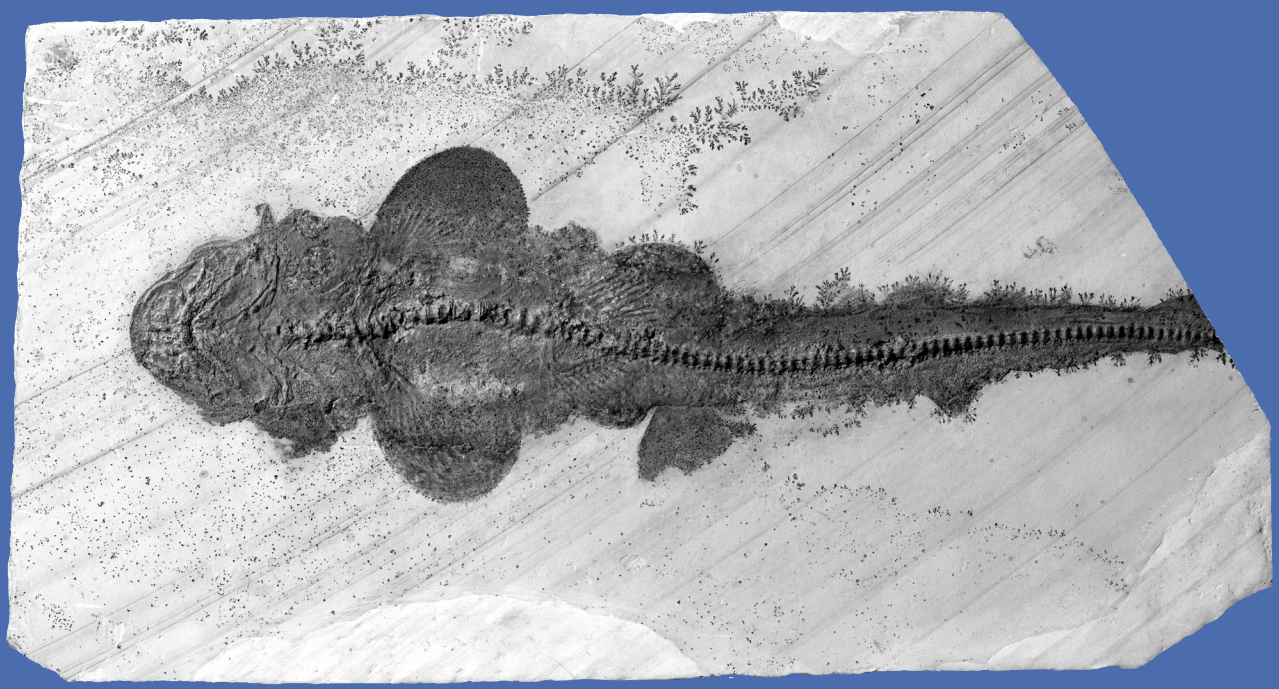
Zitteliana

An International Journal
of Palaeontology and Geobiology

Series A /Reihe A
Mitteilungen der Bayerischen Staatssammlung
für Paläontologie und Geologie

44



München 2004

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44

CONTENTS/INHALT

Zitteliana	A 44	136 Seiten	München, 30.12.2004	ISSN 1612-412X

EDITORIAL NOTE

As of in 2003, the journal *Zitteliana* is published in two series.

Series A: *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) replaces the former „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). The numbering of issues is continued (last published: Heft 43, 2003).

Series B: *Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-4138) continues the previous „Zitteliana – Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627).

Instructions for authors are included at the end of this volume.

HINWEIS DES HERAUSGEBERS

Vom Jahr 2003 an erscheint die Zeitschrift *Zitteliana* in zwei Reihen.

Die *Reihe A*: *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) ersetzt die bisherigen „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). Die Bandzählung (zuletzt erschienen: Heft 43, 2003) wird fortgesetzt.

Die Reihe B: *Abhandlungen der Bayerischen Staatssammlung für aPaläontologie und Geologie* (ISSN 1612-4138) führt die bisherige „Zitteliana – Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627) fort.

Hinweise für Autoren beider Reihen sind am Ende dieses Bandes enthalten.

Editors-in-Chief/Herausgeber: Reinhold Leinfelder, Michael Krings
Production and Layout/Bildbearbeitung und Layout: Lydia Geißler, Manuela Schellenberger

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ISSN 1612-412X

Cover illustration: *Phorcynis catulina* Thiollière, 1854 (BSP 1990 XVIII 51) from the lower Tithonian of Zandt / Denkendorf (Bavaria), ventral view, 25 cm. Photograph: G. Janßen (LMU München, Department für Geo- und Umweltwissenschaften, Sektion Paläontologie)

Umschlagbild: *Phorcynis catulina* Thiollière, 1854 (BSP 1990 XVIII 51) aus dem unteren Tithon von Zandt / Denkendorf (Bayern), Ventralansicht, 25 cm. Foto: G. Janßen (LMU München, Department für Geo- und Umweltwissenschaften, Sektion Paläontologie)

