



## Chronostratigraphic significance of an early Valanginian (Cretaceous) calpionellid association (Hochkogel section, Upper Austria, Northern Calcareous Alps)

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Early Cretaceous calpionellid samples were collected at the ammonoid-bearing Hochkogel locality in the southernmost part of the Reichraming Nappe (Ebenforst Syncline, Northern Calcareous Alps). The microfossil fauna sampled from limestone parts of the Rossfeld Formation indicates an early Valanginian age. The standard *Calpionellites* Zone (with *darderi* and *major* subzones) coincides with the early Valanginian ammonoid zones of *Busnardoites campylotoxus* and *Tirnovella pertransiens*. The deposition of the limestones in this area occurred in an unstable environment disturbed by gravitational transport which accounts for the different sedimentary components and accompanying fossils in the accumulated layers, transported from a source area situated to the south.

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### INTRODUCTION

In the Reichraming Nappe (Bajuvaric Unit, Northern Calcareous Alps), Valanginian cephalopod-bearing deposits are recorded in two different lithostratigraphic units, the Schrambach and the Rossfeld formations (Lukeneder, 2004, 2005a, b, c; Piller *et al.*, 2004). Upper Valanginian sediments of the Rossfeld Formation comprise mainly limestones and sandstones, whereas the Schrambach Formation consists of limestones with turbiditic sandstone intercalations (Vašíček and Faupl, 1996; Lukeneder 2005a, b; Lukeneder and Schlagintweit, 2005). The Rossfeld Formation is restricted to southern parts of the Reichraming Nappe. It is interpreted as a synorogenic succession deposited at the beginning of the compressional deformation within the Austroalpine Unit (Faupl, 1979; Decker *et al.*, 1987). The source area for the Rossfeld Formation and the sandstone intercalations of the Schrambach Formation was situated to the south of the basin (Faupl and Wagreich, 1992; Vašíček and Faupl, 1996, 1998; Lukeneder, 2005a).

The stratigraphy of the Lower Cretaceous sediments in the area investigated (Fig. 1) is based on ammonoids. A new calpionellid and dinoflagellate association was collected in limestone interbeds of the Rossfeld Formation by the authors. During the 1990s, a rich cephalopod fauna was collected from Lower Cretaceous deposits from the area surrounding the locality described herein (Immel, 1987; Vašíček *et al.*, 1994; Vašíček and Faupl, 1996, 1998, 1999). The ammonoids from this locality were described by Lukeneder (2005a). The ammonoids are rare and not well preserved. We therefore sought other parameters to more precisely determine the age.

The present contribution is a continuation of papers by Lukeneder (2004b, c; 2005a, b, c) and Lukeneder and Reháková (2004). The latter paper describes a new calpionellid fauna from the Northern Calcareous Alps which strengthened the biostratigraphy established on ammonoids of this Lower Cretaceous section. It underlines the tremendous importance of correlating different fossil groups. This approach reveals that the age given by Lukeneder (2005a) for the same section was somewhat too young (e.g. base of late Valanginian). The poor preservation of the ammonoids hindered a more precise age determination. After investigating additionally the microfossils a

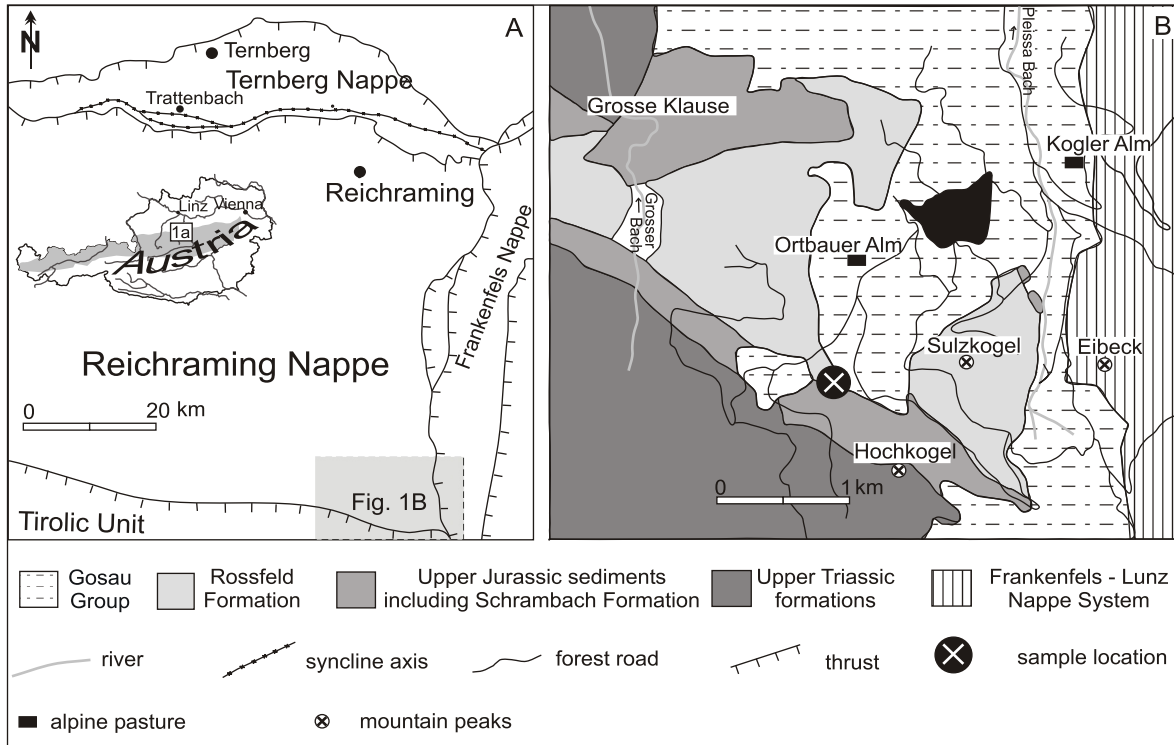


Fig. 1. A — locality map of Upper Austria showing tectonic context (Reichraming Nappe, Frankenfels Nappe) around the section investigated within the Northern Calcareous Alps; B — position of the Hochkogel locality on the geological map of the Ebenforst Syncline

more correct age can be given. Besides ammonoids, the calpionellids are the key elements, and among the microfossils the calcareous dinoflagellates. Finally the combined study of both micro- and macrofossils yielded a better defined age for the section.

