BARBARA OLSZEWSKA

Microfossils of the Upper Jurassic–Lower Cretaceous formations of the Lublin Upland (SE Poland) based on thin section studies

Polish Geological Institute Special Papers, 26

WARSZAWA 2010

CONTENTS

Polish Geological Institute Special Papers, 26 (2010): 1–56

Barbara OLSZEWSKA — **Microfossils of the Upper Jurassic–Lower Cretaceous formations of the Lublin Upland (SE Poland) based on thin section studies.** *Polish Geological Institute Special Papers,* 26: 1–56

Polish Geological Institute-National Research Institute, Carpathian Branch, Skrzatów St., 1,Pl-31-560 Kraków, Poland,
e-mail: barbara.olszewska@pgi.gov.pl.

Abstract. Microfacies studies show that the Upper Jurassic–Lower Cretaceous shallow-water, carbonate sediments of the SE Poland are rich in microfossils that supply additional data for stratigraphical and paleoenvironmental interpretation of formerly described subdivisions. Local equivalent of the European sponge megafacies (the Kraśnik Fm.) contains characteristic microfossils *Globuligerina oxfordiana* and *Colomisphaera fibrata*.

Foraminiferal species *Alveosepta jaccardi*, *Labirynthina mirabilis* and *Mesoendothyra izjumiana* identified in the Upper Jurassic subdivisions (the Bełżyce and Głowaczów formations) are known from Oxfordian–Kimmeridgian carbonate platforms of the Mediterranean Tethys. The transitional (Tithonian/Berriasian) character of the peri-reefal Babczyn Fm. is documented by occurrence of foraminifera (*Protopeneroplis ultragranulata*, *Monsalevia salevensis*) and calcareous dinocysts (*Carpistomiosphaera tithonica*, *Stomiosphaerina proxima*). The age of the siliciclastic Cieszanów Fm. is based on the Early Cretaceous foraminifera (*Meandrospira bancilai*, *Pfenderina neocomiensis*, *Stomatostoecha condensa*) and calcareous dinocysts (*Carpistomiosphaera valanginiana*, *Colomisphaera conferta*, *Stomiosphaera wanneri*).

Key words: microfossils, thin sections, Upper Jurassic, Lower Cretaceous, southeastern Poland.

Abstrakt. Badania mikrofacjalne utworów górnej jury i dolnej kredy południowo-wschodniej Polski wykazały, że utwory te zawierają liczne mikroskamieniałości, w sposób znaczący uzupełniające interpretacje wiekowe i paleośrodowiskowe wydzieleń litofacjalnych. Lokalny odpowiednik europejskiej megafacji gąbkowej – formacja kraśnicka – zawiera charakterystyczne gatunki: *Globuligerina oxfordiana* i *Colomisphaera fibrata*. Stwierdzone w utworach górnej jury (formacje bełżycka i głowaczowska) gatunki *Alveosepta jaccardi*, *Labirynthina mirabilis* i *Mesoendothyra izjumiana* znane są z węglanowych utworów oksfordu i kimerydu śródziemnomorskiej Tetydy. Przejściowy (tyton/berias) charakter peri-rafowej formacji z Babczyna określa występowanie otwornic (*Protopeneroplis ultragranulata*, *Monsalevia salevensis*) i wapiennych dinocyst (*Carpistomiosphaera tithnonica*, *Stomiosphaerina proxima*). Wiek silikoklastycznej formacji z Cieszanowa wyznacza obecność wczesnokredowych otwornic (*Meandrospira bancilai, Pfenderina neocomiensis*, *Stomatostoecha condensa*) i wapiennych dinocyst (*Carpistomiosphaera valanginiana*, *Colomisphaera conferta*, *Stomiosphaera wanneri*).

Słowa kluczowe: mikroskamieniałości, płytki cienkie, jura górna, kreda dolna, Polska południowo-wschodnia.

INTRODUCTION

The study area (Fig. 1) lies at the south-eastern edge of the Mid-Polish Trough along the margin of the East European Craton (Dadlez *et al*., 1995). The shallow water Upper Jurassic and Cretaceous sediments continue, further south-east into Ukrainian territory (the Volhynian–Podolian region) and into the south-west beneath the Carpathians (the Bilche–Volytsa

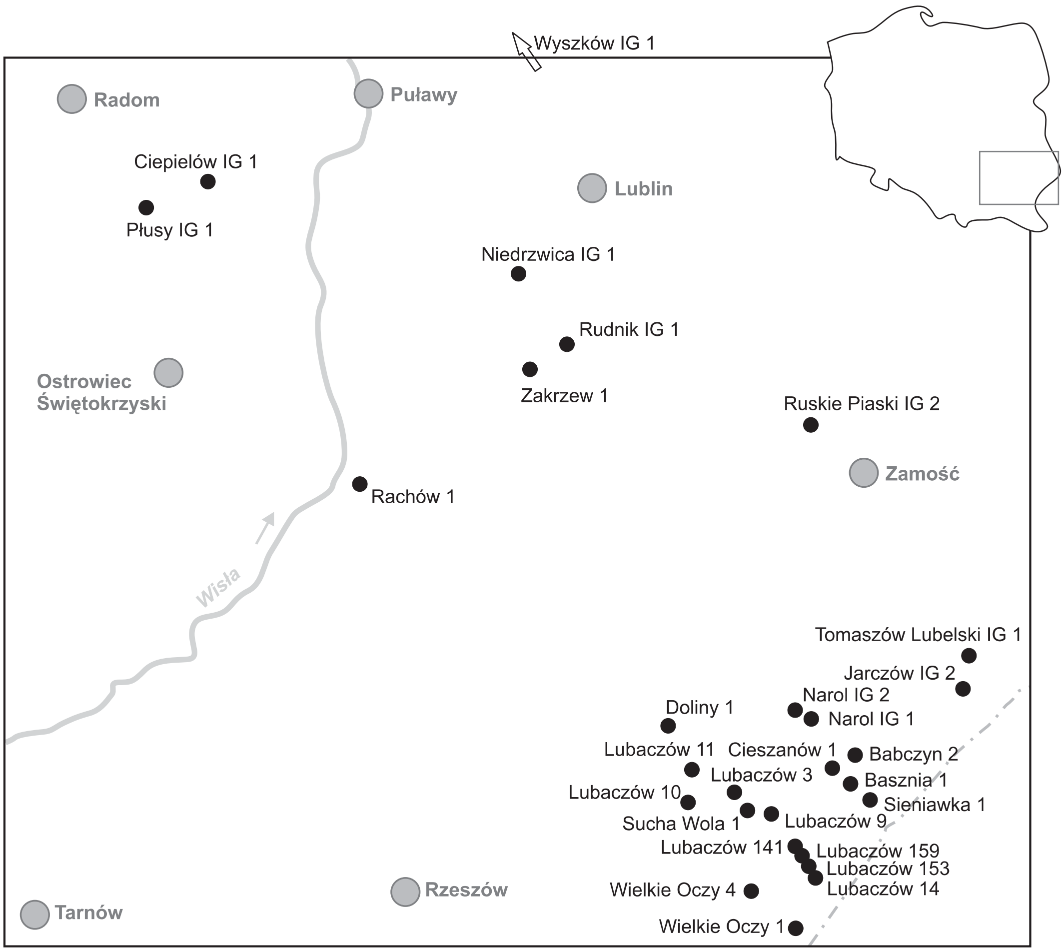


Fig. 1. Location of selected studied boreholes (after Niemczycka, 1976a, b)

Zone of Carpathian Foredeep). The geological structure of the region was the subject of intense and complex geological research (*vide* Marek, Pajchlowa, eds., 1997). Part of the research constituted micropaleontological studies carried out predominantly on soft, easy to process sediments (Niemczycka, 1976a; Sztejn, 1996; Dziadzio *et al*., 2004, Gutowski *et al*., 2005) while indurated deposits were mainly subjects of petrological examinations.

However, the last decades have brought about considerable progress in identification of microfossils of the indurated sediments observed in thin sections (Sliter, 1992, 1999; Coccioni *et al*., 1992; Bucur *et al*., 1993, 2005; Sykora *et al*., 1997; Ebli, Schlagintweit, 1998; Ivanova, 2000; Tasli, 2001; Ivanova, Koleva-Rekalova, 2004; Lakova *et al*., 2007; Ivanova *et al*., 2008). This made it possible to gather more information from the previously overlooked samples obtained from the Upper Jurassic and (as appeared in the course of the study), Lower Cretaceous sediments of the SE Poland. The last problem concerned with micropaleontological investigations based on thin section refers to the specific composition of the obtained assemblages that usually differ from composition of assemblages of the soft parts same sediment (*vide* Sztejn, 1996; Dziadzio *et al.*, 2004 – Fig. 32). It is due to subtle changes of depositional environment influencing living biota and taphocoenoses of amount of processed rock and simply in different mode of preparation that reveal different parts of the same assemblage.

Author's investigations disclosed the presence of foraminifera (over 50 species, many not reported from the area), calcareous dinocysts (15 species), calpionellids (3 species) both reported for the first time as well as numerous calcareous algae which shed a new light on the age and environment of the studied sediments. It provided supplementary data for the micropaleontological characteristics of the Upper Jurassic–Lower Cretaceous sediments of the Lublin Upland whose depositional architecture has been described recently (Gutowski *et al*., 2005).

MATERIAL AND METHODS

The investigated material came predominantly from the boreholes. Samples were kindly supplied by the Polish Geological Institute archives (Ciepielów IG 1, Babczyn 2, Basznia 1, Jarczów IG 2, Narol IG 1, Narol IG 2, Niedrzwica IG 1, Płusy IG 1, Rachów 1, Rudnik IG 1, Ruskie Piaski IG 1, Tomaszów Lubelski IG 1, Wyszków IG 1, Zakrzew 1 boreholes) and former Geological Bureau "Geonafta" – Jasło division (Cieszanów 1, Doliny 1, Lubaczów 3, Lubaczów 9, Lubaczów 11, Lubaczów 14, Lubaczów 141, Lubaczów 153, Lubaczów 159, Sieniawka 1, Sucha Wola 1, Wielkie Oczy 1, Wielkie Oczy 4 boreholes) (Fig. 1).

Thin sections were examined under a polar Nikon Labophot microscope. Photos of the microfossils were taken using a Nikon Microflex HFX-DX photomicrographic device.

GEOLOGICAL SETTING

The study area includes two large sedimentary areas of the Polish Lowland: the West European platform (the Mazury–Lublin Monocline) and the Middle Polish Through (the Lubaczów region) (Moryc, 1961; Niemczycka, Brochwicz Lewiński, 1988; Kowalska *et al*., 2000). According to paleontological data during the Late Jurassic the Polish Lowland was covered by rather shallow epicontinental sea occassionally connected with other marine realms: the Tethys ocean, the Boreal sea and other epicontinetal seas (Niemczycka *In*: Marek, Pajchlowa, 1997). The size and depth of the Late Jurassic basin was greatest in the Oxfordian while toward the end of Jurassic it gradually downsized to a small, brackish lagoon. The lagoon was surrounded in the north, north-west and east by land that supplied terrigenous material to the basin. In the south-east the marine lagoon merged into marginal marine marshes and deltaic sedimentary environments.

Diverse geotectonic history of investigated regions resulted in individual sedimentary profiles of the Upper Jurassic and Lower Cretaceous deposits.

The Mazury–Lublin Monocline. During the Late Jurassic the area was a site of carbonate sedimentation – "carbonate platform marine association" (Niemczycka, Brochwicz-Lewiński, 1988). In the lower (Oxfordian) part of succession the open shelf reefal, bioclastic and oolitic limestones predominate. In the upper (Kimmeridgian) part the increase of clastic material resulted in sedimentation of marly limestones and marls. In the southern part of the Monocline accumulated "continental-lagoon platform association" (Niemczycka, Brochwicz-Lewiński, 1988). The Oxfordian sediments are represented by aluvial variegated sandstones and mudstones and the dark mudstones with marsh plants. In the Kimmeridgian the deltaic and fluvial sedimentation was replaced by lagoonal deposits composed of anhydrites and dolomites. Lithological variability of the Upper Jurassic deposits of the Monocline led to discrimination of 11 lithostratigraphical subdivisions (Niemczycka, 1976a). The Lower Cretaceous deposits, have been described from the study area only recently (Olszewska, 2004, 2007b). The Berriassian age was attributed to the upper part of the Babczyn Formation on the base of index foraminifera and calcareous dinocysts. Overlying dark marly claystones, mudstones and limestones were identified as the Cieszanów Formation. Its age (Valanginian–Hauterivian) was determined on the presence of stratigraphically significant foraminifera.

The Lubaczów region. The region is characterised by a complex fault system and three distinct sedimentary-structural complexes: the Cambrian, the Ordovician–Silurian, and the Jurassic–Cretaceous complex. The Upper Jurassic limestones and marls of the third complex, occur on the Lubaczów–Uszkowce, Łukawiec–Wielkie Oczy and Kobylnica Wołoska blocks directly overlying Palaeozoic sediments (Moryc, 1961; Kowalska *et al*., 2000). Older (Oxfordian) sediments are represented by grey and light brown limestones with cherts overlied by oolithic and detrital limestones. Younger (Kimmeridgian–Tithonian) deposits are developed as anhydrites and dolomites and partly as detrital limestones (Kowalska *et al*., 2000; this paper). The Early Cretaceous (Berriassian–Valanginian) deposits are composed of oolithic-oncolithic and dolomitic limestones (in the lower part) and marly or arenaceous limestones (in the upper part). Recent paleontological investigations suggest the occurrence of Hauterivian or even Barremian deposits in the region (the Cieszanów and Białobrzegi Formations).Generally the Lower Cretaceous deposits on the investigated area represent the marine terrigenous association with prevalence of sands and clays in the north-west and the occurrence of limestones within sandy-clayey sequence in the south-east (Marek *In*: Marek, Pajchlowa, 1997a).

At the final stage of development of Mesozoic basin of the Polish Lowland the carbonate sedimentation prevailed. On the study area the Upper Cretaceous sediments occur exclusively in the Mazury–Lublin Monocline (Krassowska *In* Marek, Pajchlowa, 1997; Kowalska *et al*., 2000; Pióro, 2007). The end of Cretaceous is marked the inversion of the Middle Polish Through that continued up to the Early Eocene together with other tectonic phenomena (Marek *In*: Marek, Pajchlowa, 1997b). These tectonic phenomena may be related to geotectonic evolution of Western Tethys or Atlantic basins (Gutowski *et al*., 2005).

RESULTS OF THIN SECTION STUDIES

LITHOSTRATIGRAPHY

The following lithostratigraphical subdivisions of the Upper Jurassic–Lower Cretaceous sediments of the Lublin area have been studied for the presence of microfossils:

1. The "nodular layer" (uppermost Callovian–lowermost Oxfordian). The "nodular layer" regarded by Niemczycka (1976a) as an informal unit is composed of reddish nodular limestone with quartz and glauconite. It represents a condensed deposit including several ammonite zones (*Quenstedtoceras lamberti–Quenstedtoceras mariae*) of the Callovian/Oxfordian transition. (Niemczycka, 1976b; Gradstein *et al*., 2004).

The litofacies was studied in the Cieszanów 1 borehole at the depth of 1213.1 m where typical assemblage rich in planktonic microfossils (calcareous dinocysts, radiolaria, planktonic green algae, foraminifera) have been encountered. Foraminifera were represented predominantly by planktonic *Globuligerina oxfordiana* (Grigelis) with minor admixture of benthic species – e.g. *Ophthalmidium sagittum* (Bykova), *Protomarssonella donieziana* Dain, *Epistomina* sp. The calcareous dinocyst assemblage was composed mainly of *Colomisphaera fibrata* (Nagy), rare *Committosphaera czestochowiensis* Řehánek and *Schizosphaerella minutissima* (Colom). Numerous radiolaria were accompanied by planktonic green algae *Globochaete alpina* (Lombard) and sponge spicules.

2. The Kraśnik Formation (Oxfordian). The formation is a local equivalent of the European sponge facies (Niemczycka, 1976b). The sediments of the Kraśnik Formation were studied in the following boreholes: Cieszanów 1 (1108.0–1212.5 m), Jarczów IG 2 (1217.0–1227.0 m), Płusy IG 1 (1302.0–1305.8 m, Doliny 1 (884.0–950.0 m), Lubaczów 3 (1036.8–1119.3 m), Lubaczów 10 (1103.0–1109.0 m). Characteristic microfossils of the lower part of the formation are foraminifera such as: *Protomarssonella donieziana* (Dain), *Ammobaculites irregularis* (Gümbel), *Ophthalmidium strumosum* (Gümbel), *O. sagittum* (Bykova), *Paalzowella turbinella* (Gümbel), *Epistomina* cf. *uhligi* Myatliuk, *Crescentiela morronensis* (Crescenti), *Globuligerina oxfordiana* (Grigelis), and calcareous dinocysts: *Colomisphaera fibrata* (Nagy), *Committosphaera czestochoviensis* Řehánek, *Colomisphaera lapidosa* (Vogler). The polychaeten *Terebella lapilloides* Münster and sponge "mummies" are characteristic of the formation. This part of the formation probably represents Lower–Middle Oxfordian.

In the upper part of the formation appear foraminifera: *Protomarssonella jurassica* (Mityanina), *Mohlerina basiliensis* (Mohler), *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Bicazammina jurassica* (Haeusler), *Quinqueloculina semisphaeroidalis* Danitsch and a calcareous dinocyst – *Cadosina parvula* Nagy. Sponge spicules are gradually replaced by fragments of crinoids, echinoids and snails. The stratigraphic distribution of diagnostic microfossils (Fig. 2) suggests the lower Upper Oxfordian for this part of the formation.

3. The Zakrzew Formation (? Upper Oxfordian). The formation includes predominantly dolomites and sandstones, probably of terrigenous origin (Niemczycka, 1976b). The sediments of the formation were studied in the Rudnik IG 1 borehole (1385.0–1411.0 m). Associations of foraminifera were composed of a few representatives of genera *Haplophragmium* and *Epistomina*. Rare fragments of dasycladacean genus *Acicularia* have also been recognized as well as fragments of snails, crinoids and bryozoans. Except foraminifera the microfossils of this formation resemble those of the upper part of the Kraśnik Formation.

4. The Jasieniec Formation (Middle–Upper Oxfordian). The formation is composed of detritic limestones with ooids and oncoids (Niemczycka, 1976b). The sediments of the formation were studied in the following boreholes: Babczyn 2 (1121.0–1140.0 m), Cieszanów 1 (1041.0–1108.0 m), Doliny 1 (820.0–884.0), Lubaczów 159 (1199.0–1202.0 m), Tomaszów Lubelski IG 1 (1264.5–1277.0 m), Sucha Wola 1 (1163.0 –1200.0). Foraminiferal assemblages of the formation contain: *Ammobaculites irregularis* (Gümbel), *Protomarssonella jurassica* (Mityanina), *P. dumortieri* (Schwager), *Bicazammina jurassica* (Haeusler), *Haghimashella arcuata* (Haeusler), *Crescentiella morronensis* (Crescenti), *Epistomina* aff. *uhligi* Mjatliuk, *Ophthalmidium oxfordianum* (Deecke), *Cornuspira eichbergensis* Kübler & Zwingli, *Paalzowella turbinella* (Gümbel), *P. feifeli* (Paalzow), and *Mohlerina basiliensis* (Mohler). Foraminifera are accompanied by calcareous dinocysts: *Orthopithonella gustafsonii* (Bolli) and *Crustocadosina semiradiata* (Wanner).

In the Babczyn 2 borehole within the formation appears foraminifer *Alveosepta jaccardi* (Schrodt) known in the Mediterranean Tethys from the Upper Oxfordian (Bassoulet, 1997) and *Paleogaudryina varsoviensis* (Bielecka & Pożaryski). Other characteristic microfossils of the formation include calcareous algae: Solenoporacea (*Girvanella jurassica* Wethered) and Dasycladacea. Fragments of planktonic crinoids of the genus *Saccocoma* Agassiz and polychaete *Terebella lapilloides* Münster are also present. The age of the formation was designated as the Upper Oxfordian.

5. The Bełżyce Formation (Upper Oxfordian–Lower Kimmeridgian). The formation is composed mainly of oolithic and pelitic limestones (Niemczycka, 1976b). The sediments of the formation were studied in the following boreholes: Ciepielów IG 1 (935.6–1101.0 m), Niedrzwica IG 1 (1115.0–1200.0 m), Płusy IG 1 (745.5–1169.9 m), Rachów 1 (65.6–453.0 m) Sieniawka 1 (1100.0–1200.0 m), and Wyszków 1 (861.0–991.5 m).

The lower part of the formation contains foraminiferal assemblage composed of: *Globuligerina oxfordiana* (Grigelis), *Haghimashella arcuata* (Haeusler), *Protomarssonella jurassica* (Mityanina), *Cornuspira eichbergensis* Kubler & Zwingli, *Ophthalmidium pseudocarinatum* (Dain), *Trocholina belo-*

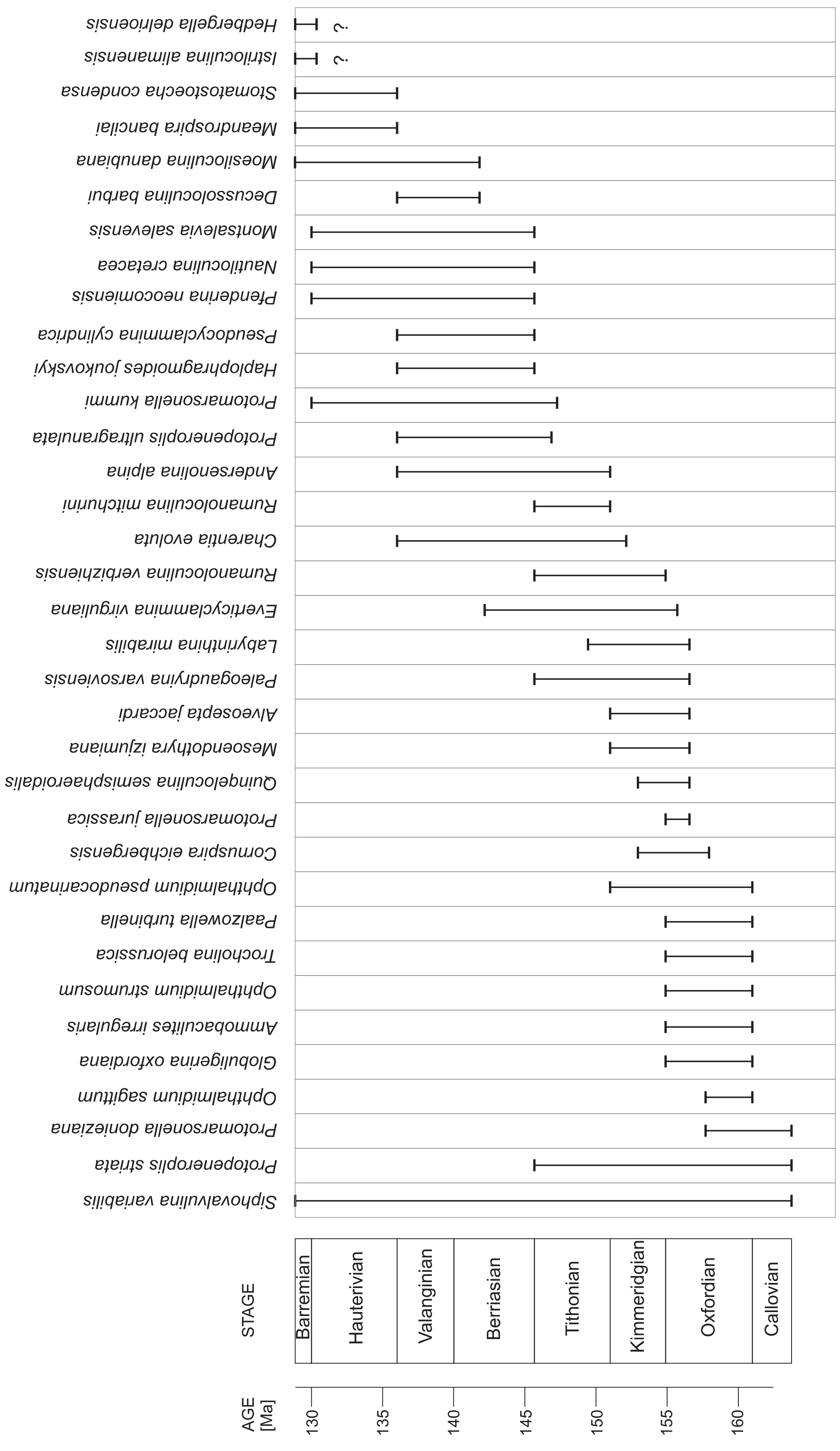


Fig. 2. Stratigraphic distribution of age relevant foraminifera of the formations studied after literature

russica Mityanina, *Paalzowella feifeli* (Paalzow), *Crescentiella morronensis* (Crescenti). The specific composition of the assemblage resembles those assigned to the Upper Oxfordian. In the upper part of the formation appear: *Alveosepta jaccardi* (Schrodt), *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Labirynthina mirabilis* Weynschenk, *Mesoendothyra izjumiana* Dain, *Everticyclammina virguliana* Koechlin, *Rumanoloculina verbizhiensis* (Dulub). Frequent and characteristic elements of the formation are calcareous algae such as *Marinella lugeoni* Pfender, *Thaumatoporella parvovesiculifera* Rainieri, and calcimicrobes *"Porostromata"* as well as fragments of macrofossils such as: crinoids, snails, echinoderms and bryozoans.

Stratigraphic distribution of significant foraminifera indicates the Lower Kimmeridgian age of the greater part of the formation.

6. The Basznia Formation (uppermost Oxfordian–Lower Kimmeridgian). The main lithofacies of the formation are conglomeratic marls with glauconite (Niemczycka, 1976b). The microfossil content was studied in the following boreholes: Babczyn 2 (1096.0–1132.0 m), Cieszanów 1 (993.0 –1041.0 m), Doliny 1 (750.0–820.0 m). The foraminiferal assemblage of the formation resembles that of the Bełżyce Formation. In the lower part of the formation the following foraminifera occur: *Haghimashella arcuata* (Haeusler), *Textulariopsis jurassica* (Gümbel), *Ophthalmidium pseudocarinatum* (Dain), and *Nautiloculina oolithica* Mohler. The assemblages of the upper part contain: *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Quinqueloculina jurassica* Bielecka & Styk, *Q. frumenta* Azbel & Danitsch, *Alveosepta jaccardi* (Schrodt), and *Labirynthina mirabilis* Weynschenk. Numerous fragments of the red algae *Marinella lugeoni* Pfender are very characteristic as well as is the occurrence of ostracods. The persistent presence of *Labirynthina mirabilis* Weynschenk suggests that the formation is not older that the uppermost Oxfordian, and more probably represents Kimmeridgian.

7. The Jarczów Formation (? Upper Oxfordian–? Lower Kimmeridgian). The formation includes terrigenous mudstones and claystones with plants that probably accumulated in a marginal marine environment (Niemczycka, 1976b). The sediments of the formation were studied in Ruskie Piaski IG 2 borehole (1090.3–1103.8). Among rare foraminifera the presence of *Alveosepta jaccardi* (Schrodt) and *Rumanoloculina verbizhiensis* (Dulub) are noteworthy. The marginal marine environment is supported by the presence of representatives of the foraminiferal family Polymorphinidae.

8. The Głowaczów Formation (uppermost Oxfordian –?Lower Kimmeridgian). Marls and marly limestones are the dominant lithologies of the formation. Microfossil content of both lithofacies was studied in the Ciepielów IG 1 (837.0–936.5 m) and Zakrzew 1 boreholes (1212.0–1315.0 m). Foraminifera were encountered in the Zakrzew 1 borehole forming the assemblage composed of: *Protomarssonella jurassica* (Mityanina), *P. dumortieri* (Schwager), *Alveosepta jaccardi* (Schrodt), *Labirynthina mirabilis* Weynschenk, *Trocholina belorussica* Mityanina, and *Paleogaudryina varsoviensis* (Bielecka & Pożaryski). The presence of *Labirynthina mirabilis* Weynschenk indicates, at least, the uppermost Oxfordian age. Characteristic of the formation are also fragments of corals, crinoids, snails, echinoderms, incrusting "bereniciformis" bryozoans and ostracods. The calcareous algae of genera *Girvanella* and *Acicularia* as well as microproblematic *Baccinella irregularis* Radoičič were also identified.

9. The Urzędów Formation (?Upper Kimmeridgian). The formation is composed mainly of dolomites, limestones and dolomitic marls (Niemczycka, 1976b). The sediments of the Formation were studied in the Zakrzew 1 borehole (1143.0–1212.0 m). They contain poor foraminiferal assemblage composed of *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Haplophragmium* sp., and polymorphinids suggesting unfavorable conditions and shallow depth. Poor microfossils do not permit precise age determination, however Niemczycka (1976a, b) suggested the Upper Kimmeridgian age for the formation.

10. The Ruda Lubycka Formation (Upper Kimmeridgian–?Lower Tithonian). The formation encloses dolomites intercalated by anhydrites with sporadic layers of marls (Niemczycka, 1976a, b). The sediments of the Formation were studied in the following boreholes: Babczyn 2 (860.0–1094.0 m), Basznia 1 (1020.0–1102.0 m), Cieszanów IG 1 (674.0–993.0 m), Doliny 1 (470.0–750.0 m), Jarczów IG 2 (988.0–1120.0 m), Tomaszów Lubelski IG 1 (1056.0–1155.0 m), Narol IG 1 (1557.5–1559.6 m), Narol IG 2 (1500.0–16134.0 m), and Sieniawka 1 (700.0–1060.0 m).

