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Microfossils of the Cieszyn Beds (Silesian Unit, Polish Outer Carpathians) — a thin sections study

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Abstract: Indurated sediments of the Cieszyn Beds (hard marls and limestones) contain abundant microfossils important for stratigraphy and paleoenvironmental interpretation of the subdivision. Tintinnid associations can be attributed to zones: *Chitinoidella*, *Crassicollaria*, *Calpionella alpina*, *Calpionella elliptica*, *Tintinopsella*. Within calcareous dinocysts the local acme *pulla*, *malmica*, *fortis*, *wanneri* and *echinata* zones have been recognised. Both kinds of microfossils suggest for the investigated sediments the Tithonian–Early Hauterivian age. Foraminifera observed in indurated sediments represent population of the shallow water carbonate environment of the southern edge of the European platform extending from the South France to the Crimea.

Key words: tintinnids, calcareous dinocysts, shallow water foraminifera, Cieszyn Beds, Outer Carpathians.

Abstrakt: Twarde margle i wapienie warstw cieszyńskich polskich Karpat zewnętrznych zawierają liczne mikroskamieniałości ważne dla stratygrafii i interpretacji paleośrodowiskowej. Występujące tintinnidy można odnieść do regionalnych poziomów: *Chitinoidella*, *Crassicollaria*, *Calpionella alpina*, *Calpionella elliptica* oraz *Tintinopsella*. W zespołach wapiennych dinocyst rozpoznano lokalne poziomy: acme *pulla*, *malmica*, *fortis*, *wanneri* i *echinata*. Powyższe mikroskamieniałości określają dla badanych utworów wiek jako tyton–wczesny hoteryw. Otwornice obecne w badanych utworach reprezentują formy płytkowodne środowiska węglanowego południowej krawędzi platformy Europejskiej, znane od południowej Francji po Krym.

Słowa kluczowe: tintinnidy, wapienne dinocysty, płytkowodne otwornice, warstwy cieszyńskie, Karpaty zewnętrzne.

INTRODUCTION

The origin of the Outer Carpathians basin is related to the Neo-Cimmerian deformations of the Alpine orogeny. The basin developed between the SE margin of the European platform (the Bohemian Massif) and the mouth of the Polish through (Michalík *et al.*, 1991; Michalík, 1994). The earliest sediments occur in the western part of the basin between the state border and the valley of the Soła river (Fig. 1). These sediments referred as "the Cieszyn Beds" (the Cieszyn series) described in the 19th century (*vide* Świdziński, 1948), were separated into three subdivisions: the Lower Cieszyn Shales, the Cieszyn Limestones and the Upper Cieszyn Shales (Bieda *et al.*, 1963). The subdivisions differ in lithology, sedimentary character, origin and age. Their sedimentation spanned the terminal Jurassic–ear-

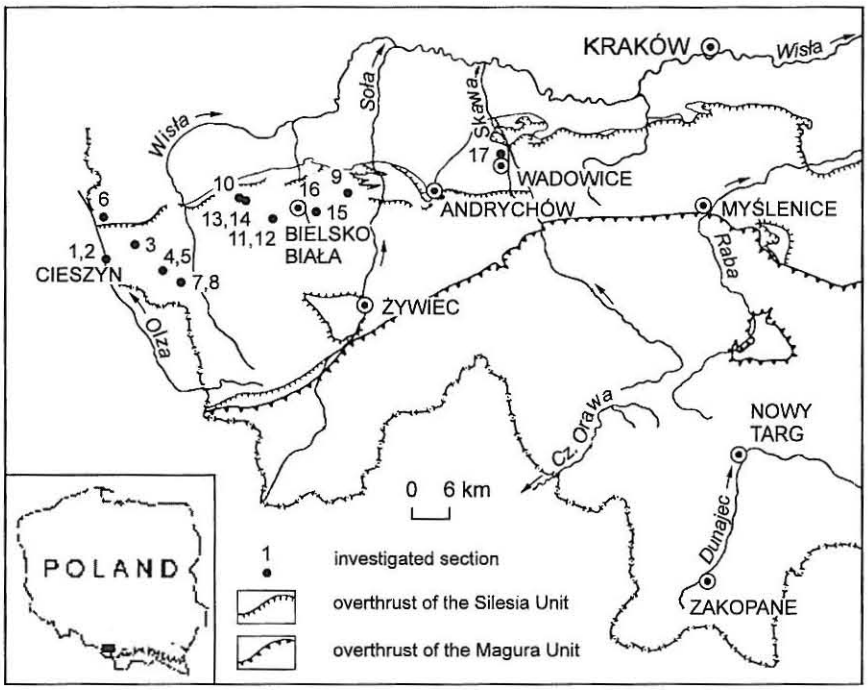

Fig. 1. Location of the investigated sections (partly after Nowak, 1968)

liest Cretaceous. The Cieszyn Beds are overlaid by the Hauterivian–Early Aptian Grodziszcze Beds.

Due to their unique status (the earliest sediments of the basin) the Cieszyn beds were the subjects of numerous investigations. Extended geological characteristics of the Cieszyn Beds are described by Peszat (1967), Eliaš (1970), Książkiewicz (1971), Nowak (1973), Mišík (1974), Eliaš, Eliašova (1984), Malik (1986), Słomka (1986a, b), Matyszkiewicz, Słomka (1994).

The macrofossils were studied by Zejszner (1846), Uhlig (1901), Gąsiorowski (1961), Morycowa (1964) and Szymakowska (1981). Trace fossils were studied by Książkiewicz (1977). Foraminifera were the subject of a study by Geroch (*In*: Bieda *et al.*, 1963; Geroch, 1966; Geroch *et al.*, 1967, Bielecka, Geroch, 1977), Olszewska (1984, 1990 *In*: Geroch, Olszewska, 1990), Szydło (1999, 2003, 2004; Szydło, Jugowiec, 1999). Tintinnids and calcareous dinocysts were studied by Nowak (1968, 1980, 1984), the calcareous nannoplankton by Radomski (1967), and Jugowiec (*In*: Szydło, Jugowiec, 1999).

The whole series is subdivided into three subdivisions: the Lower Cieszyn Shales, the Cieszyn Limestones and the Upper Cieszyn Shales. The Lower Cieszyn Shales recognised for the first time by Hohenegger (*vide* Świdziński, 1948) are developed as rather soft, coarsely splitting, marly, dark shales. The lower boundary of the subdivision is tectonic. Exotics bearing layers are typical for the upper part of the subdivision. Their origin is related to the Neocimmerian tectonic phase (Nowak, 1964). The Cieszyn Limestones recognised by Pusch (Świdziński, *op. cit.*) constitute the first turbidite sequence of the Flysch Carpathians. They are composed of pelitic and detrital marls intercalated by marly shales. The thickness of the Cieszyn Limestones increases towards the south, where a hypothetical sediment source area was located (Malik, 1986). The Upper Cieszyn Shales recognised by Hohenegger (*vide* Świdziński *op. cit.*) display typical clayey turbidites with alternating layers of shales and sandstones. Characteristic for the subdivision is the occurrence of sphaerosyderitic layers and the veins of magmatic rocks referred as teschenites (Geroch, Nowak, 1980).

Frequent and extended studies did not, however, produce a consistent view of the origin and age of the discussed subdivision. The presumed deep-water origin of the series kept the geologists preoccupied with the study of the turbidite sedimentary environments and deep basin biotas. Studies of the carbonate shallow water sediments that contributed to the origin of the Cieszyn Beds were largely neglected. The rich and diversified organic life of the shallow water environment reflected in abundant bioclasts of the detrital layers is much less known. The present paper is meant to add some new data to the stratigraphical and paleoenvironmental interpretation of the Cieszyn Beds. It is based on the investigations of the thin sections made from the indurated parts of the Cieszyn Beds, mainly pelitic and detrital limestones in which shallow water fossils are common.

MATERIAL AND METHODS

Over 300 thin sections from the 18 surface sections and boreholes (Fig. 1) have been investigated. The majority of the thin sections come from the collection of the late W. Nowak stored in the Carpathian Branch of the Polish Geological Institute. Samples from localities: Nowa Marglownia, Hałcnów, Witanowice were kindly supplied by K. Malik (Silesian University, Sosnowiec), those from localities Olza and Cisownica by P. Nescieruk (PGI Carpathian Branch). Samples from the Cieszyn IG 1, Zamarski PIG 1, and Bielowicko IG 1 boreholes were kindly supplied by Z. Buła (PGI Upper Silesian Branch). In other cases thin sections were cut from the samples previously used by the author for other projects.

The thin sections were examined under the Labophot 2-pol Nikon polarising microscope. The photos of the microfossils were taken with the aid of the Nikon photomicrographic attachment Microflex HFX-DX.

About 16 species of tintinnids, 27 species of the calcareous dinocysts and 39 species of predominantly shallow water foraminifera have been recognised and described. Many foraminiferal species are reported for the first time from the Flysch Carpathians.

THE MICROPALEONTOLOGICAL CHARACTERISTIC OF THE INVESTIGATED SECTIONS (LOCALITIES)

1. Olza. The Lower Cieszyn Shales and the Cieszyn Limestones outcrop along the right bank of the river Olza in the town of Cieszyn. The Cieszyn Beds in this section contain several olistostromal complexes that make proper stratigraphical interpretation of succesive samples difficult. For the purpose of the study only samples from the undisturbed part of the Cieszyn Limestones were examined. The more fine grained grainstones contained predominatly tintinnids and the calcareous dinocysts. Among the former the numerous *Calpionella alpina* Lorenz and single *Calpionella elliptica* Cadish were recognised suggesting the Middle Berriasian age for this part of the section. The calcareous dinocysts assemblage consisted of: *Cadosina minuta* Borza, *Colomisphaera tenuis* (Nagy), *C. vogleri* (Borza), *Colomisphaera heliosphaera* (Vogler) and *Crustocadosina semiradiata* (Vogler). The coarse grained packstones contained foraminifera typical for the shallow water carbonate environment: *Palaeogaudryina magharaensis* Said & Bakarat, *Gaudryinella hannoverana* Bartenstein & Brand, *Protopeneroplis ultragranulata* (Gorbatchik), *Valvulina alpina* Dragastan, *Trochammina neocomiana* Mjatliuk, *Andersenolina histeri* Neagu, *A. alpina* (Leupold), *Siphovalvulina variabilis* Septfontaine, *Protomarssonella kummi* (Zedler), *P. hechti* (Dieni & Massari), *Pseudomorulaeplecta franconica* (Gümbel), *Belorussiella* cf. *taurica* Antonova, *Charentia evoluta* (Gorbatchik), *Pfenderina* cf. *aureliae* Neagu, and *Istriloculina terekensis* Matsieva & Temirbekova. Species with arenaceous tests such as *Pseudoreophax cisovnicensis* Geroch, *Glomospira variabilis* (Kübler & Zwingli), *Trochammina neocomiana* Mjatliuk are rare. Fragments of calcareous algae: *Carpathocodium anae* (Dragastan), *Clypeina* sp., and mikroproblematika (*Tubiphytes* sp.) are common.

In the upper part of the section the number of shale intercalations increases and the Cieszyn Limestones pass into the Upper Cieszyn Shales.

2. Góra Zamkowa (Fig. 2). The marly shales and platy limestones outcropping at the west slope of the Góra Zamkowa hill in the town Cieszyn were sampled and investigated by Nowak (1965). Originally described as the Lower Cieszyn Shales and referred to Kimmeridgian yielded representatives of the genus *Calpionella* which made Nowak (1967) assign them to the Late Tithonian–Berriasian, and regard them as "specific facies" of the Cieszyn Limestones. Recent investigations of over 40 thin plates confirmed the presence of *Calpionella* already in the lowest samples suggesting that the strata are not older than the latest Tithonian (the upper part of the *Crassicollaria* Zone). The presence of *Calpionella elliptica* Cadish about 2 m above the base of the typical Cieszyn Limestones indicates the Middle Berriasian age instead of the Upper Tithonian for this part of the section. The top of the section (Lower Valanginian) is marked by the presence of numerous *Tintinnopsella carpathica* (Murgeanu & Filipescu) rare *Remaniella filipescui* Pop and *Calpionellopsis simplex* (Colom) both known in the Western Carpathians from the Middle Berriasian (Reháková, 1998). The calpionellid assemblage is composed predominatly of *Calpionella alpina* Lorenz, *C. elliptalpina* Nagy, rare *C. elliptica* (Cadish), *Crassicollaria intermedia* (Durand Delga), *C. massutiniana* (Colom), *C. brevis* Remane, *Tintinopsella subacuta* (Colom).

Frequent calcareous dinocysts are represented by *Crustocadosina semiradiata* (Wanner), *Colomisphaera lucida* Borza, *C. carpathica* (Borza), *Cadosina minuta* Borza, *Stomiosphaera* cf. *wanneri* Borza. In the upper part of the section

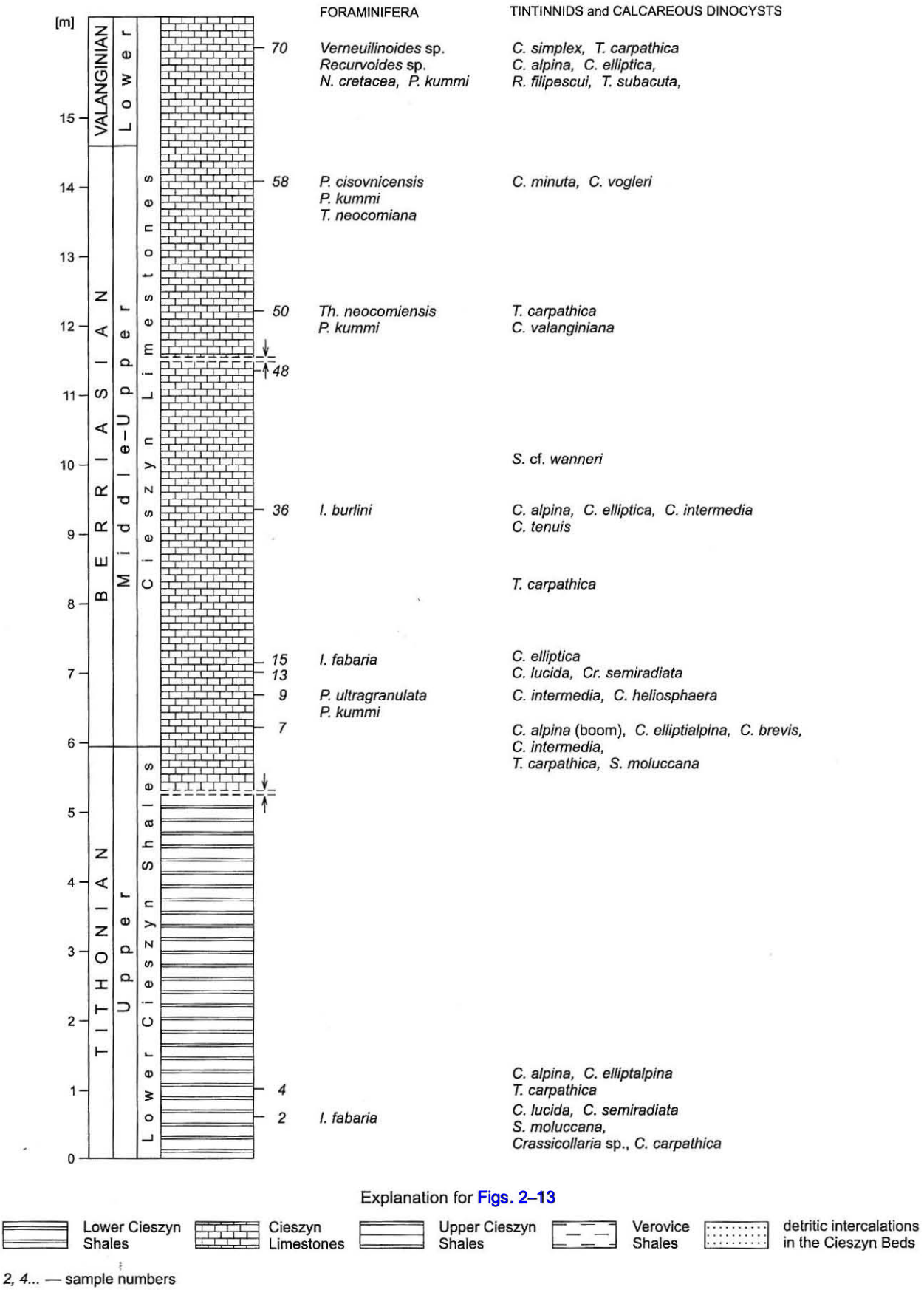

Fig. 2. Distribution of microfossils in the Góra Zamkowa section (lithology after Nowak, 1971, modified)

appear Valanginian–Hauterivian forms: *Carpistomiosphaera valanginiana* Borza and *Colomisphaera vogleri* (Borza). Foraminifera are rare in this section. The assemblage consists of: *Protomarssonella kummi* (Zedler), *Protopeneroplis ultragranulata* (Gorbatchik), *Istriloculina fabaria* Matsieva & Temirbekova, in the lower part of the section and *Thalmannammina neocomiensis* Geroch, *Pseudoreophax cisovnicensis* Geroch, *Nautiloculina cretacea* Peybernes in the upper part. Abundant sponge spicules are characteristic components of the microfossil assemblages. The predominance of sponge fragments over tintinnids and calcareous dinocysts (the open sea elements) may suggest proximity to the sponge biostrome that supplied debris to the basin.

3. Gumna (Fig. 3). The well known outcrop in Gumna is situated at the point where the side road to the village Dębowiec crosses with the main road Cieszyn–Skoczów. In the outcrop the Lower Cieszyn Shales are developed as the grey, soft, nonbedded, marls with several thin layers of detrital limestones (Geroch *et al.*, 1967; Bielecka, Geroch, 1977 and author's studies). Foraminifera from the washed samples were very diverse. Characteristic were: *Melathrokerion spirialis* Gorbatchik, *Palaeogaudryina varsoviensis* (Bielecka & Pożaryski), *Praedorothia praehauteriviana* (Dieni & Massari), *Vaginulinopsis embaensis* (Fursenko & Poljenova), *Tristix temirica* Dain, *Planularia poljenovae* Kuznetsova, *Lenticulina dogieli* Fursenko, *Trocholina solecensis* Bielecka & Pożaryski and *Pseudolamarckina polonica* Bielecka & Pożaryski, *Ichnusella burlini* (Gorbatchik) and *Epistomina caracolla* (Roemer).

Thin sections revealed the grainstone texture of the investigated sediments. The microfossil assemblage was composed of calcified radiolarians, sponge spicules, juvenile stages of ammonites and rare foraminifera, among others: *Mesoendothyra izjumiana* Dain, *Nautiloculina oolithica* Mohler, *Siphovalvulina variabilis* Septfontaine, *Uvigerinammina uvigeriniformis* Seibold & Seibold, *Textularia densa* Hoffman, *Coscinophragma cribrosa* (Reuss) and others. Among the calcareous dinocysts occur: *Stomiosphaera moluccana* Wanner, *Crustocadosina semiradiata* (Wanner) and *Cadosina fusca* Wanner, *Colomisphaera radiata* (Vogler), rare *Carpistomiosphaera borzai* (Nagy) and *Parastomiosphaera malmica* (Borza) making typical Early Tithonian assemblage and others. Previous investigations revealed the presence of *Chitinoidella* sp. approximately 50 m higher in the same section (Nowak *In*: Geroch *et al.*, 1967) which may suggest that the top of the section reaches the Middle Tithonian (Reháková, Michalík, 1997).

4. Nowa Marglownia. Samples were collected by Malik (Silesian University) in the partly closed quarry Nowa Marglownia in Goleszów. The outcropping Lower Cieszyn Shales display olistostromal character (Słomka, 1986b; Malik, 1994). Foraminifera in the washed samples are poor but are characteristic for the latest Jurassic. The assemblages are composed of: *Pseudocyclammina lituus* (Yokoyama), *Vaginulinopsis embaensis* (Fursenko & Poljenova), *Palaeogaudryina varsoviensis* (Bielecka & Pożaryski), *Planularia poljenovae* Kuznetsova, *Epistomina stellicostata* Bielecka & Pożaryski, *Geinitzinita wolinensis* Bielecka, *Belorussiella wolinensis* Bielecka, *Citharina brevis* Fursenko & Poljenova and *Lenticulina infravolgensis* Fursenko & Poljenova. Thin sections revealed the presence of additional arenaceous species of foraminifera: *Paleogaudryina magharaensis* Said & Bakarat, ?*Pseudoclavulina* sp., *Textularia densa* Hoffman, *Haplophragmoides pygmaeus* (Haeussler), *Haplophragmium* cf. *inconstans* Bart. & Brand and *Mesoendothyra izjumiana* Dain. The calcareous dinocysts were represented mainly by: *Parastomiosphaera malmica* (Borza) and *Stomiosphaera moluccana* Wanner, both indicating at least an Early Tithonian age for the investigated strata.

5. Puńców. The Lower Cieszyn Shales were sampled in the stream indicated in excursion No 1 in the Geological Guide for the Western Flysch Carpathians (Unrug, 1969). The dark grey, coarse splitting, marly shales were packed with calcified radiolarians. Assemblages of foraminifera from the washed samples are similar to those previously reported. In the washed samples there occur: *Pseudolamarckina polonica* Bielecka & Pożaryski, *Vaginulinopsis embaensis* Fursenko & Poljenova, *Praedorothia praehauteriviana* (Dieni & Massari), *Belorussiella wolinensis* Bielecka, *Planularia poljenovae* Kuznetsova.

Thin sections made from the same samples revealed rare calcareous dinocysts: *Comittosphaera pulla* (Borza), *Parastomiosphaera malmica* (Borza) and *Colomisphaera radiata* (Vogler). Single representatives of the tintinnid genus *Praetintinnopsella* Borza suggest the latest Middle–earliest Late Tithonian age for the discussed section.

6. Cieszyn IG 1 (Fig. 4). The Cieszyn IG 1 bore hole was drilled through the Cieszyn Beds at different intervals between 500.0–568.0 m. The Lower Cieszyn Shales contained poor foraminiferal assemblages composed of: *Textularia densa* Hoffman, *Palaeogaudryina magharaensis* Said & Bakarat, *Paalzowella feifeli* (Paalzow) and *Planularia poljenovae* Kuznetsova. The calcareous dinocysts are represented by *Colomisphaera tenuis* (Nagy) and *C. fortis* Řehánek. The (? Upper) Tithonian age for the samples has been assumed on the basis of calcareous dinocysts.

Thin sections from the Cieszyn Limestones contained foraminifera: *Protomarssonella kummi* (Zedler), *P. hechti* (Dieni & Massari), *Istriloculina fabaria* Matsieva & Temirbekova, *Andersenolina alpina* (Leupold), *A. elongata* (Leupold), *Trochammina quinqueloba* Geroch.

Foraminifera are accompanied by calcareous dinocyst *Carpistomiosphaera valanginiana* Borza suggesting at least Late Berriasian age. The Upper Cieszyn Shales contain more arenaceous foraminifera. Washed samples yielded: *Trochammina vocontiana* Moullade, *Verneuilinoides neocomiensis* Mjatliuk, *Spirillina minima* Schacko, *Patellina subcretacea* (Cushman & Alexander). Rare calcareous dinocysts belong to species *Colomisphaera vogleri* (Borza).

7. Cisownica (Fig. 5). The section encloses the complete Cieszyn Beds outcropping in the bed of the Radoń river that traverses the village Cisownica (sampled by Nescieruk and the author). The Lower Cieszyn Shales are developed as strongly folded, grey, hard marls.