#### GEOGRAPHICAL SETTING

The position of this Upper Austrian locality is about 5 km south of Brunnbach (652 m, ÖK 1:50 000, sheet 69 Großraming, Fig. 1). The exposure is located in the southernmost part of the east-west striking Ebenforst Syncline along a forest road running between the Sulzkogel (840 m) to the north and the Hochkogel (1157 m) to the south at the topmost part of the Reixengraben at 885 m. The grey sandstone succession comprising the ammonoid-bearing beds (dipping 225/60°) is located on the northern side of the Hochkogel (Lukeneder, 2005a). The exact GPS (global positioning system) position of the calpionellid occurrence described is: N 47°47'15'' and E 14°30'00'' (Fig. 2).



Fig. 2. Exposures of the detailed lower Valanginian logs with indicated fossiliferous beds 1–3 within the Rossfeld Formation

GEOLOGICAL SETTING AND LITHOLOGY

The lower Valanginian microfossils described here were collected from a small exposure (20 m in length) of sandstones and marly limestones located at the southern margin of the Ebenforst Syncline. The calpionellid occurrence investigated is situated in marly limestones of the Rossfeld Formation. The Ebenforst Syncline is located in the southernmost part of the Reichraming Nappe of the Northern Calcareous Alps (Fig. 1). This region is part of the Bajuvaric Unit, which is bordered by and overlain to the south by the Tyrolian Nappes (Staufen-Höllengebirgs Nappe; Lukeneder, 2005a). The locality is 500 m north of the border with the southern Tyrolian Units. The Ebenforst Syncline is made up of a Jurassic succession (Oberalm Formation, Scheiblberg-Kirchstein Formation,

Hierlatzkalk). The core of the Ebenforst Syncline consists of the Lower Cretaceous Rossfeld Formation.

The Rossfeld Formation is mainly composed of grey silty marls accompanied by conglomerates and sandstones. Sandstones are fine-grained and show slump structures. The intercalated marly bioturbated limestones are light-coloured and are associated with a relatively monotonous benthic macrofauna (brachiopods and bivalves). The fabric is mottled to completely homogenised due to bioturbation and indicates rich benthic colonization (Fig. 3).

The Rossfeld Formation at the Hochkogel section shows approx. 30 m of fine-grained, grey calcareous sandstones (5–50 cm beds). Three intercalated limestone beds 10 to 40 cm thick (Fig. 3, beds 1–3, rich in calpionellids and ammonoids) can be distinguished. These limestone beds are in turn marked by thin, rhythmically intercalated turbiditic sandstone layers

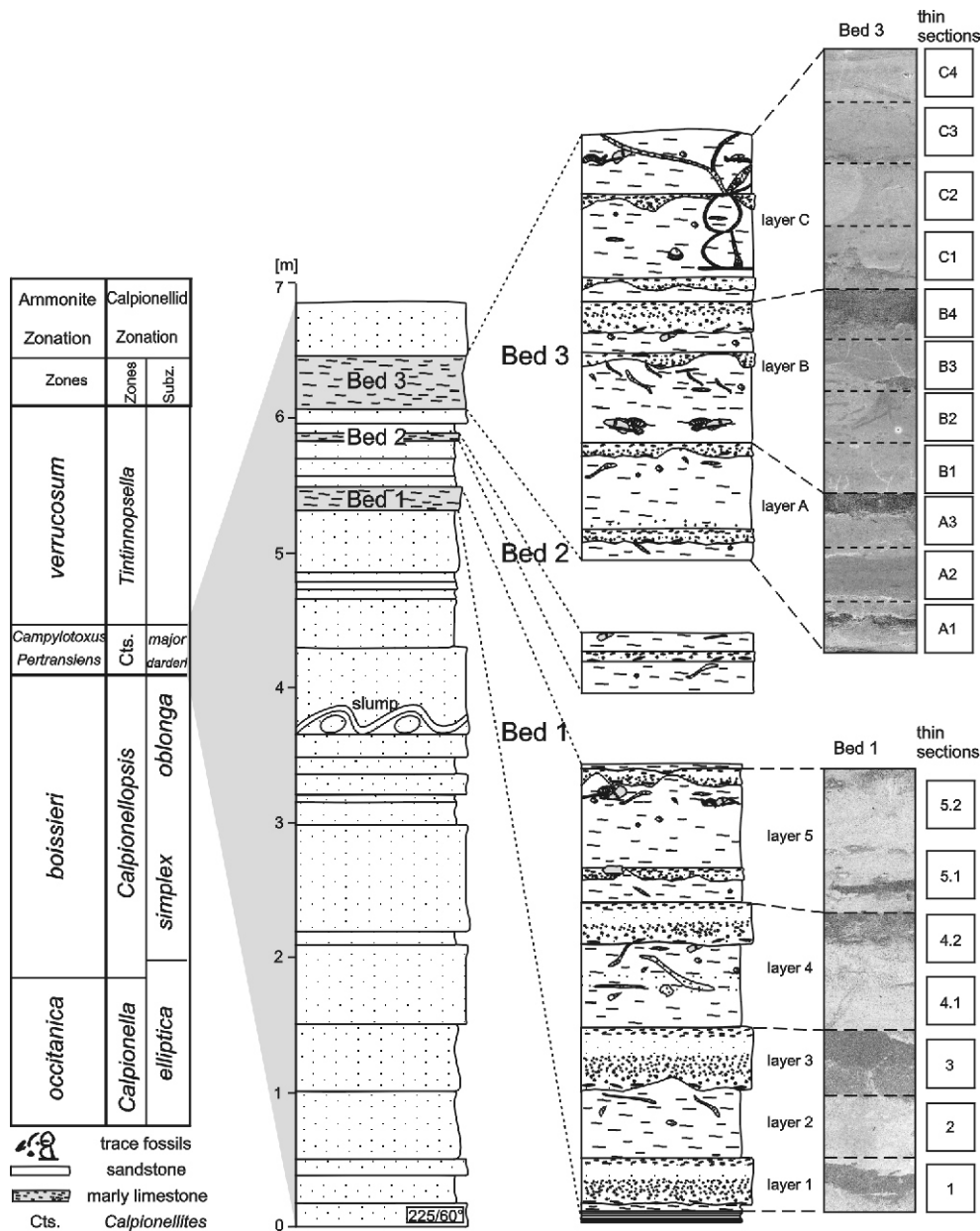


Fig. 3. Position of the fossiliferous beds (enlarged) within the log of the exposure investigated in the road-cut on the northern flank of the Hochkogel

