

## NEW RECORD OF HALIMEDACEAN ALGAE FROM THE UPPER TRIASSIC OF THE SOUTHERN ALPS (DOLOMITES, ITALY)

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**Keywords:** green algae; halimedaceans; Heiligkreuz Formation; Late Triassic; Dolomites.

**Abstract.** A new record of halimedacean algae is reported from the Upper Triassic (Carnian) of the Dolomites (Southern Alps) near Cortina d'Ampezzo. Based on the gross morphology (non-segmented non-branched thalli) and the internal skeletal arrangement (e.g., medulla with thicker siphons, sometimes bifurcating at high angles; cortex with thinner siphons with multiple Y-like branching), the material can be assigned to the genus *Boueina*. It is the first record of halimedacean algae from the Upper Triassic of the Southern Alps (Dolomites) and the highly diverse San Cassiano Formation *sensu lato* (Heiligkreuz Formation). Although the fossilization potential of these algae was low, it is likely that they were much more common than suggested by this sparse fossil record and that they contributed considerably to carbonate production in early Mesozoic times.

### INTRODUCTION

Calcareous green algae are common constituents in Triassic marine shallow water limestone sequences. They mostly belong to the Dasycladales. However, Triassic halimedacean algae are rare although various genera assigned to halimedacean algae have their first occurrence in the Middle Triassic. Reports of the genus *Halimeda* Lamouroux (or *Boueina* Toula) are especially scarce worldwide including few reports from the Upper Triassic (Norian-Rhaetian) of Thailand, Iran, Greece and the Northern Calcareous Alps (Flügel 1975, 1988; Dragastan et al. 1999; Senowbari-Daryan & Hamadani 1999a, b; Schlagintweit & Pawlik 2008). Until the 1960's *Halimeda* (or *Boueina*) had not been known to occur in Triassic strata and their first occurrence was considered Early Jurassic in age (e.g., Johnson 1964). A comprehensive overview of the occurrence and distribution pattern of Triassic halimedacean algae was provided by Senowbari-Daryan & Zamparel-

li (2005). Herein, we report the halimedacean alga *Boueina* sp. from the lower Heiligkreuz Formation at Rumerlo near Cortina d'Ampezzo, Dolomites. It represents the first record of a representative of the “*Halimeda-Boueina*-couplet” from the Upper Triassic of the Southern Alps, which extends our knowledge of Triassic halimedacean algae in terms of both, overall record and geographical distribution pattern (Thailand, Iran, Greece, Austria, northern Italy).

### GEOLOGICAL OVERVIEW AND MATERIAL

The Dolomites (Southern Alps) are well-known for their exposures of large-scale progradational carbonate platforms. Middle Triassic synsedimentary faulting, associated with magmatism, produced several small basins whose sedimentary successions recorded rapid facies changes (Leonardi 1967; Assereto et al. 1977; Brandner 1984; Bosselini 1991; Bosselini et al. 1996; Gianolla et al. 1998b; Keim et al. 2001). These basins were filled by marlstones and volcanoclastic sediments, whereas carbonate platforms grew on elevated blocks. The

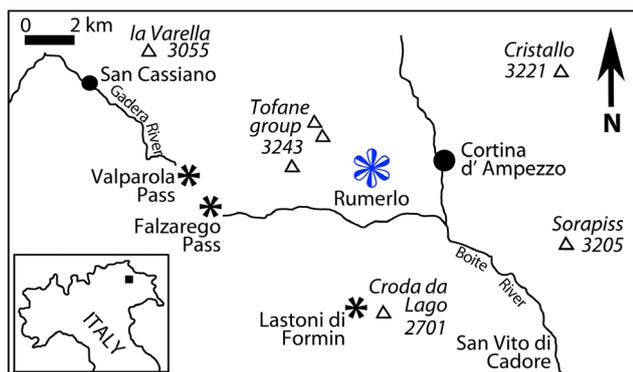


Fig. 1 - Sketch map with Rumerlo locality near Cortina d'Ampezzo, Dolomites, Northern Italy.

area of the Dolomites was affected by high subsidence rates during the Ladinian as recorded by pronounced aggradation of these carbonate platforms. The subsidence decreased considerably during the Carnian. Mostly high-relief, small (< 6 km diameter), isolated carbonate platforms with mainly climbing progradational geometries developed (Cassian Dolomite; Bosellini 1984, 1991; Keim et al. 2006; Neri et al. 2007; Gattolin et al. 2013). At the end of the early Carnian, this complex palaeogeography and -topography changed significantly with a shift to flat coastal plains. Besides a steady decrease of the high subsidence rates typical for the Middle Triassic and the early Carnian, this process is mainly due to a turnover of highly productive tropical carbonate factories facilitating the development of high-relief platforms to less productive cool-water to tropical carbonate factories characterized by ramp geometries (cf. Schlager 2003). This change was accompanied by a marked siliciclastic shedding into the basins equalizing the inherited topographic complexity. These changes are presumably due to a climatic change to more humid conditions (i.e. the Carnian Pluvial Event; Simms & Ruffell 1989; Dal Corso et al. 2012) triggered by the eruption of the Wrangellia large igneous province and a sea level fall with subaerial exposure and subsequent karstification of the Cassian platforms and erosion of adjacent land areas (Keim et al. 2001; Gattolin et al. 2013).