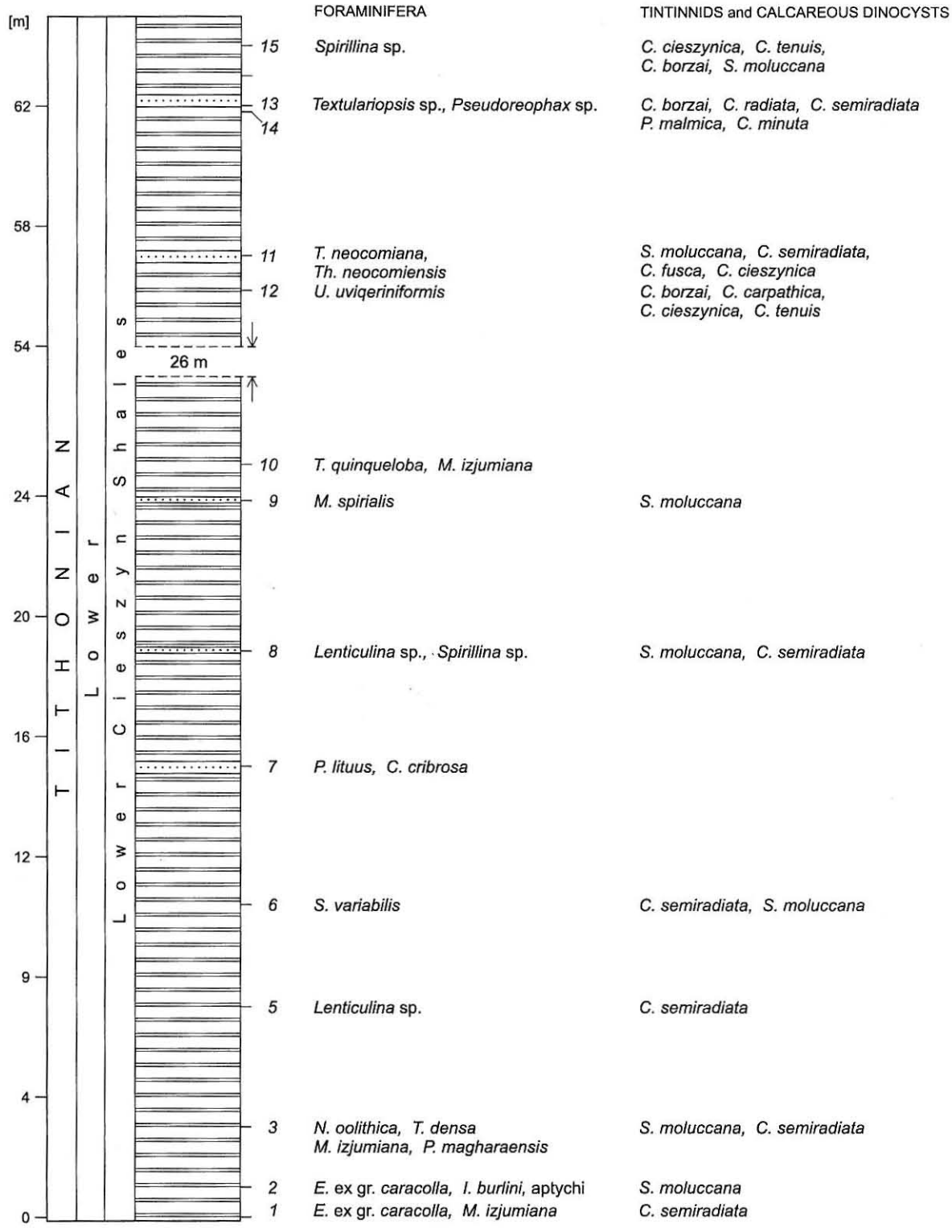

Fig. 3. Distribution of microfossils in the Gumna section (lithology after Nowak, 1976, modified)

Thin sections revealed the grainstone nature of many layers. They contained abundant calcified radiolarians, corals, echinoderms, snails, calcareous algae, foraminifera and calcareous dinocysts. Among foraminifera ?*Pseudoclavulina* sp., *Mesoendothyra involuta* Neagu, *Glomospira variabilis* Kübler & Zwingli, *Protomarssonella kummi* (Zedler), *Pseudocyclammina lituus* (Yokoyama), *Istriloculina* cf. *rectoangularia* Matsieva & Temirbekova, *Belorussiella taurica* Gorbatchik as well as early stages of *Pseudoreophax cisovnicensis* Geroch have been identified. The calcareous dinocysts

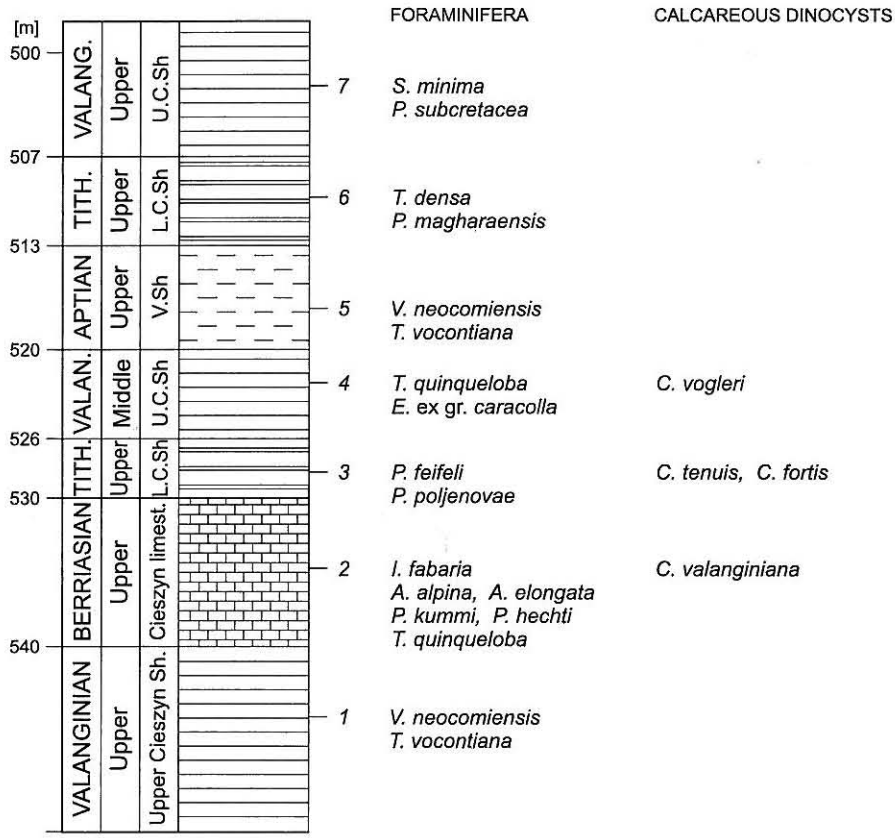

Fig. 4. Distribution of microfossils in the Cieszyn IG 1section (lithology after Bula, 1982, modified)

are represented mainly by: *Stomiosphaera moluccana* Wanner, *Comittosphaera lapidosa* (Vogler), *C. pulla* (Borza), *Colomisphaera tenuis* (Nagy), *C. fortis* Řehánek, *C. lucida* Borza, *Parastomiosphaera malmica* (Borza). Isolated sections of the hyaline tintinnids make the Late Tithonian a probable age for the subdivision.

The overlaying Cieszyn Limestones can be traced in isolated outcrops where they occur as detrital or pelitic limestones. Thin section of the detrital limestones yielded fossils typical for the carbonate environment: foraminifera — *Andersenolina alpina* (Leupold), *A. delphinensis* (Arnaud Vanneau, Boisseau & Darsac), *Textularia densa* Hoffman, *Pseudomorulaeplecta franconica* (Gümbel), *Pseudocyclammina lituus* (Yokoyama), *Charentia evoluta* (Gorbatchik) and *Decussoloculina barbui* Neagu, as well as sections of snails (*Nerinea* sp.), calcareous algae (*Actinoporella podolica* Alth) and isolated sections of tintinnids (*Calpionella alpina*). Pelitic limestones contained calcareous dinocysts such as *Comittosphaera pulla* (Borza) and *Colomisphaera radiata* (Vogler). In the uppermost part of the subdivision forms referred to *C.* cf. *conferta* Řehánek occur suggesting proximity of the Valanginian.

The washed samples from the adjacent Upper Cieszyn Shales contained very poor assemblages of predominantly arenaceous foraminifera: *Rhizammina indivisa* Brady, *Pseudoreophax cisownicensis* Geroch, *Trochammina vocontiana* Moullade and *Thalmannammina neocomiensis* Geroch. Thin sections from mudstones were devoid of fossils, those of the wackestones contained redeposited carbonate platform foraminifera: *Textularia densa* Hoffman, *Nautiloculina cretacea* Peybernes, *Siphovalvulina variabilis* Septfontaine, *Pfenderina neocomiensis* (Pfender), *P.* cf. *aureliae* Neagu, *P.* cf. *flandrini* (Moullade) and fragments of calcareous algae. Among calcareous dinocysts rare specimens of *Stomiosphaera wanneri* Borza have been spotted.

8. Cisownica–Tuł (Fig. 6). The section described and studied by Nowak (1976) was sampled along the same Radoń river in the village Cisownica. It is composed of several isolated outcrops of the Lower Cieszyn Shales and the Cieszyn Limestones.. The results of earlier studies were used for designation of the calcareous dinocyst *Parastomiosphaera malmica* Zone in the Polish Flysch Carpathians (*op. cit.*).

Both the Lower Cieszyn Shales and the Cieszyn Limestones in this section display turbiditic character of sedimentation. Thin sections from the Lower Cieszyn Shales reveal the chaotic mode of sedimentation of the subdivision predominantly composed of packstones and grainstones. Among the inorganic clasts a lithoclast of volcanic rock has been observed (rock designation of Skulich — *pers. inf.*). In the upper part of this subdivision (limestones of the Góra Tuł Member — Nowak, 1976) there occurs a characteristic slump layer. In the lowest part of the Lower Cieszyn Shales a several meter thick aptychi layer (packstone) had been found (*op.cit.*). Specific designations of the aptychi taxa — *Punctaptychus*, *Lamellaptychus beyrichi* (Oppel) — allowed to refer the assemblage to the VI-1 local zone (Gąsiorowski *In*: Nowak, 1976)

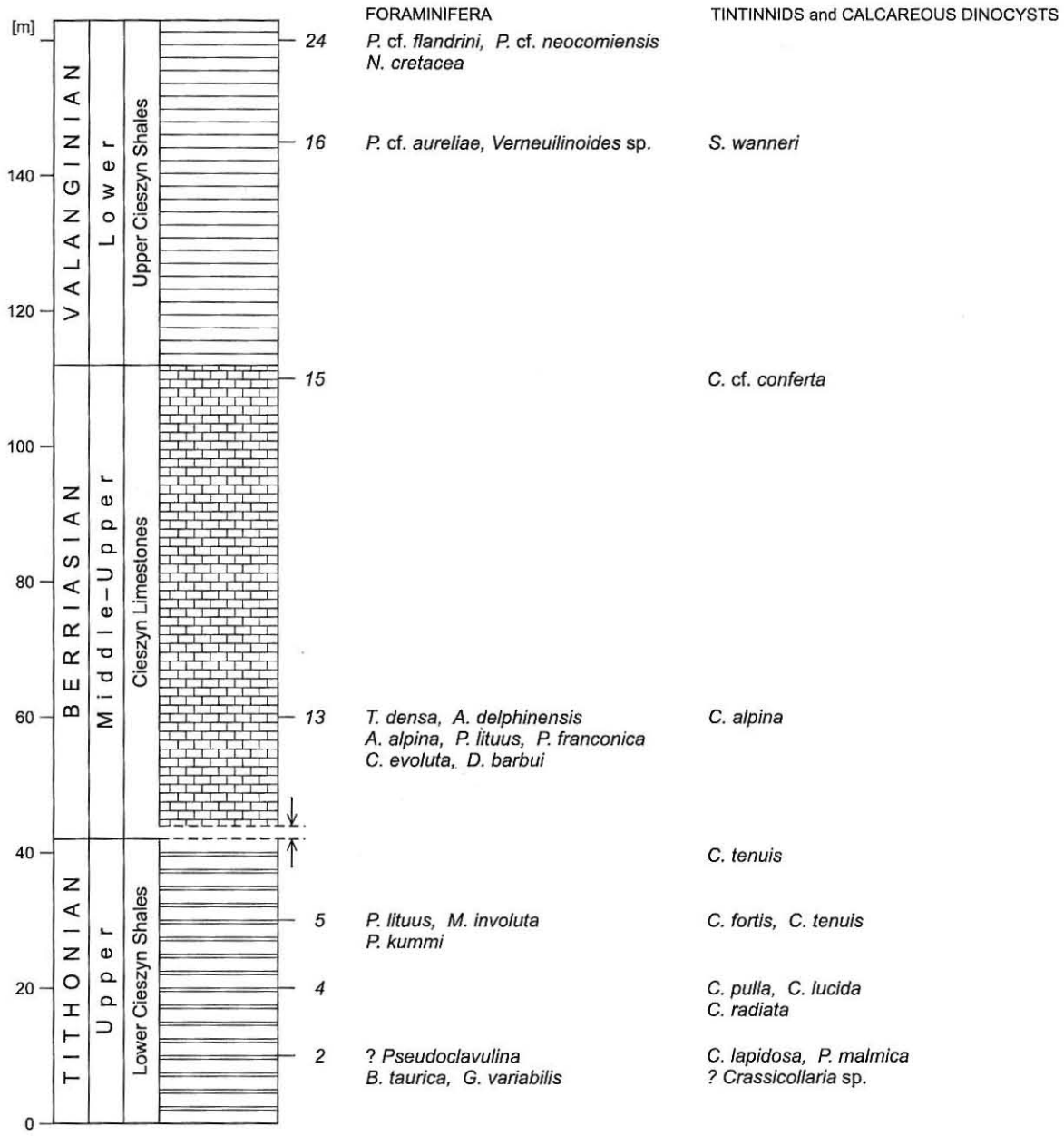

Fig. 5. Distribution of microfossils in the Cisownica section (lithology after Nescieruk, *pers. inf.*)

and assume the Late Kimmeridgian–Early Tithonian age for the lowest part of the section. However in the earlier paper (Gąsiorowski *In*: Birkenmajer, Gąsiorowski, 1961) the former author reported the same VI-1 zone aptychi assemblage in the *Calpionella* bearing strata, i.e. from at least Late Tithonian. Recent investigations of the Carpathian aptychi (Vašícek, 1996) suggest the co-occurrence of both forms rather in the Late Tithonian *Crassicollaria* Zone which makes the former age designations invalid.

Authors' investigations revealed the presence of *Chitinoidella boneti* Doben (Pl. I, Fig. 1,2) in samples collected within the aptychi layer which suggests that the earliest part of the section may correspond to the *Chitinoidella* standard Zone and is younger than the Early Tithonian (Reháková, 1995; Pop, 1997).

The dinocyst assemblage contains *Parastomiosphaera malmica* (Borza), *Comittosphaera pulla* (Borza), *Colomisphaera radiata* (Vogler), *C. ornata* Nowak, *C. tenuis* (Nagy), *C. lucida* Borza, *Carpistomiosphaera borzai* (Nagy), *C. tithonica* Nowak and *Stomiosphaera moluccana* Wanner.

Foraminiferal assemblages are composed of taxa typical for the shallow carbonate environment: *Charentia evoluta* (Gorbatchik), ?*Pseudoclavulina* sp., *Siphovalvulina variabilis* Septfontaine, *Mezoendothyra izjumiana* Dain, *Nautiloculina oolithica* Mohler, *Decussoloculina barbui* Neagu, *Quinqueloculina mitchurini* Dain and *Q. podlubiensis* Tereschuk.

It is difficult to asses the beginning of the Cieszyn Limestones because of gaps in outcrops. Those gaps, however, may not be great because the *Chitinoidella* assemblages are

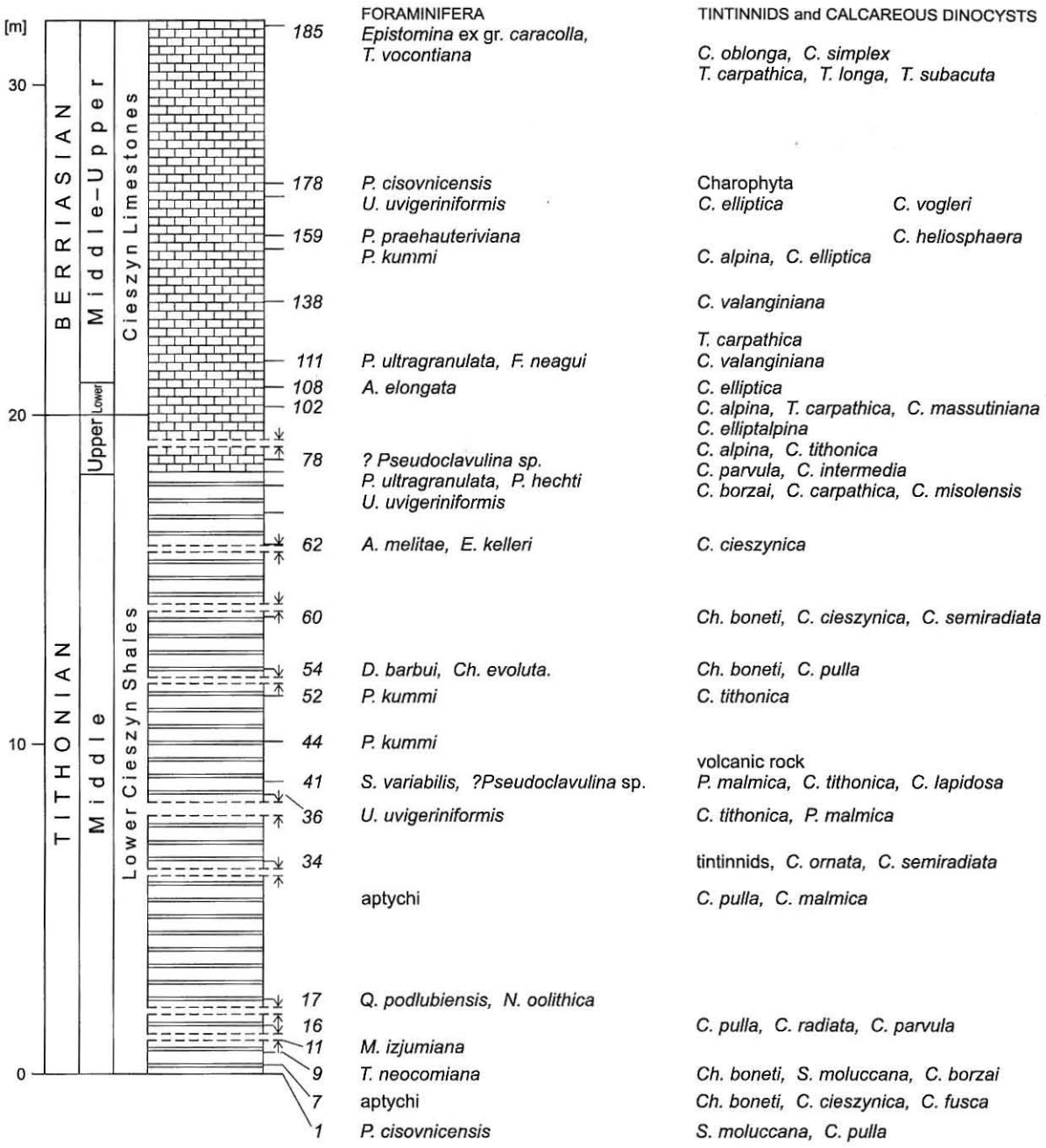

Fig. 6. Distribution of microfossils in the Cisownica–Tul section (lithology after Nowak, 1976, modified)

followed by those with numerous *Crassicollaria*: *C. intermedia* Durand Delga, *C. parvula* Remane and *C. massutiniana* Colom. They suggest the Late Tithonian age for the early part of the Cieszyn Limestones in the discussed section.

The accompanying calcareous dinocysts belong to species: *Carpistomiosphaera borzai* (Nagy), *C. tithonica* Nowak, *Crustocadosina semiradiata* (Wanner), *Colomisphaera lapidosa* (Vogler), *C. carpathica* (Borza) and *Comittosphaera misolensis* (Vogler). Foraminifera occur only in the detrital layers, and contain few new species, among others: *Protopeneroplis ultragranulata* (Gorbatchik), *Uvigerinammina uvigeriniformis* (Seibold & Seibold), *Protomarssonella hechti* (Dieni & Massari), *Trochammina neocomiana* Mjatliuk, *Arenobulimina melitae* Neagu, ?*Pseudoclavulina* sp., *Falsogaudryinella neagui* (Bartenstein), *Andersenolina alpina* (Leupold), *Neotrocholina molesta* (Gorbatchik). Fragments of algae: *Thaumatoporella parvovesiculifera* Rainieri, *Baccinella irregularis* Radoičič, *Carpathocodium anae* (Dragastan); mikroproblematics: *Koscinobullina socialis* Cherchi & Schroeder (Pl. III, Fig. 12), and annelid worm *Terebella lapilloides* Münster (Pl. III, Fig. 14) were also observed.

The next fragment of the section yielded tintinnid assemblage containing, as well as numerous *Crassicollaria* also *Calpionella alpina* (Lorenz) and *C. elliptalpina* Nagy. The occurrence of both species suggests already the Berriasian age. About 1.6 m higher *C. elliptica* Cadish appears indicating

Middle Berriasian. Towards the top of the section *Tintinnopsella carpathica* Murgeanu & Filipescu becomes the most frequent species observed. The presence of *Calpionellopsis simplex* (Colom) and *C. oblonga* (Cadish) indicates the Late Berriasian age. Simultaneously in the calcareous dinocysts assemblages *Carpistomiosphaera valanginiana* Borza and *Colomisphaera vogleri* (Borza) appear.

Minor changes are observed in the foraminiferal assemblages predominantly within detrital layers (packstones). In the very top of the section specimens of *Epistomina* sp. and *Trochammina vocontiana* Moullade has been spotted. The presence of Charophyta fragments (Clavatoracea) indicates an inner shelf environment as an occasional source of bioclastic material (**Pl. III, fig. 15**). Stratigraphically the discussed section represent the interval Middle Tithonian–Berriasian.

9. Kozy (**Fig. 7**). The middle part of the Cieszyn Limestones was sampled by Nowak (1971) in the old quarry, one of the best known outcrops of the subdivision in the Polish Carpathians. The Cieszyn Limestones are developed there as marly shales intercalating with detrital and pelitic limestones. Thin sections were made only from the pelitic limestones. Dominant microfossils are tintinnids and calcareous dinocysts. Among the tintinnids, *Calpionella alpina* Lorenz and *C. elliptica* Cadish are conspicuous. In the lower part of the section the above mentioned species are accompanied by: *Crassicollaria intermedia* Durand Delga, *C. massutiniana* (Colom), *C. parvula* Remane and *C. brevis* Remane. In the upper part of the section *Tintinnopsella carpathica* Murgeanu & Filipescu becomes more frequent. Poor dinocyst assemblage is formed by: *Colomisphaera tenuis* (Nagy), *C. lucida* Borza, *Crustocadosina semiradiata* (Wanner) and *Stomiosphaera wanneri* Borza. The latter suggests already Late Berriaisan age for the section studied.