The lower part of the formation contains foraminiferal assemblages composed of the open marine species: *Pseudocyclammina lituus* (Yokoyama), *Alveosepta jaccardi* (Schrodt), *Textularia densa* Hoffman, *Nautiloculina oolithica* Mohler, *Protopeneroplis striata* Weynschenk, *Charentia evoluta* (Gorbatchik), and *Rumanoloculina mitchurini* Dain. Red algae *Marinella lugeoni* Pfender occurs frequently.

In the upper part of the formation microfossils of the restricted environments prevail: ostracods, coproliths (*Favreina* cf. *fendiensis* Brönnimann & Zaninetti, *Favreina* cf. *dinarica* Brönnimann), and foraminifera of the family Polymorphinidae.

The age of the formation is based on cooccurence of *Charentia evoluta* (Gorbatchik) (FAD in the Late Kimmeridgian), *Protopeneroplis striata* Weynschenk (LAD in Tithonian), and *Rumanoloculina mitchurini* (Dain) (FAD in Tithonian). Stratigraphical ranges of the mentioned foraminiferal species suggest that the main part of the discussed formation represents Upper Kimmeridgian locally passing into Tithonian.

11. The Babczyn Formation (Tithonian–Berriasian). The formation is composed of detritic, oolithic and oncoidal limestones (Niemczycka, 1976b). Microfossils of the formation were studied from: Babczyn 2 (700.0–870.0 m), Basznia 1 (727.0–968.0 m), Cieszanów 1 (524.0–674.0 m), Doliny 1 (365.0–470.0 m), Lubaczów 9 (1060.0–1180.0 m), Lubaczów 153 (1119.0–1188.0 m), Lubaczów 159 (1087.0–1200.0 m), Narol IG 1 (1442.4–1443.5 m), Tomaszów Lubelski IG 1 (1013.0–1056.0 m), Wielkie Oczy 1 (1490.6–1907.6), and Wielkie Oczy 4 (1356.0–1444.0 m) boreholes.

Characteristic microfossils of the formation include: foraminifera, calpionellids, calcareous dinocysts and calcareous algae. Rich foraminiferal assemblages are composed of: *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Uvigerina uvigeriniformis* (Seibold & Seibold), *Montsalevia salevensis* (Charollais, Brönnimann & Zaninetti), *Textularia densa* Hoffman, *Protomarssonella kummi* (Zedler), *Protomarssonella hechti* (Dieni & Massari), *Pseudocyclammina lituus* (Yokoyama), *P. cylindrica* Redmond, *Siphovalvulina variabilis* Septfontaine, *Charentia evoluta* (Gorbatchik), *Haplophragmoides joukovskyi* Charollais, Brönnimann & Zaninetti, *Protopeneroplis striata* Weynschenk, *P. ultragranulata* (Gorbatchik), *Trocholina solecensis* Bielecka & Pożaryski, *Neotrocholina molesta* (Gorbatchik), *Ichnusella burlini* (Gorbatchik), *Andersenolina alpina* (Leupold), *A. histeri* Neagu, *Rumanoloculina mitchurini* (Dain), *Istriloculina terekensis* Matseva & Temirbekova, *Decussoloculina mirceai* Neagu, *Nautiloculina cretacea* Peybernès, and *Mohlerina basiliensis* (Mohler).

Numerous calcareous algae are represented by: *Actinoporella podolica* Alth, *Pratumiella fastigiata* Dragastan, *Clypeina jurassica* Favre, *Salpingoporella annulata* Carozzi, *Salpingoporella* ex gr. *pygmaea* (Gümbel). The polychaeten *Terebella lapilloides* Münster occurs locally. Microproblematic *Baccinella irregularis* Radoičič is also frequent.

Characteristic for the formation is also the occurrence of the calcareous dinocysts: *Stomiosphaera moluccana* Wanner, *Colomisphaera radiata* (Vogler) and *C. cieszynica* Nowak. At the base of the formation in the Wielkie Oczy 4 borehole a Upper Kimmeridgian–Middle Tithonian calcdinocyst *Carpistomiosphaera borzai* (Nagy) has been identified. In the Lubaczów 153 borehole, the assemblage from the basal part of the formation contained the Tithonian calcidinocyst index species *Carpistomiosphaera tithonica* Nowak, while in the Wielkie Oczy 1 borehole a Berriasian *Stomiosphaerina proxima* Řehánek appeared.

Sediments of the Babczyn Formation also yielded numerous coprolithes and ostracods and rare *Charophyta*.

The Jurassic/Cretaceous boundary may be determined in the Wielkie Oczy 1 borehole between the last occurrence of *Protopeneroplis striata* Weynschenk and *Colomisphaera radiata* (Vogler) and first occurrence of *Protopeneroplis ultragranulata* (Gorbatchik) and *Stomiosphaerina proxima* Řehanek. In the upper part of the Babczyn Formation in the Babczyn 2 borehole a single specimen of calpionellid *Calpionella alpina* Lorenz has been recognized. The species has its first appearance datum (FAD) in the middle of the Upper Tithonian *Crassicollaria* Zone which suggests that the upper part of the formation is younger than the Upper Tithonian. Thus, the Babczyn Formation may represent the Jurassic/Cretaceous transition (Tithonian–Berriasian).

12. The Cieszanów Formation (Valanginian–Hauterivian). The formation recognised in the Lubaczów region is composed of marly claystones, mudstones and limestones intercalated, in places, by oolitic, detrital limestones (Marek, Raczyńska, 1979). The sediments of the formation were studied in the following boreholes: Babczyn 2 (665.0–700.0 m), Basznia 1 (516.0–703.0 m), Cieszanów 1 (10.0–524.0 m), Narol IG 1 (1392.0–1396.5 m).

The prevalence of soft sediments in the formation favored the study of microfossils obtained by water treatment of samples (Sztejn, 1996; Dziadzio *et al*., 2004). The study of thin sections made from the intercalating limestones revealed the presence of numerous miliolids (partly redeposited), among others: *Scythiloculina confusa* Neagu, *S. bancilai* Neagu, *Decussoloculina barbui* Neagu, *D. mirceai* Neagu, *Moesiloculina danubiana* Neagu, *Quinqueloculina stellata* Matseva & Temirbekova, *Istriloculina alimanensis* Neagu, accompanied by *Charentia evoluta* (Gorbatchik) and *Protopeneroplis ultragranulata* (Gorbatchik). Other redeposited microfossils such as calpionellids: *Calpionella elliptalpina* Nagy, *Tintinnopsella carpathica* Murgeanu & Filipescu or calcareous algae: *Pratumiella fastigiata* Dragastan, and *Trinocladus orientalis* Dragastan have also been observed.

Agglutinated foraminifera are represented by rare specimens of *Recurvoides* cf. *obskiensis* Romanova, *Protomarssonella kummi* (Zedler), *Textularia densa* Hoffman and unidentified representatives of genera *Trochammina* and *Verneuilinoides*.

In some samples, numerous sections of epistominids, probably *Epistomina caracolla* (Roemer), suggests a post-Berriasian age. The occurrence of: *Meandrospira bancilai* Neagu, *Pfenderina neocomiensis* (Pfender), *Stomatostoecha condensa* (Dulub) and *Hedbergella delrioensis* (Carsey) suggest for the formation age – Valanginian–Hauterivian. The younger age (Hauterivian–Barremian) was attributed to the assemblage of similar composition found in the sandy mudstones E from Lubaczów based on (Gutowski *et al*., 2007).

The investigated sediments also yielded calcareous cysts of dinoflagellata (calcdinocysts): *Stomiosphaera moluccana* Wanner, *Stomiosphaera wanneri* Borza, *Crustocadosina semiradiata* (Wanner), *Carpistomiosphaera valanginiana* Borza, *Colomisphaera conferta* Řehánek. The last two species support the age indicated by foraminifera.

BIOSTRATIGRAPHY

The significant number of stratigraphically important microfossils (Figs. 2, 3) encountered in all investigated Upper Jurassic–Lower Cretaceous formations of the SE Poland led to the proposal of the local, informal microfossil zonation. The early draft of the biozonation was already presented during the conference "Jurassica IV" (Olszewska, 2004). Recent investigations updated the former proposal and make it more useful for designation of age and correlation of the strata studied.

Following zones have been proposed for the uppermost Callovian–Hauterivian sedimentary succession of the south-eastern Poland:

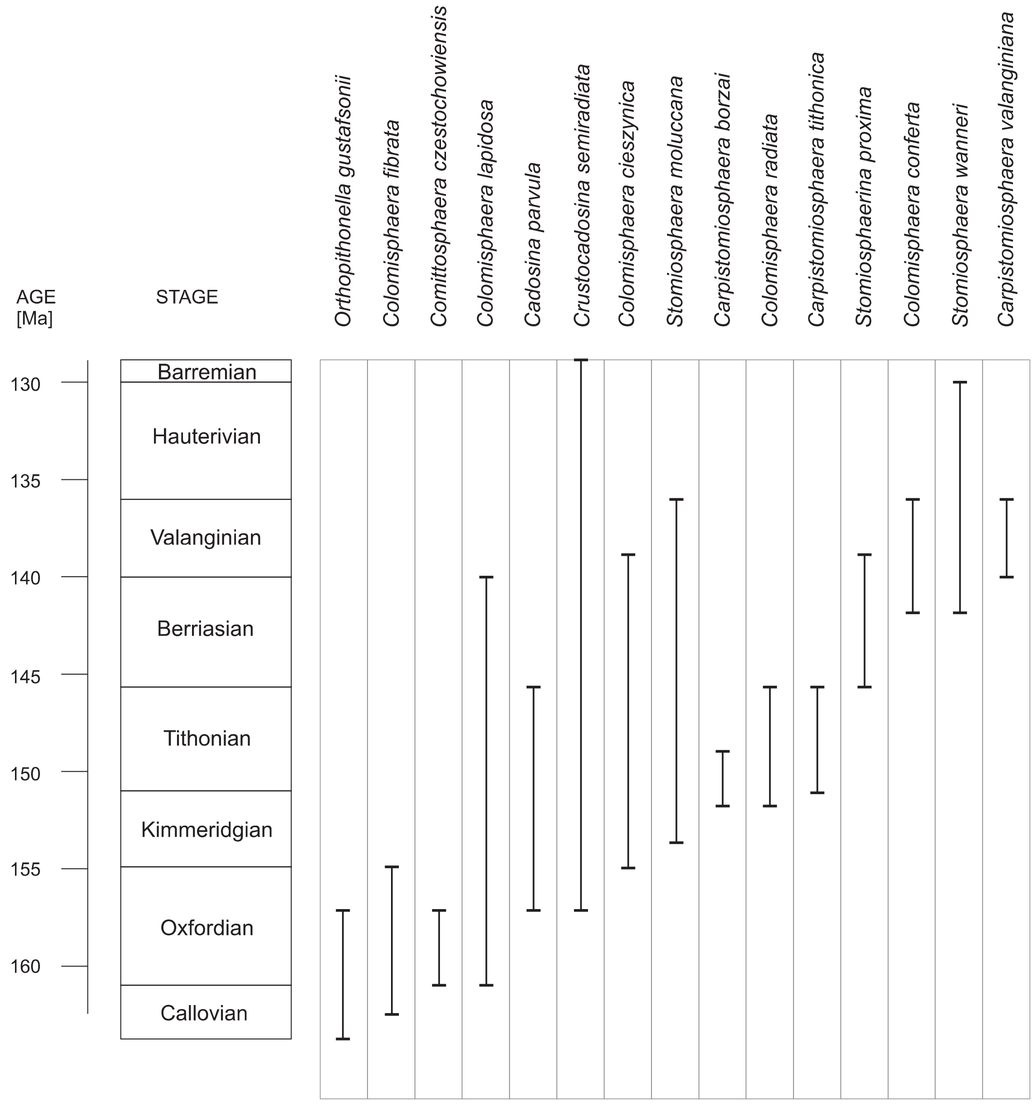


Fig. 3. Stratigraphic distribution of calcareous dinocysts of the formations studied after literature

1. *Globuligerina oxfordiana–Colomisphaera fibrata* Zone

Equivalent: Assemblage A (Olszewska, 2004).

Occurrence: "nodular layer".

Characteristic microfossils: foraminifera – *Globuligerina oxfordiana* (Grigelis), *Protomarssonella donieziana* Dain, *Ophthalmidium sagittum* (Bykova); calcareous dinocysts – *Colomisphaera fibrata* (Nagy); calcareous algae – *Globochaete alpina* Lombard. Other: radiolarians, sponge spicules.

Age: uppermost Callovian–lowermost Oxfordian.

2. *Ophthalmidium strumosum–Paalzowella turbinella* Zone

Equivalent: Assemblage B (Olszewska, 2004).

Occurrence: lower part of the Kraśnik Formation.

Characteristic microfossils: foraminifera – *Ophthalmidium strumosum* (Gümbel), *Ammobaculites irregularis* (Gümbel), *Paalzowella turbinella* (Gümbel), *Crescentiella morronensis* (Crescenti) *Globuligerina oxfordiana* (Grigelis); calcareous dinocysts – *Colomisphara fibrata* (Nagy), *Committosphaera czestochowiensis* Řehánek, *Colomisphaera lapidosa* (Vogler): polychaetans: *Terebella lapilloides* Münster; others: sponge mummies.

Age: Lower–Middle Oxfordian.

3. *Alveosepta jaccardi–Protomarssonella jurassica* Zone

Equivalent: Assemblage C (Olszewska, 2004).

Occurrence: upper part of the Kraśnik Formation, Zakrzew Formation, Jasieniec Formation, lower part of the Bełżyce Formation, and part of the Jarczów Formation.

Characteristic microfossils: foraminifera – *Ophthalmidium pseudocarinatum* (Dain), *Protomarssonella jurassica* (Mityanina), *Alveosepta jaccardi* (Schrodt), *Cornuspira eichbergensis* Kübler & Zwingli, *Mohlerina basiliensis* (Mohler), *Bicazammina jurassica* (Haeusler), *Haghimashella arcuata* (Haeusler), *Paalzowella feifeli* (Paalzow), *Trocholina belorussica* Mityanina; calcareous dinocysts – *Cadosina parvula* Nagy, *Crustocadosina semiradiata (*Wanner), *Orthopithonella gustafsonii* (Bolli); planktic crinoids: *Saccocoma* cf. *quenstedti* Verniory.

Age: Upper Oxfordian.

4. *Labirynthina mirabilis–Mesoendothyra izjumiana* Zone

Equivalent: Assemblage D (Olszewska, 2004).

Occurrence: upper part of the Bełżyce Formation, Basznia Formation, ?Głowaczów Formation, part of the ?Jarczów Formation and lower part of the Ruda Lubycka Formation.

Characteristic microfossils: foraminifera – *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), *Labirynthina mirabilis* Weynschenk, *Quinqueloculina verbizhiensis* Dulub, *Everticyclammina virguliana* (Koechlin), *Mesoendothyra izjumiana* Dain, *Nautiloculina oolithica* Mohler; frequent are coprolits, ostracods, calcareous algae (*Marinella lugeoni* Pfender) and charophyta. Beyond the study area (the southern Poland) rare specimens of the calcareous dinocyst *Carpistomiosphaera borzai* (Nagy) accompanies the foraminiferal assemblage.

Age: Kimmeridgian.

5. *Andersenolina alpina–Rumanoloculina mitchurini* Zone

Equivalents: *Protopeneroplis striata* Zone (Soták *In*: Vašíček *et al*., 1994), *Anchispirocyclina lusitanica* Zone (Pélissié *et al.*, 1984; Septfontaine *et al.*, 1991), lower part of the *Protopeneroplis trochangulata* Zone (Altiner, 1991), lower part of the Assemblage E (Olszewska, 2004).

Characteristic microfossils: foraminifera – *Pseudocyclammina lituus* (Yokoyama), *Protopeneroplis striata* Weynschenk, *Andersenolina alpina* (Leupold), *A. elongata* (Leupold), *A. histri* Neagu, *Rumanoloculina mitchurini* (Dain); calcareous dinocysts – *Carpistomiosphaera tithonica* Nowak, *Colomisphaera cieszynica* Nowak, *Stomiosphaera moluccana* Wanner; calcareous algae are frequent, especially dasycladaceans – *Actinoporella*, *Clypeina*, *Salpingoporella*.

Occurrence: topmost part of the Ruda Lubycka Formation, lower part of the Babczyn Formation.

Age: Tithonian.

6. *Protomarssonella kummi–Protopeneroplis ultragranulata* Zone

Equivalents: *Protopeneroplis trochangulata–Pseudotextulariella courtionensis* zones (Soták *In*: Vašíček *et al*., 1994), *Haplophragmoides joukowskyi* Interval Biozone (Ivanova, 2000), upper part of the Assemblage E (Olszewska, 2004).

Occurrence: upper part of the Babczyn Formation.

Characteristic microfossils: foraminifera – *Protomarssonella kummi* (Zedler), *Uvigerinammina uvigeriniformis* (Seibold & Seibold), *Pseudocyclammina cylindrica* Redmond, *Siphovalvulina variabilis* Septfontaine, *Haplophragmoides joukovskyi* Charollais, Brönnimann & Zaninetti, *Protopeneroplis ultragranulata* (Gorbatchik) – numerous, *Charentia evoluta* (Gorbatchik), *Rumanoloculina mitchurini* (Dain), *Andersenolina alpina* (Leupold), *Ichnusella burlini* (Gorbatchik), *Montsalevia ? salevensis* (Charollais, Brönnimann & Zaninetti), *Nautiloculina cretacea* Peybernès; calcareous dinocysts – *Stomiosphaera moluccana* Wanner, *Stomiosphaerina proxima* Řehánek.

Age: Beriassian.

7. *Epistomina caracolla–Pfenderina neocomiensis* Zone

Equivalents: *Pfenderina neocomiensis*–?*Montsalevia salevensis* zones ((Soták *In*: Vašíček *et al*., 1994), *Meandrospira favrei* Interval Biozone (Ivanova, 2000), Assemblage F (Olszewska, 2004).

Occurrence: Cieszanów Formation.

Characteristic microfossils: foraminifera – *Meandrospira bancilai* Neagu, *Decussoloculina barbui* Neagu, *Pfenderina neocomiensis* (Pfender), *Stomatostoecha condensa* (Dulub), *Charentia evoluta* (Gorbatchik), *Epistomina* cf. *caracolla* (Roemer), *Hedbergella delrioensis* (Carsey); calcareous dinocysts – *Carpistomiosphaera valanginiana* Borza, *Colomisphaera conferta* Řehánek, *Stomiosphaera wanneri* Borza.

Age: (?upper) Valanginian –Hauterivian.

CORRELATION WITH THE AMMONITE AND CALPIONELLID STANDARD ZONES

The most precise stratigraphy of the Jurassic sediments is based on the ammonites (Gradstein *et al*., 2004). The Upper Jurassic sediments in the Lublin area are rather poor in ammonites and direct reference to the ammonite zones is possible only for the lowest Oxfordian sediments (Marek, Pajchlowa, eds, 1997). The stratigraphy of the remaining part of the Upper Jurassic succession was based on "non-ammonite" faunas (Niemczycka, 1976a) and on the indirect correlation. Recent studies of the foraminiferal assemblages from the Upper Jurassic sediments from the Holy Cross Mts and Cracow region (Olszewska, 2007a) revealed the presence of distinct foraminiferal assemblages similar to those encountered in the study area. Foraminifera are accompanied by calcareous cyst of dinoflagellata (calcdinocysts) succesively correlated with standart ammonite and calpionellid zones (Cecca, Řehánek, 1991; Řehánek, Cecca, 1993; Řehánek, Heliasz, 1993; Lakova *et al*., 2007). This justify an attempt to correlate the described microfossil zones with the orthostratigraphic zonations (Fig. 4).

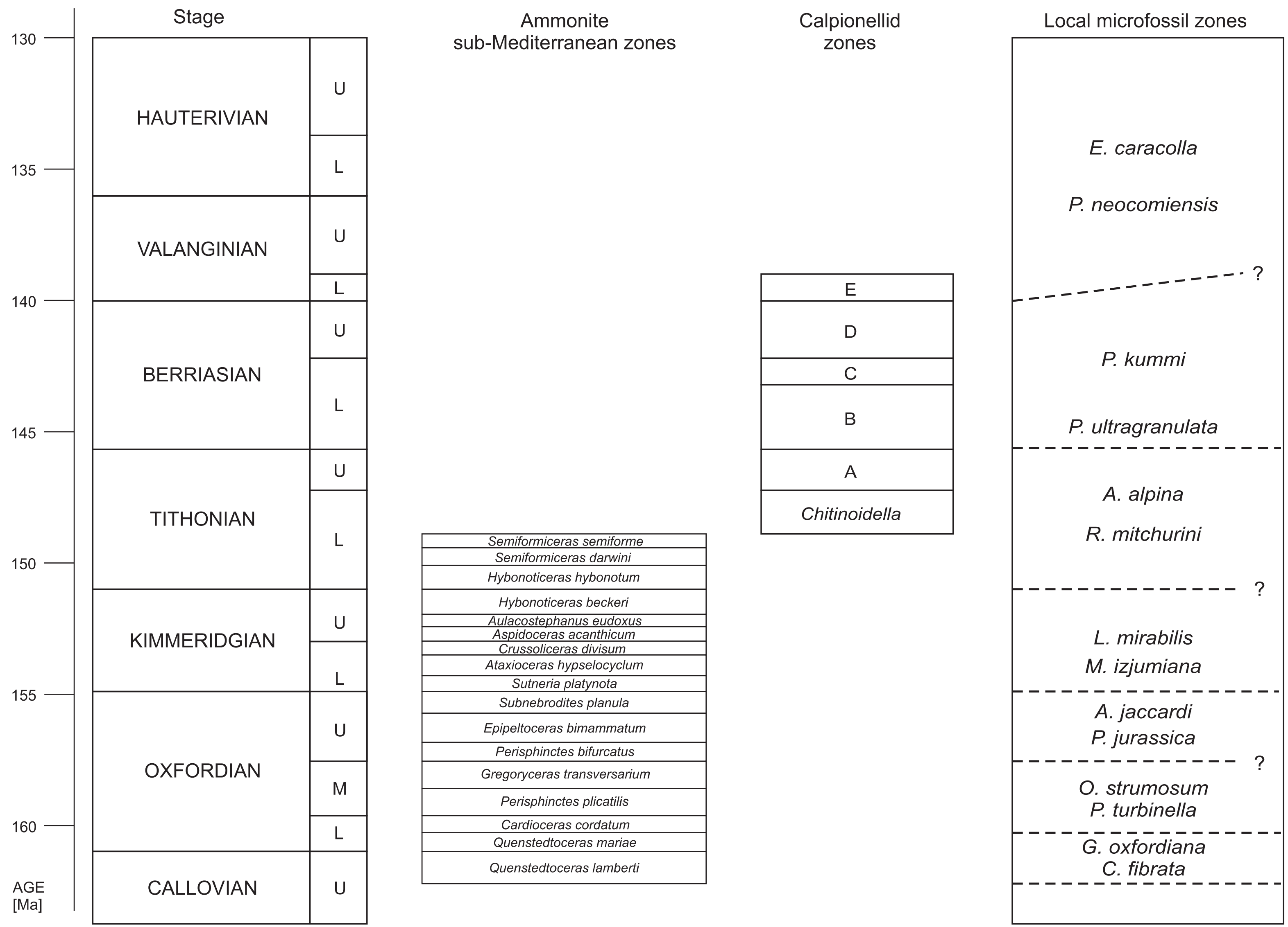


Fig. 4. Correlation of the local microfossil zones with the standard ammonite and calpionellid zonations; ammonite zonation after Matyja, Wierzbowski (2000) and Gradstein *et al.*, (2004), calpionellid zonation after Gradstein *et al.* (*op.cit.*)

1. *Globuligerina oxfordiana–Colomisphaera fibrata* Zone. The calcareous dinocyst assemblage of the zone corresponds to the "Assemblage A" of the *Colomisphaera fibrata* Zone from the Upper Jurassic sediments of the Cracow region (Garlicka, 1976). The complete zone, according to Garlicka corresponds to several ammonite zones from *Quendstedtoceras lamberti* (upper part of Upper Callovian) to *Perisphinctes plicatilis* (lower Middle Oxfordian).

Some authors (Řehánek, Heliasz 1993; Lakova *et al*., 2007) place the *Colomisphaera fibrata* Zone between the *Cardioceras cordatum* (upper Lower Oxfordian) and *Perisphinctes bifurcatus* (lower Upper Oxfordian) zones. The "Assemblage A" was correlated by Garlicka with the *Quenstedtoceras lamberti* and *Quendstedtoceras praecordatum* (= *Quenstedtoceras mariae*) zones. Position of the assemblage fits the time span indicated for the "nodular layer" by Niemczycka (1976b). The microfossils content of the discussed zone has many taxa common with foraminiferal "Assemblage A" of the Southern Poland (Olszewska, 2004, 2007a).

2. *Ophthalmidium strumosum–Paalzowella turbinella* Zone. The zone was identified in the lower part of the Kraśnik Formation. According to Niemczycka (1976a) the lower part of the Kraśnik Formation belongs to the *Cardioceras bukowskii–Cardioceras excavatum* subzones (*Cardioceras cordatum* Zone of Matyja, Wierzbowski, 2000), while the upper part of the formation has been referred to as the Middle Oxfordian *Cardioceras tenuiserratum–Amoeboceras alternans* zones (*plicatilis–tranversarium* zones of Matyja, Wierzbowski, 2000). The calcareous dinocysts present in the zone resemble "Assemblage B" of Garlicka (1976) referred to the *Cardioceras bukowskii–Cardioceras excavatum* subzones. The same calcareous dinocyst assemblage has been found in the sample collected in the Bielawy quarry during the meeting "Jurassica I" from the *Cardioceras bukowskii* Zone identified there by Matyja (prof. UW, personal information).

Foraminiferal assemblage of the discussed zone corresponds to the "Assemblage B" of the Southern Poland (Olszewska, 2004) that, in turn, was identified within the *cordatum–plicatilis* ammonite zones (Olszewska, 2007a).

3. *Alveosepta jaccardi–Protomarssonella jurassica* Zone. Foraminiferal assemblage of the zone has many forms in common with the "Assemblage C" of Southern Poland (Olszewska, 2004). The "Assemblage C" has recently been found in the Late Oxfordian strata representing the *bimammatum–planula* zones (Olszewska, 2007a).

In the Holy Cross Mountains foraminiferal *Alveosepta jaccardi* Zone, according to Barwicz-Piskorz (1995) represents the span of *planula–divisum* ammonite zones. However, other authors place the *Alveosepta jaccardi* Zone only in the Upper Oxfordian (Septfontaine, 1980; Dulub *et al*., 1986; Kuznetsova, 1989). In the Mediterranean region, the stratigraphic distribution of *Alveosepta jaccardi* covers the zones *bifurcatus*–lower part of *acanthicum* (Upper Oxfordian–lower Upper Kimmeridgian) (Bassoulet, 1997).

The assemblage of calcareous dinocysts from the discussed zone contain *Colomisphaera lapidosa* (Vogler), *Crustocadosina semiradiata* (Wanner) and *Cadosina parvula* Nagy – elements of the Upper Oxfordian–Lower Kimmeridgian "*parvula*" Zone (Řehanek, Heliasz, 1993). In the West Balkan Mountains the *Cadosina parvula* Zone also encroaches the Oxfordian/Kimmeridgian boundary (Lakova *et. al*., 2007). Fragments of planktic crinoids (*Saccocoma* cf. *quenstedti* Verniory) characteristic of the discussed assemblage, were encountered in the vicinity of Cracow in strata corresponding to *Epipeltoceras bimammatum*/*Idoceras planula* zones (Matyszkiewicz, 1996).

4. *Labyrinthina mirabilis–Mezoendothyra izjumiana* Zone. Its correlation with specific ammonite zone is somewhat difficult. Gutowski (*In*: Gutowski *et al*., 2005) equates the upper boundary of the "megasquence I" with upper limits of the Bełżyce and Basznia formations. He located the boundary between the *platynota*/*hypselocyclum* ammonite zones. The same author included the Głowaczów and Ruda Lubycka formations (also containing microfossil assemblage of the discussed zone) in the "megasequence II" between the *divisum* and *eudoxus* ammonite zones. Niemczycka (1976a) expressed the opinion that the lower part of the Ruda Lubycka Formation passes laterally towards the SW into beds of the *divisum* ammonite Zone (upper part of the Lower Kimmeridgian).

In the southern (Tethyan) regions of Russia the zone with *Mesoendothyra izjuminana* covers the time span of the Upper Kimmerdigian–Lower Tithonian age corresponding to the *eudoxus–pseudoscythica* zones (Kuznetsova, 1989). On the other hand the cooccurrence of index species of the described zone is indicative for the Subzone IIa in, containing Kimmeridgian ammonites, part of carbonate succession of the NW Turkey (Altiner, 1991).

