# Microfacies and stratigraphic position of the Upper Jurassic Rogoża coquinas at Rogoźnik, Pieniny Klippen Belt, Carpathians

## Mikrofacje i pozycja stratygraficzna górnojurajskich muszlowców z Rogoży w Rogoźniku (pieniński pas skałkowy)

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**ABSTRACT:** The Rogoża Coquina Member (Pieniny Klippen Belt, Carpathians, Poland) develped as red micritic ammonite coquinas covers the stratigraphical interval from Kimmeridgian to Upper Tithonian as indicated by microfossils study (calcareous dinocysts and calpionellids) in the type-section of the unit, in the Rogoźnik Quarry. These deposits are overlain by white micritic limestones attributed to the Sobótka Limestone Member of Lower to Middle Berriasian.

## INTRODUCTION

Red-coloured micritic coquinas exposed in the abandoned quarry at Rogoźnik (coordinates N49°26'06'', E19°57'21.6''), in western part of the Pieniny Klippen Belt in Poland, represent the type section of the Rogoża Coquina Member – one of the formal lithostratigraphic units distinguished in the Rogoża Klippes by Birkenmajer (1977, figs 7, 30 C). These deposits called earlier the „red Rogoźnik lumachelle" (Birkenmajer 1962, 1963) contain abundant ammonites (both shell detritus as well as fairly complete specimens), brachiopods (Krobicki 1994), and crinoids, besides some rare fossils as *e.g.* solitary corals. The coquinas are very tough what makes difficult extracting the fossils from the matrix. Occasionally they contain ferromanganese nodules up to 4 cm in size (Zydorowicz & Wierzbowski 1986). The deposits are well bedded, thickness of particular beds reaches from about 0.5 m to 2 m.

The stratigraphical relation of the discussed Rogoża coquinas to the celebrated Rogoźnik coquinas (Rogozniker Breccie/Ammonitenbreccie, Rogoźnik Coquina Member) known of wealth Tithonian ammonites remained for a long time unclear. Birkenmajer (1977) thought that the Rogoża Coquina Member was older than the Rogoźnik Coquina Member – and placed the units into continuous stratigraphical succession from Lower Titho-

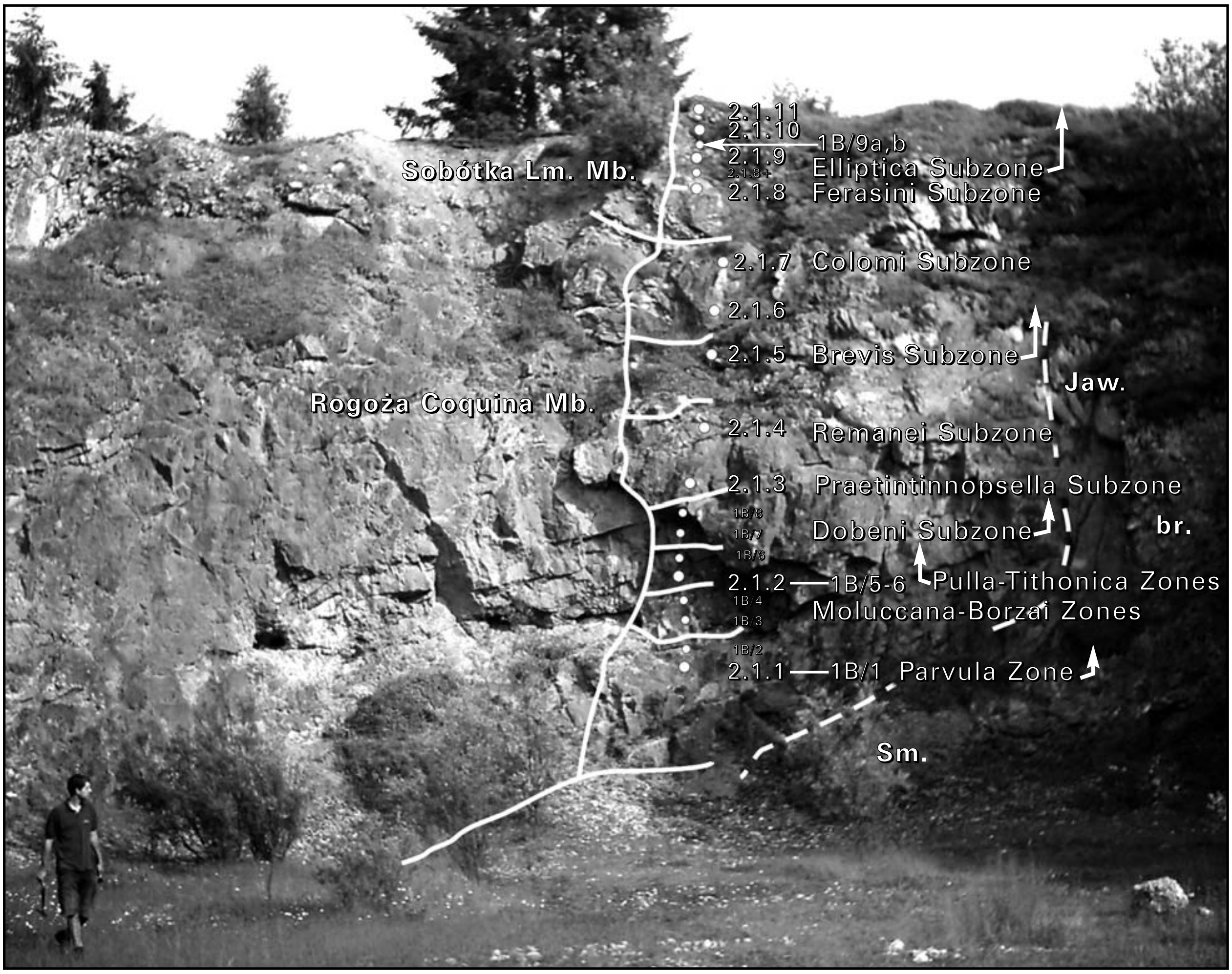



Fig. 1. View of the south-eastern face at Rogożnik Quarry; the location of the samples and their biostratigraphical interpretation is indicated; large dots – samples of the Masłowska's collection (Ms); small dots – of the authors' collection (1B); other explanations: Sm. – Smolegowa Limestone Fm., Jaw. – Jaworki Marl Formation, br. – tectonic breccia; dashed line – fault zone.

nian to Lower Berriasian. This opinion has been modified by Kutek & Wierzbowski (1986) who indicated that these lithostratigraphical units represented in fact two coeval facies development: one with pure red micritic matrix typical of the Rogoża Coquina Member, and another with much of the sparite recrystallization of the matrix typical of the bulk of the Rogoźnik Coquina Member. Both these units were capped by white micritic coquinas which lithostratigraphic interpretation became somewhat unclear. The Rogoża Coquina Member and the Rogoźnik Coquina Member were originally referred to the Dursztyn Limestone Formation (Birkenmajer 1977) which included, however, also mudstones and wackestones of the Korowa Limestone Member, as well as of the Sobótka Limestone Member (Birkenmajer 1977), and thus the deposits markedly differing in facies and in age. On the other hand, the detailed study of the deposits referred to the coquina units (Kutek & Wierzbowski 1986; Wierzbowski 1994) has shown their marked similarities to the Czorsztyn Limestone Formation.