10. Jasienica (**Fig. 8**). The section enclosed the upper part of the Cieszyn Limestones and the lower part of the Upper Cieszyn Shales sampled in the outcrops close to the town of Bielsko Biała. The Cieszyn Limestones are composed of marly shales with intercalations of the detrital and pelitic

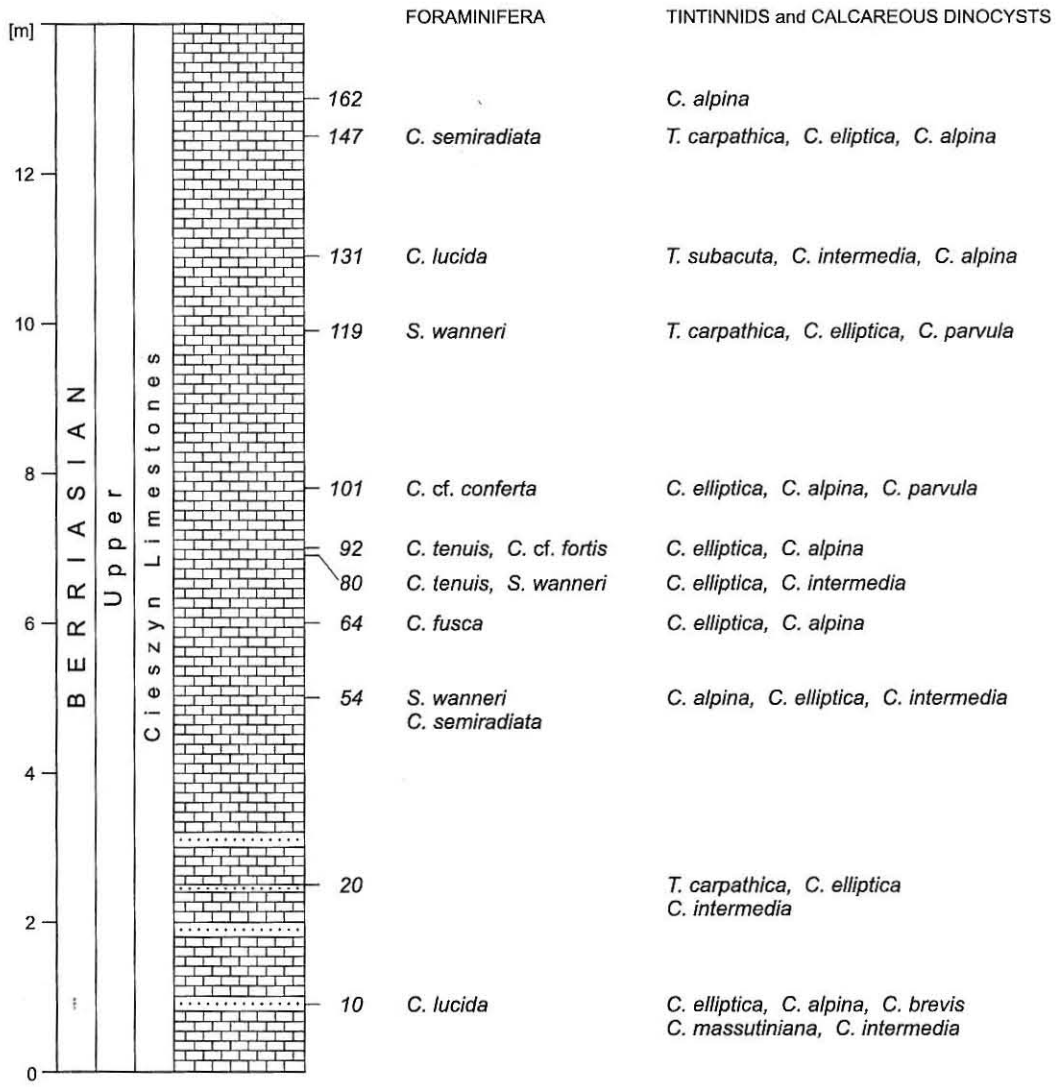

Fig. 7. Distribution of microfossils in the Kozy section (lithology after Nowak, 1971, modified)

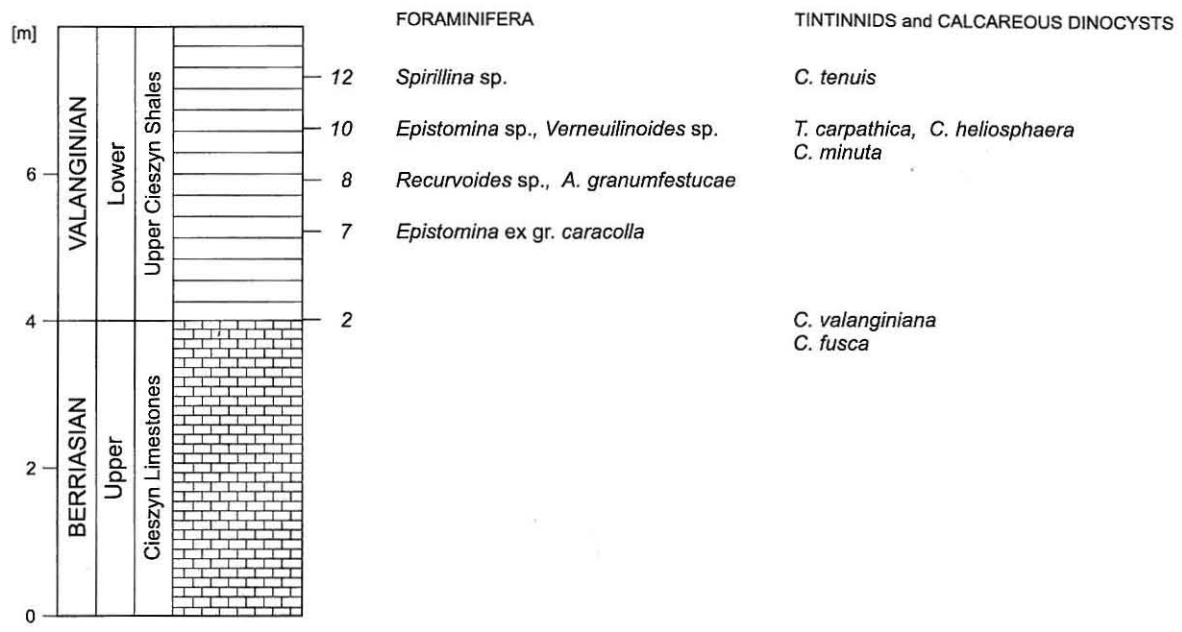

Fig. 8. Distribution of microfossils in the Jasienica section (after Nescieruk, *pers. inf.*)

limestones. No samples were taken from that subdivision. Mudstones from the Upper Cieszyn Shales contained rare foraminifera and calcareous dinocysts: *Cadosina fusca* Wanner and *Carpistomiosphaera valanginiana* Borza. Coarse grained intercalations contained, probably redeposited, foraminifera: *Protopeneroplis ultragranulata* (Gorbatchik), *Protomarssonella kummi* (Zedler), *Valvulina alpina* Dragastan, *Axiopolina granumfestucae* Neagu, ?*Pseudoclavulina* sp., rare arenaceous *Recurvoides* sp. and *Verneuilinoides* sp. and a single specimens of *Epistomina* cf. *caracolla* (Roemer) and *Spirillina* sp. Tintinnids are represented by single specimens of *Tintinnopsella carpathica* (Murgeanu & Filipescu), calcareous dinocysts by: *Cadosina minuta* Borza and *Colomisphaera heliosphaera* (Vogler). The Early Valanginian age has been assumed for the investigated part of the section.

11. Kamienica I–II (Fig. 9). The section was partly sampled in the stream traversing the village Kamienica — the top of the Lower Cieszyn Shales (olistostromal part) and in the abandoned quarry — the lower part of the Cieszyn Limestones (Nowak, 1976). Re-examination of the thin sections revealed the presence of *Calpionella alpina* Lorenz in the upper part of the Lower Cieszyn Shales dating the top of this subdivision as the latest Tithonian (not the Early Tithonian as it was previously assumed). In the lowest part of the Cieszyn Limestones *C. alpina* is abundant permitting correlation of this part of the subdivision with the earliest Berriasian *C. alpina* Zone (Pop, 1997). In the same assemblage occur: *Crassicolaria posttithonica* Nowak, *Calpionella elliptalpina* Nagy, *Tintinnopsella carpathica* (Murgeanu & Filipescu) and others. About 3 m above the base of the Cieszyn Limestones *Calpionella elliptica* Cadish appears indicating the Middle Berriasian.

Among foraminifera the presence of *Protopeneroplis ultragranulata* (Gorbatchik), *Mohlerina basiliensis* (Mohler), *Protomarssonella kummi* (Zedler), *P. hechti* (Dieni & Massari), *Scythiloculina confusa* Neagu, *Rumanoloculina malitiosa* Neagu and *Pfenderina* sp. is noteworthy.

The appearance in the upper part of the section of *Stomiosphaera wanneri* Borza may suggest the Late Berriasian while the first appearance of *Carpistomiosphaera valanginiana* Borza already may be linked to the begginning of the Valanginian.

It is interesting that the change in calcareous dinocysts coincides with the increase amount of forms with arenaceous tests in foraminiferal assemblages such as: *Trochammina*, *Pseudoreophax* and *Gaudryinella*. Other microfossils valuable for the paleoenvironmental interpretation belong to the calcareous algae: *Thaumatoporella parvovesiculifera* Rainieri, Solenoporacea and microproblematic organism (?foraminifera) known as *Tubiphytes morronensis* Crescenti, and *Koskinobullina. socialis* Cherchi & Schroeder.

12. Kamienica III (Fig. 10). The section is continuation of the former encompassing the upper part of the Cieszyn Limestones and transition to the Upper Cieszyn Shales (Nowak, 1971). About 1 m from the base of the section *Calpionella elliptica* Cadish appears suggesting the Middle B 5.5 m higher Nowak (*op. cit.*) identified *Calpionellopsis simplex* (Colom), the early Late Berriasian index tintinnid species. In the upper part of the section the presence of the genus *Tintinnopsella* is conspicuous (?*Tintinnopsella* Zone). In the same part the number of arenaceous foraminifera increases (*Rhizammina, Ammodiscus*, *Pseudoreophax, Trochammina, Gaudryinella*) indicating greater influx of the terrigenous material. About 1.5 m above the occurrence of *Calpionellopsis simplex* (Colom) the first specimens of *Epistomina* sp. and *Hechtina praeantiqua* Bartenstein & Brand has been found also suggesting the change to more clayey environment. Together with *Epistomina* sp. among the calcareous dinocysts appear: *Carpistomiosphaera valanginiana* Borza, *Colomi-*

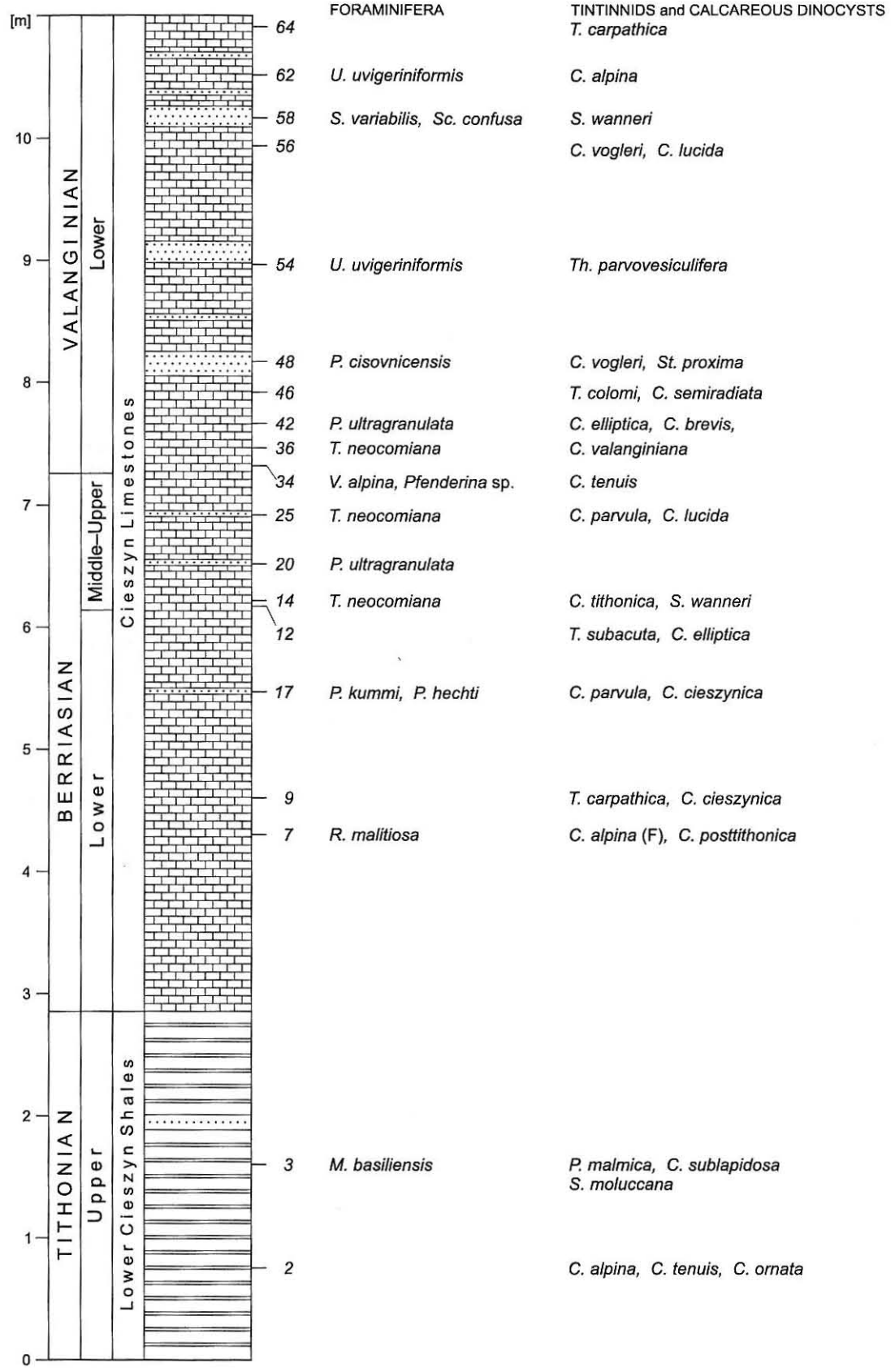

Fig. 9. Distribution of microfossils in the Kamienica I–II section (lithology after Nowak, 1976, modified)

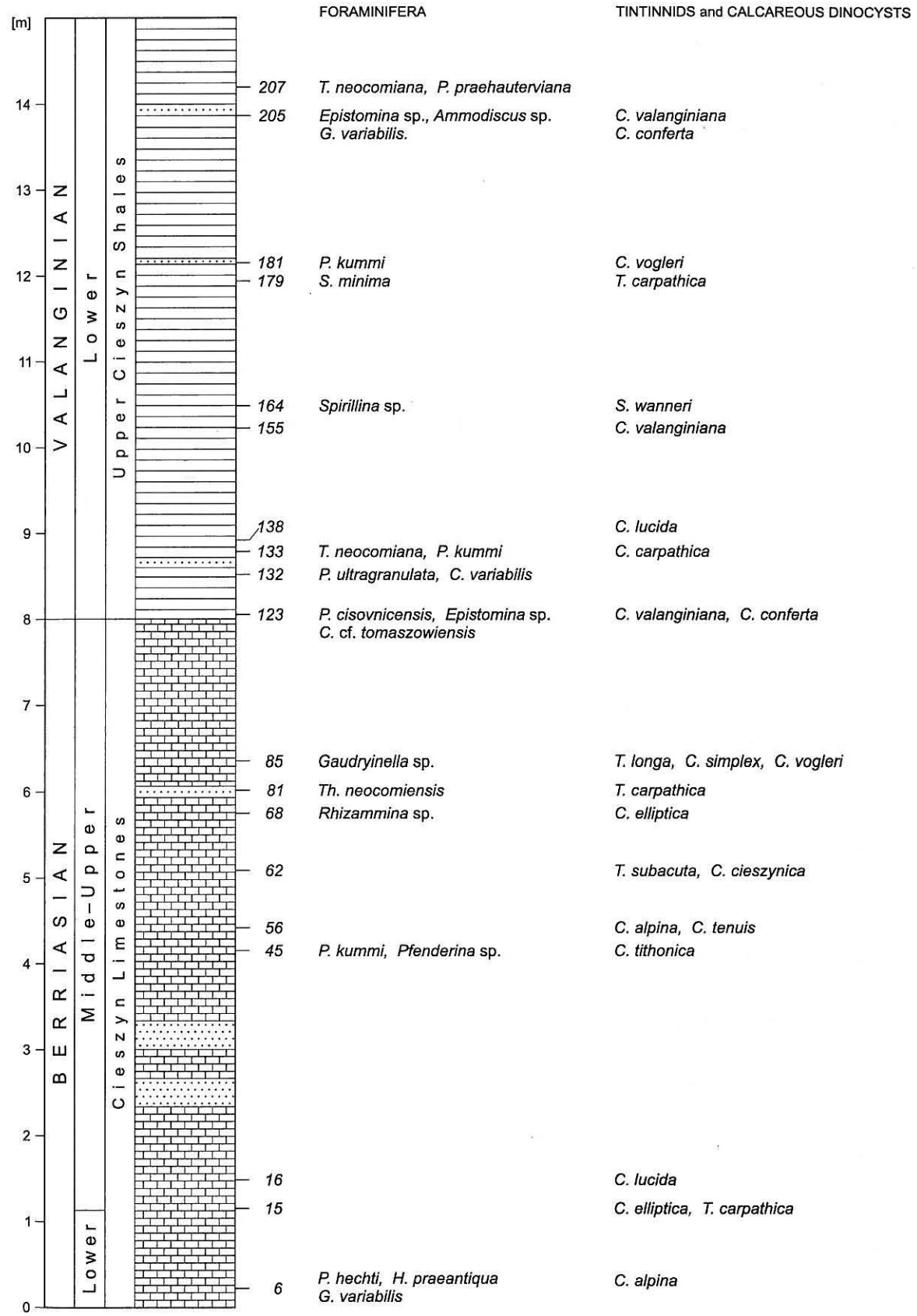

Fig. 10. Distribution of microfossils in the Kamienica III section (lithology after Nowak, 1971)

sphaera conferta Řehánek and *Stomiosphaera wanneri* Borza indicating the proximity of the Valanginian. At the same time the species *Carpistomiosphaera tithonica* Nowak disappears. In the higher part of the section the content of noncalcareous shales considerably increases.

13. Wapienica I (Fig. 11). The outcropping Cieszyn Limestones were sampled by Nowak in a small quarry in the village Wapienica close to the town Bielsko-Biała. They represent the higher part of the subdivision developed as successive alternation of the detrital and pelitic limestones. Thin sections were

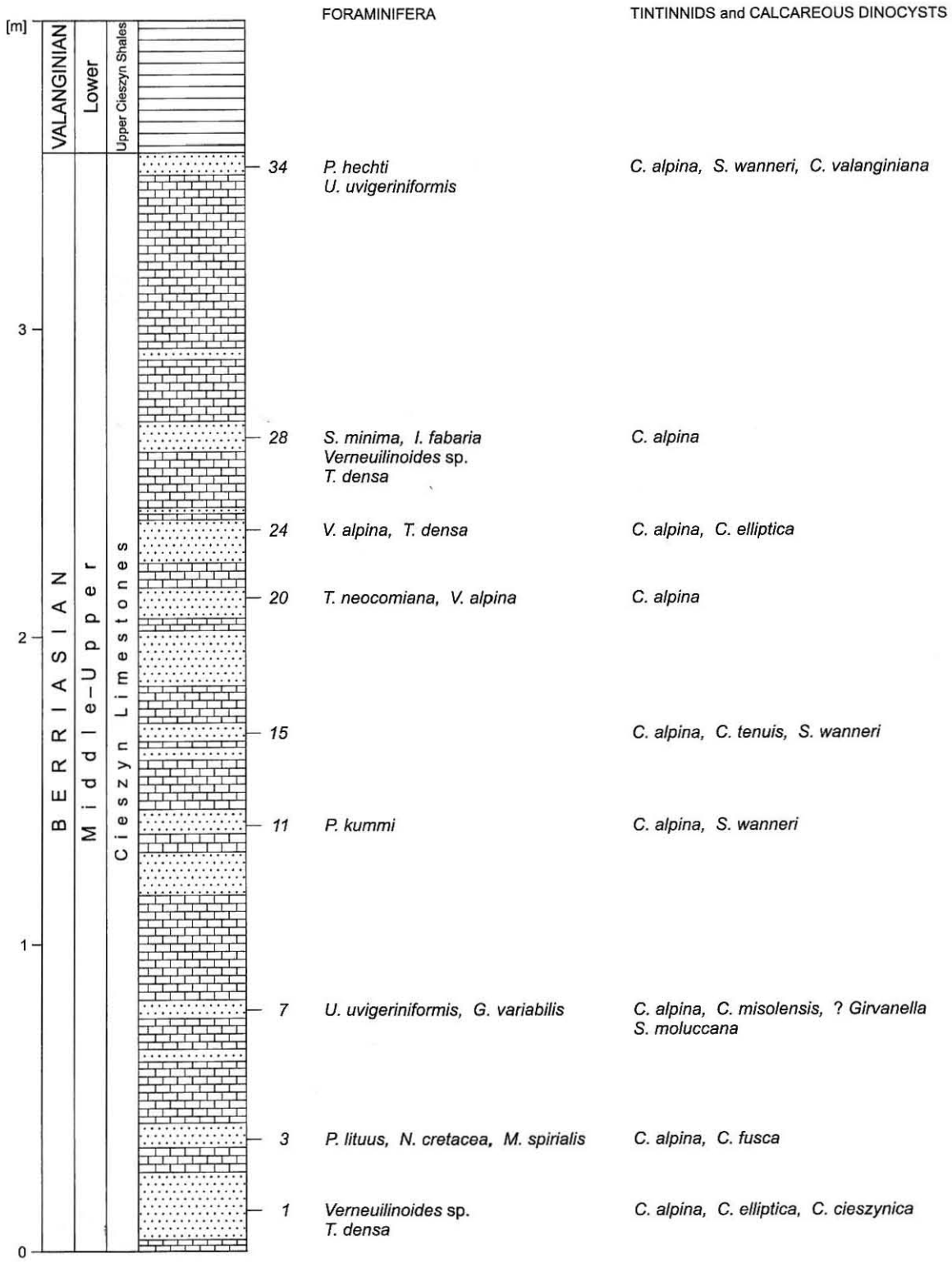

Fig. 11. Distribution of microfossils in the Wapienica I section (lithology after Nowak, 1986)

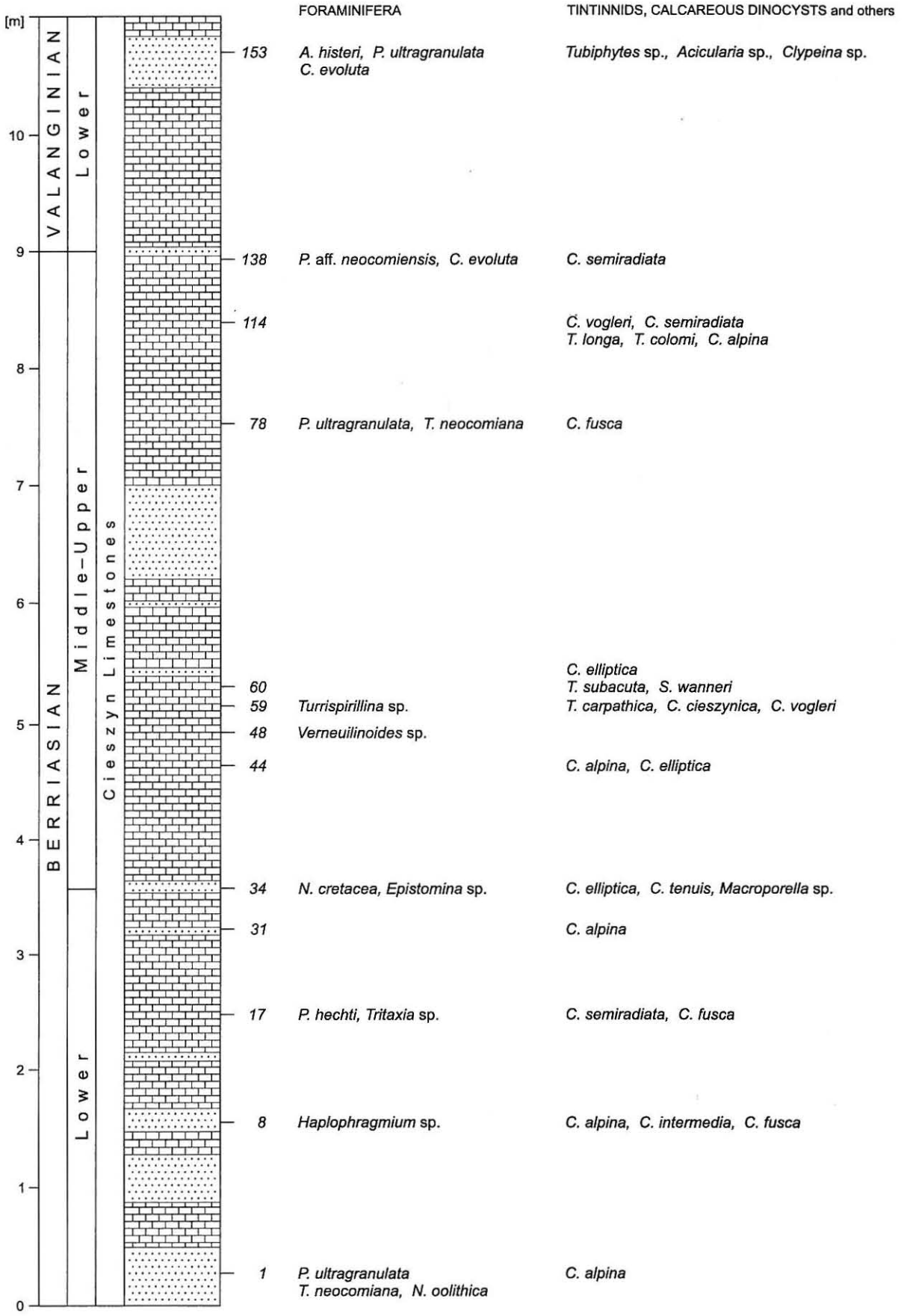

Fig. 12. Distribution of microfossils in the Wapienica Fabryczna section (lithology after Nowak, 1986)

made predominatly from the former type of sediment. Tintinnid assemblages from the lowest part of the section contain *Calpionella elliptica* Cadish suggesting that the investigated strata are younger than the Middle Berriasian. Foraminifera, generally rare, are represented by agglutinated: *Protomarssonella hechti* (Dieni & Massari), *P. kummi* (Zedler), *Uvigerinammina uvigeriniformis* (Seibold & Seibold), *Trochammina neocomniana* Mjatliuk, and *Textularia densa* Hoffman. Detrital layers contain the following species: *Melathrokerion spiralis* Gorbatchik, *Pseudocyclammina lituus* (Yokoyama), *Valvulina alpina* Dragastan and *Nautiloculina cretacea* Peybernes. The calcareous dinocysts assemblages are composed mainly of *Cadosina fusca* Wanner, *Comittosphaera misolensis* (Vogler), *Stomiosphaera moluccana* Wanner, and (in the top of the section) *S. wanneri* Borza, *Carpistomiosphaera valanginiana* Borza which suggest at least the Late Berriasian age.