The material studied herein stems from the Cortina basin and was collected at the Rumerlo locality, 2.5 km west of Cortina d'Ampezzo (Fig. 1). The location is basically a forested area with broad ski slopes so that there are few bedrock outcrops as it is typical for many of the Carnian basinal sediments of the Cortina basin. The studied algal materi-

al was found on isolated fieldstones. However, based on ammonite findings (*Sirenites senticosus* [Dittmar]) and the overall geological context, Rumerlo most probably belongs to the lower Heiligkreuz Formation (Borca Member) within the upper Julian (Austriacum Zone) (Fig. 2, Breda et al. 2009). Formerly, Lower Carnian marly basin fills including transported shallow water and siliciclastic material, as exposed at Rumerlo, was assigned to the San Cassiano Formation (e.g., Zardini 1978). The Heiligkreuz Formation (ex Dürrenstein Formation) was deposited immediately after the demise of the high relief carbonate platforms. It recorded the flattening of complex topography of the Lower Carnian and a period of anomalously abundant coarse siliciclastic supply. Generally, it consists of mixed siliciclastic-carbonate successions, recording broad shallow-water carbonate environments subject to strong terrigenous input. In the Cortina area the Heiligkreuz Formation can be subdivided in the basal Borca Member followed up-section by the Areniti di Dibona Member and the Lagazuoi Member. The Borca Member is composed of pelitic deposits with freshwater influence, dolomitized mudstones-grainstones, arenitic dolostones and hybrid arenites with pelitic intercalations as well as boundstones and patch reefs (Neri et al. 2007; Meneguolo 2008). According to Meneguolo (2008) the Borca Member succession corresponds to lithofacies associations A-D of Preto & Hinnov (2003). At Rumerlo, fossiliferous beds with chert pebbles and large oncoids can be frequently found. This material was clearly transported into the basin. The location yielded a very diverse gastropod fauna (Zardini 1978); bivalves and echinoids are also abundant. The Heiligkreuz Formation lies both on the shallow-water carbonate platforms of the Cassian Dolomites and on the basinal shales and limestones of the San Cassiano Formation. It is, in turn, unconformably overlain by the sabkha and paralic facies of the Travenanzes Formation. The age of this relatively narrow stratigraphic interval is defined close to the Julian-Tuvalian boundary based on ammonoids and palynomorphs (Gianolla et al. 1998a; De Zanche et al. 2000; Roghi et al. 2006).