The Rogoża coquinas in the quarry yielded a few ammonites collected in the rubble (Kutek & Wierzbowski 1986): *Schaireria neoburgensis* (Oppel) and *Haploceras carachtheis* (Zeuschner). These ammonites together with ones previously reported from „red Rogoźnik lumachelle“ (*i.e.* from the Rogoża Coquina Member – see Birkenmajer 1962, 1963, 1977), such as *Glochiceras lithographicum* (Oppel) and *Semiformiceras semiforme* (Oppel), indicate the presence of the Hybonotum Zone to the Semiforme Zone of the Lower Tithonian (or Lower and Middle Tithonian in threefold division of this stage). Moreover, the presence of ammonites such as *Taramelliceras compsum* (Oppel), *Streblites* cf. *tenuilobatus* (Oppel), and *Aspidoceras iphicerum* (Oppel) reported by earlier workers from „red Rogoźnik lumachelle" (Zittel 1870; Neumayr 1871; Uhlig 1890; *cf*. Birkenmajer 1963) suggests that the Rogoża Coquina Member could belong partly to the Kimmeridgian, and even to Oxfordian (Kutek & Wierzbowski 1986).

Although the base of the Rogoża Coquina Member is nowhere exposed in the quarry, there is a little doubt that the coquinas rest directly on the Bajocian crinoidal limestones of the Smolegowa Limestone Formation (Birkenmajer 1977, fig. 30; Kutek & Wierzbowski 1986). It should be remembered, however, that the coquinas in the quarry are in tectonic contact with the Smolegowa Limestone Formation as well as with red Upper Cretaceous marls (Jaworki Marl Formation) along subvertical zone of breccias (Birkenmajer 1962, figs 1 and 6; Kutek & Wierzbowski 1986, fig. 2). The succession of red coquinas of the Rogoża Coquina Member is available at the south-eastern face of the quarry where it attains about 11 m in thickness (fig. 1). These deposits are overlain by white micritic coquinas having here about 3 m in thickness, and corresponding in their lithology to white micritic coquinas resting on sparry coquinas of the Rogoźnik Coquina Member in the Rogoża Klippes (*cf*. Kutek & Wierzbowski 1986, figs 1 and 4).

The red and white micritic coquinas in the quarry contain abundant microfossils recognized in thin-sections. These enable recognition of the microfacies types, as well as make possible the detailed chronostratigraphical interpretation of the succession studied.

## DESCRIPTION OF MICROFACIES

The main Upper Jurassic – Lower Cretaceous carbonate microfacies characteristics of Western Carpathians and adjacent palaeogeographic units were given by Reháková (1995). The present study includes description of the microfacies succession, and determination of microfossils, including important for stratigraphy calcareous dinoflagellates and calpionellids, in the Rogoźnik Quarry. The following description is based on samples taken from south-eastern vertical face of the quarry (fig. 1). The samples denoted as Ms 2.1.1 to Ms 2.1.11 were described originally by Masłowska (1989) who recognized the general microfacies succession and gave the stratigraphical interpretation of the section: these samples are redescribed in details herein. Additional samples denoted as 1B/1 to 1B/9ab taken from the lowermost and uppermost part of the section are also studied in detail here. Three rock units differing in character of microfacies can be distinguished in the section studied.

**Red-coloured wackestones to packstones of the *Saccocoma/Globochaete* microfacies**: these deposits comprise the lower part of the section (samples Ms 2.1.1-Ms 2.1.3, and 1B/1-1B/8), about 6 m in thickness. The detailed description of the particular thin sections is given below (see also fig. 2).

Samples Ms 2.1.1 and 1B/1 (pl. 1: 1):
*Saccocoma-Globochaete* wackestone to packstone; there occur also: echinoid spines, aptychi and bivalves fragments, foraminifers (*Lenticulina* sp., *Dentalina* sp., *Nodosaria* sp.), sponge spicules, gastropods, ostracods, juvenile ammonite, crinoid ossicles, calcareous dinocysts – *Schizosphaerella minutissima* (Colom), *Colomisphaera fibrata* (Nagy). Bivalve fragments are penetrated by tubes of boring organisms; the tubes are impregnated by Fe-minerals. There are silt-sized grains of glauconite and quartz visible in matrix.

Samples 1B/2-4 (pl. 2: 5-6):
*Saccocoma-Globochaete* wackestone to packstone; it contains also aptychi, crinoid ossicles, bivalves, gastropods, brachiopods, juvenile ammonites, agglutinated foraminifers, ostracods, echinoderm fragments; calcareous dinocyst assemblage includes: *Colomisphaera carpathica* (Borza), *Colomisphaera pieninensis* (Borza), *Colomisphaera nagyi* (Borza), *Schizosphaerella minutissima* (Colom), *Stomiosphaera moluccana* Wanner, *Cadosina parvula* Nagy, *Carpistomiosphaera borzai* (Nagy). Aptychi and bivalve fragments are penetrated by tubes of boring organisms; the tubes are impregnated by Fe-minerals.

Samples Ms 2.1.2 and 1B/5 (pl. 1: 2, pl. 2: 7, pl. 3: 1):
*Globochaete-Saccocoma* wackestone to packstone, moreover – bivalves and gastropods fragments, ostracods (also with ornamented shells – *Pokor-*

