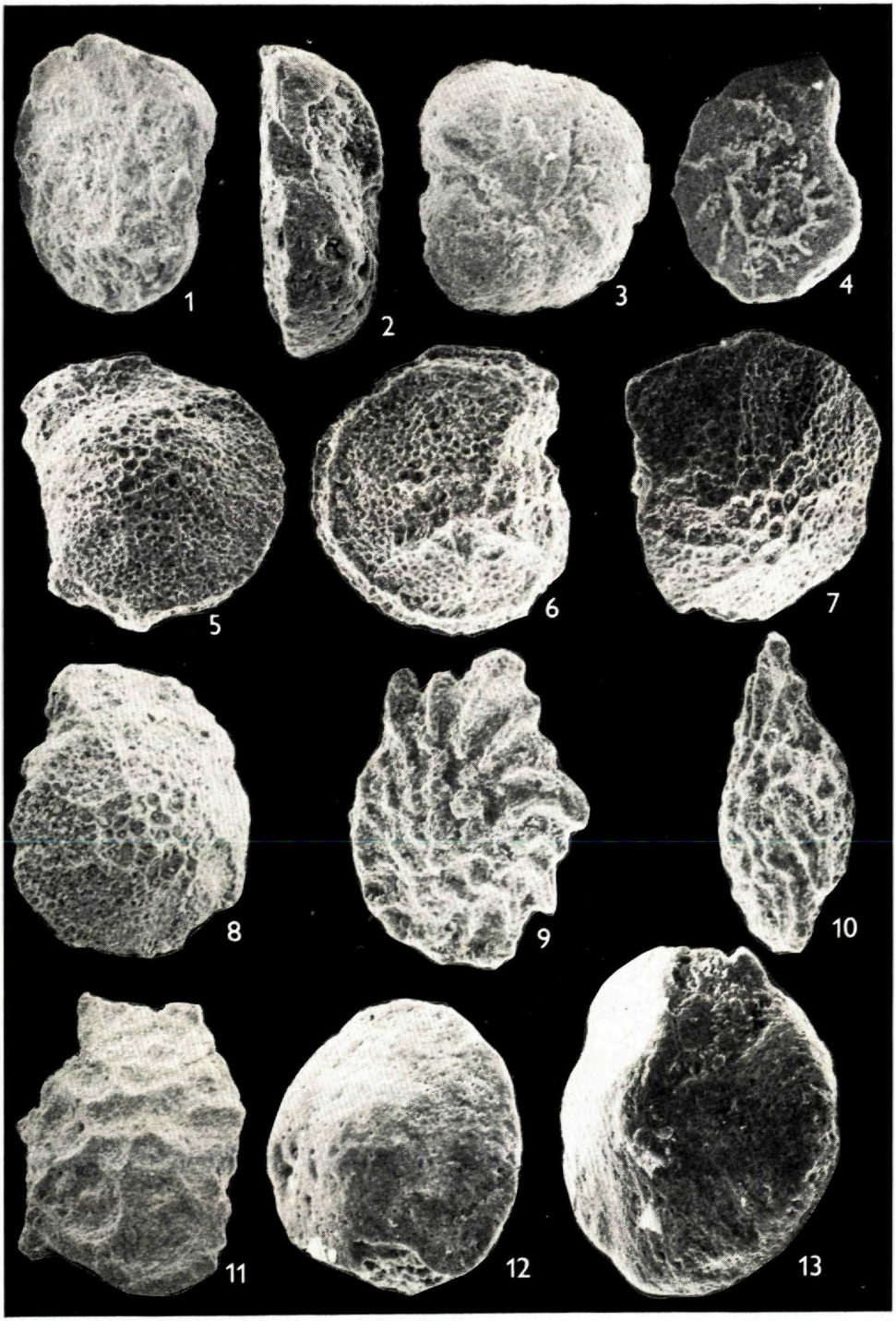
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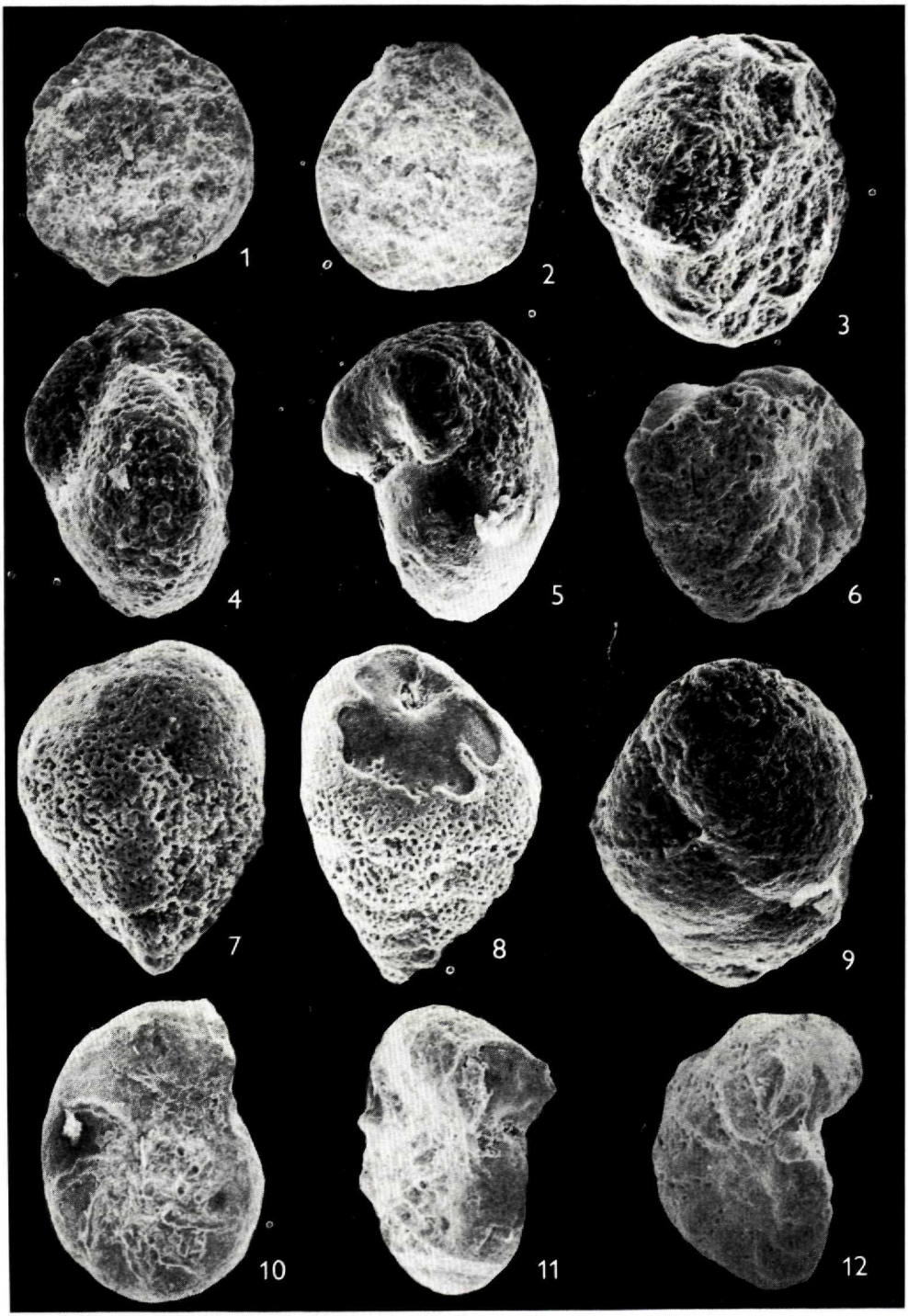
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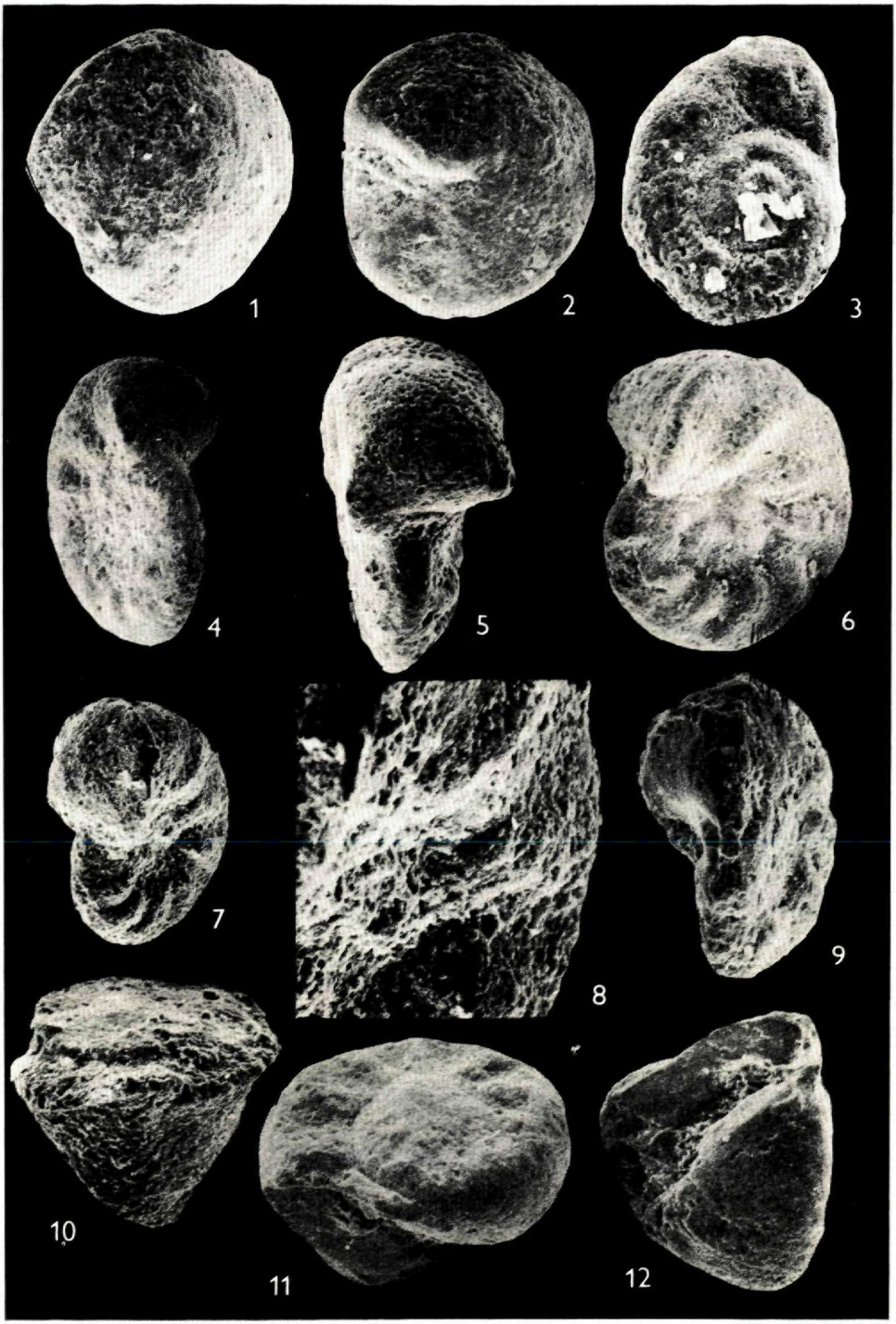
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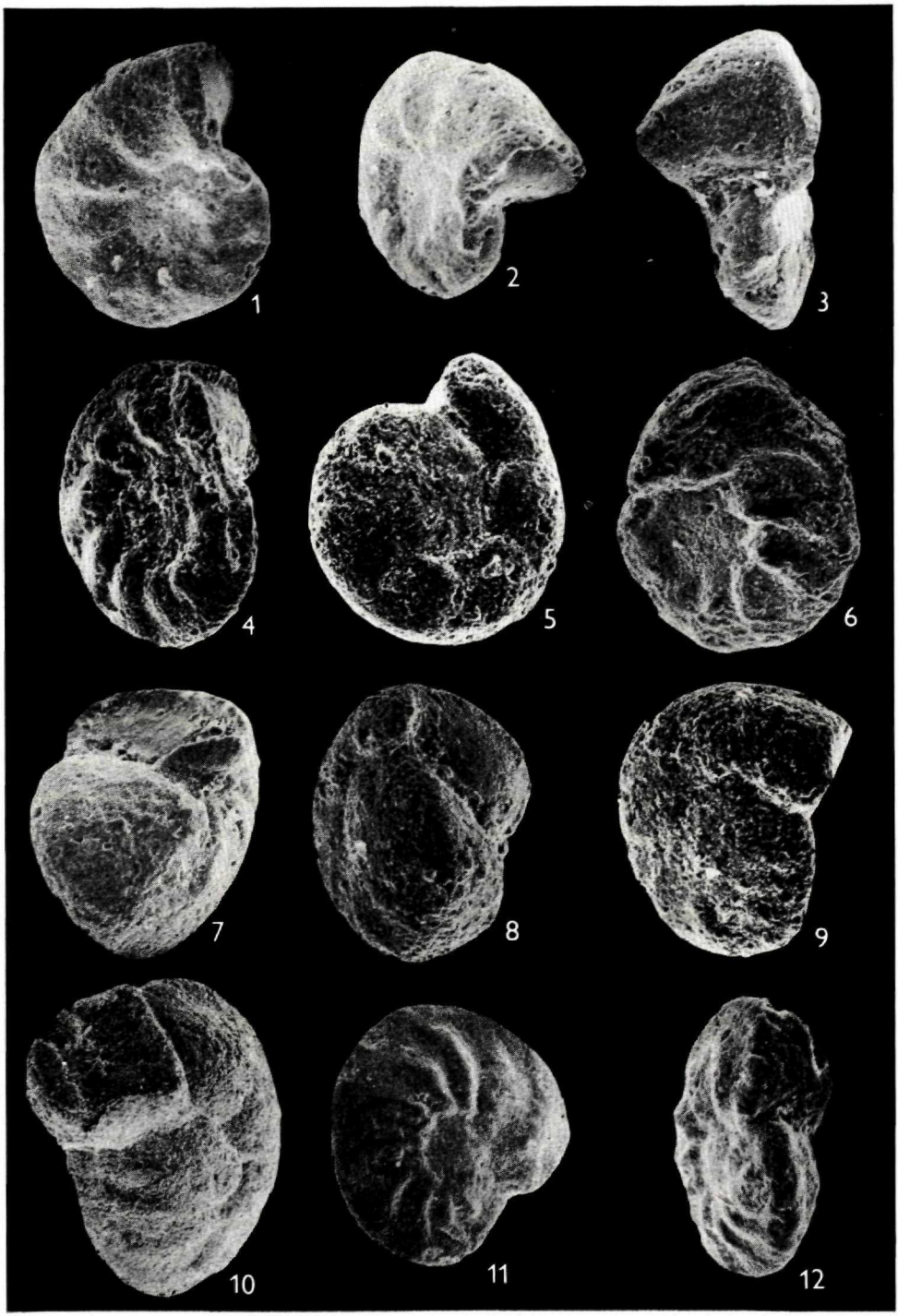
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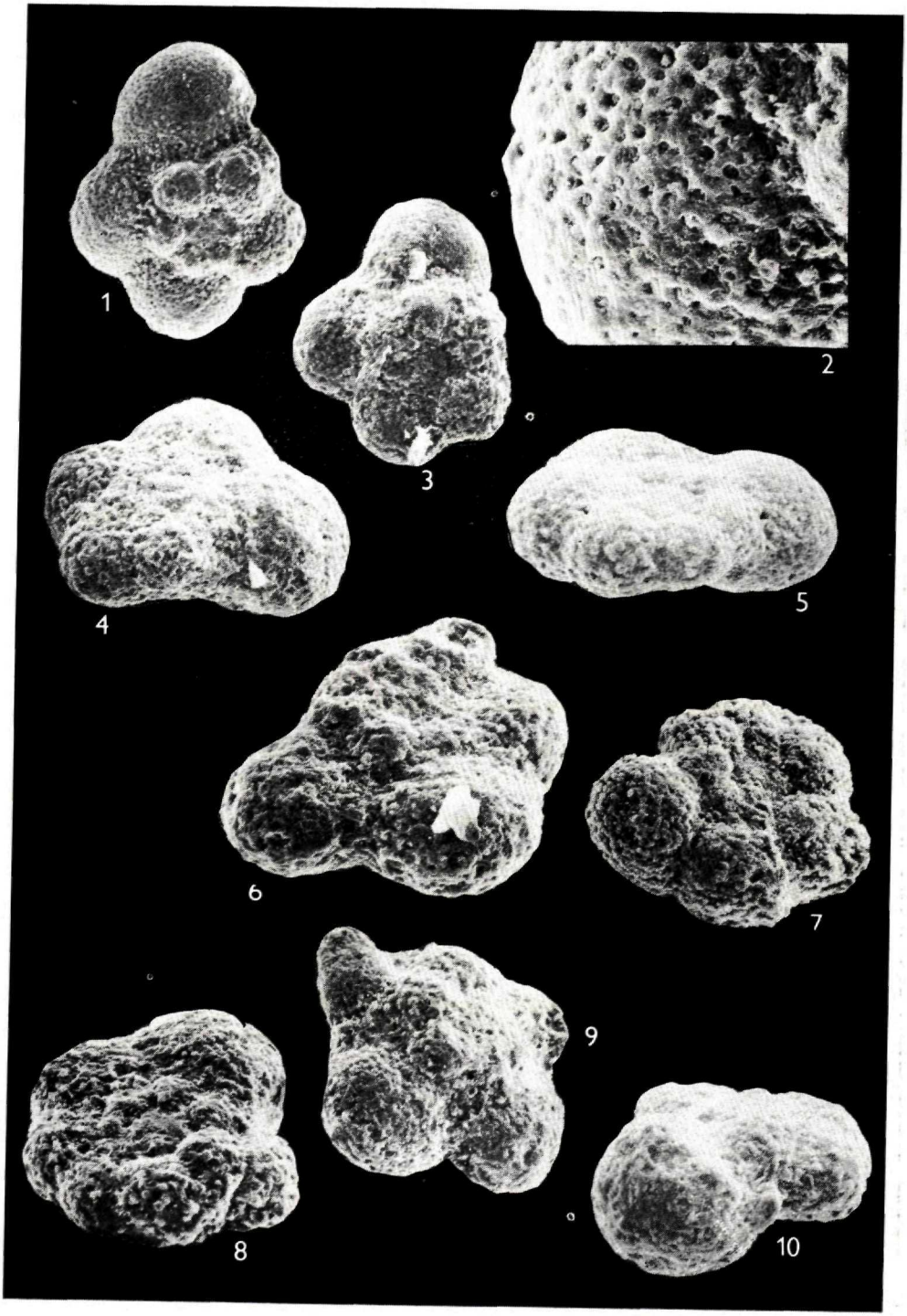
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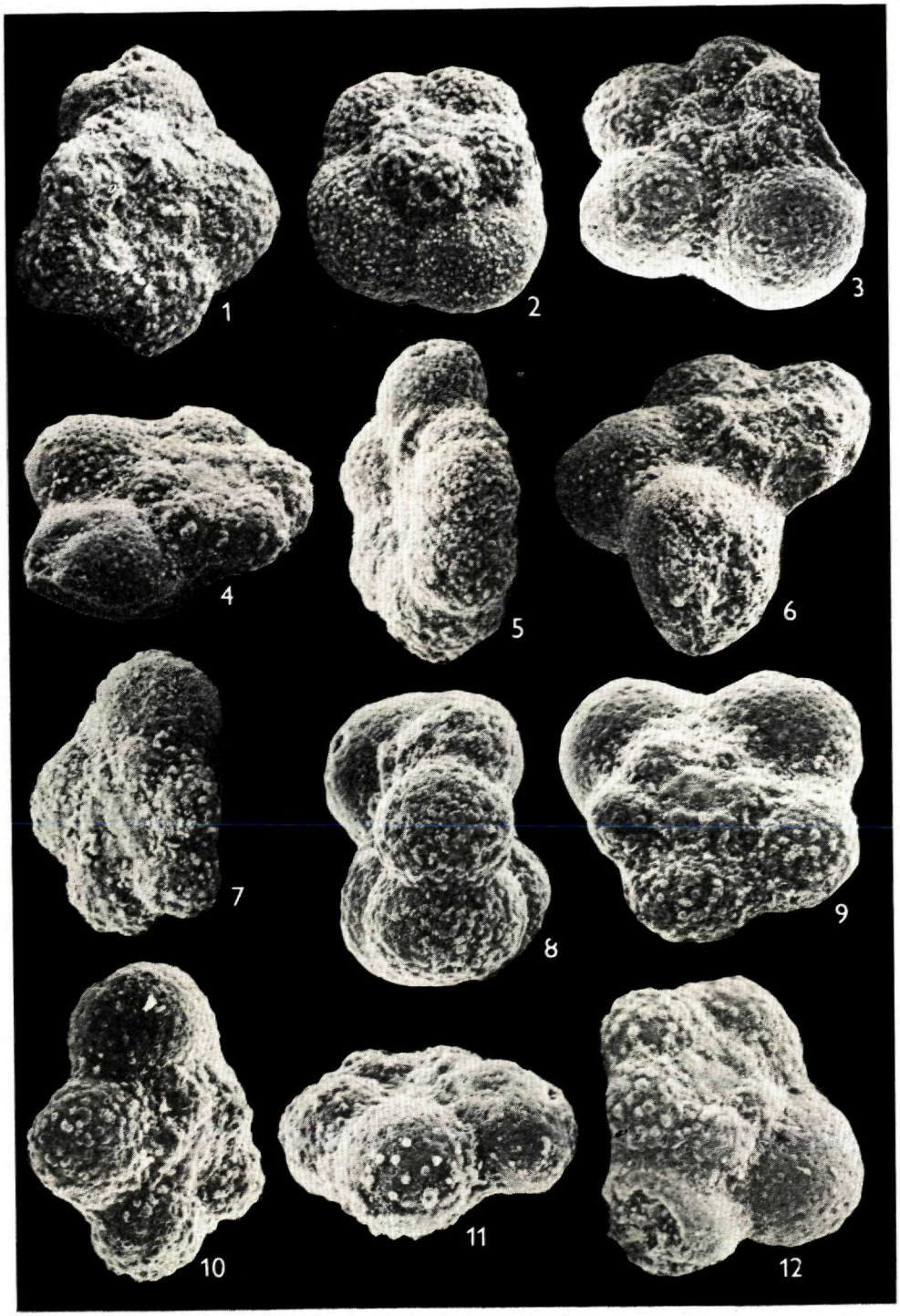
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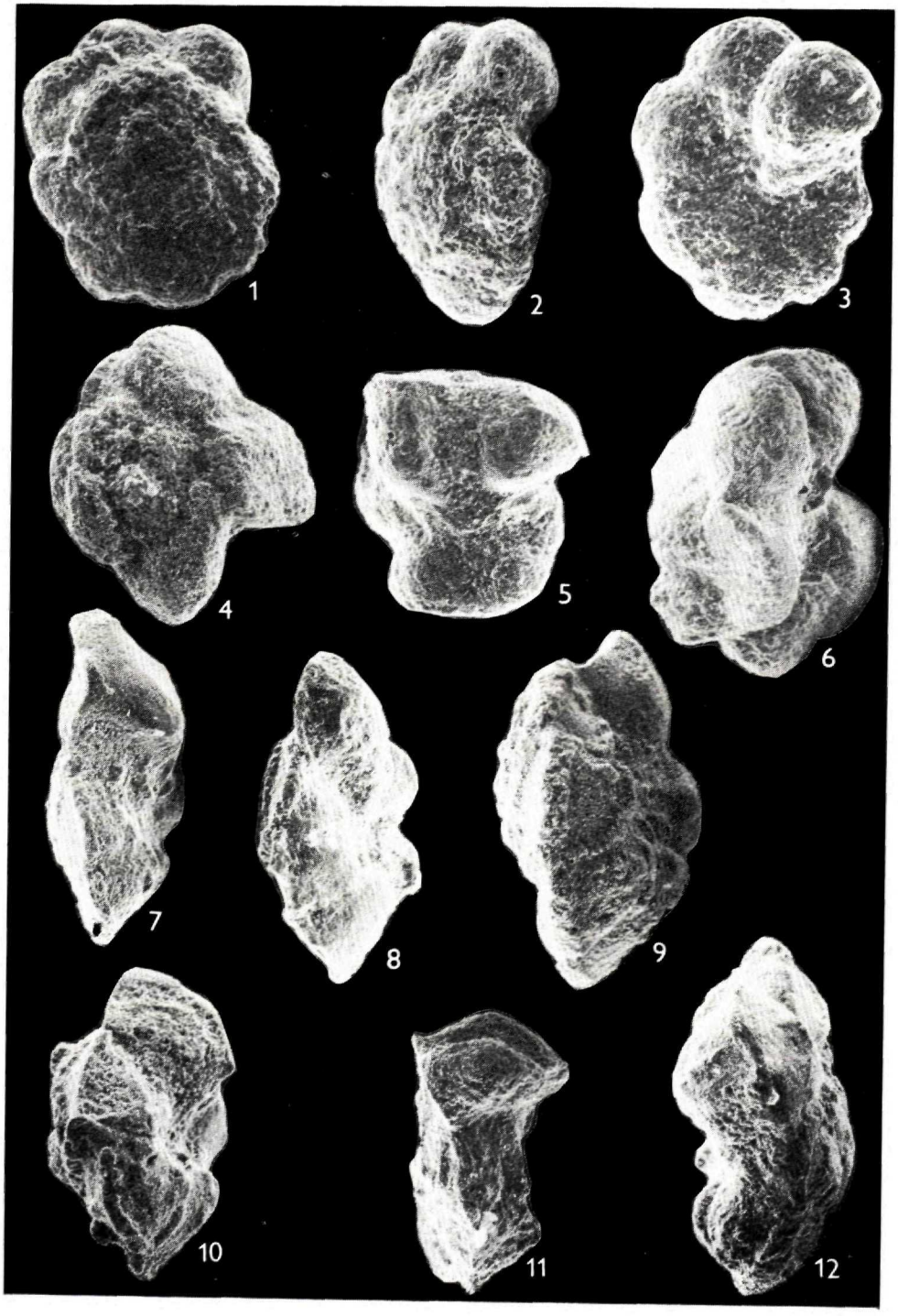
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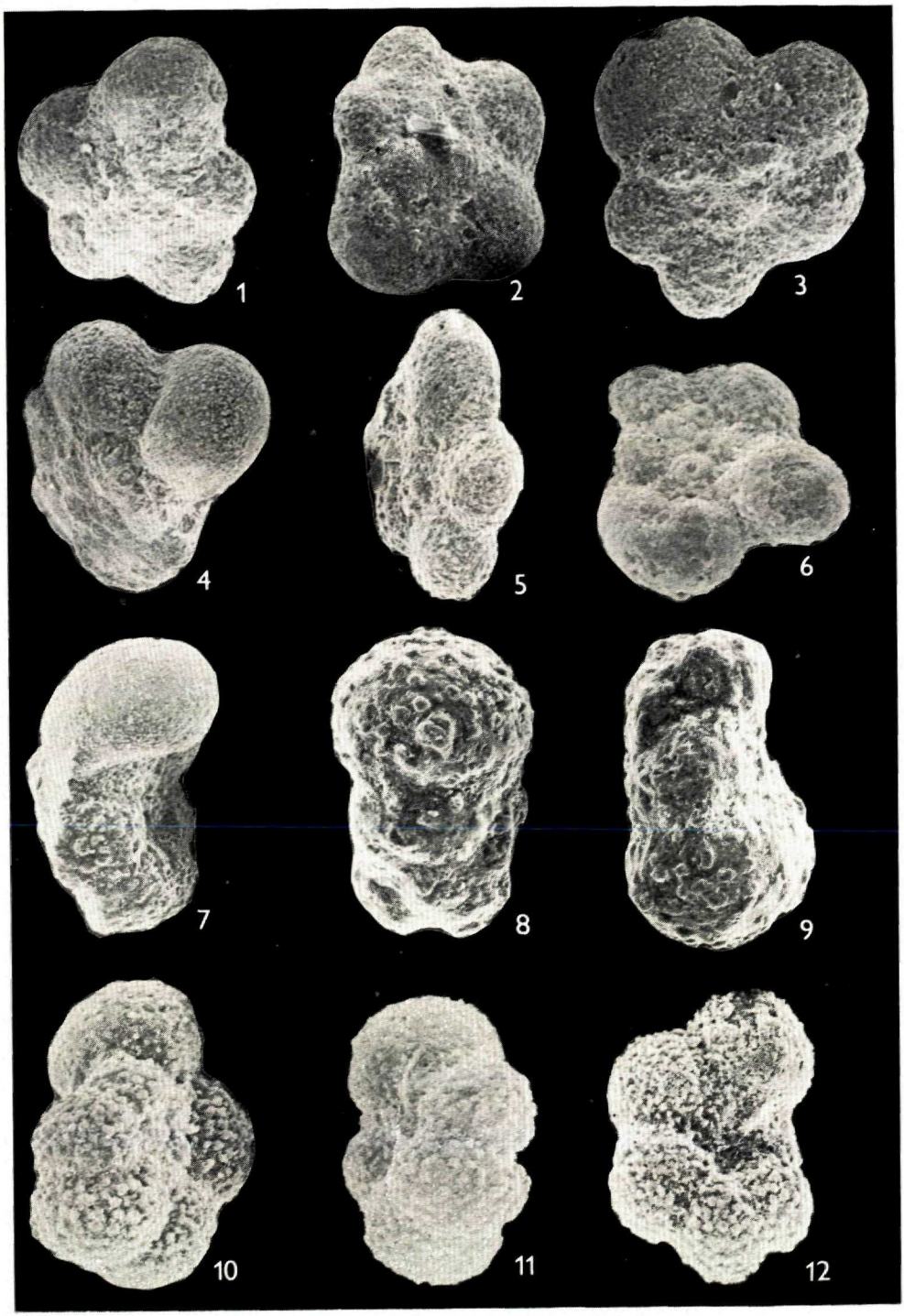
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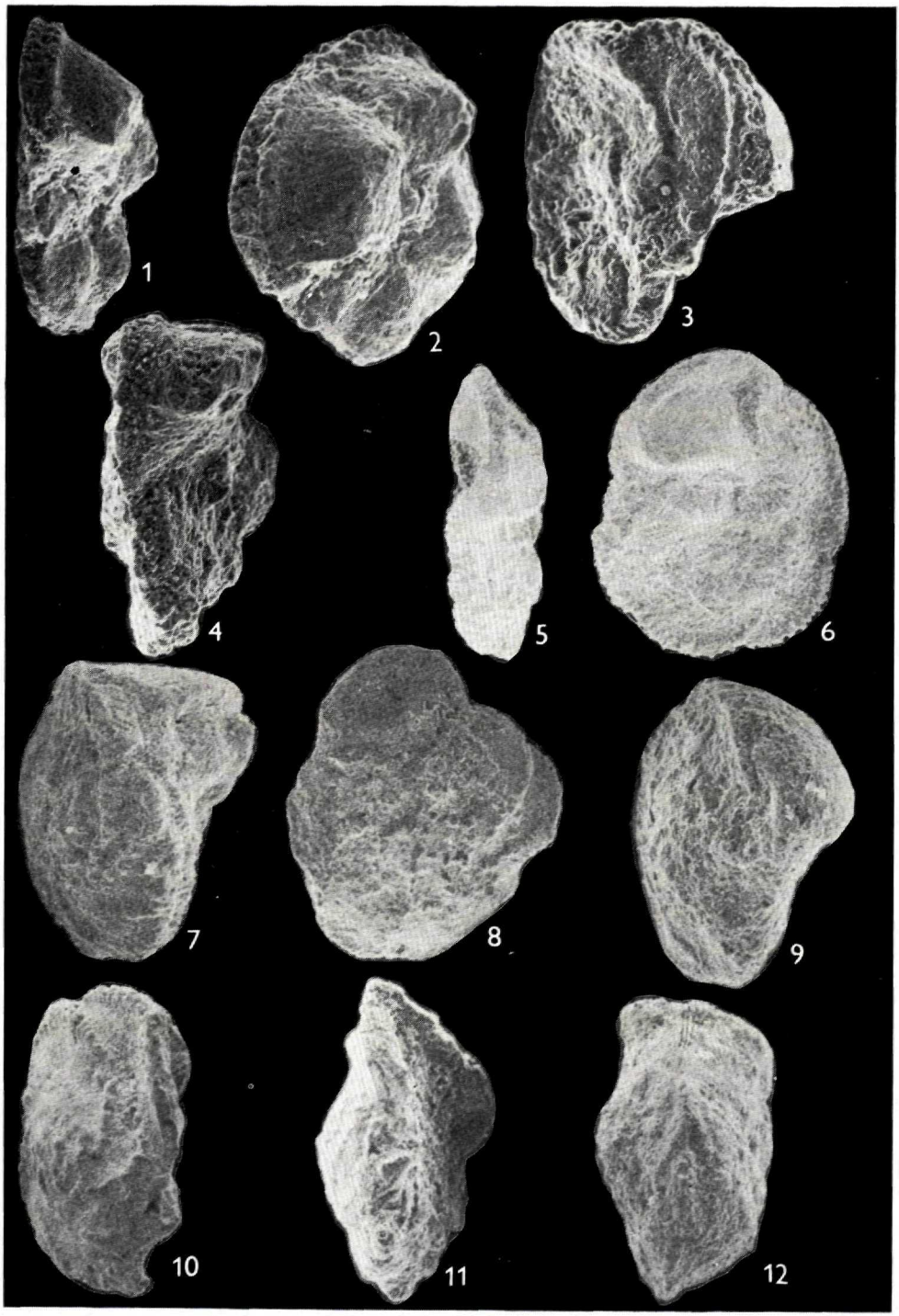
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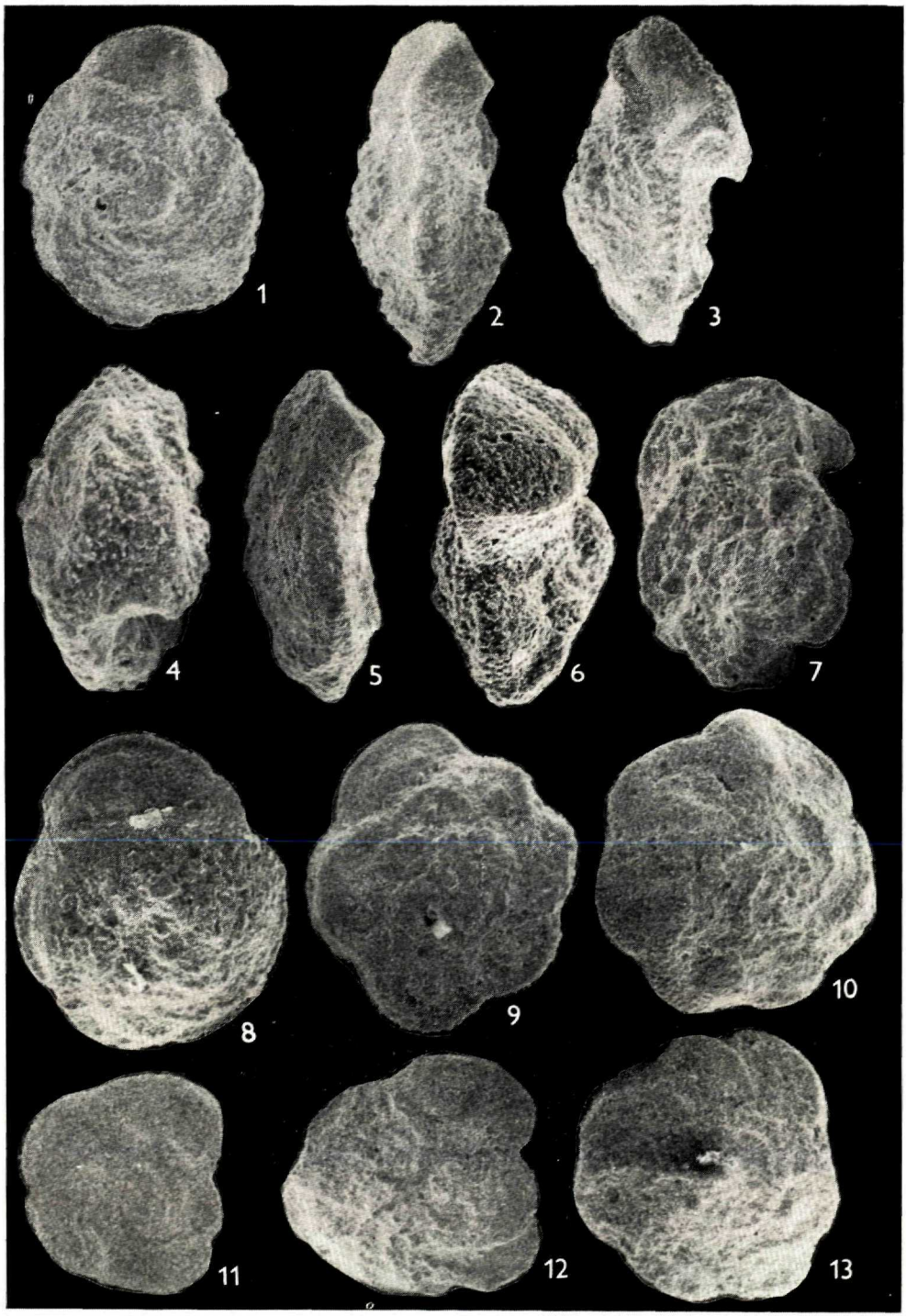
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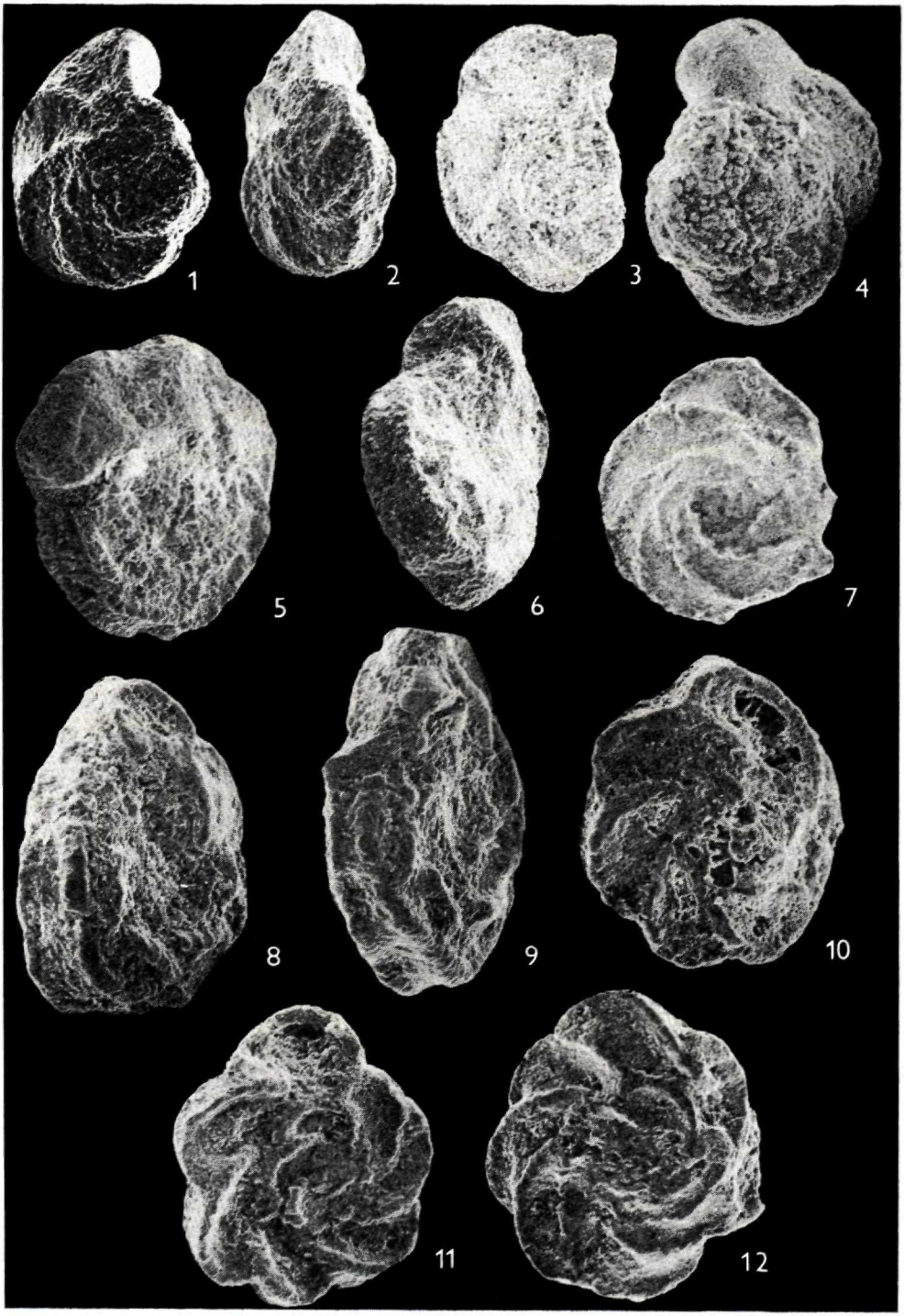
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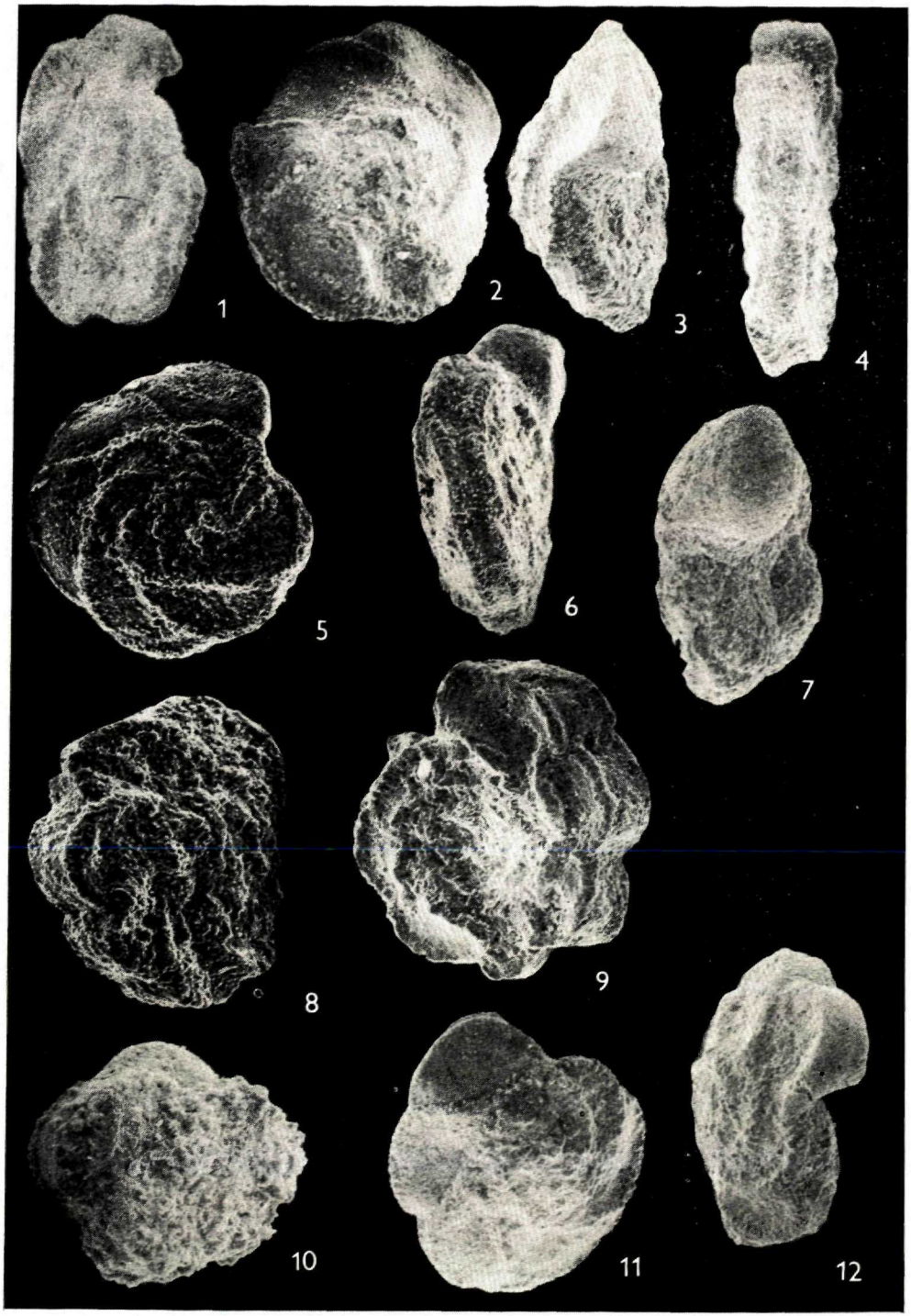
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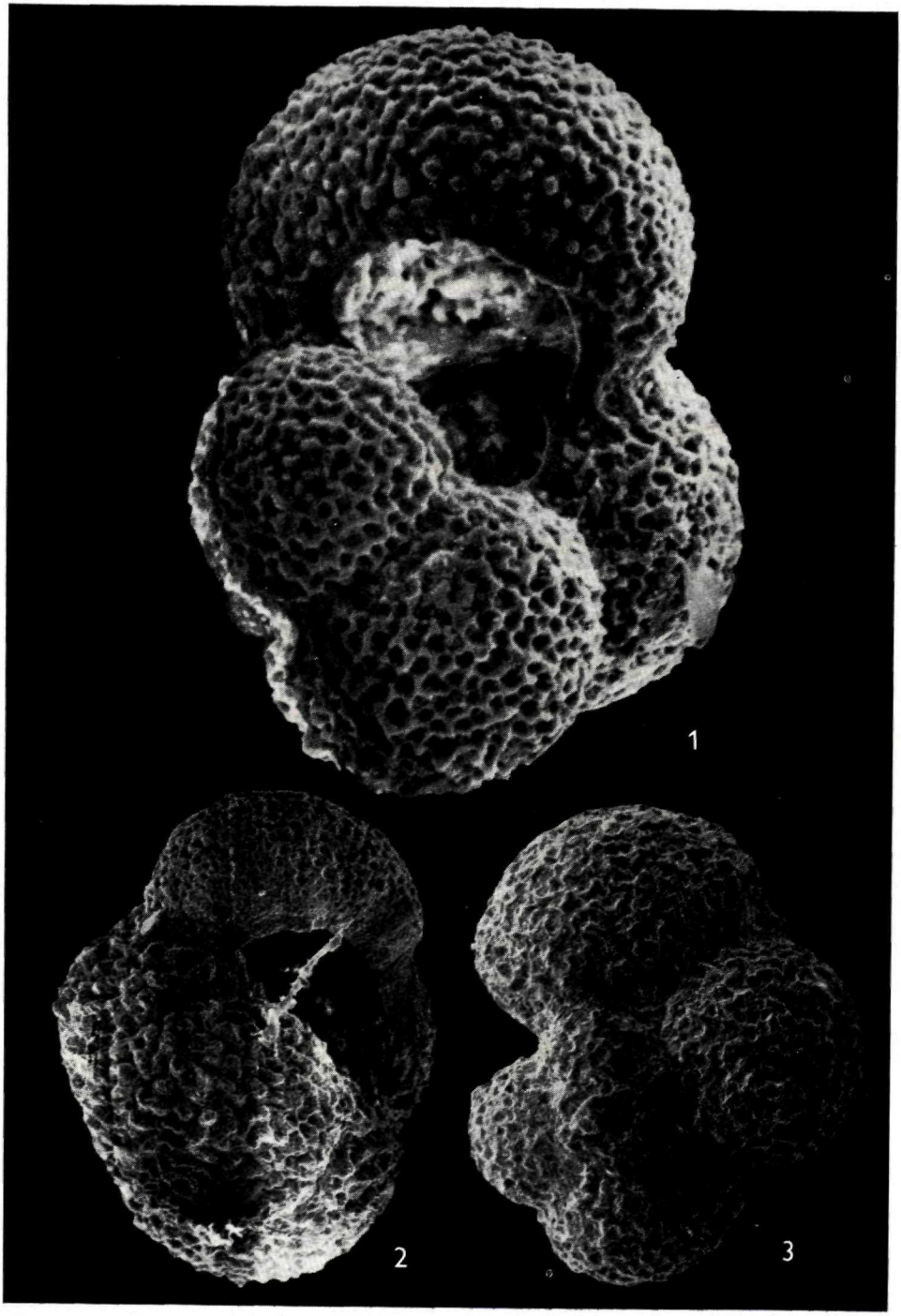