14. Wapienica Fabryczna (Fig. 12). The section was sampled by Nowak in the surface outcrop on the left bank of the river Wapienica in the industrial quarter of the village. Here the Cieszyn Limestones display distinct turbiditic character. This may affect the distribution of fossils. For example *Calpionella elliptica* Cadish appears somewhat higher than in the previous section. Other characteristic tintinnid species are: *C. alpina* Lorenz, *Tintinnopsella subacuta* (Colom), *T. carpathica* (Murgeanu & Filipescu), *T. longa* (Colom), *T. colomi* Knauer and *Crassicollaria parvula* Remane. Foraminifera occur mainly in the turbiditic layers. The characteristic forms are *Trochammina neocomiana* Mjatliuk, *Protopeneroplis ultragranulata* (Gorbatchik), *Pfenderina* aff. *neocomiensis* (Pfender), *Nautiloculina cretacea* Peybernes and *Charentia evoluta* (Gorbatchik). The calcareous dinocysts assemblages in the coarse grained sediment (detrital limestones) are poor. In the pelitic limestones the assemblages are composed of *Cadosina fusca* Wanner, *Crustocadosina semiradiata* (Wanner), *Colomisphaera* cf. *vogleri* (Borza) and *C. cieszynica* (Nowak).

In the upper part of the section rare fragments of the calcareous algae: *Clypeina* sp. (Pl. III, Fig. 13), and *Acicularia* sp. as well as problematic microfossil *Tubiphytes* sp. occur

The sediments of the Cieszyn Beds are overlain by those of the Grodziszcze Beds which are developed as calcareous shales in the study area. To complete the information about distribution of discussed groups of fossils, samples from the Grodziszcze Beds from several localities have been investigated.

15. Lipnik. The calcareous shales of the shally Grodziszcze Beds from this locality contained predominantly calcareous dinocysts *Stomiosphaera wanneri* Borza, *Colomisphaera vogleri* (Borza) and *Cadosinopsis nowaki* Borza. The last species suggest the Hauterivian age for the investigated samples.

16. Hałcnów. Microfossils assemblages from the Grodziszcze Beds contained calcareous dinocysts and rare foraminifera. The calcareous dinocyst assemblage is composed of the following species: *Stomiosphaera polygona* Vogler, *S. echinata* Nowak, *Carpistomiosphaera valanginiana* Borza and *Colomisphaera vogleri* (Borza), suggesting the Valanginian–Hauterivian age for the assemblage. Poor foraminiferal assemblage contained *Trochammina* cf. *vocontiana* Moulade, *Gaudryinella* aff. *scherlocki* Bartensten, *Spirillina* cf. *minima* Schacko and *Nodosaria* sp.

17. Witanowice. Thin sections from the detrital layer from the Grodziszcze beds, in this section, revealed the presence of shallow water carbonate foraminifera with addition of the *Epistomina* sp. that prefers a rather clayey environment and is common in the Hauterivian of the Flysch Carpathians (Olszewska, 1997). A poor calcareous dinocysts assemblage is composed of *Colomisphaera vogleri* (Borza) and *Crustocadosina semiradiata* (Wanner).

REMARKS ON STRATIGRAPHY

Three groups of fossils recognised in thin sections appear to be significant for the stratigraphy of the Cieszyn Beds: tintinnids, calcareous dinocysts and foraminifera. Their importance for the age designation of the succesive subdivisions is discussed separately.

Tintinnids. The key role of tintinnids for the stratigraphy of the Jurassic/Cretaceous transition pelagic sediments is widely accepted (Reháková, Michalík, 1997). The importance of this group is reflected in numerous propositions of standard and regional zonations (Borza, 1969, 1984a; Allemman *et al.*, 1971; Remane *et al.*, 1986; Lakova, 1993; Pop, 1994, 1997; Reháková, 1995; Reháková, Michalík, 1997; Lakova *et al.*, 1999). Some of these tintinnid zonations were correlated with the primary ortostratigraphic ammonite zones (Zeiss, 1986; Wierzbowski, Remane, 1992; Vašícek *et al.*, 1994). Although tintinnids were reported from the Polish Carpathians in the early thirties (Sujkowski, 1931) they became the subject of systematic studies about 20 years later (Birkenmajer, 1953; Lefeld, 1959; Nowak, 1968, 1971, 1978, 1980, 1984). Five of the tintinnid zones known from the Slovak Carpathians (Borza, 1984a; Reháková, 1995) have been recog-

nised in Poland (Wierzbowski, Remane, 1992; Pszczółkowski, 1996). In the Flysch Carpathians however, their occurrence is considerably hindered by the turbiditic type of sedimentation. Only periods of maximum occurrence of specific forms like *Chitinoidella* (*Chitinoidella* Zone), *Crassicollaria* (*Crassicollaria* Zone), small *Calpionella alpina* (*C. alpina* Subzone), *Tintinnopsella* (*Tintinnopsella* Zone) are preserved.

The occurrence of *Chitinoidella* sp. was reported twice (Nowak *In:* Geroch *et al.*, 1967; Nowak, 1980) from the Lower Cieszyn Shales. Recent investigation resulted in identification of *Chitinoidella boneti* Doben (**Pl. I, Fig. 1, 2**) in the lowest part of the Lower Cieszyn Shales in the Cisownica–Tuł section (8). It suggest the Middle Tithonian age (Reháková, 2002) for the base of the subdivision (**Fig. 1**). The presence of *Praetintinnopsella* (**Pl. I, Fig. 3**) in the Puńców section (5) also documents the Middle Tithonian age for the upper part of the Lower Cieszyn Shales.

The Early Tithonian age of the lower part of the Lower Cieszyn Shales is suggested by the calcareous dinocysts zone *Parastomiosphaera malmica* (Nowak, 1976) identified in at the base of the subdivision. Interestingly, there is an almost complete lack of the saccocoma facies regarded as typical for the oceanic Tethyan deposits of the Kimmeridgian age (Borza,1969, 1984b; Bernoulli, 1972; Obermajer, 1986; Keupp, Matyszkiewicz, 1997), which may support previous suggestions of this age for the investigated strata. Other Kimmeridgian indices in the area such as saccocomid-radiolarian assemblages or saccocomid-globochaetan assemblages (Reháková, *pers. inf.*) are also not known from the Lower Cieszyn Shales. The calcareous dinocyst *Carpistomiosphaera borzai* (Nagy) an index species of the latest Kimmeridgian dinocyst zone (Reháková, 2000) in large numbers occurs in exotics of the slump layer present at the top of the Lower Cieszyn Shales more rarely in the upper part of the shales (Gumna section).

The Late Tithonian *Crasscollaria* Zone was identified equally in the upper part of the Lower Cieszyn Shales in the Cisownica section (7) and in the lower part of the Cieszyn Limestones in the Cisownica–Tuł section (8) what means that Jurassic/Cretaceous boundary in the studied area is independent of lithostratigraphy. The assemblage of the Crassicollaria Zone consists of numerous *Crassicollaria intermedia* Durand Delga, *C. parvula* Remane, and *C. massutiniana* Colom.

The earliest Berriasian *Calpionella alpina* Subzone is ubiquitous in the lower part of the Cieszyn Limestones. Numerous small *C. alpina* Lorenz are sometimes accompanied by *C. elliptalpina* Nagy, reaching here the top of its distribution.

The early Middle Berriasian *Calpionella elliptica* Zone is the last to be found frequently in the investigated sections. The zone is connected with the third evolutive stage during which tintinnids attained their maximum diversity (Reháková, 1995).

The younger tintinnid zones (*Calpionellopsis, Calpionellites*) are difficult to be found in the Polish Flysch Carpathians. This is probably caused by combination of the unfavorable conditions of preservation in a successively less calcareous environment of the upper part of the Cieszyn Limestones and the Upper Cieszyn Shales and the progressive decrease of amount of tintinnids in the Late Berriasian–Hauterivian interval. Isolated occurrences of *Calpionellopsis simplex* (Colom) and *C. oblonga* (Cadish) allow stratigraphic interpretation only of particular sections.

Characteristic for the upper part of the Cieszyn Limestones and the lower part of the Upper Cieszyn Shales in the investigated sections is the persistent occurrence of *Tintinnopsella carpathica* (Murgeanu & Filipescu) the zonal marker of the *Tintinnopsella* Zone. The zone, recognised predominatly in the Carpatho-Balkan region, represents the late Early Valanginian–Hauterivian interval.

It is highly interesting that the distribution of rare tintinnids on the adjacent part of the European platform follows the same pattern (Olszewska, 1998). The occurrence of tintinnids in sediments of the Cieszyn Beds are presented on **Tables 1–3**. Position of the investigated sections in relation to the regional tintinnid zonation is presented on **Figure 13**.

The poor state of preservation of the majority of tintinnids restricted the number of illustrated and described species.

Calcareous dinocysts. Single chambered, predominatly sphaerical bodies, known as calcisphaeres, stomiosphaeres, cadosinas or pithonellas are frequent components of the pelagic Mesozoic and Cenozoic sediments. Originally Tethyan organisms, the calcareous dinocysts proliferated in warm, saline, carbonate-rich waters of epicontinental and marginal seas bordering the Tethys ocean (Dias-Brito, 2000). Their affiliation to dinoflagellates was determined by Wall and Dale (1968), Masters and Scott (1978), Keupp (1979, 1990), D'Onofrio *et al.*, (1999). It is generally accepted that calcareous dinocysts preferred low energy, carbonate, outer shelf to upper bathyal environments of Tethys. Initially the knowledge of the group was based on the study of the thin sections (Colom, 1935; Wanner, 1940; Vogler, 1941; Keller, 1946; Durand Delga, 1957). The new approach to taxonomy was introduced by Bolli (1974) after the study of the free specimens extracted from the soft Jurassic and Cretaceous sediments of the Indian Ocean. The author, however, postponed, and his followers abandoned, comparison of the free and the thin-section taxa which resulted in the creation of the two parallel taxonomies, one for the free speciments (Keupp,1987; Keupp *et al.*, 1991; Janofske, Keupp, 1992; Willems, 1992), the other for the thin-sectioned tests (Nagy, 1966; Nowak, 1968; Borza, 1969; Řehánek, Cecca, 1993). The combined, SEM and optical studies of the calcareous dinocyst are still rather rare and bring controversial results (Reháková, Michalík, 1996; Ivanova, Keupp, 1998, 1999; Streng *et al.*, 2002). Probably it will take some time before the integrated systematics of the calcareous dinocysts is produced. Until then it seems reasonable to gather as much data on their structure and temporal and spatial distribution as possible from both the soft and indurated sediments in different regions.

Table 1

Distribution of selected microfossils in the Lower Cieszyn Limestones Shales

Microfossils	Góra Zamkowa	Gumna	Nowa Marglownia	Puńców	Cieszyn IG 1	Cisownica	Cisownica Tuł	Kamienica I-II
Chitinoidella boneti		x					x	
Praetintinopsella sp.				x				
Crassicollaria sp.	x					x		
Calpionella alpina	x							x
C. elliptalpina	x							
Tintinnopsella carpathica	x							
Carpistomiosphaera borzai		x					x	
C. tithonica							x	
Cadosina fusca		x						
Crassicollaria parvula							x	
Colomisphaera cieszynica		x					x	
C. fortis					x	x		
C lapidosa						x		
C. lucida	x					x	x	
C. pulla				x		x	x	
C. radiata		x		x			x	
C. tenuis		x			x	x	x	
Comittosphaera ornata							x	
Crustacadosina semiradiata	x	x						
Parastomiosphaera malmica		x	x	x		x	x	
Stomiosphaera moluccana	x	x	x			x	x	
Arenobulimina melitae							x	
Belorussiella cf. *taurica*						x		
Charentia evoluta							x	
Decussoloculina barbui							x	
Epistomina ex gr. caracolla		x						
Glomospira variabilis						x		
Haplophragmoides pygmaeus			x					

Microfossils	Góra Zamkowa	Gumna	Nowa Marglownia	Puńców	Cieszyn IG 1	Cisownica	Cisownica Tuł	Kamienica I-II
Haplophragmium cf. *inconstans*			x					
Ichnusella burlini		x						
Istriloculina fabaria	x							
Melathrokerion spirialis		x						
Mesoendothyra involuta						x		
M. izjumiana		x	x				x	
Mohlerina basiliensis								x
Nautiloculina oolithica		x					x	
Paalzowella feifeli					x			
Palaeogaudryina magharaensis		x			x			
Patellina subcretacea			x					
Protomarssonella hechti							x	
P. kummi						x	x	
Protopeneroplis ultragranulata							x	
Pseudocyclammina lituus		x				x		
Pseudoreophax cisovnicensis							x	
Pseudoclavulina sp.		x				x	x	
Quinqueloculina mitchurini							x	
Siphovalvulina variabilis		x					x	
Textularia densa		x			x			
Thalmannammina neocomiensis		x						
Trochammina neocomiana		x					x	
T. quinqueloba		x						
Uvigerinammina uvigeriniformis		x						

Table 2

Distribution of selected microfossils in the Cieszyn Limestones

Microfossils	Olza	Góra Zamkowa	Cieszyn IG 1	Cisownica	Cisownica Tul	Kozy	Kamienica I-II	Kamienica III	Wapienica I	Wapienica Fabryczna
Crassicollaria brevis		x				x				
C. intermedia		x			x	x				x
C. massutiniana		x			x	x				
C. parvula					x	x				x
C. posttithonica							x			
Calpionella alpina	x	x		x	x	x	x	x	x	x
C. elliptalpina	x	x					x			
C. elliptica		x			x	x	x	x	x	x
Calpionellopsis simplex		x			x			x		
C. oblonga					x					
Remaniella filipescui		x								
Tintinnopsella carpathica		x			x	x	x	x		x
T. colomi							x			x
T. longa					x			x		x
T. subacuta		x			x		x	x		x
Cadosina fusca						x			x	x
C. minuta	x	x								
Carpistomiosphaera tithonica					x		x	x		
C. valanginiana		x	x		x		x	x	x	
Colomisphaera cieszynica							x	x	x	x
C. conferta				x		x		x		
C. fortis						x				
C. heliosphaera	x	x			x					
C. lucida		x				x	x	x		
Crustocadosina semiradiata	x	x				x	x			x
Colomisphaera tenuis	x					x	x		x	x
C. vogleri	x	x				x	x	x		x
Comittosphaera misolensis						x			x	
Stomiosphaera wanneri		x				x	x	x	x	x
S. proxima							x			
Andersenolina alpina	x		x	x	x					

Microfossils	Olza	Góra Zamkowa	Cieszyn IG 1	Cisownica	Cisownica Tul	Kozy	Kamienica I-II	Kamienica III	Wapienica I	Wapienica Fabryczna
A. histeri	x									x
A. elongata			x		x					
Belorussiella cf. *taurica*	x									
Charentia evoluta	x			x						x
Decussoloculina barbui				x						
Falsogaudryinella neagui					x					
Hechtina praeantiqua								x		
Glomospira variabilis	x							x	x	
Istriloculina terekensis	x									
I. fabaria		x	x						x	
Nautiloculina cretacea		x							x	x
Neotrocholina molesta					x					
Pfenderina cf. *aureliae*	x									
P. neocomiensis										x
Pseudoreophax cisovnicensis	x	x			x		x			
Pseudomorulaeplecta franconica	x			x						
Pseudocyclammina lituus				x					x	
Protomarssonella hechti	x		x		x		x	x	x	x
P. kummi	x	x	x		x		x	x	x	
Protopeneroplis ultragranulata	x	x			x		x			x
Palaeogaudryina magharaensis	x									
Rumanoloculina malitiosa							x		x	
Scythiloculina confusa							x			
Siphovalvulina variabilis	x						x			
Textularia densa				x					x	
Thalmannammina neocomiensis		x						x		x
Trochammina neocomiana	x	x			x		x		x	x
Uvigerinammina uvigeriniformis					x		x		x	
Valvulina alpina	x						x		x	

Table 3

Distribution of selected microfossils in the Upper Cieszyn Shales

Microfossils	Cieszyn IG 1	Cisownica	Jasienica	Kamienica I-II	Kamienica III	Wapienica I
Calpionella alpina						x
Tintinnopsella carpathica			x		x	
Cadosina fusca			x			
C. minuta			x			
Carpistomiosphaera valanginiana			x		x	x
Colomisphaera carpathica					x	
C. conferta					x	
C. heliosphaera			x			
C. lucida					x	
C. vogleri	x				x	
C. tenuis			x			
Stomiosphaera wanneri		x			x	x
Conorboides cf. *tomaszowiensis*					x	
Epistomina ex gr. *caracolla*	x		x			
Glomospira variabilis					x	
Nautiloculina cretacea		x				
Patellina subcretacea	x					
Pfenderina aureliae		x				
P. cf. *flandrini*		x				
P. neocomensis		x				
Protomarssonella hechti						x
P. kummi					x	
Praedorothia praehauteriviana					x	
Protopeneroplis ultragranulata					x	
Pseudoreophax cisovnicensis					x	
Spirillina minima	x					
Recurvoides sp.			x			
Trochammina neocomiana					x	
T. quinqueloba	x					
T. vocontiana	x					
Uvigerinammina uvigeriniformis						x
Verneuilinoides neocomiensis			x			

The Polish record of the calcareous dinocysts comes from the early thirties when they were reported from the Late Cretaceous sediments of the Polish Lowland (Sujkowski, 1931, 1934). The succesive findings of the calcareous dinocysts of same age, were reported by Alexandrowicz (1954), Barczyk (1956), Pożaryski (1956) and Marcinowski (1970, 1974). The Early Cretaceous occurrence of the calcareous dinocysts in Poland was reported by Samsonowicz (1948) from Central Poland and by Nowak (1963,1968) from the Flysch Carpathians. Much later, the calcareous dinocysts were reported from the Jurassic sediments of the Polish Lowland (Garlicka, 1974, 1976; Morycowa, Moryc, 1976; Golonka, 1978; Garlicka, Tarkowski, 1980).

Because of their co-occurrence with stratigraphically relevant fossils such as ammonites or tintinnids, the calcareous dinocysts were thought to have lesser application for stratigraphy. Nevertheless their persistent occurrence in the Late Jurassic and Early Cretaceous sediments inclined some authors to include more significant species to local biostratigraphical schemes. In the Carpatho-Balkan region the widely used schemes were those of Nagy (1966), Nowak (1968) and Borza (1969). After the unexpected passing away of Nowak the studies of the calcareous dinocysts in Poland almost ceased (Obermajer, 1986). They were continued, however, in adjacent countries (Czech and Slovak Republics and Bulgaria) what allowed for the refinement of biostratigraphical schemes of the calcareous dinocysts elaborated in these countries (Borza, 1984a; Řehánek, 1992; Řehánek, Cecca, 1993; Vašícek *et al.*, 1994; Lakova *et al.*, 1999, Reháková, 2000). The progress in studies of calcareous dinocysts made interpretation of taxa of the Polish Flysch Carpathians more credible.

Since the occurrence of the calcareous dinocysts in the Cieszyn Beds (Tab. 3) is strongly affected by the turbiditic mode of accumulation of these subdivisions direct correlation with Carpathian calcareous dinocysts zones (Reháková, 2000) is rather difficult because the former were elaborated for pelagic sediments. Thus in the majority of cases distribution of the calcareous dinocysts in the Cieszyn Beds was determined by relation to tintinnids present in the same samples. In many cases, however the appearance of species may be referred to specific dinocyst zones: *Comittosphaera pulla* (Borza) appears in the Lower Cieszyn Shales below the *Chitinoidella* Zone, approximately in the acme *pulla* Zone (*op. cit.*). *Parastomiosphaera malmica* (Borza) appears directly below the tintinnid *Chitinoidella* Zone in the dinocyst *malmica* Zone. *Colomisphaera fortis* Řehánek appears within the tintinnid *Crassicolaria* Zone that corresponds to the dinocyst *fortis* Zone (*op. cit.*). *Colomisphaera vogleri* (Borza) and *Carpistomiosphaera valanginiana* Borza appear in the upper part of the Cieszyn Limestones corresponding to the Late Berriasian tintinnid *Calpionellopsis* Zone. *Stomiosphaera wanneri* Borza appears in the upper part this zone which corresponds to the dinocyst *wanneri* Zone. Finally, in the earliest

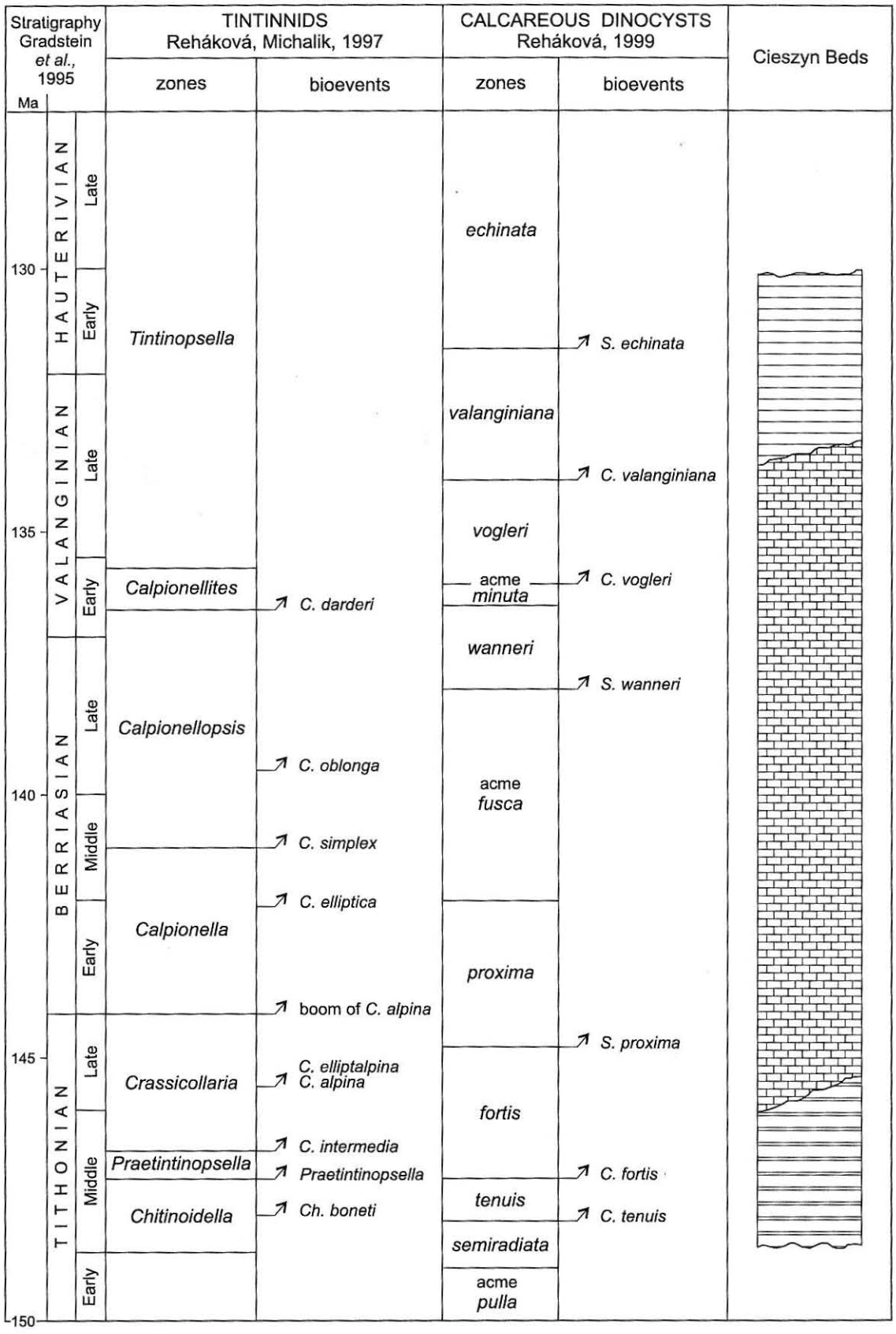

Fig. 13. Position of the Cieszyn Beds in relation to the regional zonations and major bioevents

part of the Hauterivian–Early Aptian Grodziszcze Beds appear *Stomiosphaera echinata* Nowak and *Cadosinopsis nowaki* Borza both in the dinocyst *echinata* Zone (*op. cit.*). The calcareous dinocysts found in the Cieszyn Beds cover the interval between the acme *pulla* (Early Tithonian) to the *echinata* (Hauterivian) calcareous dinocysts Carpathian zones. These examples also confirm the value of the calcareous dinocysts for stratigraphy in the non-pelagic sediments of the Flysch Carpathians. The occurrence of the calcareous dinocysts in sediments of the Cieszyn Beds show Tables 1–3. Position of the Cieszyn Beds in relation to the regional dinocyst zonation is presented on Figure 13.