Zitteliana	A44	97-103	2 Textfigs, 1 Pl.	München, 30.12.2004	ISSN 1612-412X

Calcareous green algae from the Santonian Hochmoos Formation of Gosau (Northern Calcareous Alps, Austria, Lower Gosau Subgroup)

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Manuscript received 10.06.2004, revision accepted 07.10.2004

Abstract

The microflora of the mixed siliciclastic-carbonate Hofergraben marls (Hochmoos Formation, Santonian) near Gosau, Upper Austria is presented. Apart from several taxa that are already well known from localities elsewhere, *Jodotella koradae* (Dieni et al.) Parente is described for the first time from the Northern Calcareous Alps. This discovery expands the stratigraphic range of the genus *Jodotella* Morellet & Morellet, which was to date only known from the Upper Maastrichtian to Paleocene. In contrast to the diversified microflora that occurs in the Paleocene Kambühel Formation (Tragelehn 1996), the microflora found in the alpine Late Cretaceous is comparatively poor in taxa. This is due in part to the general decline of dasycladalean algae during the Late Cretaceous, but also caused by stratigraphical and geographical restrictions of suitable lithologies and a still incomplete data base for the Northern Calcareous Alps.

Key words: Calcareous algae, Gosau Group, Upper Cretaceous, Northern Calcareous Alps, Austria.

Zusammenfassung

Die Mikroflora der gemischt siliziklastisch-karbonatischen Hofergraben-Mergel (Hochmoos-Formation, Santonium) in der Nähe von Gosau in Oberösterreich wird vorgestellt. Neben Taxa, die bereits von anderen Lokalitäten bekannt gemacht worden sind, wird die Art *Jodotella koradae* (Dieni et al.) Parente erstmalig aus den Nördlichen Kalkalpen beschrieben. Dieser Fund erweitert die bekannte stratigraphische Reichweite der Gattung *Jodotella* Morellet & Morellet, welche bislang nur aus dem Bereich Ober-Maastrichtium-Paleozän bekannt war. Im Gegensatz zu der hochdiversen Mikroflora der Kambühel-Formation (Tragelehn 1996), ist die Mikroflora, die man in der alpinen Oberkreide antrifft, vergleichsweise arm an Taxa. Das liegt zum einen an dem generellen Rückgang der Dasycladales während der Oberkreide, aber auch an der geographisch-stratigraphischen Beschränkung geeigneter Lithologien und einer immer noch unvollständigen Datengrundlage für die Nördlichen Kalkalpen.

Schlüsselwörter: Kalkalgen, Gosau-Gruppe, Oberkreide, Nördliche Kalkalpen, Österreich.

1. Introduction

The depositional cycle of the Late Cretaceous Gosau Group in the Northern Calcareous Alps comprises transgressive series with terrestrial, shallow-water, and deeper water facies of various palaeoenvironments (e.g., Sanders 1998, Wagreich & Faupl 1994, Sanders et al. 1997). The type-locality is situated in the area of Gosau, Upper Austria. Within the shallow-water carbonate dominated successions, calcareous algae occur in different palaeohabitats (e.g., lagoonal and reefal facies). An inventory of calcareous green algae from the Upper Turonian – Santonian interval has recently been presented by Schlagintweit & Sanders (2003). These authors report more than 10 different dasycladales, most of which are significant proxy indicators for palaeoenvironmental conditions; some can also be used for biostratigraphy (Tab. 1).

2. Geographical and Geological Setting

The Hofergraben is situated approximately 1 km southeast of Gosau, Upper Austria. In the most recent issue of the topographic map of Austria (ÖK 1:50.000, no. 95 St. Wolfgang), the name Sattelgraben is used instead of Hofergraben. The material described comes from two small southern tributaries at an altitude of 900 m above sea-level (see Textfig. 1). The coordinates of the outcrop are 47° 34´ geographic width and 13° 32´ geographic length.

The so-called Hofergraben marls belong to the (Upper) Santonian Hochmoos Formation, and represent a shallow neritic mixed siliciclastic-carbonate environment (Wagreich 1988). The lithostratigraphic definition of the Hochmoos Formation and other units were established by Weigel (1937). The Ho-