each about 2–3 cm thick. The rapid accumulation of several, consecutive independent accumulation “events” is proposed for the sandstone layers, whereas the limestone- and marl-beds reflect “normal” sedimentation rates.

CaCO<sub>3</sub> (calcium carbonate contents, equivalents calculated from total inorganic carbon) has values of about 64%. The weight % TOC values (total organic carbon) are about 0.7% within the limestones of the exposure. The maximum amount of sulphur (3.1 mg/g) stems from the middle of limestone Bed 2.

## MATERIAL AND METHODS

The macrofossil fauna is dominated by ammonoids, followed by rare benthic crinoids, bivalves and brachiopods. Carefully selected and washed samples of the limestones contain primarily fine silt-sized, angular quartz grains, some pyrite and phosphatic material (fish scales and teeth). The generally poorly preserved micro-invertebrate fauna consists of calpionellids, calcareous dinoflagellates, rare foraminifera (benthic), radiolarians, ostracods, and sponge spicules, all of which were investigated.

During this study, determinable calpionellids were investigated on 32 thin sections from Bed 1 (10 thin sections) and Bed 2 (22 thin sections; Fig. 4), which together are 1 m thick. This small interval represents the only possibility to obtain determinable fossils for dating from the entire sandstone/limestone section (20 m). Nearly every preservational stage was observed. The calpionellid preservation was typically not excellent but still good enough for identification, allowing the vertical distribution to be established.

Bed-by-bed collecting and a systematic taxonomic study provided the basic data for the detailed investigation of the calpionellid fauna. Palaeontological, palaeoecological and sedimentological investigations, combined with studies of lithofacies in thin sections and geochemical investigations, yielded information about the environmental conditions in the area of deposition. Calcium carbonate contents (CaCO<sub>3</sub>) were determined using the carbonate bomb technique. Total carbon content was determined using a *LECO WR-12* analyser. Total organic carbon (TOC) contents were calculated as the difference between total carbon and carbonate carbon, assuming that all carbonate is pure calcite. All the chemical analyses were carried out in the laboratories of the Department of Geological Sciences and the Department of Forest Ecology at the University of Vienna.

The material examined is deposited in the palaeontological collection of the Natural History Museum, Vienna, Austria (NHMW).

### MICROFAUNA OF THE HOCHKOGEL SECTION: EVALUATION OF THIN SECTIONS (FIGS. 4–7)

#### BED 1

The stratigraphical succession of the set of 10 thin sections was investigated within Bed number 1.

**Layer 1** (2 thin sections): marly limestone (mudstone) containing a graded clastic admixture in which quartz grains domi-

nate over muscovite, rutile, glauconite, serpentinite and fragments of micrite limestone.

**Layer 2** (3 thin sections): bioturbated marly limestone (mudstone) with a clastic admixture locally concentrated in lenses or burrows and irregular layers. The fauna includes *Calpionella alpina* Lorenz, *Intinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella subacuta* (Colom), *Tintinnopsella longa* (Colom), *Calpionella elliptica* Cadisch, *Calpionellopsis oblonga* (Cadisch), ?*Calpionellites caravacaensis* Allemann, *Praecalpionellites siriniaensis* Pop, *Lorenziella hungarica* (Knauer), *Cadosina semiradiata fusca* Wanner, *Colomisphaera lucida* Borza, *Cadosina semiradiata cieszynica* (Nowak), *Cadosina minuta* Borza, *Patelina* sp., and crinoids. Calpionellid loricas are thinner in layer 2, and many of these are rimmed by dark layers (possible concentrations of organic matter). The clastic admixture contains fragments of volcanic rocks (basalt) and minerals: chromium spinels, albite, quartz, muscovite, biotite, glauconite.

**Layer 3**: marly limestone (mudstone). A graded layer of clastic material is situated in the lower part of the thin section. Quartz grains dominate over micrite limestone clasts and fragments of metamorphic rocks. Serpentinite and chloritized fragments (with fibrous structure), framboidal pyrite, and rare grains of rutile were also identified.

**Layer 4.1**: marly mudstone with *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella subacuta* (Colom), *Cadosina minuta* Borza, *Cadosina semiradiata fusca* Wanner. The silt-sized clastic admixture consists of quartz, muscovite, glauconite, serpentinite and micritic limestone fragments and is concentrated in nests or irregular fine laminae.

**Layer 4.2**: bioturbated marly limestone with *Tintinnopsella carpathica*, *Tintinnopsella subacuta* (Colom) *Tintinnopsella longa* (Colom), *Calpionellopsis oblonga* (Cadisch), *Lorenziella hungarica* (Knauer), *Lorenziella plicata* Remane, *Calpionellites darderi* (Colom), *Calpionellites uncinata* Cita and Pasquaré, *Cadosina minuta*, *Cadosina semiradiata fusca* Wanner, *Colomisphaera vogleri* (Borza).

**Layer 5.1**: bioturbated marly mudstone with abundant *Cadosina minuta* dominating over *Cadosina semiradiata fusca*, *Calpionellopsis oblonga* (Cadisch), *Remaniella borzai* Pop, *Tintinnopsella carpathica* (Murgeanu et Filipescu), *Tintinnopsella subacuta* (Colom) and bivalve fragments. The clastic admixture of silt size is concentrated in indistinct layers.