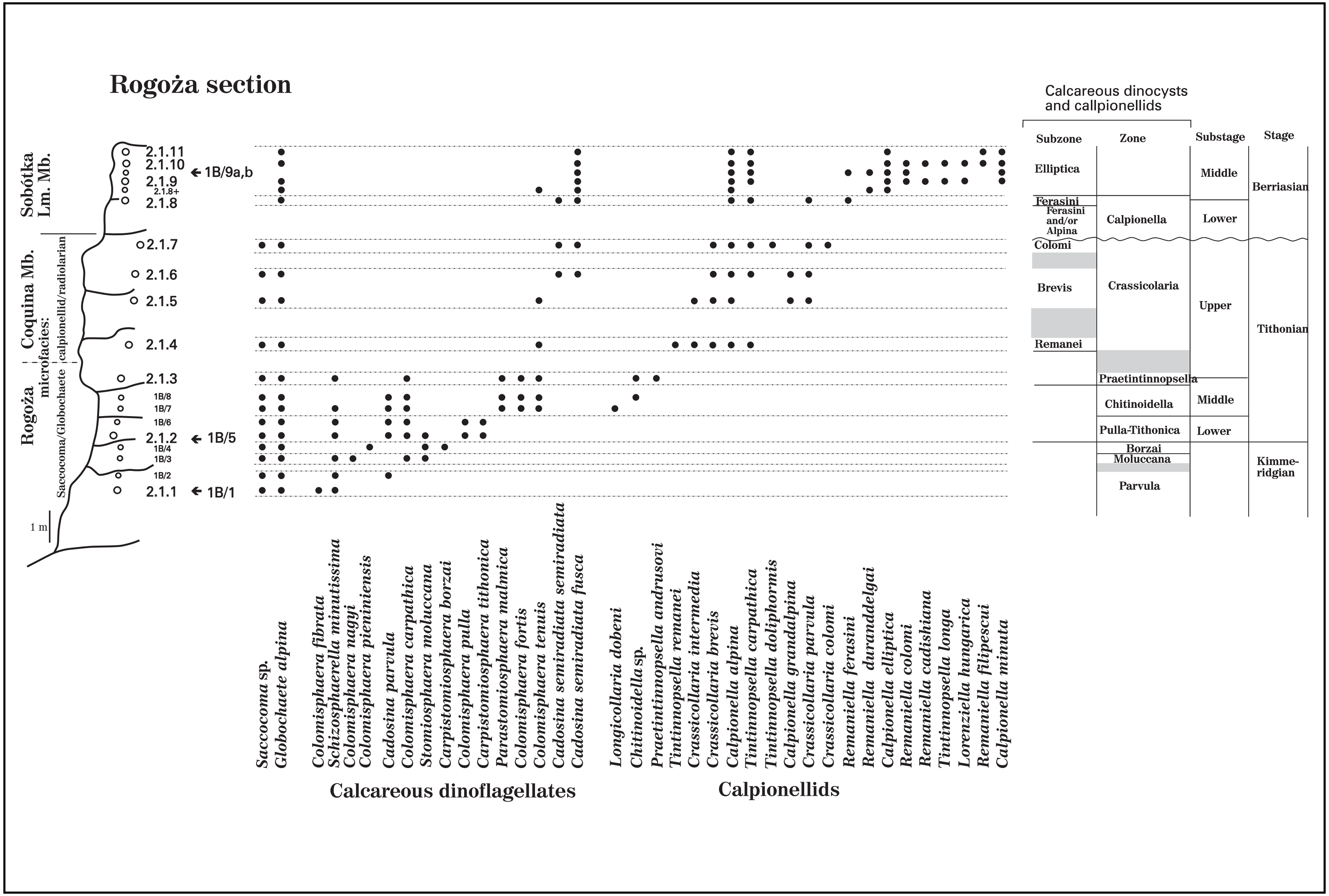



Fig. 2. Stratigraphical distribution of calcareous dinoflagellate cysts and calpionellids and chronostratigraphical interpretation of studied section in the Rogoźnik Quarry; location of samples: large circles – samples of the Masłowska's collection (Ms); small circles – of the authors' collection (1B); grey belts in zonal scheme indicate the intervals of uncertain stratigraphical interpretation; wavy line shows possible sedimentary discontinuity.

*nyopsis* sp.), crinoid ossicles, juvenile ammonites, aptychi – fragments of *Laevaptychus* sp., ophiurids, foraminifers (*Lenticulina*, sp., *Dentalina* sp.), calcareous dinocysts – *Schizosphaerella minutissima* (Colom), *Carpistomiosphaera tithonica* Nowak, *Stomiosphaera moluccana* Wanner, *Colomisphaera carpathica* (Borza), *Colomisphaera pulla* (Borza), *Cadosina parvula* Wanner. In sample Ms 2.1.2 the caverns in matrix are infilled by calcite of two generation – radiaxialy oriented and blocky calcite crystallites. Some of organic fragments are silicified and also impregnated by Fe-minerals.

Samples 1B/6:

*Saccocoma*-*Globochaete* packstone, moreover terebratulids and foraminifers; calcareous dinocysts: *Schizosphaerella minutissima* (Colom), *Cadosina parvula* (Borza), *Colomisphaera carpathica* (Borza), *Colomisphaera pulla* (Borza), *Carpistomiosphaera tithonica* Nowak.

Samples 1B/7-8:

*Saccocoma*-*Globochaete* wackestone to packstone containing calcareous dinocysts: *Schizosphaerella minutissima* (Colom), *Cadosina parvula* Nagy, *Parastomiosphaera malmica* (Borza), *Colomisphaera carpathica* (Borza), *Colomisphaera fortis* Rehánek, *Colomisphaera tenuis* (Nagy), as well as the first calpionellids *Longicollaria dobeni* (Borza) and *Chitinoidella* sp.

Sample Ms 2.1.3 (pl. 3: 2-4):

biodetritical wackestone passing to *Saccocoma*-*Globochaete* packstone; it contains also: foraminifers (*Lenticulina* sp.), gastropods and bivalves fragments, ostracods, aptychi, ophiurids, crinoid ossicles, juvenile ammonites, small algal fragments, calcified radiolarians, and calcareous dinocysts: *Parastomiosphaera malmica* (Borza), *Colomisphaera carpathica* (Borza), *Colomisphaera fortis* Rehánek, *Colomisphaera tenuis* (Nagy), *Schizosphaerella minutissima* (Colom), the first hyaline calpionellids *Praetintinnopsella andrusovi* Borza are present in the matrix along with *Chitinoidella* sp.

**Reddish to pinkish wackestones of the calpionellid-radiolarian microfacies towards the top with more common biodetrital admixture**. These deposits, about 5 meters in thickness, represent the middle part of the section; they include samples from Ms 2.1.4 to Ms 2.1.7 (2.1.6 and Ms 2.1.7 with common biodetrital fragments).

Sample Ms 2.1.4 (pl. 1: 3-4, pl. 3: 6):

slightly bioturbated biomicrite wackestone with calpionellids, *Globochaete alpina* Lombard (also filaments jointed with globochaete gamets), and increased number of calcified radiolarians; moreover – crinoid ossicles including *Saccocoma*, ostracods, juvenile ammonites, aptychi (*Punctaptychus* sp.), foraminifers (*Gaudryina* sp.), calcareous dinocysts – *Colomisphaera tenuis* (Nagy); calpionellids: *Tintinnopsella remanei* Borza, *Tintinnopsella carpathica* (Murg. et Filip.), *Crassicollaria intermedia* (Durand Delga), *Crassicollaria brevis* Remane, *Calpionella alpina* Lorenz.

Sample Ms 2.1.5 (pl. 3: 5):

biomicrite wackestone with calpionellids. It contain also: calcified radiolarians, bivalves (also with tubes of boring organisms), foraminifers (*Lenticulina* sp., *Spirillina* sp., *Patelina* sp.; also agglutinated foraminifers), ostracodes, crinoids (including *Saccocoma*), ophiuroids, and gastropods fragments, aptychi, juvenile ammonites, globochaetes (filaments jointed with globochaete gamets are frequent), calpionellids: *Crassicollaria brevis* Remane, *Crassicollaria intermedia* (Durand Delga), *Crassicollaria parvula* Remane, *Calpionella alpina* Lorenz, *Calpionella grandalpina* Nagy; moreover calcareous dinocysts: *Colomisphaera tenuis* (Nagy). There are marks of bioturbation, and boring structures within bioclasts. Locally, accumulation of Fe-minerals (pyrite) in radiolarian tests, in bivalve fragments as well as in matrix is visible. Fractures in matrix are filled with radiaxial and blocky calcite crystallites, some of organic remains, and voids are silicified.