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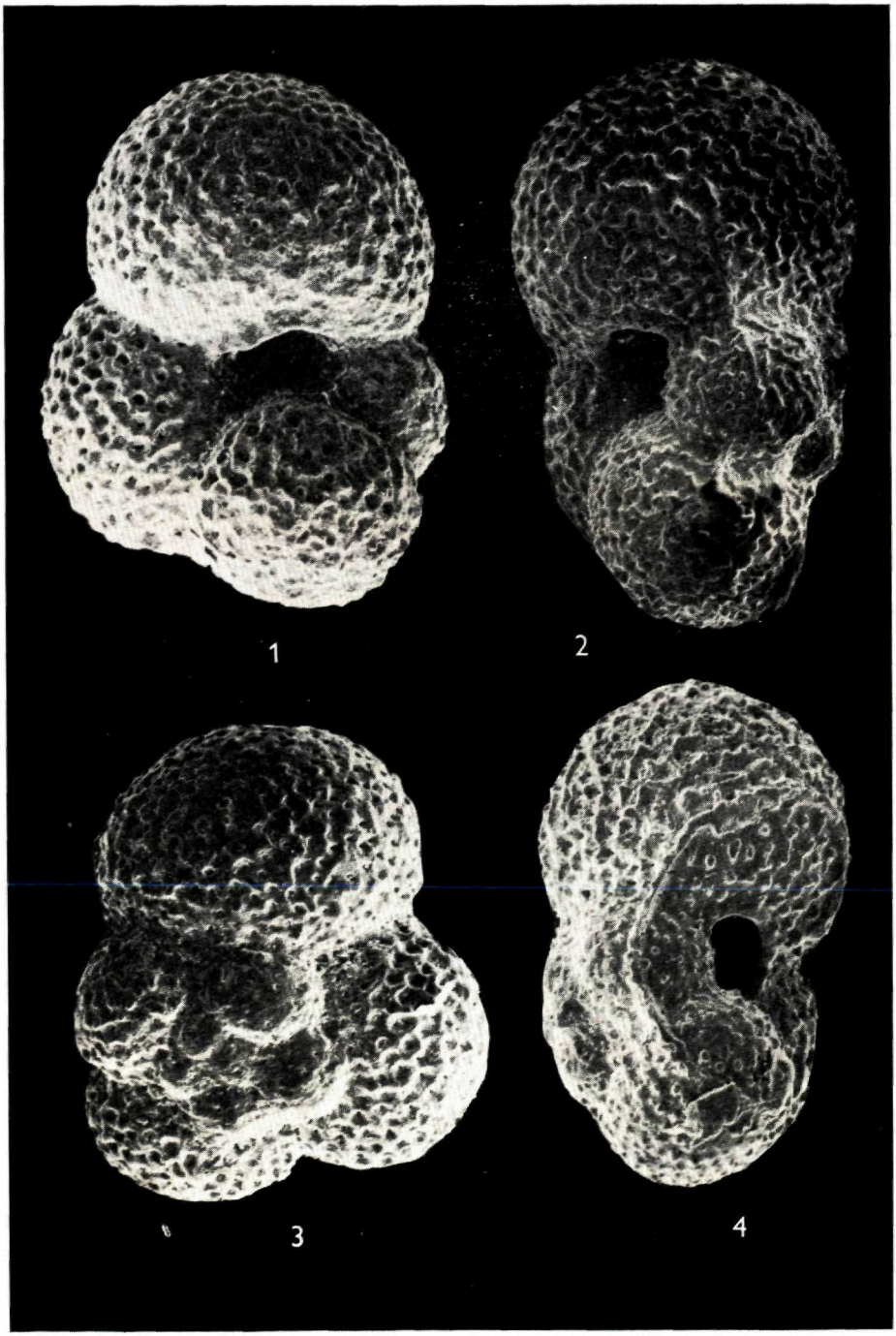
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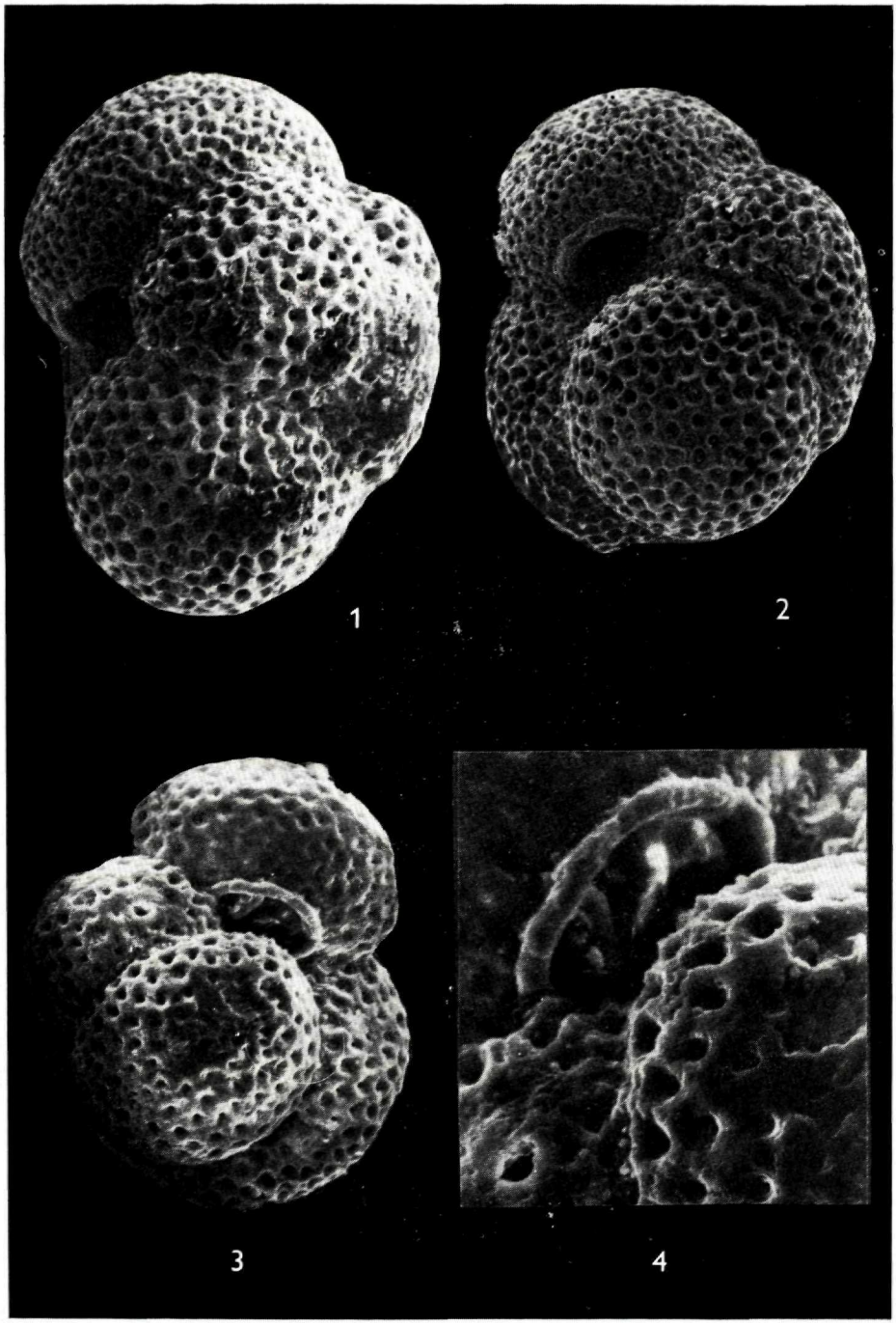
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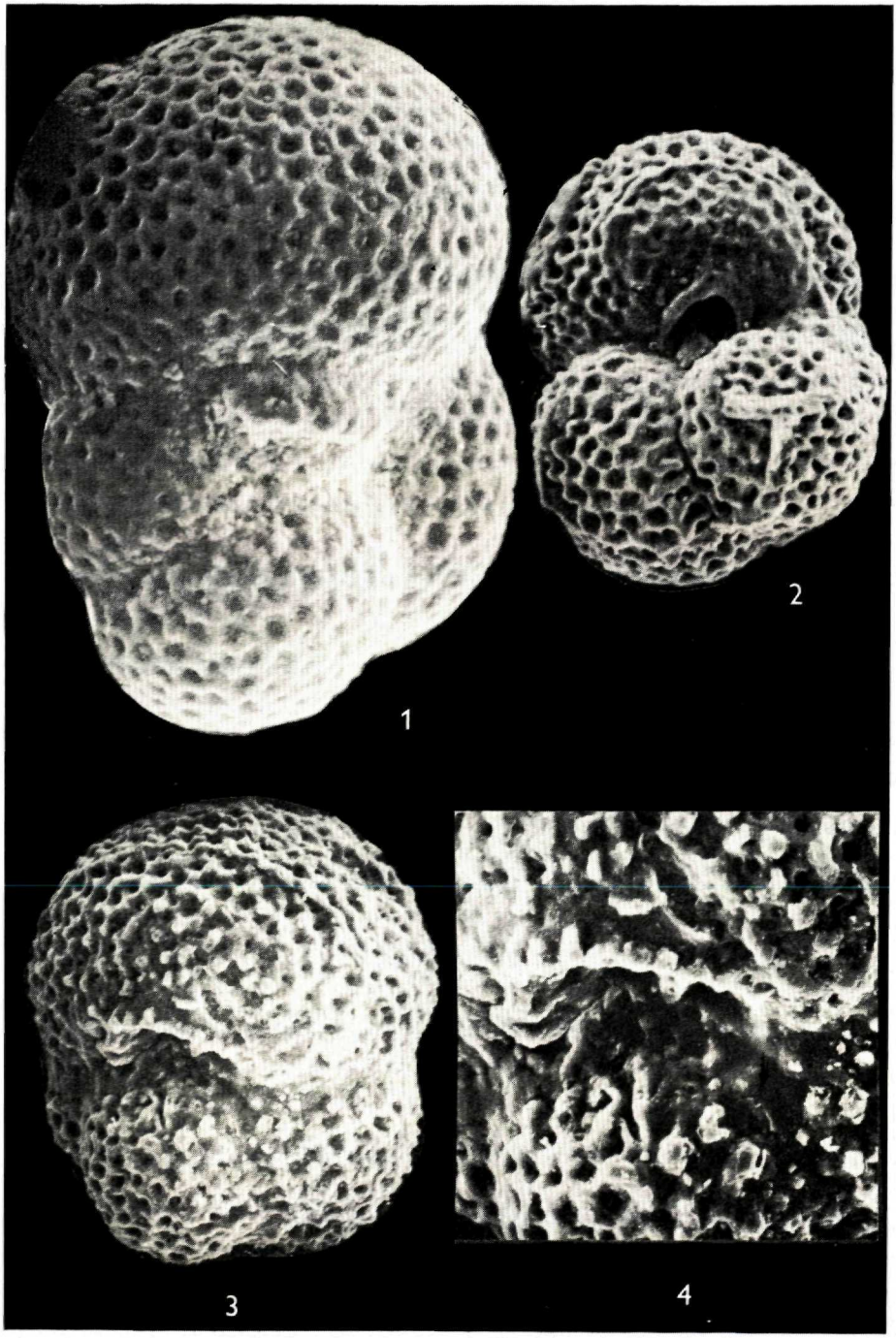
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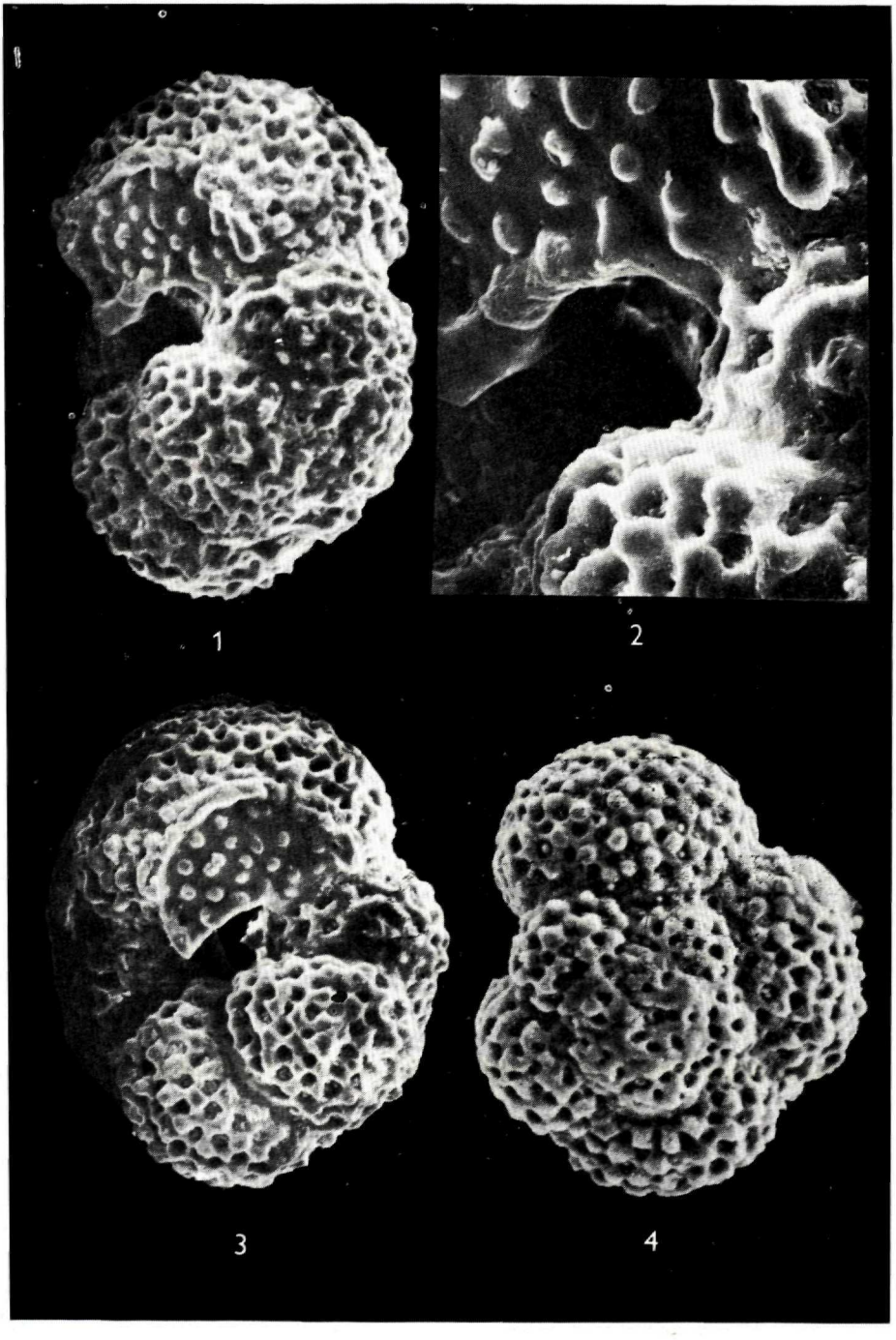
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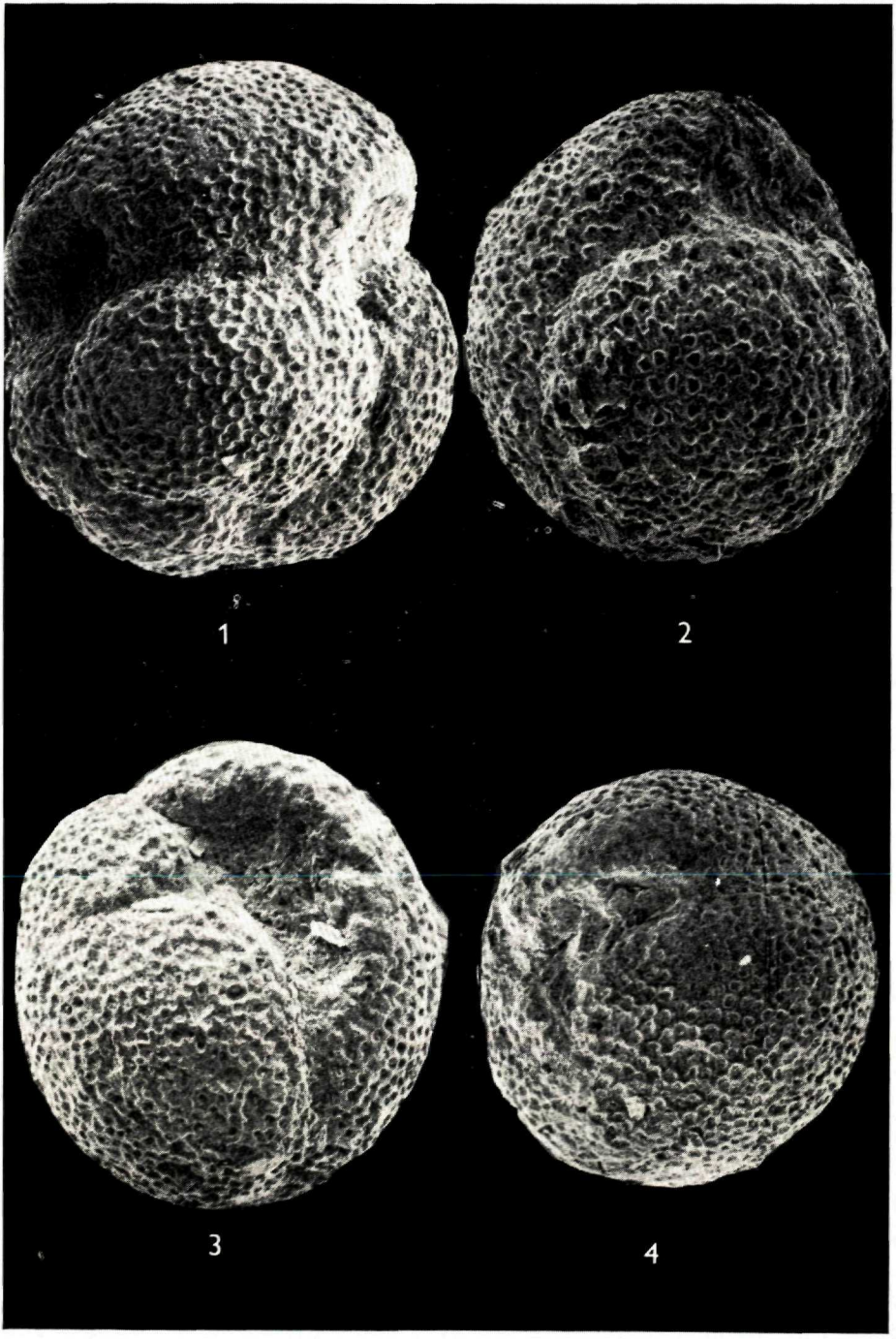
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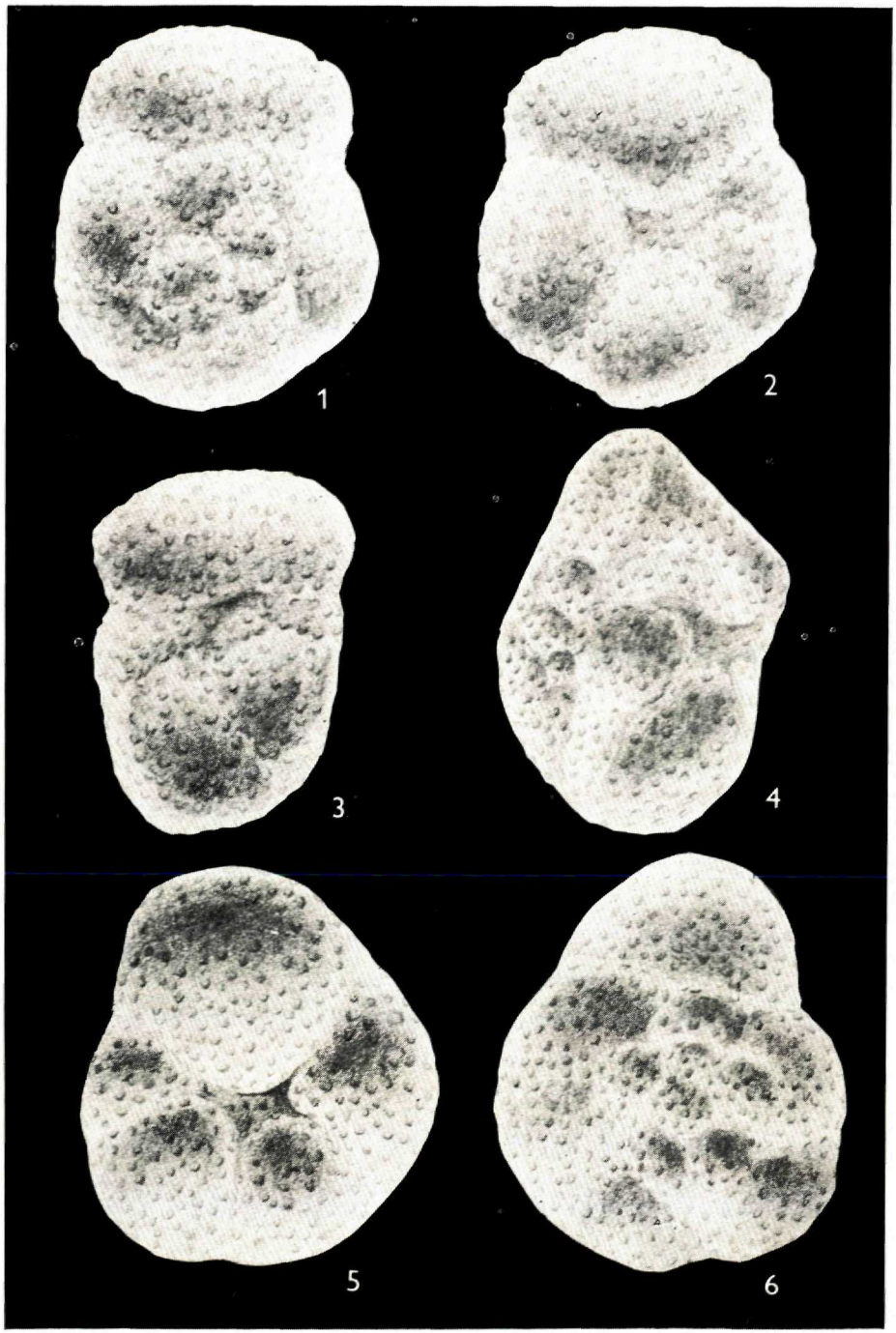
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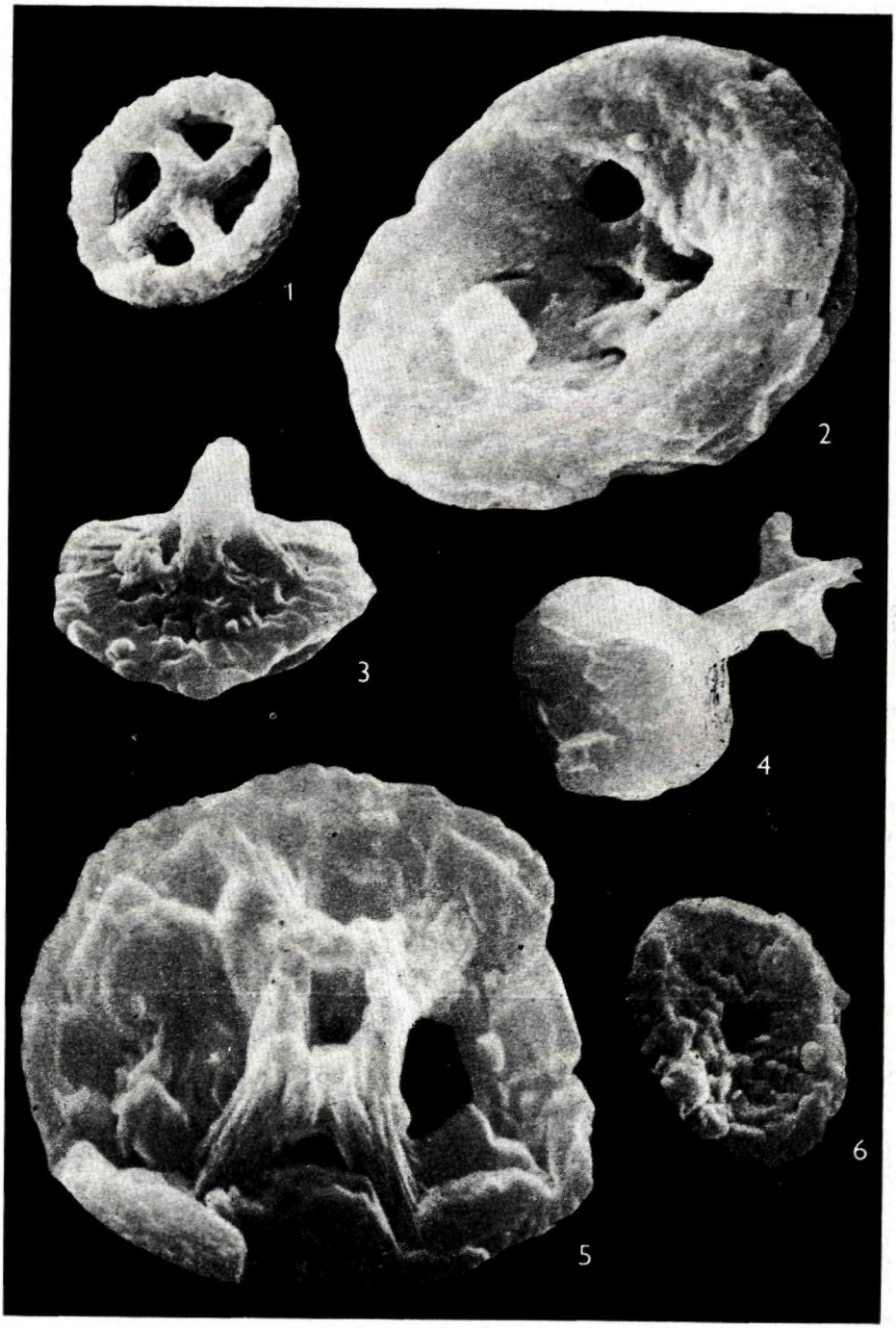
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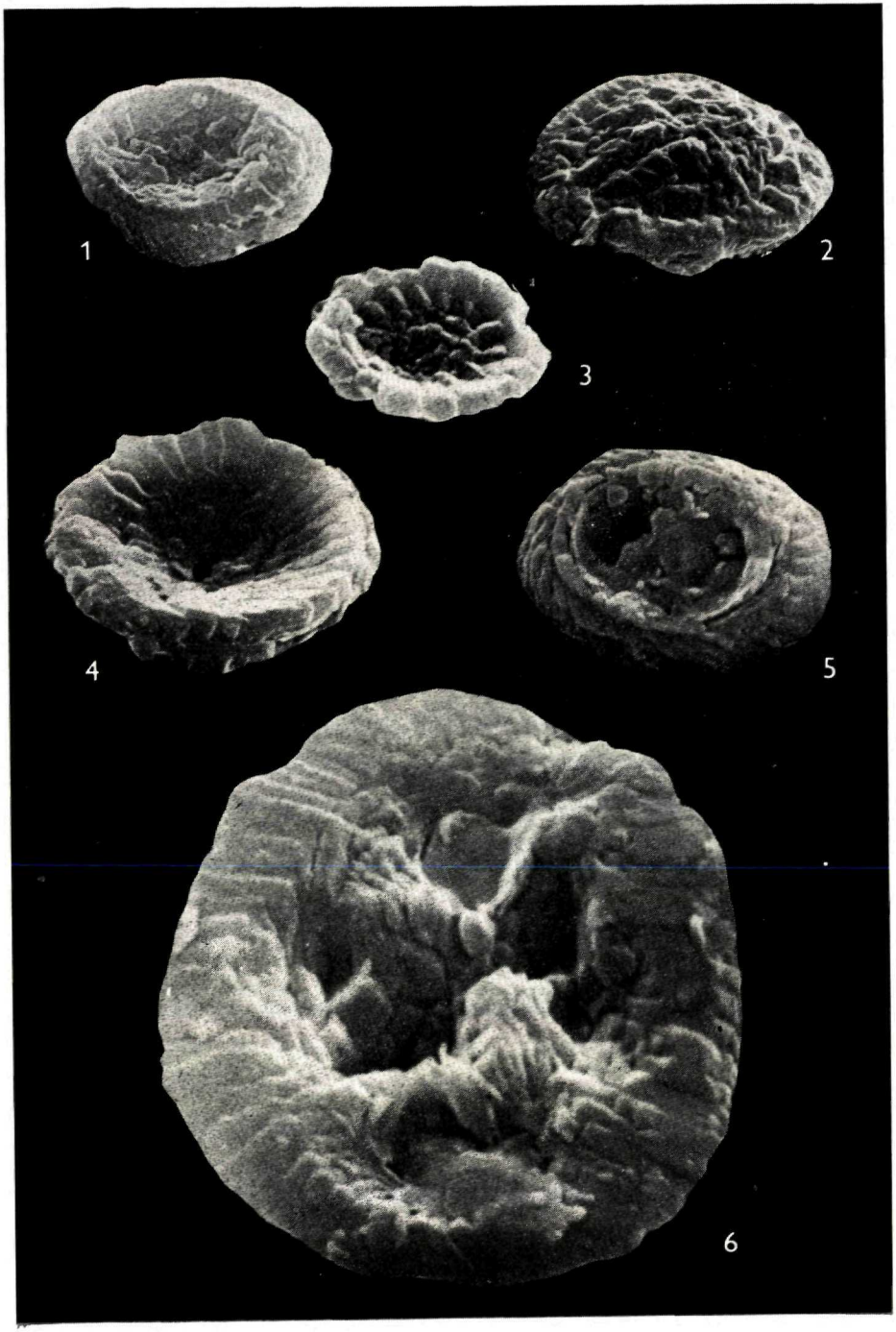
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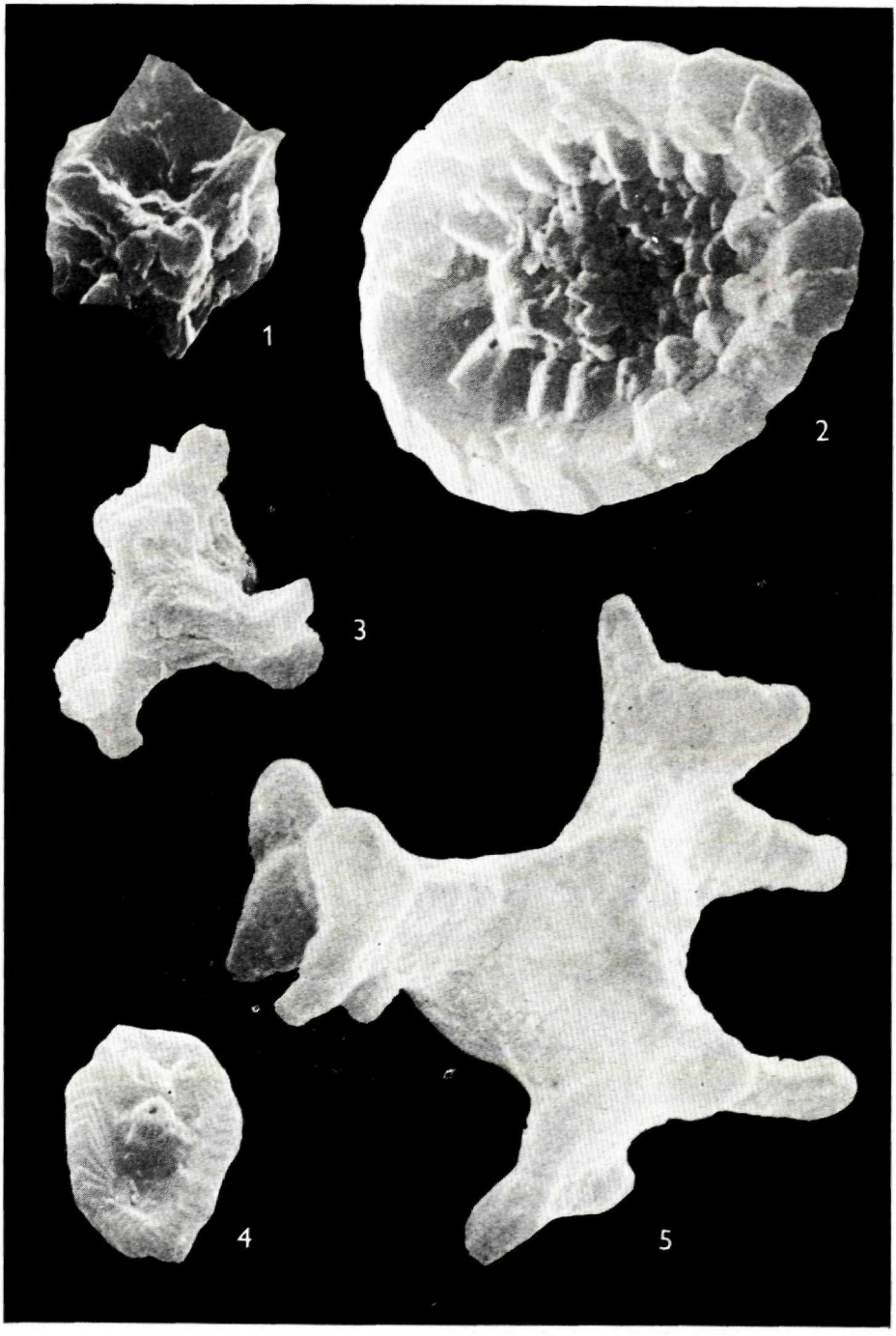
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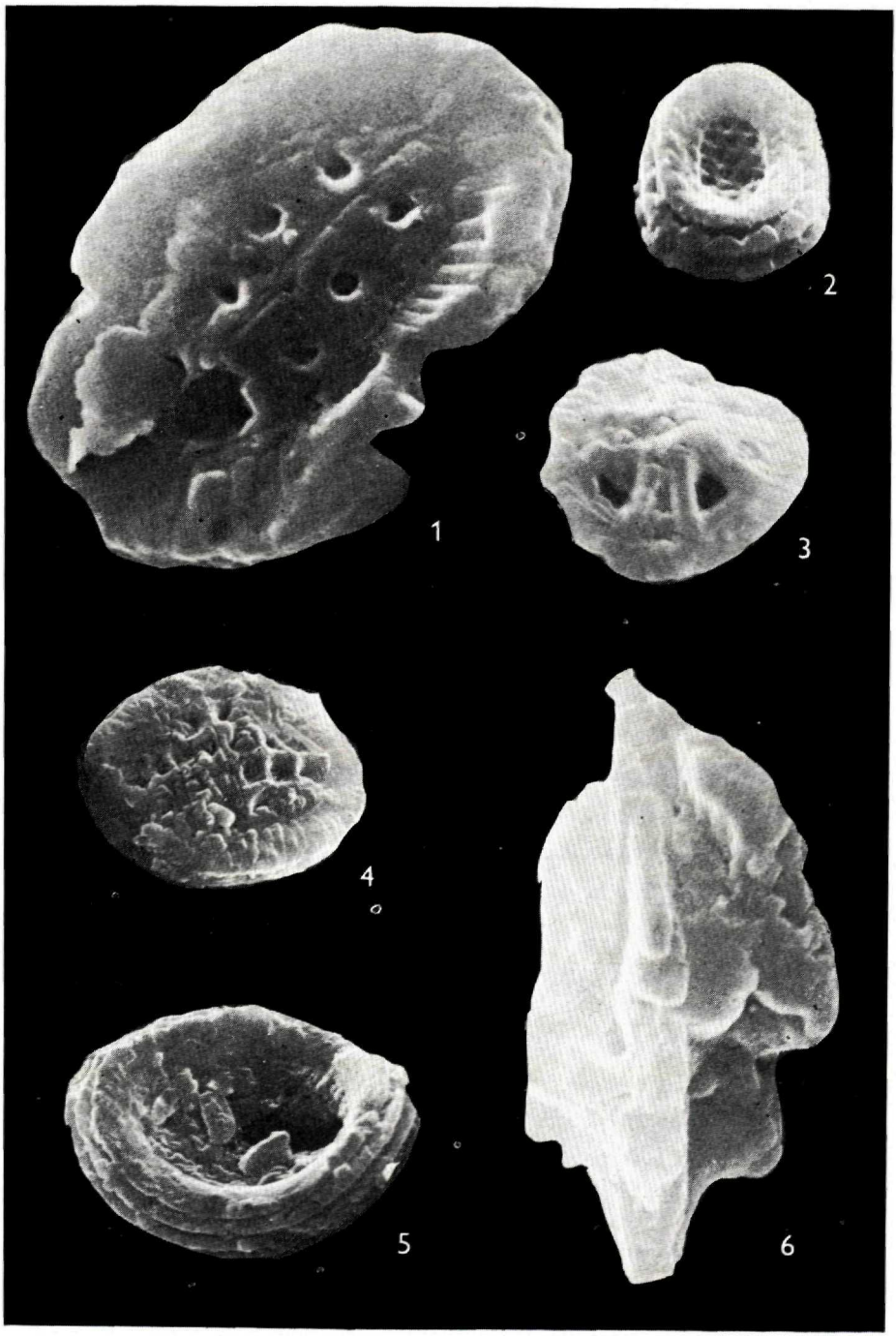
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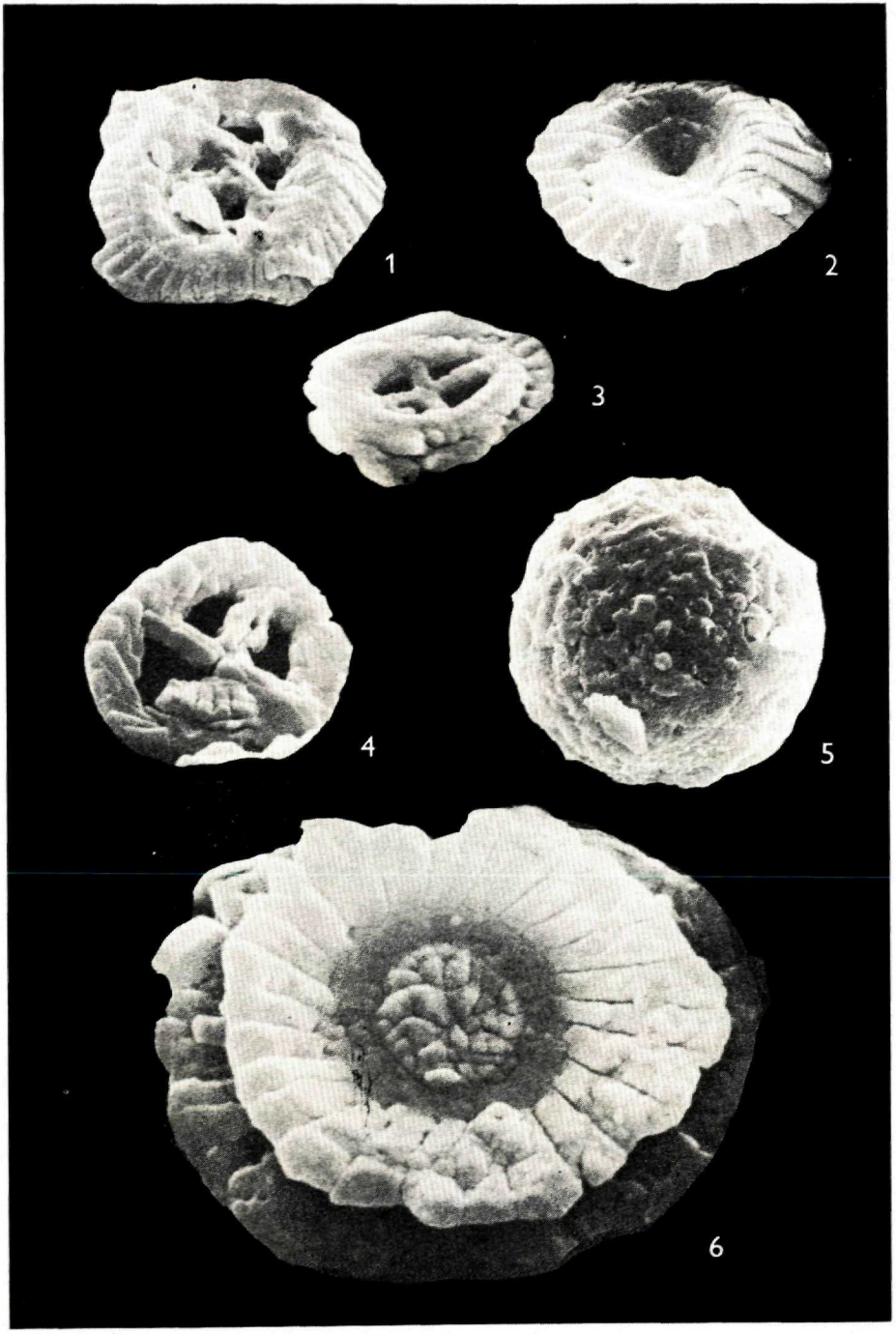
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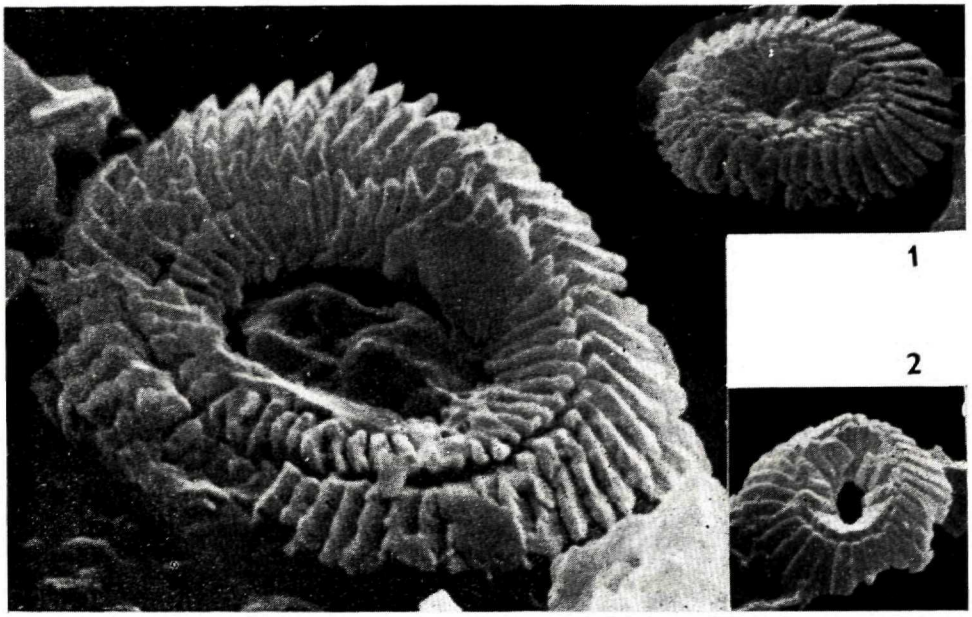

