

**HALIMEDA PAUCIMEDULLARIS SCHLAGINTWEIT & EBLI 1998 (CALCAREOUS GREEN ALGA)  
FROM THE LOWER SANTONIAN GOSAU GROUP OF HOFERGRABEN  
(SALZKAMMERGUT, UPPER AUSTRIA)**

**HALIMEDA PAUCIMEDULLARIS SCHLAGINTWEIT & EBLI 1998 (KALKIGE GRÜNALGE) AUS  
DEM UNTERSANTONIUM DER GOSAU-GRUPPE DES HOFERGRABENS  
(SALZKAMMERGUT, OBERÖSTERREICH)**

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**ABSTRACT**

In the Upper Turonian-Santonian Lower Gosau Subgroup of the Northern Calcareous Alps, representatives of the green alga *Halimeda* Lamouroux are a typical constituent of lagoonal marly limestones that usually occur associated with marls rich in corals, bivalves and gastropods. According to the recent critical review of Dragastan, Littler, Littler (2002), the species *Halimeda paucimedullaris* Schlagintweit, Ebli 1998 established from the Alpine Gosau Group is one of two Cretaceous species that have not been synonymized with modern taxa. From the classical locus typicus of the Gosau Group, a new occurrence of abundant and well-preserved thalli of *H. paucimedullaris* is described from the so-called Hofergraben marls (Hochmoos Fm.) of Lower Santonian age.

**ZUSAMMENFASSUNG**

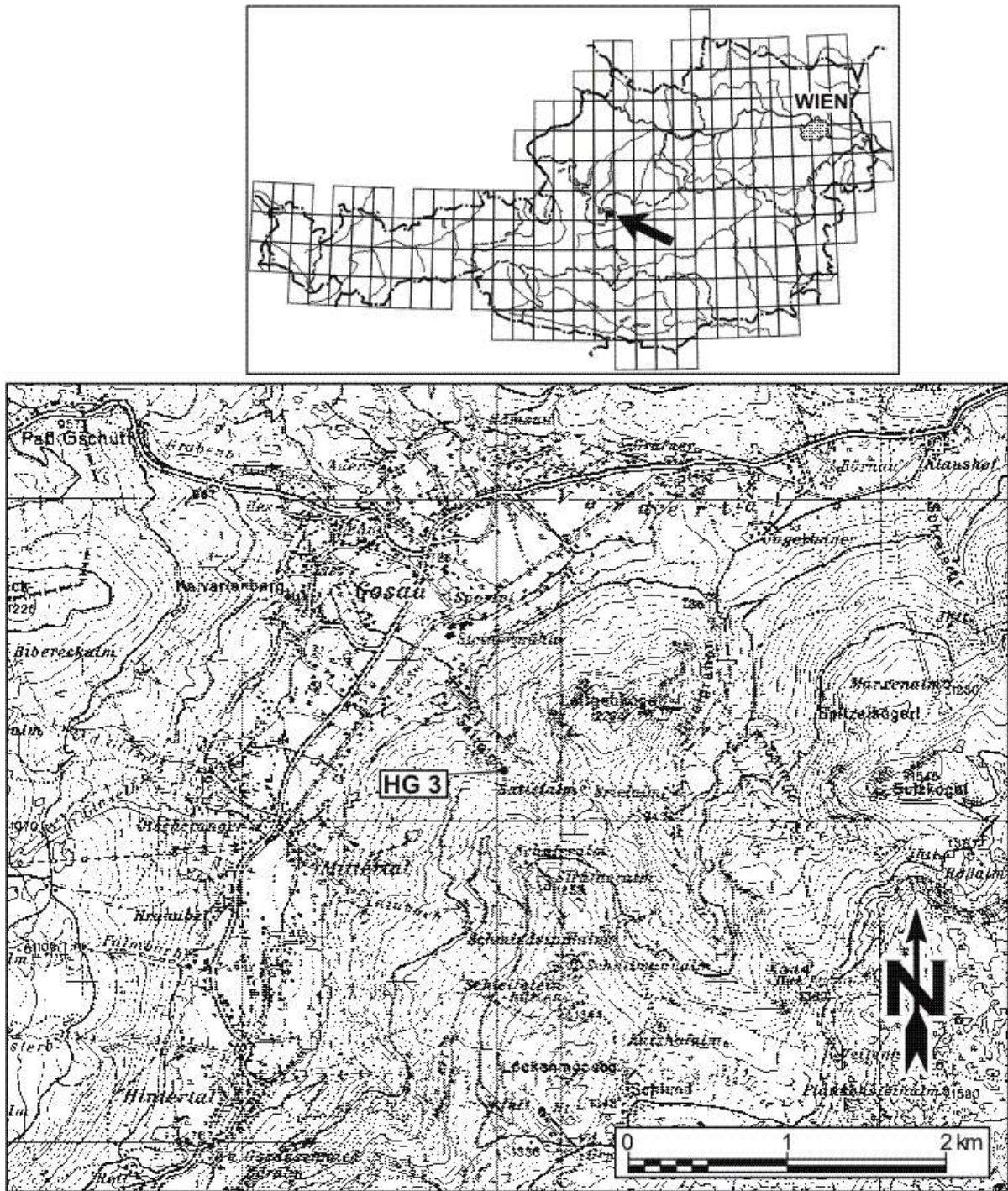
In der unteren Gosau Gruppe des Ober-Turoniums bis Ober-Santoniums finden sich Vertreter der Grünalge *Halimeda* Lamouroux typischerweise in lagunären Mergelkalken, die gewöhnlich mit Mergeln, die reich an Korallen, Bivalven und Gastropoden sind, assoziiert. Gemäß der aktuellen Arbeit von Dragastan, Littler, Littler (2002), stellt die aus der alpinen Gosau Gruppe aufgestellte Art *Halimeda paucimedullaris* Schlagintweit, Ebli 1998 eine der zwei in der Kreide vorkommenden Arten dar, die nicht mit rezenten Vertretern synonymisiert wurden. Vom locus typicus der Gosau-Gruppe, wird ein neues Vorkommen von *H. paucimedullaris* mit häufigen und gut erhaltenen Thalli aus den sogenannten Hofergraben-Mergeln (Hochmoos-Formation) des unteren Santoniums beschrieben.

