Field Trip B3: Lower to Middle Devonian algal limestones of the Graz Palaeozoic (Austria)

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Abstract

The Devonian (Emsian to Eifelian) calcareous green algal flora of the Graz Palaeozoic (Austria) contains representatives of *Pseudolitanaia*, *Pseudopalaeoporella*, *Zeapora*, *Maslovina* and a new lanciculoid genus. Findings are restricted to a couple of localities in the "Rannach Facies" of the Graz thrust complex and may be characterised as monogeneric mass occurrences. Consequently, they are interpreted as algal bafflestones originating from halimedalean meadows.

The Graz Palaeozoic

Palaeozoic remnants of the Eastern Alps belong to the Upper Austroalpine Nappe System (SCHMID et al., 2004) whose nappe stacking was created during Cretaceous times. Today weakly and unmetamorphosed Palaeozoic successions are irregularly distributed in Austria (Fig. 1). Separated by the Periadriatic Fault, Southern Alpine sequences (i.e., Carnic Alps and Karavanke Mountains) oppose Eastern Alpine Variscan sequences (i.e., Greywacke Zone, Gurktal Nappe System, Graz Palaeozoic and some isolated outcrops in south Styria and Burgenland).

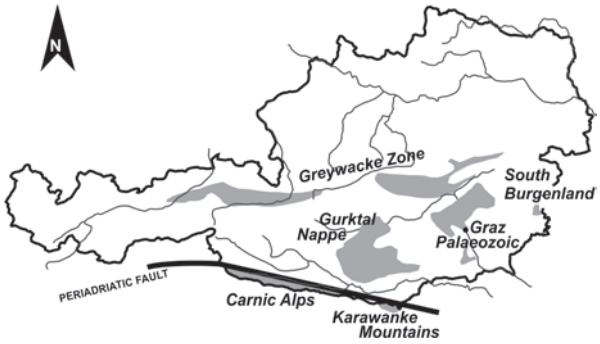


Figure 1: Austria and its disconnected Palaeozoic units (shaded areas).

The "Graz Palaeozoic" located in eastern Austria (Styria) is isolated from other low metamorphic Palaeozoic occurrences in the alpine region by tectonic borders to the north, east and west as well as by its younger overlays in the south (Fig. 2).

Depending on the tectonic concept the Graz thrust complex may be subdivided internally into three (lower, intermediate, and upper; FRITZ & NEUBAUER, 1990) or only two (lower and upper; GASSER et al., 2010) nappe groups. However, both tectonic concepts have in common that the upper nappe group is characterized by basal Silurian volcanic rocks, exposed around the small town Kehr. They are overlain by Devonian to Carboniferous successions of dolomites, sandy and tufaceous dolostones, limestones and marly shales of the "Rannach Facies" (exposed west of the Mur valley and in the Hohe Rannach area), and of the "Hochlantsch Facies" (exposed in the Hochlantsch massif). The "two nappe concept" also includes parts of the "Kalkschiefer Facies" characterized by successions of

carbonaceous schists, sandstones and limestones. The lower nappe group (i.e., "Schöckel Facies"; including the "Laufnitzdorf Facies", and parts of the "Kalkschiefer Facies" in the concept of GASSER et al., 2010) was intensely deformed with penetrative foliation and pronounced stretching lineation under upper greenschist facies conditions. In contrast, the Upper Nappe System experienced only very low to low grade metamorphism hence preservation of fossils is mostly acceptable (HUBMANN & MESSNER, 2007, cum lit.).