Microfossil content of the discussed zone corresponds to the "Assemblage D" of the Southern Poland (Olszewska, 2004). Recent studies of the microfossils of the Holy Cross Mts. and the Cracow region have demonstrated the presence of the "Assemblage D" in the *platynota–divisum* ammonite zones (Olszewska, 2007a). Foraminiferal assemblage of the discussed zone may be also correlated with the *Protopeneroplis striata* Interval Biozone (uppermost Oxfordian–Kimmeridgian) of the West Balkan Mountains (Ivanova, 2000).

5. *Andersenolina alpina–Rumanoloculina mitchurini* Zone. In the study area the zone was recognized in the lower part of the Babczyn Formation. According to Gutowski (*In*: Gutowski *et al*., 2005) the lowermost part of the formation coincides with the Krzyżanowice Nerineacean Limestone of the NE margin of the Holy Cross Mts. which, in turn, represents the *eudoxus* or *autissiodorensis* ammonite zones (Kutek, 1994). According to the latest data (Gradstein *et al*., 2004) in the northwest subboreal Europe the Kimmeridgian/Tithonian boundary is situated within the *autissiodorensis* Zone. The base of the discussed microfossil zone may tentatively correspond to that boundary.

The characteristic calcdinocysts of the zone (*C. cieszynica*, *S. moluccana*) are part of *cieszynica* Zone described from the Lower–Middle Tithonian ammonite *darwini* to *volanense* zones in the Central Italy (Cecca, Řehánek, 1991; Řehánek, Cecca, 1993). The microfossil content of the discussed zone (prior to the appearance of predominantly Berriasian *Stomiosphaerina proxima* Řehanek), permits its correlation with lower part of the "Assemblage E" of the Southern Poland (Olszewska, 2004).

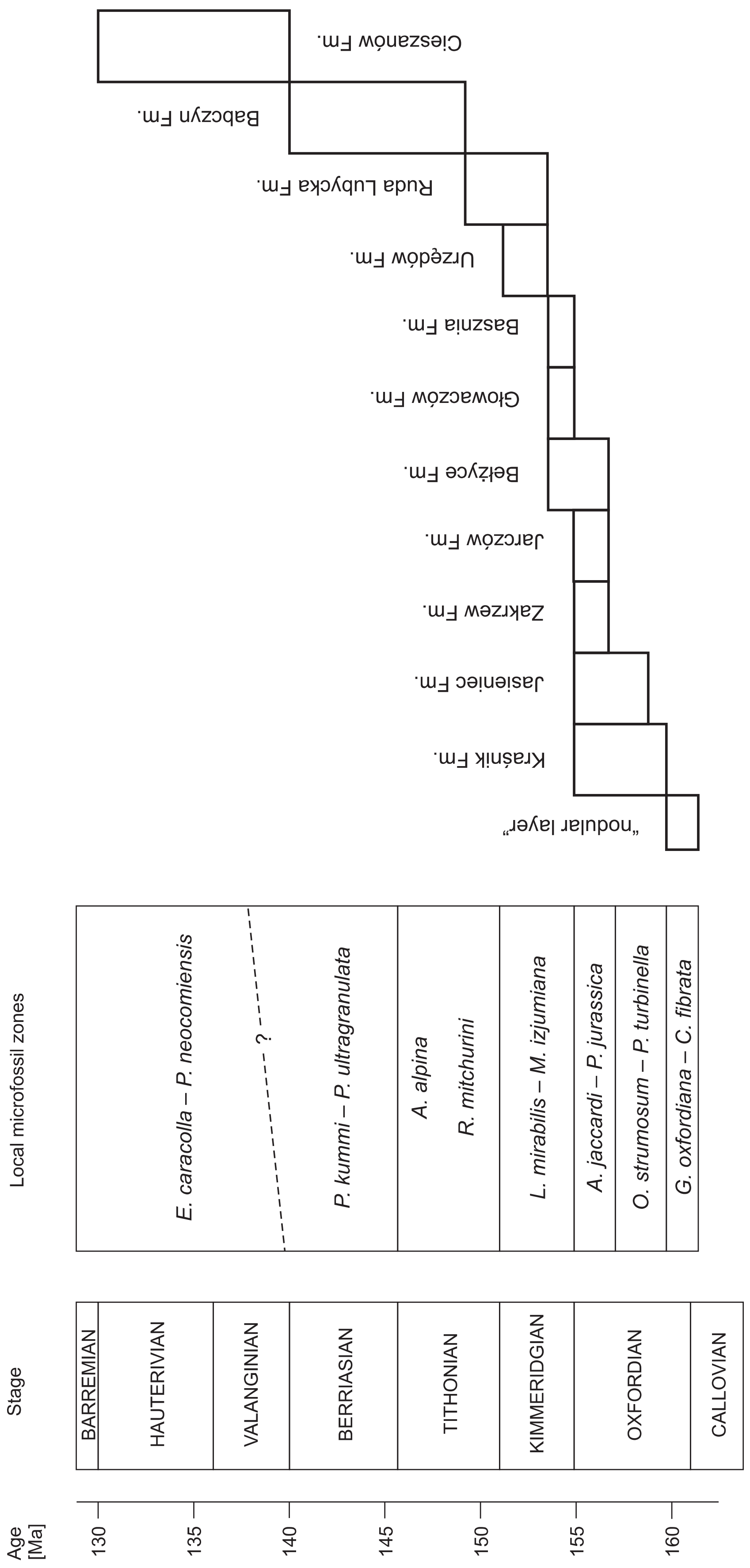


Fig. 5. Position of the Upper Jurassic–Lower Cretaceous formations of the SE Poland in relation to the local microfossil zones and chronostratigraphy

6. *Protomarssonella kummi–Protopeneroplis ultragranulata* Zone. In the Western Carpathians the *Protopeneroplis trochangulata* (= *ultragranulata*)–*Pseudotextulariella courtionensis* zones of Soták (*In*: Vašíček *et al*., 1994), correspond to Berriasian ammonite *Berriasella jacobi –Fauriella boissieri* zones and calcdinocyst *Stomiosphaerina* (*Colomisphaerina*) *proxima* zones. Somewhat lower position – uppermost Tithonian–Middle Berriasian (upper *Durangites*–lower *occitanica*) was proposed later for the *proxima* zone by Reháková (2000) in the same region.

The identification of the calpionellid species *Calpionella alpina* Lorenz in the upper part of the Babczyn Formation indicates that the sedimentation of the formation continued over the middle part of the Upper Tithonian *Crassicollaria* Zone (FAD of *C. alpina*). Foraminifera (*Haplophragmoides joukovskyi, Montsalevia ?salevensis, Pseudocyclammina cylindrica*) and calcareous dinocysts (*Stomiosphaerina proxima*) suggest the continuation of sedimentation at least up to the Late Beriassian. The microfossil content of the discussed zone resembles that of Berriasian part of the "Assemblage E" of southern Poland (Olszewska, 2004).

7. *Epistomina caracolla–Pfenderina neocomiensis* Zone. Direct correlation of the zone with the ammonite/calpionellid standart zonations is not possible yet. In the Western Carpathians foraminiferal zones *Pfenderina neocomiensis* and *Montsalevia salevensis* correspond to the uppermost Berriasian–Valanginian (Soták *In*: Vašiček *et al.*, 1994), although the younger age (Hauterivian–Baremian) is also possible (Soták, 1989). The Bulgarian *Meandrospira favrei* Interval Biozone is referred to the Upper Valanginian–Hauterivian (Ivanova, 2000). The occurrence of *Stomiosphaera wanneri, Colomisphaera conferta* and *Carpistomiosphera valanginiana* suggests correlation with the *Calpionellites* (Valanginian) to *Tintinopsella* (Hauterivian) calpionellid zones (Reháková, 2000; Lakova *et al*., 2007).

Some authors (Marek, 1997a; Dziadzio *et al*., 2004) regard the Cieszanów Formation (from which the zone was described) as an equivalent of the Upper Valanginian–Hauterivian Włocławek Formation of the Kujawy region characterised by the presence of the ammonite genera *Dichotomites*, *Saynoceras*, *Endemoceras* and *Simbirskites*. Tentative correlation of the described microfossil zones with the standart ammonite/calionellid zonations is presented in Figure 5.

CORRELATION OF THE STUDIED SEDIMENTS WITH THE ADJACENT PART OF SW UKRAINE

Equivalents of the discussed formations occur in two zones of the adjacent part of SW Ukraine: in the Bilche–Volytsa Zone of the Carpathian foreland and in the Volhynian-Podolian part of the European Platform (Dulub, Burowa *et al*., 1986; Dulub, Zhabina, 2000). The suggested correlation is based on the considerable similarity of the microfossil assemblages reported from the lithostratigraphic subdivisions (Fig. 6).

Oxfordian. In the Bilche–Volytsa Zone the Oxfordian is represented by the Rudki and Bonov suites (Dulub *et al*., 1986, 2003; Dulub, 1999; Zhabina, 2001). The species *Globuligerina oxfordiana* (Grigelis) occurs in the lower part of the Bonov suite while in the upper part of both suites *Alveosepta jaccardi* (Schrodt) has been recognized. The mentioned foraminiferal species suggest the equivalence of the discussed suites of the Bilche–Volytsa Zone with the Kraśnik and Jasieniec formations of the Lublin area.

The Oxfordian in the Volhynian-Podolian part of the European Platform is represented by the Sokal suite (Zhabina, 2001). Foraminiferal assemblages of the suite contain, among others: *Trocholina belorussica* Mityanina, *Protomarssonella jurassica* (Mityanina), *Alveosepta jaccardi* (Schrodt) which permits the correlation of the Sokal suite with the Jasieniec Formation of Poland.

The discussed Ukrainian subdivisions are overlain by a so called, "variegated horizon" (Zhabina, 2001), a probable equivalent of the Jarczów Formation.

Kimmeridgian. On the Ukrainian territory the following suites are referred to as the Kimmeridgian: in the Bilche–Volytsa Zone – the Moraniec suite; in the Volhynian-Podolian region – the Rawa Russka suite (Dulub, Zhabina, 1999; Zhabina, 2001). Microfossils assemblages of of the Moraniec suite contain, among others: *Mesoendothyra izjumiana* Dulub, *Quinqueloculina semisphaeroidalis* Dulub, *Colomisphaera carpathica* (Borza), *Colomisphaera radiata* (Vogler), *Carpistomiosphaera borzai* (Nagy), *Colomisphaera pieniniensis* (Borza), *Parastomiosphaera malmica* (Borza). The sediments of the Rawa Russka suite are poor in the organic remnants among which only *Alveosepta personata* (Tobler) (= *A. jaccardi*), *Torinosuella peneropliformis* (Yabe & Hanzawa), and *Charophyta* have been reported (Dulub *et al.,* 1986).

In the Lublin area the Bełżyce, Basznia and the lower part of the Ruda Lubycka formations may be regarded as the equivalents of the discussed Ukrainian suites based on a similarity of microfossil assemblages. The essential difference is the numerous occurrence of pelagic crinoids *Saccocoma* in sediments of the Moraniec suite.

Tithonian. On the Ukrainian territory, to the Tithonian are referred: in the Bilche–Volytsa Zone – the Opary and Karolina suites (Dulub, Zhabina, 1999) or the Karolina and Kochanovka (Dulub *et al*., 1986) suites, in the Volhynian-Podolian region – the Niżniów suite (Dulub *et. al*., 1986; Izotova, Popadyuk, 1996; Dulub, Zhabina, 1999).

The sediments of the Karolina suite contain abundant pelagic microfossils: calpionellids and pelagic crinoids indicating free connections with the open sea. The sediments of the Niżniów suite accumulated rather in a restricted carbonate environment indicated by the presence of coproliths, calcareous algae and shallow water foraminifera (miliolids, polymorphinids, involutinids) and snails (Dulub *et al*., 1986; Gutowski *et al.*, 2005). On the Lublin area the only equivalent of the Niżniów suite seems to be the Babczyn Formation. However, recent investigations have revealed the presence of calpionellid *Calpionella alpina* Lorenz in the sediments of

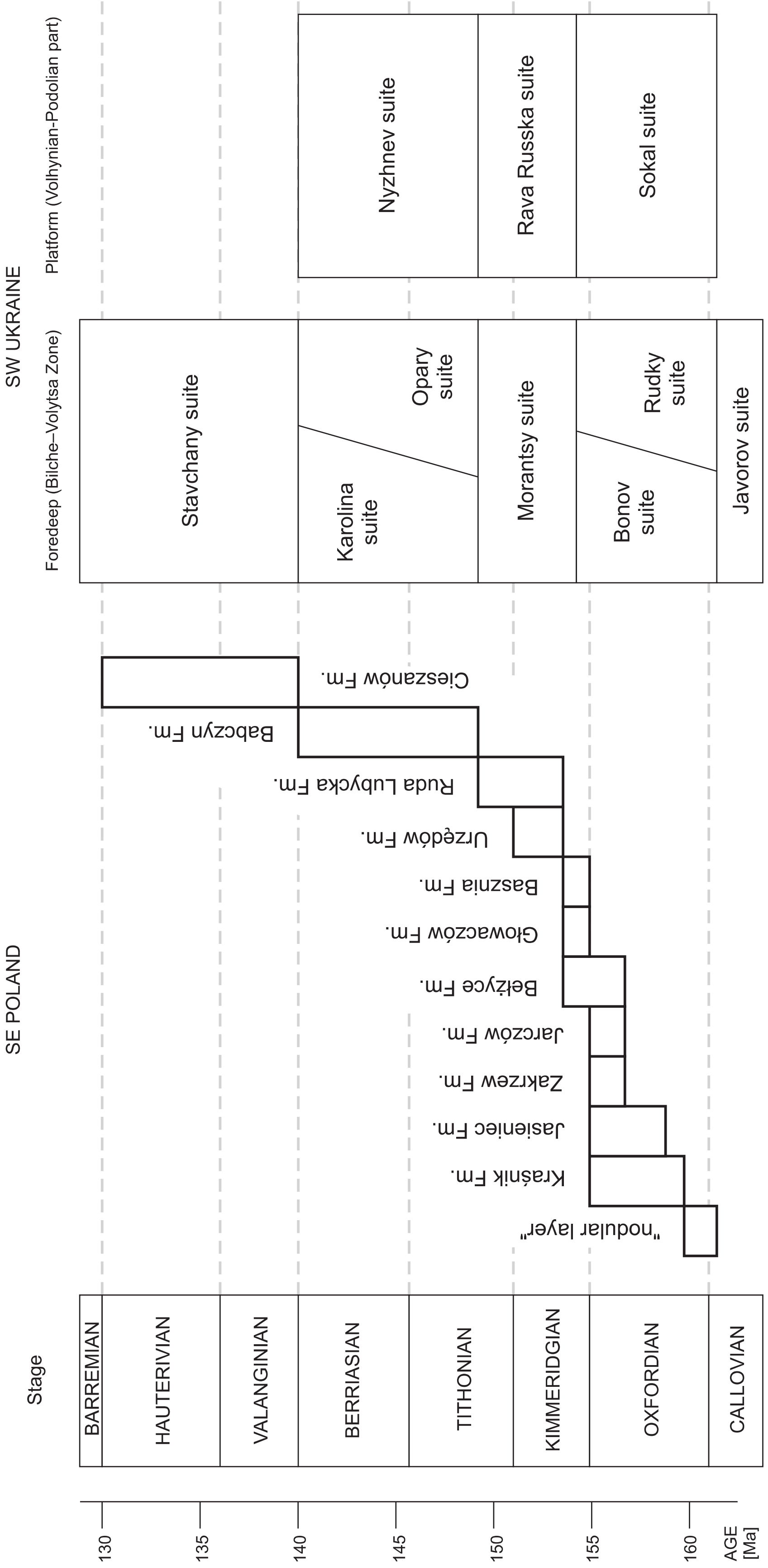


Fig. 6. Correlation of the Upper Jurassic–Lower Cretaceous lithostratigraphic units of the SE Poland and SW Ukraine

the formation. It suggests temporal connections of the studied sedimentary area with the open sea.

Berriasian–Barremian (Neocomian)**.** On the Ukrainian territory to lower part of the Lower Cretaceous belongs the Stavchanska suite composed of intercalating clastic and carbonate sediments (Utrobin, 1962; Dulub, 1972). The suite is subdivided into 4 sequences. In the 3rd sequence Berriasian calpionellids *Calpionella alpina* Lorenz and *Calpionella elliptica* Cadish have been found (Utrobin, 1962). The sequence, however, on the base of abundant glauconite, was correlated by the author with Barremian-Aptian sediments of Bulgaria. Later Dulub (1972) described from the sequence new species of foraminifera *Stomatostoecha condensa* (Dulub) with the large duration span: the Upper Hauterivian –Aptian.

In the Lublin area the lithology and to minor extent, microfossil content similar to those of the 3rd sequence of the Stavchanska suite displays the Cieszanów (Włocławek) Formation (Dziadzio *et al*., 2004).

Recent interpretation, attributing the Berriasian–Valanginian age to the Stavchanska suite (Zhabina, Anikeyeva, 2007) make proposed correlation more credible.

REMARKS ON PALEOENVIRONMENT

The evolution of the investigated area was closely related to the evolution of the Mid-Polish Trough, although the influence of the global phenomena such as sea-level or climatic changes can not be excluded (Dadlez *et al*., 1995). During the Oxfordian and Kimmeridgian the Mid-Polish Trough underwent intensive subsidence correlated with rifting phases of the Arctic-North Atlantic area and the northern Tethyan margin (Dadlez *et al*., 1995).

The end of Callovian marks the beginning of the global transgression with optimum in Kimmeridgian (Moore *et al*., 1992). In the investigated area this event is marked by so called "nodular layer", a condensed sediment representing several ammonite zones and containing abundant planktonic fossils. The Early Oxfordian growth of the sponge build-ups with thrombolites indicates an increased nutrient content and progressive eutrofization of basins (Weissert, Mohr, 1996; Pisera, 1999). Detritic quartz and fragments of sandstones and mudstones reported from the Jasieniec Formation (Niemczycka, 1976a) suggest weathering and erosion as sources of nutrients responsible for eutrofization. The increase in terrigenous material in sediments of the Basznia, Bełżyce and Głowaczów formations indicates erosion of the sourrounding land masses in the warm and humid conditions – a possible effect of the Late Jurassic greenhouse period (Weissert, Mohr, 1996).

The Late Jurassic global transgression reached its maximum in Kimmeridgian. Submerged land areas did not supply enough nutrients causing oligotrophisation of water. Such conditions favoured the development of the coral-algal reefs (Weissert, Mohr, 1996). This trend is also observed in the investigated area (the Głowaczów Formation) but the origin of evaporites and the dolomitisation of sediments of the Ruda Lubycka Formation are attributed rather to the local tectonics (Dadlez *et al*., 1995). The microfossils of the upper part of the Ruda Lubycka Formation (coprolites, Characeae, Polymorphinidae) represent restricted environments of the inner lagoon.

Changes in the sea-level and direction of the sea currents during Tithonian generated rapid development of the planktonic microorganism – calpionellids, calcareous dinocysts and calcareous nannoplankton and shifted the carbonaceous sedimentation into the open sea (Michalik, 1999). However, in the investigated area, accumulation of the shallow-water, high energy sediments of the Babczyn Formation continued. The occurrence of planktonic calpionellids and calcareous dinocysts in sediments of the formation indicates temporal connections with the Tethyan realm.

The Cretaceous period is characterised by intense tectonics and remodelling of continents (Michalik, 2002). In Berriasian, more humid conditions developed leading to the first Cretaceous greenhouse effect in Valanginian (Ruffell, Batten, 1990; Lini *et al*., 1992).

Dark silicoclastic sediments with siderites are characteristic of those conditions (Weissert, 1990). The corresponding sediments on the investigated area may be that of the Cieszanów (Włocławek) Formation (Valanginian–Hauterivian) containing Tethyan ammonites (Marek, Raczyńska, 1979; Kutek, Marcinowski, 1996). It is accepted, however, that sedimentary conditions of the Early Cretaceous in the epicontinental Poland were mainly determined by evolution of the Mid-Polish Through (Marek *In*: Marek, Pajchlowa, eds, 1997a).

PALEONTOLOGICAL PART

Only microfossils important for stratigraphy and paleoenvironmental interpretation are presented herein. They are described in order of their significance for stratigraphy of the investigated sediments.

FORAMINIFERA

(systematics after Neagu, 1984, 1994; Loeblich, Tappan, 1988 and Kaminski, 2004)

Order **Lituolida** Lankester, 1885

Family **Haplophragmoididae** Maync, 1952

Genus *Haplophragmoides* Cushman, 1910
Haplophragmoides joukowskyi Charollais, Brönnimann & Zaninetti, 1966

Pl. VI, Fig. 9

1966 *Haplophragmoides joukowskyi* n.sp.; J. Charollais, P. Brönnimann, L. Zaninetti, p. 34–36, pl. 2, figs. 1, 5, 7, text-fig. 2, 3.
1988 *Haplophragmoides joukovskyi* Charollais, Brönnimann & Zaninetti; I.I. Bucur, p. 383, pl. II, figs. 4, 5.

Remarks. – Horizontal sections show the involute mode of coiling and regular, slowly enlarging chambers.
Range. – Berriasian–Valanginian.
Occurrence. – Babczyn Formation.

Family **Lituolidae** de Blainville, 1827

Genus *Ammobaculites* Cushman, 1910
Ammobaculites irregularis (Gümbel, 1862)

Pl. I, Fig. 6

1862 *Marginulina irregularis* n.sp.; W.C. Gümbel, p. 220, pl. 3, figs. 15–19 (*fide* B. Ellis, A. Messina, 1940–2009).
1968 *Ammobaculites irregularis* (Gümbel, 1862); H. Oesterle, p. 735–736, text-fig. 31.

Remarks. – Longitudinal sections show the coiled initial part, elongated, uniserial late stage composed of the slowly enlarging, sack-like chambers connected by thin tubes.
Range. – Oxfordian.
Occurrence. – Kraśnik and Jasieniec formations.

Family **Ammosphaeroidinidae** Cushman, 1927

Genus *Recurvoides* Earland, 1934
Recurvoides cf. *obskiensis* Romanova, 1960

Pl.VII, Fig. 3

1960 *Recurvoides obskiensis* n.sp.; I. Romanova (*In*: Glazunova *et al*.,) p. 55, 56, pl. 4, fig. 1–4.
1990 *Recurvoides* cf. *obskiensis* Romanova; K.F. Weidich, p. 89, 90, pl. 4, fig. 13–17.

Remarks. – The axial section shows the almost circular outline of the species and numerous (about 13) chambers arranged streptospirally in two whorls.
Range. – Valanginian.
Occurrence. – Cieszanów Formation.

Family **Textulariopsidae** Loeblich & Tappan, 1982

Genus *Bicazammina* Neagu & Neagu, 1995
Bicazammina jurassica (Haeusler, 1890)

Pl. I, Fig. 4

1890 *Pleurostomella jurassica* n.sp.; R. Haeusler, p. 77, pl. 12, figs. 14–22 (*fide* B. Ellis, A. Messina, 1940–2009).
1968 *Bigenerina jurassica* (Haeusler); H. Oesterle, p. 745, text-figs. 40–42.
1995 *Bicazammina jurassica* (Haeusler); T. Neagu, M. Neagu, p. 216, pl. 2, figs. 44–53.

Remarks. – The longitudinal section shows an early biserial stage followed by lax-uniserial adult stage.
Range. – Callovian–Valanginian.
Occurrence. – Kraśnik and Jasieniec formations.

Genus *Haghimashella* Neagu & Neagu, 1995
Haghimashella arcuata (Haeusler, 1890)

Pl. II, Fig 11

1890 *Bigenerina arcuata* n.sp.; R. Haeusler, p. 73 (*fide* B. Ellis, A. Messina, 1940–2009).
1968 *Bigenerina arcuata* Haeusler; H. Oesterle, p. 742–744, Figs. 37–39.
1995 *Haghimashella arcuata* (Haeusler); T. Neagu, M. Neagu, p. 216, pl. 2, figs. 1–11.
2007 *Haghimashella arcuata* (Haeusler); M. Krajewski, B. Olszewska, p. 295, fig. 4 D.

Remarks. – Typical test is composed of the biserial early and uniserial, somewhat inclined, late stage. In the material studied complete test are very rare, usually occur the early biserial part composed of initial chamber and two to three sets of inflated, ovoid, younger chambers.
Range. – Middle Oxfordian–Tithonian.
Occurrence. – Jasieniec, Bełżyce and Basznia formations.

Genus *Textulariopsis* Banner & Pereiera, 1981
Textulariopsis jurassica (Gümbel, 1862)

Pl. III, Fig. 1

1862 *Textilaria jurassica* n.sp. W.C. Gümbel, p. 228, pl. 4, fig. 17 (*fide* B. Ellis, A. Messina, 1940–2009).

1989 *Textulariopsis jurassica* (Gümbel); W. Riegraf, H-P. Luterbacher, p. 1026, pl. 1, figs. 23, 24.

Remarks. – The longitudinal sections show slowly enlarging, low, ovoid chambers arranged in two rows. Sometimes an adventitious chamber is visible in the initial part.

Range. – ?Bajocian–Valanginian.

Occurrence. – Basznia Formation.

Family **Prolixoplectidae** Loeblich & Tappan, 1985

Genus *Protomarssonella* Desai & Banner, 1987
Protomarssonella doneziana (Dain, 1958)

Pl. I, Fig. 13

1958 *Marssonella doneziana* n.sp.; L.G. Dain *In*: Bykova *et al*., p. 25, 26, pl. III, figs. 9, 10.
1972 *Marssonella donieziana* Dain; H.P. Luterbacher, p. 579, pl. 1, fig. 16, 17.

Remarks. – The species differs from *Protomarssonella jurassica* (Mityanina) in stocky appearance and in the stratigraphic distribution. Structural features of the test motivated Desai and Banner (1987) to include the species to into the new genus *Protomarssonella*.

Range. – Upper Callovian–? Middle Oxfordian.

Occurrence. – "Nodular layer", Kraśnik Formation.

Protomarssonella dumortieri (Schwager, 1866)

PL. II, Fig. 5

1866 *Textularia dumortieri* n.sp.; C. Schwager *In*: Oppel, p. 309 (*fide* B. Ellis, A. Messina, 1940–2009).
1989 *Pseudomarssonella dumortieri* (Schwager); W. Riegraf, H.P. Luterbacher, p. 1023–1026., pl. 2, figs. 1–8.

Remarks. – Longitudinal sections reveal typical for the species broad, fan-like outline of the test and small number of the pair of chambers.

Range. – Oxfordian–Tithonian.

Occurrence. – Jasieniec and Głowaczów formations.

Protomarssonella jurassica (Mityanina, 1957)

Pl. II, Fig. 6

1957 *Marssonella jurassica* n.sp.; I.V. Mityanina, p. 219, pl. I, figs. 5–7.
1980 *Dorothia jurassica* (Mityanina); W. Bielecka, p. 302, pl. 82, fig. 9.

Remarks. – The species transferred herein to the genus *Protomarssonella* differs from *Protomarssonella donieziana* Dain by its slender test and more restricted stratigraphic distribution.

Range. – Middle–Upper Oxfordian.

Occurrence. – Kraśnik, Jasieniec, Bełżyce and Głowaczów formations.

Protomarssonella kummi (Zedler, 1961)

Pl. V, Fig. 5

1961 *Marssonella kummi* n.sp.; B. Zedler, p. 31, 32, pl. 7, fig. 1 (*fide* B. Ellis, A. Messina, 1940–2009).
1987 *Protomarssonella kummi* (Zedler); D. Desai, F.T. Banner, p. 24, pl. 5, figs. 2a–e.
2005b *Protomarssonella kummi* (Zedler); B. Olszewska, p. 34, pl. 5, fig. 5.

Remarks. – Longitudinal section shows the typical form of a narrow cone with thick wall and part of the early trochospire.

Range. – Upper Tithonian–Hauterivian.

Occurrence. – Babczyn and Cieszanów formations.

Family **Verneuilinidae** Cushman, 1911

Genus *Paleogaudryina* Said & Bakarat, 1958
Paleogaudryina varsoviensis (Bielecka & Pożaryski, 1954)

Pl. III, Fig. 3

1954 *Neobulimina varsoviensis* n.sp.; W. Bielecka, W. Pożaryski, p. 65, pl. 10, fig. 30.
1980 *Paleogaudryina varsoviensis* (Bielecka & Pożaryski); W. Bielecka, p. 303, pl. 82, fig. 10.
2007 *Paleogaudryina varsoviensis* (Bielecka & Pozaryski); M. Krajewski, B. Olszewska, p. 295, fig. 4F.

Remarks. – Specific structure of the test (three-serial stage followed by a biserial one) makes the discussed species susceptible to cracking. Usually the three and biserial parts occur separately. Rare complete specimens when sectioned longitudinally show typical structure of the test.

Range. – Upper Oxfordian–Tithonian.

Occurrence. – Kraśnik, Jasieniec, Bełżyce, Basznia, Głowaczów, Urzędów and Babczyn formations.

Family **Reophacellidae** Mikhalevich & Kaminski, 2004

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

Pl. V, Fig. 4

1960 *Gaudryina uvigeriniformis* n.sp.; E. Seibold, I. Seibold, p. 334, 335, pl. 7, fig. 4, text-fig. 8b.
1995 *Uvigerinammina uvigeriniformis* (Seibold & Seibold); T. Neagu, M. Neagu, p. 218, pl. 2, figs. 28–43; pl. 6, figs. 11–14.
2005b *Uvigerinammina uvigeriniformis* (Seibold & Seibold); B. Olszewska, p. 34, pl. 5, fig.1.
2007 *Uvigerinammina uvigeriniformis* (Seibold & Seibold); M. Krajewski, B. Olszewska, p. 297, fig. 4G.