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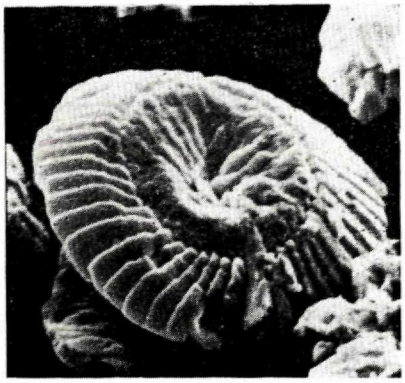

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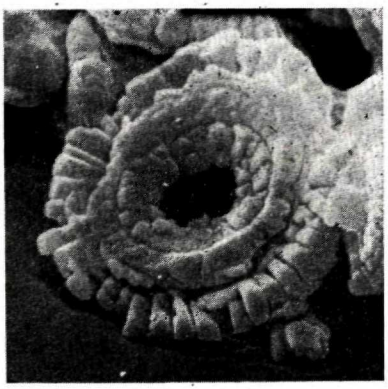

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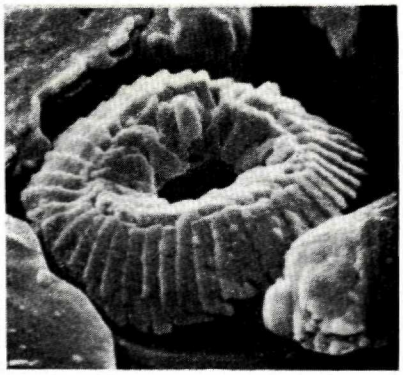

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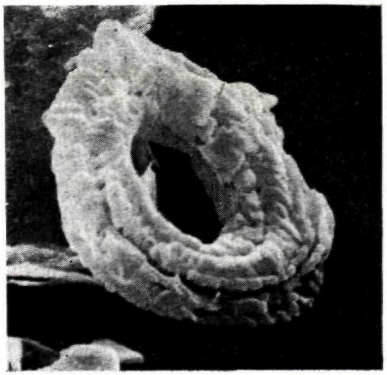

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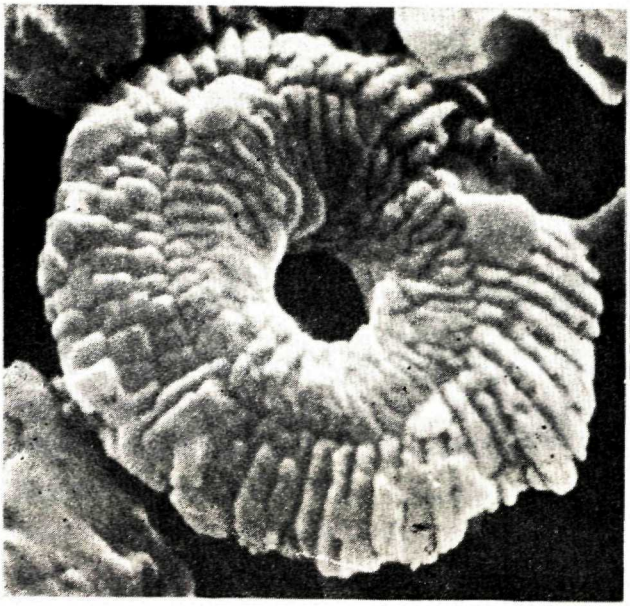

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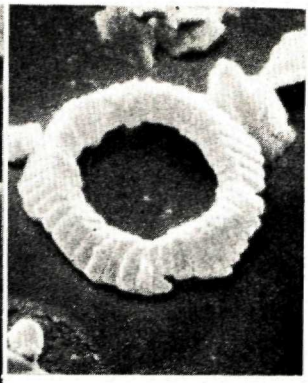

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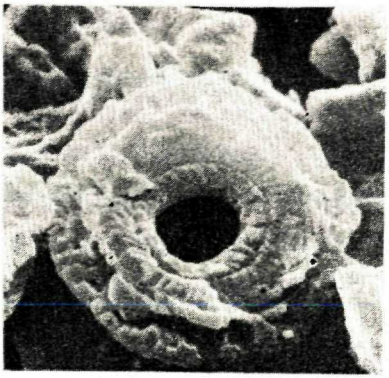