## TAXONOMY

### General Remarks

The systematic position of the halimedaceans

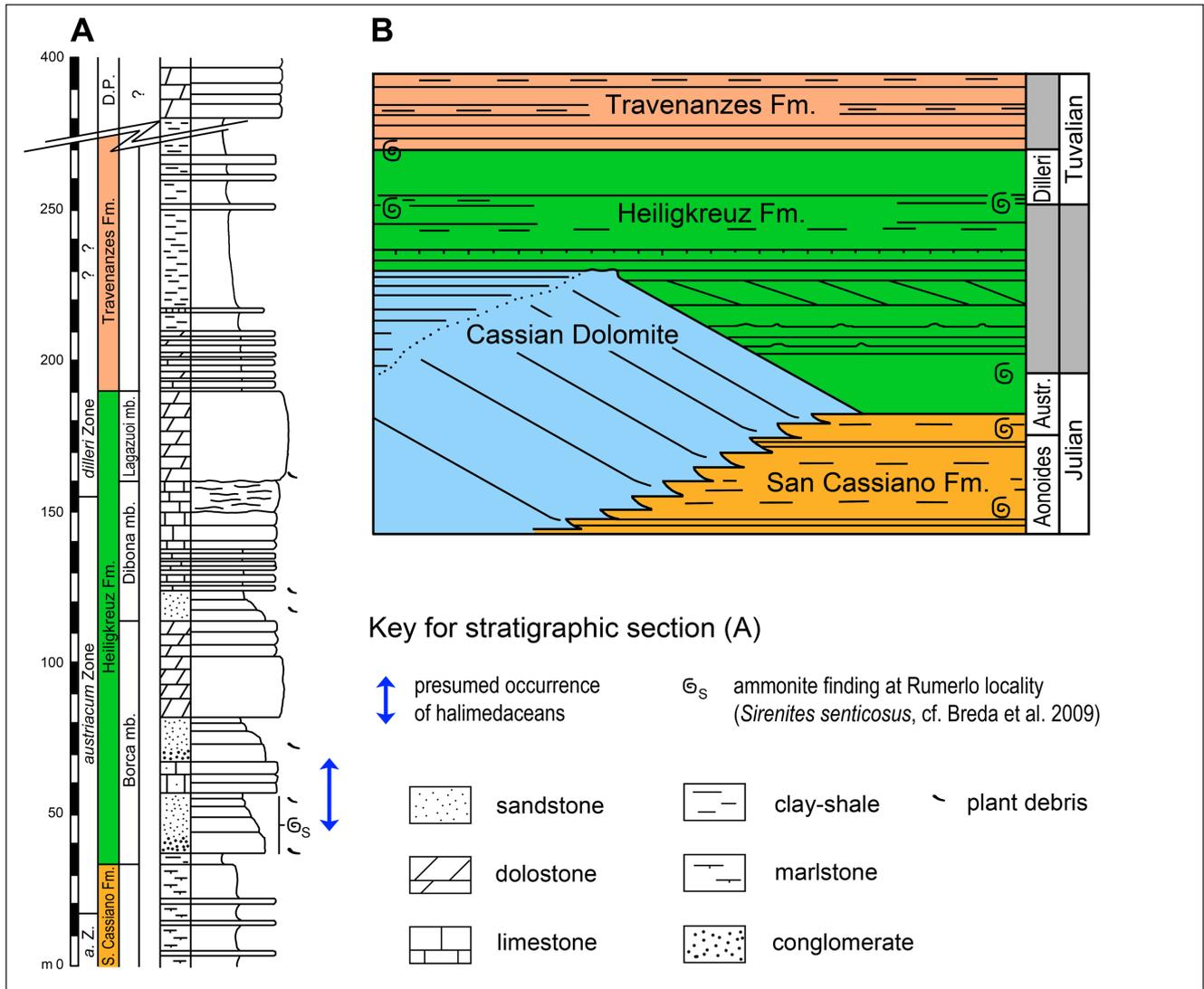


Fig. 2 - A) Composite synthetic stratigraphic section of the Lower Carnian (Upper Julian) in basinal settings of the Cortina area. The presumed interval within the lower Heiligkreuz Fm. (San Cassiano Fm. sensu lato) from which the algae-bearing samples were collected, is marked with a double arrow. Modified after Breda et al. (2009); B) Lithostratigraphy of the area west of Cortina d'Ampezzo based on large-scale outcrops of the Torri del Falzarego-Rifugio Dibona area. Ammonoid symbols indicate ammonite findings in the area. Modified after Preto & Hinnov (2003).

within the calcareous algae is still controversial. Generally, halimedaceans can be differentiated by the shape and construction of the thallus and the arrangement, shape and branching pattern of the medullar and cortical filaments (siphons and utricles; cf. Mu 1991; Senowbari-Daryan & Zamparelli 2005).

For a long time *Halimeda*, *Boueina* and *Arabicodium* were placed in the family Codiaceae of the Chlorophycean group Caulerpales (e.g., Wray 1977). Then, following the scheme proposed for the classification of extant green algae, the genera were included within the family Udoteaceae (cf. Hillis-Colinvaux 1980, Bassoullet et al. 1983). Accord-

ing to Hillis-Colinvaux (1984) and Bucur (1994a) the family name Halimedaceae Link is synonymous with Udoteaceae Agardh contrasting the taxonomic considerations of Dragastan et al. (1997, 2002) and Schlagintweit (2010) who kept Udoteaceae and Halimedaceae separate. This is in accordance with today's classification of living green algae (Chlorophyta) of M.D. Guiry and G.M. Guiry (2017, "AlgaeBase"), who listed both families within the order Bryopsidales (class Ulvophyceae) with monogeneric Halimedaceae bearing only *Halimeda*. Recent palaeontological studies included also fossil taxa (e.g., *Boueina*, *Alpinocodium*, *Collarecodium*, *Egericodium*) within the family Halimedaceae (e.g., Se-