**Layer 5.2**: marly mudstone with rare calpionellids and other microfossils: *Calpionellopsis oblonga* (Cadisch), *Calpionella minuta* (Houša) *Tintinnopsella carpathica* (Murgeanu et Filipescu), *Lorenziella hungarica* (Knauer), *Lenticulina* sp. (chloritized test), *Colomisphaera vogleri* (Borza), bivalve, ostracod fragments, *Cadosina semiradiata semiradiata* Wanner, *Cadosina semiradiata fusca* Wanner, *Cadosina minuta* Borza. In this layer fine clastic (silt) quartz grains, serpentinite fragments, rare glauconite grains, muscovite and limestone clasts are present.

#### BED 3

Twenty two thin sections were examined in Bed no. 3, which is formed of three layers (A, B, C). Each of these is further subdivided (A1–A3, B1–B4, C1–C4).

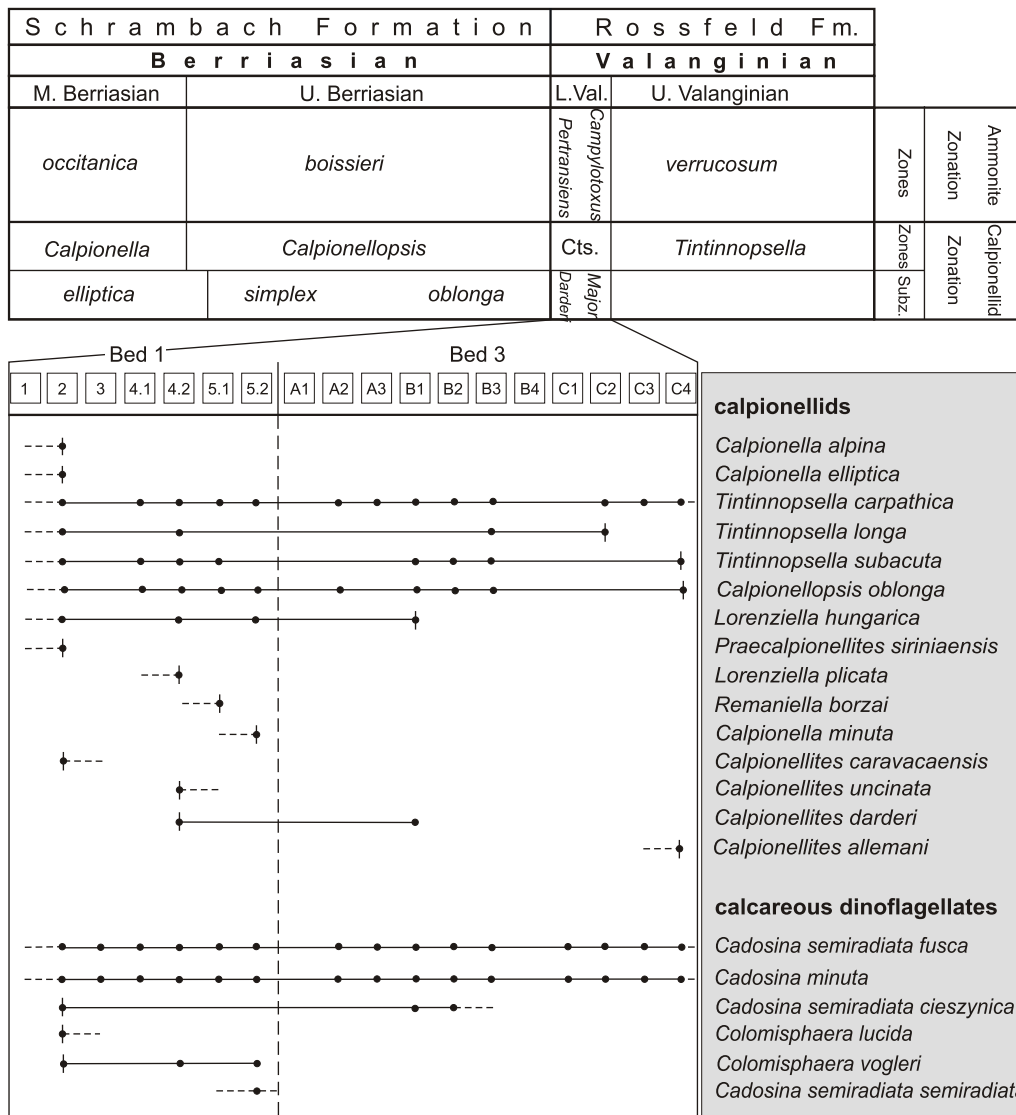


Fig. 4. Calpionellid and calcareous dinoflagellate assemblages from the Hochkogel locality

**Layer A1** (2 thin sections): bioturbated marly limestone with nests and irregular layers of clasts. No calpionellids were observed in the matrix. Clasts consist of quartz, muscovite, biotite, rutile, chromium spinel, pyroxene and micritic limestone fragments.

**Layer A2** (2 thin sections): bioturbated marly limestone (mudstone) with dispersed clastic admixture. *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and Filipescu) (many loricas are dark), frequent *Cadosina minuta* Borza, rare *Cadosina semiradiata fusca* Wanner, bivalve fragments, crinoids and ostracods.