Sample Ms 2.1.6 (pl. 1: 5-6, pl. 2: 1-2):

bioturbated biomicrite wackestone with calpionellids showing more frequent biodetrital bivalve fragments, crinoid ossicles (rare *Saccocoma*), brachiopod, gastropod, and ophiuroid fragments, juvenile ammonites, aptychi (*Laevaptychus* sp.), calcified radiolarians, ostracods (also *Pokornyopsis* sp.), foraminifers (*Dentalina* sp., *Spirillina* sp., *Lenticulina* sp.), sponge spicules, globochaetes; calpionellids with dominated *Crassicollaria parvula*

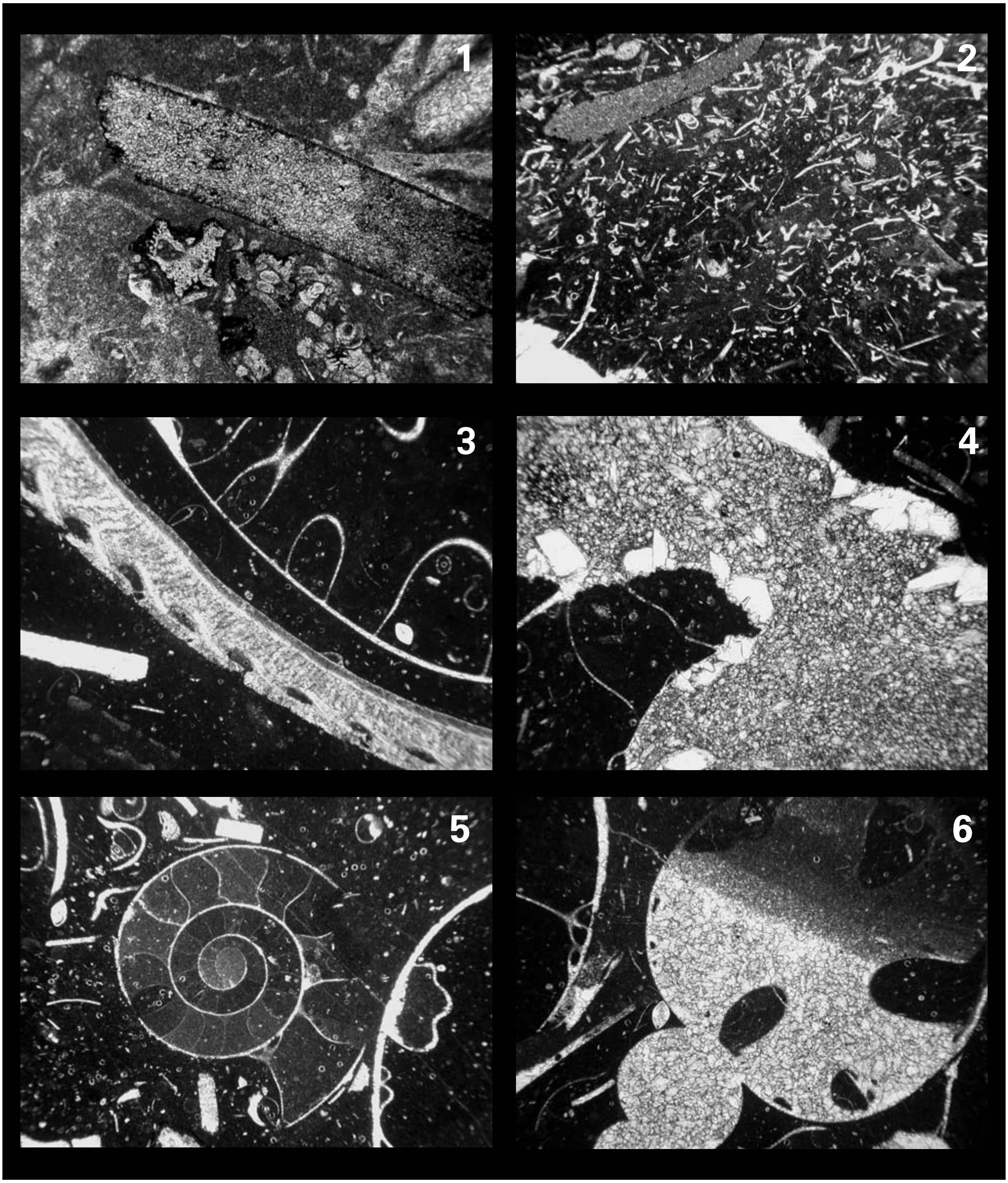



Plate 1
1 – Aptychi and bivalve fragments in *Saccocoma-Globochaete* wackestone – organic remnants are frequently penetrated by tubes of boring organisms, tubes are usually impregnated by Fe-minerals, Kimmeridgian, (Ms 2.1.1), taken x45; 2 – *Globochaete-Saccocoma* wackestone to packstone, secundibranchialia and ramuli from the *Saccocoma* arms, Lower Tithonian, (Ms 2.1.2), taken x45; 3 – *Punctaptychus* sp., and brachiopod fragment in biomicritic calpionellid limestone, Upper Tithonian, (Ms 2.1.4), taken x45; 4 – fracture in biomicritic calpionellid limestone filled by sparitic calcite crystals, there are the blocky calcite crystals rimming the contact with micrite matrix, Upper Tithonian, (Ms 2.1.4), taken x45; 5 – ammonite, brachiopod, gastropod, bivalve, aptychi, foraminifer and crinoid fragments, in biomicritic calpionellid limestone, Upper Tithonian, (Ms 2.1.6), taken x45; 6 – fenestral texture displaying geopetal filling overlain by sparite cement within ammonite shell, caplionellid microfacies, Upper Tithonian, (Ms 2.1.6), taken x45.