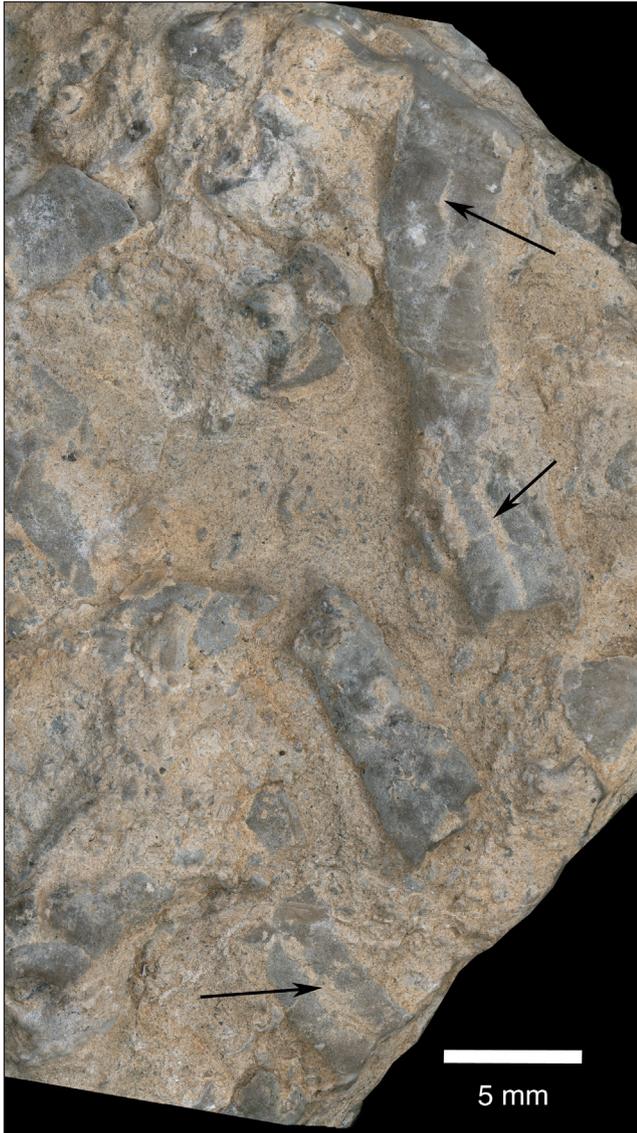


Fig. 3 - Weathered surface of algal bioclastic wackestone/floatstone from Rumerlo. Note the non-branched and non-segmented *Boueina* sp. stems partly broken lengthwise (arrows). Inv.-no. PAL 2211.

nowbari-Daryan & Zamparelli 2005; Schlagintweit 2010). Recent molecular DNA studies suggest that *Boueina* could belong to the Udoteaceae (e.g., Verbruggen et al. 2009; cf. Bucur et al. 2018; Bucur pers. commun.). However, both superfamilies, Udoteaceae and Halimedaceae, are in need of revision which is beyond the scope of this contribution. Moreover, there is still no consensus about the family members in the Udoteacea and the Halimedaceae, which is partly due to the problematic integration of the existing data of fossil and extant taxa (cf. Schlagintweit 2010). We thus stay with the traditional view at present. Remarkably, some modern algal systematic classifications keep Wray's (1977) concept with



Fig. 4 - Weathered rock sample (bioclastic wackestone/floatstone) from Rumerlo. Cross sectional view due to transverse breakage. Inv.-no. PAL 2212 (front side).

*Halimeda* and related genera attributed to the family Codiaceae within the order Caulerpales (class Ulvophyceae; Lee 2008).

Dragastan et al. (2012) transferred *Boueina* to the family Boueinaeae (originally introduced as tribe Boueinaeae by Shuysky 1987) including the genera *Boueina* Toulou and *Funiculus* Shuysky & Schirschova. Within this family, Dragastan et al. (2012) defined the new genus *Toulouina* with *Boueina hochstetteri* var. *liasica* Le Maître (1937) being the type species. In fact, the material described by Le Maître (1937) and its assignment to *B. hochstetteri* var. *liasica* is somewhat dubious. Some illustrations show very little affinities to *Boueina* or algal remains at all (resembling coral or calcareous sponges, see also Dragastan et al. 2012) and a determination on subspecies level seems unjustified due to gradual variability and lack of distinct differences of skeletal characteristics (cf. Flügel 1975, 1988).

We also think that the family Boueinaeae represents a synonym of Halimedaceae and cannot follow the argumentation of Dragastan et al. (2012).



Fig. 5 - Polished slab of allochthonous halimedacean oolitic wackestone/floatstone with numerous *Boueina* remains (various sectional planes). Inv.-no. PAL.2212 (reverse side).

The diagnosis of *Boueina* sensu Toula (1883) and Steinmann (1899) refers to simple, non-segmented and non-branched cylindrical calcareous bodies with differentiation in larger medullar and smaller cortical siphonal structures, clearly contrasting the diagnosis of the family Boueinaeae given by Shuysky (1987) and emended by Dragastan et al. (2012) including branching thalli, equal sized siphons and sometimes medullar siphon differentiation (central and radial medullar siphons).

However, De Castro et al. (2008) hypothesized that *Boueina* has branched thalli based on own observations of *B. moncharmontiae* (De Castro) De Castro, Cimmino & Barattolo (see De Castro et al. 2008, Plate 1, Figs. 2, 5, 6) and an illustration of Toula himself (Plate 9, Fig. 1). So, branching might occur within *Boueina* species, which is corroborated by recent investigations of new outcrops with new *Boueina* material at the type locality (Bucur et al. 2018).