Foraminifera. Foraminifera observed in thin sections (Fig. 13) represent population of the shallow water carbonate environment. Representatives of species with calcareous particles in agglutinated tests (*Protomarssonella, Praedorothia, Pseudocyclammina, Palaeogaudryina, Belorussiella, Gaudryinella, Mesoendothyra, Pfenderina, Melathrokerion*) and taxa with secreted calcareous tests typical for the peri-reefal environment such as *Nautiloculina, Charentia, Trocholina, Andersenolina, Mohlerina, Protopeneroplis*, Miliolidae occur frequently. Foraminiferal assemblages of the Lower Cieszyn Shales represent surface dwelling active detritivores (B 3) and infaunal detrital scavenger (C 1) communities of Jones and Charnock (1985) predominating in the outer shelf — upper bathyal depths. The above mentioned genera formed part of the diversified shallow water communities during the Late Jurassic–Early Cretaceous in the Western Carpathians area. They occur in the algal limestones (*Pseudocyclammina, Haplophragmium*), reefal limestones (*Protopeneroplis, Trocholina*, Ataxophragmiidae), ooidal grainstones (*Charentia, Protopeneroplis, Haplophragmoides*) and in the sandy limestones (*Pseudocyclammina, Pfenderina*) (Soták, Mišík, 1997). Characteristic genera (*Protopeneroplis, Pfenderina, Pseudotextulariella*) were used to elaborate local shallow water benthic foraminiferal zones (Soták *In*: Vašíček *et al.*, 1994).

The Cieszyn Beds shallow water foraminifera, analogous to tintinnids and calcareous dinocysts, cannot be precisely referred to these zones but they follow general trends of distribution of index forms used in zonation elaborated for pelagic sediments (*op. cit.*).

Representatives of the genus *Protopeneroplis* are restricted to the Tithonian (*P. striata*) and early Berriasian (*P. ultragranulata*) and representatives of the genus *Pfenderina* to the Valanginian–Hauterivian similarly like on areas of pelagic sedimentation. That means that they were components of the shallow water Western Carpathian biotas and responded in the same way to changes of environment (Michalík, Soták, 1990). They were transported to the basin as a result of erosion of areas of carbonate sedimentation exposed to destruction by tectonic movements at the end of the Jurassic (Michalík, Soták, 1990; Ślączka *et al.*, 1999). Foraminiferal morphogroups characteristic for assemblages of the Cieszyn Limestones are: B 2 (active deritivores), B 3 (active herbivores or detritivores browsing on weed), C 1 (infaunal passive detritivores) and rarely A (suspension feeders).

The turbidite mode of sedimentation of the investigated subdivisions (mainly Cieszyn Limestones and Upper Cieszyn Shales) is reflected in the occurrence of arenaceous basin foraminifera (*Rhizammina, Glomospira, Thalmannammina, Trochammina, Pseudoreophax*, and *Gaudryina*) included in the non-calcareous clastics intercalating marls and detrital limestones. The amount of arenaceous species increase in the younger part of subdivisions (upper part of the Cieszyn Limestones, the Upper Cieszyn Shales) where the number of non-calcareous intercalations is greater. They represent the two earliest Flysch Carpathians zones based on the arenaceous foraminifera: the *Trochammina quinqueloba* Zone and the *Pseudoreophax cisovnicensis* Zone (Olszewska, 1997). The identified morphotypes belong mainly to B 3 and C 1 morphogroups characteristic for the outer shelf — upper bathyal depths (Jones, Charnock, 1985; Nagy, 1992). The occurrence of foramnifera in sediments of the Cieszyn Beds show Tables 1–3.

REMARKS ON PALEOGEOGRAPHY

Numerous interpretations of the tectonic evolution of the region (Książkiewicz, 1960; Nowak, 1967; Mišík, 1974; Birkenmajer, 1975; Michalík, 1994; Ślączka *et al.*, 1999; Golonka *et al.*, 2000, 2001, 2003) situate the developing Carpathian basin at the southern edge of the European platform covered at that time (Late Jurassic–earliest Cretaceous) by carbonate sedimentation with bioherms and patch reefs scattered near the platform ridge. Large (*Pseudocyclammina, Charentia, Everticyclammina*) and small (*Protopeneroplis, Protomarssonella, Nautiloculina, Pfenderina*) foraminifera migrated freely across shoals from the southern France to the Crimea (Pélissié *et al.*, 1982). Abundant algae (Cyanophyta, Chlorophyta, Dasycladales, Codiacea) as well as bryozoans, corals, snails, hydrozoans and worms constructed shallow marine buildups (Moussavian, 1992). Ocean currents from the Tethys brought onto shelves planktonic microorganisms such as tintinnids, radiolarians and calcareous dinocysts (Olszewska, 1998). Destruction of those areas during the Neocimmerian movements supplied carbonate debris to developing adjacent basins of the Flysh Carpathians (Matyszkiewicz, Słomka, 1994; Michalík, 1994; Reháková, 1995). The debris constitute the main components of the detrital limestones and olistostromes in the Cieszyn Beds.

PALEONTOLOGICAL CHART

Microfossils are described in order of their significance for stratigraphy of the investigated strata.

TINTINNIDS

(systematics after Lynn, 2002)

Order **Tintinida** Kofoid & Campbell, 1929

Family **Codonellidae** Kent, 1882

Genus *Chitinoidella* Doben, 1963
Chitinoidella boneti Doben, 1963

Pl. I, Figs. 1, 2

1963 *Chitinoidella boneti* n. gen., n. sp.; K. Doben, p. 42, pl. 6, figs. 1–5.
1980 *Chitinoidella boneti* Doben; W. Nowak, p. 332, pl. 89, fig. 3.

Description. — Lorica short, vase-like. Aboral part sharpened, or with the caudal appendage. Collar simple, slantwise. Wall microcristalline, pigmented with the organic substance, brownish in transmitted light. Height: 310 μm. Width: 250 μm.

Range. — Middle Tithonian.

Occurrence. — Upper part of the Lower Cieszyn Shales.

Genus *Crassicollaria* Remane, 1962
Crassicollaria brevis Remane, 1962

Pl. II, Fig. 12

1962 *Crassicollaria brevis* n. sp.; J. Remane, p. 16, figs. 19–26.
1980 *Crassicollaria brevis* Remane; W. Nowak, p. 335, 336, pl. 92, fig. 1.

Description. — Lorica short, cup-like. Aboral part subacute or with the caudal appendage. Aperture broad. Collar in the lower part cylindrical, later bent outwards with swelling at the base. Height: 350–370 μm. Maximum width: 200–270 μm.

Range. — Middle Late Tithonian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Crassicollaria intermedia (Durand Delga, 1957)

Pl. I, Fig. 13

1957 *Calpionella intermedia* n. sp.; M. Durand Delga, p. 167, fig. 1C; pl. 1, figs. 2–4.
1980 *Crassicollaria intermedia* (Durand Delga); W. Nowak, p. 336, pl. 92, fig. 2.

Description. — Lorica subcylindrical with nearly parallel sides. Aboral part conical with the short caudal appendage. Aperture nearly as broad as the width of lorica. Collar in the lower part cylindrical, later slightly bent outwards with well pronounced swelling at the base. Height: 500 μm. Maximum width: 250 μm.

Range. — Early Late Tithonian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Crassicollaria parvula Remane, 1962

Pl. I, Fig. 14

1962 *Crassicollaria parvula* n. sp.; J. Remane, p. 19, figs. 36–45.
1980 *Crassicollaria parvula* Remane; W. Nowak, p. 336, 337, pl. 92, fig. 4.

Description. — Lorica elongated, cone shaped. Aboral part subacute without caudal appendage. Aperture slightly narrower than the maximum width of lorica. Collar in the lower part cylindrical, later slightly bent outwards with swelling at the base. Height: 400–500 μm. Maximum width: 100–150 μm.

Range. — Late Tithonian–Early Berriasian.

Occurrence. — Top of the Lower Cieszyn Shales, Cieszyn Limestones.

Crassicollaria posttithonica Nowak, 1968

Pl. I, Fig. 15

1968 *Crassicollaria posttithonica* n. sp.; W. Nowak, p. 333, figs. 2f, 3d, e; pl. 32, figs. 3, 4.
1984 *Crassicollaria posttithonica* Nowak; W. Nowak, p. 73, pl. 13, fig. 2.

Description. — Lorica narrow, cylindrical. Aboral part subacute. Aperture narrow. Collar cylindrical, in the upper part slightly bent outwards, with swelling at the base. Height: 550 μm. Maximum width: 150 μm.

Range. — Early Berriasian.

Occurrence — Lower part of the Cieszyn Limestones.

Genus *Praetintinnopsella* Borza, 1969
Praetintinnopsella andrusovi Borza, 1969

Pl. I, Fig. 3

1969 *Praetintinopsella andrusovi* n. sp.; K. Borza, p. 80, 81, pl. 69, figs. 9–16; pl. 70, figs. 1–10.
1980 *Praetintinopsella andrusovi* Borza; W. Nowak, p. 334, 335, pl. 91, fig. 1.

Description. — Lorica cup-like with the broad aperture and a wide, slantwise collar. Wall composed of the two layers. The inner layer, glassy white in the transmitted light, is covered by outer layer dark, pigmented with the organic substance. Height: 370 μm. Width: 250 μm.

Range. — Latest Middle—early Late Tithonian.

Occurrence. — Upper part of the Lower Cieszyn Shales.

Genus *Remaniella* Catalano, 1965

Remaniella filipescui Pop, 1994

Pl. I, Fig. 16

1994 *Remaniella filipescui* n. sp.; G. Pop, p. 325, 326, fig. 1b; pl. I, figs. 7–12.

Description. — Lorica short, cup-like. Aboral part subacute with a short caudal appendage. Aperture broad. Collar composed of two detached, unequal, circumoral rings obliquely arranged.

Range. — Berriasian–Early Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones.

Genus *Tintinnopsella* Colom, 1948

Tintinnopsella carpathica (Murgeanu & Filipescu, 1933)

Pl. I, Fig. 8

1933 *Calpionella carpathica* n. sp.; G. Murgeanu, M. Filipescu, p. 63, fig. 1c.
1980 *Tintinnopsella carpathica* (Murgeanu & Filipescu); W. Nowak, p. 337, 338, pl. 91, fig. 2.
1984 *Tintinnopsella carpathica* (Murgeanu & Filipescu); W. Nowak, p. 74, pl. 15, figs. 2–4.

Description. — Lorica cup-like. Aboral part conical with the caudal appendage. Aperture broad, but smaller than lorica. Collar plicate, trough-like, bent outwards to a right angle with the tip curved upwards. Height: 450–600 μm. Maximum width: 300 μm.

Remarks. — In sediments of the Cieszyn Series small ("Jurassic") forms of *Tintinnopsella*, prevail, larger ("Cretaceous") forms occur rarely in the upper part of the Beds in form of isolated fragments. This is probably caused by destructive, turbiditic mode of sedimentation.

Range. — Middle Late Tithonian–Late Hauterivian.

Occurrence. — Cieszyn Limestones, lower part of the Upper Cieszyn Shales.

Tintinnopsella colomi Boller, 1963

Pl. I, Fig. 9

1963 *Tintinnopsella colomi* nom. nov.; K. Boller, p. 41, fig. 2, 28–31.
1969 *Tintinnopsella colomi* Boller; K. Borza, p. 95, 96.

Description. — Lorica elongated, cylindrical. Aboral part semicircular. Aperture broad nearly as wide as lorica width. Collar plicate, small, trough-like, bent outwards to a right angle with the tip curved upwards. Height: 600–700 μm. Maximum width: 250 μm.

Range. — Berriasian.

Occurrence. — Upper part of Cieszyn Limestones.

Tintinnopsella longa (Colom, 1939)

Pl. I, Fig. 10

1939 *Calpionella longa* n. sp.; G. Colom, p. 5, pl. 2, fig. 9; pl. 3, fig. 3.
1984 *Tintinnopsella longa* (Colom); W. Nowak, p. 74, pl. 16, figs. 2, 3.

Description. — Lorica elongated, elliptical. Aboral part subacute, or with the caudal appendage. Aperture slightly narrower than the width of lorica. Collar short plicate, trough-like bent outward to a right angle with the tip curved upwards. Height: 750 μm. Maximum width: 370 μm.

Range. — Berriasian–Early Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones.

Tintinnopsella subacuta (Colom, 1948)

Pl. I, Fig. 7

1948 *Amphorellina subacuta* n. sp.; G. Colom, p. 249, 250, pl. 33, figs. 8, 10; fig. 12: 45, 48, 53, 58–60.
1984 *Amphorellina subacuta* Colom; W. Nowak, p. 75, pl. 16, fig. 4.
1994 *Tintinnopsella subacuta* (Colom); G. Pop, p. 327.

Description. — Lorica, elongated, spindle-like. Aboral part acute or with the causal appendage. Aperture smaller than the maximum width of lorica. Collar plicate, trough-like slightly bent outward, with the tip curved upwards. Height: 450 μm. Maximum width: 150 μm.

Range. — Middlle Berriasian–Early Barremian.

Occurrence. — Upper part of the Cieszyn Limestones.

Family **Codonellopsidae** Kofoid & Campbell, 1929

Genus *Calpionella* Lorenz, 1902

Calpionella alpina Lorenz, 1902

Pl. I, Fig. 5

1902 *Calpionella alpina* n. sp.; T. Lorenz, p. 60, pl. 9, fig. 1.
1980 *Calpionella alpina* Lorenz; W. Nowak, p. 335, pl. 91, fig. 3.

Description. — Lorica short, sphaerical to slightly oval. Aboral part semicircular or parabolic. Aperture simple, distinctly smaller than the width of lorica. Collar cylindrical, short, connected with lorica with a "shoulder". Height: 180 μm. Width: 150 μm.

Range. — Middle part of the Late Tithonian–Berriasian.

Occurrence. — Uppermost Lower Cieszyn Shales, Cieszyn Limestones.

Calpionella elliptalpina Nagy, 1986

Pl. I, Fig. 4

1986 *Calpionella elliptalpina* n. sp.; I. Nagy, p. 58, pl. I, fig. 4; pl. Ia, fig. 4.

Description.— Lorica oval, broadest in the proximity of aperture. Aboral part oval. Aperture broad, slightly smaller than the width of lorica. Collar cylindrical, short connected with lorica with indistinct "shoulder". Height: 370 μm. Width: 270 μm.

Range. — Late Tithonian–Early Berriasian.

Occurrence. — Upper part of the Lower Cieszyn Shales, lower part of the Cieszyn Limestones

Calpionella elliptica Cadish, 1932

Pl. I, Fig. 6

1932 *Calpionella elliptica* n. sp.; J. Cadish, p. 249, fig. 3: 10, 11, 17.
1984 *Calpionella elliptica* Cadish; W. Nowak, p. 70, 71, pl. 13, fig. 4.

Description. — Lorica elongated, cylindrical. Aboral part semicircular or parabolic. Aperture simple, distinctly smaller than the diameter of lorica. Collar cylindrical, short, connected with lorica with a "shoulder". Height: 500 μm. Width: 300 μm.

Range. — Latest Early–Middle Berriasian.

Occurrence. — Middle part of the Cieszyn Limestones.

Genus *Calpionellopsis* Colom, 1948
Calpionellopsis oblonga (Cadish, 1932)

Pl. I, Fig. 11

1932 *Calpionella oblonga* n. sp.; J. Cadish, p. 252, pl. 3, fig. 20.
1984 *Calpionellopsis oblonga* (Cadish); W. Nowak, p. 71, 72, pl. 14, fig. 4.

Description. — Lorica elongated, subcylindrical, narrowing towards the aperture. Aboral part rounded. Collar a simple ring surrounding the aperture. Height: 750 μm. Maximum width: 320 μm.

Range. — Middle Late Berriasian–Early Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones.

Calpionellopsis simplex (Colom, 1939)

Pl. I, Fig. 16

1939 *Calpionella simplex* n. sp.; G. Colom, p. 820, pl. 2, fig. 11.
1984 *Calpionellopsis simplex* (Colom); W. Nowak, p. 72, pl. 14, fig. 3.

Description. — Lorica elongated, subcylindrical with parallel sides. Aboral part rounded. Aperture broad, equal to lorica width. Collar a simple ring surrounding the aperture. Height: 500–750 μm. Maximum width: 250 μm.

Range. — Late Middlle–Late Berriasian.

Occurrence. — Upper part of the Cieszyn Limestones.

CALCAREOUS DINOCYSTS

(systematics after Řehánek, Cecca, 1993)

Order **Peridiniales** Haeckel, 1894

Family **Calciodinellaceae** Deflandre, 1947, emend. Bujak & Davies, 1983

Genus *Stomiosphaera* Wanner, 1940
Stomiosphaera echinata Nowak, 1968

Pl. II, Fig. 5

1968 *Stomiosphaera echinata* n. sp.; W. Nowak, p. 294–298, text-fig. 4, pl. 26, figs. 1, 2.

Description. — Cysts unilocular, spherical to oval. Wall homogenous, white in transmitted light. In polarised light visible extinction cross. The outer wall margin rugged with spiny processes. Cyst diameter: 320 μm. Thickness of the wall: up to 200 μm.

Range. — Late Valanginian–Late Barremian.

Occurrence. — Grodziszcze Beds.

Stomiosphaera moluccana Wanner, 1940

Pl. II, Fig. 6

1940 *Stomiosphaera moluccana* n. sp.; J. Wanner, p. 76, text-figs. 1–18, pl. 1, figs. 1, 2.
1968 *Stomiosphaera moluccana* Wanner; W. Nowak, p. 291, 292, pl. 25, figs.1–4.

Description. — Sphaerical cyst with a one-layered wall built of the tightly packed calcite cristals. The inner margin of the wall usually smooth, outer margin sometimes rugged due to dissolution processes. In transmitted light milky white, in polarised light shows the extinction cross. Cyst diameter: 250–350 μm. Thickness of the wall: 30 μm.

Range. — Late Kimmerdigian–Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Stomiosphaera polygona Vogler, 1941

Pl. II, Fig. 7

1941 *Stomiosphaera polygona* n. sp.; J. Vogler, p. 283, pl. 21, fig. 61.

Description. — Sphaerical cyst with the one layered wall built of tightly packed calcite cristals. and a characteristic pentagonal outline. Both margins of the wall are rugged due to dissolution processes. In transmitted light milky white, in polarised light shows the extinction cross. Cyst diameter: 300–350 μm. Thickness of the wall 30 μm.

Range. — Berriasian–Hauterivian.

Occurrence. — Grodziszcze Shales.

Stomiosphaera wanneri Borza, 1969

Pl. II, Fig. 11

1969 *Stomiosphaera wanneri* n. sp.; K. Borza, p. 62, 63, pl. 61, figs. 4–13.

Description. — Minute, sphaerical cyst with a one layered wall and uneven outer margin. In transmitted light glassy white, in crossed nicols the extinction cross visible. Cyst diameter: 170–200 μm. Thickness of the wall: 10 μm.

Range. — Late Late Berriasian–Hauterivian.

Occurrence. — Upper part of the Cieszyn Limestones, Upper Cieszyn Shales.

Genus *Colomisphaera* Nowak, 1968
Colomisphaera carpathica (Borza, 1964)

Pl. II, Fig. 8

1964 *Stomiosphaera carpathica* n. sp.; K. Borza, p. 191, pl. 1, figs. 3, 4.
1968 *Colomisphaera carpathica* (Borza); W. Nowak, p. 307, 308, pl. 30, figs. 3, 4.

Description. — Sphaerical cyst with a one-layered wall built of radial, fibrous calcite crystals. The thickness of the wall is approximately half of the cyst inner diameter. The inner surface of the wall is smooth, the outer surface is uneven. The wall is separated from the infilling by a thin dark layer. Cyst diameter: 350 μm. Thickness of the wall: 60 μm.

Range. — Late Oxfordian–Berriasian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Colomisphaera cieszynica Nowak, 1968

Pl. II, Fig. 9

1968 *Colomisphaera cieszynica* n. sp.; W. Nowak, p. 309, 310, pl. 30, figs. 1–5.

Description. — Sphaerical cyst with the one layered wall built of the radially arranged, long, fibrous calcite crystals. Thickness of the wall is equal to the inner diameter of the cysts. Both margins of the wall are uneven. Thin dark layer separates the inner margin from the infilling of the cyst. Cyst diameter: 450 μm. Thickness of the wall: 140 μm.

Range. — Kimmeridgian–Early Valanginian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Colomisphaera conferta Řehánek, 1985

Pl. II, Fig. 13

1985a *Colomisphaera conferta* n. sp.; J. Řehánek, p. 171–173, pl. 1, figs. 1–8.

Description. — Sphaerical to slightly oval cyst with a one-layered wall built of the radially arranged, tightly packed, fibrous calcite crystals. The outer margin of the wall is uneven, the inner margin, more or less smooth with the rim of the dark pigment. Cyst diameter: 450 μm. Thickness of the wall: 30–40 μm.

Range. — Late Berriasian–Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones, Upper Cieszyn Shales.

Colomisphaera fortis Řehánek, 1982

Pl. II, Fig. 10

1982 *Colomisphaera fortis* n. sp.; J. Řehánek, p. 220, 221, pl. 1, figs. 1–8.

Description. — Sphaerical to oval cyst with a one-layered wall built of the radially arranged, short, block-like, uneven calcite crystals. The inner margin of the wall is separated from the infilling by a very thin, dark layer. Cyst diameter: 300 μm. Thickness of the wall: 20–30 μm.

Range. — Late Middle Tithonian–?Early Berriasian.

Occurrence. — Cieszyn Limestones.

Colomisphaera heliosphaera (Vogler, 1941)

Pl. II, Fig. 4

1941 *Cadosina heliosphaera* n. sp.; J. Vogler, p. 281, pl. 20, fig. 6.
1993 *Colomisphaera heliosphaera* (Vogler); J. Řehánek, F. Cecca, p. 154, text-fig. 6D, pl. 1, fig. 5.

Description. — Sphaerical cyst with a one-layered wall built of the radially arranged, tightly packed fine calcite crystals. The cyst differs from C. carpathica (Borza) by its smaller size. Cyst diameter: 250–300 μm. Thickness of the wall: 60 μm.

Range. — ?Oxfordian–Early Albian.

Occurrence. — Middle part of the Cieszyn Limestones, Upper Cieszyn Shales.

Colomisphaera lapidosa (Vogler, 1941)

Pl. II, Fig. 12

1941 *Cadosina lapidosa* n. sp.; J. Vogler, p. 281, pl. 21, fig. 58.
1993 Colomisphaera lapidosa (Vogler); J. Řehánek, F. Cecca, p. 153, 154, text-fig. 6E, pl.1, fig. 4.

Description. — Sphaerical cyst, with a one-layered wall composed of radially arranged, block-like calcite crystals. Both margins of the wall are uneven. Cyst diameter: 270–300 μm. Thickness of the wall: 80 μm.

Range. — Oxfordian–Berriasian.

Occurrence. — Upper part of the Lower Cieszyn Shales–early part of the Cieszyn Limestones.

Colomisphaera lucida Borza, 1986

Pl. II, Fig. 16

1986 *Colomisphaera lucida* n. sp.; K. Borza, p. 27, text-fig. 7, pl. 4, figs. 1–12.

Description. — Sphaerical cyst with a one-layered wall built of the radially arranged, fine, short calcite crystals. Both margins of the wall are more or less even. In transmitted light the wall is milky white. Cyst diameter: 300 μm. Thickness of the wall: 30–50 μm.

Range. — Late Tithonian–Aptian.

Occurrence. — Upper part of the Lower Cieszyn Shales–middle part of the Cieszyn Limestones.

Colomisphaera radiata (Vogler, 1941)

Pl. III, Fig. 1

1941 *Cadosina radiata* n. sp.; J. Vogler, p. 281, pl. 20, fig. 4.
2000 *Colomisphaera radiata* (Vogler); D. Reháková, p. 84, pl. 2, figs. 1, 2.

Description. — Sphaerical cyst with a one-layered wall built of the radially arranged, short, thin fibrous calcite crystals. Both margins of the wall are even. In the transmitted light the cyst is slightly brownish. Cyst diameter: 250 μm. Thickness of the wall: 20–40 μm.

Range. — Late Kimmeridgian–Tithonian

Occurrence. — Upper part of the Lower Cieszyn Shales.