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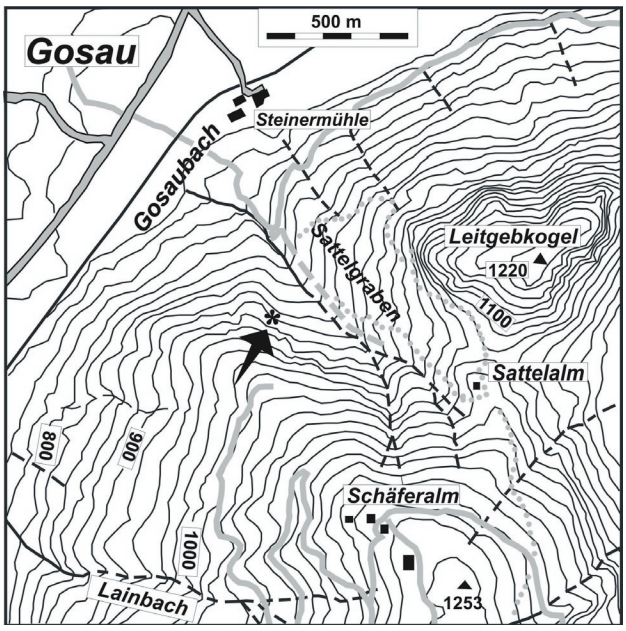
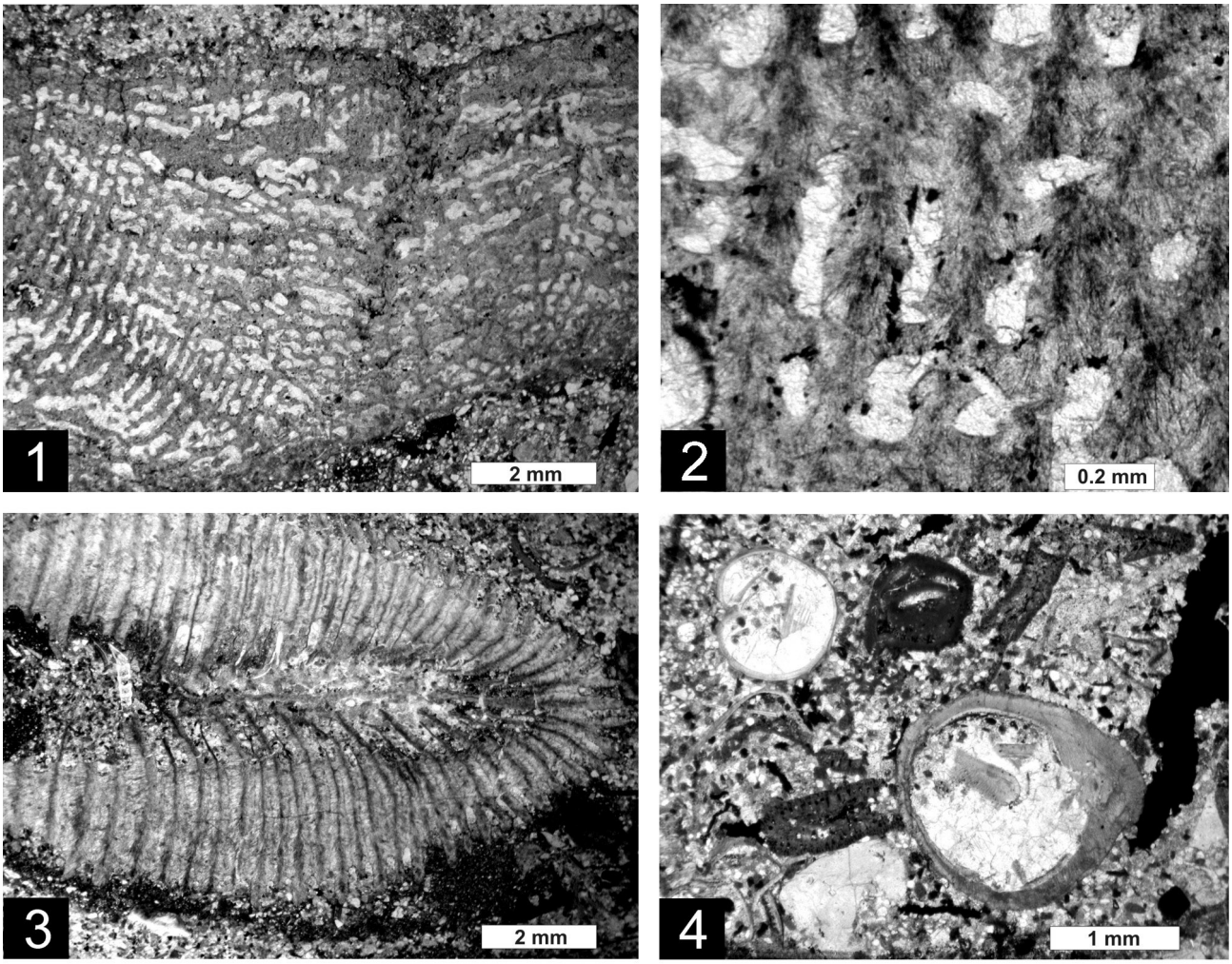
Taxa without biostratigraphic significance	**Benthonic foraminifera** *Cuneolina* gr. *pavonia* d´ORBIGNY *Dictyopsella kiliani* SCHLUMBERGER *Dictyopselloides cuvillieri* (GENDROT) *Lenticulina* sp. *Reophax* sp. *Vidalina hispanica* SCHLUMBERGER	**Dasycladales** *Acicularia-Terquemella* *Dissocladella*? *pyriformis* SCHLAGINTWEIT *Neomeris circularis* BADVE & NAYAK *Trinocladus tripolitanus* RAINERI **Others** *Lithocodium aggregatum* ELLIOTT *Girvanella* sp. *Halimeda paucimedullaris* SCHLAGINTWEIT & EBLI *Marinella lugeoni* PFENDER *Parachaetetes hadramautensis* ELLIOTT *Oroseina pletzachensis* SCHLAGINTWEIT & EBLI *Pycnoporidium* cf. *sinuosum* JOHNSON & KASKA
Taxa, with assumed biostratigraphic significance	**Benthonic foraminifera** *Hemicyclammina chalmasi* (SCHLUMBERGER) *Idalina antiqua* MUNIER-CHALMAS & SCHLUMB. *Nummofallotia cretacea* SCHLUMBERGER *Pseudocyclammina sphaeroidea* GENDROT *Reticulinella cuvillieri* CVETKO et al.	**Dasycladales** *Heteroporella lepina* PRATURLON *Milanovicella hammudai* (RADOIČIĆ *Neomeris* (*Drimella*) cf. *jerinae* RADOIČIĆ **Others** *Permocalculus* (*Pyrulites*) n. sp. *Permocalculus nicolapantici* RADOIČIĆ
Biostratigraphic significance unknown	**Benthonic foraminifera** *Conorboides*? sp. *Goupillaudina*? sp. *Gendrotella* aff. *rugoretis* (GENDROT) *Lituola* aff. *nautiloidea* LAMARCK *Lituola*? sp. *Minouxia* cf. *lobata* GENDROT *Montcharmontia appeninica* DE CASTRO *Nezzazatinella piccardi* DARMOIAN *Nummofallotia apula* LUPERTO SINNI *Pararotalia* cf. *minimalis* HOFKER *Vidalina discoidea* SCHLAGINTWEIT	**Dasycladales** *Acicularia*? *antiqua* PIA *Acicularia magnapora* KUSS *Clypeina* cf. *pastriki* RADOIČIĆ *Clypeina* sp. *Dissocladella*? n. sp. *Hungariporella baconica* CONRAD et al. *Jodotella koradae* (DIENI et al.) PARENTE *Neomeris* sp. *Thrysoporella eisenbachensis* SCHLAGINTWEIT & LOBITZER **Others** *Halimeda* sp. *Permocalculus gosaviense* SCHLAGINTWEIT *Vermiporella tenuipora* CONRAD