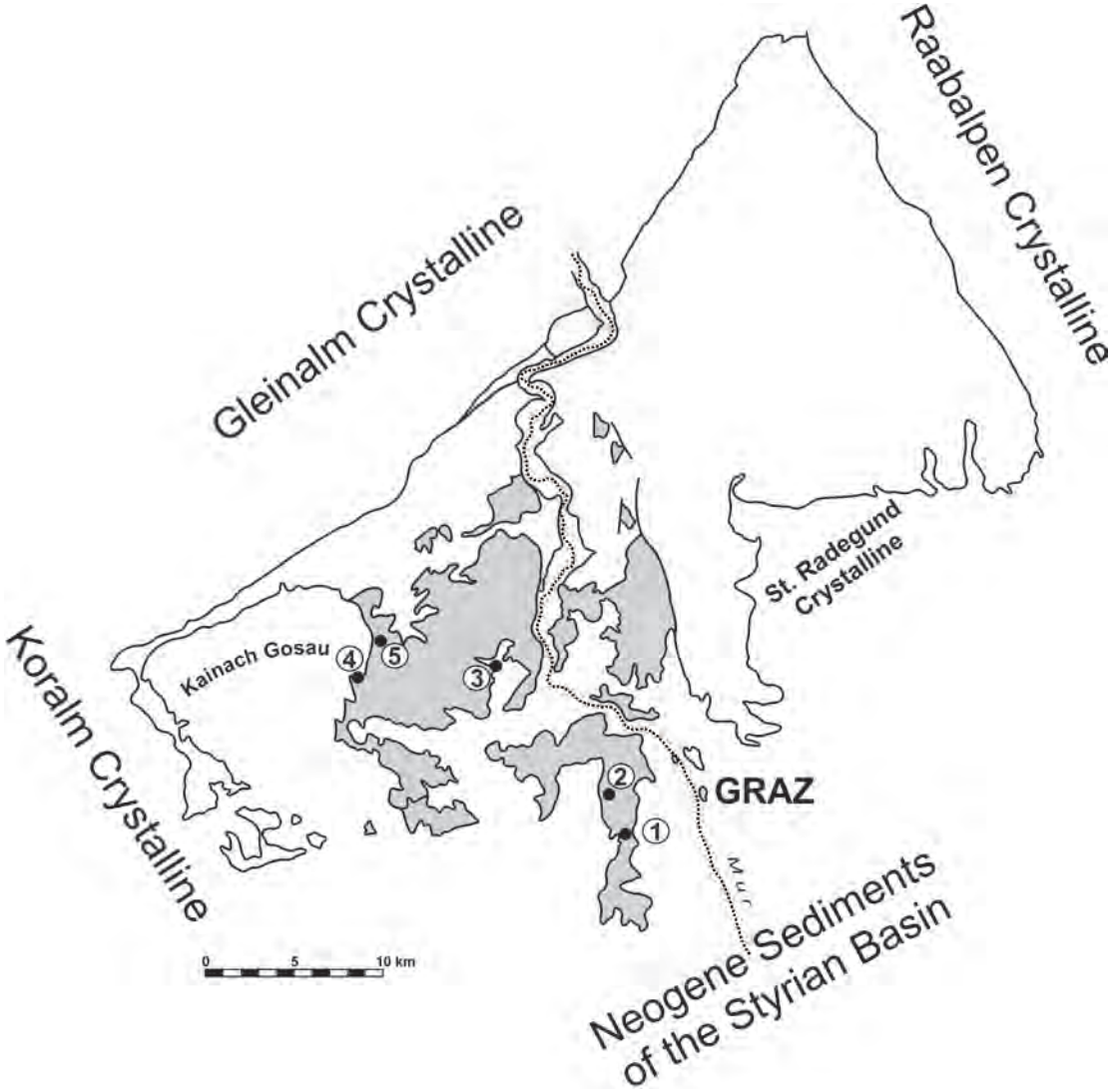


Figure 2: Simplified sketch of the Graz Palaeozoic. The northwestern and western parts are bordered by polycrystalline units (i.e., Gleinalm Crystalline, St. Radegund and Raabalm Crystalline). In the south, Neogene sediments of the "Styrian Basin" are transgressively overlain; the southwestern sector of the Graz Palaeozoic is unconformly covered by Upper Cretaceous sediments of the Kainach Gosau. Shaded patches correspond with outcropping area of the Rannach Facies. Dots with numbers indicate localities with algal findings (further information see text).

Since the "Rannach Facies" which is part of the Upper Nappe System is famous for its shallow marine fossil content, it has been a favoured destination during the last two decades for geologic excursions and, as a result, several excursion guides were published (HUBMANN & HASENHÜTTL, 1995; EBNER et al., 2000, 2001; HUBMANN et al., 2003; HUBMANN & FRITZ, 2004; HUBMANN & MESSNER, 2005; SUTTNER & HUBMANN, 2009; HUBMANN & WEBER, 2010; EBNER & HUBMANN, 2012). The present guide therefore intentionally wants to provide necessary information succinctly; for more detailed information on the stratigraphic development of the Graz Palaeozoic the reader is referred either to the before mentioned field trip guides or to HUBMANN et al. (2013) and complementary literature listed there.

