AN OCCURRENCE OF PALEOCENE REEFAL LIMESTONE IN THE ZWIESELALM FORMATION OF GOSAU (UPPER AUSTRIA)

EIN VORKOMMEN PALEOZÄNER RIFF-KALKE IN DER ZWIESELALM-FORMATION VON GOSAU (OBERÖSTERREICH)

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ZUSAMMENFASSUNG

Von der klassischen Lokalität der Zwieselalm-Formation, Teil der oberen Gosau-Gruppe, wird ein schon seit den Arbeiten von Felix (1908), Spengler (1914) und Kühn (1930) bekanntes Vorkommen von wohl allodapisch verfrachteten Flachwasserkalken vom Typus Kambühelkalk hinsichtlich Mikrofazies, Mikropaläontologie und Stratigraphie beschrieben. Die auftretenden Mikrofaziestypen mit Korallen, Rotalgen, Bryozoen, Dasycladales und benthonischen sowie planktonischen Foraminiferen legen einen ursprünglichen rezifalen Bildungsraum auf einem externen Plattformbereich nahe. Das Vorkommen der Dasycladale *Sarosiella feremollis* Segonzac und anderer Mikrofossilien erlaubt eine Einstufung in das höhere Paleozän (Thanet). Bei dem Neufund handelt es sich um das bisher westlichste Vorkommen von umgelagertem Kambühelkalk in der höheren Gosau. Unterlagert wird die Thanet-Kalkstein-Scholle, konkordant von spröden mittelgrauen Mergeln der Nierental-Formation, welche eine artendiverse Nannoflora zeigen, die eine Einstufung in die Nannozone NP5, d.h. in das Selandium erlaubt.

ABSTRACT

From the classical locality of the Zwieselalm Formation, which is part of the Upper Gosau Group, an occurrence known since the works of Felix (1908), Spengler (1914) and Kühn (1930) of allodapic Thanetian (Upper Paleocene) shallow-water limestones (typus Kambühel Limestone) is described with reference to microfacies, micropalaeontology and stratigraphy. The microfacies types are dominated by corals, red algae, bryozoa, dasycladales and both, benthonic and planktonic foraminifera, assuming an originally outer platform reefal setting. The occurrence of the dasycladale *Sarosiella feremollis* Segonzac and other microfossils give a Upper Paleocene (Thanetian) age. This new finding is the most western occurrence of resedimented Kambühel Limestone in the Upper Gosau Group. The Thanetian limestone is concordantly underlain by brittle medium-grey marls of the Nierental Formation, which display a diverse calcareous nannoflora of Selandian age (Nannozone NP5).

I. INTRODUCTION

The occurrence of „*Lithothamnium*“ - bearing limestone boulders in the area of Liesenhütte is already known since the papers by (of ?) Felix (1908), Spengler (1914), Kühn (1930) and Kollmann, Summesberger (1982: Stop 14). The stratigraphic dating of these „exotic blocks“, however, was not sufficient so far. In addition to the transported limestone boulders with a well-preserved and rich macrofauna and -flora of Paleocene (Thanetian) age, also a slice of calcarenitic limestones is exposed, which shows dimensions of about 8 m length and 1,5 m thickness. This limestone slice (text-fig. 2) is concordantly underlain by brittle marls of Selandian age belonging to the Nierental Formation. On top of the pronounced limestone slice a sequence of alternating marls and limestones is poorly exposed. Towards the north it seems that the limestones interfinger with coarse arenitic sandstones and fine-grained breccias, consisting of quartz, phyllites and other „exotic“ fragments, but also of coralline-algae-encrusted components. According to our present opinion, the limestone boulders, but also the slice of calcarenites is allochthonous in origin, however, further detailed studies are still necessary. The microfacies, the occuring faunal and floral elements and the stratigraphy can directly be compared with the „Kambühelkalk“ (sensu Tollmann 1976), which is well exposed in the easternmost part of the Northern Calcareous Alps and in the Mürzalpen (Plöchinger 1967, Lein 1982, Tragelehn 1996). The latter author conducted a detailed microfacies and stratigraphic analysis of the eastern Kambühel Limestone occurrences in