Table 1: Compilation of benthonic foraminifera and calcareous algae (coralline algae excluded) from the Turonian-Santonian of the Gosau Group in the Northern Calcareous Alps, with a preliminary subdivision according to their biostratigraphic significance (modified after SCHLAGINTWEIT & SANDERS 2003).



Textfigure 1: Topographic map of the Gosau; asterisk and arrow indicate the sample locality.

fergraben is a classic locality for macrofossils, especially corals (e.g., BARON-SZABO 2003a, b [contains a short research history]; SZENTE 2003). Based on the richness in corals, this lithology has also been named "coral marls". These "coral marls" yielded several classic faunas, which have been detailed in a number of extensive studies during the 19th and early 20th century (see summary in RASSER & SANDERS 2003). The succession is predominantly composed of grey fossiliferous marls with intercalated mixed siliciclastic-carbonate layers. Based on the high content of the heavy mineral chrome spinel in the lower part, which is missing in the upper part, WAGREICH (1988: p. 672) proposes a subdivision of the Lower and Upper Hochmoos Formation. The mixed silicilastic-carbonate beds contain fairly abundant remains of solitary coral of the genus *Cunnolites*, which forms the largest bioclasts together with rare Axinellid demosponge with stromatoporoid skeletons, small gastropods, serpulids, bryozoans, and debris of oyster shells (Textfig. 2). Benthic foraminifera include nodosariids, small rotaliids, comparatively large miliolids (sometimes with agglutinated material in the test walls), and, more occasionally, *Vidalina hispanica* SCHLUMBERGER. These banks have been interpreted by WAGREICH (1988) as storm - induced layers showing gradation and different types of laminations. The biogenic content was



Textfigure 2: Microfacies and selected macrofossils from the tempestite layers of the Santonian Hofergraben marls. 1: Axinellid demosponge with stromatoporoid skeleton. 2: Detail from 1, showing the fascicular fibrous microstructure. 3: Solitary coral, cf. *Cunnolites* sp. 4: mixed carbonate-siliciclastic facies with gastropods and remains of Dasycladales.

interpreted either as parautochthonous or laterally transported from a near-by depositional setting; however, also a mixture of both is possible. On the basis of an analysis of the macro- and microfauna/-flora, a shallow-marine near-coast fine-clastic environment, which is rich in corals, gastropods, and bivalves, has been suggested by Hradecká et al. (2003).

In addition to the bioclasts mentioned above, fragments of the following calcareous green algae (Dasycladales, Halimedaceae) have been detected (in alphabetical order): *Halimeda paucimedullaris* Schlagintweit & Ebli, *Jodotella koradae* (Dieni et al.) Parente, *Neomeris circularis* Badve & Nayak, *Oroseina pletzachensis* Schlagintweit & Ebli, and *Trinocladus tripolitanus* Raineri. *Trinocladus tripolitanus* Raineri is the most abundant taxon in the investigated samples. It must be mentioned that all the algae listed above occur with typical "brown calcification", representing either primary calcite or aragonitic relics (for discussion, see Masse & Bucur 2002: p. 160).