The Rannach Facies: Stratigraphical overview and environmental architecture

The sedimentary sequence of the Rannach Facies (Fig. 3) indicates a change of the depositional area from a passive continental margin with a continental breakup (alkaline volcanism) to shelf and platform geometries during the Upper Silurian to Middle Devonian (FRITZ et al., 1992). During Middle/Late Devonian time the deposition environment changed from near-shore to open platform facies. During Frasnian time the facies changed to a pelagic environment (Forstkogel Group) which continued until the Serpukhovian and is followed by limestones and slates of the Dult Group (Bashkirian).

The sequence starts with more than 100 m thick alkaline basic volcanites and volcaniclastics (Kehr Fm.) which change over to dolostones (Kötschberg Fm.) locally rich in fossils (orthocon cephalopods, bivalves, corals) indicating at least a Ludfordian age (HISTON et al., 2010).

A succession predominantly composed of platy crinoidal limestones intercalated with sandy marls and sand/siltstones (Parmasegg Fm.; Pragian) passing into mostly monotonous light grey late diagenetic dolostones which may be intercalated in different stratigraphic levels by reddish-purple to green volcaniclastics, pure quartz sandstones, marly dolomites, and biolaminated and bioclastic dolomites (Flösserkogel Fm., ?lower Pragian-Emsian) follows. The latter are interpreted as depositions of a supra- to shallow subtidal, barrier-surrounded lagoon, and tidal flats (FENNINGER & HOLZER, 1978).

Overlying and/or interfingering the Flösserkogel Fm. the Plabutsch Fm. (Eifelian) is dominated by dark marly bioclastic limestones. In the lower parts of the formation, especially at the boundary to the Flösserkogel Fm. yellow to brownish shales occasionally blotched with moulds of chonetid brachiopods are characteristic. In the upper parts of the formation intercalations of red marls and marly limestones are common. The limestones predominantly contain typical “reefbuilding organisms” (HUBMANN, 1993, 2003) deriving from coral-stromatoporoid-carpets.

This phase is terminated by biolaminated dolomites, mudstones to bioclastic dolostones and clayey siltstones obviously caused by a eustatic sea level fall (HUBMANN & BRANDNER, 2009). An anew transgression resulted in a sequence with sharp (bio)facial contrasts between patch-reefs and monotonous mudstones (Kollerkogel Fm., Givetian). According to the *Polygnathus-Icriodus* ratio a higher energetic open platform environment is assumed (EBNER, 1998).

During the uppermost Givetian to lower Frasnian the sedimentation changed to variegated micritic cephalopod limestones (Steinberg Fm.) which continue up to the Bashkirian (Sanzenkogel Fm.). The thickness of this pelagic sequence reaches approximately 100 m, except in the eastern part of the Rannach Facies it is reduced due to karstification around the Devonian-Carboniferous boundary (EBNER, 1978, 1980). After an erosional gap at the top of the Sanzenkogel Fm. dark coloured limestones containing birdseye-structures which are interfingering/superposed with/by an alternation of shales with black limestones occur (Höchkogel Fm.).

The sequence of the Rannach Facies is terminated by approximately 50 m thick black shales, sometimes with intercalations of silt- and sandstones with fine phytoclastic material (Hahngaben Fm.). Due to the lack of diagnostic fossils the age of the formation is unknown, however an upper Bashkirian or even younger age is possible (EBNER, 1998).

Algal horizons

Localities with remains of algal thalli are known from the Lower Devonian (Pragian?-Emsian) Flösserkogel Fm. and lower Middle Devonian (Eifelian) Plabutsch Fm.. All these algal findings have in common that they represent monogeneric mass occurrences which are interpreted as (par)autochthonous bafflestones originating from halimedalean meadows (HUBMANN et al., 2008).