**I. INTRODUCTION**

The calcareous green alga *Halimeda* Lamouroux is a typical inhabitant of modern shallow water settings in the tropical and subtropical zones associated with coral reefs. In some areas, however, it may also occur in deeper marine settings on reef slopes from a depth up to 130 m (Littler et al. 1986), an environment where fossil records of *Halimeda* are not yet known (Flügel 1988).

From the Upper Cretaceous of the Northern Calcareous Alps, representatives of *Halimeda* have been reported from the Lower Gosau Subgroup and the Branderfleck Formation (Höfiling 1985, Schlagintweit 1992, Schlagintweit, Ebli 1998). In a recent paper, Dragastan, Littler, Littler (2002) critically reconsidered fossil *versus* modern *Halimeda* species on the background of the high thallus variability in the latter. By distinguishing different morphological lines, most of the fossil species have been synonymized. In conclusion of the authors species concept, there remain two morphological different valid species reported from Cretaceous strata, one of them being *Halimeda paucimedullaris* Schlagintweit, Ebli 1998 established from Turonian-Santonian Gosau Group deposits of the Northern Calcareous Alps. In the present paper, new findings of the taxon in question with well preserved specimens are reported and illustrated in detail.

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Text-Fig. 1: Location Map of the Hofergraben outcrop HG 3.

## II. GEOLOGICAL SETTING

The Gosau “basin” is situated in the Salzkammergut – in the border area of Upper Austria and Salzburg province – and represents the locus typicus of the transgressive Upper Cretaceous to Paleogene sediments in the Northern Calcareous Alps. For specific data on stratigraphy and sedimentology see Kollmann (1980) and Wagreich (1988 cum. lit.).