The sample HG-5, which contains the calcareous algae described in this paper, belongs to the Lower Hochmoos Formation. The marls of the Hofergraben are situated below the horizon of the so-called "Sandkalkbank", which has been dated as late Santonian (e.g., Kollmann 1980). This assignment seems to be in accordance with the benthic and planktonic foraminifera probably indicating a Lower Santonian age (Hradecká et al. 2003). However, an Upper Santonian age could also be suggested based on the fact that we often observe reworking of both calcareous nannofossils and foraminifera within the Gosau deposits.

3. Systematic Palaeontology

Order Dasycladales Pascher

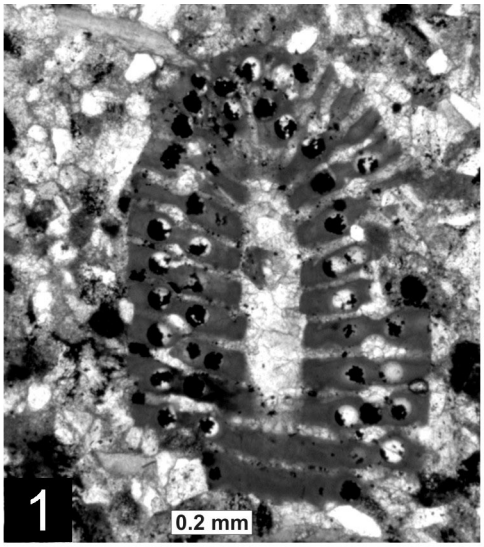
Genus *Jodotella* Morellet & Morellet, 1913

Jodotella koradae (Dieni, Massari & Radoičić , 1983) Parente, 1997

(Pl. 1, Figs 1, 4, 7, 10-11)

* 1983 *Neomeris* (*Larvaria*) *koradae* n. sp. – Dieni, Massari & Radoičić: 42, pl. 1, figs 1-3, Dano-Montian of Sardinia.