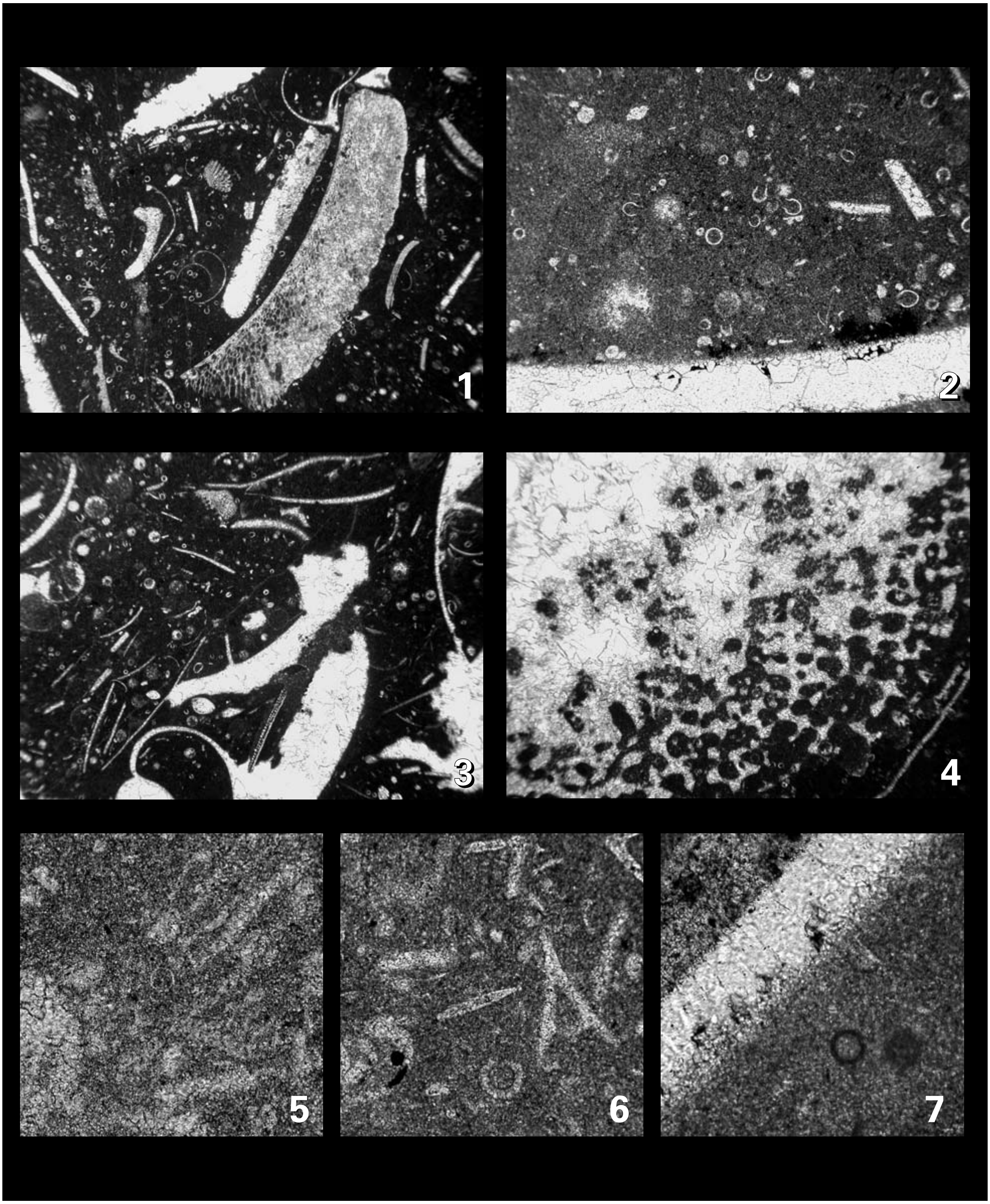
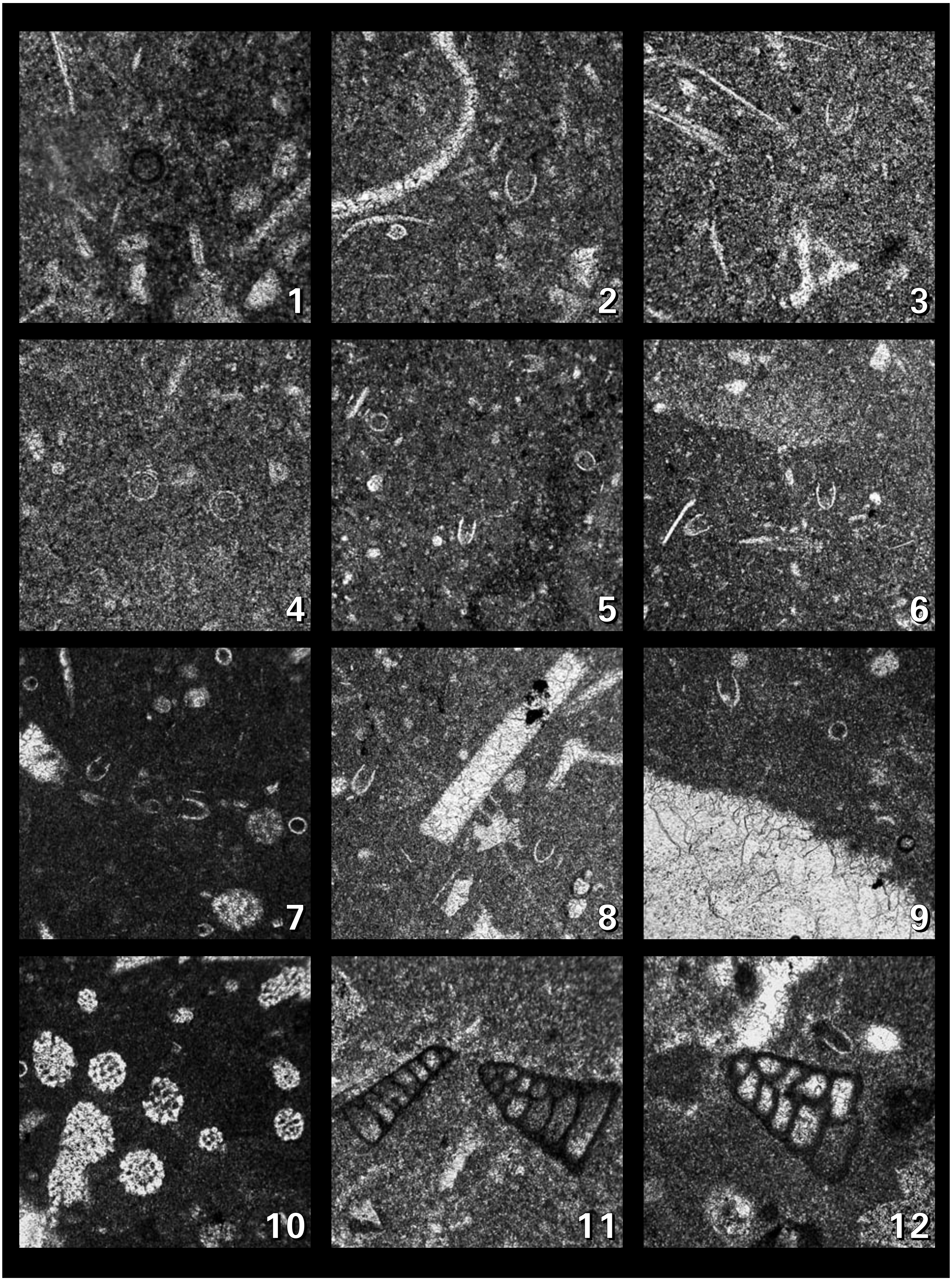



Plate 2
1 – *Laevaptychus* sp., bivalve, gastropod, ophiuroid and crinoid fragments in Upper Tithonian calpionellid limestone, (Ms 2.1.6), taken x45; 2 – *Calpionella alpina* Lorenz, *Calpionella grandalpina* Nagy in Upper Tithonian biomicritic wackestone, (Ms 2.1.6), taken x60; 3 – bivalve, gastropod, crinoid fragments and calcified radiolarians in Lower Berriasian calpionellid limestone, (Ms 2.1.8) x45; 4 – hydrozoan fragment in Middle Berriasian organodetritic limestone, (Ms 2.1.9), taken x45; 5 – *Stomiosphaera moluccana* Wanner, Kimmeridgian, (1B/3), taken x90; 6 – *Colomispahera carpathica* (Borza), Kimmeridgian, (1B/3), taken x90; 7 – *Colomisphaera pulla* (Borza), Lower Tithonian, (Ms 2.1.2), taken x90.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Remane over *Crassicollaria brevis* Remane, *Calpionella alpina* Lorenz, *Calpionella grandalpina* Nagy, *Tintinnopsella carpathica* (Murg. et Filip.); calcareous dinoflagellates include: *Cadosina semiradiata fusca* (Wanner), *Cadosina semiradiata semiradiata* (Wanner).

Sample Ms 2.1.7:

biomicrite wackestone with common calpionellids; moreover bivalve fragments, rhyncholit, crinoid ossicles including rare fragments of *Saccocoma*, juvenile ammonites, gastropods, brachiopods, aptychi, calcified radiolarians, *Globochaete alpina* Lombard, foraminifers (*Lenticulina* sp., *Dentalina* sp., *Nodosaria* sp.); calpionellids include: *Crassicollaria brevis* Remane, *Crassicollaria parvula* Remane, *Crassicollaria colomi* Doben, *Calpionella alpina* Lorenz, *Tintinnopsella carpathica* (Murg. et Filip.) and *Tintinnopsella doliphormis* (Colom); dinoflagellates: *Cadosina semiradiata fusca* (Wanner) and *Cadosina semiradiata semiradiata* (Wanner).

**White and white-grey wackestones and locally mudstones of radiolarian-calpionellid and calpionellid microfacies, locally enriched in biodetrital material.** These are the youngest deposits in the section, about 3 meters in thickness. The samples have not been taken from the lowermost part of the unit, about 1 m thick; all the studied samples, from Ms 2.1.8 and Ms 2.1.8(+), to Ms 2.1.11 and 1B/9a-b, cover thus the middle and the upper part of the unit.