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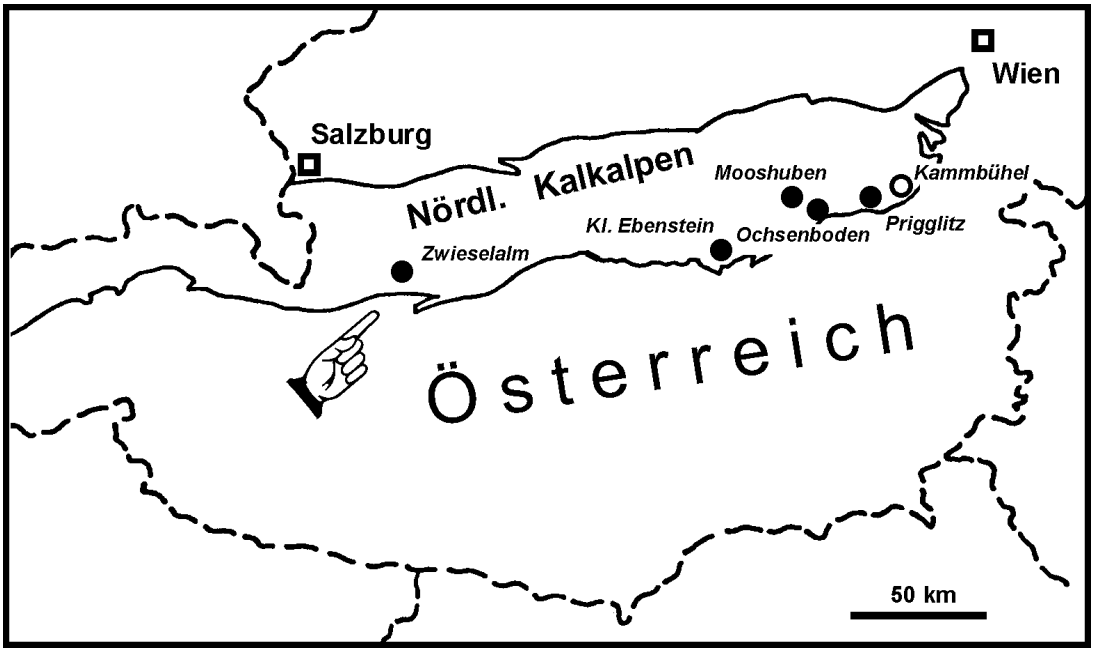
his doctoral thesis. The new finding in the Zwieselalm Formation is the most western occurrence from the Gosau Group known so far (see text-fig. 1). Further to the west, in the Inntal valley area pebbles of equivalent Paleocene limestones are reported from Oligocene and Eocene conglomerates (Hagn 1976, Moussavian 1984). The most western occurrences of allochthonous Paleocene shallow water limestones are from Molasse conglomerates of the Allgäu area (Hagn 1989). An eastern continuation of these Alpine Paleocene shallow water limestones is well-known from the Western Carpathians (Samuel et al. 1972; Bucev, Köhler 1987).



Text-fig. 1: Paleocene shallow water limestones ("Kambühel Limestone") in the Northern Calcareous Alps. All other occurrences besides the Kambühel type-locality are from olistostromes within the Upper Gosau Subgroup (modified after Tragelehn 1996).

Text-fig. 2: The slice of calcarenitic limestone of paleocene age

II. MICROFACIES, MICROPALAEONTOLOGY AND STRATIGRAPHY OF THE ALLODAPIC KAMBÜHEL LIMESTONE

Thin-sections have been prepared from different boulder samples (K&S 14-1 to 14-7). Micritic coral-rich microfacies-types (e.g. K&S 14-1, K&S 14-5, see Pl. 1, figs. 1, 5) with encrusting corallinacean algae and often the soleporacean alga *Parachaetetes asvapatii* Pia are dominating. Other microfacies types (packstones, rud-