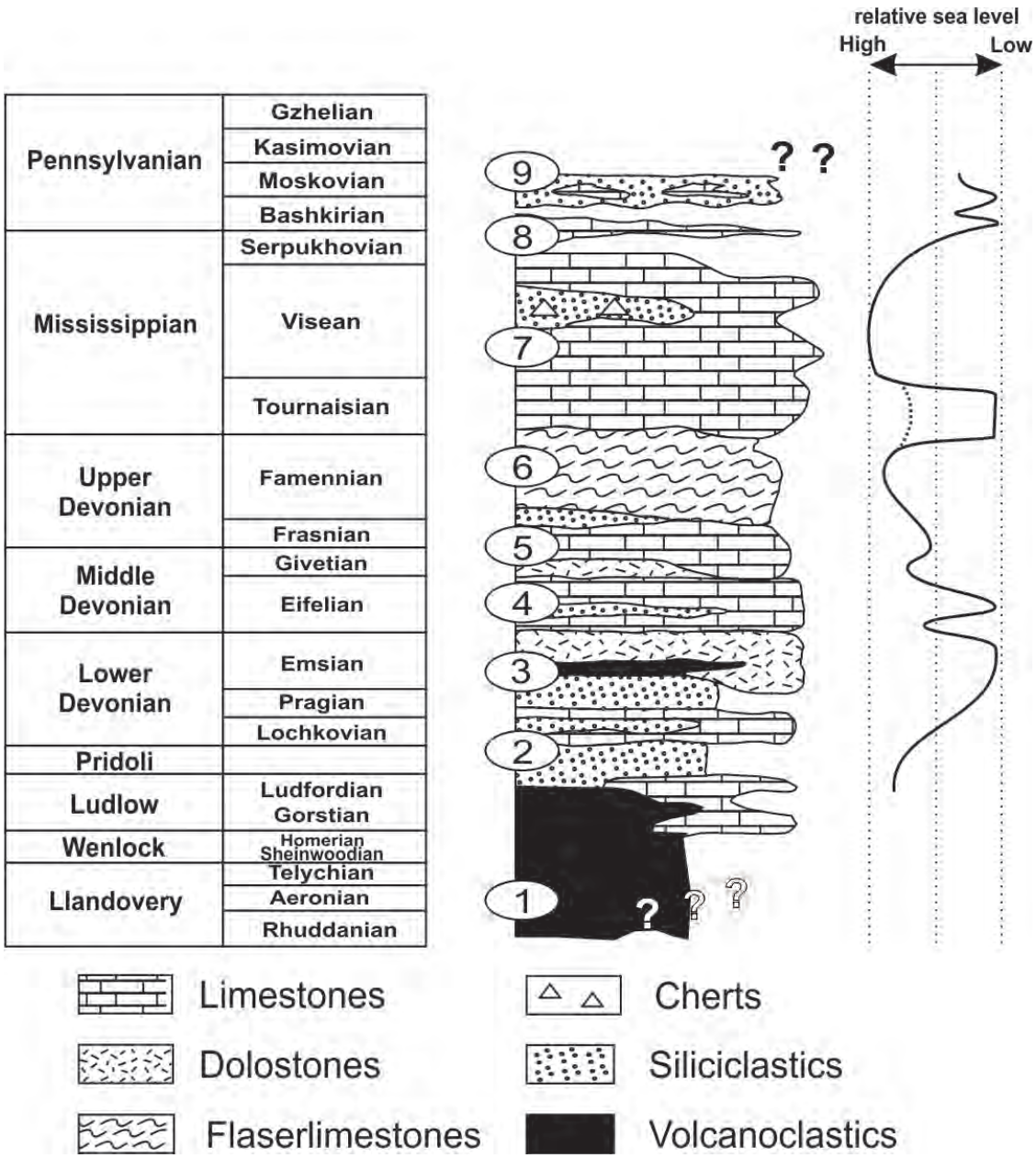


Figure 3: Stratigraphic column of the Rannach Facies and relative sea-level curve estimated from sedimentological and palaeontological data. 1 ... Kehr Fm., Kötschberg Fm., 2 ... Parmasegg Fm., 3 ... Flösserkogel Fm., 4 ... Plabutsch Fm., 5 ... Kollerkogel Fm., 6 ... Steinberg Fm., 7 ... Sanzenkogel Fm., 8 ... Höchkogel Fm., 9 .. Hahngraben Fm.

Localities

The geographic position of localities which will be visited during the excursion are shown in Fig. 2. All below mentioned algal findings have in common only a slight disarticulation of the thalli. Additionally, they occur in clayey lime- to dolostones pointing to hydrodynamically low depositional environments.