Samples Ms 2.1.8 – two samples taken in a close proximity (pl. 2: 3, pl. 3: 7, 10):

Lower sample – Ms 2.1.8 is biomicrite wackestone rich in radiolaria and calpionellids; it contains also: microforaminifers, aptychi, gastropod, ammonite, bivalve, and crinoid fragments, ostracods, foraminifers (*Textularia* sp., *Lenticulina* sp. and further agglutinated forms), calcareous dinoflagellates – *Cadosina semiradiata fusca* (Wanner) and *Cadosina semiradiata semiradiata* (Wanner); calpionellids include: *Calpionella alpina* Lorenz, *Tintinnopsella carpathica* (Murg. et Filip.), *Crassicollaria parvula* Remane, *Remaniella ferasini* (Catalano).

Upper sample – Ms 2.1.8.(+) is biomicrite wackestone with calpionellids, sponge spicules, microforaminifers, foraminifers (*Spirillina* sp., *Lenticulina* sp.), ostracods, juvenile ammonites, gastropod, echinoid and crinoid fragments, globochaetes, laevaptychi, calcified radiolarians, calcareous dinocysts – *Cadosina semiradiata fusca* (Wanner), *Colomisphaera tenuis* (Nagy); calpionellids include: *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Remaniella duranddelgai* Pop.

Sample Ms 2.1.9 (pl. 2: 4; pl. 3: 8-9, 11):

biomicrite wackestone to mudstone with common calpionellids, but containing also sponge spicules, hydrozoans, gastropods, ammonites, ostracods, microforaminifers and foraminifers (*Textularia* sp., *Gaudryina* sp., *Lenticulina* sp.), also frequent agglutinated foraminifers, frequent dinoflagellates represented by *Cadosina semiradiata fusca* (Wanner), aptychi, crinoids, calcified radiolarians; calpionellids include: *Tintinnopsella carpathica* (Murg. et Filip.), *Tintinnopsella longa* (Colom), *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Calpionella minuta* Houša, *Remaniella cadischiana* (Colom), *Remaniella colomi* Pop, *Remaniella cadischiana* (Colom), *Lorenziella hungarica* Knauer. The caverns in micrite matrix are filled by blocky calcite.

Samples 1B/9a and 1B/9b:

Sample 1B/9a is biomicrite wackestone with calpionellids: *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Calpionella minuta* Houša, *Tintinnopsella carpathica* (Murg. et Filip.), *Remaniella ferasini* (Catalano), *Remaniella colomi* Pop.; it contains also

Plate 3

1 – *Carpistomiosphaera tithonica* Nowak, Lower Tithonian, (Ms 2.1.2), taken x90; 2-3 – *Praetintinnopsella andrusovi* Borza, uppermost Middle to lowermost Upper Tithonian, (Ms 2.1.3), taken x90; 4 – *Colomisphaera fortis* Rehánek, uppermost Middle to lowermost Upper Tithonian, (Ms 2.1.3), taken x90; 5 – *Crassicollaria parvula* Remane, *Crassicollaria brevis* Remane in Upper Tithonian biomicritic limestone, (Ms 2.1.5), taken x90; 6 – *Crassicollaria intermedia* (Durand Delga) in Upper Tithonian biomicritic limestone, (Ms 2.1.4), taken x90; 7 – *Remaniella duranddelgai* Pop and *Calpionella alpina* Lorenz in uppermost Lower to Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.8 (+)), taken x90; 8 – *Calpionella elliptica* Cadisch in Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.9), taken x90; 9 – *Tintinnopsella carpathica* (Murgeanu et Filipescu) and *Cadosina semiradiata fusca* (Wanner) in Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.9), taken x90; 10 – Echinoid fragments in uppermost Lower to Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.8(+)), taken x60; 11 – *Textularia* sp. in Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.9), taken x60;12 – *Gaudryina* sp, and *Tintinnopsella longa* (Colom) in Middle Berriasian biomicritic calpionellid limestone, (Ms 2.1.10), taken x60.

bivalve fragments, ostracods, gastropods, globochaets, ammonites, crinoids, calcified radiolarians, foraminifers (*Lenticulina* sp.).

Sample 1B/9b is biodetritic wackestone; it contains: gastropods, crinoids, ammonites, brachiopods, bivalves, ostracods, aptychi, bryozoan fragments, sponge spicules, radiolarians, foraminifers (frequent *Lenticulina* sp.), calpionellids – *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Tintinnopsella carpathica* (Murg. et Filip.), *Remaniella duranddelgai* Pop, *Remaniella colomi* Pop, dinoflagellates – *Cadosina semiradiata fusca* (Wanner).

Samples Ms 2.1.10 and Ms 2.1.11 (pl. 3: 12):

biomicrite wackestone with increasing amount of biodetrital fragments: sponge spicules, ammonites, aptychi, gastropods, ostracods, crinoids, foraminifers (*Lenticulina* sp., *Dentalina* sp., *Gaudryina* sp.); calcareous dinocysts are frequent: *Cadosina semiradiata fusca* (Wanner); calpionellids include: *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Calpionella minuta* Houša, *Remaniella colomi* Pop, *Remaniella filipescui* Pop, *Remaniella cadischiana* (Colom), *Lorenziella hungarica* Knauer, *Tintinnopsella carpathica* (Murg. et Filip.), *Tintinnopsella longa* (Colom). The sample Ms 2.1.11 contains some biodetrital fragments and shows calpionellid assemblage similar to that of sample Ms 2.1.10.

Of the three distinguished rock-units in the section (figs 1-2), these representing the lower and middle parts of the succession developed as red to pink coloured wackestones and packstones are typical deposits of the Rogoża Coquina Member. The upper unit of the succession consisting of white and white-grey wackestones and mudstones differs markedly in rock-colour, as well as less common occurrence of detrital material, also in lack of *Saccocoma* fragments, from underlying deposits. These youngest deposits in the succession show a marked similarity to the Sobótka Limestone Member of Birkenmajer (1977) differing only in less common occurrence of micritic limestones of the mudstone type, which are frequently encountered in the latter unit (see Birkenmajer 1977; Wierzbowski & Remane 1992).

MICROFOSSIL STRATIGRAPHY

Calpionellid biostratigraphy presented herein is based on the recent study of distribution of chitinoidellid and calpionellid taxa by Reháková (1998, 2002), and Reháková & Michalík (1997). The detailed study of distribution, diversity and abundance of the calcareous dinoflagellates taxa by Reháková (2000) is the basis for presented here dinocyst zonation established for the Western Carpathian area.

**Lower to Upper Kimmeridgian** interval comprises the red *Saccocoma-Globochaete* microfacies (wackestone to packstone) which contain calcareous dinoflagellates: *Colomisphaera carpathica* (Borza), *Colomisphaera pieniniensis* (Borza), *Cadosina parvula* Nagy, *Stomiosphaera moluccana* Wanner, *Carpistomiosphaera borzai* (Nagy), *Colomisphaera fibrata* (Nagy), *Colomisphaera nagyi* (Borza), *Schizosphaerella minutissima* (Colom). These calcareous dinoflagellates indicate the presence of the Parvula Zone (samples Ms 2.1.1, 1B/1, 1B/2), the Moluccana Zone (sample 1B/3), and the Borzai Zone (sample 1B/4). The deposits are about 4 m in thickness (figs 1-2).