Sample **Biogens**	**K&S 14-1**	**K&S 14-2**	**K&S 14-3**	**K&S 14-4**	**K&S 14-5**	**K&S 14-6**	**K&S 14-7**
Dasycladales							
Acicularia-Terquemella typus	**X**	**XX**	**X**		**XX**	**X**	**X**
Frederica arbutiformis Dieni Massari					**X**		**X**
& Radoic.		**XX**			**X**	**X**	**?**
Clypeina sp. aff. *bucuri* Barattolo		**X**			**X**		
Neomeris sp.		**XXX**	**X**			**XX**	
Russoella sp.		**X**			**XX**	**XX**	**XX**
Sandalia multipora Dieni, Massari &		**?**			**XX**	**X**	**XXX**
Radoicic						**X**	**XX**
Sarosiella feremolis Segonzac							
Trinocladus-Sarosiella Group							
Rhodophyceae							
Lithothamnium div. sp.		**X**	**XXX**	**XXX**		**XX**	
Parachaetetes asvapatii Pia		**XXX**	**XX**	**X**	**X**	**XX**	**XX**
Peysonellia antiqua Johnson					**X**	**X**	**X**
Polystrata alba (Pfender)		**XX**	**X**	**X**			**X**
Pseudoamphiroapropria (Lemoine)			**XX**	**XX**			
Moussavian			**X**	**X**	**X**	**X**	**X**
Sporolithon sp.	**X**	**X**		**XX**		**X**	**X**
Jania sp.	**X**	**X**	**X**				**X**
Encrusting corallinaceae indet.							
Foraminifera							
Miniacina multiformis Scheibner				**?**	**X**	**X**	**X**
Miniacina multicamerata (Scheibner)	**X**	**?**				**X**	
Miscellanea gr. *primitiva-minuta*		**X**		**X**	**X**	**XX**	**XX**
Rahagi	**X**	**X**		**XX**	**X**	**X**	
Planktonic foraminifera		**X**			**X**	**X**	
Haddonia sp.				**XX**	**X**	**X**	
Planorbulina ? *cretae* (Marsson)			**X**				
Sigmoilina sp.		**XX**			**X**	**X**	**X**
Quinqueloculina sp.		**X**	**X**	**X**		**X**	
Gavelinellidae		**X**	**X**	**X**			
Anomalinoides sp.				**X**		**X**	
Smoutina? sp.						**X**	
"Cavity dwelling foraminifera" sensu							
Tragelehn							
Incertae sedis							
Carpathiella triangulata Misik et al.	**X**	**XX**	**XXX**	**X**		**X**	**X**
(serpulid)	**X**			**X**	**X**		**X**
Piennia oblonga Borza & Misik							
corals	**XXX**	**XX**			**XX**	**XX**	**X**
Bryozoa	**X**			**XX**	**X**	**XX**	**X**
Echinoid debris	**X**		**X**	**XX**		**X**	
Serpulids (besides *Carpathiella*)	**X**		**X**	**XX**	**XXX**	**XX**	
Brachiopods			**X**				

Tab. 1 Thin-sections studied, micropalaeontological inventory and distribution of major fossil groups. X = rare, XX = common, XXX = abundant.