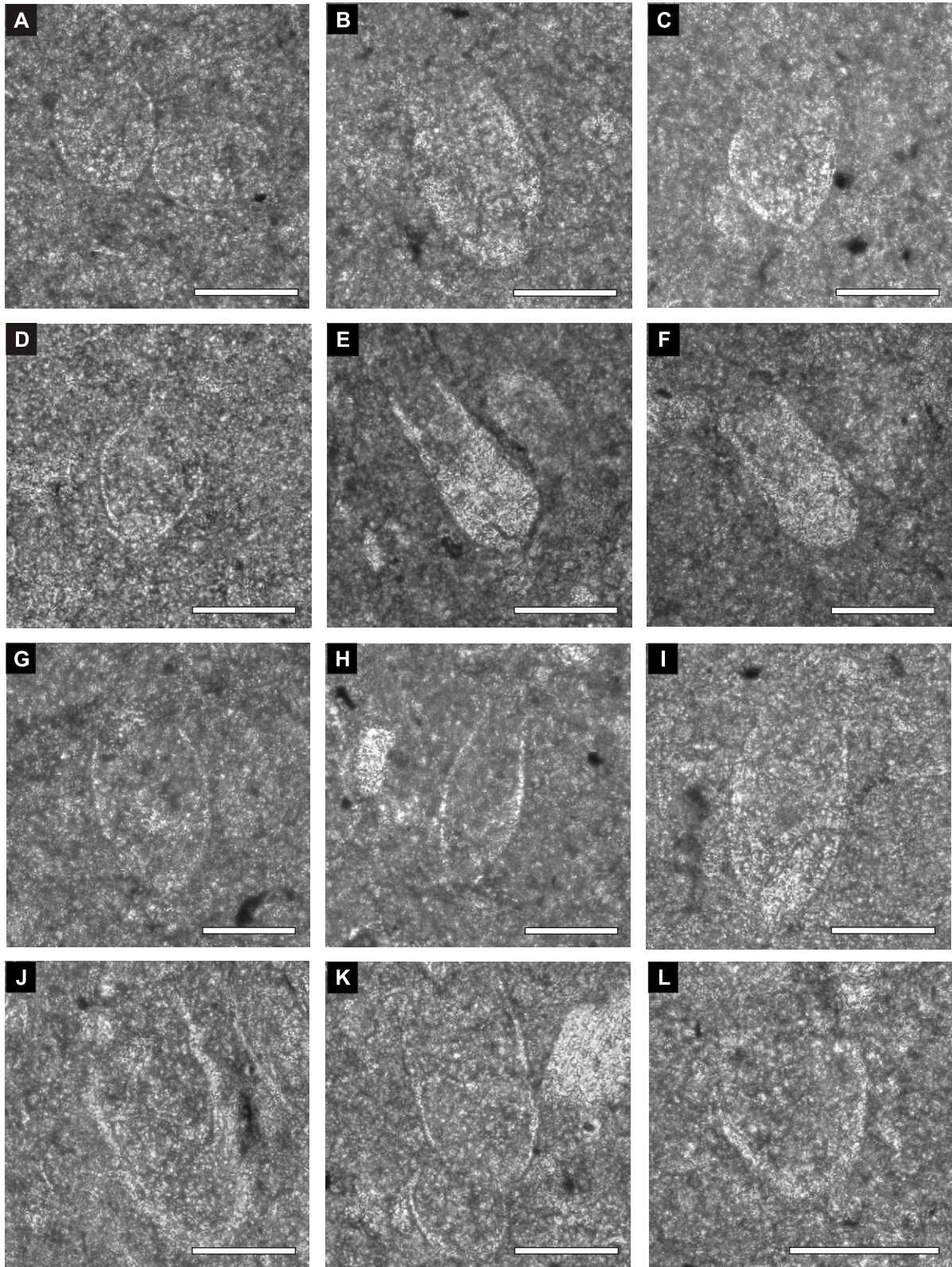
**Layer A3** (2 thin sections): bioturbated marly limestone (mudstone) with graded clasts. Rare *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Cadosina minuta* Borza, *Cadosina semiradiata fusca* Wanner, bivalve fragments, ostracods and crinoids.

**Layer B1** (2 thin sections): bioturbated marly limestone (mudstone) with sparse silt-sized clastic admixture. *Calpionellites darderi* (Colom), *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and

Filipescu), *Tintinnopsella subacuta* (Colom), *Lorenziella hungarica* (Knauer), ostracods, bivalve fragments, ostracods, crinoids, *Cadosina minuta* Borza, *Cadosina semiradiata fusca* Wanner and frequent *Cadosina semiradiata cieszynica* (Nowak). The base of a layer with a coarser-grained clastic admixture is visible in the lowermost part of the thin section.