Remarks. – The longitudinal section shows characteristic uvigerinammine shape and arrangement of sack-like chambers.

Range. – Oxfordian, Berriasian–Lower Valanginian.

Occurrence. – Babczyn Formation.

Family **Nautiloculinidae** Loeblich & Tappan, 1985

Genus *Nautiloculina* Mohler, 1930
Nautiloculina cretacea Peybernès, 1976

Pl. V, Fig. 10

1976 *Nautiloculina cretacea* n.sp.; B. Peybernès, p. 398, pl. 40, fig. 15, 16 (*fide* B. Ellis, A. Messina, 1940–2009).
2005b *Nautiloculina cretacea* Peybernès; B. Olszewska, p. 34, 35, pl. 5, fig. 3.

Remarks. – The axial section shows typical lenticular outline and chambers with regular, high, arched shape.

Range. – Berriasian–Hauterivian.

Occurrence. – Babczyn Formation.

Nautiloculina oolithica Mohler, 1938

Pl. III, Fig. 2

1938 *Nautiloculina oolithica* n.sp.; W. Mohler, p. 18, 19, pl. 4, figs., 1–3, 6; text-fig. 6.
1967 *Nautiloculina oolithica* Mohler; P. Brönnimann, p. 54–61, pl. 1, figs. 1–6; pl. 2, figs. 1–9; pl. 3, figs. 1–9, text-fig. 1–4.
2005a *Nautiloculina oolithica* Mohler; B. Olszewska, pl. 1, fig. 9.
2007 *Nautiloculina oolithica* Mohler; M. Krajewski, B. Olszewska, p. 297, fig. 4I.

Remarks. – The axial sections show typical, broadly lenticular outline of the test and interior of chambers that sometimes display short septal projections.

Range. – ?Lower, Middle, Upper Jurassic, Lower Cretaceous.

Occurrence. – Basznia and Ruda Lubycka formations.

Genus *Stomatostoecha* Applin, Loeblich & Tappan, 1950
Stomatostoecha condensa (Dulub), 1972

Pl. VII, Fig. 1, 2

1972 *Buccicrenata condensa* n.sp.; V.G. Dulub, p. 19, 20, pl. 2, fig. 3; pl. 3, fig. 1, 2; pl. 10, fig. 2.
1996 *Buccicrenata condensa* Dulub; J. Sztejn, pl. 1, figs. 1, 2.
2004 *Buccicrenata condensa* Dulub; P. Dziadzio *et al*., fig. 18G, H.

Remarks. – Axial section shows characteristic narrow chambers slowly changing their shape from almost circular in the early whorl to narrow rectangular in later part. Number of chambers, mode of their arrangement and the slit like aperture argue for transferring the species to the genus *Stomatostoecha* Applin, Loeblich et Tappan.

Range. – Upper Valanginian–Aptian.

Occurrence. – Cieszanów Formation.

Family **Mesoendothyridae** Voloshinova, 1958

Genus *Mesoendothyra* Dain, 1958
Mesoendothyra izjumiana Dain, 1958

Pl. IV, Fig. 4, 5

1958 *Mesoendothyra izjumiana* n.sp.; L.G. Dain *In*: Bykova *et al*., p. 20, pl. 4, figs. 7–9.
2005b *Mesoendothyra izjumiana* Dain; B. Olszewska, p. 35, pl. 4, figs. 5, 6.

Remarks. – Rare but characteristic species in transverse sections shows two whorls and slowly increasing rectangular chambers, in axial sections the streptospiral mode of coiling is frequently visible.

Range. – Upper Oxfordian–Kimmeridgian.

Occurrence. – Bełżyce Formation.

Genus *Labyrinthina* Weynschenk, 1951
Labyrinthina mirabilis Weynschenk, 1951

Pl. IV, Fig. 6, 9

1951 *Labyrinthina mirabilis* n.sp.; R. Weynschenk, pl. 112, fig. 9.
1984 *Labyrinthina mirabilis* Weynschenk; P. Bernier, p. 515, 516, pl. 19, figs. 3, 4.
1997 *Labyrinthina mirabilis* Weynschenk; J.-P. Bassoulet, p. 301, 302.
2007 *Labyrinthina mirabilis* Weynschenk; M. Krajewski, B. Olszewska, p. 297, 298, fig. 5B.
2008 *Labyrinthina mirabilis* Weynschenk; D. Ivanova *et al*., fig. 6B, C.

Remarks. – Longitudinal sections show typical for the species early planispiral and late uncoiled stages. Chambers divided regularly by short pillars visible also in transverse sections of the early involute stage.

Range. – Uppermost Oxfordian–lawermost Tithonian.

Occurrence. – Bełżyce, Basznia and Głowaczów formations.

Family **Everticyclamminidae** Septfontaine, 1988

Genus *Everticyclammina* Redmond, 1964
Everticyclammina virguliana Koechlin, (1942)

Pl. IV, Fig. 2

1942 *Pseudocyclammina virguliana* n.sp.; E. Koechlin, p. 195, pl. 6, fig. 7.
1975 *Everticyclammina virguliana* (Koechlin); W. Bielecka, p. 306, 307, pl. 1, figs. 3, 4.
1984 *Everticyclammina virguliana* (Koechlin); P. Bernier, p. 512, 513, pl. 18, figs. 1–9.

Remarks. – Equatorial section shows the early, involute stage of the species with, slowly enlarging chambers, short intercameral septa and agglutinated, alveolar wall. Adult stages display tendency to uncoil.

Range. – Uppermost Oxfordian–? Berriasian.

Occurrence. – Bełżyce Formation.

Family **Charentiidae**, Loeblich & Tappan, 1985

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

Pl. VI, Fig. 1, 2

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.
2005b *Charentia evoluta* (Gorbatchik); B. Olszewska, p. 35, pl. 4, figs. 7, 8.
2007 *Charentia evoluta* (Gorbatchik); M. Krajewski, B. Olszewska, p. 299, fig. 5G, H.

Remarks. – Both axial and longitudinal sections display early planispiral and late uniserial arrangement of chambers without septal projections.

Range. – Upper Kimmeridgian–Valanginian.

Occurrence. – Ruda Lubycka, Babczyn and Cieszanów formations.

Family **Montsalevidae** Zaninetti, Salvini-Bonnard, Charollais & Decrouez, 1987

Genus *Monsalevia* Zaninetti, Salvini-Bonnard, Charollais & Decrouez, 1987

Montsalevia ?salevensis (Charollais, Brönnimann & Zaninetti, 1966)

Pl. V, Fig. 1

1966 *Pseudotextulariella salevensis* n.sp; J. Charollais, P. Brönnimann, L. Zaninetti, p. 28–34, pl. I, fig.1–5; pl. II, fig. 2, 6; text-fig 1.
1988 *Pseudotextulariella salevensis* Charollais, Brönnimann & Zaninetti; I.I. Bucur, p. 382, pl. II, figs.11, 12.
2004 *Montsalevia salevensis* (Charollais, Brönnimann & Zaninetti); D. Ivanova, E. Koleva-Rekalova, p. 220, pl. 2, figs. 4–6.
2007 *Montsalevia salevensis* (Charollais, Brönnimann & Zaninetti); M. Krajewski, B. Olszewska, p. 299–301, fig. 5K.

Remarks. – Longitudinal section of specimens show lack of partitions in early chambers and their presence in younger part of the test. Generally poorly preserved. Affiliation of the species to the genus *Montsalevia* Zaninetti, Salvini-Bonnard, Charollais and Decrouez seems controversial (Bulot *et al*., 1997) and is not followed by all scientists.

Range. – Berriassian–Hauterivian.

Occurrence. – Upper part of the Babczyn Formation.

Family **Pfenderinidae** Smout & Sugden, 1962

Genus *Siphovalvulina* Septfontaine,1988
Siphovalvulina variabilis Septfontaine, 1988

Pl.V, Fig. 8

1988 *Siphovalvulina variabilis* n.sp.; M. Septfontaine, p. 245, text-fig. 5.
1991 *Siphovalvulina variabilis* Septfontaine; R. Darga, F. Schlagintweit; p. 214, pl. 4, fig. 14.
2007 *Siphovalvulina variabilis* Septfontaine; M. Krajewski, B. Olszewska, p. 301, fig. 6A.
2008 *Siphovalvulina variabilis* Septfontaine; D. Ivanova *et al*., fig. 6R.

Remarks. – A frequent species, typical for the shallow-water carbonate environment. Longitudinal sections show a high trochospiral coiling of chambers and an internal twisted siphonal canal.

Range. – Hettangian–Lower Cretaceous.

Occurrence. – Babczyn Formation.

Genus *Pfenderina* Henson, 1948
Pfenderina neocomiensis (Pfender, 1938)

Pl.V, Fig. 7

1938 *Eorupertia neocomiensis* n.sp.; J. Pfender, p. 236 (*fide* B. Ellis, A. Messina, 1940–2009).
1961 *Pfenderina neocomiensis* (Pfender); A.H. Smout, W. Sugden, p. 585–588, pl. 73, figs. 1–9; pl. 74, figs. 1–3; pl. 75, fig. 1; text-fig. 1, A–D.
1989 *Pfenderina neocomiensis* (Pfender); J. Soták, pl. I, fig. 1.

Remarks. – Sections usually show juvenile specimens with few early high trochospiral whorls.

Range. – Berriasian–Hauterivian,

Occurrence. – Cieszanów Formation.

Family **Hauraniidae**, Septfontaine, 1988

Genus *Alveosepta* Hottinger,1967

Alveosepta jaccardi (Schrodt, 1894)

Pl. IV, Fig. 7, 8

1894 *Cyclammina jaccardi* n. sp.; F. Schrodt, p. 734 (*fide* B. Ellis, A. Messina, 1940–2009).
1967 *Alveosepta jaccardi* (Schrodt); L. Hottinger, p. 79, pl. 15, figs. 9–13; pl. 16, figs. 1–9.
1997 *Alveosepta jaccardi* (Schrodt); J.-P. Bassoulet, p. 301.

Remarks. – Transverse sections show almost planispiral mode of coiling, slowly enlarging crescentic chambers and disctinct subepidermal lining of entire chambers. The axial sections often show the streptospiral mode of coiling of the early stage.

Range. – Upper Oxfordian–Kimmeridgian.

Occurrence. – Jasieniec, Bełżyce, Basznia, Jarczów, Głowaczów and Ruda Lubycka formations.

Genus *Pseudocyclammina* Yabe & Hanzawa, 1926
Pseudocyclammina cylindrica Redmond, 1964

Pl. V, Fig. 6

1964 *Pseudocyclammina cylindrica* n.sp.; C.D. Redmond, p. 406, tabl. 1, fig. 1; tabl. 2, fig. 1, 2.
1991 *Pseudocyclammina vasconica* Maync *cylindrica* Redmond; F.T. Banner, J.E. Whittaker, p. 45, 46, pl. 5, fig. 5a–7; pl. 6, fig. 1–4.

Remarks. – The equatorial section of the Polish specimens are identical with the microspheric paratype of the species showing circular outline of the early stage and straight uncoiled part.

Range. – Berriasian–Valanginian.

Occurrence. – Babczyn Formation.

Pseudocyclammina lituus (Yokoyama, 1890)

Pl. V, Fig. 2

1890 *Cyclammina lituus* n. sp.; M. Yokoyama, p. 26, pl. 5, fig. 7 (*fide* B. Ellis, A. Messina, 1940–2009).
1997 *Pseudocyclammina lituus* (Yokoyama); J.-P. Bassoulet, p. 303.
2005b *Pseudocyclammina lituus* (Yokoyama); B. Olszewska, p. 35, pl. 4, fig. 10.
2007 *Pseudocyclammina lituus* (Yokoyama); M. Krajewski, B. Olszewska, p. 301, 302, fig. 6F.
2008 *Pseudocyclammina lituus* (Yokoyama); D. Ivanova *et al*., fig. 7A

Remarks. – Specimen similar to the holotype with characteristic thick wall with septa and a network of large canals.

Range. – Oxfordian–Berriasian.

Occurrence. – Ruda Lubycka and Babczyn formations.

Order **Textulariida** Delage & Herouard, 1896

Family **Textulariidae** Ehrenberg, 1838

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

Pl. V, Fig. 3

1967 *Textularia densa* n. sp.; E.A. Hoffman, p. 99, text-fig. 5, 5a (*fide* B. Ellis, A. Messina, 1940–2009).
2005b *Textularia densa* Hoffman; B. Olszewska, p. 36, pl. 5, fig. 8.

Remarks. – Longitudinal section shows typical specimen with low chambers arranged biserially and rather narrow shape of the test.

Range. – Tithonian–Lower Valanginian.

Occurrence. – Babczyn and Cieszanów formations.

Suborder Involutinina Hohenegger & Piller, 1977

Family **Involutinidae** Bütschli, 1880

Genus *Andersenolina* Neagu, 1994

Andersenolina alpina (Leupold, 1935)

Pl. VII, Fig. 8

1935 *Coscinodiscus alpinus* n.sp.; W. Leupold, p. 610, pl.18, figs. 1–8 (*fide* B. Ellis, A. Messina, 1940–2009).
1994 *Andersenolina alpina* (Leupold); T. Neagu, p. 133, pl. 7, figs. 8, 9; pl. 8, figs. 1–10; pl. 12, figs. 1–5, text-fig. 4, figs,. 3, 4.
2005b *Andersenolina alpina* (Leupold); B. Olszewska, p. 36, pl. 5, fig. 9.
2007 *Andersenolina alpina* (Leupold); M. Krajewski, B. Olszewska, p. 302, fig. 6J.
2008 *Trocholina alpina* (Leupold); D. Ivanova *et al*., Fig. 7Q, R.

Remarks. – Small, conical form with an apical angle of 80–95° and up to 5 whorls of low crescentic chambers.

Range. – Tithonian–Lower Valanginian.

Occurrence. – Babczyn and Cieszanów formations.

Andersenolina histeri Neagu, 1994

Pl. VII, Fig. 9

1994 *Andersenolina histeri* n.sp.; T. Neagu, p. 137, pl. 11, fig. 1–21, 23–25, 27–40; pl. 13, fig. 1–5; text-fig. 3/1–4.
2005b *Andersenolina histeri* Neagu; B. Olszewska, p. 36, pl. 5, fig. 11.

Remarks. – The longitudinal sections shows high, conical form with an apical angle between 60–80° and more than 6 whorls of low chambers.

Range. – Tithonian–Middle Berriasian.

Occurrence. – Babczyn Formation.

Genus *Ichnusella* Dieni & Masari, 1966

Ichnusella burlini (Gorbatchik, 1959)

Pl. VII, Fig. 6

1959 *Trocholina burlini* n. sp.; T.N. Gorbatchik, p. 81, pl. 4, fig. 3–5.
1995 *Ichnusella burlini* (Gorbatchik); T. Neagu, p. 271, 272, pl. 2, figs. 45–48; pl. 3, figs. 40–48; pl. 13, fig. 10.
2005b *Ichnusella burlini* (Gorbatchik); B. Olszewska, p. 36, pl. 5, fig.14.
2007 *Ichnusella burlini* (Gorbatchik); M. Krajewski, B. Olszewska, p. 302, 303, fig. 6L.

Remarks. – A low conical species with an apical angle of about 100°; test usually recrystallised.

Range. – Tithonian–Valanginian.

Occurrence. – Babczyn Formation.

Genus *Trocholina* Paalzow, 1922

Trocholina belorussica Mityanina, 1957

Pl. III, Fig. 7

1957 *Trocholina belorussica* n.sp.; I.V. Mityanina, p. 226, pl. II, figs. 1, 2.

Remarks. – A moderately conical species with an angle of about 90°, with considerable height of the last whorl on the umbilical side and rarely visible few nodes. The species *Trocholina nodulosa* Seibold & Seibold (Seibold, Seibold, 1960) may be a junior synonym of the species.

Range. – Oxfordian.

Occurrence. – Bełżyce and Głowaczów formations.

Trocholina solecensis Bielecka & Pożaryski, 1954

Pl. VII, Fig. 7

1954 *Trocholina solecensis* n.sp.; W. Bielecka, W. Pożaryski, p. 69, pl. 11, fig. 57.
1975 *Trocholina solecensis* Bielecka & Pożaryski; W. Bielecka, p. 259, pl. 11, fig. 8.
1980 *Trocholina solecensis* Bielecka & Pożaryski; W. Bielecka, p. 324, pl. 87, fig. 13.

Remarks. – Transverse section shows typical very low cone with an apical angle exceeding 110° and a few projections at the base.

Range. – Kimmeridgian–Tithonian.

Occurrence. – Babczyn Formation.

Family **Ventrolaminidae** Weynschenk, 1950

Genus *Protopeneroplis* Weynschenk, 1950

Protopeneroplis striata Weynschenk, 1950

Pl. V, Fig. 9

1950 *Protopeneroplis striata* n.sp.; R. Weynschenk, p. 13, pl. 2, fig. 12–14.
1999 *Protopeneroplis striata* Weynschenk; F. Schlagintweit, O. Ebli, p. 402, pl. 6, figs. 3, 4.
2005b *Protopeneroplis striata* Weynschenk; B. Olszewska, p. 37, pl. V, fig. 13.
2007 *Protopenerolis striata* Weynschenk; M. Krajewski, B. Olszewska, p. 303, Fig. 8D, E.
2008 *Protopeneroplis striata* Weynschenk; D. Ivanova *et al*., Fig. 6J, K.

Remarks. – The axial section of the species shows planispiral coiling, two layered wall -microgranular (dark) and hyaline (light) forming striae characteristic of the species.

Range. – Middle, Upper Jurassic.

Occurrence. – Ruda Lubycka and Babczyn formations.

Protopeneroplis ultragranulata (Gorbatchik, 1971)

Pl. V, Fig. 11, 12

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.
2005b *Protopeneroplis ultragranulata* (Gorbatchik); B. Olszewska, p. 37, pl. V, figs. 15, 16.

2007 *Protopeneroplis ultragranulata* (Gorbatchik); M. Krajewski, B. Olszewska, p. 303, fig. 7C.
2008 *Protopeneroplis ultragranulata* (Gorbatchik); D. Ivanova *et al*., fig. 7E, F.

Remarks. – The species differs from *P. striata* by a trochospiral mode of coiling, thickened hyaline layer of chamber wall and the presence of pustules on the spiral side.
Range. – Middle Tithonian–Valanginian.
Occurrence. – Babczyn and Cieszanów formations.

Suborder Miliolina Delage & Herouard, 1896

Family **Cornuspiridae** Schulze, 1854

Genus *Cornuspira* Schulze, 1854
Cornuspira eichbergensis Kübler & Zwingli, 1870

Pl. II, Fig. 1

1870 *Cornuspira eichbergensis* n.sp.; J. Kübler, H. Zwingli, p. 17, pl. 2 (III) , fig. 2 (*fide* B. Ellis, A. Messina, 1940–2009).
1971 *Cornuspira media* Kübler & Zwingli; L. Romanov, M. Danitsch, p. 103, pl. XVII, figs. 6, 7.

Remarks. – Equatorial section shows a large initial chamber and the second, tubular one, slowly increasing in size. The imperforate, porcelaneous wall in the transmitted light appears brownish.
Range. – Middle Oxfordian–Lower Kimmeridgian.
Occurrence. – Jasieniec and Bełżyce formations.

Genus *Meandrospira* Loeblich & Tappan, 1946
Meandrospira bancilai Neagu, 1970

Pl. VII, Fig. 4

1970 *Meandrospira bancilai* n.sp., T. Neagu, p. 412, 413, pl. 1, figs. 6–16.
1996 *Meandrospira bancilai* Neagu; J. Sztejn, pl. 2, fig. 1.

Remarks. – Variously oriented sections show a small globular initial chamber and/or a second undivided tubular chamber that initially wounds around the initial chamber in a zigzag mode and later becomes more or less planispiral.
Range. – Upper Valanginian–Barremian.
Occurrence – Cieszanów Formation.

Family **Nubeculariidae** Jones 1875

Genus *Crescentiella* Senowbari-Daryan, Bucur, Schlagintweit, Săsăran & Matyszkiewicz, 2008
Crescentiella morronensis (Crescenti, 1969)

Pl. I, Fig. 15

1969 *Tubiphytes morronensis* n.sp.; U. Crescenti, p. 35, figs.10, 20–22.
1996 "*Tubiphytes*" *morronensis* Crescenti; D. Schmid, p. 188–199, Figs. 63, 64, 96, 97, 109–118.
1999 *Tubiphytes morronensis* Crescenti; F. Schlagintweit, O. Ebli, p. 412, pl. 2, fig. 5; pl. 4, fig. 13; pl. 12, figs. 4, 5.
2003 *Tubiphytes morronensis* Crescenti; O.N. Dragastan, D.K. Richter, p. 86, pl. 1, fig. 5 t; pl. 2, fig. 2t; pl. 3, fig. 2a; pl.5, fig. 3t.
2008 *Crescentiella morronensis* Crescenti; B. Senowbari-Daryan *et al*., p. 187, 186, Figs. 1–3, 8; pl.1, figs. a–i; pl. 2, figs. a–h; pl. 3. figs. a–g; pl. 4, figs. b–h; pl. 5, figs. b, d–h; pl. 6, figs. a–h.

Remarks. – This common microincruster usually occurs as a free dark micritic, tubiform mass with nubeculinid foraminifer as a central canal encrusted with cyanobacterial cortex. Among other suggested taxonomical affinities of *Crescentiella* (*Tubiphytes)* are: cyanobacteria, porifera, hydrozoa and red algae (Riding, Guo, 1992).
Range. – Upper Jurassic–Berriasian.
Occurrence. – Kraśnik, Jasieniec, Bełżyce, Basznia and Babczyn formations.

Family **Ophthalmidiidae** Wiesner, 1920

Genus *Ophthalmidium* Kübler & Zwingli, 1870
Ophthalmidium oxfordianum (Deecke,1886)

Pl. II, Figs. 2, 10

1886 *Triloculina oxfordiana* n.sp.; W. Deecke, p. 18, pl. 1, figs. 32, 32a. (*fide* B. Ellis, A. Messina, 1940–2009).
1989 *Ophthalmidium oxfordianum* Deecke); W. Riegraf, H. Luterbacher, p. 1027, pl. 2, figs. 25–27.

Remarks. – The longitudinal sections show the elongated (fusiform) shape of the test. The transverse sections (elongated with rounded periphery) show planispiral mode of chamber arrangement. Riegraf and Luterbacher included in synonymy the species *Spirophthalmidium milioliniforme* Paalzow. Similar in general shape *Sigmoilina fussiformis* Danitsch differs in a semi-triangular transverse section due to sigmoiline chamber arrangement.
Range. – Upper Bajocian–lowermost Kimmeridgian (mostly Oxfordian from which it was described).
Occurrence. – Jasieniec Formation.

Ophthalmidium pseudocarinatum (Dain) Mityanina, 1963

Pl. III, Figs. 5, 6

1963 *Spirophthalmidium* (?) *pseudocarinatum* Dain; I.V. Mityanina, p. 127–129, pl. I, figs. 1–5.
1971 *Spirophthalmidium pseudocarinatum* Dain; L. Romanov, M. Danitsch, p. 134–136, pl. 35, figs. 6, 7; pl. 36, figs. 1–3.
1985 *Ophthalmidium pseudocarinatum* (Dain); U.T. Temirbekova, Z.A. Antonova, p. 80; pl. V, fig. 29.

Remarks. – Longitudinal sections show somewhat loose arrangement of chambers while the transverse sections show characteristic elongated outline of the test and acute peripheral margins.
Range. – Oxfordian–Kimmeridgian.
Occurrence. – Bełżyce and Basznia formations.

Ophthalmidium sagittum (Bykova, 1948)

Pl. I, Figs. 12, 14

1948 *Spirophthalmidium sagittum* n.sp.; E.V. Bykova, p. 104, pl. III, figs. 1–5.
1973 *Ophthalmidium sagittum* (Bykova); A.Ya. Azbel, p. 106, pl. I, figs. 1–3; pl. II, figs. 1–4.

Remarks. – Both longitudinal and transverse sections show the compact structure of test with involute mode of chambers coiling and acute periphery. Differs from *Ophthalmidium strumosum* (Gümbel) in much broader transverse section.

Range. – Lower Oxfordian.

Occurrence. – "Nodular layer", lower part of the Kraśnik Formation.

Ophthalmidium strumosum (Gümbel, 1862)

Pl. II, Fig. 3, 7

1862 *Guttulina strumosa* n. sp.; C.W. Gümbel, p. 227, 228, pl. 4, figs. 13, 14 (*fide* B. Ellis, A. Messina, 1941–2009).
1980 *Ophthalmidium strumosum* (Gümbel); W. Bielecka, p. 304, pl. 83, fig. 4.
1988 *Ophthalmidium strumosum* (Gümbel); B. Olszewska, J. Wieczorek, pl. I, fig. 3.
1989 *Ophthalmidium strumosum* (Gümbel); W. Riegraf, H. Luterbacher, p. 1027, 1028; pl. 2, figs. 34, 35.
2008 *Ophthalmidium strumosum* (Gümbel); D. Ivanova *et al*., fig. 6G, S.

Remarks. – The longitudinal section show the moderately involute mode of coiling while transverse section shows lenticular outline of test and sharpened peripheral margins.

Range. – Oxfordian.

Occurrence. – Kraśnik Formation.

Family **Hauerinidae** Schwager, 1876

Genus *Decussoloculina* Neagu, 1984
Decussoloculina barbui Neagu, 1984

Pl. VI, Fig. 8

1984 *Decussoloculina barbui* n. sp.; T. Neagu, p. 81, 82, pl. 2, figs. 8–12.
2005b *Decussoloculina barbui* Neagu; B. Olszewska, p. 37, pl. 6, figs. 4, 5.
2007 *Decussoloculina barbui* Neagu; M. Krajewski, B. Olszewska, p. 303, fig. 7D.

Remarks. – The transverse section of an adult form shows specific X-like chamber arrangement in set of four chambers and almost circular outline of the test.

Range. – Upper Berriasian–Valanginian.

Occurrence. – Cieszanów Formation.

Decussoloculina mirceai Neagu, 1984

Pl. VI, Fig. 4

1984 *Decussoloculina mirceai* n.sp.; T. Neagu, p. 81, pl. 2, figs. 1–7.

Remarks. – The transverse section shows typical for the species early qunqueloculine chamber arrangement passing into almost planispiral one in the late stage.

Range. – Upper Berriasian–Valanginian.

Occurrence. – Babczyn Formation.

Genus *Istriloculina* Neagu, 1984
Istriloculina alimanensis Neagu, 1984

Pl. VI, Fig. 10

1984 *Istriloculina alimanensis* n.sp.; T. Neagu, p. 88, pl. 2, figs. 32–39.
2005 *Istriloculina alimanensis* Neagu; M. Krobicki, B. Olszewska, p. 223, fig. 5H.

Remarks. – The species is characterized by its circular outline in transverse section with three chambers in whorl arranged in Y mode.

Range. – ? Barremian–Lower Aptian. The precise range of the species is unknown since it was described from the profile with sedimentary hiatus between Valanginian and Barremian (Neagu, 1986).

Occurrence. – Cieszanów Formation.

Istriloculina terekensis Matseva & Temirbekova, 1989

Pl. VI, Fig. 6, 7

1989 *Istriloculina terekensis* n. sp.; T.V. Matseva, U.T. Temirbekova, p.118, pl. 1, fig. s–u.
2005b *Istriloculina terekensis* Matseva & Temirbekova; B. Olszewska, p. 37, pl. VI, fig. 7.

Remarks. – Both sections are identical with Caucasian holotype.

Range. – Tithonian–Berriasian in Caucasus.

Occurrence. – Babczyn Formation, redeposited into the Cieszanów Formation.

Genus *Moesiloculina* Neagu, 1984
Moesiloculina danubiana (Neagu, 1968)

Pl. VI, Fig. 11

1968 *Quinqueloculina danubiana* n.sp.; T. Neagu, p. 567, pl. 2, fig. 8–21 (*fide* B. Ellis, A. Messina, 1940–2009).

Remarks. – The transverse section shows typical triangular chambers with acute margins.

Range. – Upper Berriasian–Lower Aptian.

Occurrence. – Cieszanów Formation.

Genus *Quinqueloculina* d'Orbigny, 1826
Quinqueloculina frumenta Azbel & Danitsch, 1971

Pl. III, Fig. 9, 10

1971 *Quinqueloculina frumenta* n. sp.; A.Y. Azbel, M.M. Danitsch *In*: L.F. Romanov, M.M. Danitsch, p. 143, pl. 38, figs. 4–9.
1984 *Quinqueloculina frumenta* Azbel & Danitsch; I.V. Dolitskaya *et al*., pl. I, figs. 9, 13.

Remarks. – The longitudinal section shows the elliptical outline of the test composed of few chambers. The transverse section shows gently rounded periphery and chambers arrangement in a Y mode.

Range. – Upper Oxfordian–Lower Kimmeridgian.

Occurrence. – Basznia Formation.