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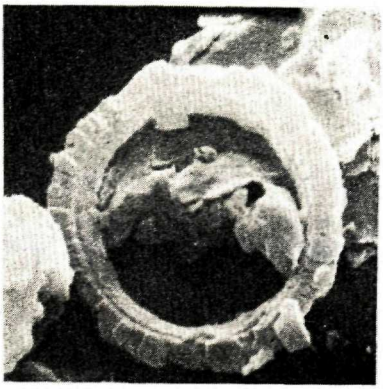

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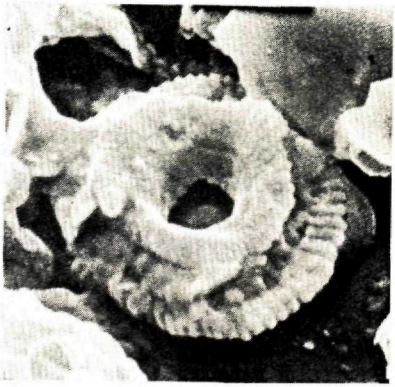

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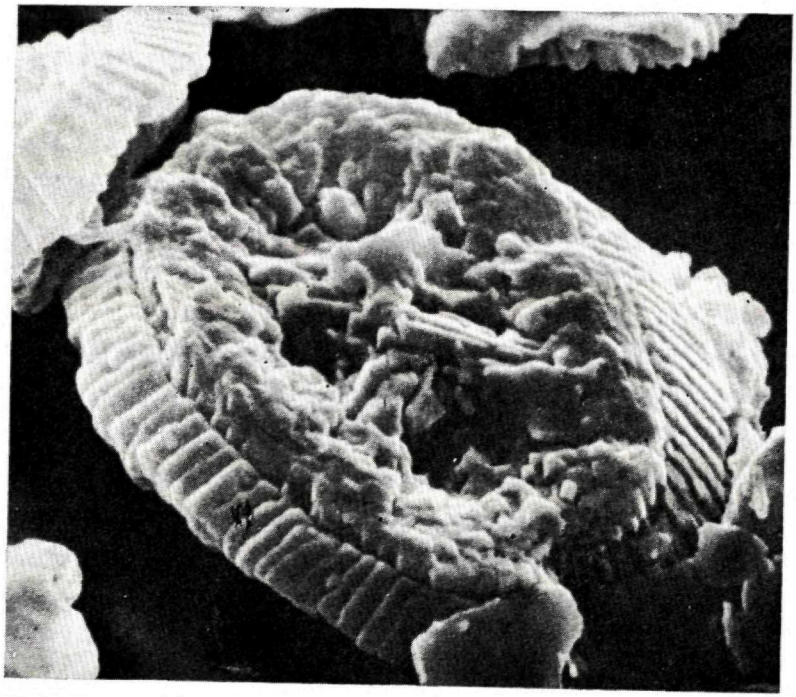

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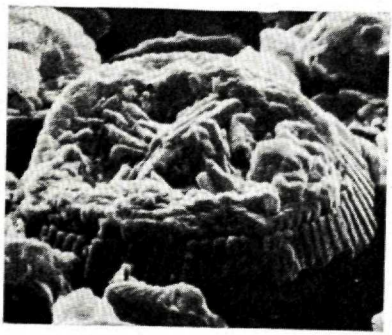

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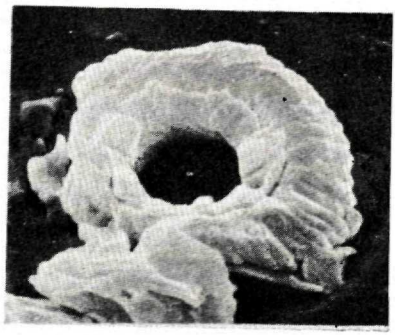

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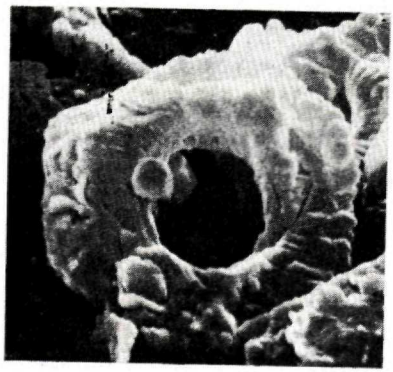

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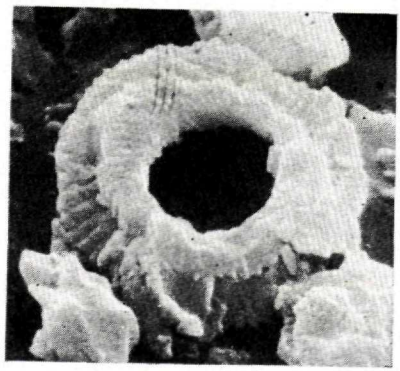

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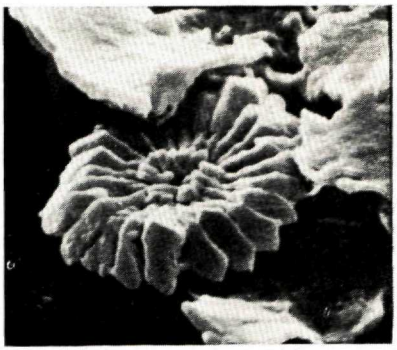
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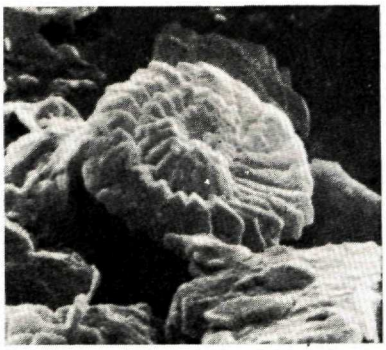
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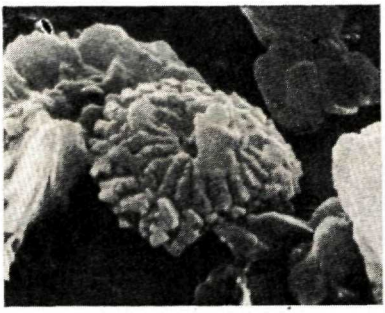
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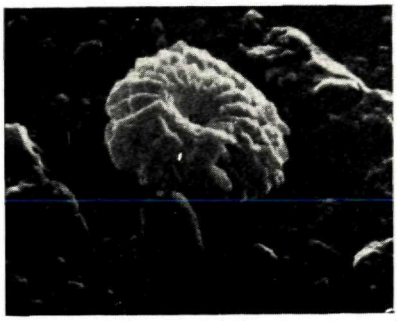
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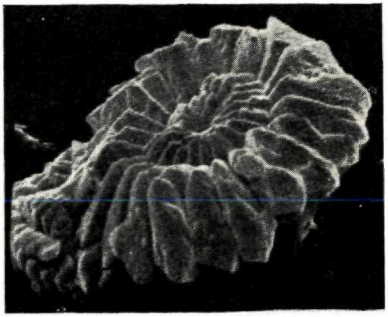
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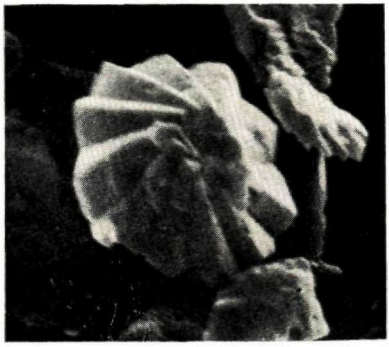
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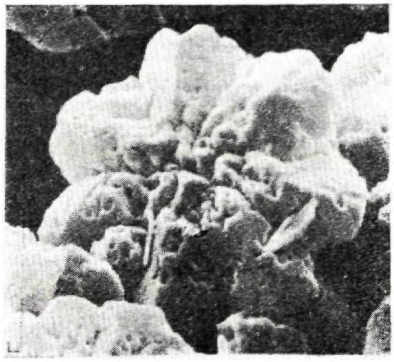
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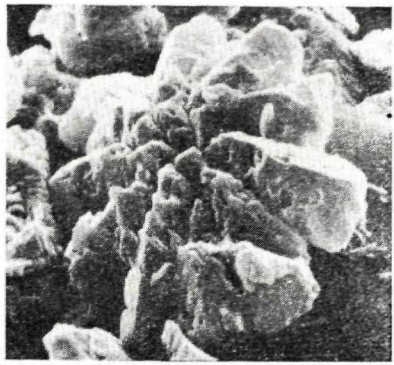
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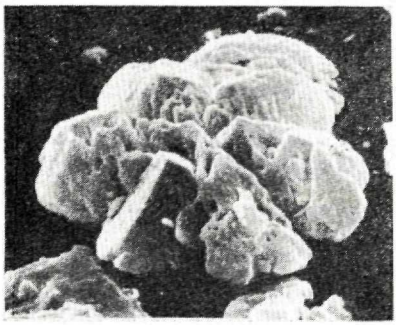
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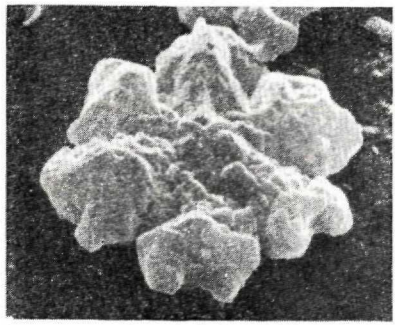
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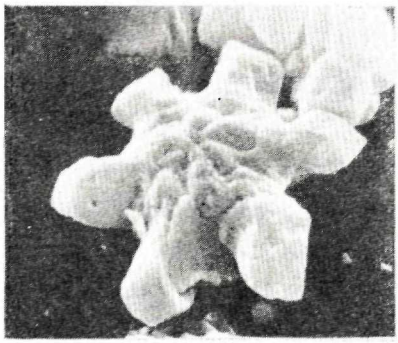
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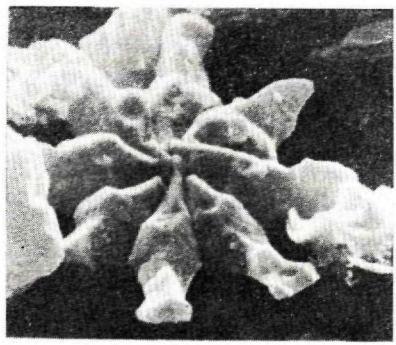
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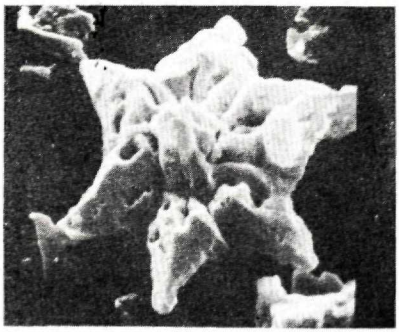
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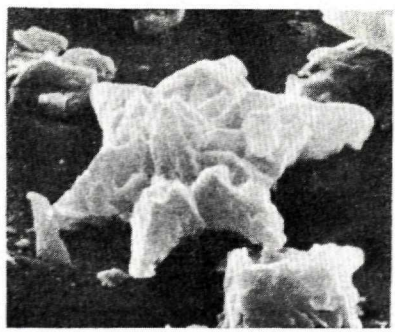
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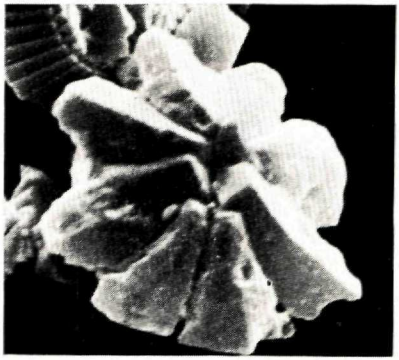
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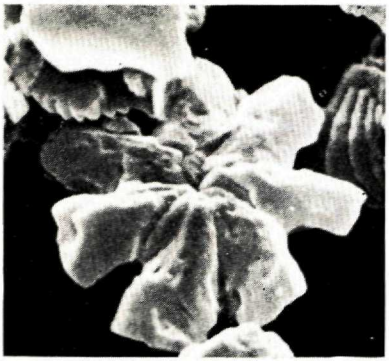
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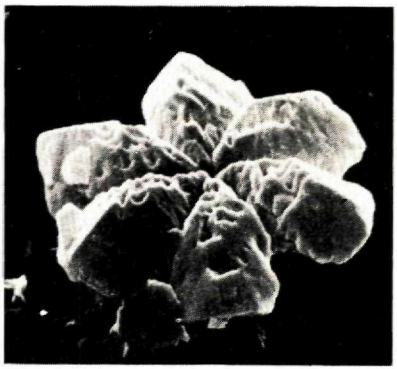
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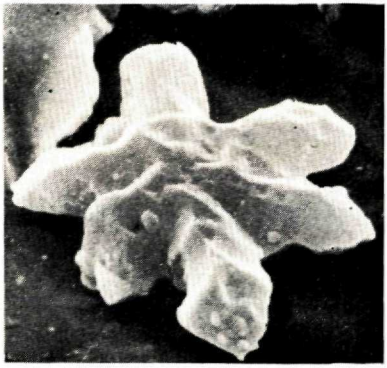
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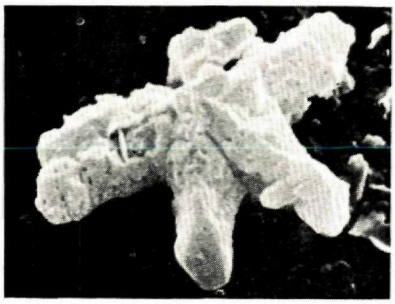
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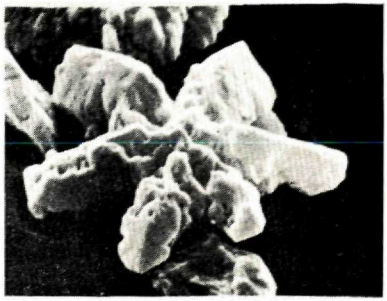
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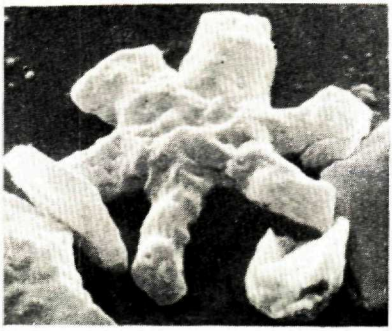
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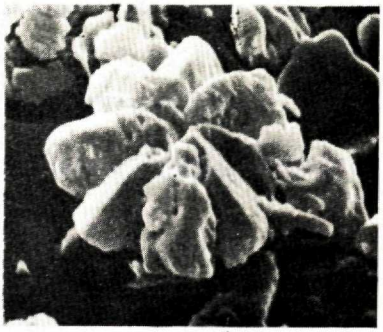
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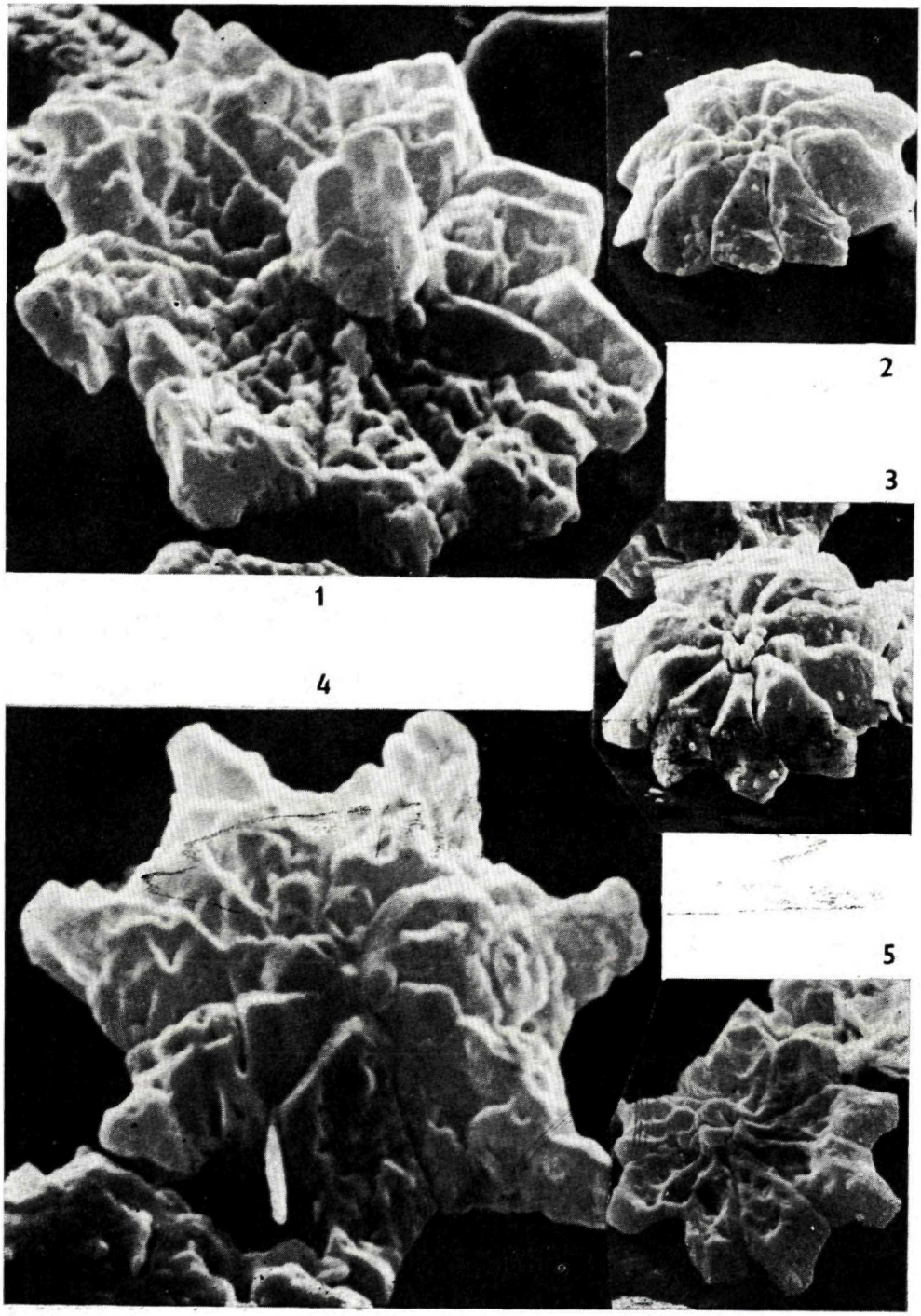
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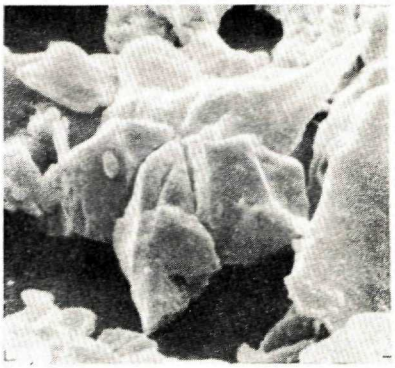
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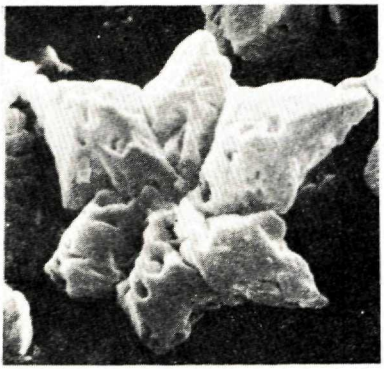
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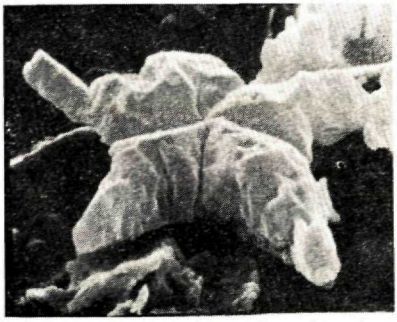
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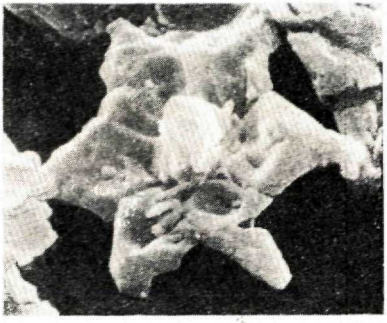
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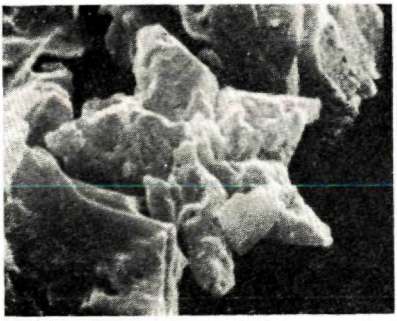
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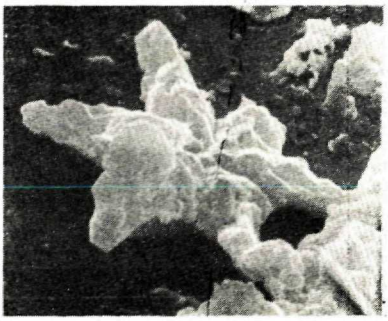
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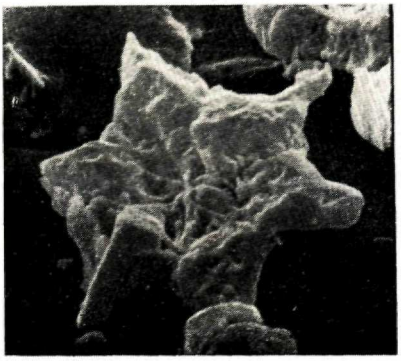
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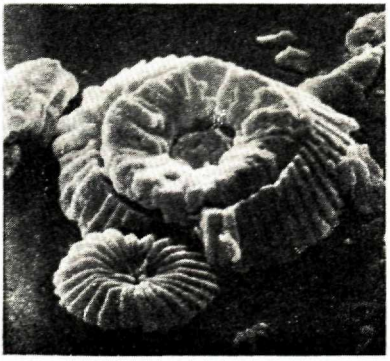
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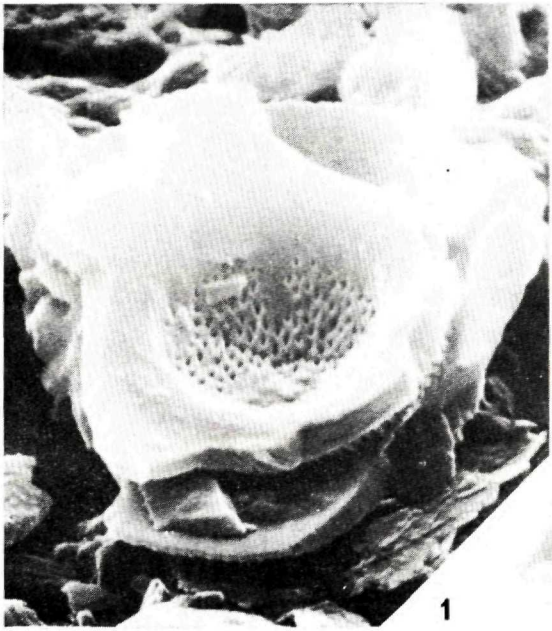
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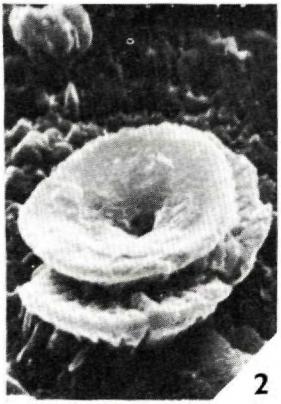
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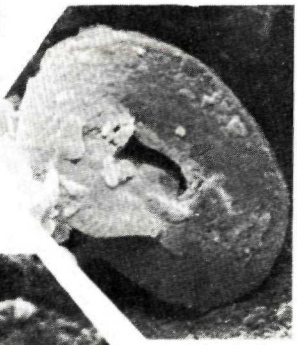
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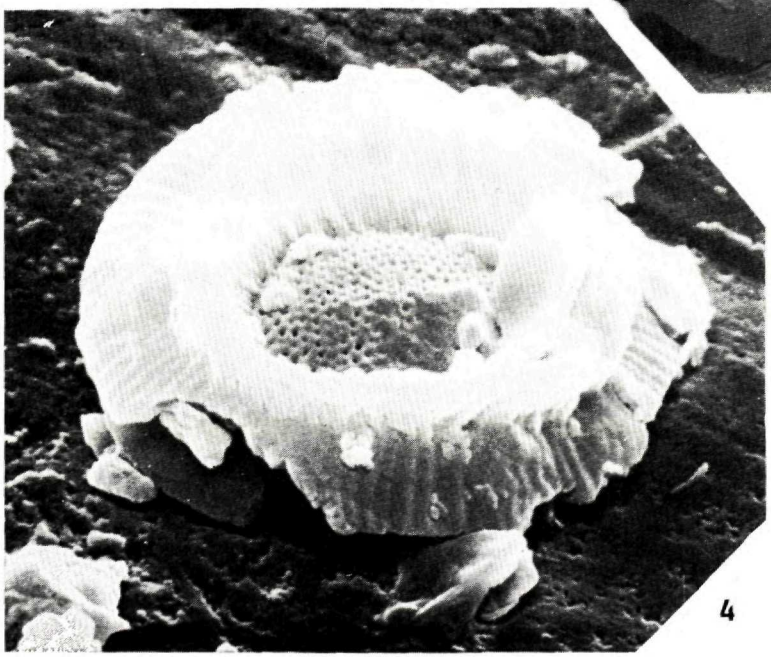
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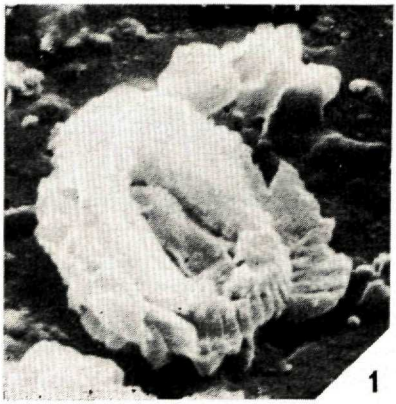
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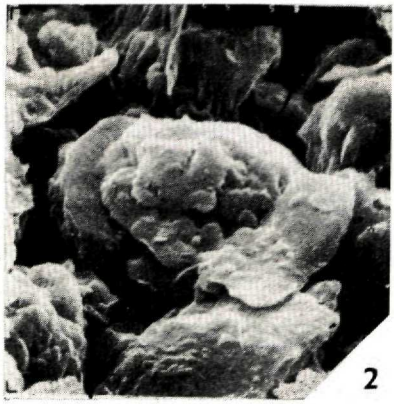
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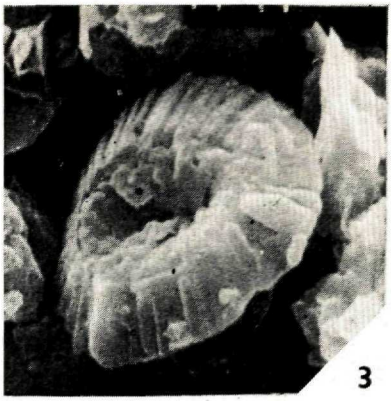
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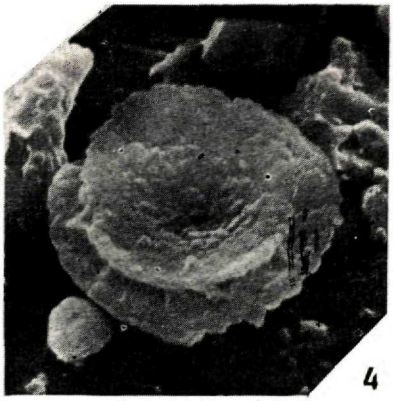
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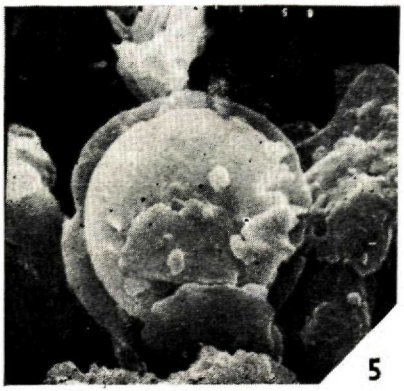
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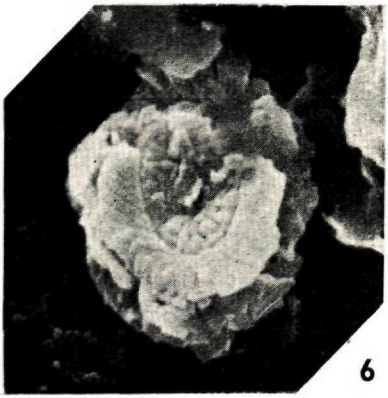
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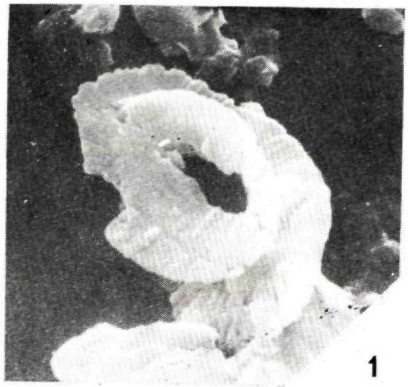
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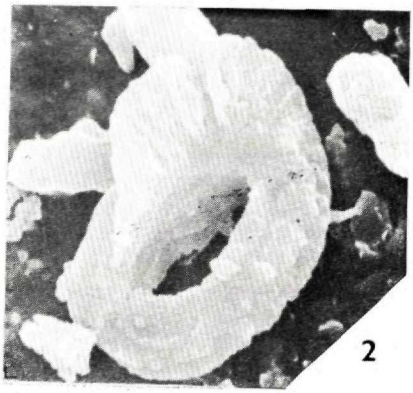
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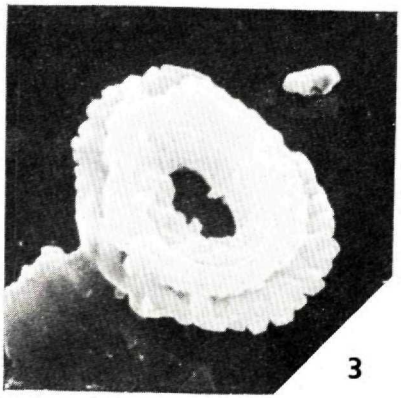
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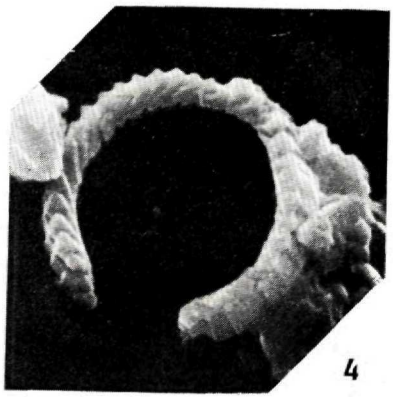
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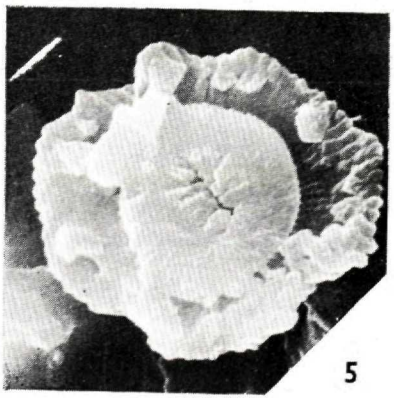
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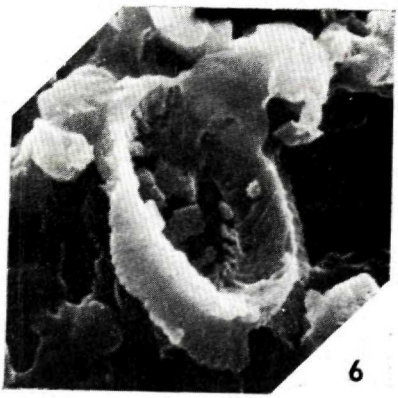
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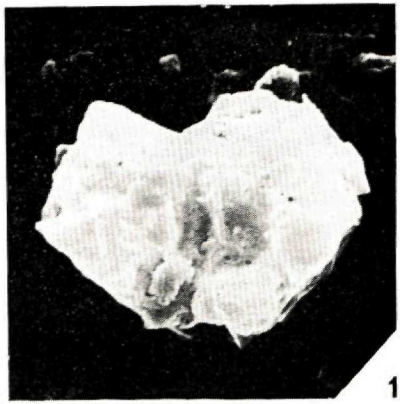
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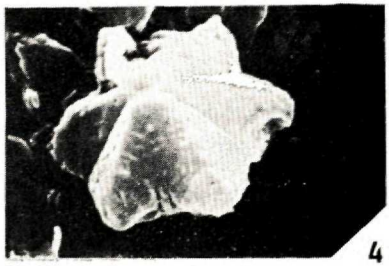
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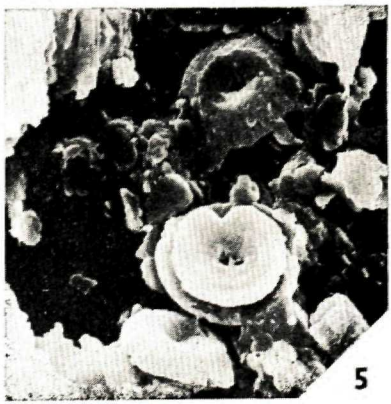
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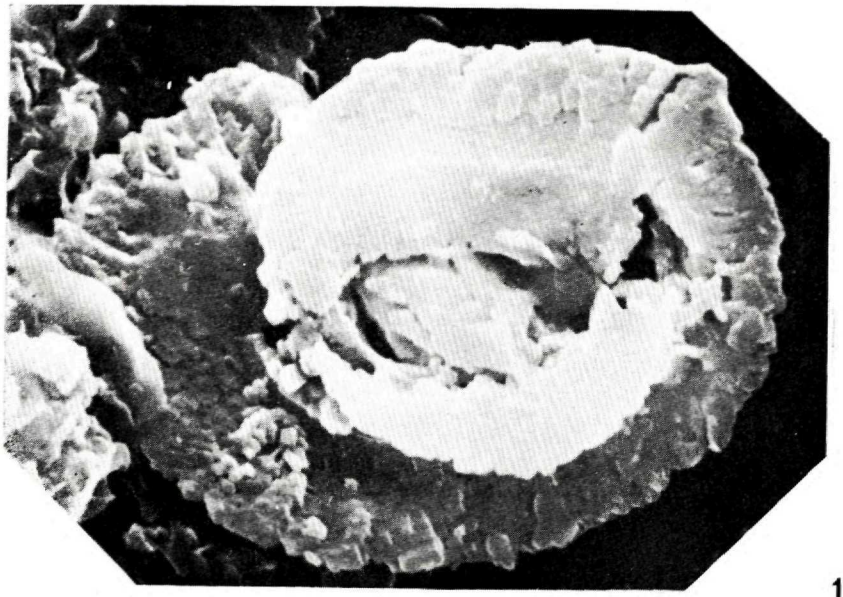