Dragastan et al. (2002, 2003) presented a taxonomic concept with the synonymization of a large number of the fossil taxa, including *Boueina* Toula

and *Arabicodium* Elliott with extant representatives of *Halimeda*. Consequently, the halimedacean species known from the Triassic *Boueina hochstetteri*, *B. marondei*, *Halimeda belladica* and *H. discreta* were synonymized with *H. cylindracea* Decaisne. This radical synonymization of the genera *Boueina* Toula and *Arabicodium* Elliott with *Halimeda* Lamoroux (having priority) is strongly debated, especially among palaeontologists (e.g., Senowbari-Daryan & Zamparelli 2005; Schlagintweit & Pavlik 2008; Schlagintweit 2010). The assumption that both type species (*Boueina hochstetteri*, *Arabicodium aegagrapiloides*), with their entirely different morphology of medullary and cortical zones, represent the same species *H. cylindracea*, seems to be very unlikely. All the more because *H. cylindracea* does not possess real cylindrical segments with typical transverse sections. *Halimeda* species with discoidal-flattened segments, that can morphologically be compared with extant species are not known prior to the Turonian. Forms possessing cylindrical segments date further back, but these segments differ considerably from those of their counterparts, thus casting doubts on the existence of long-lasting “Methuselah” species by uniting extant and fossil species (Schlagintweit 2010).

Also Senowbari-Daryan & Zamparelli (2005) questioned the radical taxonomic concept of Dragastan et al. (2002, 2003). For example, their comparison of *Boueina marondei* with *Halimeda belladica* (later synonymized with extant *H. cylindracea*), based on the type and ramification of the siphons (without taking diagenetic alteration into account), is very theoretical and not discernible in the illustrations of Flügel (1988) and Dragastan et al. (1999).

Phylum **CHLOROPHYTA** Reichenbach, 1834  
 Class **ULVOPHYCEAE** Mattox & Stewart, 1984  
 Order **Bryopsidales** Schaffner, 1922  
 Family **Halimedaceae** Link, 1832

*Boueina* sp.

**Material:** four samples collected from the lower part of Rumerlo ski slope (north of “Tofana express” chairlift), basically bioclastic peloidal algal wackestones, packstones and floatstones, bearing variable amounts of iron-impregnated ooids. Some rock samples exhibit a dolomitized, partly marly matrix with algal remains weathering out well (Fig. 3, 4). Two thin sections each with longitudinal and transverse sections were prepared from all samples. Remaining rock samples were partly cut and prepared to polished slabs. The illustrated material (plus one sample not shown) is housed in the Natur-

museum Südtirol, Bolzano, Italy (NMS BOZ) under the inventory numbers PAL 2211 – PAL 2217 (four rock samples in total including thin sections and polished slabs). Additional material is housed in the Bayerische Staatssammlung für Paläontologie und Geologie München (BSPG) under the inventory numbers SNSB-BSPG 2018 I 55-57.

**Description.** The alga is characterized by long cylindrical to subcylindrical thalli, which are mostly circular to oval in transverse sections (Fig. 5). Segmentation or branching is not observable. Length of the algal remains range from 2 to 3 cm, the diameter varies between 2 and 5 mm due to slightly undulating outlines. Rarely, algal stems appear flat and leaflike due to compaction and early diagenetic breakage (Figs 3, 6.1). Cortical and medullar zones can be differentiated though often complicated by only moderate or poor preservation (e.g., Figs 6.2, 6.5). This might be due to differential calcification of the living alga proceeding from outer towards inner parts during growth (cf. calcification pattern of extant *Halimeda*, e.g., Johnson 1964). But also the cortical part is often poorly preserved due to physical erosion of the algal remains during sedimentary transport in an allochthonous regime.

The average diameter of the cortex ranges from 0.4-0.6 mm and represents ca. 25-35% of the total branch diameter. The medullar zone makes up 65-75% of the total algal diameter.

The cortical siphons are closely packed and exhibit multiple Y-like branching (Figs 6.3., 6.6., 6.7). Normally, siphons are oriented perpendicular to the outer surface. The diameter of the cortical siphons varies from 0.025- 0.05 mm becoming successively smaller towards the outer surface (Fig. 6.7).