Quinqueloculina semisphaeroidalis Danitsch, 1971

Pl. I, Figs. 1, 3

1971 *Quinqueloculina semisphaeroidalis* n.sp.; M.M. Danitsch *In*: L.F. Romanov, M.M. Danitsch, p. 144, 145, pl. 39, figs. 1–4.
2007 *Quinqueloculina semisphaeroidalis* Danitsch; M. Krajewski, B. Olszewska, p. 303, Fig. 7H.

Remarks. – The longitudinal sections show typical small difference in the height/width ratio. The transverse sections appear to be almost circular.

Range. – Upper Oxfordian–Lower Kimmeridgian.
Occurrence. – Upper part of the Kraśnik Formation.

Quinqueloculina stellata Matseva & Temirbekova, 1989

Pl. VI, Fig. 3

1989 *Quinqueloculina stellata* n. sp.; T.V. Matseva, U.T. Temirbekova, p. 115, pl. I, fig. d, e, ż.
2007 *Quinqueloculina stellata* Matseva & Temirbekova; M. Krajewski, B. Olszewska, p. 304, fig. 7F.

Remarks. – The transverse section show a quinqueloculine form with concave chamber peripheral walls, truncate external periphery and acute edges.
Range. – Tithonian.
Occurrence. – Redeposited into the Cieszanów Formation.

Genus Rumanoloculina Neagu, 1986
Rumanoloculina mitchurini (Dain), 1971

Pl. VI, Fig. 5

1971 *Quinqueloculina mitchurini* n.sp.; L.G. Dain *In*: L.G. Dain, K.I. Kuznetsova, p. 114–115, pl. I, figs. 9, 10.
1989 *Quinqueloculina mitchurini* Dain; T.V. Matseva, U.T. Temirbekova, p. 115, pl. I, figs. a–g.
2007 *Rumanoloculina mitchurini* (Dain); M. Krajewski, B. Olszewska, p. 304, fig. 7E

Remarks. – The transverse sections show typical roughly triangular shape of the test with three quinquloculine type whorls of chambers. The longitudinal sections (depending of the plane of section) show parts of successive chambers.
Range. – Tithonian.
Occurrence. – Ruda Lubycka and Babczyn formations.

Rumanoloculina verbizhiensis (Dulub, 1964)

Pl. IV, Figs. 1, 3

1964 *Quinqueloculina verbizhiensis* n.sp.; V.G. Dulub *In*: V.G. Dulub, A.S. Tereschuk, p. 108, pl. I, figs. 3, 4.
1989 *Quinqueloculina verbizhiensis* Dulub; T.V. Matseva, U.T. Temirbekova, p. 115, 116, pl. 1, figs. z, c, k.

Remarks. – The species differs from *Quinqueloculina semisphaeroidalis* Danitsch in more distinct triangular outline of the test in transverse sections and slightly younger stratigraphical distribution.
Range. – Kimmeridgian–Tithonian.
Occurrence. – Bełżyce and Jarczów formations.

Suborder Robertinina Loeblich & Tappan, 1984

Family **Epistominidae** Wedekind, 1937

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

Pl. VII, Fig. 10

Remarks. – The vertical section of juvenile specimen shows unequally lenticular outline of the test, unornamented walls and chambers of successive whorls. Similar characteristic display randomly oriented sections of the Early Cretaceous (Valanginian–Barremian) species *Epistomina caracolla* (Roemer).
Occurrence. – Cieszanów Formation.

Suborder Rotaliina Delage & Herouard, 1896

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

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

Pl. III, Fig. 4

1932 *Trocholina feifeli* n.sp.; S. Paalzow, p. 140, pl. 9, figs. 6, 7 (*fide* B. Ellis, A. Messina, 1941–2009).
1970 *Paalzowella feifeli* (Paalzow); J.T. Groiss, p. 75.
2005b *Paalzowella feifeli* (Paalzow); B. Olszewska, p. 38, pl. 6, fig. 13.

Remarks. – Vertical sections show the conical shape of the test with an apical angle of about 90°, typical arrangement of chambers, elevated keels in successive chambers and the slightly concave apertural side.
Range. – Oxfordian–Hauterivian.
Occurrence. – Jasieniec and Bełżyce formations.

Paalzowella turbinella (Gümbel, 1962)

Pl. I, Fig. 11

1862 *Rotalina turbinella* n.sp.; C.W. Gümbel, p. 230, pl. 4, fig. 10 (*fide* B. Ellis, A.Messina, 1940–2009).
1980 *Paalzowella turbinella* (Gümbel); W. Bielecka, p. 323, pl 87, fig. 11.
2008 *Paalzowella turbinella* (Gümbel);D. Ivanova *et al*., fig. 6D.

Remarks. – Axial sections show the low conical shape of the test with the apical angle close to 180°, distinct keels on the successive chambers and a deep hollow in the centre of the apertural side.
Range. – Oxfordian.
Occurrence. – Kraśnik and Jasieniec formations.

Family **Discorbidae** Ehrenberg, 1838

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

Pl. II, Fig. 4

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.
1999 *Mohlerina basiliensis* (Mohler); F. Schlagintweit, O. Ebli, p. 400, pl. 6, figs. 1, 2.
2005b *Mohlerina basiliensis* (Mohler); B. Olszewska, p. 38, pl. 6, fig. 1.
2007 *Mohlerina basiliensis* (Mohler); M. Krajewski, B. Olszewska, p. 305, fig. 8A.
2008 *Mohlerina basiliensis* (Mohler); D. Ivanova *et al*., fig. 6N, Q.

Remarks. – Transverse sections show trochospiral mode of coiling and characteristic two layered wall. Frequent in the high energy outer platform environment (Schlagintweit, Ebli, 1999).

Range. – Oxfordian–Valanginian.
Occurrence. – Kraśnik, Jasieniec and Babczyn formations.

Superfamily Favusellacea Michael, 1972

Family **Globuligerinidae** Loeblich & Tappan, 1984

Genus *Globuligerina* Bignot & Guyader, 1971
Globuligerina oxfordiana (Grigelis, 1956)

Pl. I, Fig. 7

1958 *Globigerina oxfordiana* n.sp.; A.A. Grigelis, p. 109–111, text-fig. a,b,w (*fide* B. Ellis, A. Messina, 1940–2009).
1971 *Globuligerina oxfordiana* (Grigelis); G. Bignot, J. Guyader, p. 79–81, pl. 1, figs. 1–4; pl. 2, figs. 3, 4.
1986 *Globuligerina oxfordiana* (Grigelis); R. Wernli, P. Kindler, p. 141–143, pl, figs. 1–4, 8, 12, 14–16, 17–19.
2008 *Globuligerina oxfordiana* (Grigelis); D. Ivanova *et al*., fig. 6O, P.

Remarks. – Diverse sections show typical streptospiral arrangement of chambers, their inflated shape and differences in the height of the spire.
Range. – Uppermost Callovian–Oxfordian.
Occurrence. – Kraśnik and Bełżyce formations.

Superfamily Globigerinacea Carpenter, Parker & Jones, 1862

Family **Hedbergellidae** Loeblich & Tappan, 1961

Genus *Hedbergella* Brönnimann & Brown, 1958
Hedbergella delrioensis (Carsey, 1926)

Pl. VII, Fig. 5

1926 *Globigerina cretacea* d'Orbigny var *delrioensis*; D.O. Carsey, p. 43 (*fide* B. Ellis, A. Messina, 1940–2009).
1994 *Hedbergella delrioensis* (Carsey); R. Coccioni, I. Premoli--Silva, p. 674, 675, Fig. 10: 19–21; Fig. 11: 1–12.
2004 *Hedbergella infracretacea* (Glaessner); P. Dziadzio *et al*., p. 149, Fig. 19/A, B.

Remarks. – Forms similar in morphology to the species appear as minute specimens with 5 quickly enlarging globular chambers, often damaged and pyritized. Rare. Similarity of *Hedbergella infracretacea* (Glaessner) to the species *Hedbergella delrioensis* (Carsey) was noted by numerous authors (Loeblich, Tappan 1961; Maslakova, 1963; Caron, 1985; Coccioni, Premoli-Silva, 1994). Both forms were recorded as early as in Valanginian and Hauterivian strata in the Tethyan domain (Cecca *et al*., 1994)
Range. – ? Hauterivian–Albian.
Occurrence. – Cieszanów Formation (upper part).

CALCAREOUS DINOCYSTS

(systematics after Řehánek, Cecca, 1993)

Up to early 70-ties taxonomy of the calcareous cysts of dinoflagellata (calcdinocysts) encountered in thin plates was based on shape, size, structure and optical properties of cysts. Since original work of Bolli (1974) who examined calcdinocysts from the soft oceanic sediments under scanning microscope some authors (Reháková, Michalik, 1996; Ivanova, Keupp, 1999) tried to compare specimens from the hard rocks with those identified by Bolli (*op. cit.*) and his followers . However using SEM studies exclusively to identify species led to misintepretations (Streng *et al*., 2002) thus until further investigations clarify systematic affliation of the "thin section" species author decided to use existing Řehánek and Cecca (1993) taxonomical scheme.

Order **Peridiniales** Haeckel, 1894

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

Genus *Stomiosphera* Wanner, 1940
Stomiosphaera moluccana Wanner, 1940

Pl. VIII, Fig. 8

1940 *Stomiosphaera moluccana* n.sp; J. Wanner, p. 76, fig. 1, 2; text-fig. 1–18
2005b *Stomiosphaera moluccana* Wanner; B. Olszewska, p. 29, pl. 2, fig. 6.

Remarks. – Spherical cyst with a one layered wall composed of tightly packed calcite crystals. The outer margin rugged and uneven due to recrystallization process.
Range. – Upper Kimmeridgian–Valanginian.
Occurrence. – Babczyn and Cieszanów formations.

Stomiosphaera wanneri Borza, 1969

Pl. VIII, Fig. 11

1969 *Stomiosphaera wanneri* n.sp; K. Borza, p. 62, 63, pl. 61, fig. 4–13.
1996 *Stomiosphaera wanneri* Borza; D. Reháková, J. Michalík, p. 93, pl. 2, Figs. 4–6.
2005b *Stomiosphaera wanneri* Borza; B. Olszewska, p. 29, pl. 2, fig. 11.

Remarks. – Characteristic minute, spherical cyst with a one layered wall and uneven outer margin. In transmitted light the wall is milky white, in polarised light the extinction cross is visible.
Range. – Upper Berriasian–Hauterivian.
Occurrence. – Cieszanów Formation.

Genus *Colomisphaera* Nowak, 1968
Colomisphaera cieszynica Nowak, 1968

Pl. VIII, Fig. 4

1968 *Colomisphaera cieszynica* n.sp.; W. Nowak, p. 309, 310, pl. 30, fig. 1–5.
2005b *Colomisphaera cieszynica* (Nowak); B. Olszewska, p. 30, pl. 2, fig. 9.

Remarks. – Spherical cyst with a one layered wall composed of long, fibrous calcite crystals tightly packed. Outer and inner margins slightly uneven.

Range. – Kimmeridgian–Lower Valanginian.

Occurrence. – Babczyn Formation.

Colomisphaera conferta Řehánek, 1985

Pl. VIII, Fig. 5

1985 *Colomisphaera conferta* n.sp; J. Řehánek p. 171–173, pl. 1, fig. 1–8.
2005b *Colomisphaera conferta* Řehánek; B. Olszewska, p. 30, pl. 2, fig. 13.

Remarks. – Slightly oval cyst with a one layered wall composed of tightly packed short thin calcite crystals. The outer margin of the wall usually uneven, the inner margin is separated from the interior of the cyst by a thin, dark, granular layer.

Range. – Upper Berriasian–Valanginian.

Occurrence. – Cieszanów Formation.

Colomisphaera fibrata (Nagy, 1966)

Pl. I, Fig. 2

1966 *Cadosina fibrata* n.sp.; I. Nagy , p. 92, pl. 5, figs. 14, 22.
1974 *Colomisphaera fibrata* (Nagy); I. Garlicka, p. 42, pl. I, figs. 3, 4.
1994 *Colomisphaera fibrata* (Nagy); D. Ivanova, p. 95, pl. I, figs. 15,16.

Remarks. – Spherical cyst with a one layered wall composed of short, thin radial arranged calcite crystals. Both margins usually even.

Range. – Upper Callovian–Oxfordian (optimum uppermost Callovian–lowermost Oxfordian).

Occurrence. – "Nodular layer" and the Kraśnik Formation.

Colomisphaera lapidosa (Vogler, 1941)

Pl. I, Fig. 8

1941 *Cadosina lapidosa* n.sp.; J. Vogler, p. 281, pl. 21, fig. 58
1994 *Colomisphaera lapidosa* (Vogler); D. Ivanova, p. 97, pl. II, figs. 3, 4.
2005b *Colomisphaera lapidosa* (Vogler); B. Olszewska, p. 30, pl. 2, fig. 12.

Remarks. – Characteristic for the species are block like calcite crystals of the outer wall .

Range. – Oxfordian–Berriasian.

Occurrence. – Kraśnik Formation.

Colomisphaera radiata (Vogler, 1941)

Pl. VIII, Fig. 7

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.
2005b *Colomisphaera radiata* (Vogler); B. Olszewska, p. 30, pl. 3, fig. 1

Remarks. – Spherical cyst with characteristic radial arranged, short, fibrous calcite crystals. The outer margin of the wall even.

Range. – Upper Kimmeridgian–Tithonian.

Occurrence. – Babczyn Formation.

Genus *Committosphaera* Řehánek, 1985
Committosphaera czestochowiensis Řehánek (1993)

Pl. I, Fig. 5

1993 *Committosphaera czestochowiensis* n.sp. J. Řehánek, Z. Heliasz, p. 87, 88, pl. II, figs. 1–5.
2005a *Committosphaera czestochowiensis* Řehánek; B. Olszewska, pl. 3, fig. 4.

Remarks. – Characteristic for the species is a two layered wall. The outer layer, milky white, is composed of short, radial arranged, fine calcite crystals. The inner, brown layer, much thinner than the outer one is made of the microcrystalline calcite.

Range. – Lower–Middle Oxfordian.

Occurrence. – "Nodular layer" and Kraśnik formations.

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

Pl. VIII, Fig. 10

1966 *Cadosina borzai* n.sp; I. Nagy, p. 92, pl. 5, fig. 15, 16.
1968 *Carpistomiosphaera borzai* (Nagy); W. Nowak, p. 301–303, pl. 28, figs.3, 4.
1994 *Carpistomiosphaera borzai* (Nagy); D. Ivanova, p. 98, pl. I, figs. 10–12.

Remarks. – The species is characterized by a two layered wall of similar thickness composed of short calcite crystals. Both margins are even.

Range. – Upper Kimmeridgian–Middle Tithonian.

Occurrence. – Base of the Babczyn Formation.

Carpistomiosphaera tithonica Nowak, 1968

Pl. VIII, Fig. 12

1968 *Carpistomiosphaera tithonica* n.sp.; W. Nowak, p. 303, pl. 31, fig. 7
2005b *Carpistomiosphaera tithonica* Nowak; B. Olszewska, p. 32, pl. 3, fig. 9.

Remarks. – Spherical cyst with a two layered wall. Each layer consist of radial arranged calcite crystals. The outer layer is about two time as thick as the inner one. The outer margin of the wall uneven.

Range. – Tithonian.

Occurrence. – Base of the Babczyn Formation.

Carpistomiosphaera valanginiana Borza, 1986

Pl. VIII, Fig. 6

1986 *Carpistomiosphaera valanginiana* n.sp; K. Borza, p. 20–26, pl. 1, fig. 1–6; pl. 2, fig. 1–6.
2005b *Carpistomiosphaera valanginiana* Borza; B. Olszewska, p. 32, pl. 3, fig. 10.

Remarks. – Oval to spherical cyst with a two layered walls composed of radial arranged thin calcite crystals. Thickness of the inner wall varies considerably but do not reach more that half of the thickness of the outer wall. Both margin of the wall even.

Range. – Valanginian.

Occurrence. – Cieszanów Formation.

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

Pl. VIII, Fig. 9

1987 *Stomiosphaerina proxima* n.sp; J. Řehánek, p. 696–703, pl. 1, fig. 1–8.
2005b *Stomiosphaerina proxima* Řehánek; B. Olszewska, p. 32, pl. 2, fig. 15.

Remarks. – The slightly oval cyst with the two layered wall. The inner layer, dark, microgranular, the outer layer is composed of the short tightly packed calcite crystals. The outer layer, under crossed nicols gives the extinction cross. Both margins of the wall uneven.

Range. – Uppermost Tithonian–Lower Valanginian.

Occurrence. – Babczyn Formation.

Genus *Cadosina* Wanner, 1940
Cadosina parvula Nagy, 1966

Pl. I, Fig. 9

1966 *Cadosina parvula* n.sp.; I. Nagy, p. 93, pl. 5, fig. 17.
1994 *Cadosina parvula* Nagy; D. Ivanova, p. 88, 89, pl. I, figs. 3, 4.

Remarks. – Minute spherical cyst with a one layered wall composed of dark microgranular calcite.

Range. – Middle Oxfordian–Tithonian.

Occurrence. – Rare in the Kraśnik Formation.

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

Pl. II, Fig. 12

1940 *Cadosina semiradiata* n.sp.; J. Wanner, p. 81, Figs. 36, 37.
1994 *Crustocadosina semiradiata* (Wanner); D. Ivanova, p. 89, 90; pl. I, figs. 8, 9.
1996 *Crustocadosina semiradiata* (Wanner), D. Reháková, J. Michalík, p. 93–95, pl. 1, Figs. 1–4.
2005b *Crustocadosina semiradiata* (Wanner); B. Olszewska, p. 33, pl. 2, fig. 1.

Remarks. – Spherical cyst with a two layered wall. The outer layer is built of the short, radial arranged calcite crystals. The inner layer, dark, usually much thicker than the outer one, is composed of the microcrystalline calcite.

Range. – Upper Oxfordian–Lower Albian.

Occurrence. – Jasieniec and Cieszanów formations.

Genus *Orthopithonella* Keupp*In* Keupp& Mutterlose, 1984
Orthopithonella gustafsonii (Bolli, 1974)

Pl. II, Fig. 8

1974 *Pithonella gustafsoni* n.sp.; H. Bolli, p. 854, pl. 3, figs. 9–12; pl. 12, figs. 7–12; pl. 13, figs. 1, 2; pl. 22, fig. 3.
1989 *Orthopithonella gustafsoni* (Bolli); H. Keupp, A. Ilg, p. 168, pl. 1, figs. 1–3.
1999 *Orthopithonella gustafsonii* (Bolli); D. Ivanova, H. Keupp; p. 9, 10, pl. 1, figs. 3–5; pl. 2, figs. 3, 4.
2002 *Orthopithonella gustafsonii* (Bolli) Lentin & Williams; M. Streng *et al*., p. 404–405.

Remarks. – Spherical cyst, with a single layered wall composed of short, block-like calcite crystals in which ressembles *Stomiosphaera moluccana* Wanner. The difference lies in the size and stratigraphic distribution. The diameter of *Orthopithonella gustafsonii* (Bolli) trespass 60 µm, and the stratigraphic range of the species covers Early–Middle Oxfordian. Similar features display *Stomiosphaera* cf. *moluccana* described by Borza (1969) from the Bathonian–Callovian, red, nodular limestones of the Pieniny Klippen Belt.

Range. – ? Bathonian–Middle Oxfordian.

Occurrence. – Jasieniec Formation.

CALPIONELLIDS

(systematics after Nowak, 1980)

Order **Tintinida** Corliss, 1956

Family **Codonellidae** Kent, 1882

Genus *Tintinopsella* Colom 1948
Tintinopsella carpathica (Murgeanu & Filipescu, 1933)

Pl. VIII, Fig. 1

1933 *Calpionella carpathica* n.sp; G, Murgeanu, M. Filipescu; p. 63, fig. 1c.
1980 *Tintinopsella carpathica* (Murgeanu & Filipescu); W. Nowak, p. 337, 338; pl. 91, fig. 2.
2005b *Tintinopsella carpathica* (Murgeanu & Filipescu); B. Olszewska, p. 28, pl. I, fig. 8.

Remarks. – Small size (less that 80 µm) of lorica suggest that the identified specimen belongs to the earliest, Tithonian breed of species.

Range. – Uppermost Tithonian–Upper Hauterivian.

Occurrence. – Redeposited into the Cieszanów Formation.

Family **Calpionellidae** Bonet, 1956

Genus *Calpionella* Lorenz 1902

Calpionella alpina Lorenz, 1902

Pl. VIII, Fig. 3

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.
2005b *Calpionella alpina* Lorenz; B. Olszewska, p. 28, pl. 1, fig. 5.

Remarks. – Poorly preserved specimen retained its characteristic outlook of small spherical lorica and short collar.

Range. – Uppermost Tithonian–Lower Valanginian.

Occurrence. – Babczyn Formation.

Calpionella elliptalpina Nagy, 1986

Pl. VIII, Fig. 2

1986 *Calpionella elliptalpina* n.sp; I. Nagy, p. 58, pl. I, fig. 4; pl. Ia, fig. 4.
2005b *Calpionella elliptalpina* Nagy; B. Olszewska, p. 28, pl. 1, fig. 4.

Remarks. – Somewhat oblique section shows an oval lorica and typical size of the species.

Range. – Uppermost Tithonian–Berriasian.

Occurrence. – Redeposited into the Cieszanów Formation.

FRAGMENTS OF MACROFLORA AND MACROFAUNA

CALCAREOUS ALGAE

Class Rhodophyceae Rabenhorst, 1863

Order **Rhodophyta** Wettstein, 1901

Family **Corallinaceae**, Lamouroux, 1816

Genus *Marinella* Pfender, 1939
Marinella lugeoni Pfender, 1939

Pl. III, Fig. 8

1939 *Marinella lugeoni* n.sp.; J. Pfender, p. 215–217, pl. 2.
1970 *Marinella lugeoni* Pfender; J. Golonka, p. 82, 83, figs. 8, 9.
1980 *Marinella lugeoni* Pfender; J. Golonka, p. 538, pl. 180, figs. 1, 2.
1993 *Marinella lugeoni* Pfender; R. Leinfelder, W. Werner, p. 105–122.

Remarks. – Recognized specimens display typical features of the species: semicircular or fan-like, branched thallus that extends radial from the wide base.

Range. – Upper Jurassic–Oligocene. Common in the Upper Jurassic–Cretaceous in Europe. In Poland known from the Upper Oxfordian–Lower Kimmeridgian strata (Golonka, 1980).

Occurrence. – Bełżyce, Basznia and Ruda Lubycka formations.

Class Chlorophyceae Kützing, 1843

Order **Dasycladales** Pascher, 1931

Family **Dasycladaceae** Kützing, 1843

Genus *Salpingoporella* Pia *In* Trauth, 1918
Salpingoporella ex gr. *pygmaea* (Gümbel, 1891)

Pl. VIII, Fig. 13

Remarks. – The species kindly designated by Prof. Ovidiu Dragastan (Univeristy of Bucharest, Romania) is regarded as the most common in the Polish Outer Carpathians (Bucur *et al.*, 2005) and generally typical for the reef environment (Senowbari-Daryan *et al.*, 1994).

Occurrence. – Babczyn Formation.

Class Charophyceae, Smith, 1938

Order **Charales** Lindley, 1936

Family **Clavatoraceae** Harris, 1939

Pl. VII, Fig. 11

Remarks. – Isolated elements (oogonia, nodes, stems and stem internodes) of forms probably belonging to the family Clavatoraceae are frequent in the sediments of the Ruda Lubycka and Babczyn formations.

Type ANNELIDA

Class Polychaeta Grube, 1850

Family **Terebellidae** Grube, 1851

Genus *Terebella* Linne, 1758
Terebella lapilloides Münster, 1833

Pl. I, Fig. 10

1833 *Terebella lapilloides* n.sp. Münster (*In*: Goldfuss); pl. 71, fig. 16.
1996 *Terebella lapilloides* Münster; D.U. Schmid, p. 204, 205, Fig. 74.

Remarks. – Characteristic of *Terebellidae* is construction of the tube by agglutinating available particles (e.g. sponge spicules).Together with nubeculariid *Crescentiella morronensis* (Crescenti) and demosponges, *Terebella lapilloides* Münster makes an association typical for dysoxic conditions and deeper environments (60–100 m) in the Late Jurassic shallow-water depositional areas (Dupraz, Strasser, 1999; Pisera, 1999).

Range. – Upper Triassic–Jurassic.

Occurrence. – Kraśnik, Jasieniec and Babczyn formations.

Type ARTHROPODA

Class Malacostraca Latreille, 1803

Order **Decapoda** Latreille, 1803

Family **Favreinidae** Vialov, 1978

Genus *Favreina* Brönnimann, 1955
Favreina cf. *dinarica* Brönnimann, 1976

Pl. VIII, Fig. 14

Remarks. – The size of the coprolite and the arrangement of canals on the transverse section resembles that of Berriasian–Hauterivian (Neocomian) *Favreina dinarica* Brönnimann (Brönnimann, 1976).

Occurrence. – The Ruda Lubycka Formation.

Favreina cf. *fendiensis* Brönnimann & Zaninetti, 1972

Pl. VIII, Fig. 15

Remarks. – The arrangement of canals in the transverse section of coprolite closely resembles the arrangement described for *Favreina fendiensis* Brönnimann & Zaninetti, (Brönnimann, Zaninetti, 1972) known from Bathonian up to Hauterivian (Molinari-Paganelli *et al.*, 1979).

Occurrence. – Ruda Lubycka Formation.

Type ECHINODERMATA

Class Crinoidea Miller, 1821

Order **Roveacrinida** Sieverts-Doreck, 1933

Family **Roveacrinidae** Peck, 1943

Genus *Saccocoma* Agassiz, 1835
Saccocoma cf. *quenstedi* Verniory, 1961

Pl. II, Fig. 9

Remarks. – Fragments of skeletons (mostly delicate radial plates with projections) of the pelagic crinoids of the genus *Saccocoma* Agassiz occur in various quantities in sediments of the Jasieniec Formation. Majority of encountered fragments may represent the middle–late Oxfordian species *Saccocoma quenstedti* Verniory (Verniory, 1961; Hess, 1972; Pisera, Dzik, 1979). The *Saccocoma* calciturbidities were also reported from the upper Oxfordian–lower Kimmeridgian sediments of the southern part of the Cracow–Wieluń Upland (Matyszkiewicz, 1996).

CONCLUSIONS

The study of the thin sections of the Upper Jurassic–Lower Cretaceous sediments in the SE Poland (Fig. 1) revealed the presence of many significant microfossils complementing data obtained from the washed-residuum microfossil assemblages (Niemczycka, 1976b; Sztejn,1996; Dziadzio *et al.*, 2004).

The Late Jurassic sediments yielded foraminiferal species (*Alveosepta jaccardi*, *Labirynthina mirabilis*, *Mesoendothyra izjumiana*), widely known from Oxfordian-Kimmeridgian carbonate platforms of the Mediterranean Tethys.

Transitional (Tithonian/Berriasian) character of the Babczyn Formation is indicated by microfossils (foraminifera calcareous dinocysts and calpionellids) having their first appearance (FAD) in the Upper Tithonian.

Microfossils encountered in the Cieszanów Formation suggest that the subdivision most probably covers a time span of Valanginian–Hauterivian. In the Babczyn and Cieszanów formations, a few specimens of calpionellids (*Calpionella alpina, C. elliptalpina, Tintinnopsella carpathica*) have been found for the first time, documenting temporal contacts with the oceanic Tethyan domain. Proposed microfossil zones may be correlated with standard ammonite and calpionellid biostratigraphic zonations.

The predominantly carbonate, peri-reefal sediments of the Babczyn Formation fit into general pattern of the final Jurassic sedimentation on the Polish Lowland. Predominantly siliciclastic sediments of the Cieszanów Formation may be linked to the first world-wide Early Cretaceous greenhouse effect. The described formations have their counterparts in adjacent regions of the Western Ukraine.

Acknowledgements. The investigations were partly supported by Committee for Scientific Research Project 6. PO4D 66 18 and PGI Research Project 6.20.1228.00.0. Designation of the calcareous algae by Prof. dr Ovidiu Dragastan (University of Bucharest, Romania) is gratefully acknowledged. Thanks are extended also to dr D. Reháková, for discussion of some aspects of the calcareous dinocysts. Warm thanks are due to dr E. Malata and P. Harris for their correction of the English form. The paper greatly profited from thorough review and useful suggestion by anonymous reviewers.

REFERENCES

ALTINER D., 1991 — Microfossila biostratigraphy (mainly foraminifers) of the Jurassic–Lower Cretaceous carbonate succession in North-Western Anatolia (Turkey). *Geologica Romana*, **27**: 167–213.

AZBEL A.Ya., 1973 — On specifying the generic features of some Post-Jurassic Miliolida (Foraminifera). [In Russian]. *Vopr. Mikropaleont*., **16**: 105–110.

BANNER F. T., WHITTAKER J.E., 1991 — Redmond's "new lituolid foraminifera" from the Mesozoic of Saudi Arabia. *Micropaleontology*, **37**: 41–59.

BARWICZ-PISKORZ W., 1995 — Foraminiferal assemblages and stratigraphy of Upper Jurrasic in the Holy Cross Mts. District [In Polish, Engl. Sum.]. *Rozprawy Monografie AGH*, **21**: 1–120.