(1) Lower part of the Plabutsch Fm. (Eifelian) at Kollerkogel: Dark grey marly limestones of the southern slope of Kollerkogel (near the border to the urban area of Graz), a few meters above the abandoned illite mine contain in scattered occurring patches *Zeapora gracilis* (PENECKE, 1894). Primarily *Zeapora* was mistakenly assigned to the Bryozoans, later to Amphiporoids (see HUBMANN, 2000) (Fig. 4).

(2) Upper part of the Plabutsch Fm. (Eifelian) at Fuchsloch: Along a forest road on the southern slope of the Frauenkogel a sequence of alternating layers of clayey limestones, red mudstones and marls is developed. In the clayey limestones of this alternating sequence *Pseudopalaeoporella lummatonensis* (ELLIOTT, 1961) and subordinate *Pseudolitanaia graecensis* (HUBMANN, 1999) occur (Fig. 5, 6).

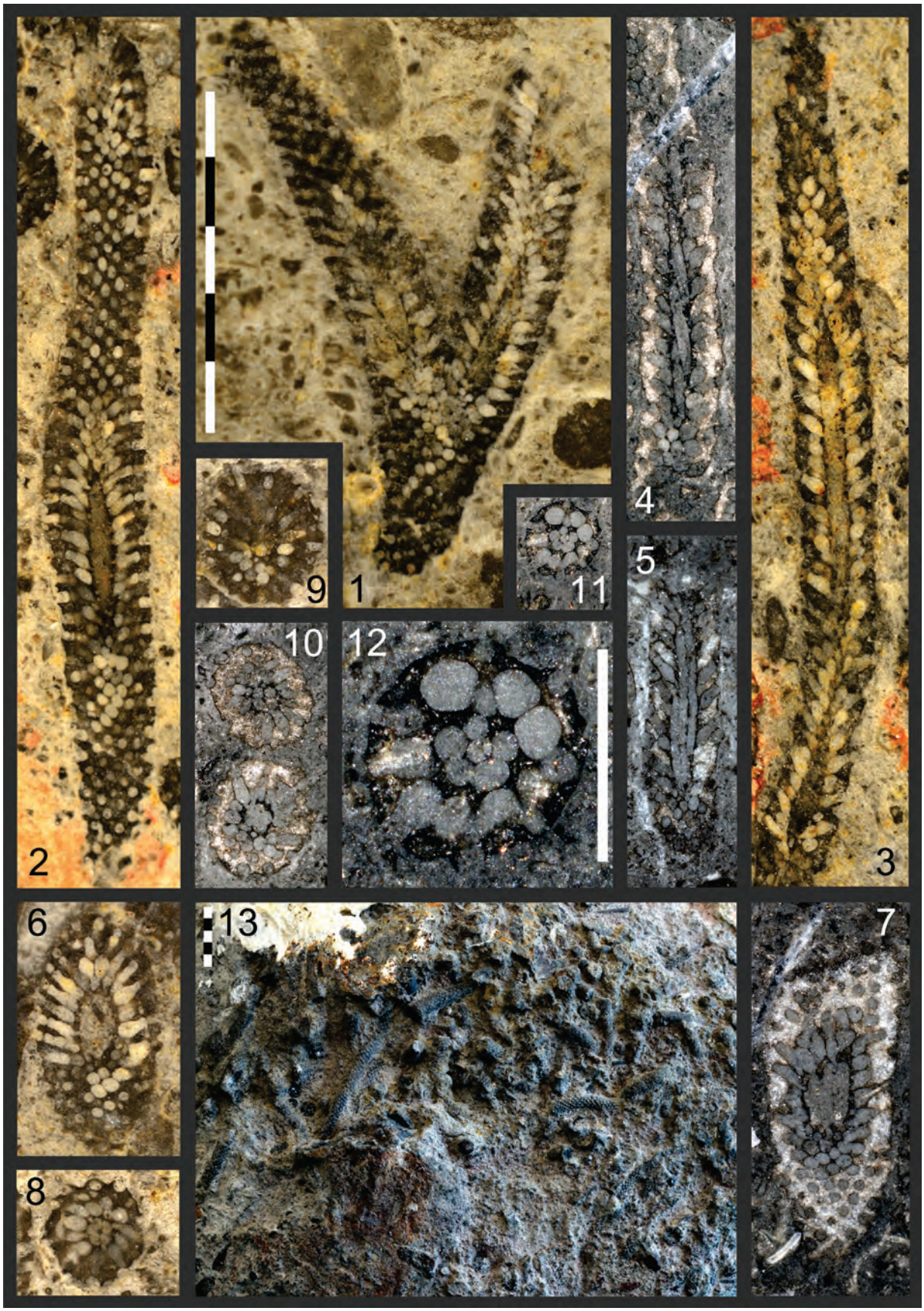
(3) Lower to middle part of the Flösserkogel Fm. (Emsian) at southeastern slope of Mount Hochstein near Rein monastery: Along a recently built forest road on the southern slope of Hochstein dark-grey micritic to pelmicritic dolomites contain a new genus of lanciculoid algae. Algal thalli show only little disarticulation thus individuals show up to 30 or more patelliform segments (articuli) (Fig. 7).