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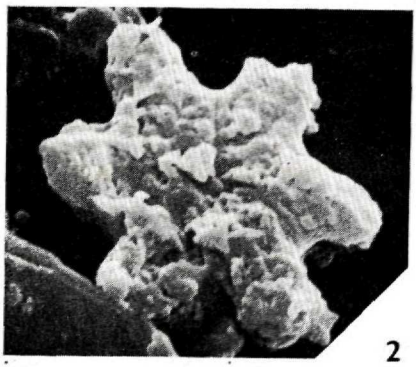

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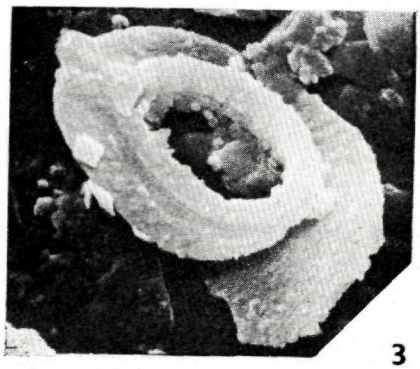

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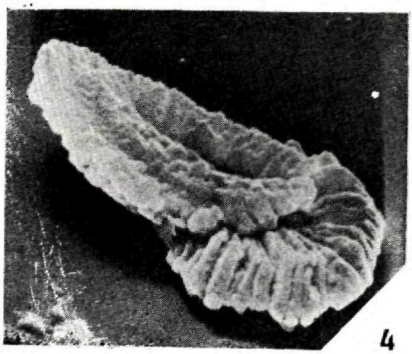

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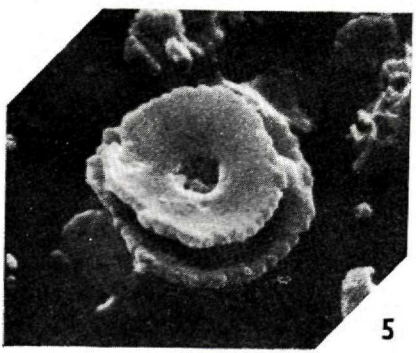

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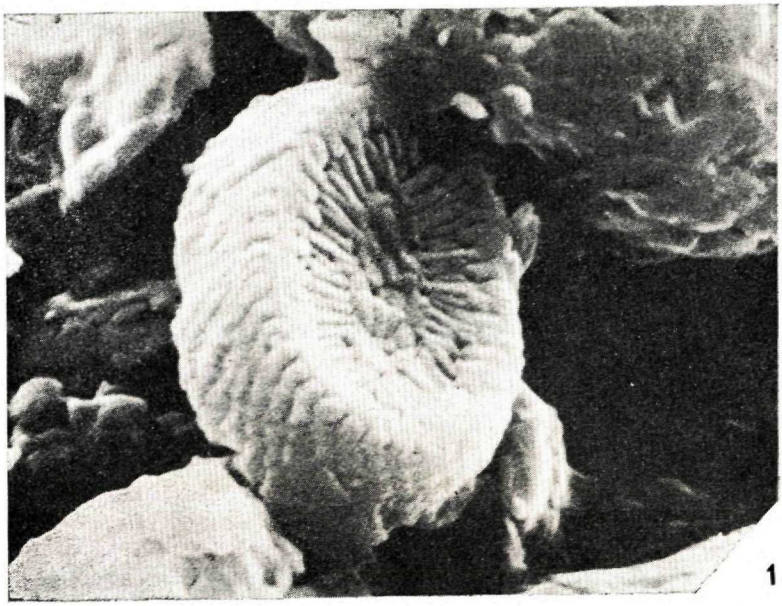

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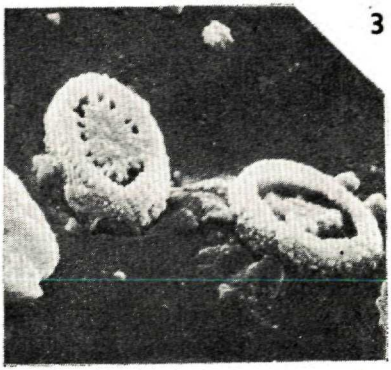

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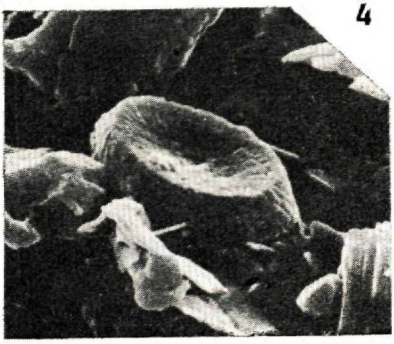

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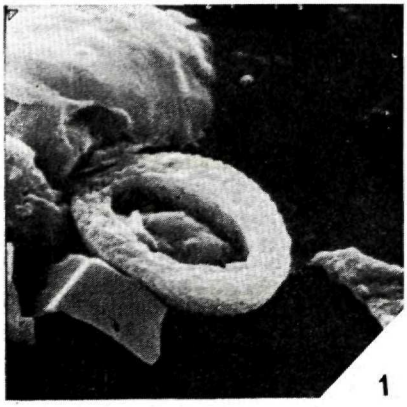
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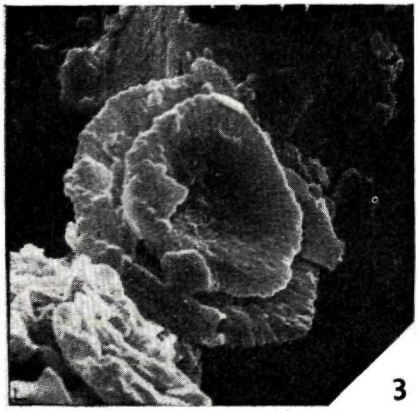
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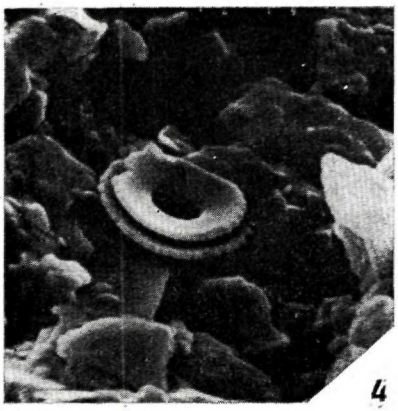
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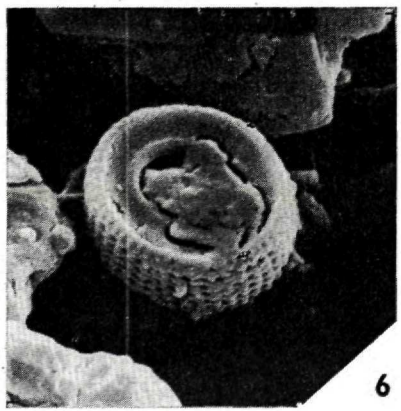
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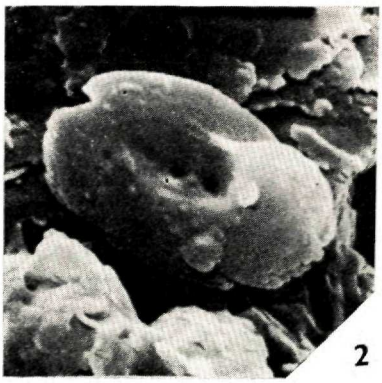
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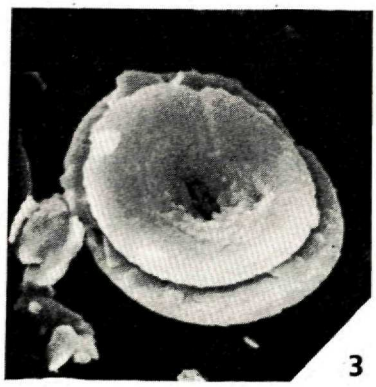
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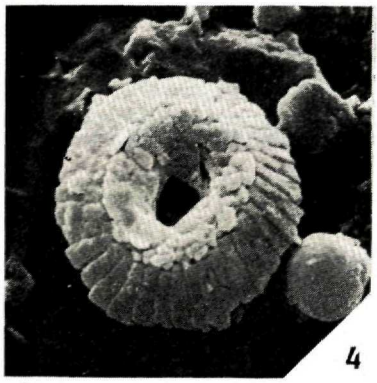
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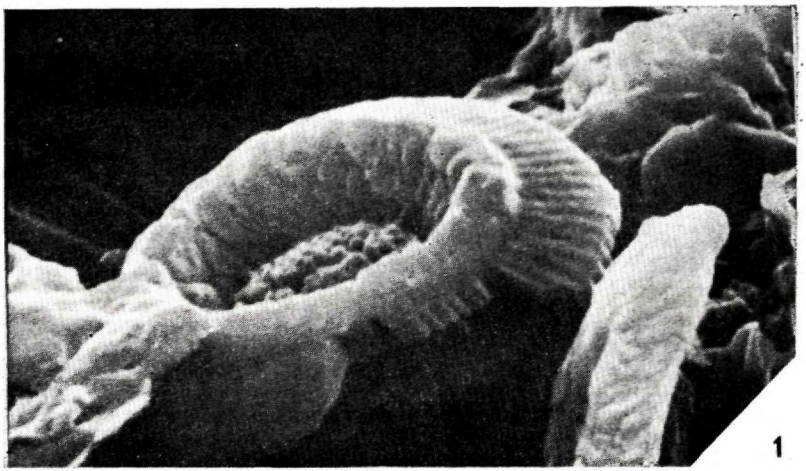
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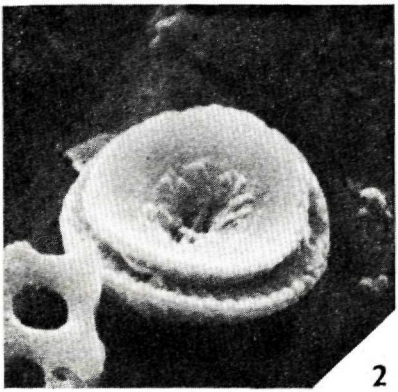
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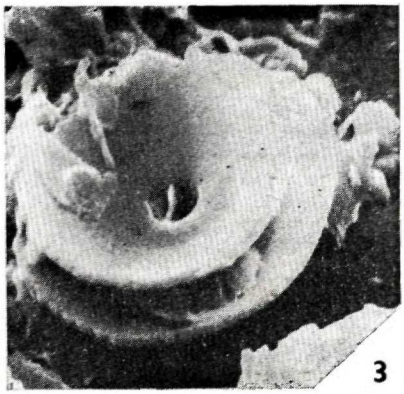
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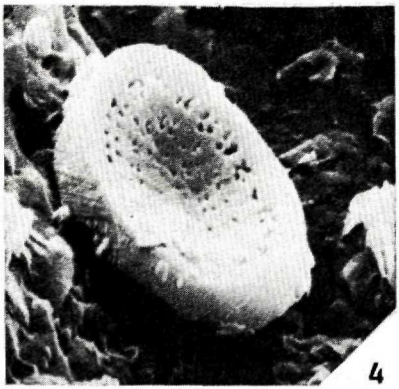
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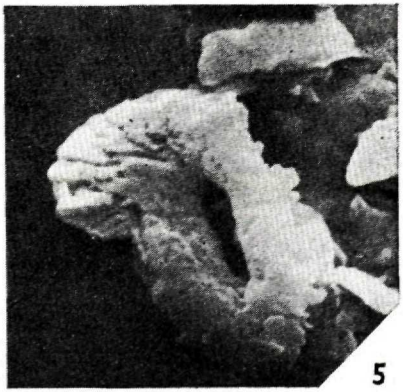
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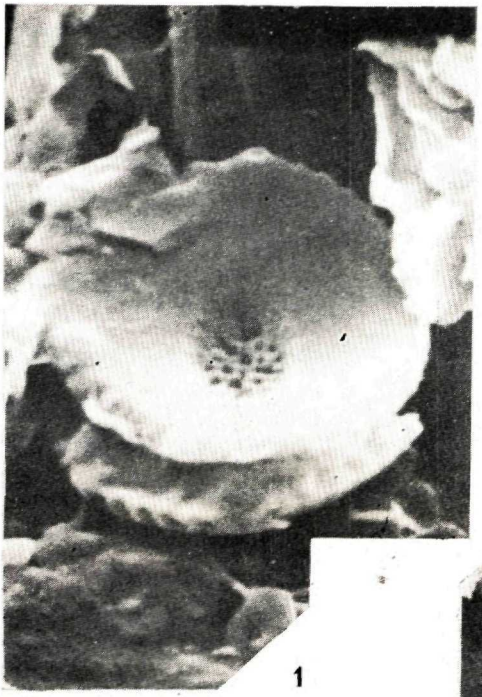
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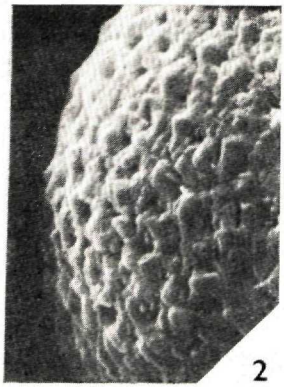
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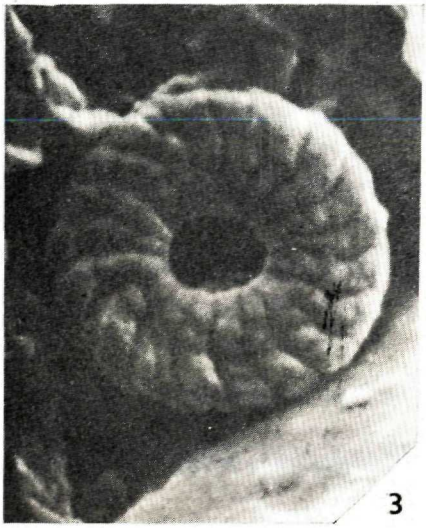
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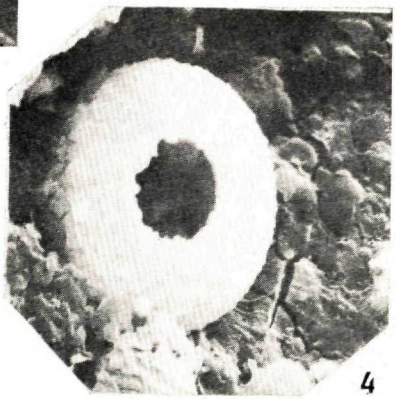
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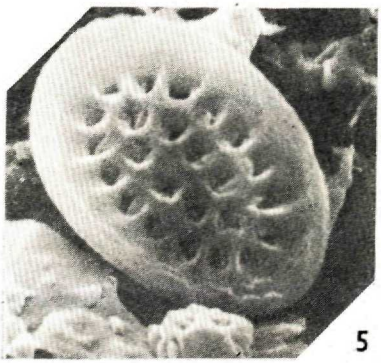
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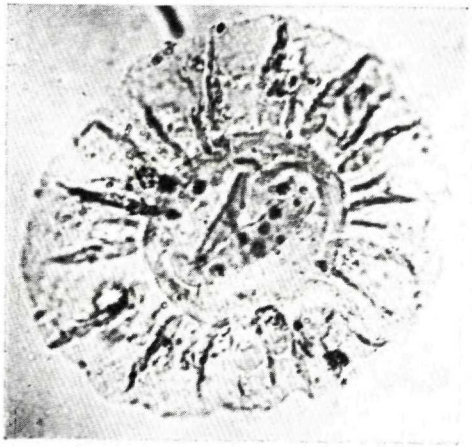

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× 2

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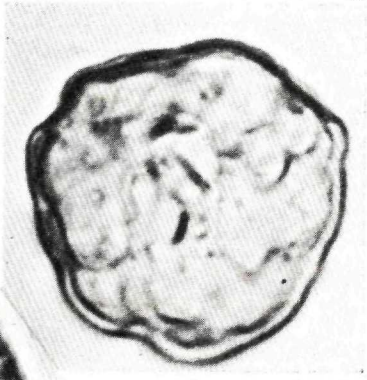

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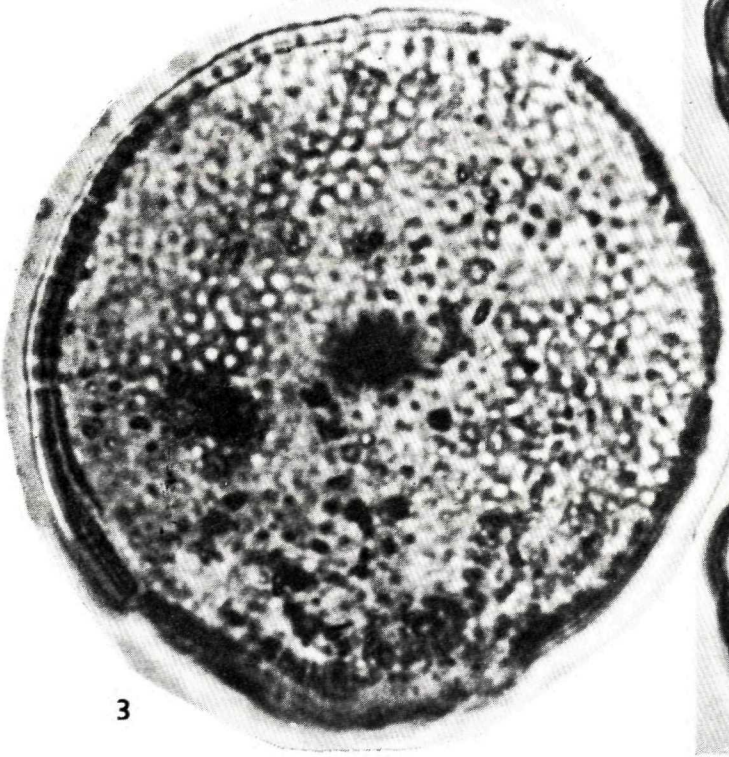

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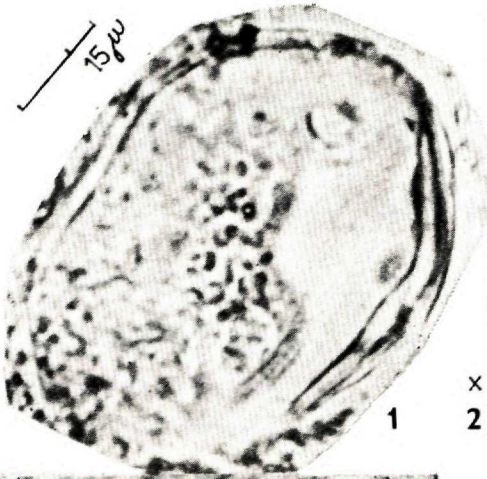

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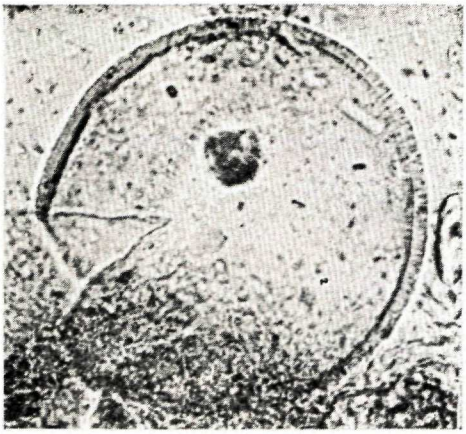

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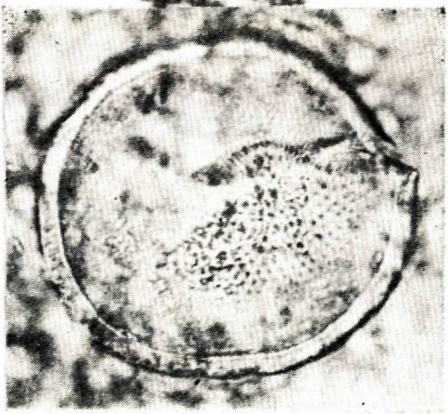

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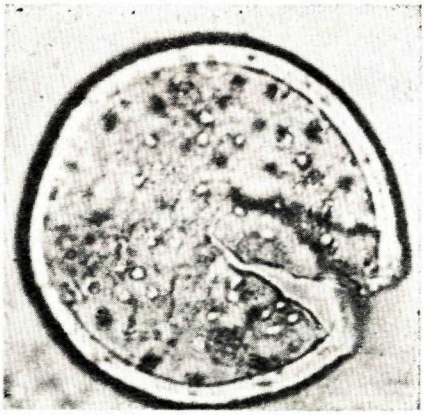

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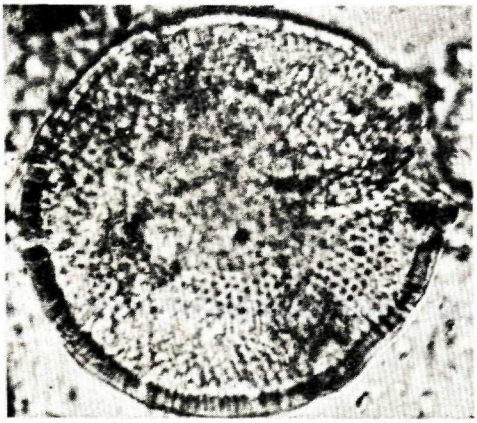

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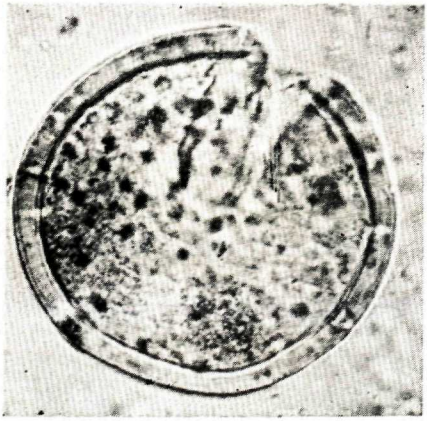


30 μ
1


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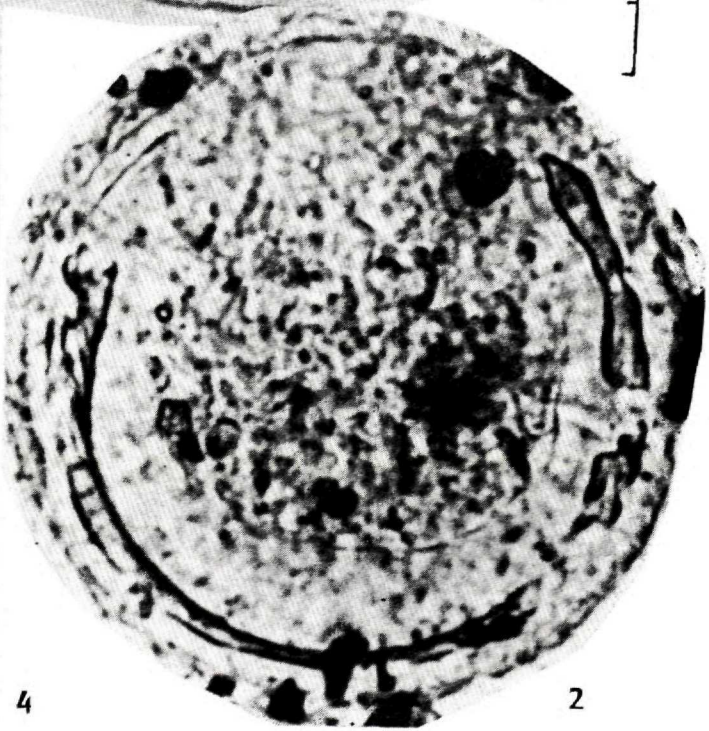
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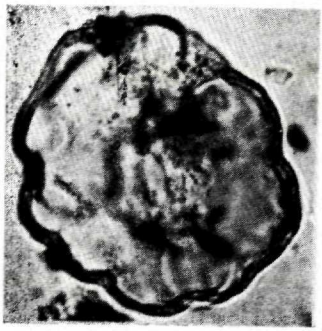
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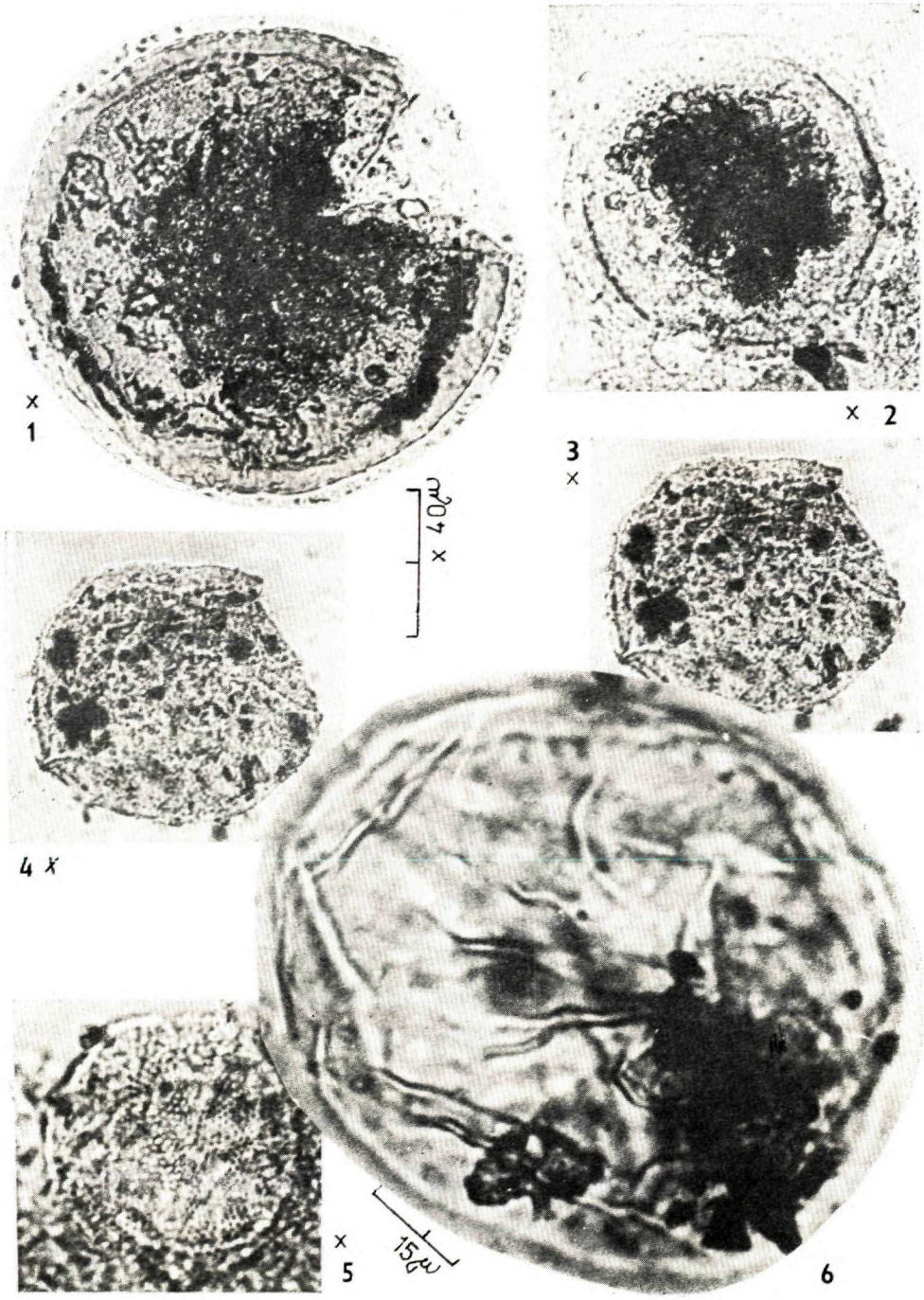
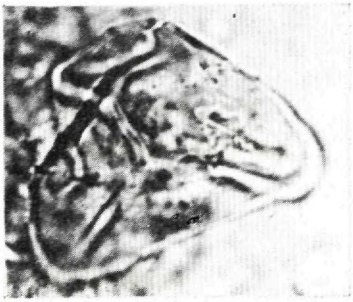

× 1
× 2
3 ×
20 × 40μ
4 ×
× 5
15μ
6



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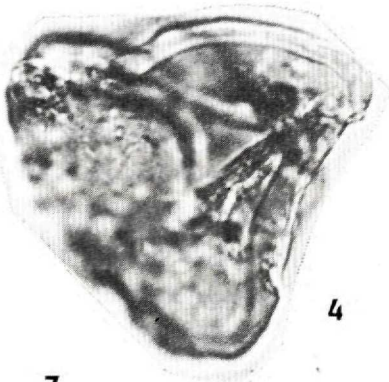