Within the clastic to carbonatic shallow marine deposits of the Lower Gosau Subgroup, the occurrence of *Halimeda paucimedullaris* has been reported from marly limestones of the locality Russbach belonging to the Upper Santonian part of the Hochmoos Formation (Schlagintweit, Ebli 1998). The lower part of the Hochmoos Formation is represented by fossiliferous marls, the so-called “Hofergraben marls”. Text-Fig. 1 shows the location of sample HG3, which was collected in a small tributary creek to the Hofergraben (=Sattelgraben). The HG3-section is dominated by grey sandy marls with local enrichments by corals, gastropods and bivalves (Baron-Szabo 2003; Szente 2003). Intercalations of several dm thick fossil-rich detrital limestones (pack-/grainstones), probably tempestites, and black, slightly bituminous limestones occur on top of the Hofergraben marl exposure, which was stratigraphically dated as Lower Santonian (see chapter “Stratigraphy”). The bivalve *Scabrotrigonia scabra* (Lamarck) is a characteristic faunal element of the *Halimeda*-bearing calcarenitic limestone/tempestite intercalations (Szente 2003).

## III. MICROPALAEONTOLOGY

Genus *Halimeda* Lamouroux 1812

*Halimeda paucimedullaris* Schlagintweit & Ebli 1998

(Taf. 1, Abb. 3)

**Description:** The Hofergraben material is equivalent to the that one from the original species description showing the same brownish segment preservation (? primary aragonite) of modern species. According to our knowledge, this peculiar kind of preservation is not known prior to the Upper Cretaceous. In the thin-sections studied, we find extremely long thallus segments (see Tab. 1) showing more or less identical arrangement of their axis within the host rock.

The medullary zone of *H. paucimedullaris* is extremely small having a width of 0,04 to 0,08 mm. With respect to the segment diameter, the medullary zone makes up 12 to 31 % (mean value 17 %). Often, the medullary zone is totally decalcified marked by a homogeneous and small calcitic mold running through the whole segment length (Pl. 1, fig. 2). The diameter of the medullary filaments is 0,016 to 0,032 mm. The cortex is composed of three to four (occasionally five) utricle layers. The primary utricles splitt off oblique from the medullary siphons than mostly become more and more arranged perpendicular to the axis. In other cases they remain obliquely arranged and only the higher order utricles become perpendicularly arranged. The primary utricles are comparable long (up to 0,14 mm), with a prominent cylindrical part (2/3 of length) and a swollen distal part (last 1/3). The swollen part (~ 0,032 mm) is about double the diameter of the cylindrical part (~ 0,016 mm). In longitudinal section, the secondary utricles are dichotomously branched and have the same morphology as the primary utricles but of smaller dimensions. The cylindrical part of the secondary utricles is about 0,008 mm and the distal end about 0,016 mm in diameter.

Representatives of the genus *Halimeda* are characterised by a segmented thallus. These segments may vary in size between different growth stages of the plant. With this respect, the segments of *H. paucimedullaris* are extremely long (l) in comparison to the diameters (d) resulting in a very low d/l-ratio (Table 1).

Segment diameter (d)	0,4	0,32	0,4	0,32	0,34	0,52	0,46
Segment length (l)	12	1,6	3,6	5,76	3,52	8,72	7,72
Ratio d/l	0,033	0,2	0,11	0,05	0,1	0,06	0,06

**Tab. 1: Dimensions of segments of *Halimeda paucimedullaris* Schlagintweit & Ebli from the Hofergraben (thin-sections HG-3 B, HG-3 D).**

Worth mentioning that in other samples (leg. D. Sanders, Innsbruck) we found segments of *Halimeda paucimedullaris* up to 20 mm in length.

<i>Halimeda</i> species	Segment diameter (d)	Segment length (l)	Ratio d/l
discoidea DECAISNE	0,5–0,75 segments with 2 layers of utricles 1,54–2,8 segments with 3 layers of utricles	5,7–8,0 2,5–3,0	About 0,9 0,62–0,93
<i>gracilis</i> HARVEY	1,5–1,65 at base	3,3–3,5	0,45–0,47
<i>cylindracea</i> DECAISNE	3,15	–	–
<i>monile</i> (ELLIS & SOLANDER)	2,1	–	–
<i>bikinensis</i> TAYLOR	1,2–1,4	3,3–4,2	0,33–0,36
<i>incrassata</i> (ELLIS)	1,1–2,5	6,0	0,18–0,42
<i>tuna</i> (ELLIS & SOLANDER)	0,36–0,6	2,4–3,6	0,17–0,25
<i>fragilis</i> TAYLOR	0,9–3,0 lobed area, 0,48–0,6 between lobes	3,0–12	
<i>opuntia</i> (LINNAEUS)	3,0–3,2	5,0–6,0	0,53–0,6
<i>micronesica</i> YAMADA	1,0–1,5	2,0	0,5–0,75