1985 *Neomeris* (*Larvaria*) *koradae* Dieni, Massari & Radoičić – Dieni, Massari & Radoičić : 19, pl. 12, figs 1-14, pl. 13, figs 1-4, Dano-Montian of Sardinia.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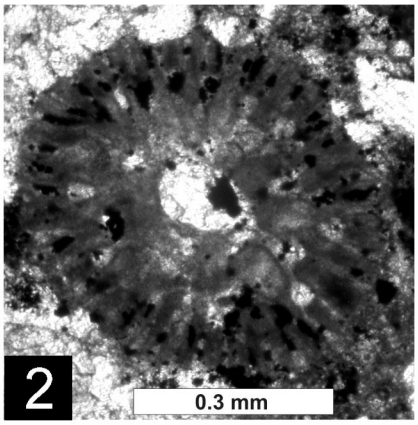
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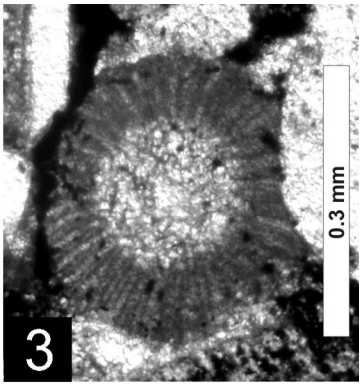
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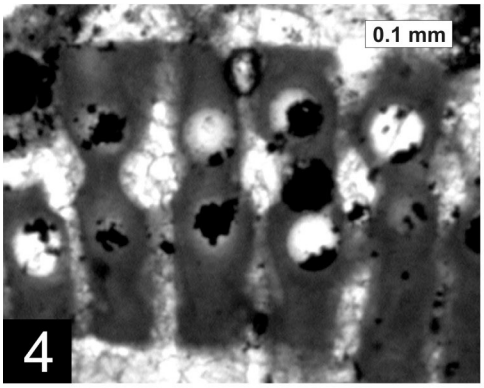
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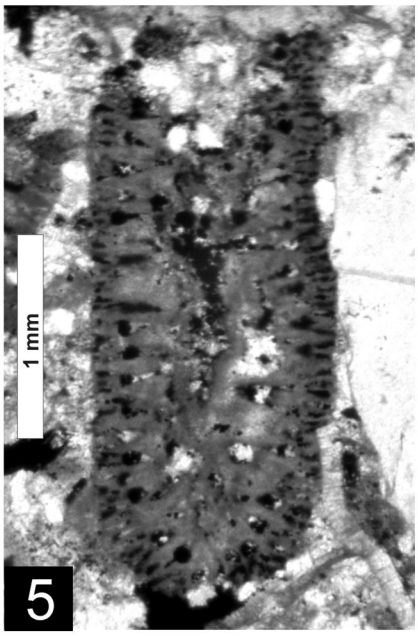
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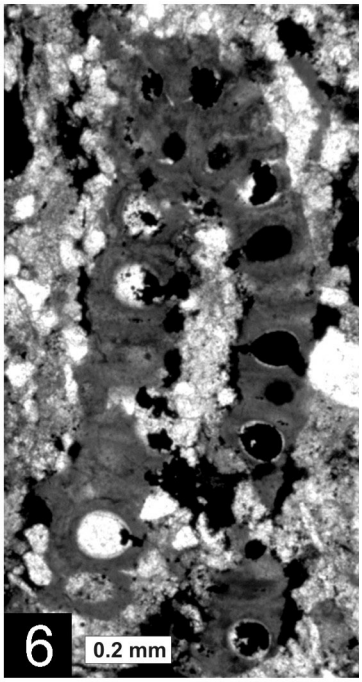
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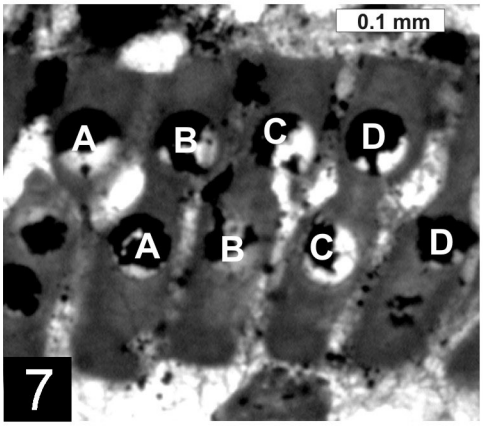
7
0.1 mm
A
B
C
D
A
B
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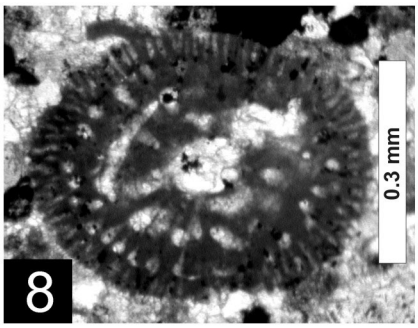
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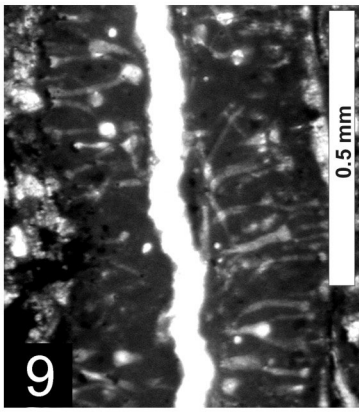
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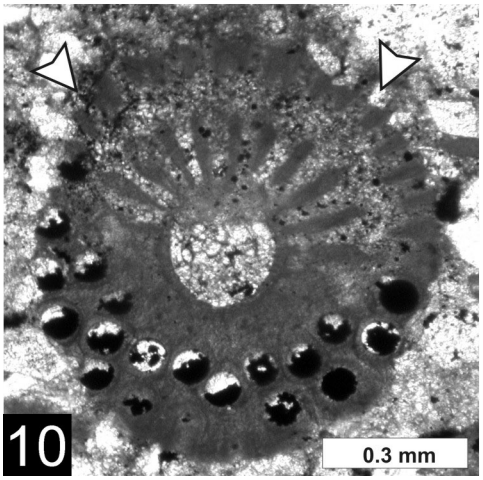
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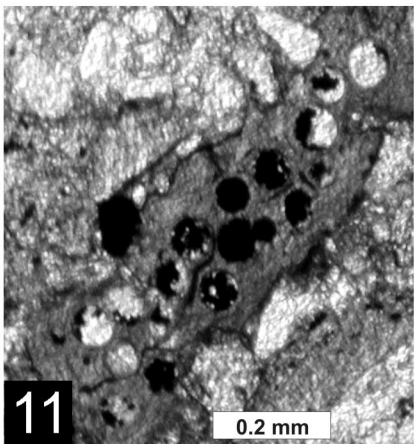
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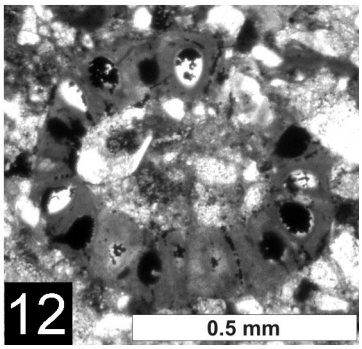
12
0.5 mm

1996 *Neomeris* (*Larvaria*) cf. *koradae* Dieni, Massari & Radoičić – Tragelehn: 175, figs 6-7, Montium of the Kambühel Formation of the Northern Calcareous Alps, Austria.

1997 *Jodotella koradae* (Dieni, Massari & Radoičić) nov. comb. – Parente: 100, pl. 29, figs 1-6, pl. 30, figs 1-8, Upper Maastrichtian of S-Italy.