(4) Lower part of the Plabutsch Fm. (Eifelian) at St. Pankrazen: Along the road from Stiwoll to the North some 2 km before St. Pankrazen dark-grey micritic limestones at the base of the Plabutsch Fm. contain a new species of *Maslovina* (*Maslovina* sp. A). The respective horizon lies only a few dm above the basis of a shale horizon which corresponds in its position to the illite horizon of the Kollerkogel (Fig. 8).

(5) Middle(?) part of the Plabutsch Fm. (Eifelian) at the eastern slope of Mount Platzlkogel (approx. 3 km west of "Abrahamwirt": Along a forest road light-grey micritic limestones contain a new species of *Maslovina* (*Maslovina* sp. B) which has apparently greater dimensions of thallus diameters (Fig. 9).

Figure 4 (next page): *Zeapora gracilis* (PENECKE, 1894) of locality 1.
The thalli consist of numerous peripheral tubules arranged around a central axis filled with a bundle of medullar filaments. The medullar zone consists of 4 to 6 (up to 10 and more) slightly interwoven filaments. The cortical zone is filled with massive carbonate deposits and perforated by roundly-elongated, densely packed filaments. Cortical filaments show bowling-like shapes.
Scale for 1 to 11: length of measuring bar 5 mm; 12: length of bar 1 mm; 13: length of bar 5 mm.