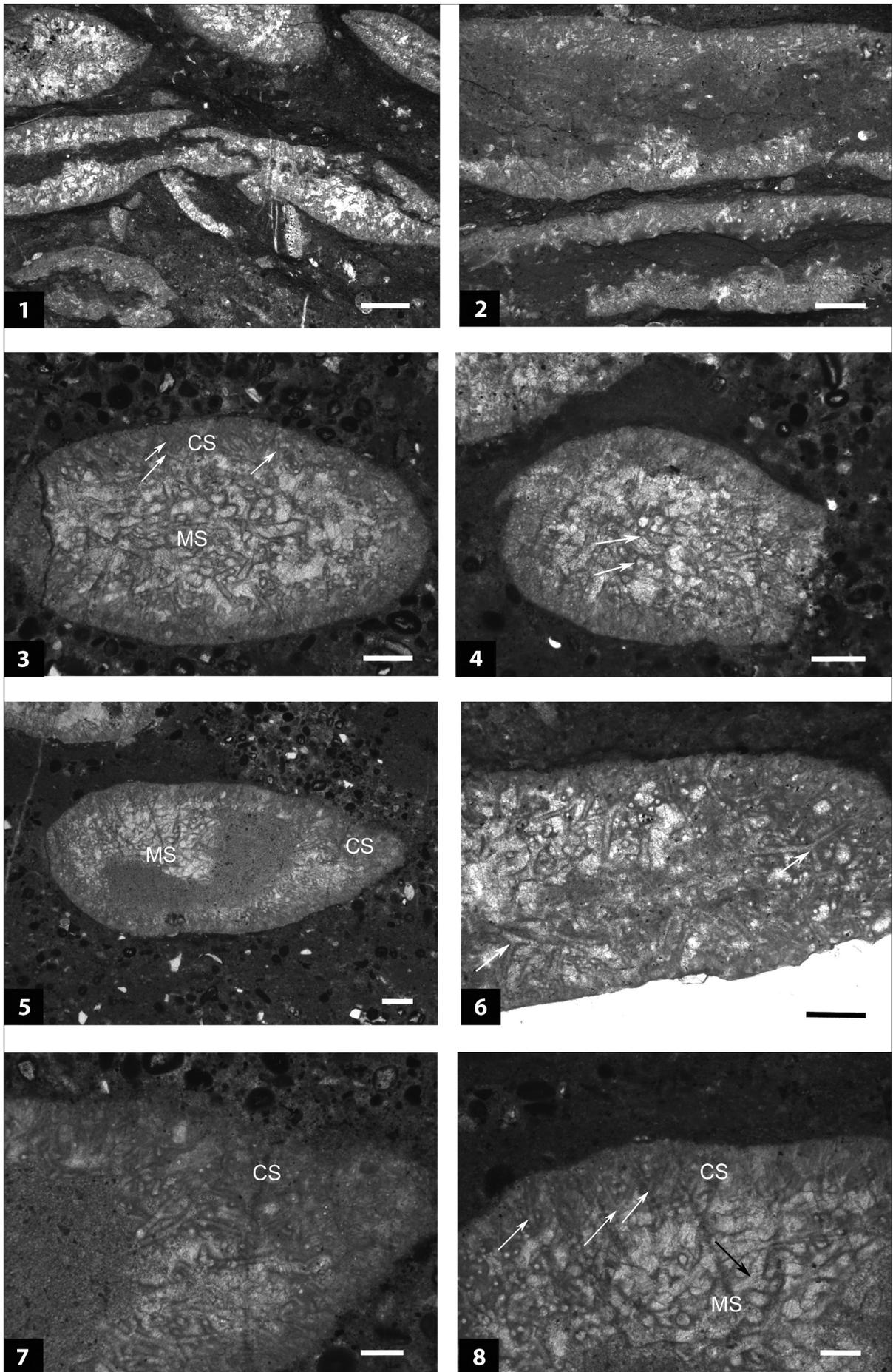
The medullar siphons are distinctly thicker and range from 0.08 (close to the cortex) – 0.2 mm (central medulla, e.g., Figs, 6.3, 6.4). They sometimes bifurcate with angles of 60-70° and form a tangled mesh rather than running strictly parallel (Fig. 7; cf. Elliott 1965).

**Comparison and discussion.** Being aware that taxonomy of fossil halimedaceans (especially *Halimeda*-group genera *Halimeda*, *Boueina* and *Arabicodium*) is still problematic related to various aspects (overall preservation, different degrees of calcification, artificial and non-specific differentiation of *Halimeda*, *Boueina* and *Arabicodium*, different taxonomic concepts, necessity of re-examination of original material, high variability of some criteria

even on species level, lack of solid statistical base of morphological characters), we accept and maintain the separation of the three mentioned taxa following Hillis (2000). Characteristics of the material described herein with a medullary zone of coarse tangled siphons and a cortex with radial finer, double branching siphons differ from the skeletal structure of *Halimeda* with longitudinally directed medullar siphons and frequently triple branching cortical siphons revealing constrictions and swellings (cf. Steinmann 1899; Elliott 1965; Bucur 1994a). However, especially the cortical siphons of extant *Halimeda* species might reveal a great variability including also dichotomous branching without swellings and constrictions (e.g., *H. opuntia*; Hillis-Colinvaux 1980) like in *Boueina*. Taken as a whole, the medullar and cortical siphon characteristics of the Rumerlo material together with the outer gross morphology, i.e. non segmented, cylindrical thalli, clearly justifies the attribution to *Boueina* despite the question of branching (see above; cf. De Castro et al. 2008).