Description: The comparatively thick calcification comprises the primaries, secondaries, and fertile ampullae; the central cavity is small. The laterals are densely spaced and slightly inclined towards the thallus axis. At the transition to the main axis, the laterals show a short and moderate proximal widening; distally, the laterals are tubular in shape or increase only slightly in diameter . In the middle part, they are slightly bent and sometimes swollen. Two small sphaerical fertile ampullae (gametophores) split off laterally, being diagonally arranged on both sides (Pl. 1, Figs 4, 7). The gametophores are attached to the sterile laterals by short narrow stalks. Due to this bending, the individual verticils are closely positioned (h about 0.1 mm). The interior of the ampullae is filled with calcite and partly with pyrite; gametangia are not visible/preserved. Longitudinal sections display the arrangement of the gametophores between the vertical planes (Pl. 1, Fig. 1). Thus, oblique transverse sections show parts only with sterile laterals without gametophores (Pl. 1, Fig. 10). In their distal portion, the laterals widen relatively abruptely with two secondaries supposedly forming a cortex; since the latter are arranged in a plane oblique to the axis of the thallus (Parente 1997: p. 102), they can best be observed in oblique transverse sections (Pl. 1, Fig. 10), but are hardly detectable in longitudinal sections (Pl. 1, Fig. 1).

Remarks: The species has originally been described as *Neomeris* (*Lavaria*) *koradae* n. sp. by Dieni et al. (1985) from the Paleocene of Sardinia. Based on the presence of two fertile ampullae that are located laterally along the primaries and terminal secondaries, the taxon has been assigned to the genus *Jodotella* by Parente (1997). In Puglia, Southern Italy, *Jodotella koradae* (Dieni et al. 1985) Parente, 1997 has been recorded from a shelf margin facies. The alpine specimens are resedimented. In the tempestite layers, they co-occur with typical lagoonal elements, including *Halimeda paucimedullaris*, *Oroseina pletzachensis*, and *Neomeris circularis*.

Dimensions: Detailed data on the biometric ranges of parameters cannot be given due to the low number of specimens in our material. All data obtained lay within the ranges stated by Parente (1997). With respect to these ranges, the specimens of the Northern Calcareous Alps can be regarded as relatively small.

Outer diameter of thallus (D):	0.8 – 0.9 mm	(0.75 – 1.45 mm)
Inner diameter of thallus (d):	0.16 – 0.24 mm	(0.2 – 0.425 mm)
d/D	0.2 – 0.265	(0.2 – 0.367)
Width of primary branches:	0.024 – 0.09 mm	(0.03 – 0.11 mm)
Number of primary branches per whorl (w):	about 20 – 22	(21 – 28)
Distance between two subsequent whorls (h):	about 0.1 mm	(0.095 – 0.16 mm)
Diameter of ampullae (da):	56 – 72 μm	(50 – 90 μm)
Length of ampullae (with peduncule)	0.065 – 0.1 mm	(0.06 – 0.1 mm)
Number of ampullae per branch:	2	(2)

Table 2: Biometric data of *Jodotella koradae* (Dieni et al.) Parente from the Santonian Hochmoos Formation of Gosau. The data from Parente (1997: Upper Maastrichtian of Italy) are given in brackets for comparison.

Genus *Neomeris* Lamouroux, 1816

Neomeris circularis Badve & Nayak, 1983

(Pl. 1, Figs 6, 12)

* 1983 *Neomeris circularis* n. sp. – Badve & Nayak: 189, pl. 1, fig. 5, Cenomanian? of India.

1995 *Neomeris circularis* Badve & Nayak – Schlagintweit & Ebli: 718, textfig. 3, pl. 1, figs 1-10 Upper Turonian Gosau Group of Pletzachalm, Sonnwend Mountains, Northern Calcareous Alps (with synonymy).

Remarks: A detailed description of *Neomeris circularis* can be found in Schlagintweit & Ebli (1995). Nonetheless, the species is still poorly understood with regard to occurrence and biostratigraphy. It is particularly noteworthy that the species has often been confused with the type-species *Neomeris cretacea* Steinmann. In the tempestite layers of the Hofergraben marls, it is a fairly common constituent. In the alpine Lower Gosau subgroup it is widely distributed and known from different localities (unpubl. data).

Genus *Trinocladus* Raineri, 1922

Trinocladus tripolitanus Raineri, 1922

(Pl. 1, Figs 2, 5, 8)

* 1922 *Trinocladus tripolitanus* n. gen., n. sp. – Raineri: 79, pl. 3, figs 15-16, Upper Cretaceous of Lybia.

1992 *Trinocladus tripolitanus* Raineri – Schlagintweit: 6, pl. 2, figs 6-9, 11, Turonian/Coniacian of the Branderfleck Formation, Northern Calcareous Alps (with synonymy).

Plate 1: Calcareous algae from the Lower Santonian Gosau Subgroup of Gosau.
Figs 1, 4, 7, 10-11: *Jodotella koradae* (Dieni et al.) Parente. Fig. 1: Oblique-longitudinal section cutting the main axis and about 11 verticils; sample HG-5B. Figs 4, 7: Details from Fig. 1, showing the diagonal arrangement of pairs of two fertile ampullae (A-A to D-D; the central cavity is at the lower part of the figures) aside of the laterals. Fig. 10: Oblique section with close-set sterile branches (above) and fertile ampullae (below), note the secondary branches (arrows); sample HG-5B. Fig. 11: Fragment with fertile ampullae; sample HG-5B.
Figs 2, 5, 8: *Trinocladus tripolitanus* Raineri. Figs 2, 8: Transverse sections, slightly oblique; sample HG-5B. Fig. 10: Longitudinal-tangential section; sample HG-5B.
Figs 6, 12: *Neomeris circularis* Badve & Nayak. Fig. 6: Longitudinal section; sample HG-5B. Fig.12: Transverse section; sample HG-5B.
Fig. 3: *Oroseina pletzachensis* Schlagintweit & Ebli; sample HG-5B.
Fig. 9: *Halimeda paucimedullaris* Schlagintweit & Ebli, longitudinal-tangential section; sample HG-3B.