**Lower Tithonian** interval is represented by *Globochaete-Saccocoma* microfacies (wackestone to packstone) belonging to dinoflagellate Pulla –Tithonica Zones. Samples Ms 2.1.2 and 1B/5, 1B/6 contain: *Carpistomiosphaera tithonica* Nowak, *Colomisphaera pulla* (Borza), as well as *Schizosphaerella minutissima* (Colom), *Cadosina parvula* Nagy, *Stomiosphaera moluccana* Wanner, and *Colomisphaera carpathica* (Borza).

**Middle Tithonian** interval is represented by *Saccocoma-Globochaete* microfacies (wackestone to packstone: samples 1B/7, 1B/8) which yielded the first very rare microgranular chitinoidellids in the matrix. Here occurs: *Longicollaria dobeni* (Borza) and *Chitinoidella* sp. of the Dobeni Subzone of the standard Chitinoidella Zone, moreover calcareous dinoflagellates, such as *Parastomiosphaera malmica* (Borza), *Colomisphaera carpathica* (Borza), *Colomisphaera fortis* Rehánek, *Colomisphaera tenuis* (Nagy), *Cadosina parvula* Nagy, *Schizosphaerella minutissima* (Colom).

The first hyaline calpionellids represented by *Praetintinnopsella andrusovi* Borza were observed in sample Ms 2.1.3. They are typical for the standard Praetintinnopsella Zone which covers the **uppermost part of the Middle Tithonian** and the **lower part of Upper Tithonian**. These rare praetintinnopsellids, as well as chitinoidellids (*Chitinoidella* sp.), were identified in biodetrital wackestone passing to *Saccocoma-Globochaete* microfacies packstone. The wackestone contains also calacareous dinoflagellates: *Parastomiosphaera malmica* (Borza), *Colomisphaera carpathica* (Borza), *Colomisphaera fortis* Rehánek, *Colomisphaera tenuis* (Nagy), *Schizosphaerella minutissima* (Colom).

**Upper Tithonian** interval (sample Ms 2.1.4) begins with biomicrite wackestones containing common calpionellids: *Tintinnopsella remanei* Borza, *Tintinnopsella carpathica* (Murg. et Filip.), *Crassicollaria intermedia* (Durand Delga), *Calpionella alpina* Lorenz. Calcified radiolarians increase also in number; calcareous dinocysts include *Colomisphaera tenuis* (Nagy). According to microfossil record the wackestones belong to the Remanei Subzone of the standard Crassicollaria Zone.

Overlying **Upper Tithonian** biomicrite wackestones of the calpionellid microfacies (samples Ms 2.1.5, Ms 2.1.6) contain *Crassicollaria brevis* Remane, the index species of Brevis Subzone (standard Crassicollaria Zone), moreover there occur: *Crassicollaria intermedia* (Durand Delga), *Crassicollaria parvula* Remane, *Calpionella alpina* Lorenz, *Calpionella grandalpina* Nagy, *Tintinnopsella carpathica* (Murg. et Filip.); calcareous dinocysts: *Colomisphaera tenuis* (Nagy), *Cadosina semiradiata fusca* (Wanner), *Cadosina semiradiata semiradiata* (Wanner).

The biomicrite wackestones of calpionellid microfacies represented by sample Ms 2.1.7 belong also to the **Upper Tithonian**. The sample contains calpionellids of the Colomi Subzone (standard Crassicollaria Zone). The calpionellid assemblage includes: *Crassicollaria brevis* Remane, *Crassicollaria parvula* Remane, *Crassicollaria colomi* Doben, *Calpionella alpina* Lorentz, *Tintinnopsella carpathica* (Murg. et Filip.), *Tintinnopsella doliphormis* (Colom); moreover some dinoflagellates *Cadosina semiradiata fusca* (Wanner), *Cadosina semiradiata semiradiata* (Wanner). The total thickness of Tithonian deposits attains about 7 meters.

The first **Lower Berriasian** calpionellid Alpina Subzone of the standard Calpionella Zone was not identified in section studied. Neverheless, this subzone, if present, is possibly reduced in thickness covering a part of the non-sampled interval of the lowermost part of white micritic limestones. This suggests that the boundary between the reddish micritic limestones of the Rogoża Coquina Member and the white micritic limestones of the Sobótka Limestone Member represents a nonsequence in the succession studied.

The index species *Remaniella ferasini* (Catalano) of the second **Lower Berriasian** Ferasini Subzone (standard Calpionella Zone) was identified in sample Ms 2.1.8 in biomicrite wackestone of radiolaria/calpionellid microfacies. Other identified calpionellids include: *Calpionella alpina* Lorenz, *Tintinnopsella carpathica* (Murg. et Filip.), and rare *Crassicollaria parvula* Remane. Moreover, some calcareous dinoflagellates were recognized: *Cadosina semiradiata fusca* (Wanner), and *Cadosina semiradiata semiradiata* (Wanner).

Biomicrite wackestones and mudstones with decreased abundance of biodetrite fragments in the uppermost part of section (samples Ms 2.1.8(+), Ms 2.1.9, Ms 2.1.10, Ms 2.1.11, 1B/9a, 1B/9b) belong to the Elliptica Subzone (standard Calpionella Zone) of the **uppermost Lower to Middle Berriasian**. They contain abundant calpionellids: *Calpionella alpina* Lorentz, *Calpionella elliptica* Cadisch, *Calpionella minuta* Houša, *Tintinnopsella longa* (Colom), *Tintinnopsella carpathica* (Murg. et Filip.), *Remaniella duranddelgai* Pop, *Remaniella cadischiana* (Colom), *Remaniella colomi* Pop, *Remaniella ferasini* (Catalano), *Remaniella filipescui* Pop, *Lorenziella hungarica* Knauer. The calcareous dinocyst assemblage includes: *Cadosina semiradiata fusca* (Wanner), *Colomisphaera tenuis* (Nagy).

## CONCLUSIONS

The Rogoźnik Quarry contains the type section of the Rogoża Coquina Member. Although the lower part of the unit is not exposed here, the studied section through the red-coloured wackestones to packstones of the *Saccocoma/Globochaete* microfacies and overlying reddish and pinkish wackestones of the calpionellid/radiolarian microfacies is the best section currently available of the lithostratigraphical unit. The studied deposits are well dated by calacareous dinocyst and callpionellid assemblages and cover the stratigraphical interval from Lower and Upper Kimmeridgian to Upper Tithonian (Crassicolaria

Zone). The overlying white and white-gray wackestones and mudstones of the radiolarian/calpionellid microfacies belong to Lower and Middle Berriasian and correspond to another lithostratigraphical unit – the Sobótka Limestone Member. It is likely that the boundary between the Rogoża Coquina Member and the Sobótka Limestone Member is marked by sedimentary discontinuity which could cover at least a part of the Alpina Subzone of the standard Calpionella Zone of the lowermost Berriasian.

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REFERENCES

Birkenmajer K. 1962. Zabytki przyrody nieożywionej pienińskiego pasa skałkowego, część II – Skałki w Rogoźniku koło Nowego Targu (Monuments of inanimate nature in the Pieniny Klippen Belt, part II – Klippen of Rogoźnik near Nowy Targ). *Ochrona Przyrody*, **28**: 159-185.

Birkenmajer K. 1963. Stratygrafia i paleogeografia serii czorsztyńskiej pienińskiego pasa skałkowego Polski (Stratigraphy and palaeogeography of the Czorsztyn series, Pieniny Klippen Belt, Carpathians, in Poland). *Studia Geologica Polonica*, **9**: 1-380.