stones) contain abundant red algae (corallinaceans) associated with bryozoa and benthic foraminifera (e.g. K&S 14-4). In this microfacies type dasycladalean green algae are absent (see tab. 1). Moussavian (1993) reported 25 different species of corallinacean/peysonelliacean algae and Tragelehn (1996) more than 65 taxa of dasycladalean green algae from the Kambühel Limestone evidencing a high degree of diversification of both algal groups within different microfacies types of the Kambühel Limestone. One characteristic and comparable abundant morpho-type of bryozoa shown in pl. 1, fig. 4 has also been figured by Traglehn (1997: Pl. 11, fig. 2) from the type-locality of the Kambühel Limestone and Misik et al. (1991) as "yellowish undetermined algae" from lower Paleocene biohermal limestones of the West Carpathians. Within coral-red algae facies, typical encrusting foraminifera include *Haddonia* sp., *Planorbulina*? *cretae* (Marsson) and representatives of *Miniacina* (e.g. Pl. 1, fig. 6, pl. 2, figs. 14). Except K&S 14-4, dasycladales are present in all samples with representatives mainly of the *Acicularia-Terquemella*-group, *Frederica, Sandalia, Neomeris* and *Sarosiella.* The latter taxon is also known from Paleocene limestones of the Western Carpathians and according to Bucek, Köhler (1987: p. 676) was limited to "shallow sea environment in reef-forming zones". For a general overview of the distribution of Paleocene dasycladales see the recent contributions provided by Barattolo (1998, 2002). Typical internal platform or back-reef facies, e.g. *Broeckella* or *Uteria* facies sensu Dieni et al. (1985) or the "*Cymopolia* assemblage" of Barattolo (1998), is not present in our material investigated. Benthic foraminifera occurring include miliolids, rotaliids, gavelinellids and as already mentioned various encrusting genera settling on corals and other hard substrates such as the thalli of red algae. Noteworthy is also the occurrence of globigerinid planktonic foraminifera in nearly all samples studied (see table 1). Finally the presence of varying amount of fine siliciclastics within the matrix of the studied thin-sections should be mentioned.
Summarizing, the samples investigated with their typical (micro)fossils and –assemblages can be referred to external platform, reefal and fore-reefal settings (see Fig. 3 in Moussavian 1984). If a redeposition of these limestones from the platform margin in adjacent basin areas is assumed, internal facies types such as dasycladale-wackestones cannot be expected. Typical lagoonal wackestones have so far only been reported from the locality Schafkogel, belonging to the Gosau Group of Mooshuben (Lein 1982, Tragelehn 1996). From the autochthonous occurrences of the Kambühel Limestone, however, this facies is well known (Tollmann 1976, Tragelehn 1996: e.g. Fig. 19).
From the stratigraphical point of view, the occurrence of the dasycladale *S. feremollis* Segonzac is worth mentioning. This species is restricted to the Thanetian-Ypresian interval (e.g. Barattolo 1998: SBZ3-SBZ4, 2002: Tab. 2). Benthic foraminifera of the genus *Miscellanea* are known from Middle to Upper Paleocene strata (Leppig 1988) and also the solenoporacean alga *Parachaetetes asvapatii* Pia does not surpass the Paleocene-Eocene boundary (Moussavian 1984, 1989). In conclusion, our limestone samples studied can be well referred to the Thanetian.

III. NIERENTAL FORMATION

The coarse arenitic „Kambühel Limestone" slice (text-fig. 2) is concordantly underlain by medium-grey marls of the Nierental Formation. The foraminifera and palynomorpha are under study and at present only the data on the calcareous nannofossils can be presented.

Calcareous nannofossils

Sediment provided higher number (10-20 specimens per 1 field of view of the microscope) of medium well preserved calcareous nannofossils; placoliths are apparently slightly etched. The relatively highly diversified assemblage is characterized by the presence of massive cylinders in form, by the genus *Fasciculithus* that is represented by the species *F. janii, F. pileatus, F. ullii*, *F. billii, F. tympaniformis* and *F* .cf. *involutus.* The association is complemented by other nannofossils, especially by placoliths, the first occurrence of which is known mostly during the Lower Paleocene, such as *Zeugrhabdotus sigmoides*, *Sullivania danica, Sphenolithus primus, Cruciplacolithus primus, C. tenuis, Thoracosphaera crassa, Toweius pertusus, T. eminens, Chiasmolithus bidens, C. consuetus, Prinsius martinii, Markalius apertus, Neochiastozygus modestus, N. perfectus, Ericsonia subpertusa*, *E.* cf. *robusta, Coccolithus pelagicus* (abundant), and others. On rare occassions, Cretaceous nannofossils reworked from the older strata were recorded.
Age: lower part of the Upper Paleocene, zone NP5 (Martini 1971); Selandian according to Varol (1998). For biostratigraphic conclusions, the presence of *Fasciculithus billi*, *F. janii* and *Chiasmolithus bidens*, and the absence of the genera *Discoaster* and *Heliolithus* are very important phenomena.
Moreover, *Fasciculithus pileatus* Bukry is mentioned by Aubry (1989) as a typical low-latitude guide species. Its presence evidences that the Gosau depositional area belongs to the Tethys and reflects warm-water depositional conditions.