Colomisphaera tenuis (Nagy, 1966)

Pl. III, Fig. 2

1966 *Cadosina tenuis* n. sp.; I. Nagy, p. 93, pl. 1, fig. 18.
1993 *Colomisphaera tenuis* (Nagy); J. Řehánek, F. Cecca, p. 154, pl. 1, fig. 6.

Description. — Sphaerical, relatively small cyst with the one layered wall built of the radially arranged, fine short, irregular calcite crystals. Both margins of the wall are uneven. At the inner margin sometimes occurs the very thin layer of the dark, microgranular calcite. Cyst diameter: 200 μm. Thickness of the wall: 10 μm.

Range. — Middle Tithonian–Early Valanginian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Colomisphaera vogleri (Borza, 1969)

Pl. III, Fig. 3

1969 *Cadosina vogleri* n. sp.; K. Borza, p. 56, 57, pl. 56, figs. 12, 19; pl. 57, figs. 1–17.
2000 *Colomisphaera vogleri* (Borza); D. Reháková, p. 86, pl. 3, figs. 1, 2.

Description. — Sphaerical to oval cyst with a one-layered wall built of the radially arranged, short, fine calcite crystals. Both margins of the wall even. In the transmitted light the wall is slightly brownish. Cyst diameter: 300 μm. Thickness of the wall: 20 μm.

Range. — Early Valanginian–Early Aptian.

Occurrence. — Upper part of the Cieszyn Limestones, Upper Cieszyn Shales, Grodziszcze Beds.

Genus *Comittosphaera* Řehánek, 1985
Comittosphaera misolensis (Vogler, 1941)

Pl. III, Fig. 4

1941 *Cadosina misolensis* n. sp.; J. Vogler, p. 281, pl. 20, figs. 1b, 8.

Description. — Sphaerical cyst with a one-layered wall built of the radially arranged, fibrous calcite crystals. The outer margin of the wall is irregular. The inner margin is separated from the central infilling by a distinctive, brownish ring of the microcrystalline calcite. Cyst diameter: 400 μm. Thickness of the wall: 50 μm. The structure of the test suggests affiliation of the species to the genus *Comittosphaera*.

Range. — Tithonian–Berriasian–Hauterivian.

Occurrence. — Upper part of the Lower Cieszyn Shales–early part of the Cieszyn Limestones.

Comittosphaera ornata (Nowak, 1968)

Pl. III, Fig. 6

1968 *Colomisphaera ornata* n. sp.; W. Nowak, p. 308–310, pl. 31, figs. 4, 5.

Description. — Sphaerical cyst with a one layered wall. built of the radially arranged, long, fibrous calcite cristals. The outer margin of the wall more or less irregular. The inner margin is separated from the central infilling by a distinctive, brownish ring of the microcrystalline calcite. Cyst diameter: 400 μm. Thickness of the wall: 100 μm. The structure of the test suggests affiliation of the species to the genus *Comittosphaera*.

Range. — Tithonian.

Occurrence. — Middle part of the Lower Cieszyn Shales–early part of the Cieszyn Limestones.

Comittosphaera pulla (Borza, 1964)

Pl. III, Fig. 5

1964 *Stomiosphaera pulla* n. sp.; K. Borza, p. 192, pl. 2, figs. 1, 2.
1965 *Colomisphaera pulla* (Borza); W. Nowak, p. 310, 311, pl. 31, figs. 1, 2.
1969 *Cadosina pulla* (Borza); K. Borza, p. 53, 54, pl. 54, figs. 11–28.
1994 *Comittosphaera pulla* (Borza); D. Ivanova, p. 100, pl. 2, figs. 11, 12.

Description. — Sphaerical cyst with a two layered wall. The inner wall, dark in transmitted light, is composed of the microgranular calcite. The outer layer, vitreous in transmitted light is built of radially arranged calcite crystals. Cyst diameter: 300–400 μm. Thickness of the inner layer: 20–30 μm, that of the outer layer: 30–40 μm.

Range. — ?Late Kimmeridgian–Middle Tithonian.

Occurrence. — Lower Cieszyn Shales–early part of the Cieszyn Limestones.

Comittosphaera sublapidosa (Vogler, 1941)

Pl. III, Fig. 7

1941 *Cadosina sublapidosa* n. sp.; J. Vogler, p. 280, pl. 20, fig. 5.
1994 *Comittosphaera sublapidosa* (Vogler); D. Ivanova, p. 99, 100, pl. 2, figs 9, 10.

Description. — Sphaerical cyst with two layered wall. The inner layer, dark in transmitted light, is composed of microgranular calcite. The outer layer, vitreous in transmitted light is composed of radially arranged, irregular, fine calcite crystals. The outer margin of the cyst is uneven. Cyst diameter: 350–400 μm. Thickness of the inner layer: 10–50 μm, that of the outer layer: 20–50 μm.

Range. — Tithonian–Hauterivian.

Occurrence. — Upper part of the Lower Cieszyn Shales.

Genus *Cadosinopsis* Scheibner, 1967
Cadosinopsis nowaki Borza, 1984

Pl. II, Fig. 14

1984c *Cadosinopsis nowaki* n. sp.; K. Borza, p. 650, pl. 1, figs. 1–12; pl. 2, figs. 1–12.

Description. — Sphaerical to slightly oval cyst with a two layered wall. The inner layer, vitreous in transmitted light is built of the coarse calcite crystals. Both margins of the layer are smooth and covered by a thin film of the dark calcite granules. The outer layer, white in transmitted light, is built of the radially arranged, short calcite crystals. The majority of the cyst diameter is occupied by a large, eccentrically situated

aperture. Cyst diameter: 300–400 μm. Thicknes of the outer layer: 25–30 μm, that of the inner layer varies from 0 to 60 μm.

Range. — Hauterivian.

Occurrence. — Grodziszcze Shales.

Genus *Parastomiosphaera* Nowak, 1968
Parastomiosphaera malmica (Borza, 1964)

Pl. III, Fig. 11

1964 *Stomiosphaera malmica* n. sp.; K. Borza, p. 192, pl. 1, figs. 5, 6.
1965 *Parastomiosphaera malmica* (Borza); W. Nowak, p. 298–301, pl. 27, figs. 3, 4.

Description. — Sphaerical to oval cyst with a two layered wall. The outer layer, milky white in transmitted light, is composed of the tightly packed calcite crystals. It produces an extinction cross under the crossed nicols. The inner margin of the layer is very irregular. The inner layer, dark in transmitted light, is composed of the fibrous calcite crystals. Cyst diameter: 330–500 μm. Thickness of the inner layer: 30–37 μm, that of the outer layer 20–25 μm.

Range. — Late Early Tithonian–Berriasian.

Occurrence. — Lower Cieszyn Shales, early part of the Cieszyn Limestones.

Genus *Carpistomiosphaera* Nowak, 1968
Carpistomiosphaera borzai (Nagy, 1966)

Pl. III, Fig. 8

1966 *Cadosina borzai* n. sp.; I. Nagy, p. 92, pl. 5, figs. 15, 16.
1968 *Carpistomiosphaera borzai* (Nagy); W. Nowak, p. 301–303, pl. 28, figs. 3, 4.

Description. — Sphaerical to slightly oval cyst with a two layered wall. Both layers of a similar thickness, are composed of the radially arranged, short, block-like calcite crystals. Margins of layers are distinct and even. Cyst diameter: 270–300 μm. Thickness of each wall: 25 μm.

Range. — Late Kimmeridgian–Middle Tithonian.
In the Marche Apennines the *Carpistomiosphaera borzai* Zone corresponds to the upper part of the Late Kimmeridgian ammonite *beckeri* Zone (Cecca, Řehánek, 1991).

Occurrence. — Sporadic occurrences in the upper part of the Lower Cieszyn Shales and the lowermost part of the Cieszyn Limestones.

Carpistomiosphaera tithonica Nowak, 1968

Pl. III, Fig. 9

1968 *Carpistomiosphaera tithonica* n. sp.; W. Nowak, p. 303, pl. 31, fig. 7.

Description. — Sphaerical cyst with a two layered wall. The outer wall, vitreous in transmitted light, is composed of the irregularly arranged, fibrous calcite crystals. Its outer margin is irregular, the boundary with the inner layer indistinct. The inner layer, much thinner as the outer one, is composed of radially arranged, short calcite crystals. In transmitted light is darker than the outer layer. Both margins of the inner layer are uneven. Cyst diameter: 400–500 μm. Thickness of the outer layer: 50–80 μm, that of the inner layer: 25–30 μm.

Range. — Tithonian.

Occurrence. — Upper part of the Lower Cieszyn Shales–early part of the Cieszyn Limestones.

Carpistomiosphaera valanginiana Borza, 1986

Pl. III, Fig. 10

1986 *Carpistomiosphaera valanginiana* n. sp.; K. Borza, p. 20–26, text-fig. 2, pl.1, figs. 1–6; pl. 2, figs. 1–6; pl. 3, figs. 1–6.
2000 *Carpistomiosphaera valanginiana* Borza; D. Reháková, p. 86, pl. 3, figs. 5, 6.

Description. — Oval to sphaerical cyst with a two layered wall. Both layers are composed of the radially arranged, tightly packed fibrous calcite crystals. Thickness of layers varies from equal to broader outer layer. The boundary between the two layers sometimes may be obscured. Commonly a large aperture is visible. Cyst diameter: 350–500 μm. Thickness of the outer layer: 25–60 μm, that of the inner layer: 20–30 μm.

Range. —?Late Berriasian–Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones, Upper Cieszyn Shales.

Genus *Stomiosphaerina* Nowak, 1974
Stomiosphaerina proxima Řehánek, 1987

Pl. II, Fig. 15

1987 *Stomiosphaerina proxima* n. sp.; J. Řehánek, p. 696–703, pl. 1, figs. 1–8.

Description. — Slightly oval cyst with the two layered wall. The outer layer, sphaerulitic in texture, is vitreous in transmitted light. It has variable thickness and uneven margins; under crossed nicols the layer gives the extinction cross. The inner layer, dark in transmitted light, is composed of the microcrystalline crystals. Cyst diameter: 300–500 μm. Thickness of the outer layer: 10–50 μm, that of the inner layer: 20–100 μm.

Remarks. — Řehánek (1987) assigned *S. proxima* to the Early Berriassian *Calpionella* Zone. However he reports among accompanying assemblage tintinnid species *Calpionellites darderi* (Colom) which appears in the Early Valanginian (Reháková, Michalík, 1997). Probably the author had in mind *Calpionellites dadayi* Knauer whose stratigraphic range encompass interval Berriassian–Valanginian.

Range. — Latest Tithonian–Early Valanginian.

Occurrence. — Uppermost part of the Cieszyn Limestones, Upper Cieszyn Shales.

Genus *Cadosina* Wanner, 1940
Cadosina fusca Wanner, 1940

Pl. II, Fig. 2

1940 *Cadosina fusca* n. sp.; J. Wanner, p. 79, text-figs. 19–30, pl. 1, figs. 1, 2; pl. 2, figs. 3, 4.

Description. — Sphaerical cyst with a one-layered wall built of the microcrystalline calcite particles. In the transmit-

ted light the wall is dark. Cyst diameter: 230–300 μm. Thickness of the wall: 30–40 m.

Range. — Latest Kimmeridgian–Early Albian.

Occurrence. — Upper part of the Cieszyn Limestones–early part of the Upper Cieszyn Shales.

Cadosina minuta Borza, 1980

Pl. II, Fig. 3

1980 *Cadosina minuta* n. sp.; K. Borza, p. 263, pl. 1, figs. 1–12.

Description. — Sphaerical cyst with a one layered, thin wall built of the microcrystalline calcite particles. In the transmitted light the wall is black. The center of the cyst filled with a glossy calcite. Cyst diameter: 200 μm. Thickness of the wall: 20–30 μm.

Range. — Middle Berriasian–Early Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones–early part of the Upper Cieszyn Shales.

Genus *Crustocadosina* Řehánek, 1985
Crustocadosina semiradiata (Wanner, 1940)

Pl. II, Fig. 1

1940 *Cadosina semiradiata* n. sp.; J. Wanner, p. 81, Figs. 36, 37.
1994 *Crustocadosina semiradiata* (Wanner); D. Ivanova, p. 89, 90, pl. I, fig. 8, 9.

Description. — Sphaerical to oval cyst with a two layered wall. The inner layer, dark in transmitted light, is composed of the microcrystalline calcite crystals. The outer layer is built of rather short radially arranged calcite crystals. Cyst diameter: 400–500 μm. Thickness of the inner layer varies depending of the section plane, but usually is at least equal to the outer layer. Thickness of the outer layer also varies but does not exceed 20–30 μm.

Range. — Late Oxfordian–Early Albian.

Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

FORAMINIFERA

The described and illustrated foraminifera are only those which have been recognised in thin sections. In majority of cases there are juvenile specimens or the early stages of common species. Many of them are reported from the Polish Carpathians for the first time. Foraminifera from the washed samples have also been studied by Szydło (1997,1999, 2003, 2004). Foraminiferal taxonomy follows schemes elaborated by Kaminski (2004) — agglutinated foraminifera; Loeblich and Tappan (1988) and Neagu (1984, 1994, 1995) — calcareous foraminifera.

Class FORAMINIFEREA d'Orbigny, 1926

Order **Astrorhizida** Lankester, 1885
Suborder Ammodiscida Mikhalevich, 1980

Family **Ammodiscidae** Reuss, 1862

Genus *Ammodiscus* Reuss, 1862
Ammodiscus sp.

Pl. IV, Fig. 4

Remarks. — Axial section shows sphaerical initial chamber and regularly enlarging second chamber. Diameter: 120 μm.

Occurrence. — Upper Cieszyn Shales (Lower Valanginian).

Genus *Glomospira* Rzehak, 1885
Glomospira variabilis (Kübler & Zwingli, 1870)

Pl. IV, Fig. 2

1870 *Cornuspira variabilis* n. sp; J. Kübler, H. Zwingli, p. 33, pl. 41, fig. 4 (*vide* Ellis, Messina, 1941–2004).
1968 *Glomospira variabilis* (Kübler & Zwingli); H. Oesterle, p. 711, 712, text-figs. 8, 10a–d.

Remarks. — Transverse section of specimen shows characteristic streptospiral to irregular coiling. Diameter: 750 μm

Range. — Late Jurassic–Berriasian–Hauterivian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones, Upper Cieszyn Shales.

Order **Lituolida** Lankester, 1885
Suborder Lituolina, 1885

Family **Ammosphaeroidinidae** Cushman, 1927

Genus *Thalmannammina* Pokorný, 1951
Thalmannammina neocomiensis Geroch, 1966

Pl. IV, Fig. 1

1962 *Thalmannammina neocomiensis* n. sp.; S. Geroch, p. 282–285, fig. 1 (a–h).

Remarks. — Saggital section shows streptospiral coiling mode of this juvenile specimen. Diameter: 100 μm

Range. — Berriasian–Cenomanian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones, Upper Cieszyn Shales.

Suborder Trochamminina Saidova, 1981

Family **Trochamminidae** Schwager, 1877

Genus *Trochammina* Parker & Jones, 1859
Trochammina vocontiana Moullade, 1960

Pl. IV, Fig. 11

1960 *Trochammina concava* Chapman var. *vocontiana*; M. Moullade, p. 200, pl. 1, fig. 1.

Remarks. — The specimen was sectioned close to the spiral side which gives the impression of the planispiral coiling. The section reveals initial part and about 5 trapezoidal cham-

bers of the last coil, quickly increasing in size. Wall finely agglutinated. Diameter: 270 µm.

Range. — Berriasian–Albian.

Occurrence. — Cieszyn Limestones, Upper Cieszyn Shales.

Suborder Verneuilina Mikhalevich & Kaminski, 2004

Family **Prolixoplectidae** Loeblich & Tappan, 1985

Genus *Protomarssonella* Desai & Banner, 1987
Protomarssonella hechti (Dieni & Massari, 1966)

Pl. V, Fig. 6

1966 *Dorothia hechti* n. sp.; I. Dieni, F. Massari, p. 106, 107, figs. 17–22; pl. 10, figs. 4–8.
1987 *Protomarssonella hechti* (Dieni & Massari); D. Desai, F.T. Banner, p. 24, pl. 5, figs. 3a–3d.

Remarks. — The longitudinal section through typical specimen in a form of a broad cone with the acute initial part and a broad apertural end. Length: 170–200 µm. Maximum width: 170 µm.

Range. — Tithonian–Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Protomarssonella kummi (Zedler, 1961)

Pl. V, Fig. 5

1961 *Marssonella kummi* n. sp.; B. Zedler, p. 31–32, pl. 7, fig. 1.
1987 *Protomarssonella kummi* (Zedler); D. Desai, F.T. Banner, p. 24, pl. 5, figs. 2a–2e.

Remarks. — Longitudinal section shows the typical specimen in form of a narrow cone with thick walls. Length: 170–220 µm. Maximum width: 50 µm.

Range. — Late Tithonian–Hauterivian.

Occurence. —Lower Cieszyn Shales, Cieszyn Limestones, Upper Cieszyn Shales.

Family **Vernuilinidae** Cushman,1911

Genus *Palaeogaudryina* Said & Bakarat, 1958
Palaeogaudryina magharaensis Said & Bakarat, 1958

Pl. IV, Fig. 12

1958 *Palaeogaudryina magharaensis* n. sp.; R. Said, M.G. Bakarat, p. 243, pl. 3, fig. 42; pl. 4, figs. 33, 36.

Remarks. — Longitudinal section of the well developed juvenile specimen shows the early triserial part with alternating globular chambers followed by a biserial stage seen from the side opposite to the terminal chamber. Height: 210 µm.

Range. — Late Kimmeridgian–Middle Berriasian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Family **Reophacellidae** Mikhalevich & Kaminski

Genus *Falsogaudryinella* Bartenstein, 1977
Falsogaudryinella neagui Bartenstein, 1981

Pl. V, Fig. 2

1981 *Falsogaudryinella neagui* n. sp.; H. Bartenstein, p. 319, figs. 3.8–11, 4.1–3.
1995 *Falsogaudryinella neagui* Bartenstein; M.A. Kaminski *et al.*, p. 148, pl. 1, figs. 18–23; pl. 4, figs.4, 5.

Remarks. — The longitudinal section reveals a trochospiral early whorl and a sack like chambers of the biserial part. Wall finelly agglutinated with calcareous cement. Lenght: 220–300 µm.

Range. — Middle Berriasian–Barremian.

Occurence. — Upper part of the Cieszyn Limestones.

Genus *Uvigerinammina* Majzon, 1943
Uvigerinammina uvigeriniformis (Seibold & Seibold, 1960)

Pl. V, Fig. 1

1960 *Gaudryina uvigeriniformis* n. sp.; E. Seibold, I. Seibold, p. 334, 335, text-fig. 8b, pl. 7, fig. 4.
1995 *Uvigerinammina uvigeriniformis* (Seibold & Seibold); T. Neagu, M. Neagu, p. 218, pl. 2, figs. 28–43; pl. 6, figs. 11–14.

Remarks. — Species reported for the first time from the Outer Carpathians. It occurs also in the Late Jurassic carbonate sediments of the Eurasian plate underlying the Carpathians and their foredeep. The longitudinal section shows characteristic uvigerinammine shape and arrangement of chambers. Length: 220–300 µm.

Range. — Kimmeridgian–Early Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Genus *Pseudoreophax* Geroch, 1961
Pseudoreophax cisovnicensis Geroch, 1961

Pl. IV, Fig. 13

1961 *Pseudoreophax cisovnicensis* n. sp.; S. Geroch, p. 160–163, text-fig. 1, pl. 17, figs. 1–20.
1990 *Pseudoreophax cisovnicensis* Geroch; S. Geroch, B. Olszewska, p. 531, pl. 3, figs. 1–11, 17; pl. 4, figs. 16–18, 23, 24, 28, 29, 33, 34.

Remarks. — In examined thin sections diversely oriented longitudinal sections of described specimens occur. The section in the pl. 4 resembles one of the holotype sections (fig. 1c) pictured by Geroch (1961) on text-fig 1. Length: 200–400 µm.

Range. — Tithonian–Barremian.

Occurrence. — Uppermost Lower Cieszyn Shales, Cieszyn Limestones, Upper Cieszyn Shales.

Genus *Belorussiella* Akimets, 1958
Belorussiella cf. *taurica* Gorbatchik, 1971

Pl. IV, Fig. 15

Remarks. — Longitudinal section shows specimen with slightly twisted biserial part and short initial triserial part. similar to *B. taurica* Gorbatchik (Gorbatchik, 1971). Length: 250–320 µm.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones (Upper Tithonian–Middle Berriasian).

Suborder Nezzazatina Kaminski, 2004

Family **Nautiloculinidae** Laeblich & Tappan, 1985

Genus *Nautiloculina* Mohler, 1938
Nautiloculina cretacea Peybernes, 1976

Pl. IV, Fig. 3

1976 *Nautiloculina cretacea* n. sp.; B. Peybernes, p. 398, pl. XL, figs. 15, 16.
1978 *Nautiloculina cretacea* Peybernes; A. Arnaud-Vanneau, B. Peybernes, p. 68–70, text-fig. 2/A, pl. 1, figs. 1–5; pl. 2, figs. 1–3.

Remarks. — The axial sections shows an oval outline and chambers with regular, high, arched shape. At the base of each chamber two characteristic projections of the spiral septum are visible. Their presence permits to distinguish genus *Nautiloculina* from *Charentia* (Arnaud-Vanneau, Peybernes, 1978). Length: 150 µm. Maximum width: 100 µm.

Range. — Berriasian–Hauterivian.

Occurrence. — Cieszyn Limestones, Upper Cieszyn Shales.

Order **Loftusiida** Kaminski & Mikhalevich, 2004
Suborder Loftusiina Kaminski & Mikhalevich, 2004

Family **Mesoendothyridae** Voloshinova, 1958

Genus *Mesoendothyra* Dain, 1958
Mesoendothyra involuta Neagu, 1999

Pl. IV, Fig. 9

1999 *Mesoendothyra involuta* n. sp.; T. Neagu, p. 292, text-fig. 3b, pl. 6, figs. 12–32; pl. 9, figs. 8, 9.

Remarks. — Axial sections display slightly steptospiral mode of the early coils, thick microgranular walls of chambers with traces of alveolar structure and a broadly rounded periphery. Height: 200 µm. Maximum width: 100 µm.

Range. — Late Tithonian–Early Valanginian.

Occurrence. — Lower Cieszyn Shales.

Mesoendothyra izjumiana Dain, 1958

Pl. IV, Figs. 5, 6

1958 *Mesoendothyra izjumiana* sp. n.; L.G. Dain, *In:* Bykova *et al.*, p. 20, 21, pl. 4, figs. 7–9.
2004 *Mesoendothyra izjumiana* Dain; D. Ivanova, E. Kolevo-Rekalova, p. 219, pl. 1, figs. 6–9.

Remarks. — The horizontal section shows planispiral coiling of the late coil, microgranular wall and thick imperforate septa. On the axial section visible typical asymetric mode of early coils and the thick microgranular wall. Diameter: 200 µm. Height: 200 µm. Width: 125 µm.

Range. — Late Oxfordian–Tithonian.

Occurrence. — Early to middle part of the Lower Cieszyn Shales.

Suborder Biokovinina Kaminski, 2004

Family **Charentiidae** Loeblich & Tappan, 1985

Genus *Charentia* Neumann, 1965
Charentia evoluta (Gorbatchik, 1968)

Pl. IV, Figs. 7, 8

1968 *Tonasia evoluta* n. sp.; T.N. Gorbatchik, p. 8, 9, pl. 2, fig. 1–5.
1985 *Charentia evoluta* (Gorbatchik); K.I. Kuznetsova, T.N. Gorbatchik, p. 82, 83, pl. 3, figs. 5, 6.

Remarks. — Thin sections usually display early, planispiral stages of the species. Chambers in the axial sections are clearly triangular without septal projections. In horizontal section they bear characteristic semi-rhomboidal shape. Height: 350 µm. Width: 350 µm.

Range. — Tithonian–Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Suborder Orbitolinina Kaminski, 2004

Family **Pfenderinidae** Smout & Sugden, 1962

Genus *Pfenderina* Henson, 1948
Pfenderina cf. *aureliae* Neagu, 1979

Pl. V, Fig. 4

Remarks. — Examined specimens show triangular outline and globular, rapidly enlarging chambers similar to *P. aureliae* Neagu (Neagu, 1979). Wall calcareous, microgranular. Length: 150–200 µm. Maximum width: 150 µm.

Occurrence. — Upper part of the Cieszyn Limestones, Upper Cieszyn Shales (Middle Berriasian–Valanginian).

Pfenderina cf. *flandrini* (Moullade, 1966)

Pl. V, Fig. 3

Remarks. — An elongated, compact test with conical initial part and thick walls closely ressembles *P. flandrini* (Moullade) (Moullade, 1966) but differs in being much smaller. Length: 200–250 µm.