In comparison with other existing Triassic species of *Boueina*, the Rumerlo material exhibits some affinities to *B. hochstetteri* (var. *liasica*) Le Maître, 1937, concerning for example the cortical siphonal

Fig. 6 - Morphology and internal structure of *Boueina* sp. from Rumerlo in thin sections: 1) Halimedacean floatstone with transverse and longitudinal sections of *Boueina* sp. Sometimes algal stems appear flat and leaf-like due to compaction and early diagenetic breakage. Note that central parts of the thalli are often recrystallized or not preserved at all, scale bar: 1 mm, inv.-no. PAL2215; 2) Longitudinal sections of two algal stems of *Boueina* sp. Only the cortical parts are preserved, the medullar area is lacking, scale bar: 1 mm, inv.-no. PAL2215; 3) Transverse section of *Boueina* sp. with large central medullar siphons (MS) and distinctly smaller cortical siphons (CS); note multiple y-like branching of cortical siphons (arrows), scale bar: 0.5 mm, inv.-no. PAL2213; 4) Transverse section of *Boueina* sp., medullar zone with many siphons arranged like organ pipes (i.e., running parallel, arrows), scale bar: 0.5 mm, inv.-no. PAL2214; 5) *Boueina* sp. with cortical (CS) and partly medullar siphons (MS) preserved, scale bar: 0.5 mm, inv.-no. PAL2213; 6) Oblique section of *Boueina* sp. with cortical siphons showing Y-like bifurcations (arrows), scale bar: 0.5 mm, inv.-no. PAL2215; 7) Cortical part of *Boueina* sp., with siphons (CS) becoming successively smaller towards the outer surface (from left to right), close up of 5., scale bar: 0.25 mm, inv.-no. PAL2213. Note the multiple Y-like branching of cortical siphons; 8) Oblique section of *Boueina* sp. with cortical (CS) and medullar siphons (MS). Note multiple Y-like branching of cortical siphons (white arrows) and scattered wide bifurcation of larger medullar siphons (black arrow), scale bar: 0.25 mm, inv.-no. PAL2213.



Taxon	Occurrences	Description	Dimensions	References
<i>Boueina marondei</i> Flügel, 1988	Norian – NW Bangkok, Thailand	Diagnosis (Flügel 1988): Non-segmented, cylindrical thallus, perhaps poorly articulated; wide, strongly calcified medullary zone, surrounded by thin distinct cortical zone; cortical zone poorly calcified in the inner part, but well calcified in the outer part of the thallus; medullary zone with thick, sometimes simply branched, subparallel or irregularly arranged filaments of varying thickness; cortical zone characterized by thin, straight, partly bifurcated filaments, broadening towards the periphery.	D: 900-1300 $\mu$ ; L: 2700-10000 $\mu$ ; DM: 480-980 $\mu$ ; DMS: 23-80 $\mu$ ; DCS: around 16 $\mu$	Kemper et al. (1976), Flügel (1988)
	Norian/Rhaetian – S Abadeh, central Iran	Cylindrical thalli with a circular outline in transverse section; distinct segmentation is lacking, but poor articulation was observed in some specimens; mostly only the isolated medullary zone is preserved, cortical zone is missing, medullary zone consists of thick siphons, bifurcation of filaments at angles less than approximately 30 degrees is relatively common; cortical zone thinner as medullary zone;	D: 1.400-2.000 $\mu$ ; L: 1.150 – 10.000 $\mu$ ; DM: 800-1.500 $\mu$ ; DMS: 30-60 $\mu$ ; DC: 250-320 $\mu$ ; DCS: 10-20 $\mu$ .	Senowbari-Daryan & Hamadani (1999a,b)
<i>Boueina</i> sp. (= <i>B. hochstetteri liasica</i> Lemaitre, 1937)	Norian or Rhaetian – Gosaukamm, Austria	Two longitudinal sections with oval outline and leaf-like morphology; medulla with irregular, partly amalgamated siphons generally running not parallel; cortex with dense short siphons running approximately perpendicular to the outer surface, diameter decreases towards algal surface, one thin section with Y-like bifurcation at the edge	D: 1350-2500 $\mu$ ; L: 5000-7000; DM/D: 54-56%; DMS: 50-60 $\mu$ ; DCS: 20-35 $\mu$ .	Flügel (1975)
<i>Boueina</i> sp.	Carnian – Rumerlo near Cortina d'Ampezzo, Italy	Cylindrical to subcylindrical thalli, mostly circular to oval in transverse sections; segmentation and branching is missing; cortical siphons are closely packed and show multiple Y-like branching; cortical siphons normally oriented perpendicular to the outer surface; large medullar siphons form a tangled mesh rather than running strictly parallel, bifurcations with angles of 60-70° occur	D: 2000-5000 $\mu$ ; L: 20000-30000 $\mu$ ; DMS: 80-200 $\mu$ ; DCS: 25-50 $\mu$	This study