BASSOULET J.-P., 1997 — Les Grands Foraminifčres. *In*: Biostratigraphie du Jurassique Ouest-Européen et Méditerranéen (eds. E. Carriou, P. Hantzpergue). *Bull. Centr. Rech. Explor. Prod. Elf-Aquit.*, **17**: 293–304.

BERNIER P., 1984 — Les Formations Carbonatées du Kimmeridgien et du Portlandien dans le Jura Méridional. *Documents Laborat. Géol. Lyon*, **92**: 445–803.

BIELECKA W., 1975 — Foraminifera and brackish Ostracoda from the Portlandian of Polish Lowlands. *Acta Geol. Pol.*, **20**, 3: 296–380.

BIELECKA W., 1980 — Rząd Foraminiferida Eichwald, 1830. *In*: Budowa geologiczna Polski. T. III, Atlas Skamieniałości przewodnich i charakterystycznych. Cz. 2 b, Mezozoik, Jura (ed. L. Malinowska): 291–328. Wyd. Geol., Warszawa.

BIELECKA W., POŻARYSKI W., 1954 — Micropalaeontological stratigraphy of the Upper Malm in Central Poland. [In Polish, Engl. Sum.]. *Pr. Inst. Geol.*, **12**: 1–72.

BIGNOT G., GUYADER J., 1971 — Observations nouvelles sur *Globigerina oxfordiana* Grigelis. Proceedings of the 2nd Planktonic Conference, Rome 1970, I: 79–81.

BOLLI H., 1974 — Jurassic AND Cretaceous Calcisphaerulidae from DSDP Le 27, eastern Indian Ocean. *In*: Initial reports of the DSDP. (eds. J.J. Veevers, J.R. Heitzler *et al.*), 27: 843–907. Washington D.C., U.S.Gov. Printing Office.

BORZA K., 1969 — Die Mikrofazies und Mikrofossilien des Oberjuras und der Unterkreide der Klippenzone der Westkarpaten. Slovenska Akadémia Vied, Bratislava.

BORZA K., 1986 – *Carpistomiosphaera valanginiana* n.sp. and *Colomisphaera lucida* n.sp. from the Lower Cretaceous of the West Carpathians. *Geol. Zb.*, *Geol. Carpath.*, **37**: 17–34.

BRÖNNIMANN P., 1967 — Re-examination of the morphology of *Nautiloculina oolithica* Mohler, 1938. *C. Rendu Séanc. Soc.*, **2**: 48–61.

BRÖNNIMANN P., 1976 — Revision of the lectotype of *Favreina salevensis* (Parejas) (Crustacea, Decapoda) and description of favreine form-species from the Jurassic and Cretaceous of Scotland, Portugal,Yougoslavia and Pakistan. *Paläontol. Zeitschr.*, **50**: 40–56.

BRÖNNIMANN P., ZANINETTI L., 1972 — New names for favreine and parafavreine thalassinid anomuran (Crustacea, Decapoda) coprolites from the Jurassic of Greece and Algeria. *Paläontol. Zeitschr.*, **46**: 221–224.

BUCUR I.I., 1988 — Les foraminifčres du Crétacé inferieur (Berriasien-Hauterivian) de la zone de Resita-Moldova Noua (Carpathes Meridionales). Remarques biostratigraphiques. *Rev. Paléobiol.*, vol. spec., **2**: 379–389.

BUCUR I., PITEIU M.-A., SĂSĂRAN E., 1993 — The Mesozoic carbonate deposits from the borehole 6042 Deleni (Transylvanian Depression). *Stud. Universit. Babeş-Bolyai, Geologia*, **49**: 27–48.

BUCUR I.I., SENOWBARI-DARYAN B., ABATE B., 1996 — Remarks on some foraminifera from the Upper Jurassic (Tithonian) reef limestone of Madonie Mountains (Sicily). *Boll. Soc. Paleont. Ital.*, **35**: 65–80.

BUCUR I.I., HOFFMANN M., KOŁODZIEJ B., 2005 — Upper Jurassic-Lowermost Cretaceous benthic algae from Tethys and the European Platform: a case study from Poland. *Rev. Espan. Micropaleontol*., **37**: 105–129.

BULOT L.G., MASSE J.P., MOUTIER L., VIRGONE A., 1997 — Organisation stratigraphique et dymanique sédimentaire du Valanginien au passage plate-forme/bassin en Basse-Provence (S–E France). *Bull. Soc. Géol. France*, **168**: 171–179.

BYKOVA N.K., 1948 — O znacheniy isskopayemykh foraminifer dla stratigrafii yurskikh otlozheniy raiona Samarskoy Łuki. *Trudy VNIGRI* **31**: 83–108.

BYKOVA N.K., BALAKHMATOVA V.T.,VASILENKO V.P., VOLOSHINOVA H.A., GRIGELIS A., DAIN L.G., IVANOVA L.V., KUZHINA B.I., KUZNETSOVA Z.V., KOZYREVA B.F., MOROZOVA V.F., MYATLIUK E.B., SUBBOTINA H.H., 1958 — Novye rody i vidy foraminifer. [In Russian]. *Mikrofauna SSSR, Sbornik* **IX**: 5–78.

CARON M., 1985 — Cretaceous planktic foraminifera. *In*: Plankton Stratigraphy (eds. H. Bolli, J.B. Saundres, K. Perch-Nielsen): 17–79. Cambridge.

CECCA F., PALLINI G., ERBA E., PREMOLI-SILVA, COCCIONI R., 1994 — Hauterivian-Barremian chronostratigraphy based on ammonites, nannofossils, planktonic foraminifera and magnetic chrons from the Mediterranean domain. *Cretaceous Research*, **15**: 457–467.

CECCA F., ŘEHÁHEK J., 1991 — First correlation between Late Jurassic ammonite and "microproblematic" biostratigraphic scales. Results from Marches Apennines (Central Italy*). C. Rend. Acad. Sci., Paris*, **313**/II: 1441–1446.

CHAROLLAIS J., BRÖNNIMANN P., ZANINETTI L., 1966 — Troisiëme note sur les foraminifères du Crétacé inférieur de la région genevoise. Remarques stratigraphiques et description de *Pseudotextulariella salevensis*, n.sp.; *Haplophragmoides joukowskyi*, n.sp.; *Citaella* ? *favrei*, n.sp. *Arch. Sci. Soc. Physiq. Hist. Nat. Geneve*, **19**: 23–48.

COCCIONI, R., ERBA E., PREMOLI-SILVA I., 1992 — Barremian-Aptian calcareous plankton biostratigraphy from the Gorgo Cerbara section (Marche, central Italy) and implication for plankton evolution. *Cretaceous Research*, **13**: 517–537.

COCCIONI R., PREMOLI-SILVA I., 1994 — Planktonic foraminifera from the Lower Cretaceous of Rio Argos section (southern Spain) and biostratigraphic implications. *Cretaceous Research*, **15**: 645–687.

CRESCENTI U., 1969 — Biostratigrafia delle facies Mesozoiche dell'Appenino centrale: correlazioni. *Geologica Romana*, **8**: 15–40.

DADLEZ R., NARKIEWICZ M., STEPHENSON R.A., VOSSER M.T.M., van VEES J-D., 1995 — Tectonic evolution of the Mid-Polish Trough: modelling implications and significance for central European geology. *Tectonophysics*, **252**: 179–195.

DAIN L.G., KUZNETSOVA K.I., 1971 — Zonal subdivision of the stratotypical section of the Volgian stage based on Foraminifera. (In Russian, Engl. Sum.). *Vopr. Mikropaleont.*, **14**: 103–123.

DARGA R., SCHLAGINWEIT F., 1991 — Mikrofazies, Paläontologie und Stratigraphie der Lerchkogelkalke (Tithon–Berrias) des Dietrichshorns (Salzburger Land, Nördliche Kalkalpen). *Jahrb. Geol. Bundes-Anstalt, Wien*, **134**: 205–226.

DESAI D., BANNER F. T., 1987 — The evolution of the Early Cretaceous Dorothiinae (Foramininiferida). *J. Micropaleont.*, **6**: 13–27.

DOLITSKAYA I.V., KUZNETSOVA K.I., FORTUNATOVA N.K., 1984 — Assocyacya verkhneyurskikh foraminifer rifovogo massiva khrebta Gaudak (Yugo-zapadnyi Gissar). *Izv. A.N. SSSR, Ser. Geol.*, **5**: 80–90.

DRAGASTAN O.N., RICHTER D.K., 2003 — Calcareous algae and foraminifera from Neocomian Limestones of Methana Peninsula, Asprovouni Mts (Greece) and from South Dobrogea (Romania). *An. Univ. Bucureşti Geol., Sp. Pub.*, **1:** 57–93

DULUB V.G.,1972 — Foraminifery verkhnejurskikh i nizhnemelovykh oltozheniy Volyno-Podolskoy okrainy Russkoy platformy i Predkarpatskogo progiba. *Tr. Ukr. NIGRI*, **27**: 5–51.

DULUB V.G., BUROVA M.I., BUROV V.S., VISHNYAKOV I. B., 1986 — Ob'yasnitelnaya zapiska k regionalnoy stratigraficheskoy skheme yurskikh otlozheniy Predkarpatskogo progiba i Volyno-Podolskoy okrainy Vostochnoy-Evropeyskoy platformy [In Ukrainian]. Ukrainskiy NIGRI, Leningrad.

DULUB V.G., TERESCHUK A.S., 1964 — Predstavitely miliolid iz yurskikh otlozheniy jugo-zapadnoy okrainy russkoy platformy i predkarpatskogo progiba. *Tr. Ukr. NIGRI*, **9**: 106–108.

DULUB V.G., ZHABINA N. M., 1999 — Stratigraphic and sedimentary aspects of the Upper Jurassic carbonate-evaporite deposits in Ukrainian Precarpathians. *Biul. Państw. Inst. Geol.*, **387**: 25–26.

DULUB V.G., ZHABINA N.M., 2000 — The conditions of forming the Upper Jurassic deposits in Ukrainian Precarpatian. *Slov. Geol. Mag*., **6**: 304.

DULUB V.G., ZHABINA N.M., OGORODNIK M.E., SMIRNOV S.E., 2003 — Poyasnuvalna zapiska do stratigrafichnoy skhemy yurskikh vidkladiv Peredkarpatt'a (Stryjskij yurskij basejn) [in Ukrainian]. L'vivskie Viddelennia Ukrainskogo Derzhavnogo Geologorozviduvalnogo Institutu. L'viv.

DUPRAZ Ch., STRASSER A., 1999 — Microbialites and micro--encrusters in shallow coral bioherms (Middle to Late Oxfordian, Swiss Jura Mountains). *Facies*, **40**: 101–130.

DZIADZIO P., GAŹDZICKA E., PLOCH I., SMOLEŃ J., 2004 — Biostratigraphy and sequence stratigraphy of the Lower Cretaceous in central and SE Poland. *Ann. Soc. Geol. Pol.*, **74**: 125–196.

EBLI O., SCHLAGINTWEIT F., 1998 — On some stratigraphically important microfossils (benthic foraminifera, dasycladales) from subsurface Late Jurassic–Early Cretaceous shallow water limestones of S-Germany. *Mitt. Bayer. Staatssamml. Paläont. Hist. Geol.*, **38**: 9–23.

ELLIS B., MESSINA A., 1940–2009 — Catalogue of Foraminifera with supplements. Amer. Mus. Nat. Hist., New York.

GARLICKA I., 1974 — Horizon with Stpomiosphaerids in the Upper Jurassic of the Carpathian Foreland (Southern Poland). *Rocz. Pol. Tow. Geol*., **44**: 37–50.

GARLICKA I., 1976 — Stratigraphic position of the lower boundary of a horizon with Colomisphaera fibrata (Nagy) in the Jurassic sequence at Zalas (Cracow Region) [In Polish, Engl. Sum.]. *Biul. Inst. Geol.*, **295**: 273–287.

GLAZUNOVA A.E., BALAKHMATOVA V.T., LIPMAN R. Kh., ROMANOVA I., KHOKHLOVA A., 1960 — Stratigrafia i fauna kreydovykh otlozheniy zapadno sibirskoy izmennosti. *Tr. Vsesoyuzn. Geol. Inst.*, **29**: 1–347.

GOLDFUSS A., 1833 — Petrefacta Germaniae. Arnz & Cie.

GOLONKA J., 1970 — Calcareous algae from the Upper Jurassic of the southern periphery of the Świętokrzyskie Mts. Part I: Rhodophyta. *Bull. Acad. Sci., Sér. géol. et géogr.*, **17**: 75–84.

GOLONKA J., 1980 — Makroflora. *In*: Budowa Geologiczna Polski., III. Atlas skamieniałości przewodnich i charakterystycznych. Część 2b, Mezozoik. Jura (ed. L. Malinowska): 533–540. Wyd. Geol., Warszawa.

GORBATCHIK T.N., 1959 — Novye vidy foraminifer izh nezhnemelovykh otlozheniy Kryma i severnogo Kavkaza. *Paleontol. Zhurnal*, **1**: 78–83.

GORBATCHIK T. N., 1968 — Homeomorphy phenomena in foraminifera [In Russian]. *Paleont. Žurn.*, **1**: 3–9.

GORBATCHIK T.N., 1971 — On Early Cretaceous Foraminifera of the Crimea. *Vopr. Micropaleont*., **14**: 125–136.

GRADSTEIN F., OGG J., SMITH A., 2004 — A Geologic Time Scale. University Press, Cambridge.

GROISS J.T., 1970 — Feinstratigraphische, ökologische und zoogeographische Untersuchungen der Foraminiferen – Faunen im Oxford der Franken-Alb. *Erlanger Geol. Abh.*, **81**: 1–76.

GUTOWSKI J., POPADYUK I.V., OLSZEWSKA B., 2005 — Late Jurassic–earliest Cretaceous evolution of the epicontinental sedimentary basin of southeastern Poland and Western Ukraine. *Geol. Quart.*, **49**: 31–44.

GUTOWSKI J., URBANIEC A., ZŁONKIEWICZ Z., BOBREK L., ŚWIETLIK B., GLINIAK P., 2007 — Upper Jurassic and Lower Cretaceous of the middle Polish Carpathian Foreland [In Polish, Engl. Sum.]. *Biul. Państw. Inst. Geol.*, **426**: 1–26.

HESS H., 1972 — Planktonic crinoids of Late Jurassic age from Leg 11 Deep Sea Drilling Project. *In*: Initial Reports of the Deep Sea Drilling Project **11** (eds. C.D. Hollister, I.Z. Ewing *et al*.): 631–643. Washington D.C. US Government Printing Office.

HOTTINGER L., 1967 — Foraminifères imperforés du Mésozoïque marocain. *Not. Mem. Serv. Geol. Maroc.*, **209**: 1–108.

IVANOVA D., 1994 — Cadosinidae Wanner, 1940 and Stomiosphaeridae Wanner, 1940 (Incertae sedis) from the Upper Jurassic of the Central Forebalkan, Bulgaria. *Geologica Balcanica*, **24**: 85–102.

IVANOVA D., 2000 — Middle Callovian to Valanginian microfossil biostratigraphy in the West balkan Mountain Bulgaria (SE Europe). *Acta Palaeont. Romaniae*, **2**: 231–236.

IVANOVA D., KEUPP H., 1999 — Calcareous dinoflagellate cysts from the Late Jurassic and Early Cretaceous of the Western Forebalkan, Bulgaria. *Berliner Geowiss. Abh.* (E)**, 30**: 3–31.

IVANOVA D., KOLEVA-REKALOVA E., 2004 — Agglutinated foraminifers in the framework of Southwestern Bulgarian palaeoenvironmental evolution during the late Jurassic and Early Cretaceous. *In*: Proceedings of the Sixth International Workshop on agglutinated Foraminifera (eds. M. Bubík, M.A. Kaminski). *Grzybowski Found. Sp. Publ*., **8**: 217–227.

IVANOVA D., KOŁODZIEJ B., KOLEVA-REKALOVA E., RONIEWICZ E., 2008 — Oxfordian to Valanginian paleoenvironmental evolution on the western Moesian Carbonate Platform: a case study from SW Bulgaria. *Ann. Soc. Geol. Pol.*, **78**: 65–90.

IZOTOVA T.S., POPADYUK I.V., 1996 — Oil and gas accumulations in the Late Jurassic reefal complex of the West Ukrainian Carpathian foredeep. *In*: Peri-Tethys Memoir 2: Structure and Prospects of Alpine Basins and Forelands (eds. P.A. Ziegler, F. Horvath). *Mém. Mus. Nat. Hist. Natur*., **170**: 375–390.

KAMINSKI M. A., 2004 — The Year 2000 Classification of the Agglutinated Foraminifera. *In*: Proceedings of the Sixth International Workshop on Agglutinated Foraminifera (eds. M. Bubík, M.A. Kaminski). *Grzybowski Found. Sp. Publ.*, **8**: 237–255.

KEUPP H., ILG A., 1989 — Die kalkigen Dinoflagellaten im Ober-Callovium und Oxfordium der Normandie/Frankreich. *Berliner Geowiss. Abh.* (A), **106**: 165–205.

KOECHLIN E., 1942 — Pseudocyclammina virguliana n.sp. aus den Virgula-Mergeln des Berner Jura. Ecl. Geol. Helv., **35**: 195–199.

KOWALSKA S., KRANC A., MAKSYM A., ŚMIST P., 2000 — Budowa geologiczna podłoża trzeciorzędu w północno--wschodniej części zapadliska przedkarpackiego w rejonie Lubaczów–Biszcza. *Nafta-Gaz*, **3**: 158–172.

KRAJEWSKI M., OLSZEWSKA B., 2007 — Foraminifera from the Late Jurassic and Early Cretaceous carbonate platform facies of the southern part of the Crimea Mountains, Southern Ukraine. *Ann. Soc. Geol. Pol.*, **77**: 291–311.

KRASSOWSKA A., 1997 — Kreda górna (alb górny–mastrycht). Litostratygrafia i litofacje. Sedymentacja, paleogeografia i paleotektonika [In Polish, Engl.Sum.]. *In*: The Epicontinental Permian and Mesozoic in Poland (eds. S. Marek, M. Pajchlowa). *Pr. Państw. Inst. Geol.*, **153**: 386–402.

KROBICKI M., OLSZEWSKA B., 2005 — Urgonian-type microfossils in exotic pebbles of the Late Cretaceous and Paleogene gravelstones from the Sromowce and Jarmuta forma-

tions (Pieniny Klippen Belt, Polis Carpathians). *Stud. Geol. Pol.* **124**: 215–235.
KUTEK J., 1994 — Jurassic tectonic events in south-eastern cratonic Poland. *Acta Geol. Pol.*, **44**: 167–214.
KUTEK J., MARCINOWSKI R., 1996 — Faunal changes in the Valanginian of Poland tectonic or eustatic control. *Mitt. Geol.-Paläont. Inst. Univ. Hamburg*, **77**: 83–88.
KUZNETSOVA K.I., 1989 — Late Jurassic: problems of stratigraphy and correlation by means of foraminifera. *In*: Problems of Upper Proterozoic and Phanerozoic Stratigraphy (ed. V.A. Krasheninnikov). [In Russian]. *Trans. USSR Acad. sci.*, **431**: 157–169.
KUZNETSOVA K.I., GORBATCHIK T.N., 1985 — Upper Jurassic and Lower Cretaceous stratigraphy and foraminifers of Crimea. [In Russian] Nauka, Moscov.
LAKOVA I., TCHOUMATCHENCO P.,IVANOVA D., KOLEVA-REKALOVA E., 2007 — Callovian to Lower Cretaceous pelagic carbonates in the West Balkan Mountains (Komishtitsa and Barlya sections): integrated biostratigraphy and microfacies. *Geol. Balcanica*, **36**: 81–89.
LEINFELDER R.R., WERNER W., 1993 — Systematic position and paleoecology of the Upper Jurassic to tertiary alga *Marinella lugeoni* Pfender. *Zitteliana*, **20**: 105–122.
LINI A., WEISSERT H., ERBA E., 1992 — The Valanginian carbon isotope event: a first episode of greenhouse climate conditions during Cretaceous. *Terra Nova*, **4**: 374–384.
LOEBLICH A.R. Jr., TAPPAN H., 1961 — Cretaceous planktonic foraminifera. Pt. 1 Cenomanian. *Micropaleontology*, **7**: 257–304.
LOEBLICH A.R. Jr., TAPPAN H., 1988 — Foraminiferal genera and their classification. Van Nostrand Reindold Co., New York.
LORENZ T., 1902 — Geologische Studien im Grentzgebiet zwischen helvetischer und ost-alpiner Fazies. II. Der südliche Rhaätikon. *Ber. Naturforsch. Ges. Freiburg*, **12**: 35–95.
LUTERBACHER H.-P., 1972 — Foraminifera from the Lower Cretaceous and Upper Jurassic of the North-western Atlanitc. *In*: Initial Reports of the Deep Sea Drilling Project Leg **11** (eds. C.D. Hollister, I.Z. Ewing *et al*.): 561–593. Washington D.C., US Government Printing Office.
MAREK S., 1997a — Kreda dolna (berias–alb górny). Litostratygrafia I litofacje. Sedymentacja, paleogeografia i paleotektonika [In Polish, Engl.Sum.]. *In*: The Epicontinental Permian and Mesozoic in Poland (eds. S. Marek, M. Pajchlowa). *Pr. Państw. Inst. Geol.*, **153**: 362–367.
MAREK S., 1997b — Tektonika kompleksu permsko-mezozoicznego. Ogólne wnioski o ewolucji tektonicznej [In Polish, Engl.Sum.]. *In*: The Epicontinental Permian and Mesozoic in Poland (eds. S. Marek, M. Pajchlowa). *Pr. Państw. Inst. Geol.*, **153**: 414–415.
MAREK S., PAJCHLOWA M. (eds.), 1997 — The Epicontinental Permian and Mesozoic in Poland [In Polish, Engl. Sum.]. *Pr. Państw. Inst. Geol.*, **153.**
MAREK S., RACZYŃSKA A., 1979 — Lithostratigraphic subdivision of epicontinental Lower Cretaceous in Poland and proposals for its rearrangement [In Polish, Engl. Sum.[. *Kwart. Geol.*, **23**, 3: 631–634.
MASLAKOVA I.I., 1963 — K systematykie roda *Hedbergella Paleont. Zhurnal*, **4**: 112–116.
MATSEVA T.V., TEMIRBEKOVA U.T., 1989 — Miliolidy titona severo-vostochnogo Kavkaza. *Paleont. Zhurnal*, **4**: 114–118.
MATYJA A., WIERZBOWSKI A., 2000 — Podział chronostratygraficzny jury pozakarpackiej: 18. Polska Grupa Robocza Systemu Jurajskiego – Jurassica; I Spotkanie, Wiktorowo 28–29.02.2000.
MATYSZKIEWICZ J., 1996 — The significance of *Saccocoma* – Calciturbidities for the analysis of the Polish Epicontinental Late Jurassic Basin: An example from the Southern Cracow–Wieluń Upland (Poland). *Facies*, **34**: 8–10.
MICHALÍK J., 1999 — Elements of Mesozoic global regimes as recorded in West Carpathian basinal infillings. *Geol. Carpath.*, **50**: 55.
MICHALÍK J.,2002 — Foreword: How to recognise the „Okeanos kingdom“ of Cretaceous time. *In*: Tethyan/Boreal Cretaceous correlation (ed. J. Michalík): 1–11. Veda, Bratislava.
MITYANINA I.V., 1957 — O foraminiferakh yurskikh oltlozheniy yugo-zapada Belorussii. *Paleontologiya i stratigrafiya BCCR*. Sbornik **II**:210–234
MITYANINA I.V., 1963 — Foraminifera of the Upper Oxfordian of Belarus [In Russian]. *Paleontologiya i Stratigrafiya BSSR*, Sb. **4**: 122–168.
MOHLER W., 1938 — Mikropaläontologische Untersuchungen in der nordschweizerischen Juraformation. *Abh. Schweizerische Palaeont. Gesellschaft*, **60**: 1–53.
MOLINARI-PAGANELLI V., PICHEZZI R.M., TILIA ZUCCARI A., 1979 — I Coproliti di Crostacei. Rassegna bibliografica e annotazioni tassonomiche. Parte I. Genere *Favreina*. *Boll. Serv. Geol. Italia*., **C**: 409–454.
MORYC W., 1961 — Budowa geologiczna rejonu Lubaczowa. *Ann. Soc. Geol. Pol*., **31**: 47–73.
MOORE G.T., HAYASHIDA D.N., ROSS Ch.A., JACOBSON S.R., 1992 — Paleoclimate of the Kimmeridgian/Tithonian (Late Jurassic) world: I. Results using general circulation model. *Palaeogeogr., Palaeoclimat., Palaeoecol*., **93**: 113–150.
MURGEANU G., FILIPESCU M., 1933 — *Calpionella carpathica* n. sp. dans les Carpathes roumaines. *Notationes Biologicae*, **1**: 63.
NAGY I., 1966 — Sur le rôle stratigraphique des genres *Stomiosphaera* et *Cadosina* dans le Jurassique supérieur de la Montagne Mecsek (In Hungarian, Engl. Sum.). *Földtani Közlony*, **96**: 86–104.
NAGY I., 1986 — Investigation of Calpionellides from the Mecsek Mountains (S. Hungary). *Acta Geol. Hung.*, **29**: 45–64.
NEAGU T., 1970 — The genus *Meandrospira* (Foram.) from the Lower Cretaceous strata in Roumania. *Senckenb. Lethaea*, **51**: 411–415.
NEAGU T., 1984 — Berriasian–Valanginian miliolid fauna of the southern Dobrogea (Romania). *Rev. Espan. Micropaleont.*, **17**: 201–220.
NEAGU T., 1986 — Barremian–Lower Aptian miliolod fauna in Southern Dobrogea (Romania). *Rev. Espan. Micropaleont.*, **18**: 313–348.
NEAGU T., 1994 — Early Cretaceous Trocholina group and some related genera from Romania. Part I. *Rev. Espan. Micropaleont.*, **26**: 117–143.
NEAGU T., 1995 — The Cretaceous *Trocholina* group and some related genera from Romania. Part II. *Rev. Esp. Micropaleont.*, **27**: 5–40.
NEAGU T., NEAGU M., 1995 — Smaller agglutinated foraminifera from the *acanhticum* Limestone (Upper Jurassic), Eastern Carpathians, Romania. *In*: Proceedings IV IWAF, Kraków, Poland, September 12–19, 1993 (eds. M.A. Kaminski *et al*.). *Grzybowski Found. Sp. Publ.*, **3**: 211–225.
NIEMCZYCKA T., 1976a —Upper Jurassic rocks of the Eastern Poland Area (beteen the Vistula and the Bug rivers) [In Polish, Engl. Sum.]. *Pr. Inst. Geol.*, **77.**
NIEMCZYCKA T., 1976b — Lithostratygraphy of Upper Jurassic deposits in the Lublin–Radom area [in Polish, Engl. Sum.]. *Acta Geol. Pol.*, **24**: 569–601.
NIEMCZYCKA, T., 1997 — Jura górna. Litostratygrafia i litofacje. Sedymentacja, paleogeografia i paleotektonika [In Polish, Engl. Sum.]. *In*: The Epicontinental Permian and Mesozoic in Poland (eds. S. Marek, M. Pajchlowa). *Pr. Państw. Inst. Geol.*, **153**: 327–331.

NIEMCZYCKA T., BROCHWICZ-LEWIŃSKI W., 1988.— Evolution of the Upper Jurassic sedimentary basin in the Polish Lowland [In Polish, Engl. Sum.]. *Kwart. Geol.*, **32**: 137–156.

NOWAK W., 1968 — Stomiosphaerids of the Cieszyn beds (Kimmeridgian–Hauterivian) in the Polish Cieszyn Silesia and their stratigraphical value [In Polish, Engl. Sum.]. *Rocz. Pol. Tow. Geol.*, **38**, 2-3: 275–312.

NOWAK W., 1980 — Podrząd Titinnina Claparède et Lachmann. *In*: Budowa geologiczna Polski, III. Atlas skamieniałości przewodnich i charakterystycznych. Część 2b, Mezozoik, Jura (ed. L. Malinowska): 329–338. Wyd. Geol., Warszawa.

OESTERLE H., 1968 — Foraminiferen der Typolokalität der Birmenstorfer-Schichten, unterer Malm. *Ecl. Geol. Helv.*, **61**: 695–792.

OLSZEWSKA B., 2004 — Próba korelacji wydzieleń litostratygraficznych górnej jury w podłożu Karpat zewnętrznych i zapadliska na podstawie mikroskamieniałości. *Tomy Jurajskie*, **II**: 165.

OLSZEWSKA B., 2005a — Charakterystyka mikropaleontologiczna budowli biohermalnych Polski południowej. *Nafta-Gaz*, **7-8**: 299–307.

OLSZEWSKA B., 2005b — Microfossils of the Cieszyn Beds (Silesian Unit, Polish Outer Carpathians) – a thin sections study. *Pol. Geol. Inst. Sp. Pap.*, **19**: 1–58.

OLSZEWSKA B., 2007a — An attempt at correlation of the thin section foraminiferal assemblages from the Upper Jurassic–Lower Cretaceous sediments of SE Poland with orthostratigraphic zonations. 6th Polish Micropaleontological Workshop, "Mikro--2007" June 18–20, 2007 Gdańsk. Abstracts: 52–53.