4

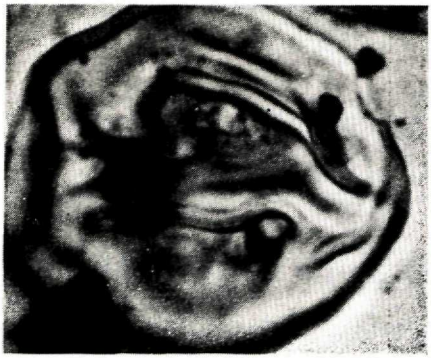
30 μ

5

6

7

1



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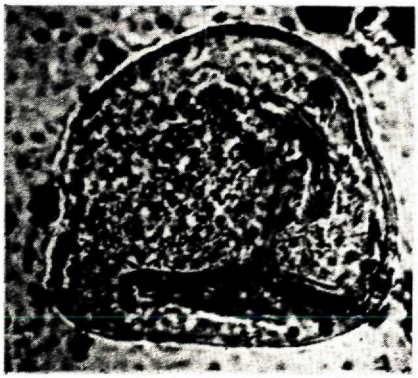
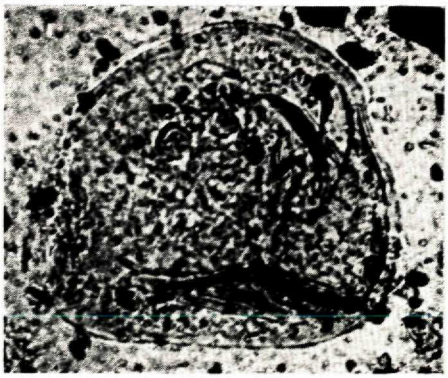
30 μ



× 3



× 4

× 40 μ

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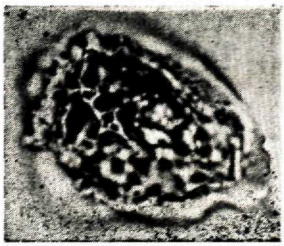

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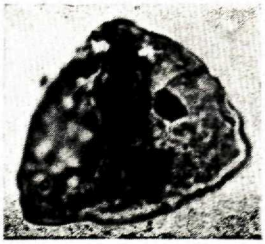

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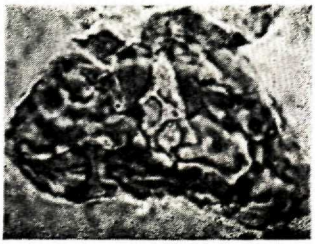

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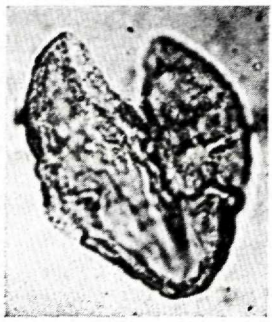

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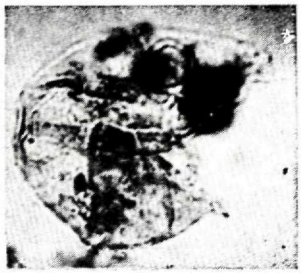

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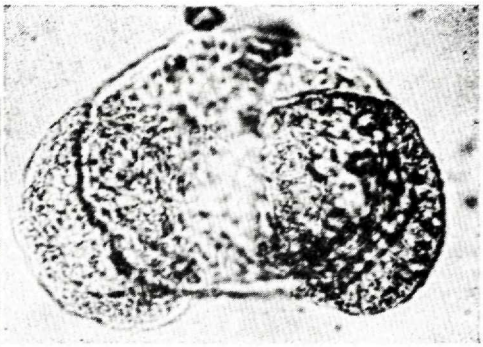
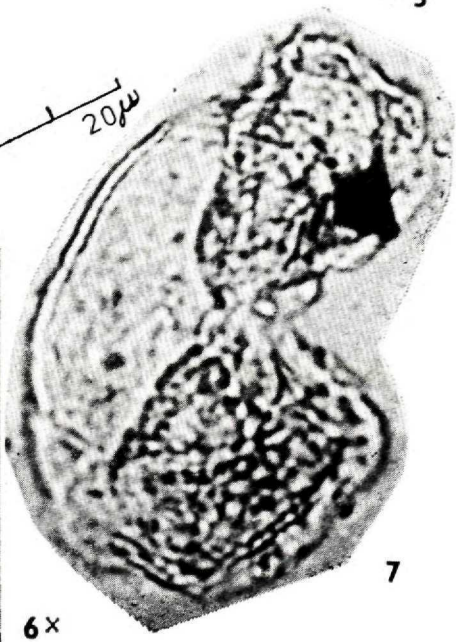


× 5

× 40μ

20μ

6 ×



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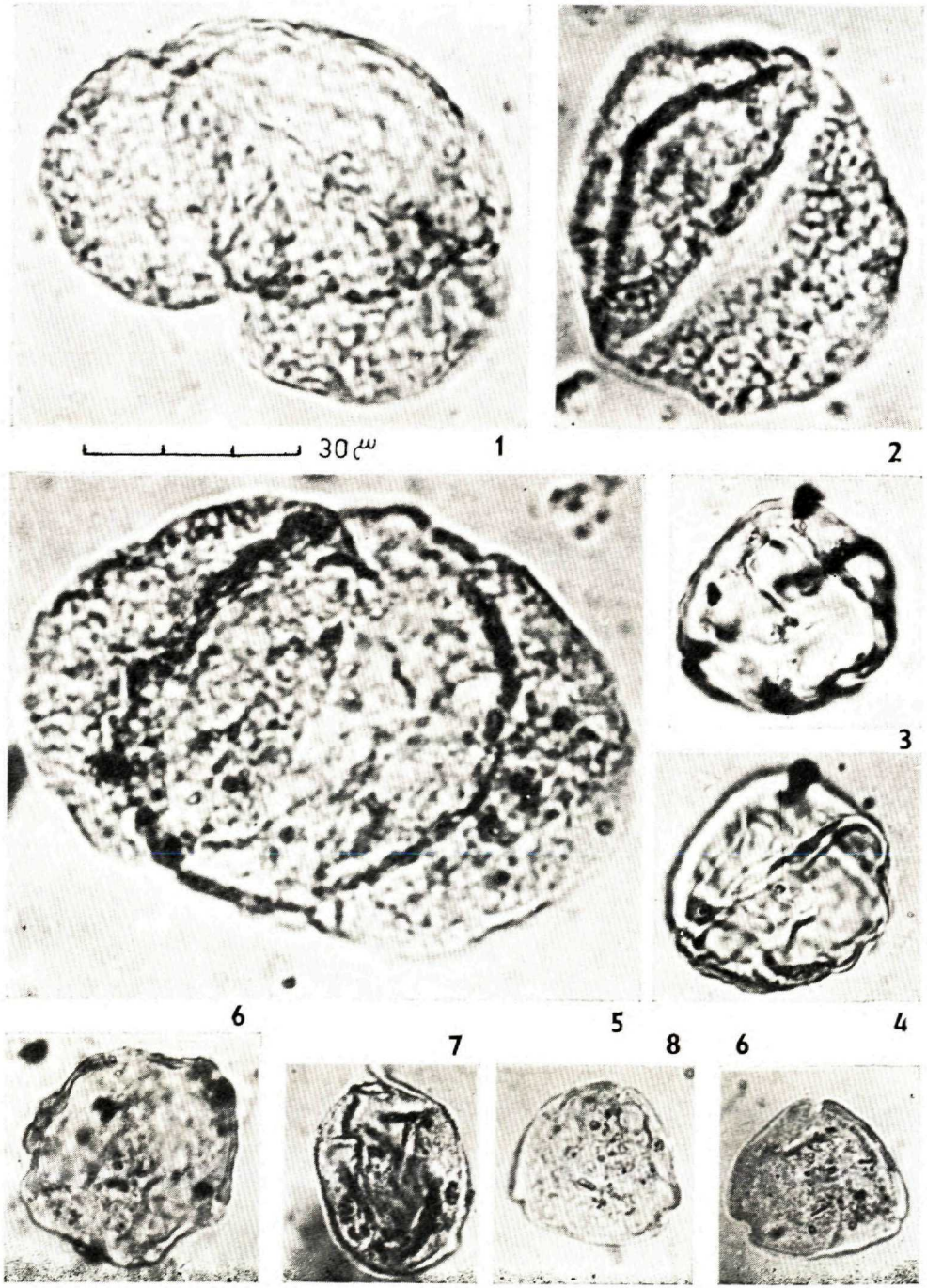
30 μ
1
2
3
4
5
6
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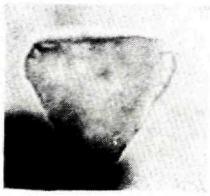
8
6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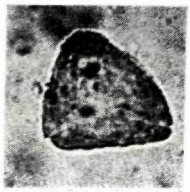
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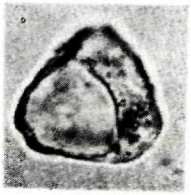
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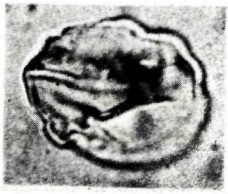
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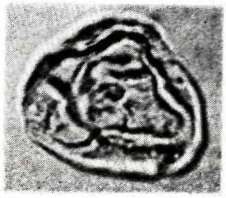
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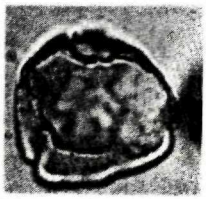
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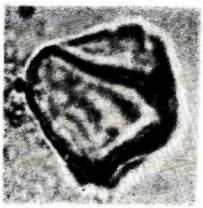
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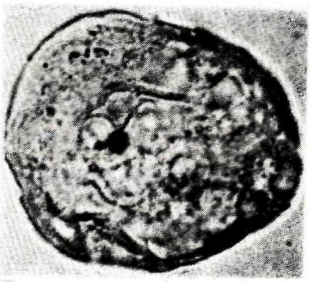
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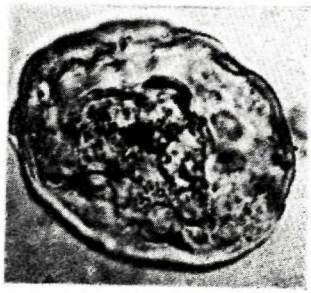
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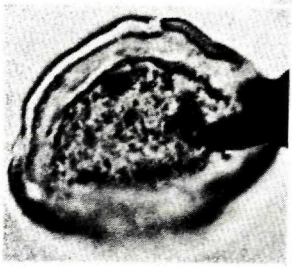
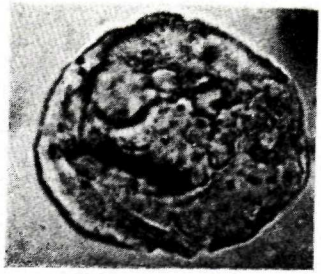

12

30μ


13

14



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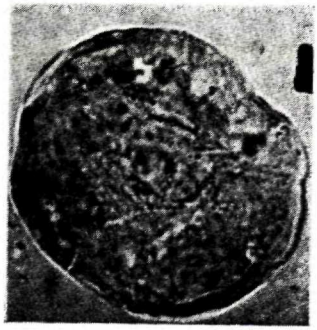

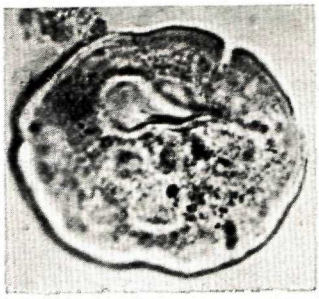

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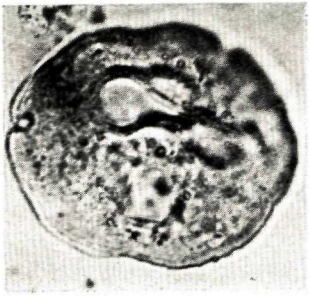

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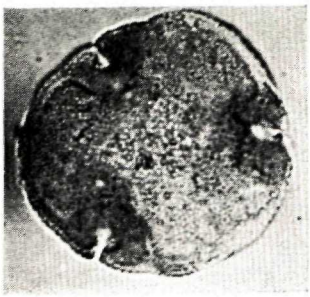

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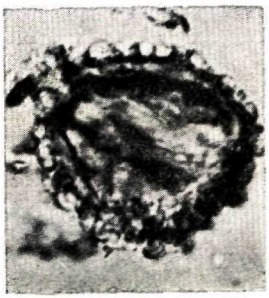

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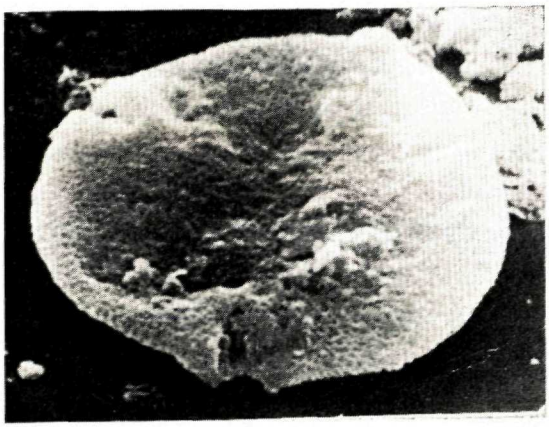

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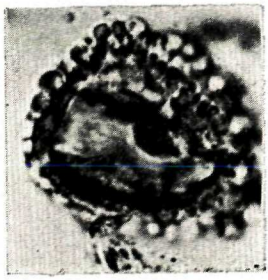

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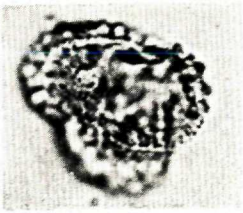

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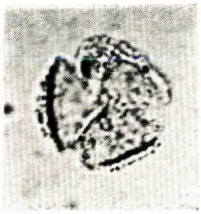

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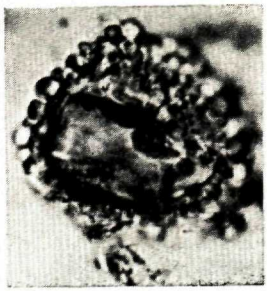
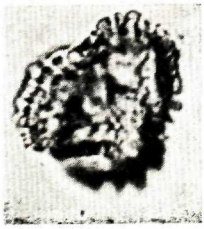


7

30 μ

10



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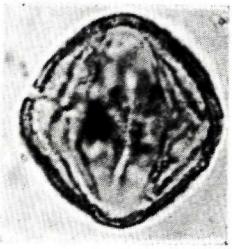
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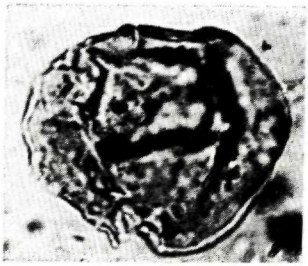
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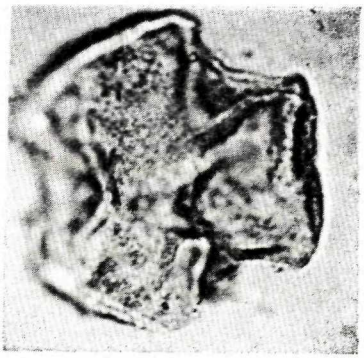
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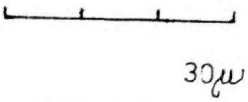


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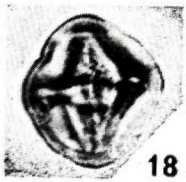
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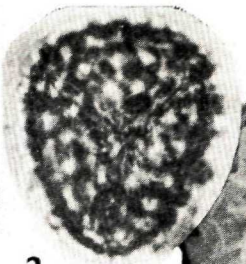

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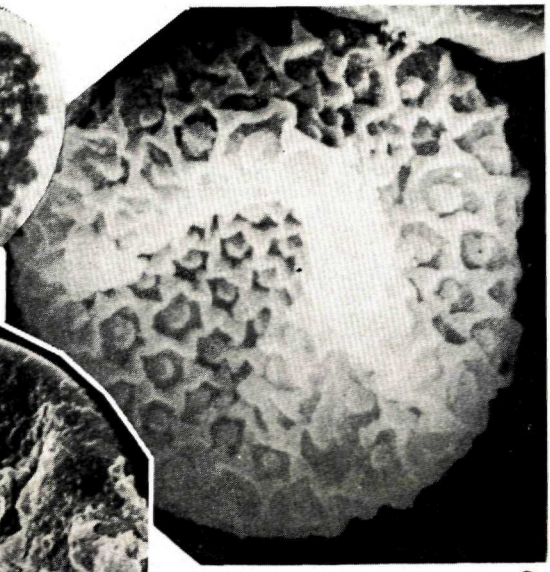

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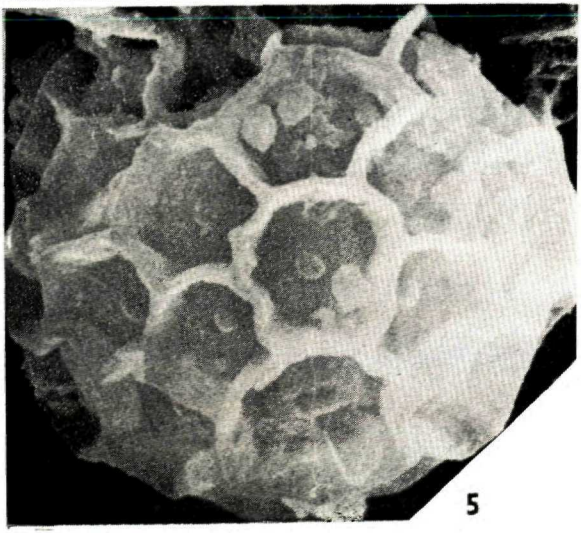

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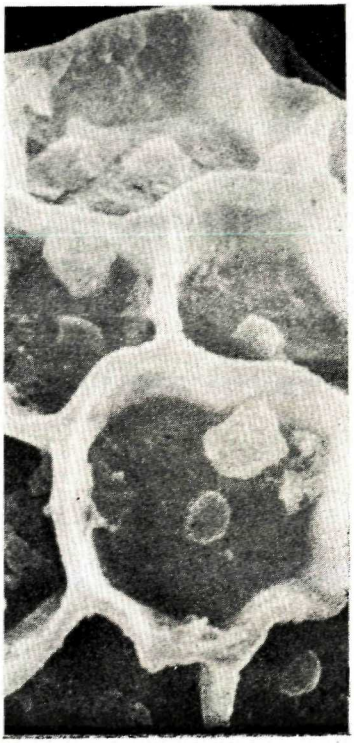

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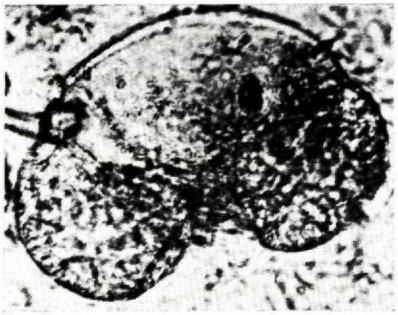

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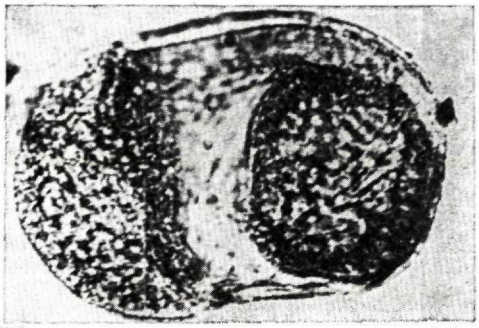

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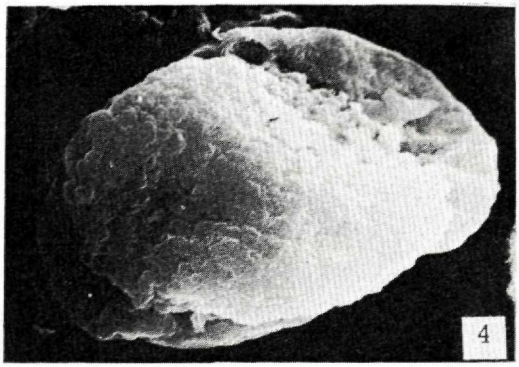

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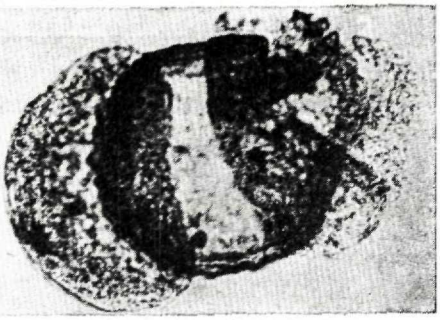

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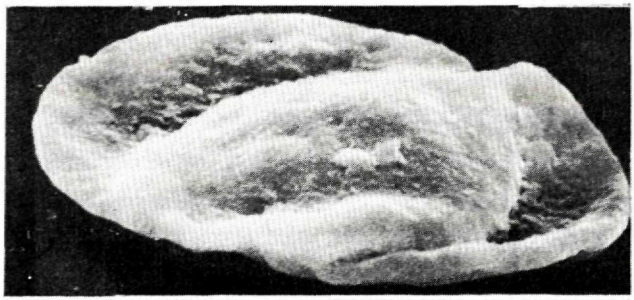

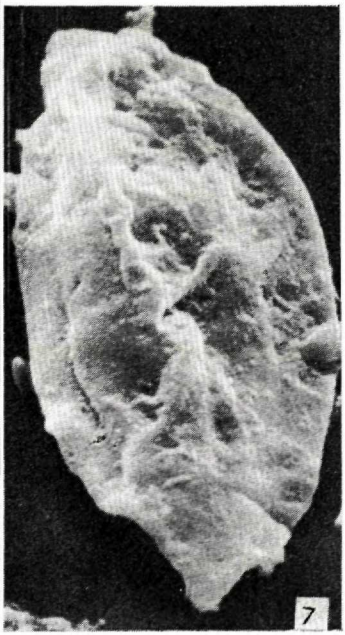

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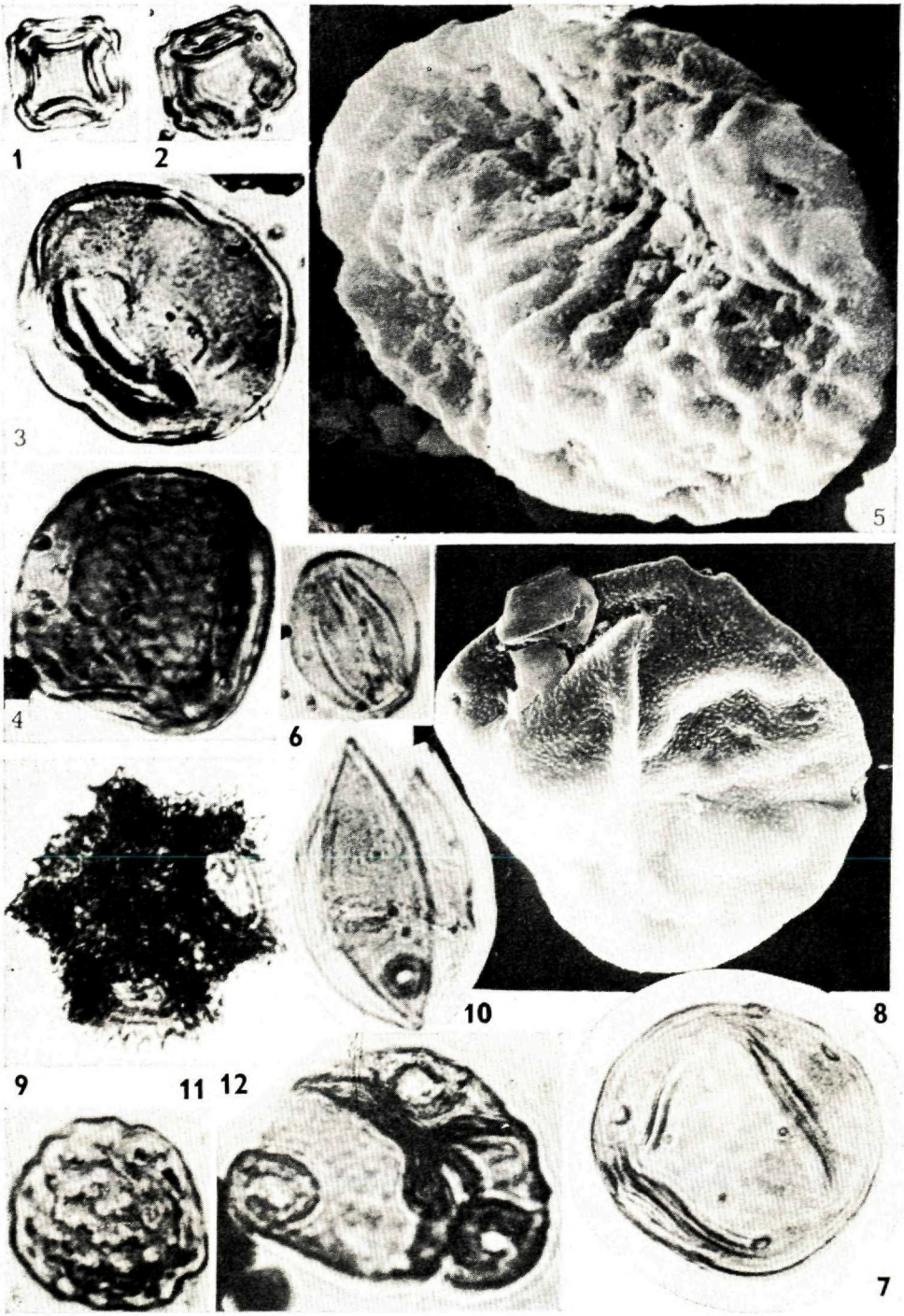
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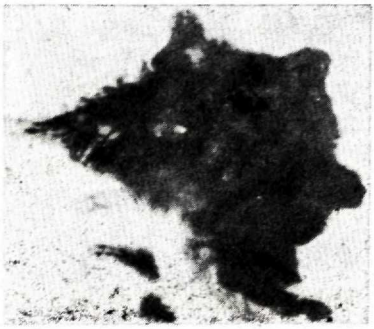
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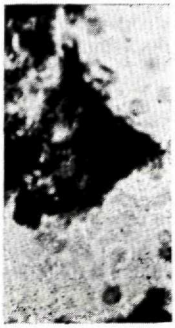
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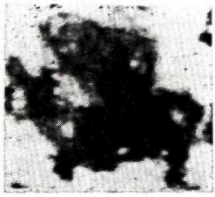
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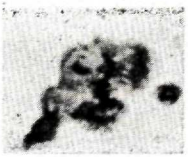
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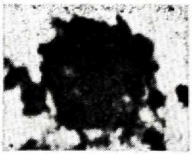
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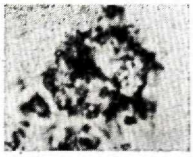
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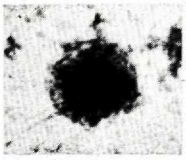
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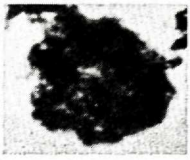
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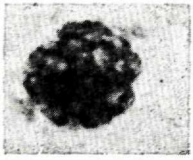
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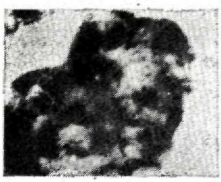
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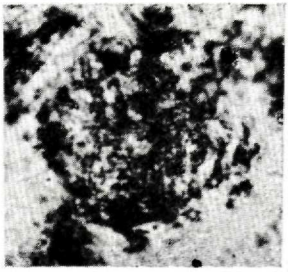

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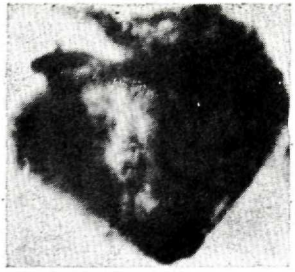

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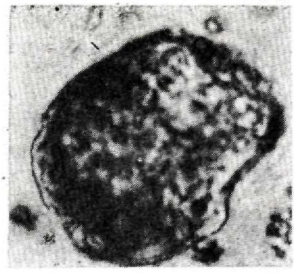

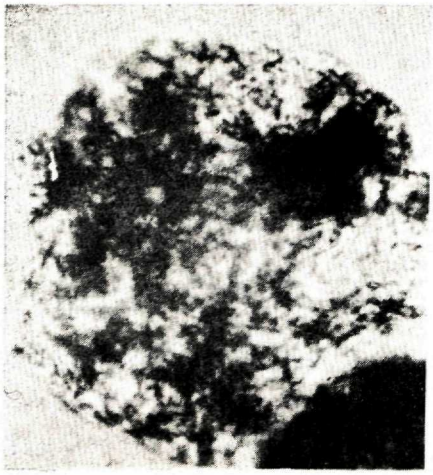

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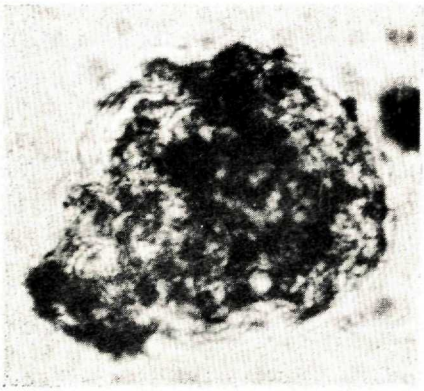

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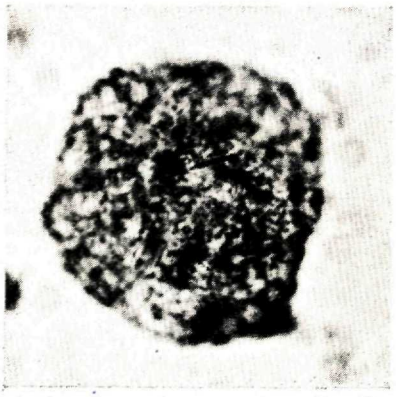

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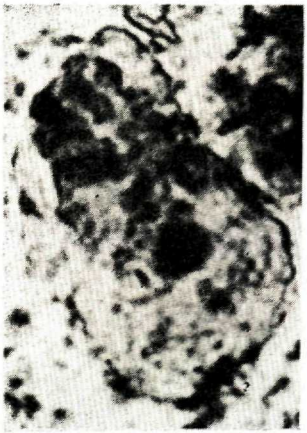

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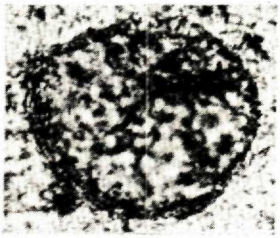

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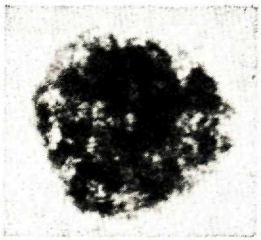

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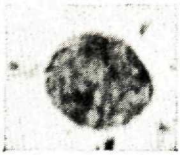

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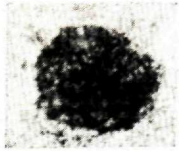