1 … Ramification of thallus; slightly oblique longitudinal section. 2 … Peripheral longitudinal section exhibiting cortical filaments in numerous longitudinal and cross sections. 3 … Longitudinal section; sector in the middle exposes the central part of the thallus. 4 … Longitudinal section showing interwoven medullar filaments. 5 … Longitudinal section with straight medullar filaments. 6, 7, 9 … Oblique transversal sections; note clubbed shapes of cortical filaments (6) and the offsets of cortical filaments branching off coarse medullary filaments (7). 8, 9-12: Transversal sections exhibiting five or six central filaments. 13 … Weathered surface of algal limestone of locality 1 built up exclusively by densely packed thalli of *Zeapora gracilis*. The hand rock sample illustrated was a present for the Institute collection by PENECKE in 1894.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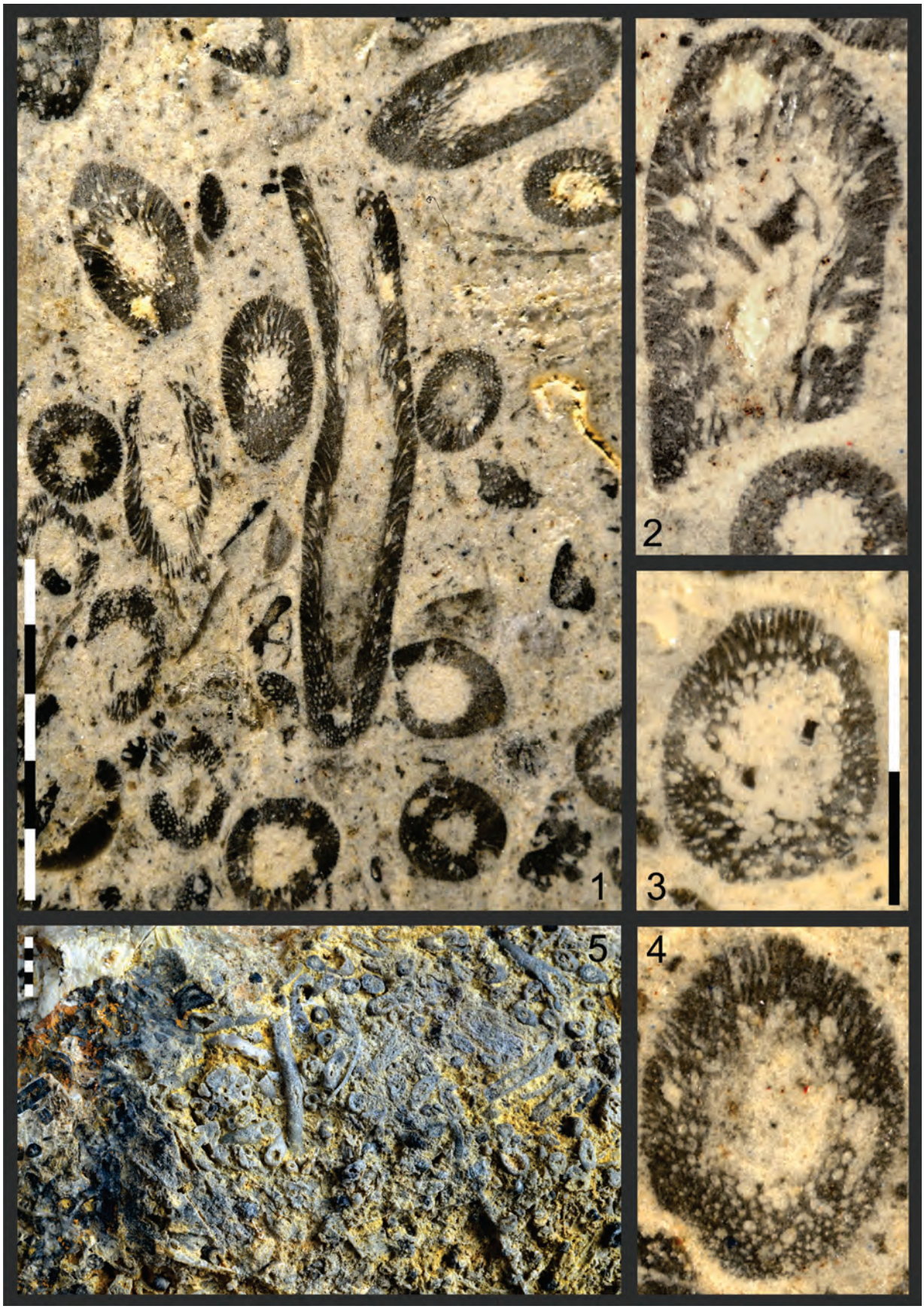
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Figure 5 (previous page): *Pseudopalaeoporella lummatonensis* (ELLIOTT, 1961) of locality 2.
Thalli are cylindrical in shape, sometimes they may slightly be undulant, with a weakly calcified medullar zone and an extensive radial envelope. The medullar zone is composed of several central tubes (up to 20?) and makes up approximately half the entire thallus diameter in cross section. Central filaments are arranged parallel to the thallus axis and are closely spaced. From central tubes cortical filaments develop in acute angles into numerous lateral tubes with a second and third order dichotomy. The filaments are commonly swollen just below the points of branching and widen trumpet-like towards the thallus surface.
Scale for 1 length of measuring bar 5 mm; 2-4: length of bar 2 mm; 5: length of bar 5 mm.

1 … Section parallel to bedding plane with various sectional planes of *Pseudopalaeoporella lummatonensis*. Note in the left upper corner a cross section of *Pseudolitanaia*. 2 … Slightly oblique longitudinal section exhibiting globular spaces in the inner cortex. 3, 4 … Slightly oblique transversal sections. 5 … Surface of algal limestone from locality 2 with densely packed thalli of *Pseudopalaeoporella lummatonensis*.

Figure 6 (next page): *Pseudolitanaia graecensis* (HUBMANN, 1990) of locality 2.
Thalli erect, cylindrical and continuous. The medullar space is built up by 4 to 12, generally 8 irregular filaments Cortical filaments are more or less oblique with a significantly increasing diameter and a spatula-shape. They end up as fine filaments of second order dichotomy.
Scale for 1-4: length of measuring bar 5 mm; 5: length of bar 2 mm.