OLSZEWSKA B., 2007b — Mikroskamieniałości i wiek utworów górnej jury i dolnej kredy Lubelszczyzny na podstawie badań płytek cienkich. *In*: Budowa geologiczna regionu lubelskiego i problemy ochrony litosfery (ed. M. Harasimiuk *et al.*): 267–270. Wyd. UMCS.

OLSZEWSKA B., WIECZOREK J., 1988 — Callovian–Oxfordian foraminifera of the Northern Tethyan shelf: an example from the Cracow Upland (Southern Poland). *Rev. Paléobiol*., vol. spec. **2** "Benthos '86": 191–196.

PÈLISSIÈ Th., PEYBERNÈS B., REY J., 1984 — Les grands Foraminifères benthiques du Jurassique moyen/superieur du sud ouest de la France (Aquitaine, Causses, Pyrénées). Interet biostratigraphique, paléoécologique et paléobiogéographique: 479–489. Benthos '83; 2nd Int.Symp. Benthic Foraminifera (Pau, April 1983).

PFENDER J., 1939 — Sur un calcaire phytogène du Lias inférieur d' Espagne et l'extension de ce faciès en quelques autres régions. *Bull. Soc. Vaudoise Sci. Nat.*, **60**, 248: 213–228.

PIÓRO K., 2007 — Wiek i paleośrodowisko depozycji górnokredowych utworów okolic Chełma i Rejowca w oparciu o zespoły otwornic. *In*: Budowa geologiczna regionu lubelskiego i problemy ochrony litosfery (ed. M. Harasimiuk *et al.*): 57–62. Wyd. UMCS.

PISERA A., 1999 — Późnojurajskie facje gąbkowe i warunki ich powstawania. Działalność PAN, Nauki Biologiczne, maj 1999: 89–90.

PISERA A., DZIK J., 1979 — Tithonian crinoids from Rogożnik (Pieniny Klippen Belt, Poland) and their evolutionary realtionship. *Ecl. Geol. Helv.*, **72**: 805–849.

REDMOND C. D., 1964 — Lituolid foraminifera from the Jurassic and Cretaceous of Saudi Arabia. *Micropaleontology*, **10**: 405–414.

REHÁKOVÁ D., 2000 — Calcareous dinoflagellate and calpionellid bioevents versus sea-level fluctuations recorded in the West-Carpathian (Late Jurassic/Early Cretaceous) pelagic environments. *Geol. Carpath.*, **51**: 29–243.

REHÁKOVÁ D., MICHALIK J.,1996 — *Stomiosphaera* or *Orthopithonella* ? *Cadosina* or *Obliquipithonella* ? notes to ultrastructure and systematic position of some Jurassic–Cretaceous calcareous dinoflagellates from Western Carpathians. *Mineralia Slovaca*, **28**: 92–98.

ŘEHÁNEK J., 1985 — *Colomisphaera conferta* n. sp. (Stomiosphaeridae Wanner, 1940) from the Lower Cretaceous of the West Carpathians. *Vest. Ústřed. Ustavu Geol.*, **60**: 171–173.

ŘEHÁNEK J., 1987 — Berriasian *Stomiosphaerina proxima* n.sp. (Stomiosphaeridae) from the central West Carpathian Paleogene basal breccias. *Geol. Zb. - Geol. Carp.*, **38**: 695–703.

ŘEHÁNEK J., CECCA F., 1993 — Calcareous dinoflagellate cysts biostratigraphy in Upper Kimmeridgian – Lower Tithonian pelagic limestones of Marches Apennines (Central Italy). *Rev. Micropaléontologie*, **36**: 143–163.

ŘEHÁNEK J., HELIASZ Z., 1993 — Microfacies and microbiostratigraphy of the Oxfordian–Lower Kimmeridgian on the basis od cadosinids and stomiosphaerids in the Częstochowa region of Poland. *Geol. Carpath.*, **44**: 81–93.

RIDING R., GUO L., 1992 — Affinity of *Tubiphytes*. *Paleontology*, **35**: 37–49.

RIEGRAF W., LUTERBACHER H., 1989 — Oberjura – Foraminiferen aus dem Nord- und Südatlantik (Deep Sea Drilling Project Leg 1–71). *Geol. Rundsch.*, **78**: 999–1045.

ROMANOV L.F., DANITSCH M.M., 1971 — Molluscs and Foraminifera of the Mesozoic of the Dnestr–Prut interfluve [In Russian]. Academy of Science of the Moldavian SSR, Kishinev.

RUFFELL A., BATTEN D.J., 1990 — The Barremian Aptian arid phase in western Europe. *Palaeogeogr.*, *Palaleoclimatol.*, *Palaeoecol.*, **80**: 197–212.

SCHLAGINTWEIT F., EBLI O., 1999 — New results on Microfacies, Biostratigraphy and Sedimentology of Late Jurassic–Early Cretaceous platform carbonates of Northern Calcareous Alps. *Abh. Geol. Bundesanst.*, **56**: 379–418.

SCHMID D.U., 1996 — Marine Mikrobolithe und Mikroinkrustieren aus dem Oberjura. *Profil*, **9**: 101–251.

SEIBOLD E., SEIBOLD I., 1960 — Foraminiferen der bank- und Schwamm-Fazies im unteren Malm Süddeutschlands. *N. Jb. Geol. Paläont. Abh.*, **109**: 309–438.

SENOWBARI-DARYAN B., BUCUR I.I., ABATE B., 1994 — Upper Jurassic Calcareous Algae from the Madonie Mountains, Sicily. *Beitr. Paläont.*, **19**: 227–259.

SENOWBARI-DARYAN B., BUCUR I.I. SCHLAGINTWEIT F., SĂSĂRAN E., MATYSZKIEWICZ J., 2008 — *Crescentiella*, a new name for „*Tubiphytes*" morronensis Crescenti, 1969: an enigmatic Jurassic–Cretaceous microfossil. *Geol. Croatica*, **61**: 185–214.

SEPTFONTAINE M., 1980 — Les Foraminifčres imperforés des milieux de plate-forme au Mésozoďque: détermination pratiqoe, interprétation phylogénétique et utilisation biostratigraphique. *Rev. Micropaléont.*, **23**: 169–203.

SEPTFONTAINE M., 1988 — Towards an evolutionary classification of Jurassic Lituolids (Foraminifera) in carbonate platform environment. *Rev. Paléobiol*., vol. spec. **2** "Benthos '86": 229–256.

SEPTFONTAINE M., ARNAUD-VANNEAU A., BASSOULER J-P., GISIČ Y., RAMALHO M., VELIČ I., 1991 — Les foraminifères imperforés des plates-formes carbonatées jurassiques: état des connaissances et perspectives d'avenir. *Bull. Soc. Vaudoise Sci. Natur.*, **80**: 255–277.

SLITER W.V., 1992 — Cretaceous planktic foraminiferal biostratigraphy and paleoceanographic events in the Pacific with emphasis on indurated sediments. *In*: Centennary of Japanese micropaleontology (eds. K. Ishizaki, T. Saito): 281–299. Terra Scienttific Publishing Company, Tokyo.

SLITER W.V., 1999 — Cretaceous planktonic foraminiferal biostratigraphy of the Calera Limestone, northern California, USA. *J. Foraminifer. Res.*, **29**: 318–339.

SMOUT A.H., SUGDEN W., 1961 — New information of the foraminiferal genus *Pfenderina*. *Paleontology*, **4**: 581–591.

SOTÁK J., 1987 — Protopeneroplide foraminifera from lowermost Cretaceous of the Štramberk carbonate platform (Outer Western Carpathians). *Geol. Zb. - Geol. Carp.*, **38**: 651–667.

SOTÁK J., 1989 — Nálezy spodnokriedových zástupcov čelade Pfenderinidae Smout et Sugden (Foraminiferida) vo valúnoch flyšových zlepencov vonkajších Západných Karpát. *In*: Zborník z Paleontologickej Konferencie, Súčasné problémy a trendy v československej paleontológii (ed. O. Samuel): 37–41. GUDŠ, Bratislava.

STRENG M., HILDEBRAND-HABEL T., WILLEMS H., 2002 — Revision of the genera *Sphaeroidinella* Keupp and Versteegh, 1989 and *Orthopithonella* Keupp *in* Keupp and Mutterlose, 1984 (Calciodinelloideae, calcareous dinoflagellate cysts). *J. Paleont.*, **76**: 397–407.

SYKORA M., OZVOLDOVA L., BOROVA D., 1997 — Turonian silicified sediments in the Czorsztyn succession of Pieniny Klippen Belt (Western Carpathians, Slovakia). *Geol. Carpath.*, **48**: 243–261.

SZTEJN J., 1996 — Stratigraphy of the Jurassic/Cretaceous Boundary in South-Eastern Poland. *Bull. Pol. Acad. Sc.*, *Earth Sc.*, **44**: 109–117.

TASLI K., 2001 — Benthic Foraminifera of the Upper Jurassic Platform Carbonate sequence in the Aydincik (İçel) Area, Central Taurides, S Turkey. *Geol. Croatica*, **54**: 1–13.

TEMIRBEKOVA Y.T., ANTONOVA Z.A., 1985 — Triassic and Jurassic Miliolidae of the Northern Caucasus. [In Russian], Nauka, Moscov.

UTROBIN V. N., 1962 — Osnovnye cherty stratigrafiy yurskikh otlozheniy Predkapatskogo progiba i yugo-zapadnoy okrainy Russkoy platformy. (In Russian). *Doklady Akademiy Nauk SSSR* **147**: 908–911.

VAŠÍCEK Z., MICHALÍK J., REHÁKOVÁ D., 1994 — Early Cretaceous stratigraphy, paleogeography and life in Western Carpathians. *Beringueria* **10**: 31–69.

VERNIORY R., 1961 — Présence de *Saccocoma quenstedti* Doreck (*in coll.*) dans les gorges de la Meouge (Sisteron, Provence). Archives des Sciences. *Soc. Phys. Hist. Natur. Geneve*, **14**: 315–321.

VOGLER J., 1941 — Ober-Jura und Kreide von Misol. *Palaeontographica*, Suppl.-Band **IV**: 246–292.

WANNER J., 1940 — Gesteinsbildende Foraminiferen aus Malm und Unterkreide des östlichen Ostindien Archipels. *Palaeont. Z.*, **22**: 75–97.

WEIDICH K.F., 1990 — Die kalkalpine Unterkreide und ihre Foraminiferenfauna. *Zitteliana* **17**: 1–312.

WEISSERT H., 1990 — Siliciclastics in the Early Cretaceous Tethys and Atlantic oceans: Documents of periodic greenhouse climate conditions. *Mem. Soc. Geol. Italiana*, **44**: 59–69.

WEISSERT H., MOHR H., 1996 — Late Jurassic climate and its impact on carbon cycling. *Palaeogeogr., Palaeoclimat., Palaeoecol.*, **122**: 27–43.

WERNLI R., KINDLER P., 1986 — Les "Protoglobigerines" du Callovo-Oxfordien de Châtillon-sue-Cluses (Préalpes internes, Haute Savoie, France). *Ecl. Geol. Helv.*, **79**: 137–147.

WEYNSCHENK R., 1950 — Die Jura – Mikrofauna und -flora des Sonnwendgebirges (Tirol). Schlern-Schriften, *Universität Innsbruck*, **83**: 1–32.

WEYNSCHENK R., 1951 — Two new Foraminifera from the Dogger and Upper triassic of the Sonnwend Mountains of the Tyrol. *J. Paleont*., **25**: 793–795.

ZHABINA N.M., 2001 — Oxfordian deposits of Predcarpathians [In Ukrainian]. *Geolog. i geohim. goryutchikh kopalin*, **1**: 1–7.

ZHABINA N.M., ANIKEYEVA O.V., 2007 — The modern stratigraphical sheme of Upper Jurassic–Neocomian deposits in Ukrainian Precarpathian. [In Ukrainian]. *Zbirn. Nauk. Prac*, **3**: 46–56.

PLATES

Plate I

Fig. 1. *Quinqueloculina semisphaeroidalis* Danitsch, longitudinal section, Cieszanów IG 1 borehole, depth 999.1 m, Basznia Fm.

Fig. 2. *Colomisphaera fibrata* (Nagy), Cieszanów IG 1 borehole, depth 1208.5 m, Kraśnik Fm.

Fig. 3. *Quinqueloculina semisphaeroidalis* Danitsch, transverse section, Cieszanów IG 1 borehole, depth 999.1 m, Basznia Fm.

Fig. 4. *Bicazammina jurassica* (Haeusler), longitudinal section, Lubaczów 10 borehole, depth 1302.0 m, Kraśnik Fm.

Fig. 5. *Committosphaera czestochowiensis* Řehánek, Cieszanów IG 1 borehole, depth 1208.5 m, Kraśnik Fm.

Fig. 6. *Ammobaculites irregularis* (Gümbel), longitudinal section, Cieszanów IG 1 borehole, depth 1183.0 m, Kraśnik Fm.

Fig. 7. *Globuligerina oxfordiana* (Grigelis), transverse section, Lubaczów 10 borehole, depth 1302.0 m, Kraśnik Fm.

Fig. 8. *Colomisphaera lapidosa* (Vogler), Doliny 1 borehole, depth 916.0 m, Kraśnik Fm.

Fig. 9. *Cadosina parvula* Nagy, Doliny 1 borehole, depth 900.0 m, Kraśnik Fm.

Fig. 10. *Terebella lapilloides* Münster, transverse section, Cieszanów IG 1 borehole, depth 1196.9 m, Kraśnik Fm.

Fig. 11. *Paalzowella turbinella* (Gümbel), axial section, Cieszanów IG 1 borehole, depth 1183.0 m, Kraśnik Fm.

Fig. 12. *Ophthalmidium sagittum* (Bykova), transverse section, Płusy IG 1 borehole, depth 1301.9 m, Kraśnik Fm.

Fig. 13. *Protomarssonella donieziana* (Dain), longitudinal section, Lubaczów 10 borehole, depth 1109.0 m, Kraśnik Fm.

Fig. 14. *Ophthalmidium sagittum* (Bykova), axial section, Płusy IG 1 borehole, depth 1301.9 m, Kraśnik Fm.

Fig. 15. *Crescentiella morronensis* (Crescenti), axial section, Cieszanów IG 1 borehole, depth 1196.9 m, Kraśnik Fm.

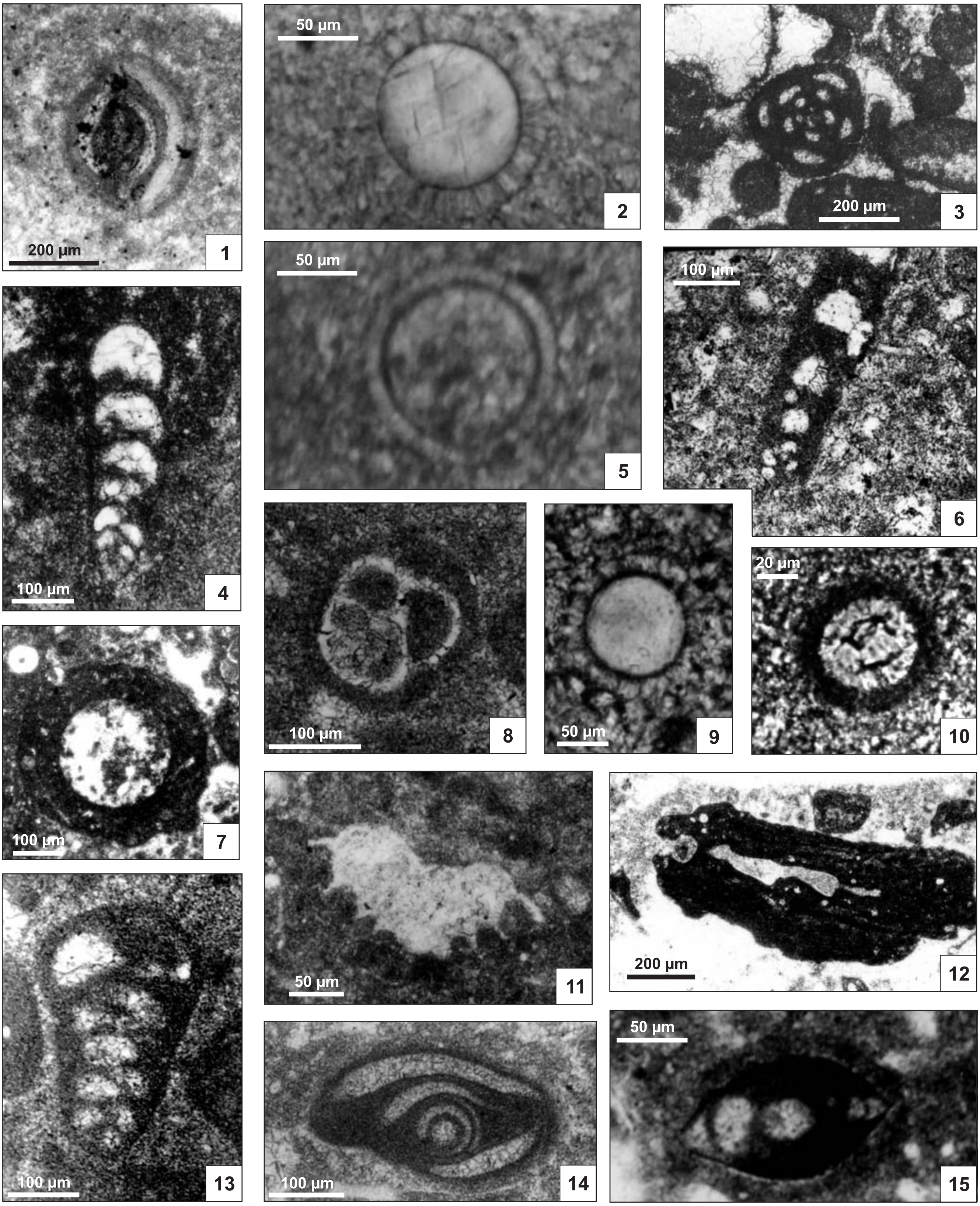

200 µm
1
50 µm
2
200 µm
3
100 µm
4
50 µm
5
100 µm
6
100 µm
7
100 µm
8
50 µm
9
20 µm
10
50 µm
11
200 µm
12
100 µm
13
100 µm
14
50 µm
15

Plate II

Fig. 1. *Cornuspira eichbergensis* Kübler & Zwingli, centered section, Babczyn 2 borehole, depth. 1125.0, Jasieniec Fm.

Fig. 2. *Ophthalmidium oxfordianum* (Deecke), axial section, well Doliny 1, depth. 824.0 m, Jasieniec Fm.

Fig. 3. *Ophthalmidium strumosum* (Gümbel), longitudinal section, Cieszanów IG 1 borehole, depth 1203.0 m, Kraśnik Fm.

Fig. 4. *Mohlerina basiliensis* (Mohler), poblique section, Tomaszów Lubelski IG 1 borehole, depth. 1279.0 m, Jasieniec Fm.

Fig. 5. *Protomarssonella dumortieri* (Schwager), longitudinal section, Doliny 1 borehole, depth 859.0 m, Jasieniec Fm.

Fig. 6. *Protomarssonella jurassica* (Mityanina), longitudinal section, Babczyn 2 borehole, depth 1136.2 m, Jasieniec Fm.

Fig. 7. *Ophthalmidium strumosum* (Gümbel), transverse section, Płusy IG 1 borehole, depth 1301.0 m, Kraśnik Fm.

Fig. 8. *Orthopithonella gustafsonii* (Bolli), Sucha Wola 1 borehole, depth 1181.0 m, Jasieniec Fm.

Fig. 9. *Saccocoma* cf. *quenstedti* Verniory, section through a radial plate, Sucha Wola 1 borehole, depth 1181.0 m, Jasieniec Fm.

Fig. 10. *Opthamidium oxfordianum* (Deecke), transverse section, Doliny 1 borehole, depth. 824.0 m, Jasieniec Fm.

Fig. 11. *Haghimashella arcuata* (Haeusler), longitudinal section, Lubaczów 158 borehole, depth 1199.0 m, Jasieniec Fm.

Fig. 12. *Crustocadosina semiradiata* (Wanner), Doliny 1 borehole, depth 824.0 m, Jasieniec Fm.

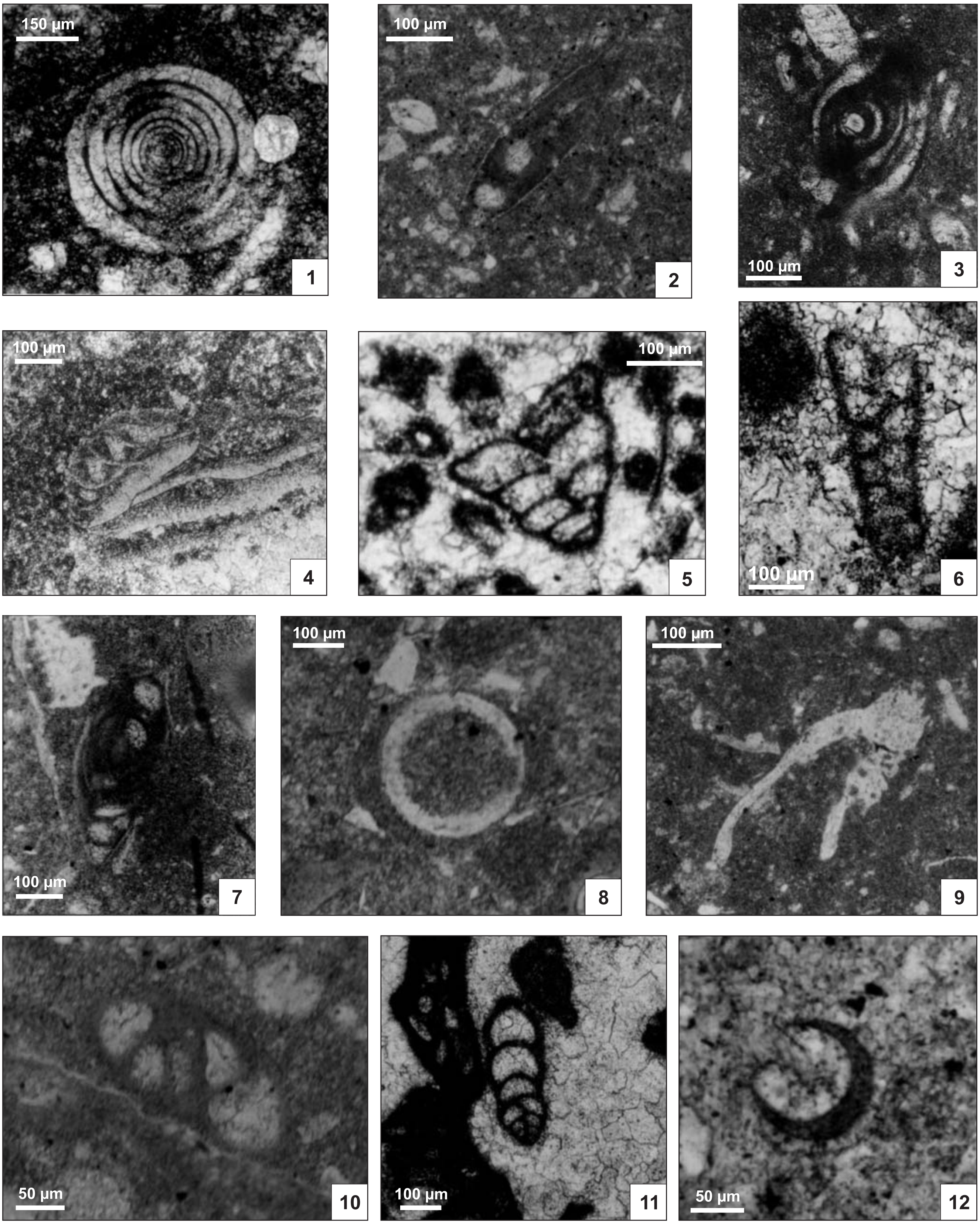

150 µm
1
100 µm
2
100 µm
3
100 µm
4
100 µm
5
100 µm
6
100 µm
7
100 µm
8
100 µm
9
50 µm
10
100 µm
11
50 µm
12

Plate III

Fig. 1. *Textulariopsis jurassica* (Gümbel), longitudinal section, Doliny 1 borehole, depth 818.1 m, Basznia Fm.

Fig. 2. *Nautiloculina oolithica* Mohler, axial section, Babczyn 2 borehole, depth 1120.0 m, Basznia Fm.

Fig. 3. *Paleogaudryina varsoviensis* (Bielecka & Pożaryski), longitudinal section, Cieszanów IG 1 borehole, depth 999.1 m, Basznia Fm

Fig. 4. *Paalzowella feifeli* (Paalzow), axial section, Doliny 1 borehole, depth 818.1 m, Basznia Fm.

Fig. 5. *Ophthalmidium pseudocarinatum* (Dain), transverse section, Płusy IG 1 borehole, depth 931.8 m, Bełżyce Fm

Fig. 6. *Ophthalmidium pseudocarinatum* (Dain), longitudinal section, Płusy IG 1 borehole, depth 931.8 m, Bełżyce Fm.

Fig. 7. *Trocholina belorussica* Mityanina, axial section, Płusy IG 1 borehole, depth 931.8 m, Bełżyce Fm.

Fig. 8. *Marinella lugeoni* Pfender, transversal section, Doliny 1 borehole, depth 756.0 m, Basznia Fm.

Fig. 9. *Quinqueloculina frumenta* Asbel & Danitsch, transverse section, Doliny 1 borehole, depth 818.1 m, Basznia Fm.

Fig. 10. *Quinqueloculina frumenta* Asbel & Danitsch, longitudinal section, Doliny 1 borehole, depth 818.1 m, Basznia Fm.

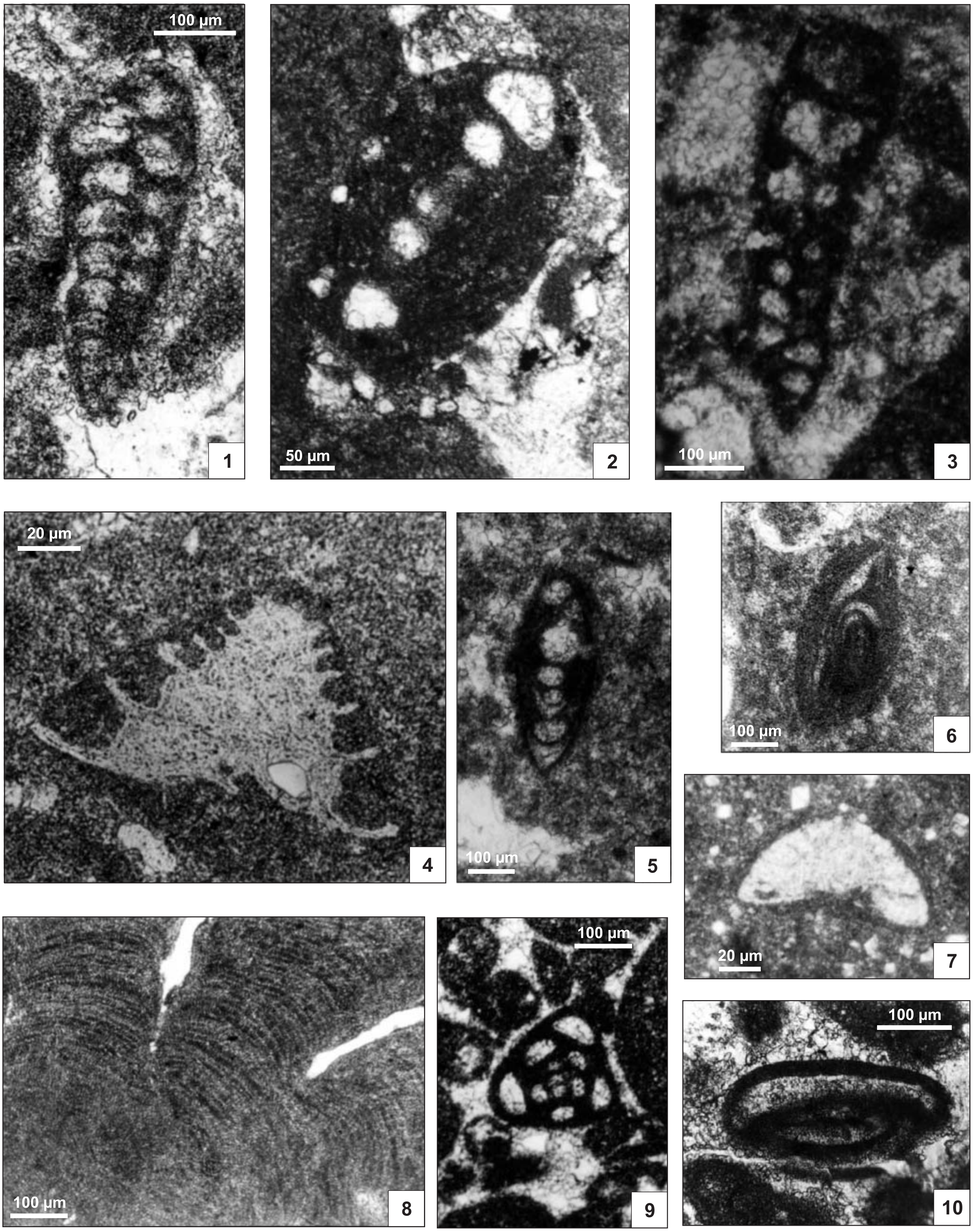

100 µm
1
50 µm
2
100 µm
3
20 µm
4
100 µm
5
100 µm
6
20 µm
7
100 µm
8
100 µm
9
100 µm
10

Plate IV

Fig. 1. *Rumanoloculina verbizhiensis* Dulub, longitudinal section, Ciepielów IG 1 borehole, depth 1011.0 m, Bełżyce Fm.