Ad genus *Fasciculithus*: Because of the short stratigraphic range of this genus, species are excellent stratigraphic markers for the late Paleocene. They first occur in the upper part of zone NP4 and radiated twice during that time (Romein 1979). The first radiation was described in the NP4-NP5 zone interval that can be correlated with the studied sample.

IV. ACKNOWLEDGMENTS

The field work of Lilian Švábenická was financed by the Austrian/Czech cooperation programme KONTAKT, Project-No. 2002-5.

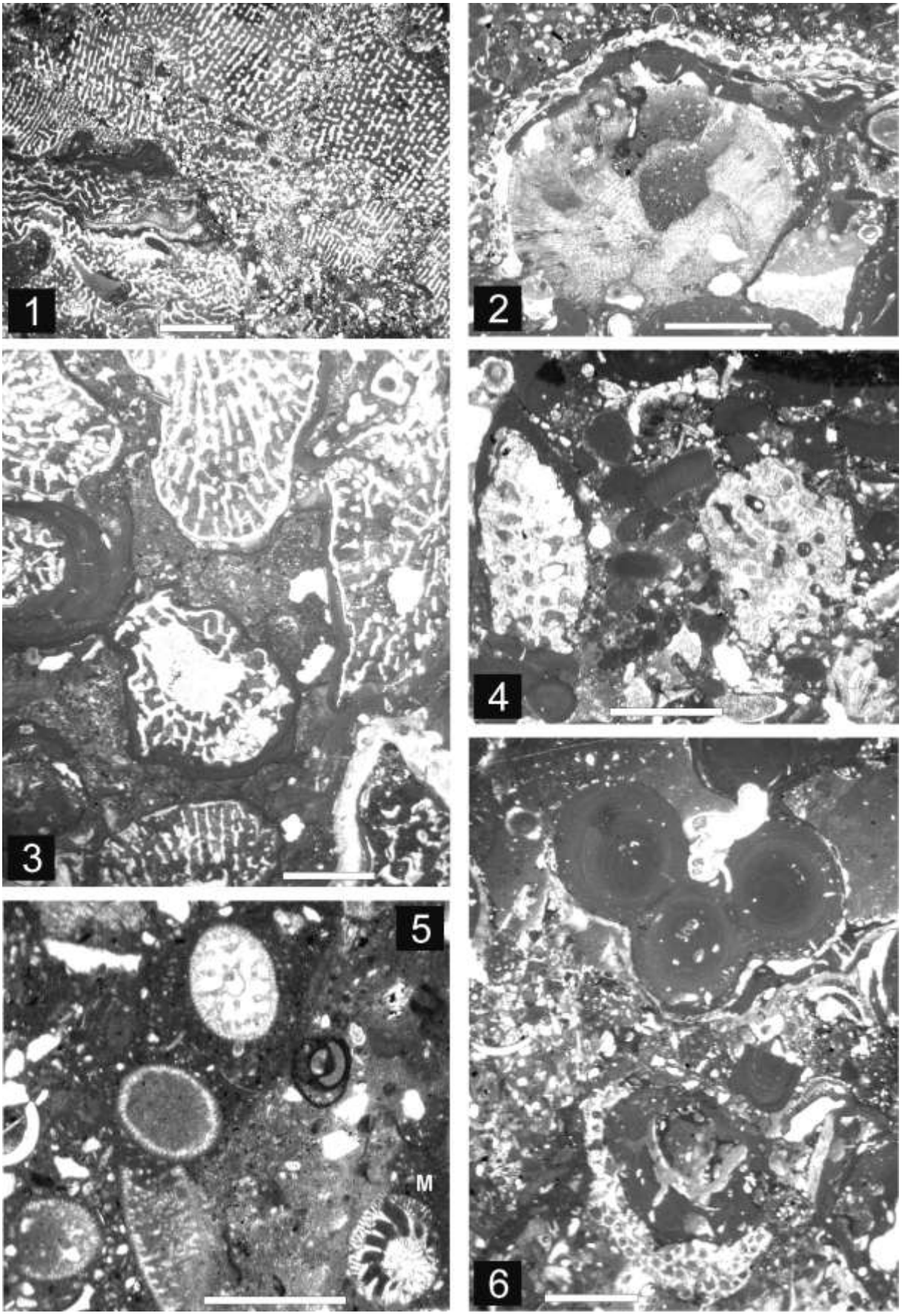
V. APPENDIX 1: TAFELN

PLATE 1: Microfacies of the Kambühel Limestone of Zwieselalm

Fig. 1 Coral-boundstone with encrustations of red algae and foraminifera. Thin-section K&S 14-1, scale bar = 2 mm.
Fig. 2 Soleporaceae *Parachaetetes asvapatii* Pia encrusted by corallinaceans followed by *Miniacina multiformis* Scheibner; note geopetal infilling right below. Sample K&S 14-6, scale bar = 2 mm.
Fig. 3 Coral-bafflestone showing partly encrustations by rhodophyceans; matrix micritic nearly unfossiliferous. Sample K&S 14-5, scale bar = 2 mm.
Fig. 4 Bryozoa-red algae-packstone to -rudstone. Sample K&S 14-4, Scale bar = 1 mm.
Abb. 5 Debris facies with different sections of the dasycladale *Sarosiella feremollis* Segonzac, miliolids and slightly oblique equatorial section of *Miscellanea* gr. primitiva – minuta Rahagi. Sample K&S 14-7, scale bar = 1 mm.
Fig. 6 Corallinaceans with encrustations of foraminifera such as *Miniacina multiformis* Scheibner and serpulids. Sample K&S 14-6, scale bar = 2 mm.