Occurrence. — Cieszyn Limestones, lower part of the Upper Cieszyn Shales (Berriasian–Valanginian).

Family **Hauraniidae Septfontaine, 1988**

Genus *Pseudocyclammina* Yabe & Hanzawa, 1926
Pseudocyclammina lituus (Yokoyama, 1890)

Pl. IV, Fig. 10

1890 *Cyclammina lituus* n. sp.; M. Yokoyama, p. 26, pl. V, fig. 7.
2004 *Pseudocyclammina lituus* (Yokoyama); D. Ivanova, E. Koleva-Rekalova, p. 219, pl. 1, fig. 10.

Remarks. — Axial section displays all characteristic features of the species: slightly streptospiral coiling of the early coils, thick walls with thick septa and network of large canals. Height: 1270 µm. Width: >1000 µm.

Range. — Oxfordian–Berriasian.

Occurrence. — Lower Cieszyn Shales, early part of the Cieszyn Limestones.

Order **Textulariida** Delage & Herouard, 1896 emend. Kaminski, 2004
Suborder Textulariina Delage & Herouard, 1896

Family **Eggerellidae** Cushman, 1937

Genus *Pseudomorulaeplecta,* Neagu & Neagu, 1995
Pseudomorulaeplecta franconica (Gümbel, 1862)

Pl. V, Fig. 7

1862 *Textilaria franconica* n. sp.; C.W. Gümbel, p. 229, pl. 4, fig. 18 (*fide* Ellis, Messina, 1941–2004).
1995 *Pseudomorulaeplecta franconica* (Gümbel); T. Neagu, M. Neagu, p. 218, pl. 1, fig. 23–32.

Remarks. — Longitudinal section shows the initial trochospiral stage followed by biserial stage with low chambers. Rare in material studied. Length: 110–150 μm.
Range. — Oxfordian–Berriasian.
Occurrence. — Lower part of the Cieszyn Limestones.

Family **Pseudogaudryinidae** Loeblich & Tappan, 1985

Genus *Pseudoclavulina* Cushman, 1936
Pseudoclavulina sp.

Pl. IV, Fig. 14

Remarks. — Longitudinal section of presumably juvenile specimens with somewhat twisted early triserial stage and short uniserial stage with terminal aperture. Wall finelly agglutinated. The described specimens closely resemble *Pseudoclavulina* sp. reported by Seibold and Seibold (1960) from the Oxfordian sponge facies in the Southern Germany. Length: 750 μm.
Occurrence. — Lower Cieszyn Shales, early part of the Cieszyn Limestones (Upper Berriasian).

Family **Textulariidae** Ehrenberg, 1838

Genus *Textularia* Defrance, 1824
Textularia densa Hoffmann, 1967

Pl. V, Fig. 8

1967 *Textularia densa* n. sp.; E.A. Hoffman, p. 99, text-fig. 5, 5a.

Remarks. — Specimens characteristically narrow biserial throughout with low chambers. Frequent in material studied. *Textularia bettenstaedti* Bartenstein & Oertli (Bartenstein, Oertli, 1977) appears to be a younger synonym of the species. Length: 220–300 μm.
Range. — Tithonian–Berriasian.
Occurence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Suborder Involutinina Hohenegger & Piller, 1977

Family **Involutinidae** Bütschli, 1880

Genus *Andersenolina* Neagu, 1994
Andersenolina alpina (Leupold, 1936)

Pl. V, Fig. 9

1936 *Coscinoconus alpinus* n. sp.; W. Leupold, p. 610, pl. 18, figs. 1–8 (*fide* Ellis, Messina, 1941–2004).
1994 *Andersenolina alpina* (Leupold); T. Neagu, p. 133, text-fig. 4, figs. 3, 4, pl. 7, figs. 8, 9; pl. 8, figs. 1–10; pl. 12, figs. 1–5.

Remarks. — Small, conical form with an apical angle of 80–95° and 4 to 5 whorls of low chambers. Umbilical pores rarely visible, probably due to small size of specimens. Heigth: 180–250 μm. Maximum width: 270–300 μm.
Range. — Tithonian–Early Valanginian.
Occurrence. — Cieszyn Limestones.

Andersenolina elongata (Leupold, 1936)

Pl. V, Fig. 10

1936 *Coscinoconus elongatus* n. sp.; W. Leupold, p. 617, pl. 8, figs. 12–14 (*fide* Ellis, Messina, 1941–2004).
1994 *Andersenolina elongata* (Leupold); T. Neagu, p. 130, text-fig. 3, fig. 7, pl. 4, figs. 1–22; pl. 6, figs. 12–14; pl. 12, figs. 13–17.

Remarks. — Species characterised by its acute-elongate shape. It consists of over 10 whorls of low chambers. Complete specimens are rarely preserved due to considerable length. Heigth: 200–1000 μm. Maximum width: 80–150 μm.
Range. — Tithonian–Early Valanginian.
Occurrence. — Cieszyn Limestones.

Andersenolina histeri Neagu, 1994

Pl. V, Fig. 11

1994 *Andersenolina histeri* n. sp.; T. Neagu, p. 137, text-fig. 3, fig. 1–4, pl. 11, figs. 1–21, 23–25, 27–40; pl. 13, figs. 1–5.
2003 *Andersenolina histeri* Neagu; O. Dragastan, D. Richter, p. 90, pl. 10, fig. 17.

Remarks. — The species belongs to a high, conical forms with an apical angle between 60–80° and more than 6 whorls of low chambers. Thickened umbilical area bears traces of gross perforation characteristic for the genus. Heigth: 300–560 μm. Maximum width: 250–460 μm.
Range. — Tithonian–Middle Berriasian.
Occurrence. — Upper part of the Lower Cieszyn Shales, Cieszyn Limestones.

Genus **Ichnusella,** Dieni & Massar, 1966
Ichnusella burlini (Gorbatchik, 1959)

Pl. V, Fig. 14

1959 *Trocholina burlini* n. sp.; T.N. Gorbatchik, p. 81, pl. 4, figs. 3–5.
1995 *Ichnusella burlini* (Gorbatchik); T. Neagu, p. 271, 272, pl. 2, figs. 45–48; pl. 3, figs. 12–36, 40–48; pl. 13, fig. 10.

Remarks. — A low conical species with an apical angle of 100–115° and 4 to 5 whorls of low chambers. In well preserved specimens calcite crystals are visible on spiral and umbilical sides giving the test a rough appearance. Height: 120–200 μm. Maximum width: 430–500 μm.
Range. — Tithonian–Valanginian.
Occurrence. — Lower Cieszyn Shales.

Genus **Neotrocholina** Reichel, 1956
emended Neagu, 1995
Neotrocholina molesta (Gorbatchik, 1959)

PL. V, Fig. 12

1959 *Trocholina molesta* n. sp.; T.N. Gorbatchik, p. 79, pl. 4, figs. 1, 2.

1995 *Neotrocholina burgeri molesta* (Gorbatchik); T. Neagu, pl. 16–17, pl. 1, figs. 13–16, 21, 22, 25, 26; pl. 7, figs. 62–67, 70, 71; pl. 9, figs. 1–9; pl. 13, figs. 13, 25, 26.

Remarks. — A moderate conical species with an apical angle of 90 to 120°, 4 to 6 whorls of the low chambers. Test thin, not thickened by secondary lamellae. Heigth: 100–150 µm. Maximum width: 200–250 µm.

Range. — Tithonian–Barremian.

Occurrence. — Upper part of Cieszyn Limestones.

Family **Ventrolaminidae** Weynschenk, 1950

Genus *Protopeneroplis* Weynschenk, 1950

Protopeneroplis striata Weynschenk, 1950

Pl. V, Fig. 13

1950 *Protopeneroplis striata* n. sp.; R. Weynschenk, p. 13, pl. 2, figs. 12–14.

1999 *Protopeneroplis striata* Weynschenk; F. Schlagintweit, O. Ebli, p. 402, pl. 6, figs. 3, 4.

Remarks. — Sub-axial section of a rare specimen shows its planispiral mode of coiling and the two layered wall: microgranular (dark) and hyaline (light) characteristic for the species. Height: 250–300 µm. Maximum width: 110–130 µm.

Range. — Dogger–Malm.

Occurrence. — Lower Cieszyn Shales.

Protopeneroplis ultragranulata (Gorbatchik, 1971)

Pl. V, Figs. 15, 16

1971 *Hoeglundina* (?) *ultragranulata* n. sp.; T.N. Gorbatchik, p. 135, pl. 26, fig. 2.

1999 *Protopeneroplis ultragranulata* (Gorbatchik); F. Schlagintweit, O. Ebli, p. 402, 403, pl. 6, figs. 5, 6, 9.

Remarks. — The species differs from *P. striata* by its trochospiral mode of coiling, thickened (often recrystalised) hyaline layer especially in the early whorl, lack of microgranular/hyaline "striae" and by the presence of pustules on the spiral side. Height: 210—300 µm. Maximum width: 370–400 µm. Diameter: 280–350 µm.

Range. — Middle Late Tithonian–Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones, Upper Cieszyn Shales.

Suborder Spirillinina Hohenegger & Piller, 1975

Family **Patellinidae** Rhumbler,1906

Genus *Patellina* Williamson, 1858

Patellina subcretacea Cushman & Alexander, 1930

Pl. VI, Fig. 2

1930 *Patellina subcretacea* n. sp.; J.A. Cushman, C. Alexander, p. 10, pl. 3, fig. 1.

2001 *Patellina subcretacea* Cushman & Alexander; T. Neagu, P. Cîrnaru, p. 286, pl. 3, figs. 32–34.

Remarks. — Rare sections of this delicate species show characteristic low conical outline, and usually low, crescentic chambers of the last whorl. Diameter: 220–250 µm. Height: 70–100 µm.

Range. — Berriasian–Albian.

Occurrence. — Cieszyn Limestones, Upper Cieszyn Shales.

Suborder Miliolina Delage & Herouard, 1896

Family **Nubeculariidae** Jones, 1875

Genus *Hechtina* Bartenstein & Brand, 1949

Hechtina praeantiqua Bartenstein & Brand, 1949

Pl. VI, Fig. 3

1949 *Hechtina praeantiqua* n. sp.; H. Bartenstein, E. Brand, p. 669, figs. 1, 2.

1991 *Hechtina praeantiqua* Bartenstein & Brand; D. Altiner, p. 173, pl. 10, figs. 9, 10.

Remarks. — Transverse section shows irregularly coiled early stage, low inflated chambers and tendency to more regular coiling of the last whorl. Diameter: 150–250 µm.

Range. — Berriasian–Valanginian.

Occurrence. — Lower part of Cieszyn Limestones.

Family **Hauerinidae** Schwager, 1876

Genus *Decussoloculina* Neagu, 1984

Decussoloculina barbui Neagu, 1984

Pl. VI, Figs. 4, 5

1984 *Decussoloculina barbui* n. sp.; T. Neagu, p. 81, 82, pl. 2, figs. 8–12.

Remarks. — Studied sections represent juvenile specimens displaying only a quinqueloculine mode of coiling. In longitudinal sections specimens are fusiform, in transversal section they show specific X-like chamber arrangement in set of four chambers. Length: 250–450 µm. Maximum width: 150–200 µm.

Range. — Middle Tithonian–Valanginian.

Occurrence. — Lower Cieszyn Shales, Cieszyn Limestones.

Genus *Istriloculina* Neagu, 1984

Istriloculina fabaria Matsieva & Temirbekova, 1989

Pl. VI, Fig. 7

1989 *Istriloculina fabaria* n. sp.; T.V. Matsieva, U.T. Temirbekova, p. 117; pl. 1, fig. l–o.

Remarks. — Longitudinal section shows typical elliptical outline and low elongated chambers of each whorl. Transversal sections have typical triangular outline suggesting a pseudotriloculine mode of chamber's arrangement. Length: 125–200 µm. Width: 50–100 µm.

Range. — Tithonian–Berriasian.

Occurrence. — Upper part of the Lower Cieszyn Shales–middle part of Cieszyn Limestones, early part of the Upper Cieszyn Shales.

Istriloculina terekensis Matsieva & Temirbekova, 1989

Pl. VI, Fig. 8

1989 *Istriloculina terekensis* n. sp.; T.V. Matsieva, U.T. Temirbekova, p. 118, pl. 1, fig. s–u

Remarks. — The species differs from *I. fabaria* by subglobular outline of the transversal section and by higher number of chambers up to 10. Maximum diameter: 150–200 μm. Minimum diameter: 125–150 μm.

Range. — Tithonian–Berriasian.

Occurrence. — Upper part of the Lower Cieszyn Shales–lower part of the Cieszyn Limestones.

Genus *Rumanoloculina* Neagu, 1986
Rumanoloculina malitiosa Neagu, 1986

Pl. VI, Fig. 6

1986 *Rumanoloculina malitiosa* n. sp.; Neagu T., p. 316–319, text-fig. 1c–e, pl. 4, figs. 37–51.

Remarks. — Transverse sections reveal characteristic features of the species: two keels on each chamber of the last whorl and a semi-planispiral arrangement of chambers of the last whorl. Maximum diameter: 150–250 μm. Minimum diameter: 100–150 μm.

Range. — Berriasian—Early Aptian.

Occurence. — Lower part of the Cieszyn Limestones.

Genus *Scythiloculina* Neagu, 1984
Scythiloculina confusa Neagu, 1984

Pl. VI, Figs. 9, 10

1984 *Scythiloculina confusa* n. sp.; T. Neagu, p. 77, 78, pl. 1, figs. 1–8, 16.
2003 *Scythiloculina confusa* Neagu; O. Dragastan, D. Richter, p. 93, fig. 14.

Remarks. — Longitudinal and transverse sections show subglobular aspect of tests with more than 5 chambers in late whorls. Chamber arrangement seems to be irregular ("confusing") but they are added three at one cycle. Length: 175–250 m. Maximum width: 160–200 m.

Range. — Late Berriasian–Valanginian.

Occurrence. — Upper part of the Cieszyn Limestones.

Suborder Robertinina Loeblich & Tappan, 1984

Family **Epistominidae** Wedekind, 1937

Genus *Epistomina* Terquem, 1883
Epistomina ex gr. *caracolla* (Roemer, 1841)

Pl. VI, Fig. 11

Remarks. — Oblique or edge sections of specimens show usually a trochospiral mode of coiling with early whorls or chambers of the last whorl and traces of ornamentation in ornamented species. Height: 90–120 μm. Diameter: 200–300 μm.

Occurrence. — Lower Cieszyn Shales, Upper part of the Cieszyn Limestones, Upper Cieszyn Shales (Tithonian–Valanginian).

Family **Conorboididae** Thalmann, 1952

Genus *Conorboides* Hofker,1952
Conorboides cf. *tomaszowiensis* (Sztejn, 1957)

Pl. VI, Fig. 12

Remarks. — The convex spiral side, slightly concave umbilical side and acute peripheral margin, visible on the vertical section, suggest affinity of examined specimen to *Conorboides tomaszowiensis* (Sztejn) (Sztejn, 1957). Diameter: 200 μm. Height: 90 μm.

Occurrence. — Upper Cieszyn Shales (Valanginian).

Suborder Rotaliina Delage & Herouard, 1896

Family **Placentulinidae** Kasimova, Poroshina & Geodakchan, 1980

Genus *Paalzowella* Cushman, 1933
Paalzowella fefeli (Paalzow, 1932)

Pl. VI, Fig. 13

1932 *Trocholina feifeli* n. sp.; S. Paalzow, p. 140, pl. 9, figs. 6, 7.
1984 *Paalzowella fefeli* (Paalzow); K. Malik, B. Olszewska, p. 325, pl. 9, figs. 1, 2.

Remarks. — Axial section shows characteristic medium conical outline of the test, 5–6 whorls and more or less preserved elevated spiral suture. Diameter: 200–300 m. Height: 90–120 m.

Range. — Malm–Berriasian–Hauterivian.

Occurence. — Lower Cieszyn Shales–lower part of the Cieszyn Limestones.

Family **Discorbidae** Ehrenberg, 1838

Genus *Mohlerina* Bucur, Senowbari-Daryan & Abate, 1996
Mohlerina basiliensis (Mohler, 1938)

Pl. VI, Fig. 1

1938 *Conicospirillina basiliensis* n. sp.; W. Mohler, p. 27, 28, pl. 4, fig. 5.
1996 *Mohlerina basiliensis* (Mohler); I. Bucur *et al.*, p. 70–74, pl. 3, figs. 3–6; pl. 4, figs. 2, 3, 5–9.

Remarks. — Numerous diversely oriented sections reveal a trochospiral mode of coiling, low conical outline and characteristic two layered wall: inner, dark, microgranular, outer, clear, hyaline, often with calcite crystals. Rare transverse sections show that the species is composed rather of separated chambers than undivided tube. Diameter: 270–300 μm.

Range. — Oxfordian–Valanginian.

Occurrence. — Lower Cieszyn Shales.

CONCLUSIONS

Investigations of thin sections shed a new light on microfossil communities of the Cieszyn Beds, the earliest sediments of the Outer Carpathians. Associations of tintinnids, although poor, follow the regional stratigraphical scheme (Reháková, 1995). The calcareous dinocysts, so successfully applied to biostratigraphical research in Carpathians by Nowak, also fit, in their distribution, to the regional zonations (Reháková, 2000).

Shallow water foraminifera, reported here for the first time, provide information about the age and microenvironments of carbonate platforms surrounding the Silesian basin. Broad palaeogeographic distribution of many taxa suggest that expanding Outer Carpathians' basin was situated on migration routes of foraminifera (*Pseudocyclammina, Charentia, Nautiloculina, Protopeneroplis, Pfenderina*) that traversed extensive shoals of the southern edge of the European platform from the South France to Crimea.

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PLATES

Plate I

Fig. 1, 2. *Chitinoidella boneti* Doben, × 800, Cisownica–Tuł 7, Lower Cieszyn Shales, Middle Tithonian

Fig. 3. *Praetintinnopsella andrusovi* Borza × 800, Puńców 3, Lower Cieszyn Shales, Middle Tithonian

Fig. 4. *Calpionella elliptalpina* Nagy, × 800, Cisownica–Tuł 108, Cieszyn Limestones, Upper Tithonian

Fig. 5. *Calpionella alpina* Lorenz, × 400, Góra Zamkowa 36, Cieszyn Limestones, Middle Berriasian

Fig. 6. *Calpionella elliptica* Cadish, × 400, Góra Zamkowa 36, Cieszyn Limestones, Middle Berriasian

Fig. 7. *Tintinnopsella subacuta* Colom, × 800, Kamienica III 62, Cieszyn Limestones, Upper Berriasian

Fig. 8. *Tintinnopsella carpathica* (Murgeanu & Filipescu), × 800, Wapienica Fabryczna 59, Cieszyn Limestones, Middle Berriasian

Fig. 9. *Tintinnopsella colomi* Boller, × 800, Wapienica Fabryczna 114, Cieszyn Limestones, Upper Berriasian

Fig. 10. *Tintinnopsella longa* (Colom), × 800, Cisownica–Tuł 185, Cieszyn Limestones, Upper Berriasian

Fig. 11. *Calpionellopsis oblonga* (Cadish), × 800, Cisownica–Tuł 185, Cieszyn Limestones, Upper Berriasian

Fig. 12. *Crassicollaria brevis* Remane, × 800, Kozy 10, redeposited to Cieszyn Limestones, Upper Berriasian

Fig. 13. *Crassicollaria intermedia* Durand Delga, × 400, Góra Zamkowa 7, redeposited to Cieszyn Limestones, Lower Berriasian

Fig. 14. *Crassicollaria parvula* Remane, × 400, Kamienica I–II 17, Cieszyn Limestones, Lower Berriasian

Fig. 15. *Crassicollaria posttithonica* Nowak, × 400, Kamienica I–II 7, Cieszyn Limestones, Lower Berriasian

Fig. 16. *Calpionellopsis simplex* (Colom), × 250, Cisownica–Tuł 185, Cieszyn Limestones, Upper Berriasian

Fig. 17. *Remaniella filipescui* Pop, × 400, Góra Zamkowa 70, Cieszyn Limestones, Lower Valanginian

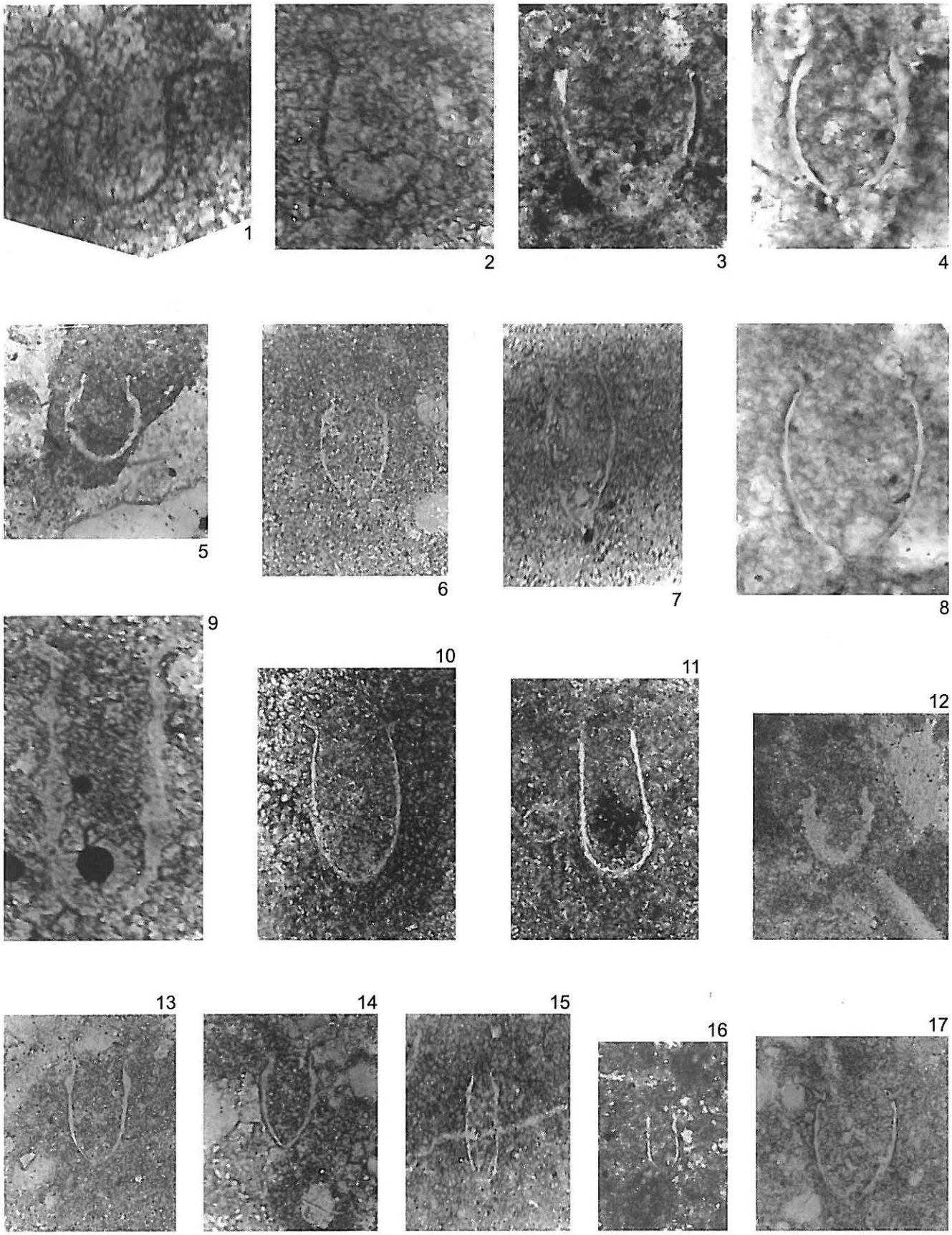
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Plate II

Fig. 1. *Crustocadosina semiradiata* (Wanner), × 800, Wapienica Fabryczna 138, Cieszyn Limestones, Upper Berriasian

Fig. 2. *Cadosina fusca* Wanner, × 800, Kozy 64, Cieszyn Limestones, Upper Berriasian

Fig. 3. *Cadosina minuta* Borza, × 800, Olza 22, Cieszyn Limestones, Middle Berriasian

Fig. 4. *Colomisphaera heliosphaera* (Vogler), × 800, Olza 23, Cieszyn Limestones, Middle Berriasian

Fig. 5. *Stomiosphaera echinata* Nowak, × 800, Hałcnów 54 093, Grodziszcze Shales, Hauterivian

Fig. 6. *Stomiosphaera moluccana* Wanner, × 800, Kamienica I–II 3, Lower Cieszyn Shales, Upper Tithonian

Fig. 7. *Stomiosphaera polygona* Vogler, × 800, Hałcnów 54 093, Grodziszcze Shales, Hauterivian

Fig. 8. *Colomisphaera carpathica* (Borza), × 800, Cisownica–Tuł 78, Cieszyn Limestones, Upper Tithonian

Fig. 9. *Colomisphaera cieszynica* Nowak, × 800, Kamienica I–II 9, Cieszyn Limestones, Lower Berriasian

Fig. 10. *Colomisphaera fortis* Řehánek, × 800, Cieszyn IG 1 85, Lower Cieszyn Shales, Upper Tithonian

Fig. 11. *Stomiosphaera wanneri* Borza, × 800, Kamienica III 164, Upper Cieszyn Shales, Lower Valanginian

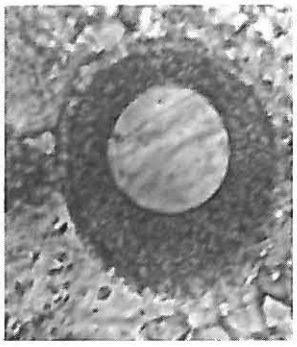
Fig. 12. *Colomisphaera lapidosa* (Vogler), × 800, Cisownica 2, upper part of the Lower Cieszyn Shales, Upper Tithonian

Fig. 13. *Colomisphaera conferta* Řehánek, Kamienica III 123, Upper Cieszyn Shales, Lower Valanginian

Fig. 14. *Cadosinopsis nowaki* Borza, × 800, Lipnik 60 136, Grodziszcze Shales, Hauterivian

Fig. 15. *Stomiosphaerina proxima* Řehánek, × 800, Kamienica I–II 48, Cieszyn Limestones, Lower Valanginian.