Fig. 2. *Everticyclammina virguliana* (Koechlin), transverse section, Niedrzwica IG 1 borehole, depth 1159.6 m, Bełżyce Fm.

Fig. 3. *Runaoloculina verbizhiensis* (Dulub), transverse section, Ciepielów IG 1 borehole, depth 1011.0 m, Bełżyce Fm.

Fig. 4. *Mesoendothyra izjumiana* Dain, transverse section, Ciepielów IG 1 borehole, depth 971.5 m, Bełżyce Fm.

Fig. 5. *Mesoendothyra izjumiana* Dain, axial section, Ciepielów IG 1 borehole, depth 971.5 m, Bełżyce Fm.

Fig. 6. *Labyrinthina mirabilis* Weynschenk, longitudinal section, Ciepielów IG 1 borehole, depth 961.8 m, Bełżyce Fm.

Fig. 7. *Alveosepta jaccardi* (Schrodt), equatorial section, Babczyn 2 borehole, depth 1078.0 m, Ruda Lubycka Fm.

Fig. 8. *Alveosepta jaccardi* (Schrodt), subaxial section, Babczyn 2 borehole, depth 1078.0 m, Ruda Lubycka Fm.

Fig. 9. *Labirynthina mirabilis* Weynschenk, transverse section of the initial part, Ciepielów IG 1 borehole, depth 961.8 m, Bełżyce Fm.

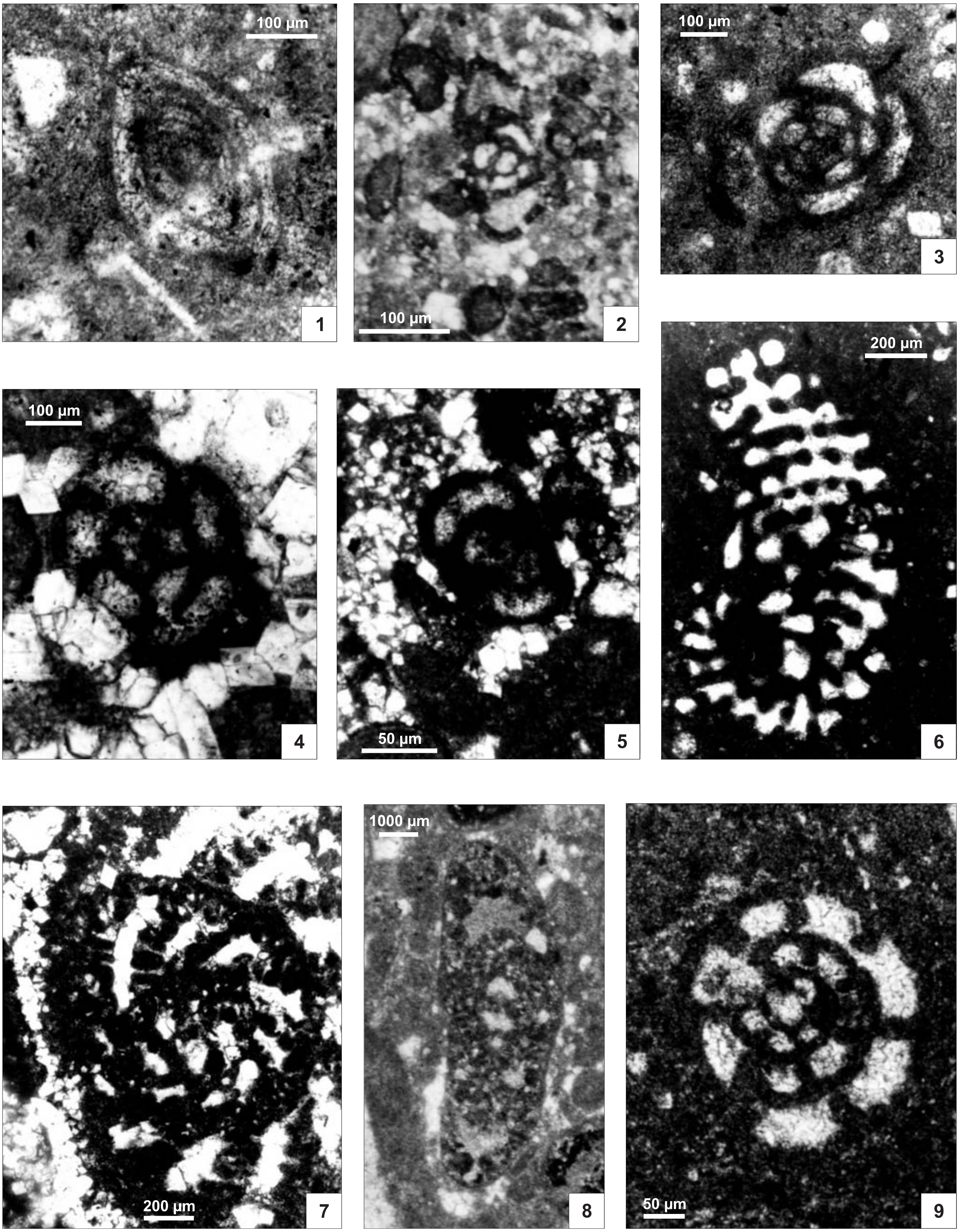

100 µm
1
100 µm
2
100 µm
3
100 µm
4
50 µm
5
200 µm
6
200 µm
7
1000 µm
8
50 µm
9

Plate V

Fig. 1. *Montsalevia* ? *salevensis* (Charollais, Brönnimann & Zaninetti), longitudinal section, Babczyn 2 borehole, depth 672.5 m, Babczyn Fm.

Fig. 2. *Pseudocyclammina lituus* (Yokoyama), subaxial section, Lubaczów 9 borehole, depth 1086.0 m, Babczyn Fm.

Fig. 3. *Textularia densa* Hoffman, longitudinal section, Basznia 1 borehole, depth 516.0 m, Cieszanów Fm.

Fig. 4. *Uvigerinammina uvigeriniformis* (Seibold & Seibold), longitudinal section, Wielkie Oczy 1 borehole, depth 1586.0 m, Babczyn Fm.

Fig. 5. *Protomarssonella kummi* (Zedler), longitudinal section, Babczyn 2 borehole, depth 696.8 m, Babczyn Fm.

Fig. 6. *Pseudocyclammina cylindrica* Redmond, longitudinal equatorial section, Lubaczów 9 borehole, depth 1086.0 m, Babczyn Fm.

Fig. 7. *Pfenderina neocomiensis* (Pfender), oblique longitudinal section, Babczyn 2 borehole, depth 675.3 m, Cieszanów Fm.

Fig. 8. *Siphovalvulina variabilis* Septfontaine, longitudinal section, Babczyn 2 borehole, depth 696.8 m, Babczyn Fm.

Fig. 9. *Protopeneroplis striata* Weynschenk, axial section, Doliny 1 borehole, depth 730.0 m, Babczyn Fm.

Fig. 10. *Nautiloculina cretacea* Peybernes, axial section, Lubaczów 9 borehole, depth 1086.0 m, Babczyn Fm.

Fig. 11. *Protopeneroplis ultragranulata* (Gorbatchik), parallel section, Babczyn 2 borehole, depth 678.1 m, Babczyn Fm.

Fig. 12. *Protopeneroplis ultragranulata* (Gorbatchik), axial section, Babczyn 2 borehole, depth 678.1 m, Babczyn Fm.

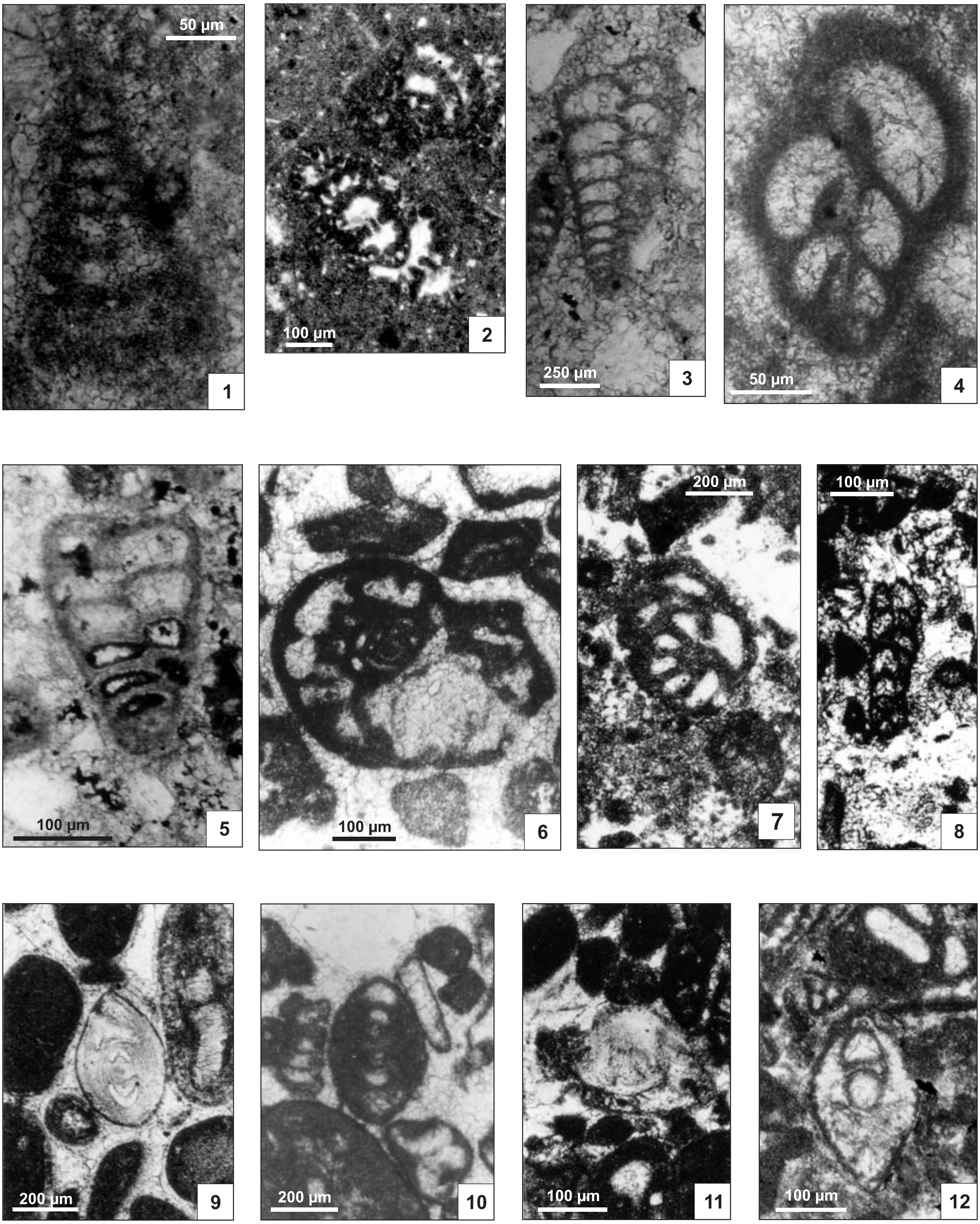

50 µm
1
100 µm
2
250 µm
3
50 µm
4
100 µm
5
100 µm
6
200 µm
7
100 µm
8
200 µm
9
200 µm
10
100 µm
11
100 µm
12

Plate VI

Fig. 1. *Charentia evoluta* (Gorbatchik), equatorial longitudinal section, Basznia 1 borehole, depth 591.6 m, Cieszanów Fm.

Fig. 2. *Charentia evoluta* (Gorbatchik), axial section, Basznia 1 borehole, depth 591.6 m, Cieszanów Fm.

Fig. 3. *Quinqueloculina stellata* Matseva & Temirbekova, transverse section, Babczyn 2 borehole, depth 678.1 m, Babczyn Fm.

Fig. 4. *Decussoloculina mirceai* Neagu, transverse section, Lubaczów 9 borehole, depth 1174.3 m, Babczyn Fm.

Fig. 5. *Rumanoloculina mitchurini* (Dain), transverse section, Lubaczów 9 borehole, depth 1174.3 m, Babczyn Fm.

Fig. 6. *Istriloculina terekensis* Matseva & Temirbekova, axial section, Basznia 1 borehole, depth 591.6 m, Cieszanów Fm.

Fig. 7. *Istriloculina terekensis* Matseva & Temirbekova, transverse section, Basznia IG 1 borehole, depth 591.6 m, Cieszanów Fm.

Fig. 8. *Decussoloculina barbui* Neagu, transverse section, Basznia 1 borehole, depth 622.0 m, Cieszanów Fm.

Fig. 9. *Haplophragmoides joukowskyi* Charollais, Brönnimann & Zaninetti, equatorial section, Babczyn 2 borehole, depth 678.1 m, Babczyn Fm.

Fig. 10. *Istriloculina alimanensis* Neagu, transverse section, Basznia 1 borehole, depth 622.0 m, Cieszanów Fm.

Fig. 11. *Moesiloculina danubiana* Neagu, transverse section, Basznia 1 borehole, depth 622.0 m, Cieszanów Fm.

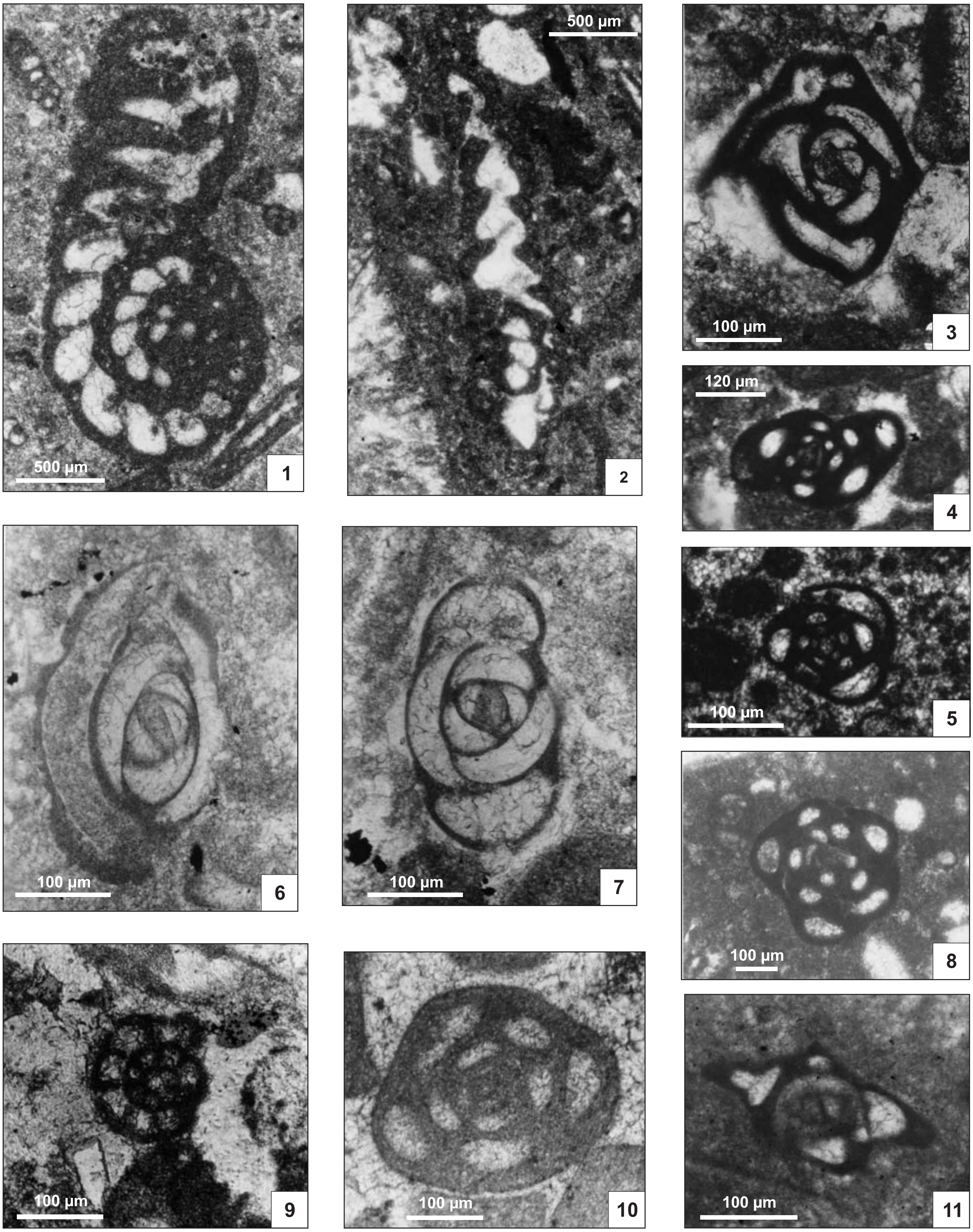

500 µm
1
500 µm
2
100 µm
3
120 µm
4
100 µm
5
100 µm
6
100 µm
7
100 µm
8
100 µm
9
100 µm
10
100 µm
11

Plate VII

Fig. 1. *Stomatostoecha condensa* (Dulub), equatorial section, Narol IG 1 borehole, depth 1392.0 m, Cieszanów Fm.

Fig. 2. *Stomatostoecha condensa* (Dulub), side view, Narol IG 1 borehole, depth 1392.0 m, Cieszanów Fm.

Fig. 3. *Recurvoides* cf. *obskiensis Romanova*, sub-equatorial section, Sieniawka 1 borehole, depth 616.0 m, Cieszanów Fm.

Fig. 4. *Meandrospira bancilai* Neagu subaxial section showing mode of coiling, Basznia 1 borehole, depth 516.0 m, Cieszanów Fm.

Fig. 5. *Hedbergella delrioensis* (Carsey), equatorial section, Babczyn 2 borehole, depth 665.8 m, Cieszanów Fm.

Fig. 6. *Ichnusella burlini* (Gorbatchik), subaxial setion showing part of the last whorl and pillars, Basznia 1 borehole, depth 962.0 m, Babczyn Fm.

Fig. 7. *Trocholina solecensis* Bielecka & Pożaryski, axial section showing umilical depression with pillars, Wielkie Oczy 4 borehole, depth 1440.0 m, Babczyn Fm.

Fig. 8. *Andersenolina alpina* (Leupold), longitudinal section, Basznia 1 borehole, depth 579.0 m, Cieszanów Fm.

Fig. 9. *Andersenolina histeri* Neagu, longitudinal section, Babczyn 2 borehole, depth 678.1 m, Babczyn Fm.

Fig. 10. *Epistomina* cf. *caracolla* (Roemer), sub-axial section, Narol IG 1 borehole, depth 1392.0 m, Cieszanów Fm.

Fig. 11. *Charophyta* (? Clavatoraceae): transverse section of oogonium and fragment of the stem node, Tomaszów Lubelski IG 1 borehole, depth 1039.0 m, Babczyn Fm.

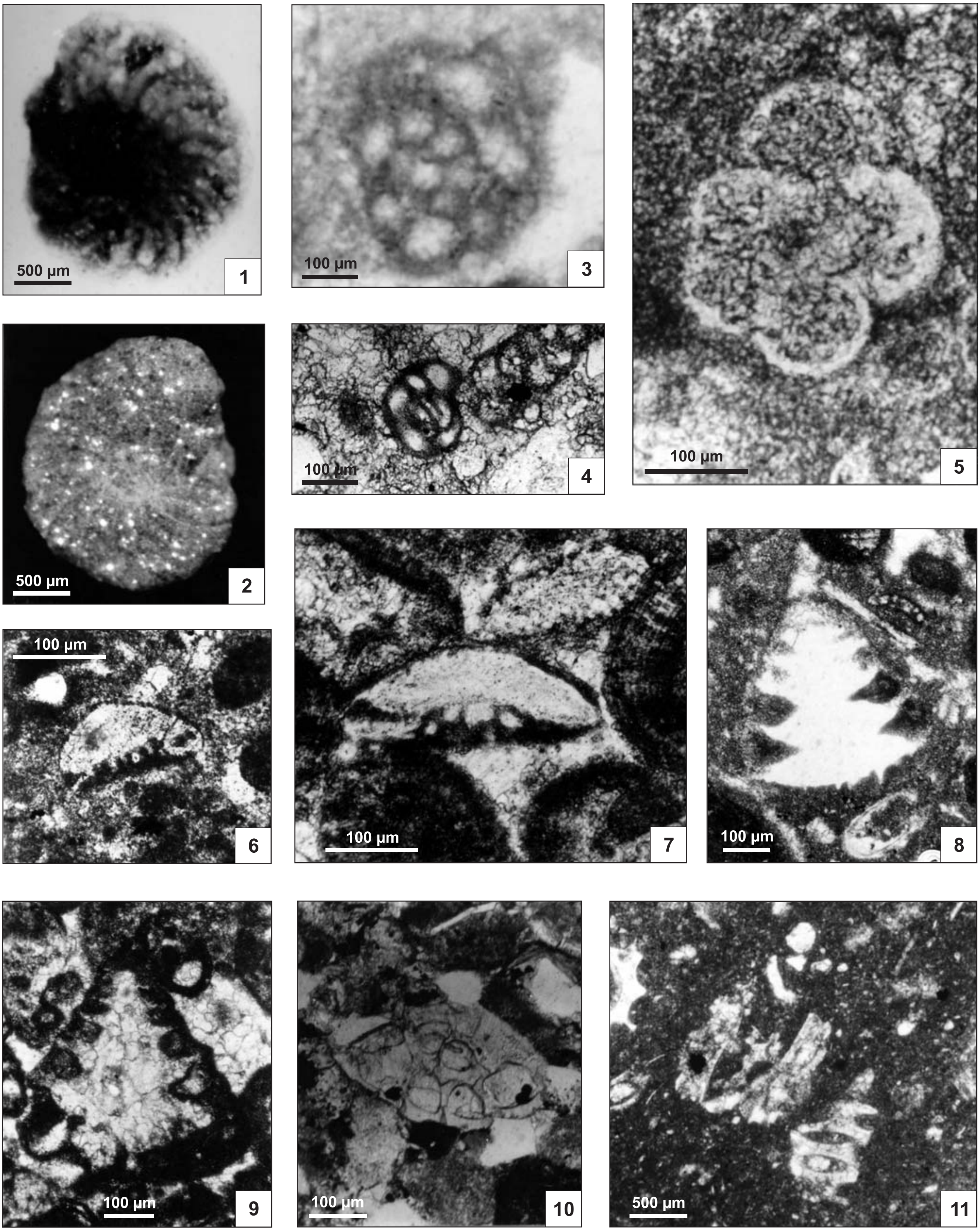

500 µm
1
100 µm
3
100 µm
5
500 µm
2
100 µm
4
100 µm
6
100 µm
7
100 µm
8
100 µm
9
100 µm
10
500 µm
11

Plate VIII

Fig. 1. *Tintinopsella carpathica* (Murgeanu & Filipescu), Basznia IG 1 borehole, depth 579.8 m, Cieszanów Fm.

Fig. 2. *Calpionella elliptalpina* Nagy, Basznia IG 1 borehole, depth 609.0 m, Cieszanów Fm.

Fig. 3. *Calpionella alpina* Lorenz, Babczyn 2 borehole, depth 748.0 m, Babczyn Fm.

Fig. 4. *Colomisphaera cieszynica* Nowak, Wielkie Oczy 1 borehole, depth 1762.0 m, Babczyn Fm.

Fig. 5. *Colomisphaera conferta* Řehánek, Babczyn 2 borehole, depth 665.8 m, Cieszanów Fm.

Fig. 6. *Carpistomiosphaera valanginiana* Borza, Babczyn 2 borehole, depth 665.8 m, Cieszanów Fm.

Fig. 7. *Colomisphaera radiata* (Vogler), Basznia IG 1 borehole, depth 960.0 m, Babczyn Fm.

Fig. 8. *Stomiosphaera moluccana* Wanner, Wielkie Oczy 1 borehole, depth 1581.0 m, Babczyn Fm.

Fig. 9. *Stomiosphaerina proxima* Řehánek, Wielkie Oczy 1 borehole, depth 1586.0 m, Babczyn Fm.

Fig. 10. *Carpistomiosphaera borzai* (Nagy), Wielkie Oczy 4 borehole, depth 1444.0 m, Babczyn Fm.

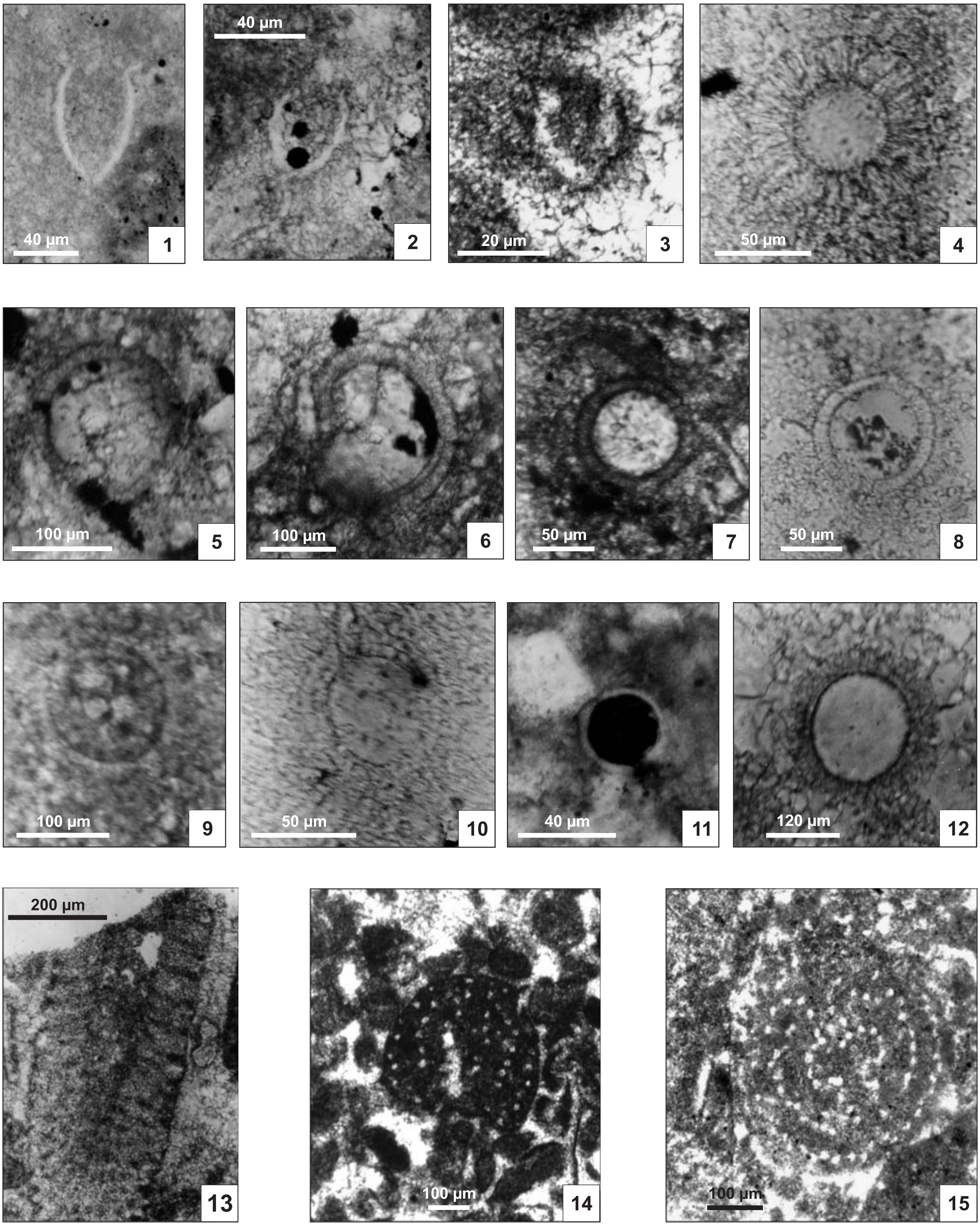
Fig. 11. *Stomiosphaera wanneri* Borza, Basznia IG 1 borehole, depth 605.0 m, Cieszanów Fm.

Fig. 12. *Carpistomiosphaera tithonica* Nowak, Wielkie Oczy 1 borehole, depth 1185.0 m, Babczyn Fm.

Fig. 13. *Salpingoporella* ex gr. *pygmaea* (Gümbel), longitudinal oblique section, Lubaczów 9 borehole, depth 1086.0 m, Babczyn Fm.

Fig. 14. *Favreina* cf. *dinarica* Brönnimann, transverse section, Babczyn 2 borehole, depth 882.0 m, Ruda Lubycka Fm.

Fig. 15. *Favreina* cf. *fendiensis* Brönnimann & Zaninetti, transverse section, Babczyn 2 borehole, depth 882.0 m, Ruda Lubycka Fm.


40 µm
1
40 µm
2
20 µm
3
50 µm
4
100 µm
5
100 µm
6
50 µm
7
50 µm
8
100 µm
9
50 µm
10
40 µm
11
120 µm
12
200 µm
13
100 µm
14
100 µm
15