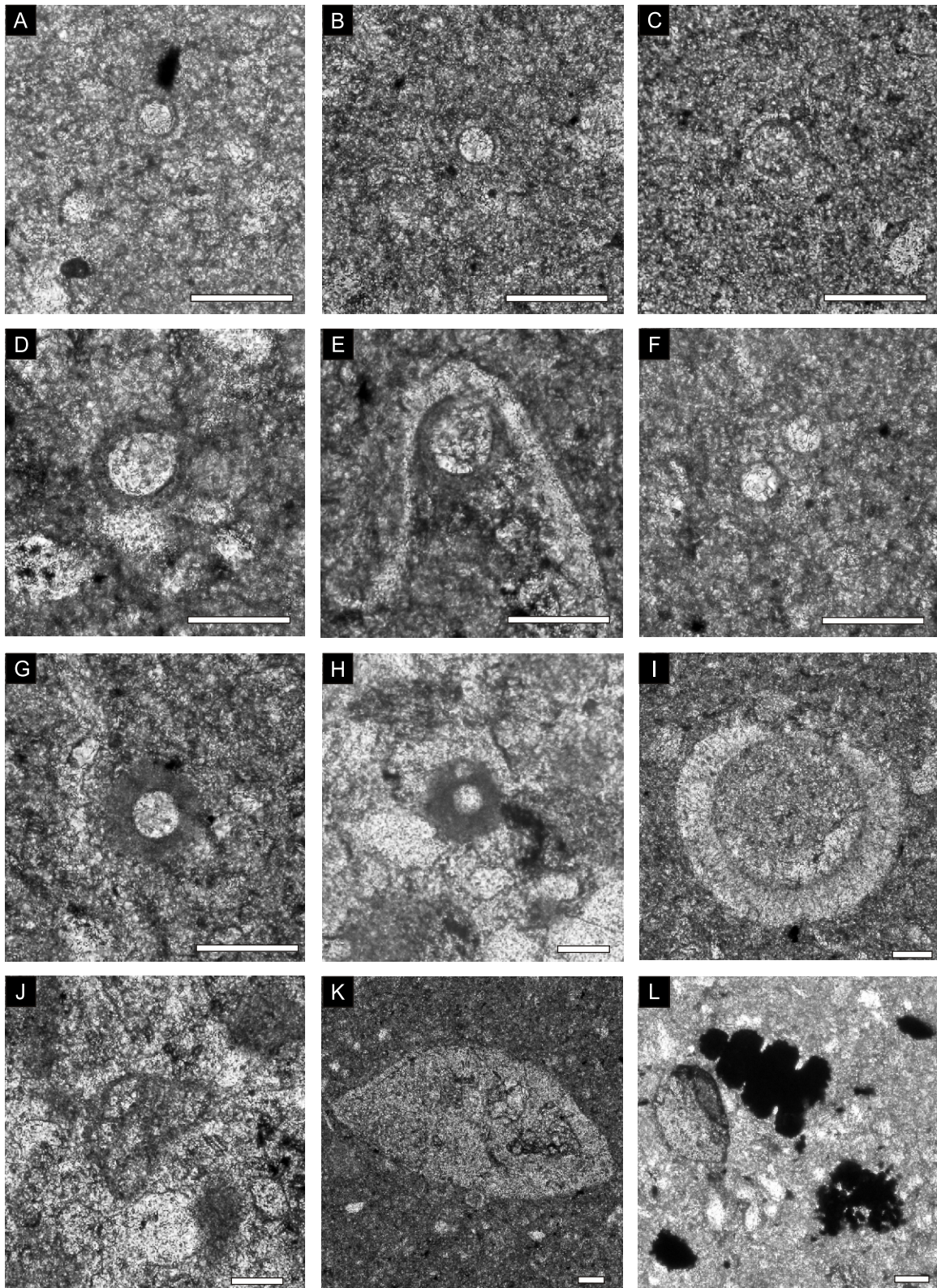
**Layer B2** (2 thin sections): bioturbated marly limestone (mudstone). A layer with clastic admixture is located in the uppermost part of the thin section. *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella subacuta* (Colom), *Cadosina minuta* Borza, *Cadosina semiradiata fusca* Wanner, *Cadosina semiradiata cieszynica* (Nowak), several calpionellid fragments, foraminifera and ostracod and crinoid fragments.

**Layer B3** (2 thin sections): marly limestone (mudstone) with infrequent clastic admixture of silt size. It is concentrated in lenses in the lower and upper part of the thin section. It contains: *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella longa* (Colom), *Tintinnopsella subacuta* (Colom), bivalve fragments,



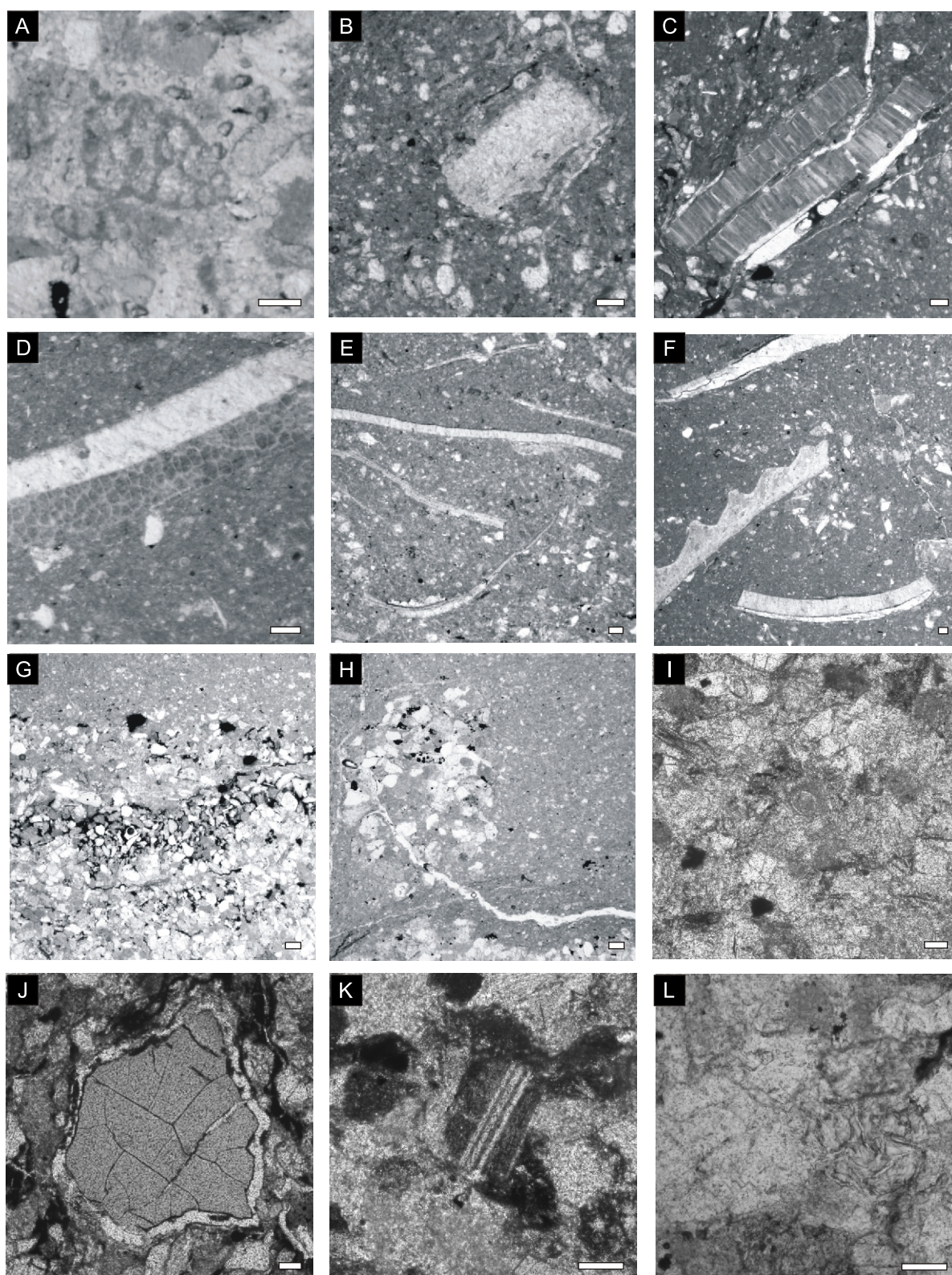
**Fig. 5. Calpionellids in thin sections**