Fig. 16. *Colomisphaera lucida* Borza, × 800, Cisownica 4, Lower Cieszyn Shales, Upper Tithonian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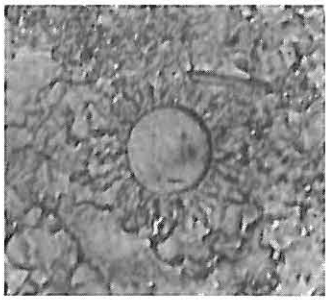
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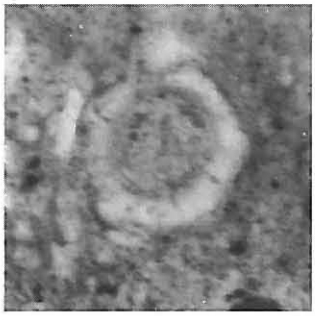
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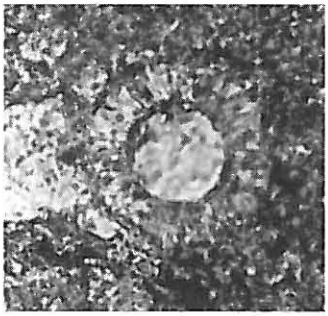
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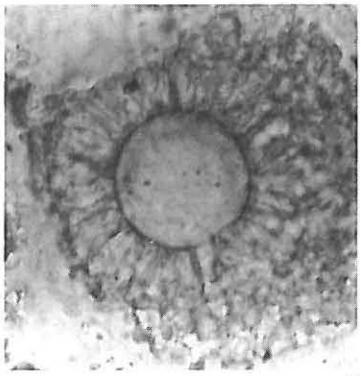
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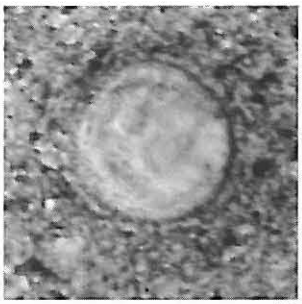
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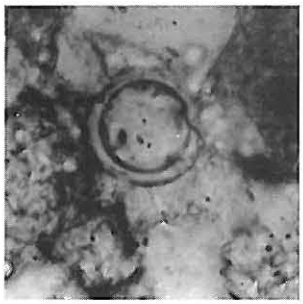
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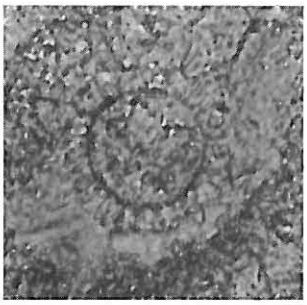
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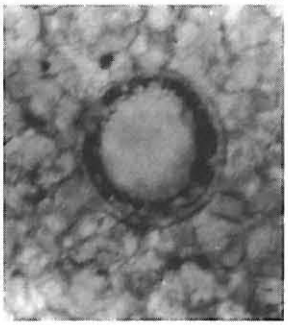
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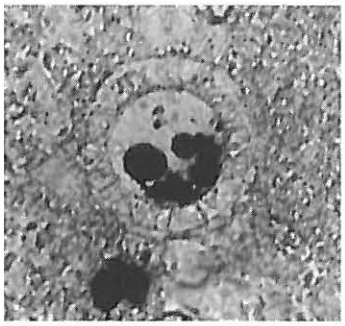
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Plate III

Fig. 1. *Colomisphaera radiata* (Vogler), × 800, Puńców 10, Lower Cieszyn Shales, Middle Tithonian

Fig. 2. *Colomisphaera tenuis* (Nagy), × 800, Kamienica I–II 2, Lower Cieszyn Shales, Upper Tithonian

Fig. 3. *Colomisphaera vogleri* (Borza), × 800, Kamienica III 181, Upper Cieszyn Shales, Lower Valanginian

Fig. 4. *Comittosphaera misolensis* (Vogler), × 800, Cisownica–Tuł 78, Cieszyn Limestones, Upper Tithonian

Fig. 5. *Comittosphaera pulla* (Borza), × 800, Puńców 3, Lower Cieszyn Shales, Middle Tithonian

Fig. 6. *Comittosphaera ornata* (Nowak), × 800, Kamienica I–II 2, Lower Cieszyn Shales, Upper Tithonian

Fig. 7. *Comittosphaera sublapidosa* (Vogler), × 800, Kamienica I–II 3, Lower Cieszyn Shales, Upper Tithonian

Fig. 8. *Carpistomiosphaera borzai* (Nagy), × 800, Cisownica–Tuł 39, Lower Cieszyn Shales, Middle Tithonian

Fig. 9. *Carpistomiosphaera tithonica* Nowak, × 400, Cisownica–Tuł 36, Lower Cieszyn Shales, Middle Tithonian

Fig. 10. *Carpistomiosphaera valanginiana* Borza, × 800, Kamienica III 123, Upper Cieszyn Shales, Upper Berriasian

Fig. 11. *Parastomiosphaera malmica* (Borza), × 800, Kamienica I–II 3, Lower Cieszyn Shales, Upper Tithonian

Fig. 12. *Koskinobullina socialis* Cherchi & Schroeder, × 200, Cisownica–Tuł 78, Lower Cieszyn Shales, Upper Tithonian

Fig. 13. *Clypeina* sp., transversal section, × 200, Wapienica Fabryczna 153, Cieszyn Limestones, Lower Valanginian

Fig. 14. *Terebella lapilloides* Münster, transversal section, × 200, Cisownica–Tuł 78, Lower Cieszyn Shales, Upper Tithonian

Fig. 15. *Charophyta* (*Clavatoracea*), transverse section of stem internode, × 200, Cisownica–Tuł 178, Cieszyn Limestones, Upper Berriasian

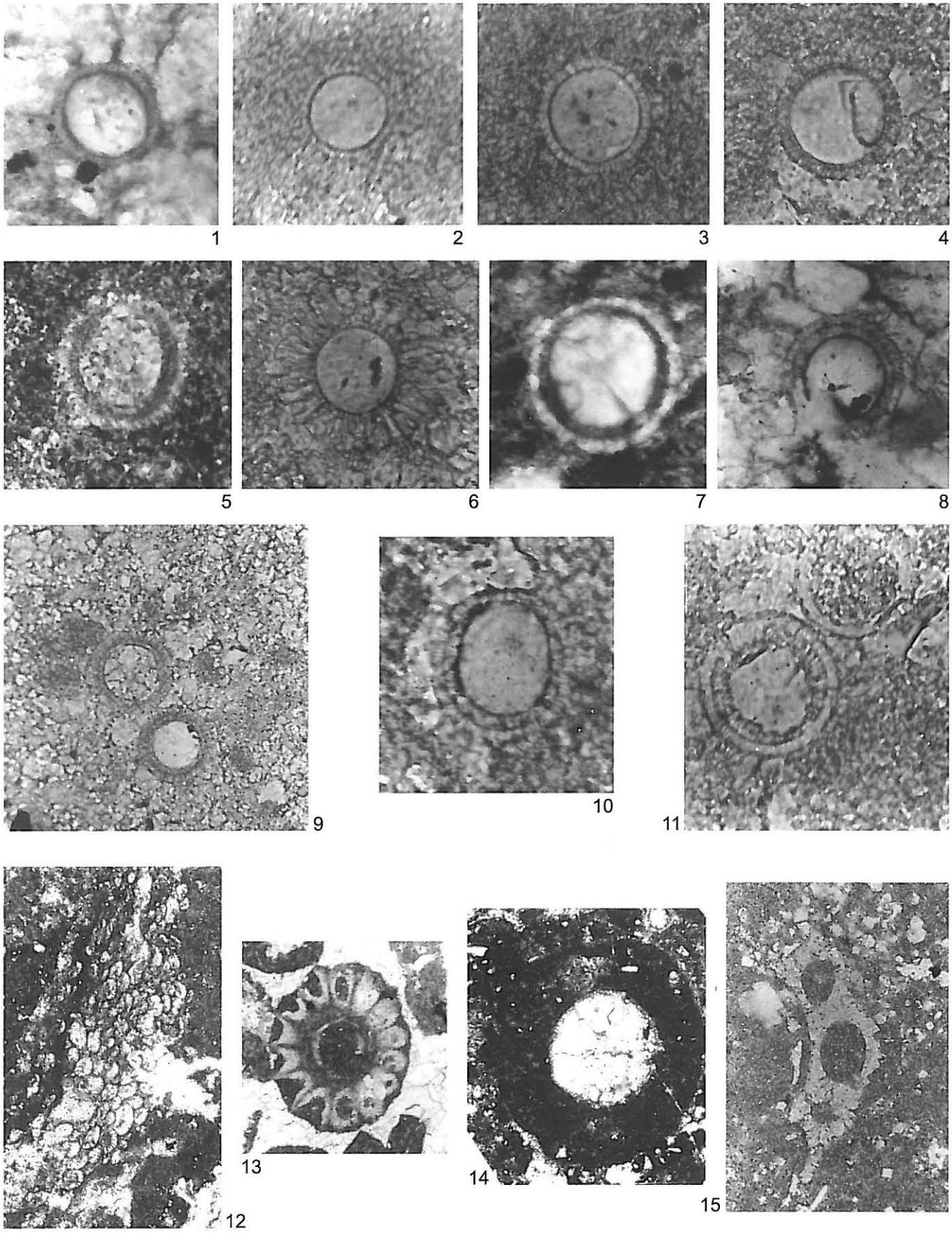
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Plate IV

Fig. 1. *Thalmannammina neocomiensis* Geroch, sagital section, × 400, Kamienica III 81, Cieszyn Limestones, Upper Berriasian

Fig. 2. *Glomospira variabilis* Kübler & Zwingli, transverse section, × 200, Kamienica III 205, Upper Cieszyn Shales, Lower Valanginian

Fig. 3. *Nautiloculina cretacea* Peybernes, axial section, × 200, Cisownica 24, Upper Cieszyn Shales, Lower Valanginian.

Fig. 4. *Ammodiscus* sp., axial section, × 400, Kamienica III 205, Upper Cieszyn Shales, Lower Valanginian

Figs. 5, 6. *Mezoendothyra izjumiana* Dain, 5 — horizontal section, × 200, 6 — axial section, × 200, Gumna 3, Lower Cieszyn Shales, Upper Tithonian

Figs. 7, 8. *Charentia evoluta* (Gorbatchik), 7 — axial section, × 80, 8 — horizontal section, × 200, Wapienica Fabryczna 138, Cieszyn Limestones, Upper Beriasian.

Fig. 9. *Mesoendothyra involuta* Neagu, axial section, × 200, Cisownica 11, Lower Cieszyn Shales, Lower Berriasian

Fig. 10. *Pseudocyclammina lituus* (Yokoyama), axial section, × 80, Cisownica 5, Lower Cieszyn Shales, Upper Tithonian

Fig. 11. *Trochammina vocontiana* Moullade, horizontal section, × 80, Cisownica–Tuł 185, Cieszyn Limestones, Upper Berriasian

Fig. 12. *Palaeogaudryina magharaensis* Said & Bakarat, longitudinal section, × 200, Olza 25, Cieszyn Limestones, Middle Berriasian

Fig. 13. *Pseudoreophax cisownicensis* Geroch, longitudinal section, × 200, Olza 25, Cieszyn Limestones, Middle Berriasian

Fig. 14. *Pseudoclavulina* sp., longitudinal section, × 400, Cisownica 2, Cieszyn Limestones, Upper Berriasian

Fig. 15. *Belorussiella* cf. *taurica* Gorbatchik, tangential longitudinal section, × 200, Olza 22, Cieszyn Limestones, Middle Berriasian


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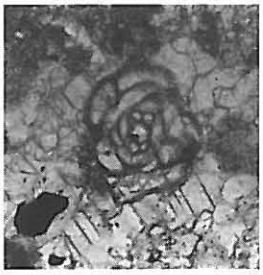
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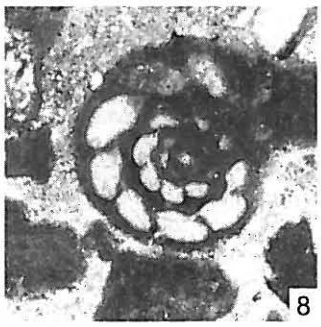
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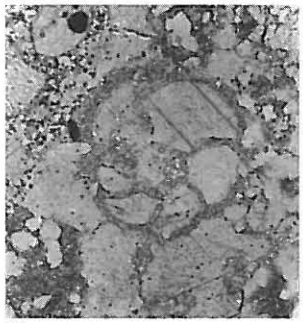
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Plate V

Fig. 1. *Uvigerinammina uvigeriniformis* (Seibold & Seibold), longitudinal section, × 200, Kamienica I–II 62, Cieszyn Limestones, Lower Valanginian

Fig. 2. *Falsogaudryinella neagui* Bartenstein, longitudinal section, × 200, Cisownica–Tuł 111, Cieszyn Limestones, Middle–Upper Berriasian

Fig. 3. *Pfenderina* cf. *flandrini* Neagu, longitudinal section, × 200, Cisownica 24, Upper Cieszyn Shales, Lower Valanginian

Fig. 4. *Pfenderina* cf. *aureliae* Neagu, longitudinal section, × 200, Olza 25, Cieszyn Limestones, Middle Berriasian

Fig. 5. *Protomarssonella kummi* (Zedler), longitudinal section, × 200, Kamienica III 45, Cieszyn Limestones, Middle Berriasian

Fig. 6. *Protomarssonella hechti* (Dieni & Massari), longitudinal section, × 200, Wapienica Fabryczn 17a, Cieszyn Limestones, Lower Berriasian

Fig. 7. *Pseudomorulaeplecta franconica* (Gümbel), longitudinal section, × 200, Olza 25, Cieszyn Limestones, Middle Berriasian

Fig. 8. *Textularia densa* Hoffman, longitudinal section, × 200, Cisownica 13, Cieszyn Limestones, Middle Berriasian

Fig. 9. *Andersenolina alpina* (Leupold), axial section, × 80, Olza 23, Cieszyn Limestones, Middle Berriasian

Fig. 10. *Andersenolina elongata* (Leupold), axial section, × 200, Cisownica–Tuł 108, Cieszyn Limestones, Lower Berriasian

Fig. 11. *Andersenolina histeri* Neagu, axial section, × 80, Olza 23, Cieszyn Limestones, Middle Berriasian

Fig. 12. *Neotrocholina molesta* (Gorbatchik), axial section, × 200, Cisownica–Tuł 108, Cieszyn Limestones, Berriasian

Fig. 13. *Protopenerolis striata* Weynschenk, sub-axial section, × 135, Nowa Marglownia 17, Lower Cieszyn Shales, Upper Tithonian

Fig. 14. *Ichnusella burlini* (Gorbatchik), axial section, × 80, Gumna 2, Lower Cieszyn Shales, Upper Tithonian

Fig. 15, 16. *Protopeneroplis ultragranulata* (Gorbatchik), 15 — oblique section, 16 — section parallel to plane of coiling, × 80, Wapienica Fabryczna 78, Cieszyn Limestones, Upper Berriasian

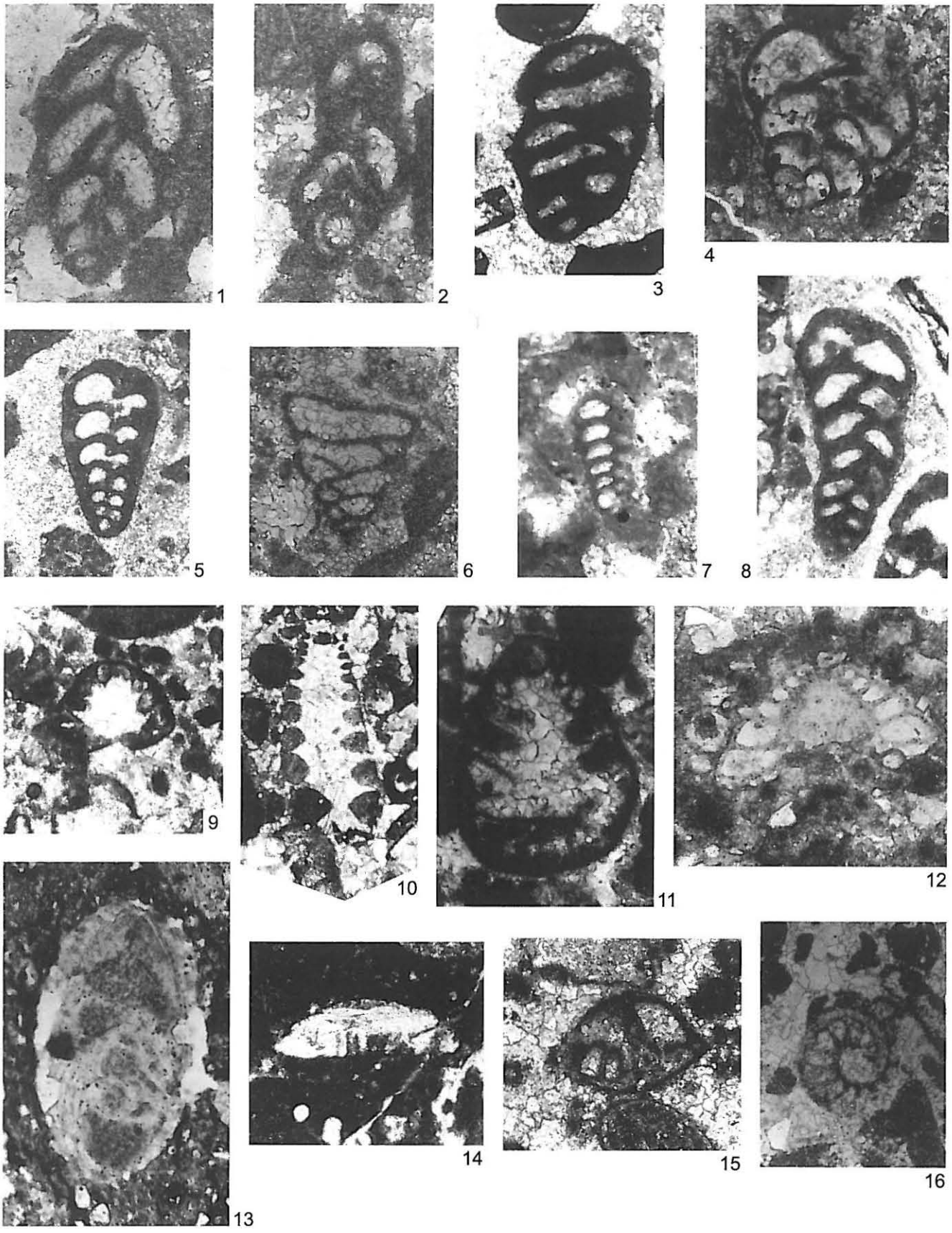
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Plate VI

Fig. 1. *Mohlerina basiliensis* (Mohler), axial section, × 200, Kamienica I–II 3, Lower Cieszyn Shales, Upper Tithonian

Fig. 2. *Patellina subcretacea* (Cushman & Alexander), axial section, × 200, Ciszyn IG 1, Upper Cieszyn Shales, Valanginian

Fig. 3. *Hechtina praeantiqua* Bartenstein & Brand, transverse section, × 200, Kamienica III 6, Cieszyn Limestones, Lower Berriasian

Figs. 4, 5. *Decussoloculina barbui* Neagu, 4 — longitudinal section, 5 — transversal section, × 200, Cisownica 13, Cieszyn Limestones, Middle–Upper Berriasian

Fig. 6. *Rumanoloculina malitiosa* Neagu, transversal section, × 200, Kamienica I–II 7, Cieszyn Limestones, Lower Berriasian

Fig. 7. *Istriloculina fabaria* Matsieva & Temirbekova, longitudinal section, × 200, Cieszyn IG 1, 2, Cieszyn Limestones, Upper Berriasian

Fig. 8. *Istriloculina terekiensis* Matsieva & Temirbekova, transversal section, × 200, Olza 25, Cieszyn Limestones, Middle Berriasian

Figs. 9, 10. *Scythiloculina confusa* Neagu, 9 — longitudinal section, 10 — transverse section, × 200, Kamienica I–II 58, Cieszyn Limestones, Lower Valanginian

Fig. 11. *Epistomina* ex gr *caracolla* (Roemer), oblique section, × 200, Cisownica–Tuł 185, Cieszyn Limestones, Upper Berriasian

Fig. 12. *Conorboides* cf. *tomaszowiensis* (Sztejn), vertical section, × 200, Kamienica III 207, Upper Cieszyn Shales, Lower Valanginian

Fig. 13. *Paalzowella feifeli* (Paalzow), axial section, × 200, Puńców 6, Lower Cieszyn Shales, Middle Tithonian


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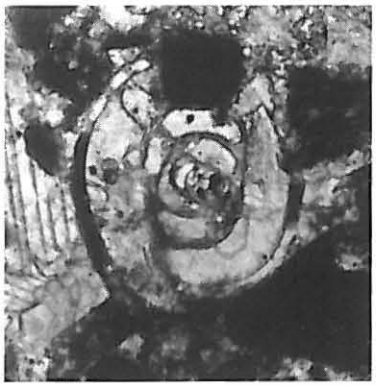
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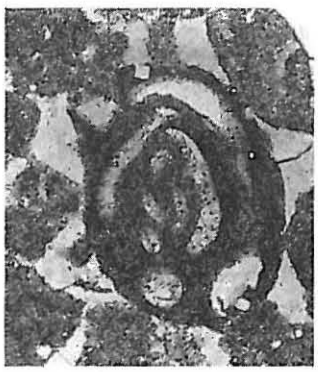
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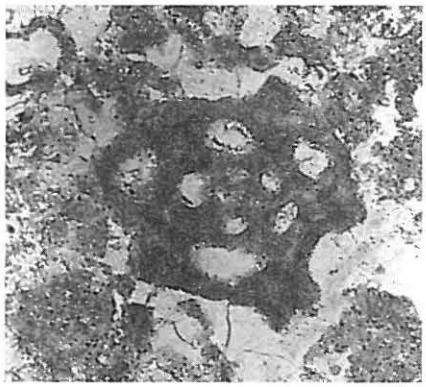
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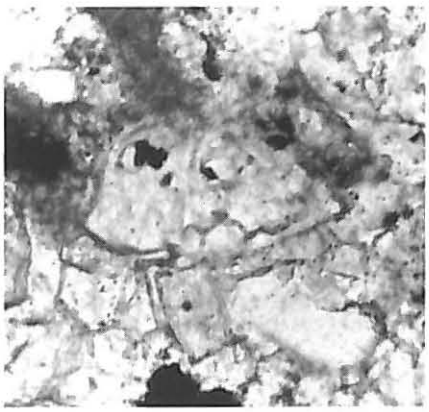
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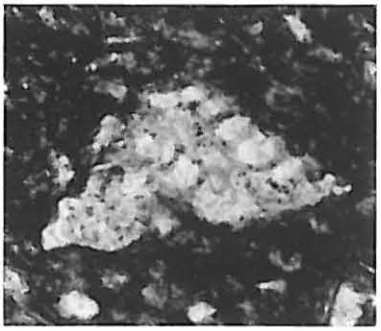
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