Remarks: *Trinocladus tripolitanus* is a common constituent of the Late Cretaceous Branderfleck Formation where it occurs either in *Orbitolina* sandstones or carbonaceous olistoliths of different microfacies (wackestones, bioclastic packstones to grainstones). The species is one of the most abundant elements in the mixed siliciclastic-carbonate storm layers of the Hofergraben marls. The stratigraphic distribution in the Northern Calcareous Alps ranges from the Lower Cenomanian to Santonian.

Genus *Halimeda* Lamouroux, 1812

Halimeda paucimedullaris Schlagintweit & Ebli, 1998

(Pl. 1, Fig. 9)

* 1998 *Halimeda paucimedullaris* n. sp. – Schlagintweit & Ebli: 362, pl. 1, figs 1-6, pl. 2, figs 1-2, Upper Turonian – Santonian Gosau Group of Northern Calcareous Alps (with synonymy).

2003b *Halimeda paucimedullaris* Schlagintweit & Ebli – Schlagintweit & Lobitzer: 161, pl. 1, figs 1-3, Santonian Hofergraben marls.

Remarks: *Halimeda paucimedullaris* has been recorded from the Lower Gosau Subgroup at several localities. From the Hofergraben marls, it has recently been described by Schlagintweit & Lobitzer (2003b), but from a different bed that is characterised by *Halimeda* fragments in great abundances; other calcareous algae are missing.

Parataxon *Oroseina* Dieni, Massari & Radoičić , 1985

Oroseina pletzachensis Schlagintweit & Ebli, 1998

(Pl. 1, Fig. 3)

* 1998 *Oroseina pletzachensis* n. sp. – Schlagintweit & Ebli: 365, pl. 2, figs 3-5, 7-13, Upper Turonian – Santonian Gosau Group, Northern Calcareous Alps.

Remarks: In the Hofergraben tempestites, *Oroseina pletzachensis* is very rare. In the Lower Gosau subgroup, *O. pletzachensis* has always been found together with *Halimeda paucimedullaris*. The former taxon has been interpreted by Schlagintweit & Ebli (1998) as calcified gametangia of the latter due to morphological comparisons with reproductive organs of extant *Halimeda* species. Barattolo (1998: p. 89, foot note), referring to the type-species *Oroseina solaris* Dieni et al. notes affinities to the isolated calcified ampullae of a dasycladalean algae such as *Neomeris*.

4. Conclusions

The microflora of the Santonian Hofergraben marls includes taxa already recorded previously from other localities of the Lower Gosau Subgroup. The discovery of *Jodotella koradae* (Dieni et al., 1985) Parente, 1997 represents the first record of this species from the Northern Calcareous Alps. The occurrence in the Santonian extends the total stratigraphic range not only of the taxon but also of the genus *Jodotella*, so far only known from the Upper Maastrichtian - Paleocene (Barattolo 2002; Bucur 1999; Deloffre & Granier 1992). This record represents yet another contribution to the knowledge of the still poorly documented phytoinventory of Upper Cretaceous dasycladales of the Lower Gosau Subgroup (Tab. 1), contrasting the extremely diversified assemblages of the Paleocene Kambühel Formation where *J. koradae* has also been recorded by Tragelehn (1996). Moreover, the successively increasing stratigraphic range of *J. koradae* demonstrates that the biostratigraphic value of dasycladales that are poorly recorded in the literature is doubtful and should therefore be substantiated by other groups such as larger benthic foraminifera.

The Late Cretaceous dasycladales display a general decline in taxa toward the C-T boundary event followed by a bloomin the Paleocene (Barattolo 1998, 2002; Bucur 1999). With respect to the Northern Calcareous Alps, I believe that the reduced number of dasycladalean taxa described to date may be related to the lack of suitable shallow-water, carbonate-dominated lithologies. On the other hand, the poor state of investigation of these organisms seems to pretend a reduced inventory of taxa. Thus, the discovery of further taxa (new forms or first records) in the alpine Upper Cretaceous in recent times (e.g., Schlagintweit & Lobitzer 2003a, this work) can be expected also in the course of further investigations. Preliminary approaches to a crude biostratigraphic zonation of the carbonaceous Lower Gosau Subgroup are already available (Tab. 1).

Acknowledgements

Helpful suggestions by B. Granier (Montainon) on a previous draft of the manuscript are kindly acknowledged. Thanks are due to D. Schmid (Munich) and M. Wagreich (Vienna) for carefully reading the manuscript. The samples from Hofergraben have kindly been provided by H. Lobitzer (Vienna).

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