PLATE 2: Micropalaeontology of the Kambühel Limestone of Zwieselalm

Fig. 1 Serpulid tube of *Carpathiella perforata* Misik, Sotak & Ziegler. Sample K&S 11-2, scale bar = 0,5 mm. Sample derives from stop 11 of Kollmann & Summesberger (1982: Stop 11, Upper Santonian Hochmoos Formation) shown for comparison purposes.
Fig. 2 Serpulid tube of *Carpathiella triangulata* Misik, Sotak & Ziegler. Sample K&S 14-7, scale bar = 0,5 mm.
Fig. 3 Rotaliid foraminifera *Smoutina*? sp., axial section. Sample K&S 14-6, scale bar = 0,5 mm.
Figs. 4, 6, 11 Dasycladale *Clypeina* sp. aff. *bucuri* Barattolo, 4: Oblique section. Sample K&S 14-7, scale bar = 0,5 mm; 6: Transverse section. Sample K&S 14-2, scale bar = 0,2 mm. 11: Transverse section. Sample K&S 14-2, scale bar = 0,2 mm.
Fig. 5 *Trinocladus-Sarosiella*-group with internal decalzification, longitudinal section. Sample K&S 14-7, scale bar = 0,5 mm.
Fig. 7 Transverse sections of the mikroproblematicum *Pienina oblonga* Borza & Misik. Sample K&S 14-4, scale bar = 0,5 mm.