Birkenmajer K. 1977. Jurassic and Cretaceous lithostratigraphic units of the Pieniny Klippen Belt. *Studia Geologica Polonica*, **45**: 1-158.

Krobicki M. 1994. Stratigraphical significance and palaeoecology of the Tithonian-Berriasian brachiopods in the Pieniny Klippen Belt, Carpathians, Poland. *Studia Geologica Polonica*, **106**: 89-156.

Kutek J. & Wierzbowski A. 1986. A new account on the Upper Jurassic stratigraphy and ammonites of the Czorsztyn succession, Pieniny Klippen Belt, Poland. *Acta Geologica Polonica*, **36**, 4: 289-316.

Masłowska B. 1989. Górna jura jednostki czorsztyńskiej miedzy Rogoźnikiem a Starem Bystrem, Podhale. Unpubl. M. Sc. Thesis. 1-120. Institute of Geology, University of Warsaw.

Neumayr M. 1871. Jurastudien: 5. Der penninische Klippenzug. *Jahrbuch der kaiserlich-königlischen geologischen Reichsanstalt*, **21**: 450-436.

Reháková D. 1995. Upper Jurassic – Lower Cretaceous carbonate microfacies and environmental models for the Western Carpathians and adjacent palaeogeographic units. *Cretaceous Research*, **16**: 283-297.

Reháková D. 1998. Calpionellid genus *Remaniella* Catalano 1956 in Lower Cretaceous pelagic deposits of Western Carpathians. *Mineralia Slovaca*, **30**: 443-452.

Reháková D. 2000. Evolution and distribution of the Late Jurassic and Early Cretaceous calcareous dinoflagellates recorded in the Western Carpathian pelagic carbonate facies. *Mineralia Slovaca*, **32**: 79-88.

Reháková D. 2002. *Chitinoidella* Trejo, 1975 in Middle Tithonian carbonate pelagic sequences of the West Carpathian Tethyan area. *Geologica Carpathica*, **53**, 6: 369-379.

Reháková D. & Michalík J. 1997. Evolution and distribution of calpionellids – the most characteristic constituents of Lower Cretaceous Tethyan microplankton. *Cretaceous Research*, **18**: 493-504.

Uhlig V. 1890. Ergebnisse geologischer Aufnahmen in den westgalizischen Karpathen, II Theil – Der pieninische Klippenzug. *Jahrbuch der kaiserlich-königlischen geologischen Reichsanstalt*, **40**: 559-824.

Wierzbowski A. 1994. Late Middle Jurassic to earliest Cretaceous stratigraphy and microfacies of the Czorsztyn Succession in the Spisz area, Pieniny Klippen Belt, Poland. *Acta Geologica Polonica*, **44**, 3-4: 223-249.

Wierzbowski A. & Remane J. 1992. The ammonite and calpionellid stratigraphy of the Berriasian and lowermost Valanginian in the Pieniny Klippen Belt (Carpathians, Poland). *Eclogae Geologicae Helvetiae*, **85**, 3: 871-891.

Zittel K. A. 1870. Die Fauna der älteren Cephalopoden fuehrenden Tithonbildungen. *Palaeontographica Supplement*, **2**: 1-192.

Zydorowicz T. & Wierzbowski A. 1986. Jurajskie konkrecje żelazisto-manganowe w sukcesji czorsztyńskiej, pieniński pas skałkowy (Jurassic ferromanganese nodules in the Czorsztyn succession of the Pieniny Klippen Belt). *Przegląd Geologiczny*, **6**: 324-327.

## STRESZCZENIE

Czerwone muszlowce amonitowe odsłonięte w nieczynnym kamieniołomie w Rogoźniku stanowią wzorzec litostratygraficzny dla ogniwa muszlowców z Rogoży (dawniejsza nazwa „czerwone muszlowce rogoźnickie" – Birkenmajer 1962, 1963, 1977). Pozycja chronostratygraficzna tych utworów i ich związek ze słynnymi muszlowcami ogniwa muszlowców z Rogoźnika (dawna nazwa „białe muszlowce rogoźnickie" – Birkenmajer 1962, 1963, 1977) pozostawały przez dłuższy czas nie w pełni wyjaśnione. Pierwotnie (Birkenmajer 1977), sądzono, że ogniwo muszlowców z Rogoży jest starsze od ogniwa muszlowców z Rogoźnika; później (Kutek & Wierzbowski 1986), wyrażono opinię, że ogniwa te są równowiekowe – czerwone mikrytowe muszlowce z Rogoży zastąpione są obocznie przez muszlowce z Rogoźnika o silnie zrekrystalizowanym matryksie przekształconym w dużym stopniu w grubokrystaliczny kalcyt.

Przeprowadzone obecnie szczegółowe badania płytek cienkich z prób zebranych w profilu muszlowców z Rogoży w kamieniołomie w Rogoźniku (fig. 1 i 2, pl. 1-3) pozwoliły na pełne przedstawienie charakterystyki mikrofacjalnej i określenie pozycji chronostratygraficznej tych utworów w oparciu o cysty wapiennych Dinoflagellata oraz kalpionelle. Widoczne w profilu muszlowce mają miąższość około 11 metrów (spąg ogniwa muszlowców z Rogoży jest tu nieodsłonięty) i wykształcone są w niższej części jako czerwone wapienie typu wackestone i packstone o mikrofacji sakkokomowo-globochetowej, a w części wyższej – jako czerwonawe i różowe wapienie typu wackestone o mikrofacji kalpionellowo-radiolariowej. Pozycja chronostratygraficzna niższej części muszlowców zawiera się w przedziale od kimerydu i dolnego tytonu (poziomy dinoflagellatowe: Parvula, Moluccana, Borzai oraz Pulla-Tithonica w klasyfikacji Rehakowej 2000) do środkowego tytonu/najniższego górnego tytonu (poziomy kalpionellowe: Chitinoidella oraz Praetintinnopsella w klasyfikacji Rehakowej i Michalika 1997). Datowania te pokazują, że omawiane utwory obejmują przedział stratygraficzny, odpowiadajacy rozwiniętym w klasycznej postaci muszlowcom z Rogoźnika w profilu skałek Rogoży (por. Kutek i Wierzbowski 1986).

Wyższa część ogniwa muszlowców z Rogoży w badanym profilu zawiera liczne kalpionelle wskazujące na górnotytoński poziom Crassicolaria i jego wszystkie trzy podpoziomy: Remanei, Brevis i Colomi (por. Rehakova i Michalik 1997).

Utwory bezpośrednio nadścielające muszlowce z Rogoży w profilu kamieniołomu w Rogoźniku reprezentowane są przez białe i biało-szare wapienie typu wackestone, a lokalnie też mudstone, wykształcone w mikrofacji radiolariowo-kalpionellowej lub kalpionellowej. Obecne tu zespoły kalpionelli wskazują na dolny i środkowy berias (poziom Calpionella), przy czym jak wydaje się, najniższa część tego poziomu, odpowiadająca podpoziomowi Alpina, jest tu nieobecna lub silnie zredukowana miąższościowo. Może to wskazywać na istnienie luki stratygraficznej pomiędzy ogniwem muszlowców z Rogoży, a omawianymi nadległymi wapieniami, które swoim charakterem litologicznym, a także swoją pozycją stratygraficzną, wyraźnie nawiązują do ogniwa wapienia z Sobótki w schemacie litostratygraficznym Birkenmajera (1977).