**A** — *Calpionella alpina* Lorenz, thin section no. 2, 2006z0275/0001; **B** — *Remaniella borzai* Pop, thin section no 5.1, 2006z0275/0002; **C** — *Lorenziella plicata* Remane, thin section no. 4.2, 2006z0275/0003; **D, E** — *Calpionellopsis oblonga* (Cadisch), thin sections 5.1 (Fig. 4) and 5.2 (Fig. 5), 2006z0275/0004-0005; **F** — *Tintinnopsella carpathica* (Murgeanu and Filipescu), thin section no. 5.2, 2006z0275/0006; **G** — *Tintinnopsella subacuta* (Colom), thin section no. B2, 2006z0275/0007; **H** — *Tintinnopsella longa* (Colom), thin section C2, 2006z0275/0008; **I, J** — *Praecalpionellites siriniaensis* Pop, thin section no. 2, 2006z0275/0009-0010; **K** — *Calpionellites uncinata* Cita and Pasquaré, thin section no. 4.2, 2006z0275/0011; **L** — *Calpionellites darderi* (Colom), thin section no. 4.2, 2006z0275/0012; the magnification of all figures is indicated by the 100  $\mu$ m bars



**Fig. 6. Calcareous dinoflagellates and foraminifera in thin sections**

**A** — *Colomisphaera vogleri* (Borza), thin section no. 4.2, 2006z0275/0013; **B** — *Colomisphaera lucida* Borza, thin section no. 2, 2006z0275/0014; **C** — *Cadosina semiradiata semiradiata* Wanner, thin section no. 5.2, 2006z0275/0015; **D, E** — *Cadosina semiradiata fusca* Wanner, thin section no. 5.1, C1, 2006z0275/0016-0017; **F** — *Cadosina minuta* Borza, thin section no. 5.1, 2006z0275/0018; **G, H** — *Cadosina semiradiata cieszynica* (Nowak), thin sections no. 2 and 3, 2006z0275/0019-0020; **I** — algal fragment, thin section no. C3, 2006z0275/0021; **J** — *Patelina* sp., thin section no. 2, 2006z0275/0022; **K** — recrystallized test of *Lenticulina* sp., thin section no. 5.2, 2006z0275/0023; **L** — foraminifera test filled by pyrite, thin section no. B3, 2006z0275/0024; the magnification of all figures is indicated by the 100  $\mu$ m bars



**Fig. 7. Foraminifera and various fossil fragments in thin sections**

A — arenaceous foraminifer, thin section no. 1, 2006z0275/0025; B — Echinoderm part, thin section no. A1, 2006z0275/0031; C — shell of *Inoceramus* sp., thin section no. B3, 2006z0275/0033; D — shell of *Inoceramus* sp., thin section no. A2, 2006z0275/0034.b; E — mixture of broken ammonoid shells, thin section no. 4.2, 2006z0275/0035; F — ammonoid shells, aptychi (wavy structure) and shell of *Inoceramus* sp. (right), thin section no. B.3, 2006z0275/0036; G — top transitional section of clastic layer in marly limestone, note abundant plant debris (black) on the top of the turbiditic layer, thin section no. 5.2, 2006z0275/0037; H — nest of clastic admixture within limestone bed reflecting bioturbation, thin section no. C1, 2006z0275/0038; I — lithoclast of micrite limestone containing a calpionellid lorica (centre), thin section no. B2, 2006z0275/0043; J — chromium spinel in clastic admixture, thin section no. A1, 2006z0275/0044; K — albitic plagioclase in the clastic admixture, thin section no. B2, 2006z0275/0045; L — fragments of serpentinite, thin section no. A2, 2006z0275/0047-0048; the magnification of all figures is indicated by the 100 µm bars



ostracods, crinoids, frequent *Cadosina minuta* Borza and rare *Cadosina semiradiata fusca* Wanner.

**Layer B4** (2 thin sections): the clastic layer passes into a marly limestone (mudstone). A wavy calcite vein is located between the clastic layer and micrite limestone matrix. The clasts consist of quartz, fragments of micrite limestone, muscovite, glauconite, albite, serpentinite, rutile, calcite, rare fragments of crinoids, bivalves (separated prisms) and aggregates of Fe oxides or hydroxides.

**Layer C1** (2 thin sections): marly limestone (mudstone) with two layers of clastic admixture in the lowermost part and at the top of the oriented thin section. Here, fragmented calcite veins traverse the clastic admixture and the micrite matrix. Limestone fragments of the mudstone type are very frequent among the clasts. Some of them contain calpionellid fragments. This is accompanied by quartz grains, less frequent spinels, glauconite, biotite, and muscovite. Aggregates of pyrite and pyrite of framboidal type was also observed. Bivalve fragments, ostracods, benthic foraminifers (locally chloritized), sponge spicules, *Cadosina semiradiata fusca* Wanner and *Cadosina minuta* Borza were recognized. The mudstone contains very rare bivalve fragments and ostracods. The clastic layers contain abundant quartz grains and fragments of micrite limestone.

**Layer C2** (2 thin sections): marly limestone (mudstone) with rare bioclasts and silt admixture. It contains: *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella longa* (Colom), *Calpionella minuta* Borza, *Cadosina semiradiata fusca* Wanner, *Lenticulina* sp., bivalve and ostracod fragments (also fragments of ornamented shells), aggregates of framboidal pyrite.