**Tab. 2: Comparisons of segment dimensions between Upper Cretaceous *Halimeda paucimedullaris* Schlagintweit & Ebli and today-living representatives of the genus *Halimeda* Lamouroux (data from Dragastan et al. 2002).**

**Facies:** With respect to microfacies, the occurrence of *Halimeda paucimedullaris* in the Lower Gosau Subgroup seems to be restricted to detrital marly limestones to fine-grained sandstones that, within the exposed successions, are associated with silty marls commonly rich in gastropods and bivalves and in the Hofergraben also solitary corals (Cyclolites/Cunolites, e.g. Summesberger et al. 2000: Fig. 16a, Baron-Szabo 2003). The latter typically occur in great abundances in open lagoonal to inner shelf siltstones and marls (Summesberger et al. 2000). According to Szente (2003) the calcarenitic detrital limestone intercalations with Scabrotrigonia-bearing shell beds probably indicate short-term high-energy, maybe also shallowing, events within the marly sedimentation. In the Gosau area, these deposits are ascribed to the Highstand Systems Tract (HST) by Sanders et al. (1997: Fig. 6). With the occurring assemblage of *Halimeda* and dasycladales as well as the associated benthic foraminifera, the paleoenvironment refers to the “carbonate shelf” sensu Sanders et al. (1997), although a certain kind of siliciclastic input is well present but distinctly reduced with respect to the contrarian “siliciclastic shelf” type. Summarizing, the paleoenvironment can be interpreted as a shallow, muddy and quiet water lagoon, not too far away from the shore-line as indicated by the certain amount of siliciclastic input and coaly plant material.

A compilation of the microfossils associated with *Halimeda paucimedullaris* in the Alpine Gosau Group is shown in table 3.

	Pletzschalm Tyrol	Hofergraben Upper Austria	Rußbach Salzburg
Stratigraphy	? Upper Turonian	Lower Santonian	Upper Santonian
<b>Calcareous Algae</b>	<b>abundant</b>	<b>common</b>	<b>common</b>
<i>Acicularia antiqua</i> PIA	X	-	-
<i>Dissocladella</i> ? pyriformis SCHLAGINTWEIT	X	-	X
<i>Neomeris circularis</i> BADVE & NAYAK	X	-	X
<i>Oroseina pletzschensis</i> SCHLAGINTWEIT & EBLI	X	-	X
<i>Halimeda paucimedullaris</i> SCHLAGINTWEIT & EBLI	X	X	X
<b>Benthic Foraminifera</b>	<b>Common</b>	<b>Rare</b>	<b>Common</b>
<i>Cuneolina</i> gr. <i>pavonia parva</i> HENSON	X	-	-
<i>Dictyopsella kiliani</i> SCHLUMBERGER	X	-	-
<i>Nummofallotia cretacea</i> (SCHLUMBERGER)	-	-	X
<i>Vidalina hispanica</i> SCHLUMBERGER	X	X	X
other miliolids (e.g. <i>Quinqueloculina</i> )	X	X	X
small rotaliids (e.g. <i>Pararotalia minimalis</i> Hofker)	-	X	X

**Tab. 3: Compilation of microfauna and microflora of the localities studied with *Halimeda paucimedullaris* Schlagintweit & Ebli.**

Another locality where *H. paucimedullaris* occurs is the Lower Gosau Subgroup of the Lattengebirge near Berchtesgaden (Höfling 1985). Data to be included for table 3 have not been made available.

**Stratigraphy:** Taking into account the available data from all occurrences in the Lower Gosau Subgroup, the total stratigraphic range of *Halimeda paucimedullaris* can be indicated as Upper Turonian – Santonian. According to written communications by L. Hradecká and L. Švábenická (Czech Geol. Survey, Prague) the marls accompanying the detrital limestone bed are of Lower Santonian age (*Dicarinella asymetrica* foram-zone, respectively nanno-zone UC11c-UC12).