Tab.1 - Overview and comparison of Triassic *Boueina* species known to date. D = diameter of algal thalli fragments, L = length of algal thalli fragments, DM = diameter medullar zone, DC = diameter cortical zone, DMS = diameter medullar siphons, DMC = diameter cortical siphons.

structure (Y-like bifurcations) and the preservational pattern (cf. Flügel 1975). However, the material from the Dachstein reefal limestone of the Gosau area, composed only of two thin sections, and its assignment to *Boueina hochstetteri liasica* Le Maître, 1937, by Flügel (1975) is inexplicable. The picture provided

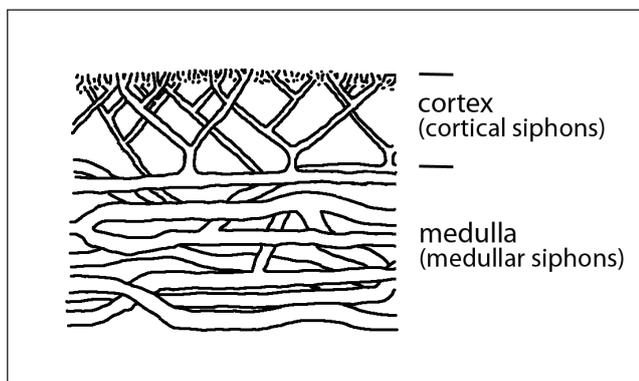


Fig. 7 - Internal structure of *Boueina* sp. from Rumerlo. Model based on thin section observations.

(Pl. 4, fig. 3) shows a small, not very well preserved, algal remain that –in our opinion– allows for an attribution to *Boueina* sp. at most. *B. marondei* Flügel, 1988 differs from the material described herein by its characteristic calcification pattern with a distinct break between the outer cortex and the medulla due to a generally poorly calcified inner cortex (Table 1; Flügel 1988). The Rumerlo halimedacean material differs from the known *Boueina* species not only from the Triassic but also from the Jurassic and Cretaceous by its large medullar siphon diameter, except for *B. globosa* Dragastan, Bucur & Demeter from the Lower Cretaceous of Romania and *B. hochstetteri* Toula from the Lower Cretaceous of Serbia. The former shows even much larger medullar siphon diameters (up to 0.3 mm!) than the material described herein (cf. Dragastan et al. 1997; Bassoullet et al. 1983), whereas *B. hochstetteri* Toula basically resembles the Rumerlo material. Steinmann (1899) provided a comprehensive description of *B. hochstetteri* Toula using topotype ma-

terial. The overall morphology, cortical and medullar structures including diameter range of siphons match the morphology and dimensions of the Rumerlo material to a large extent. However, we do not assign the present algae from the Rumerlo locality to *B. hochstetteri* here because of the moderate preservation and scarcity (lack of data on variability). Hence, species determination remains open for the time being.

### Stratigraphic and geographic distribution.

The genus *Boueina* ranges from the Late Triassic to the Late Cretaceous. To date, Triassic *Boueina* occurrences include the Norian of western Thailand (Flügel 1988), the Norian/Rhaetian of the Gosaukamm, Dachstein, Austria (Flügel 1975) and the Norian/Rhaetian of central Iran (Senowbari-Daryan & Hamadani 1999a, b). The algae from Rumerlo described herein represent the first record of *Boueina* from the Upper Triassic of the Southern Alps. Further examples have been described from the Lower Jurassic of Morocco, northern Iraq, Croatia and Italy (Elliott 1960, 1965; Le Maître 1937; Nikler & Sokac 1968; Praturlon 1966). In the Early Cretaceous *Boueina* is described, though not always in detail (including figures) from various localities, mainly in Europe (Serbia, Italy, S France, central Portugal, SE Spain, Romania) (e.g., Toulou 1883; Steinmann 1899; De Castro 1963; Poignant 1967; Masse & Poignant 1970; Rey 1972; Bucur & Dragastan 1986; Bucur 1994b; Arias et al. 1995). Upper Cretaceous occurrences are known only from northern Africa (Lybia, Aegypt)(Pia 1936; Kuss & Conrad 1991) and Spain (Cantabria) (Schlagintweit & Wilmsen 2014).

Besides *Boueina* sp. from Rumerlo, no other reports of halimedacean algae from the Upper Triassic of the Southern Alps exist. More specifically, it is the first report from the highly diverse San Cassiano Formation in a wider sense (Heiligkreuz Formation) apart from the occurrence of *Syringopora? vermicularis* Klipstein within the San Cassiano Formation described by Ott (1966) and tentatively reinterpreted as the halimedacean algae *Collarecodium oenipontanum* Brander & Resch, 1980, by Senowbari-Daryan & Zamparelli (2005).

It is likely that halimedacean algae were much more common than is suggested by this sparse fossil record and that they contributed considerably to carbonate production in the Early Mesozoic. However, the fossilization potential of this group is very low.

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