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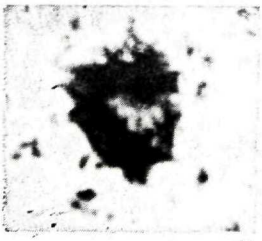
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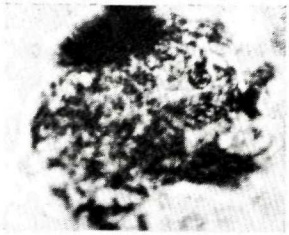
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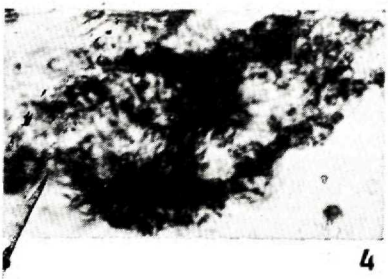
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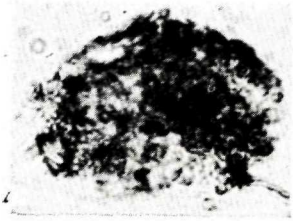
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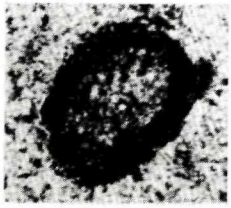
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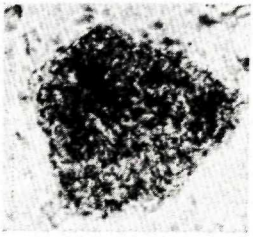
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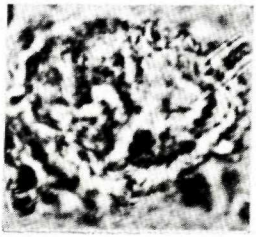
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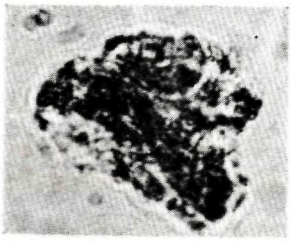
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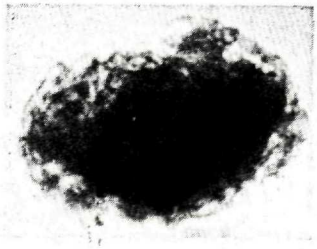
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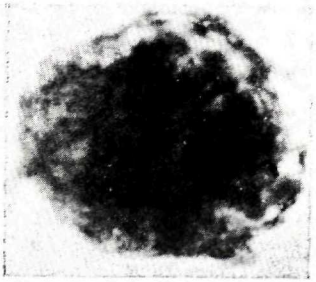
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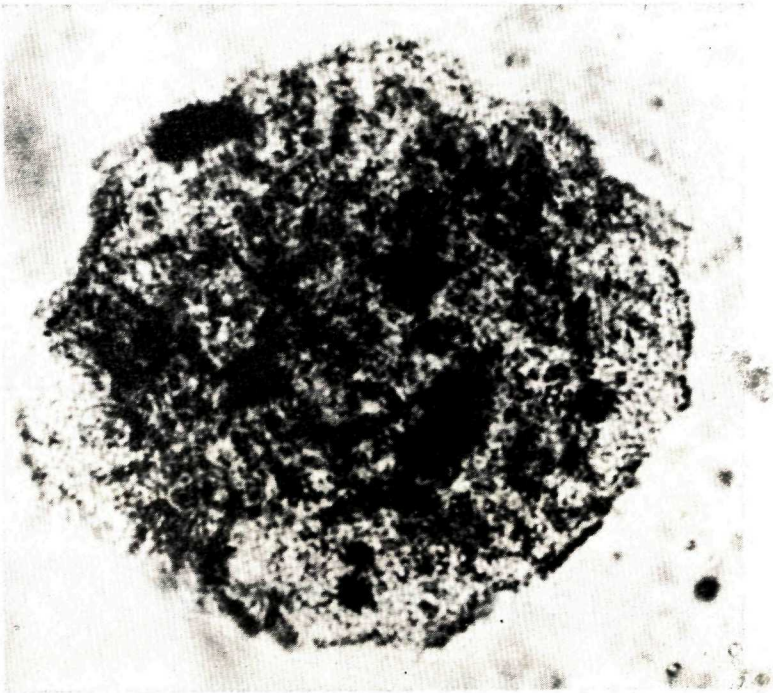

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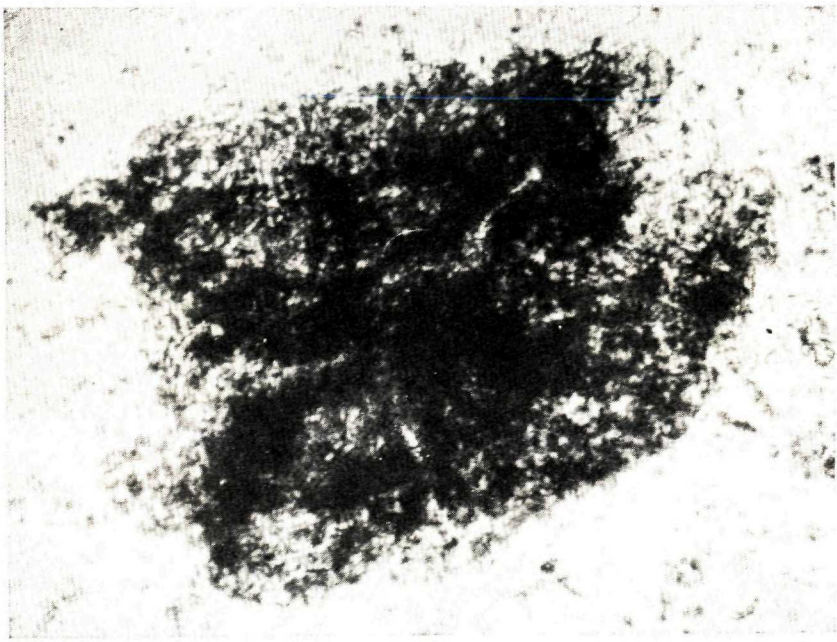

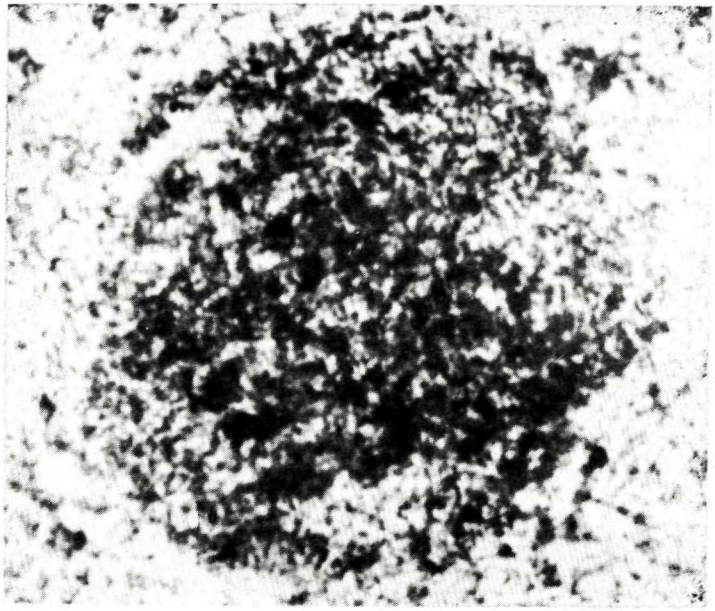

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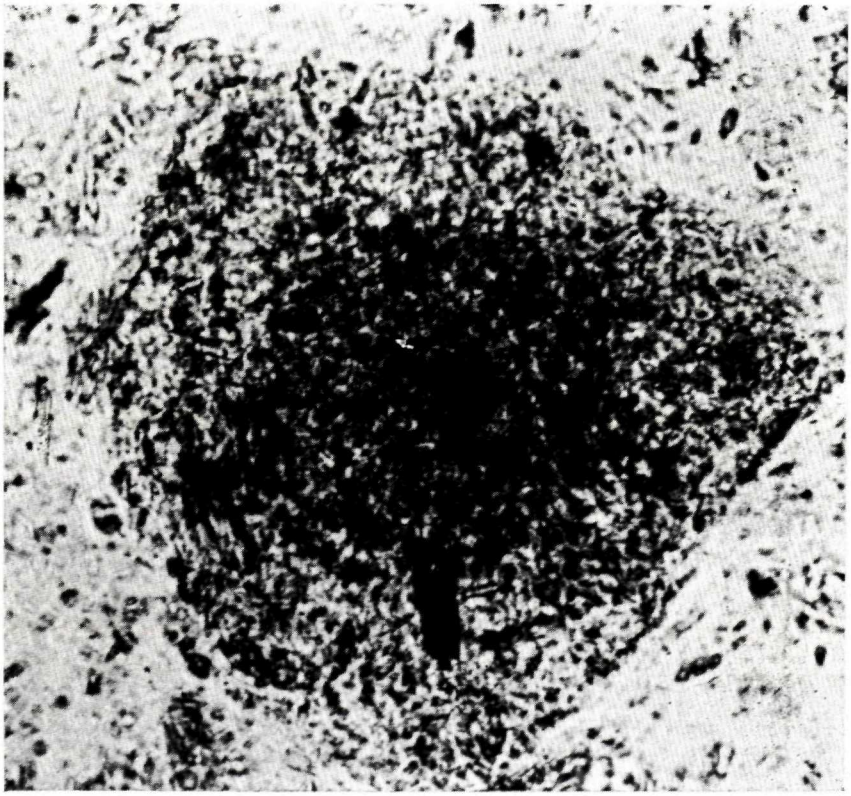

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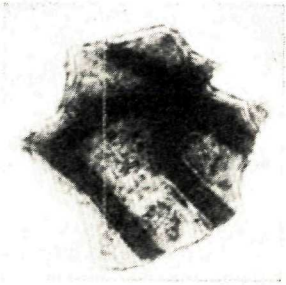

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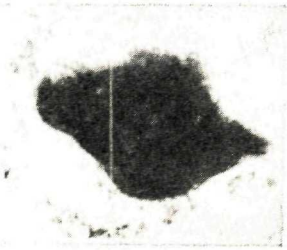

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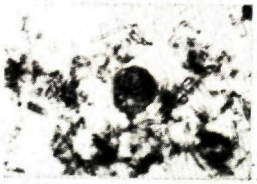

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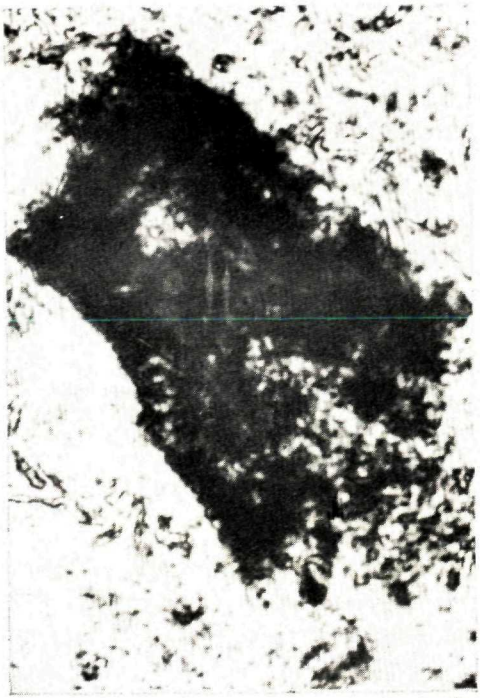

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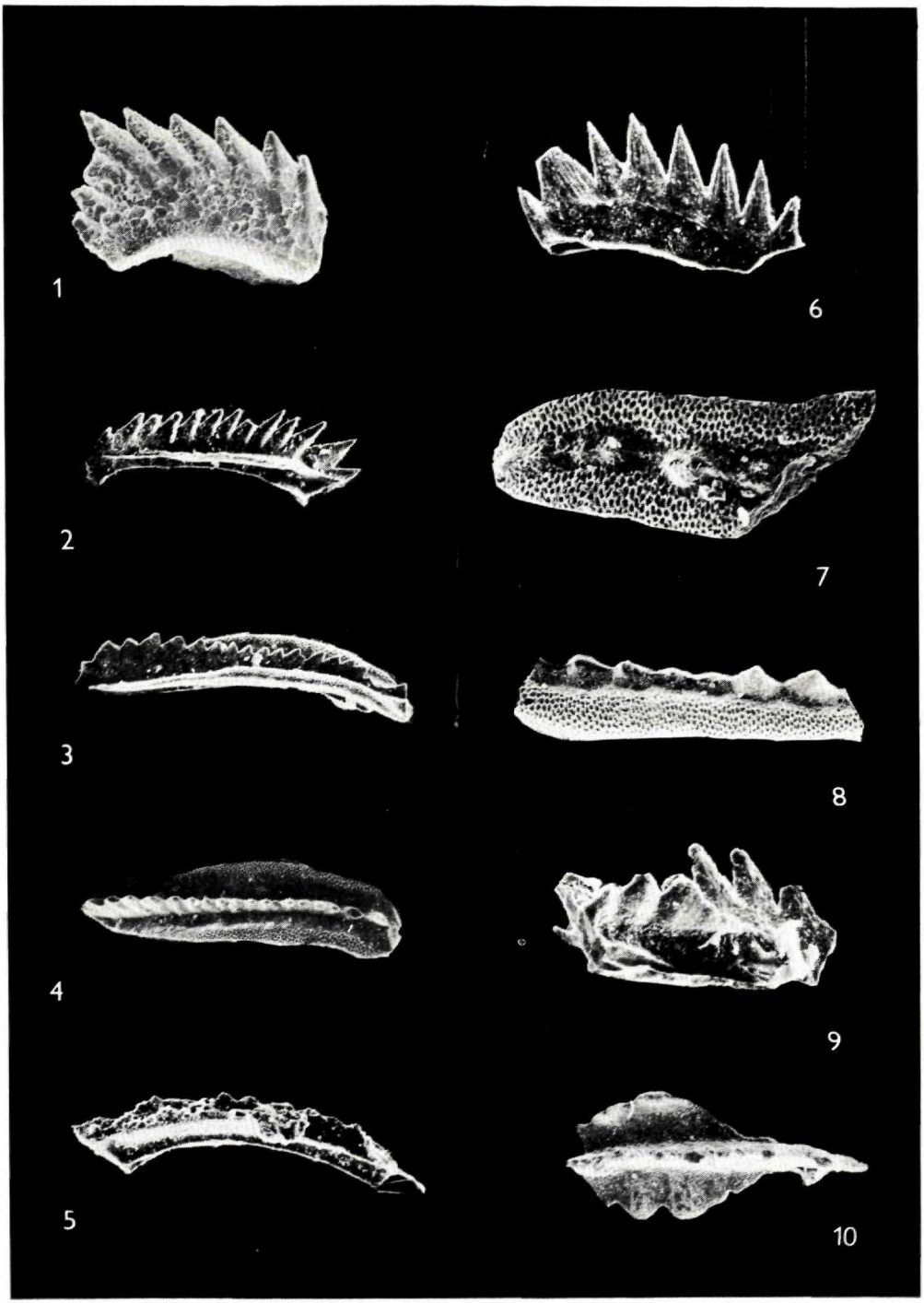
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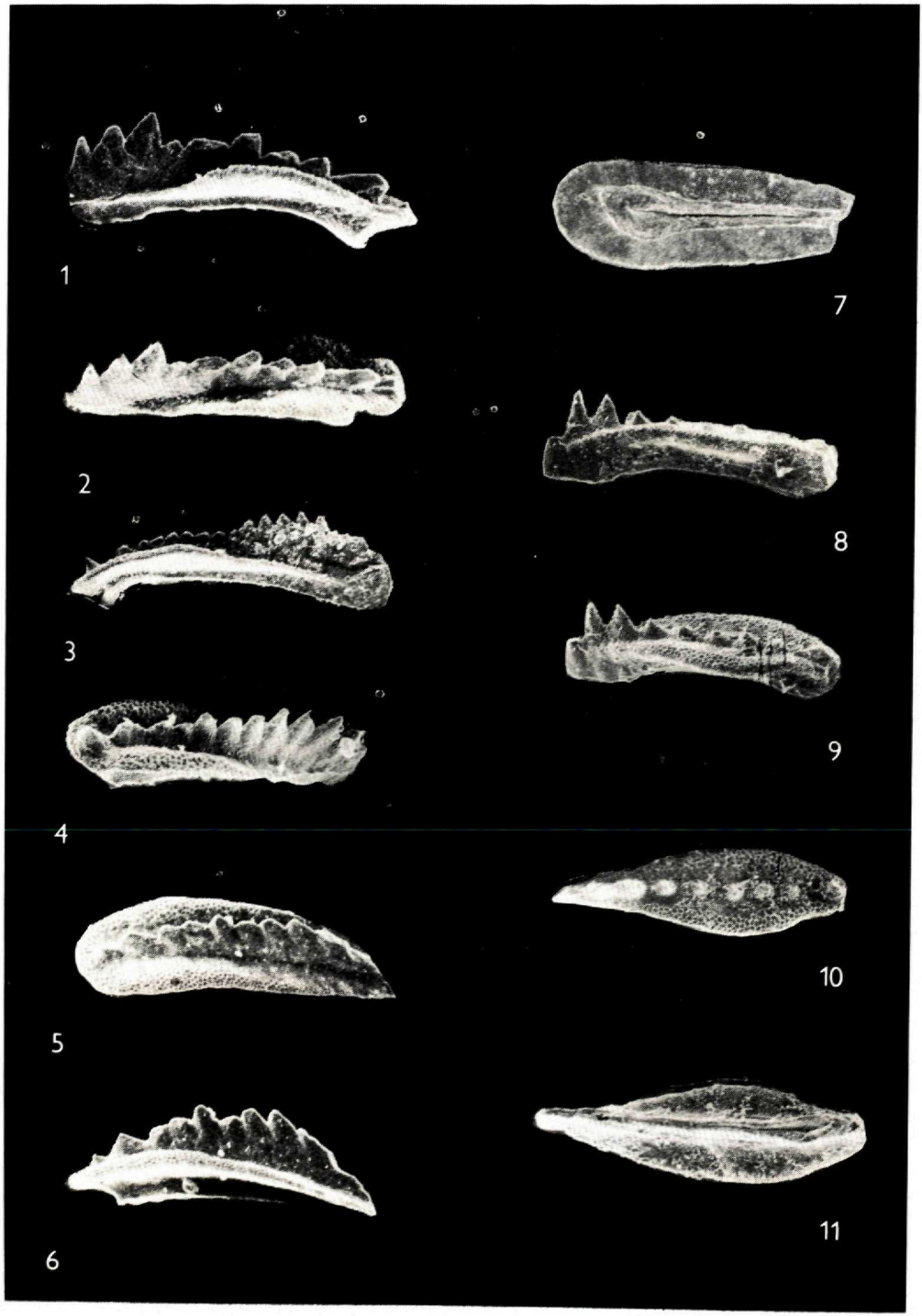
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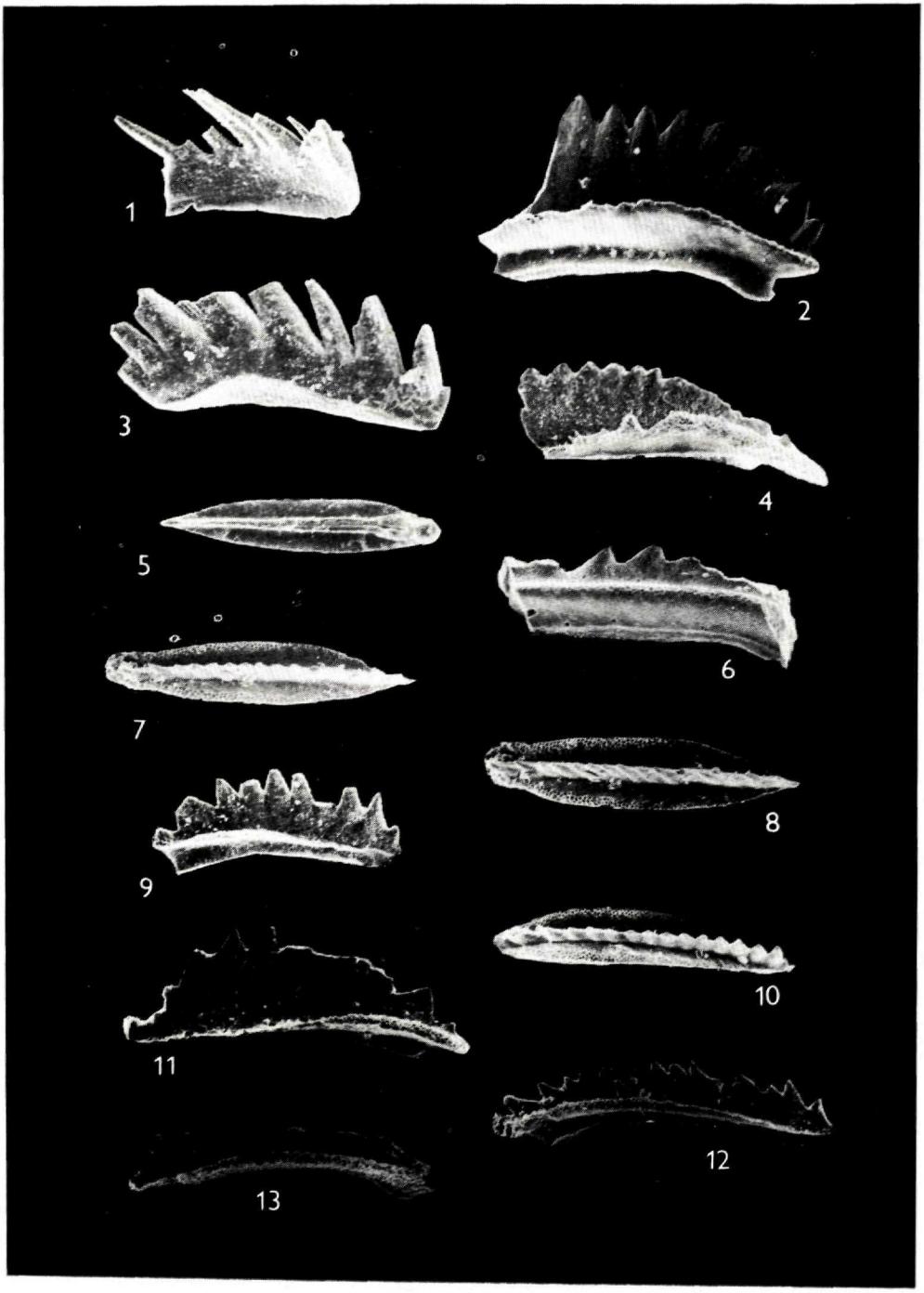
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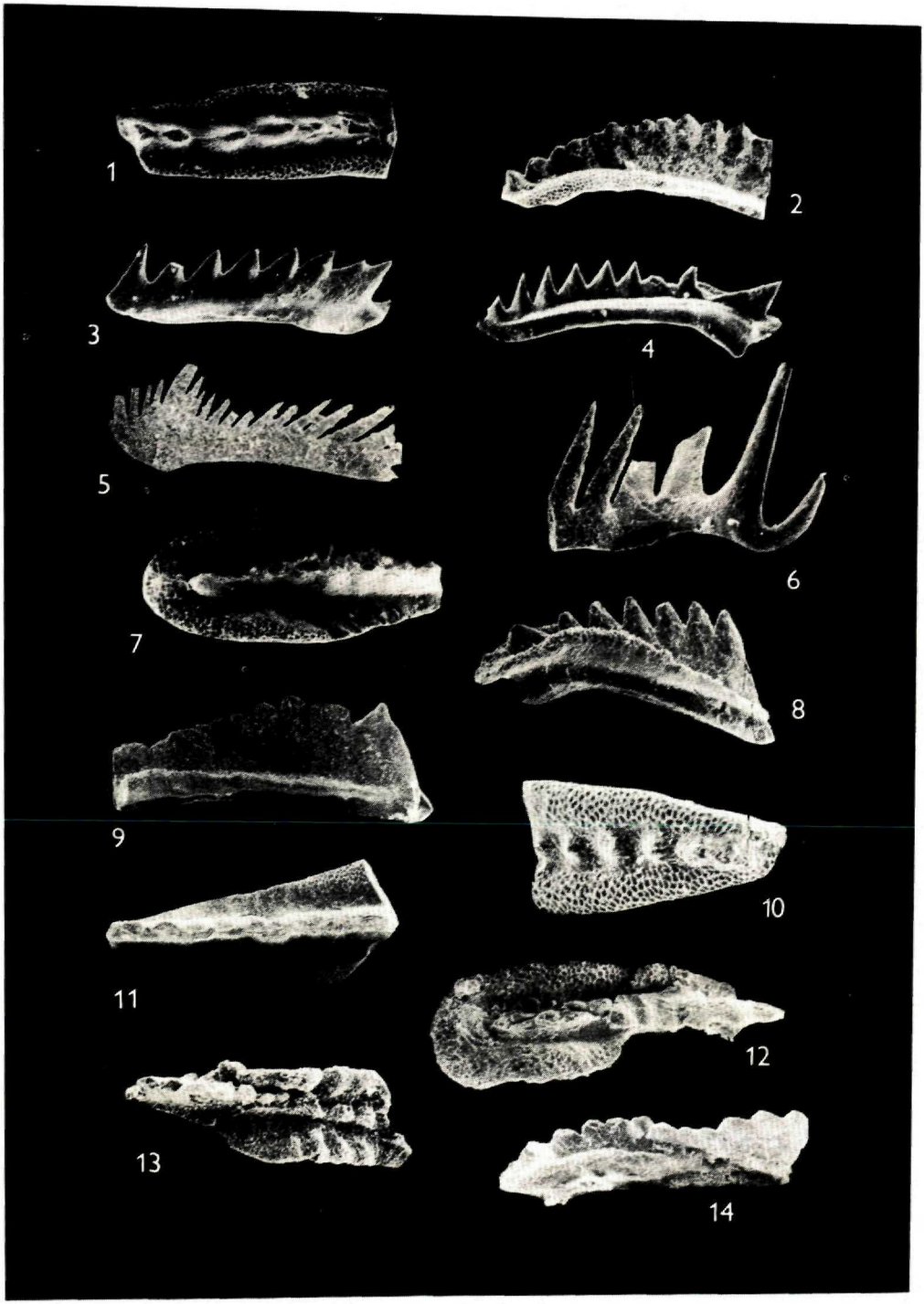
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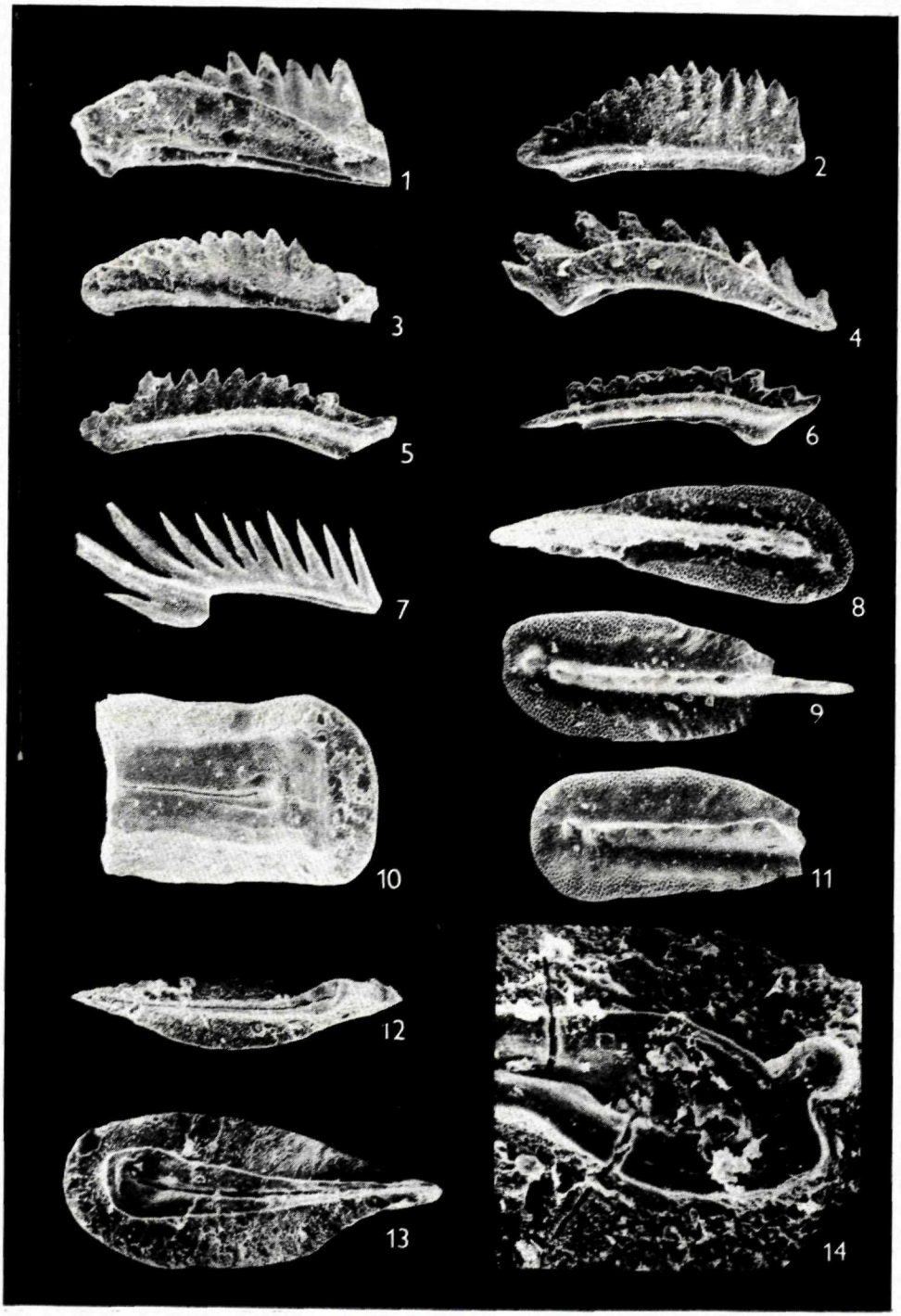
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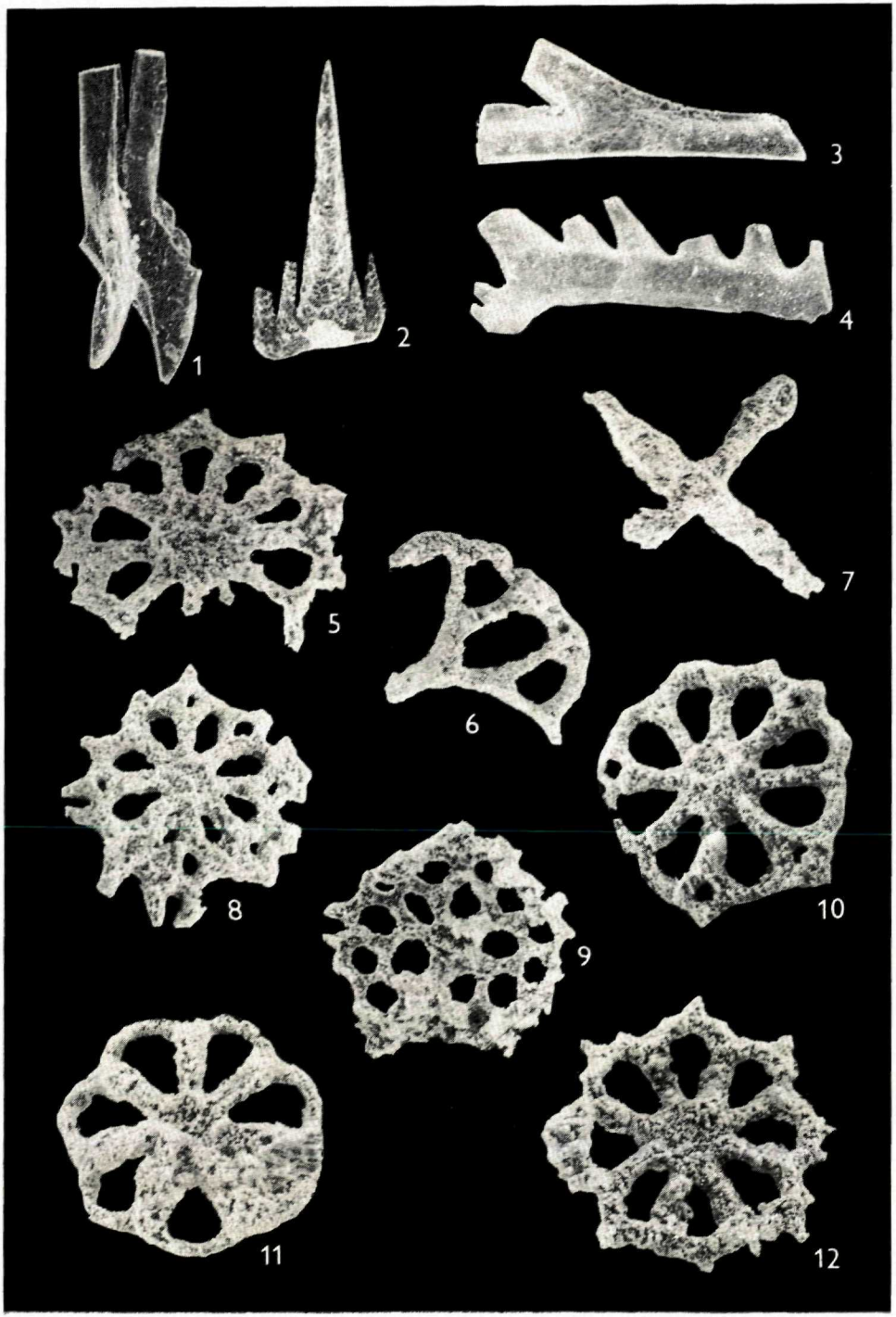
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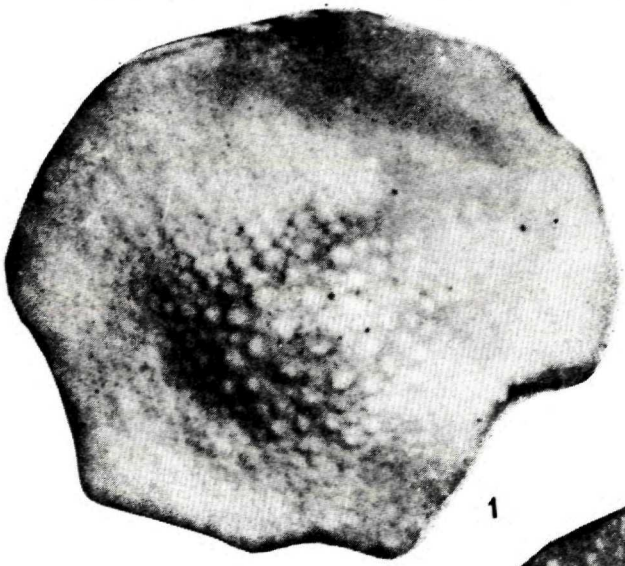