## APPENDIX I: REFERENCES

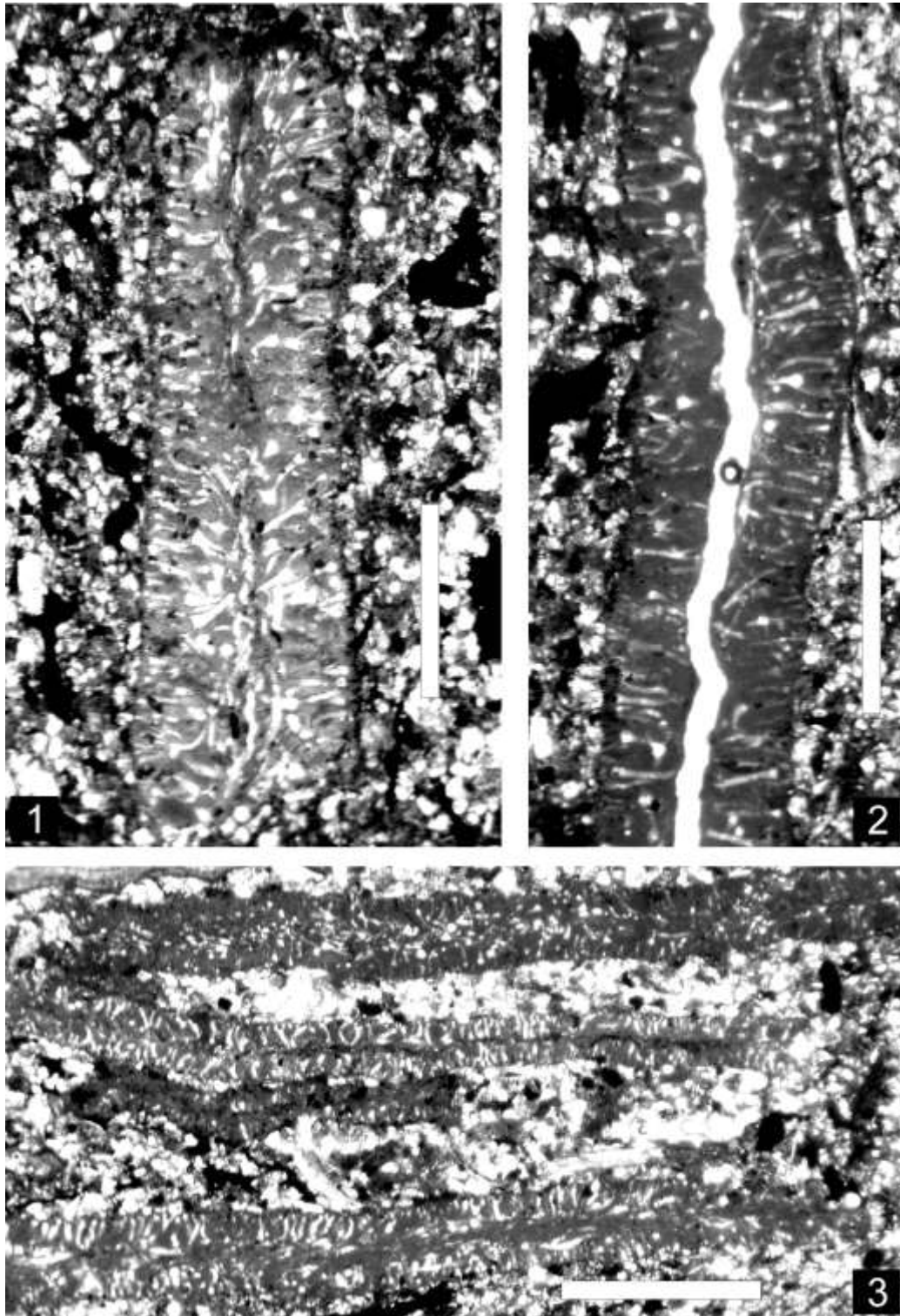
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**APPENDIX II: Plate 1 *Halimeda paucimedullaris* Schlagintweit & Ebli from the Lower Santonian Hofergraben marls**

1: Longitudinal section. Thin-section HG-3 D, scale bar = 0,5 mm.

2: Longitudinal section showing the calcitic mould of the medullary zone. Thin-section HG-3 B, scale bar = 0,5 mm.

3: Facies with numerous longitudinal sections. Thin-section HG-3 B, scale bar = 1 mm.



**TAFEL 1**