Fig. 8 Rotaliid foraminifera, oblique section. Sample K&S 14-4, scale bar = 0,5 mm.
Fig. 9 Dasycladale *Sandalia* sp. Sample K&S 14-2, scale bar = 0,5 mm.
Fig. 10 *Frederica arbutiformis* Dieni, Massari & Radoicic. Sample K&S 14-2, scale bar = 0,5 mm.
Fig. 12 Red alga *Jania* sp. Sample K&S 14-3, scale bar = 0,2 mm.
Fig. 13 Benthic foraminifera, Gavelinellidae gen. et sp. indet. Sample K&S 14-4, scale bar = 0,5 mm.
Fig. 14 Sessil foraminifera *Planorbulina* ? *cretae* (Marsson). Sample K&S 14-4, scale bar = 0,5 mm.
Fig. 15 Parataxon *Russoella* sp. (reproductory organs of Dasycladales). Sample K&S 14-2, scale bar = 0,5 mm.
Fig. 16 Peyssonneliaceae *Polystrata alba* (Pfender) Denizot growing upon sessil arenaceous foraminifera. Sample K&S 14-1, scale bar = 1 mm.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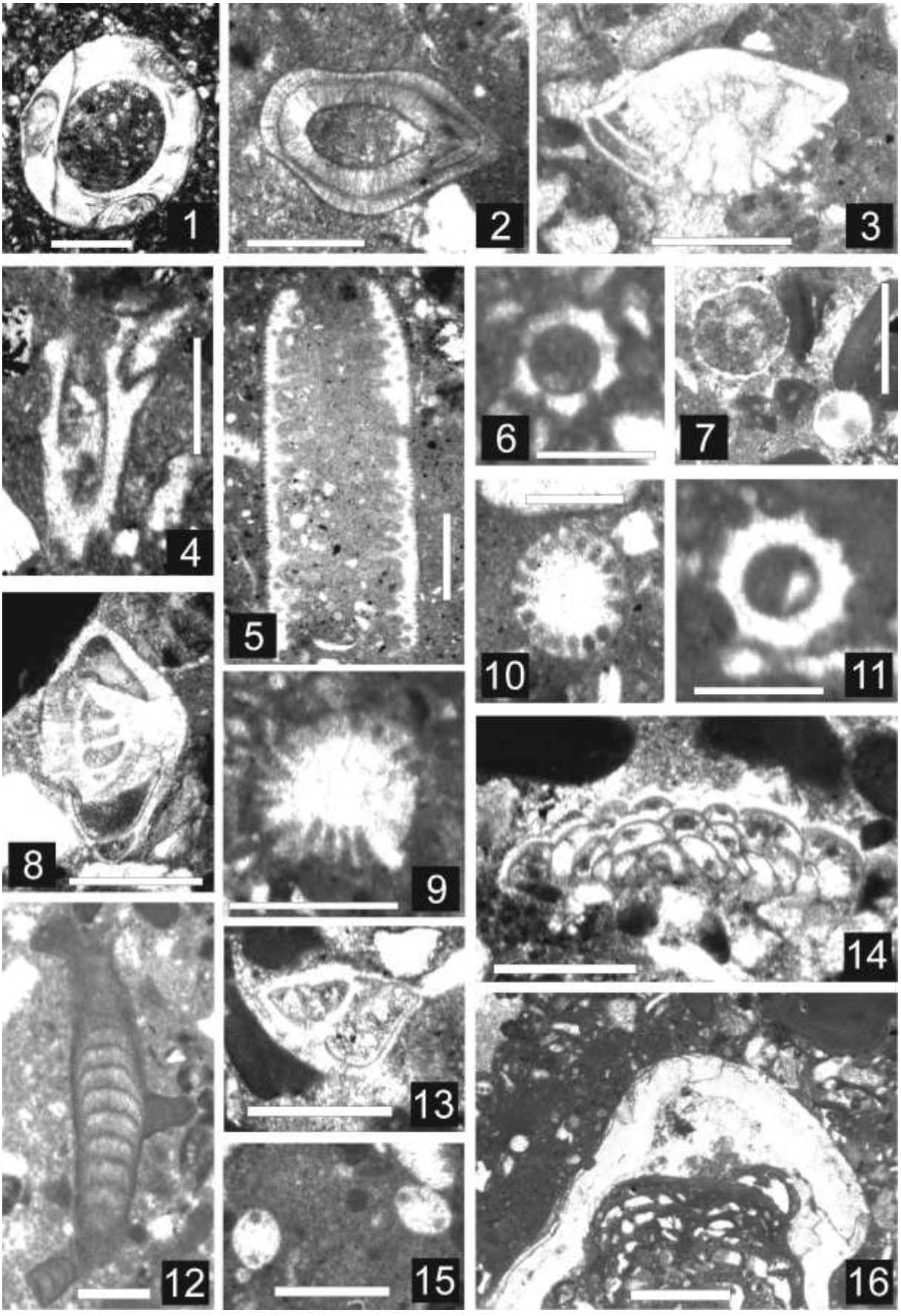
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VI. APPENDIX 1: REFERENCES

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