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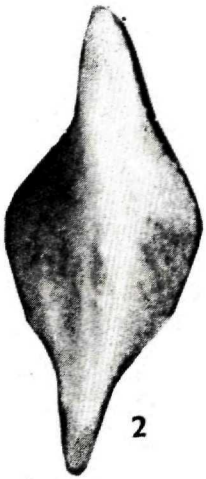

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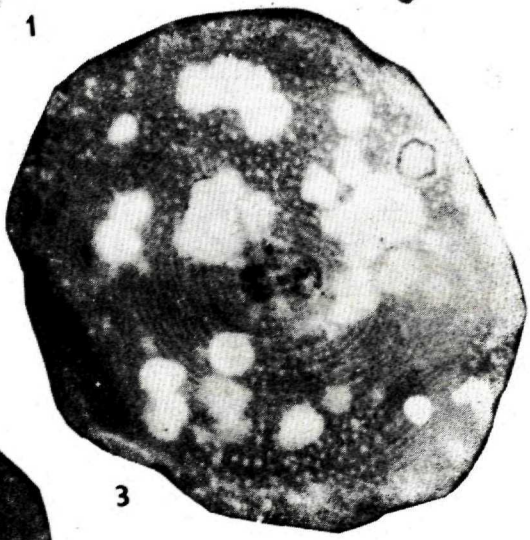

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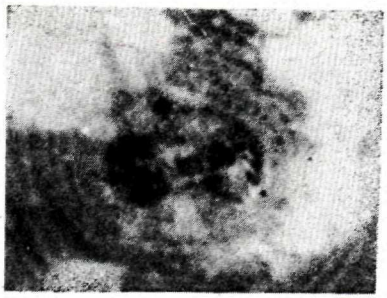

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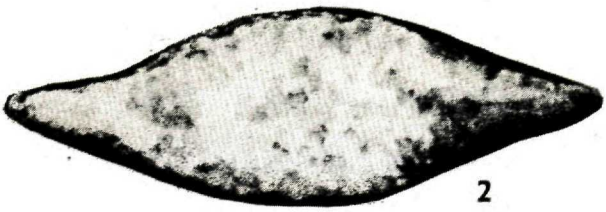

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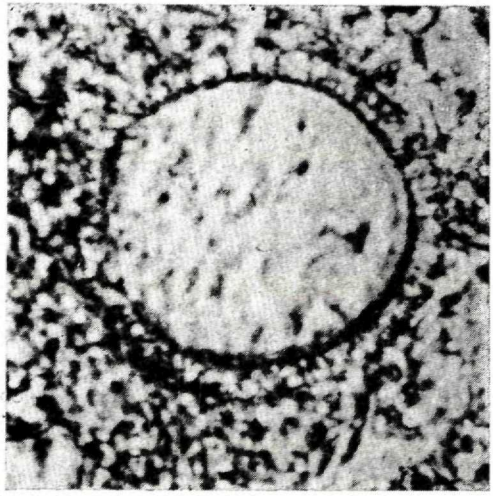

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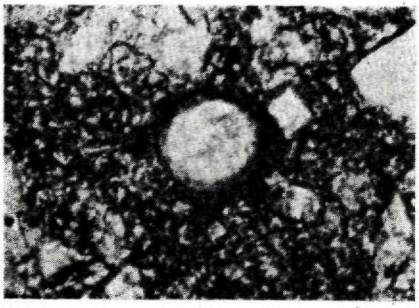

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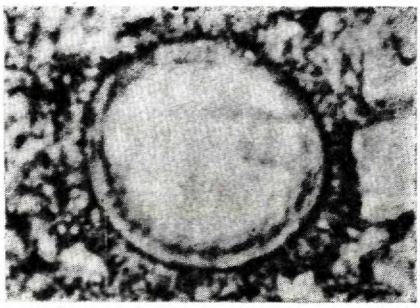

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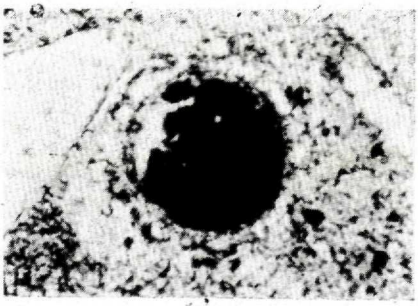

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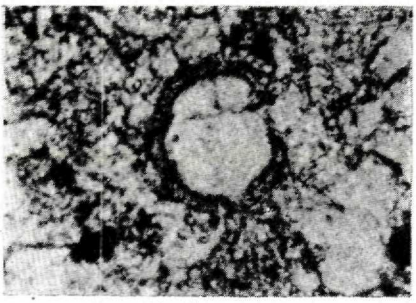

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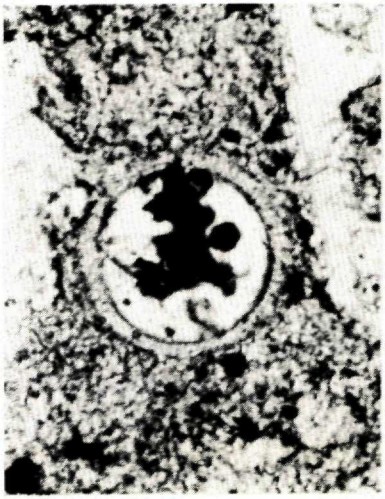

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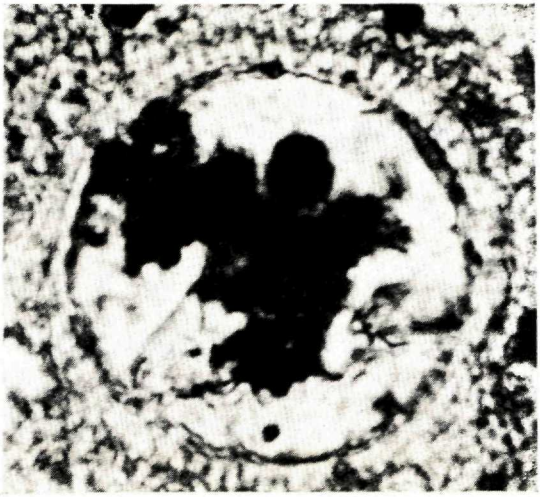

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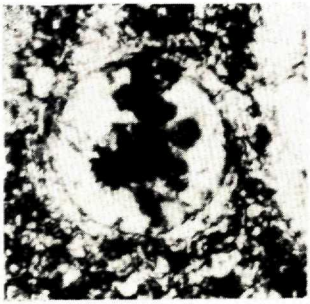

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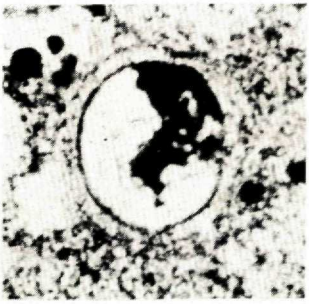

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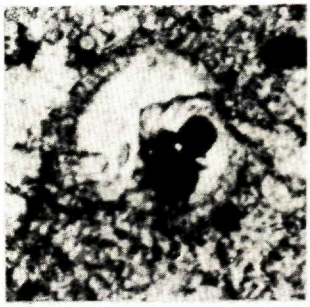

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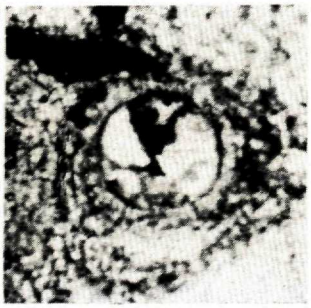

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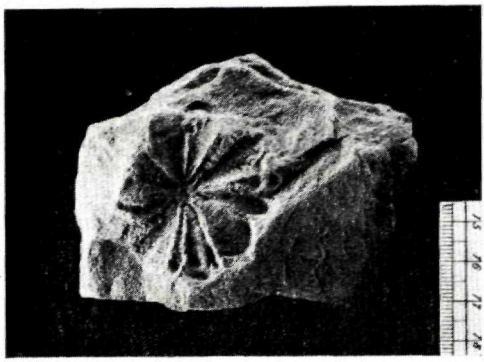

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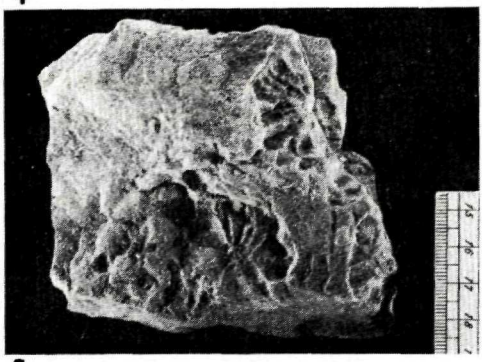

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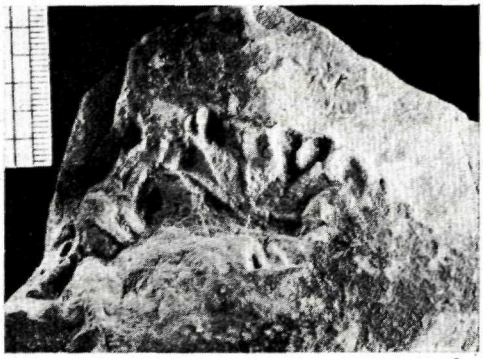

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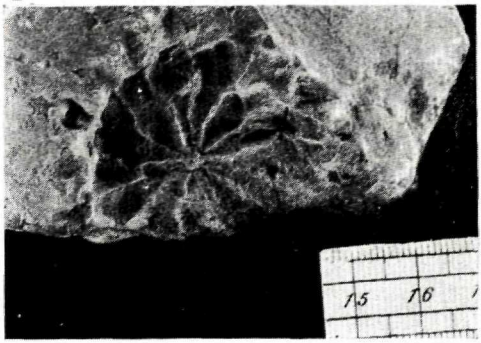

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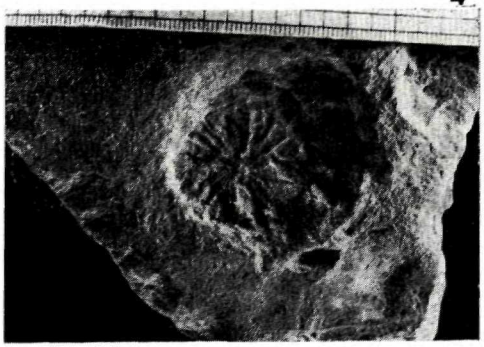

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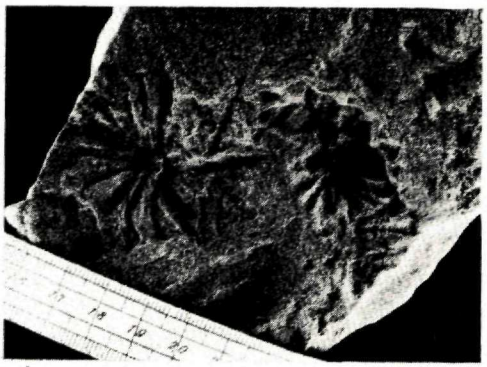

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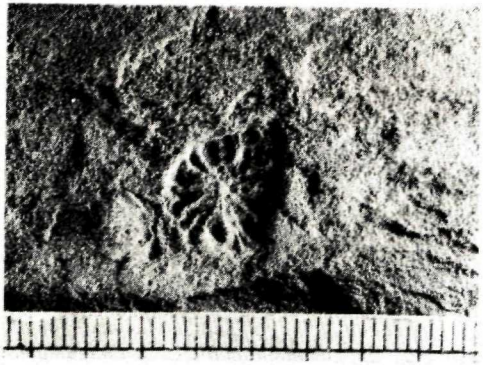

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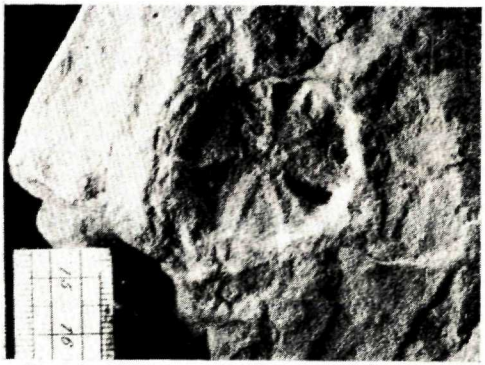

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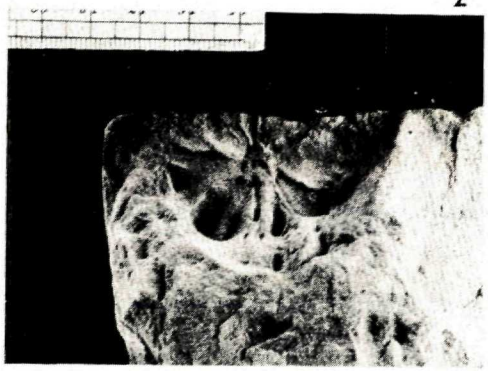

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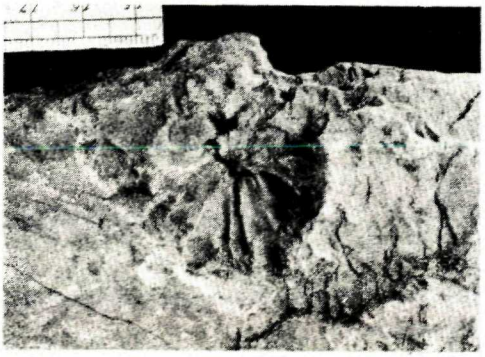

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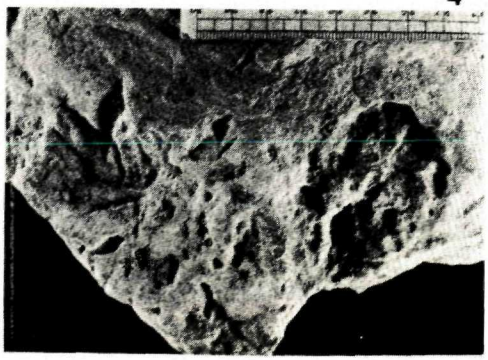

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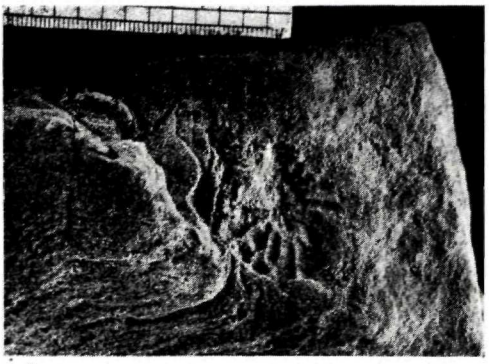

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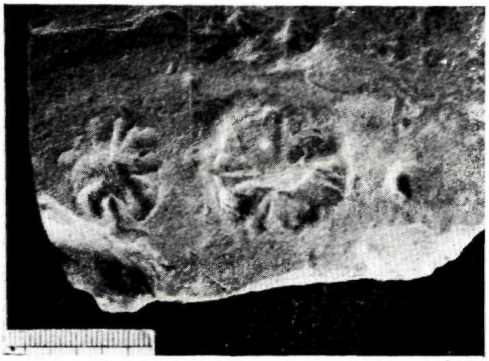

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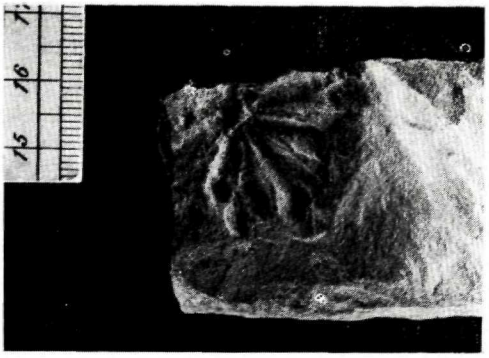

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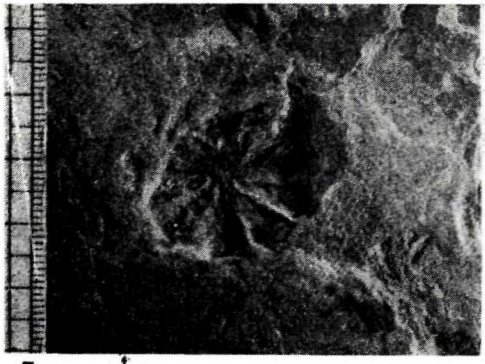

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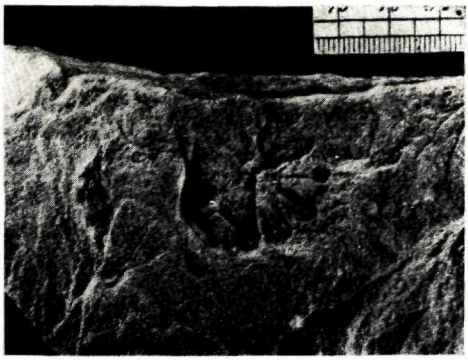

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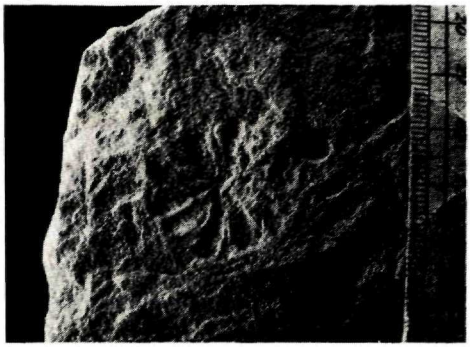

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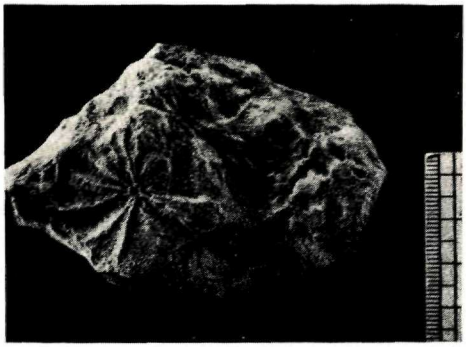

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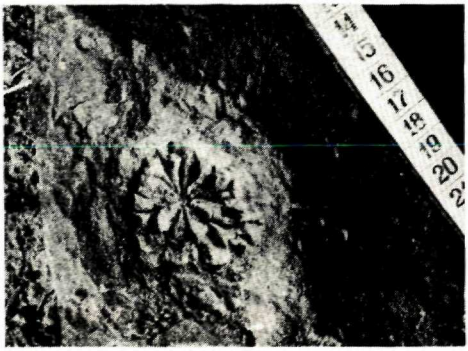

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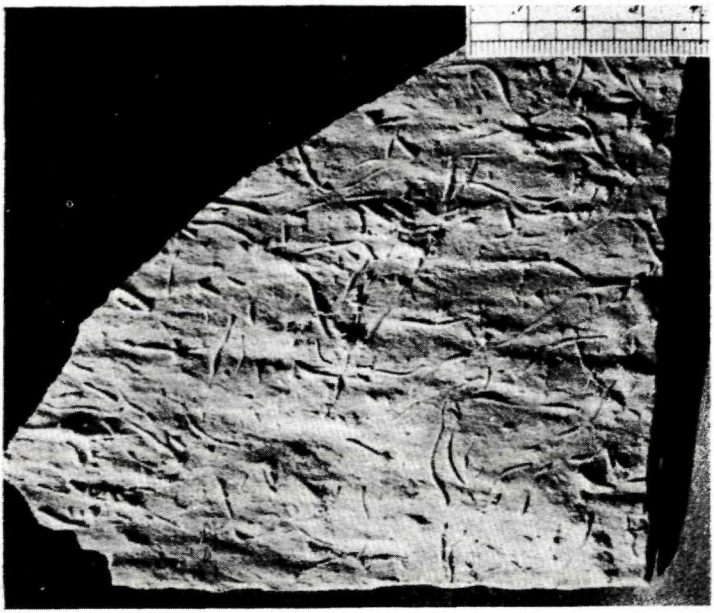

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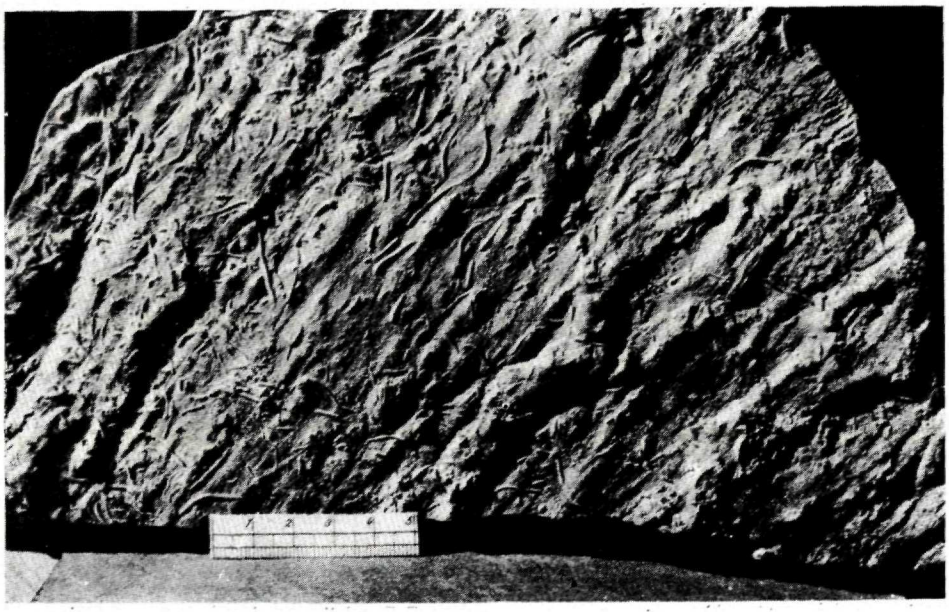

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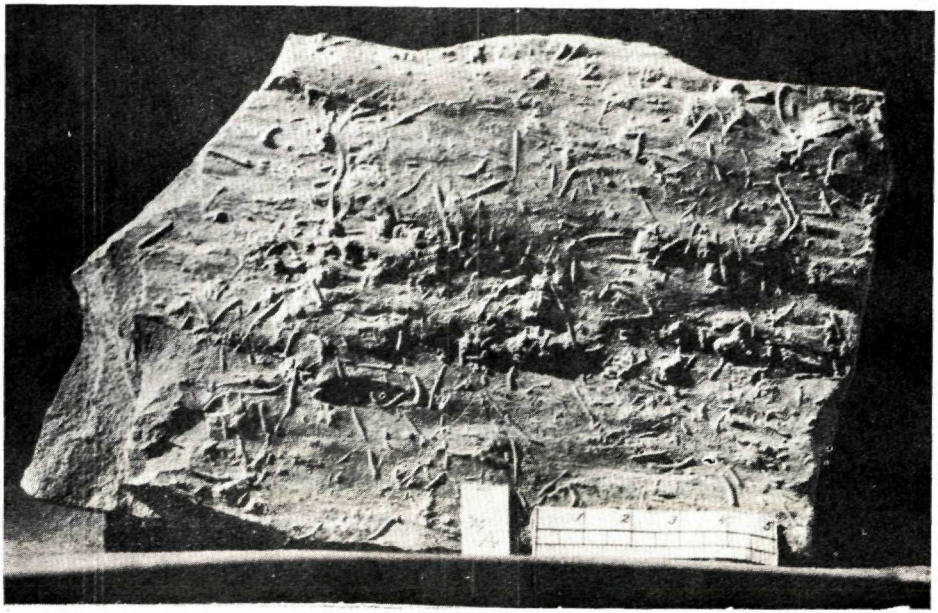

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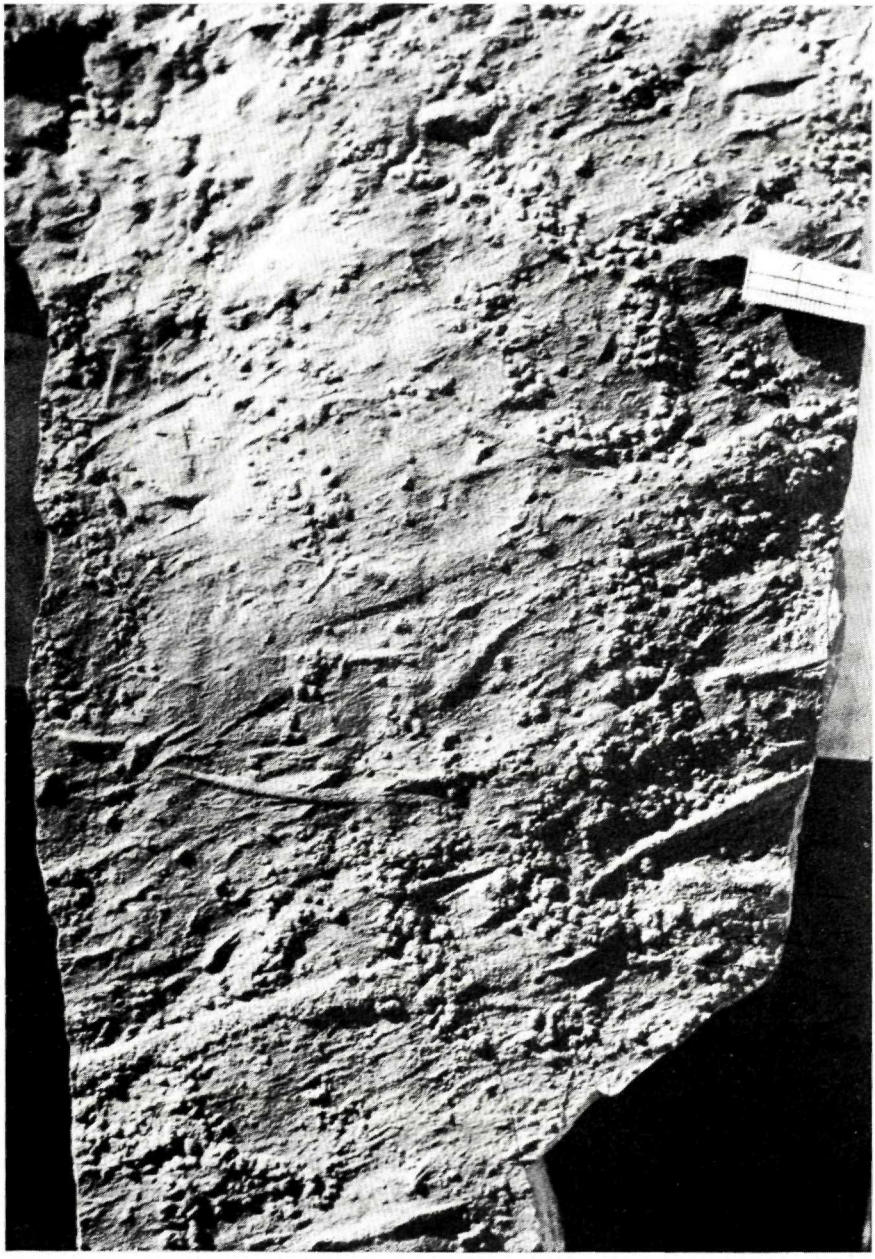

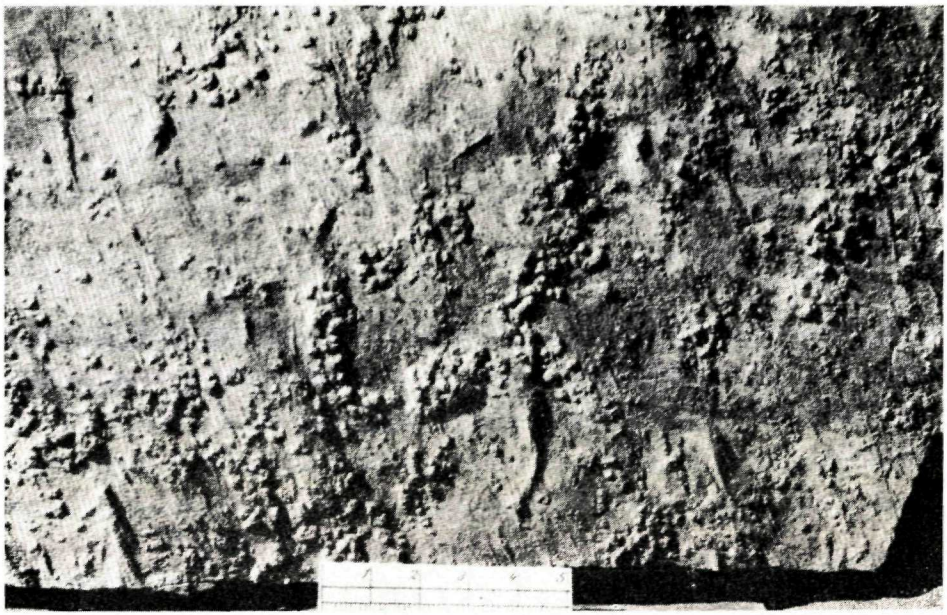

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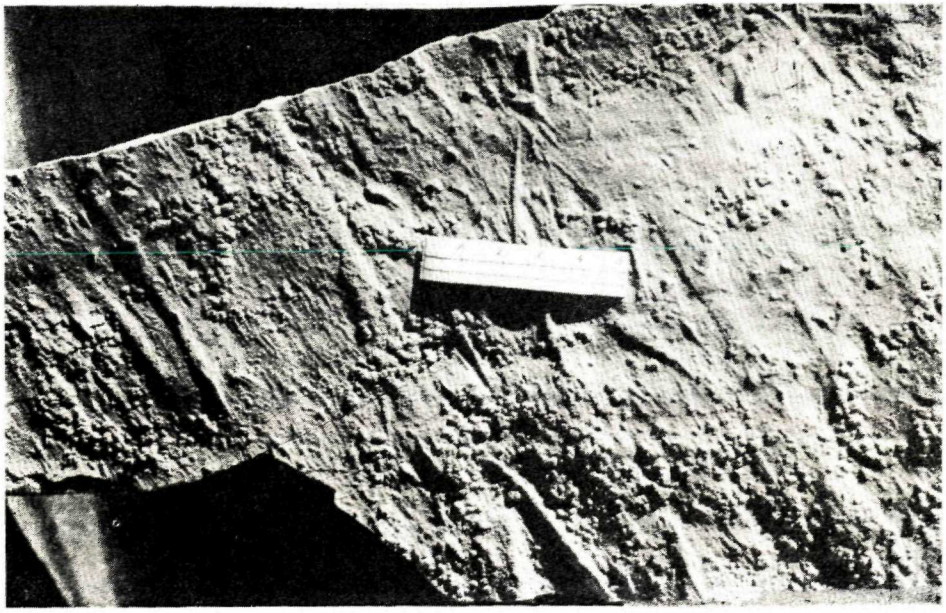

2

ZÁPADNÉ KARPATY
SÉRIA
paleontológia 9

Vydal Geologický ústav Dionýza Štúra vo vydavateľskom oprávnení Vedy, vydavateľstva Slovenskej akadémie vied v Bratislave v roku 1984

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