**Layer C3** (2 thin sections): bioturbated marly limestone with rare bioclasts and common silt-sized clastic admixture (serpentinite, quartz, muscovite, glauconite, rutile). One section of *Tintinnopsella carpathica* (Murgeanu and Filipescu) is dark the loricas are only slightly agglutinated, formed by organic matter. *Cadosina semiradiata fusca* Wanner, *Cadosina minuta* Borza are present along with very rare, not identified calpionellid loricas and individual algal and aptychi fragments.

**Layer C4** (2 thin sections): marly limestone (mudstone) with common silt-sized clastic admixture. Microfossils: *Calpionellites allemani* Řehánek, *Calpionellopsis oblonga* (Cadisch), *Tintinnopsella carpathica* (Murgeanu and Filipescu), *Tintinnopsella subacuta* (Colom), *Cadosina minuta* Borza and *Cadosina semiradiata fusca* Wanner. Fragments of benthic foraminifera and ostracods are also present.

## BIOSTRATIGRAPHY

In the section investigated, forms of *Praecalpionellites* belonging to the standard *Calpionellopsis* Zone (*murgeanui* Subzone) are followed by forms belonging to the standard *Calpionellites* Zone (*darderi* Subzone) and later by forms typical of the *major* Subzone (Reháková and Michalík, 1997). Due to the poor preservation of the fossils, we are unable to place a boundary between these two subzones. The microfossil associations observed in Bed 1 are typical of the standard *Calpionellites*

Zone (*darderi* Subzone) and also for the *minuta* Acme Zone (Reháková, 1995, 1997, 2000a). The microfossil associations in Bed 3 are typical of the standard *Calpionellites* Zone (*darderi* and *major* Subzones) (Reháková, 1995). The age of the section studied is early Valanginian. The interval studied coincides with those known as the Oravice Event defined by Reháková (2000b) from the Western Carpathians in Slovakia.

The macrofossil association indicates that the cephalopod-bearing beds in the Rossfeld Formation belong to the *B. campylotoxus* and/or the *T. pertransiens* Zone of the early Valanginian (zonation according to the results of the Lyon meeting of the Lower Cretaceous Ammonite Working Group of the IUGS; “Kilian Group”; Hoedemaeker *et al.*, 2003).

## DISCUSSION

The tectonically strongly deformed Lower Cretaceous deposits of the Ebenforst Syncline provide suboptimal conditions for excellent preservation of calpionellids. Fortunately, limestone beds are intercalated in this massive sandstone section of the Rossfeld Formation. These include calpionellid-bearing deposits. Sandstones of the Rossfeld Formation are normally barren of calpionellids because of their origin from a somewhat shallower region of the source area to the south (Lukeneder, 2005a, b, c). Within the latter sandstones, calpionellids can therefore only be detected in lithoclasts.

The deposits correspond to the period of the “Oravice Event”, which is widespread throughout the Carpathians. Collected microfossil faunas and resultant data from the West Carpathians sections assessed the Oravice Event as being the record of marked siliciclastic input coinciding with a third-order sea-level fall (Reháková, 2000b). As Lukeneder and Reháková (2004) noted, traces marking the latter event can also be detected in the Northern Calcareous Alps. Connected with this tectonically induced event, which is reflected in the lithology change and the accompanying change in micro- and macrofauna, we can correlate the depositional histories, facies and ages of the Northern Calcareous Alps and the Western Carpathians. Siliciclastic deposits of the late early Valanginian Oravice Event changed after an hiatus at the end of the early Valanginian into the mudstone sedimentation of the Schrambach Formation in the late Valanginian. This change in the lithology in the Northern Calcareous Alps and the Carpathians was accompanied by the nearly total calpionellid decimation in almost the entire Thetyan region (Reháková, 2000b). This also reveals that the thicknesses of the deposits of the same age interval are very different (see also Decker *et al.*, 1987). The closer the source area to the south, the thicker the succession. Accordingly, in the case presented, the deposits are about 30 m thick in the early Valanginian. About 10 km to the north in the Ternberg Nappe, however, the deposits are different and condensed into only 0.5 m within the same age interval (Lukeneder and Reháková, 2004). We detected the Oravice Event in both synclines — the Losenstein Syncline (Ternberg Nappe) to the north and the Ebenforst Syncline (Reichraming Nappe) to the south.

## RESULTS AND CONCLUSIONS

The stratigraphic investigation of the microfauna revealed that the Hochkogel section comprises lower Valanginian deposits of the *Calpionellites* Zone (*darderi* and *major* Subzones), which corresponds to the *B. campylotoxus* and/or *T. pertransiens* ammonoid zones. The importance of this small microfossil fauna is that it enables dating of the sandstones of the Rossfeld Formation which are normally barren of macro- and microfossils. Only thin limestone layers, intercalated in a sandstone interval of the Rossfeld Formation, yielded microfossil faunas. Based on the microfossil investigation, a better defined age could be detected, leading to a change from early late Valanginian to late early Valanginian.

Thirty two thin sections were examined from beds no. 1 and no. 3, which are formed of several different layers (1–5; A, B, C). Each of these could be further subdivided (1–5.2; A1–A3; B1–*Praecalpionellites*, *Calpionellites*, *Calpionella*, *Calpionellopsis*, *Tintinnopsella*, *Lorenziella*, *Remaniella*, The calpionellid fauna is accompanied by the following calcareous dinoflagellate genera: *Cadosina* and *Colomispæra*.

The macrofauna is represented especially by ammonoids. The entire section yielded about 800 ammonoids (including

fragments). The ammonoid moulds are restricted to the limestone beds. No ammonoids were found within the enclosing sandstone layers. The latter were deposited by turbidity currents, show gradation and, on their top, plant debris. Sorting or packing of fossil components due to sedimentological or biological effects, and alignments or concentration due to transport or bottom currents were observed. The macrofauna and the sedimentological data support the interpretation of a highly dynamic palaeoenvironment on the slope. The suggested palaeogeographic position of the section studied indicates an influence of turbiditic redeposition (“debris flow”) and an allochthonous origin of the fragmented ammonoids collected.

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