1 … Section parallel to bedding plane with various sectional planes of *Pseudolitanaia graecensis* together with more delicate *Pseudopalaeoporella* sections. Note right to the measuring bar a section through a thamnoporid tabulate coral. 2 … Central longitudinal section. 3 … Oblique longitudinal section. 4, 5 … Sections through cortical fragments.

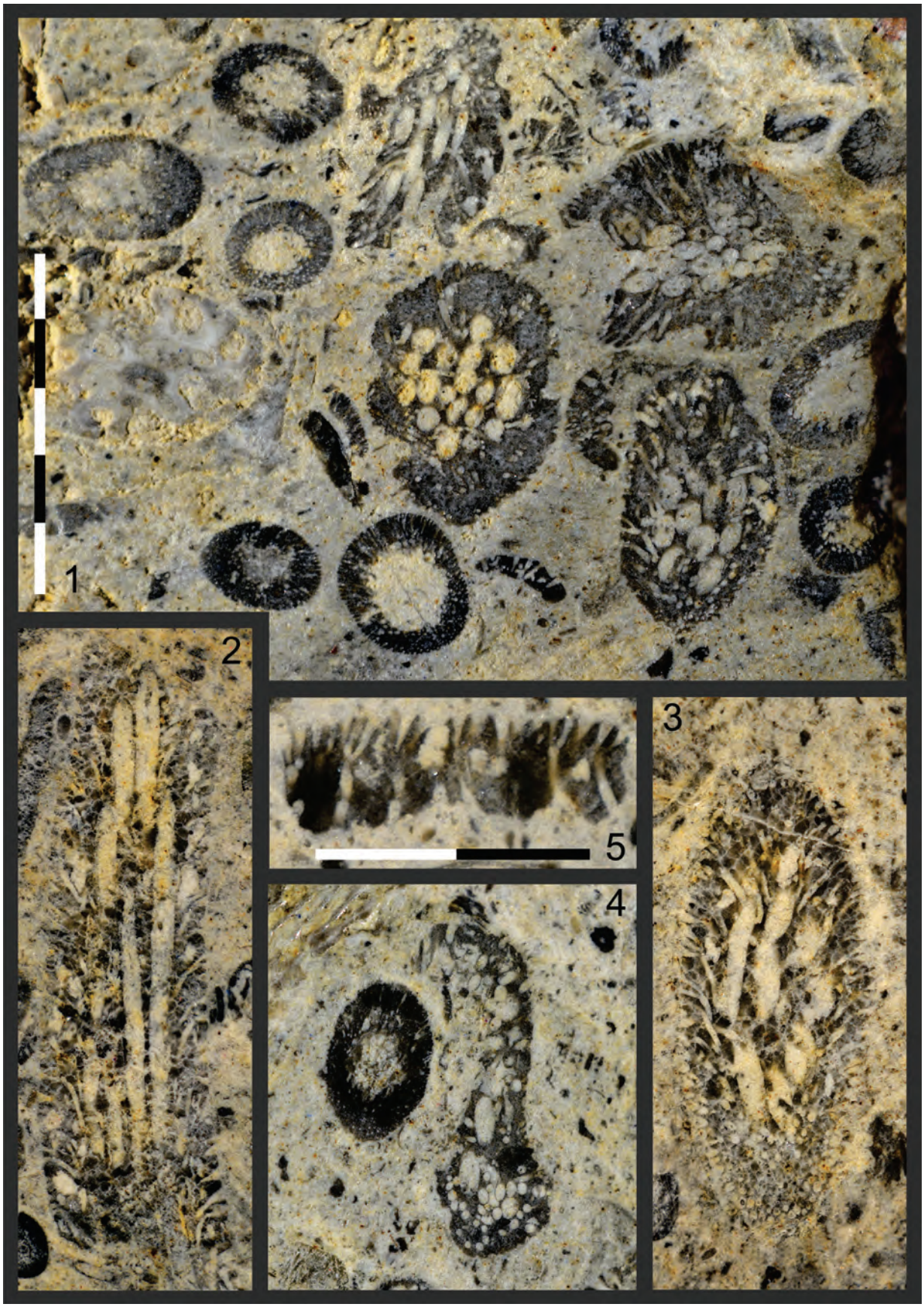
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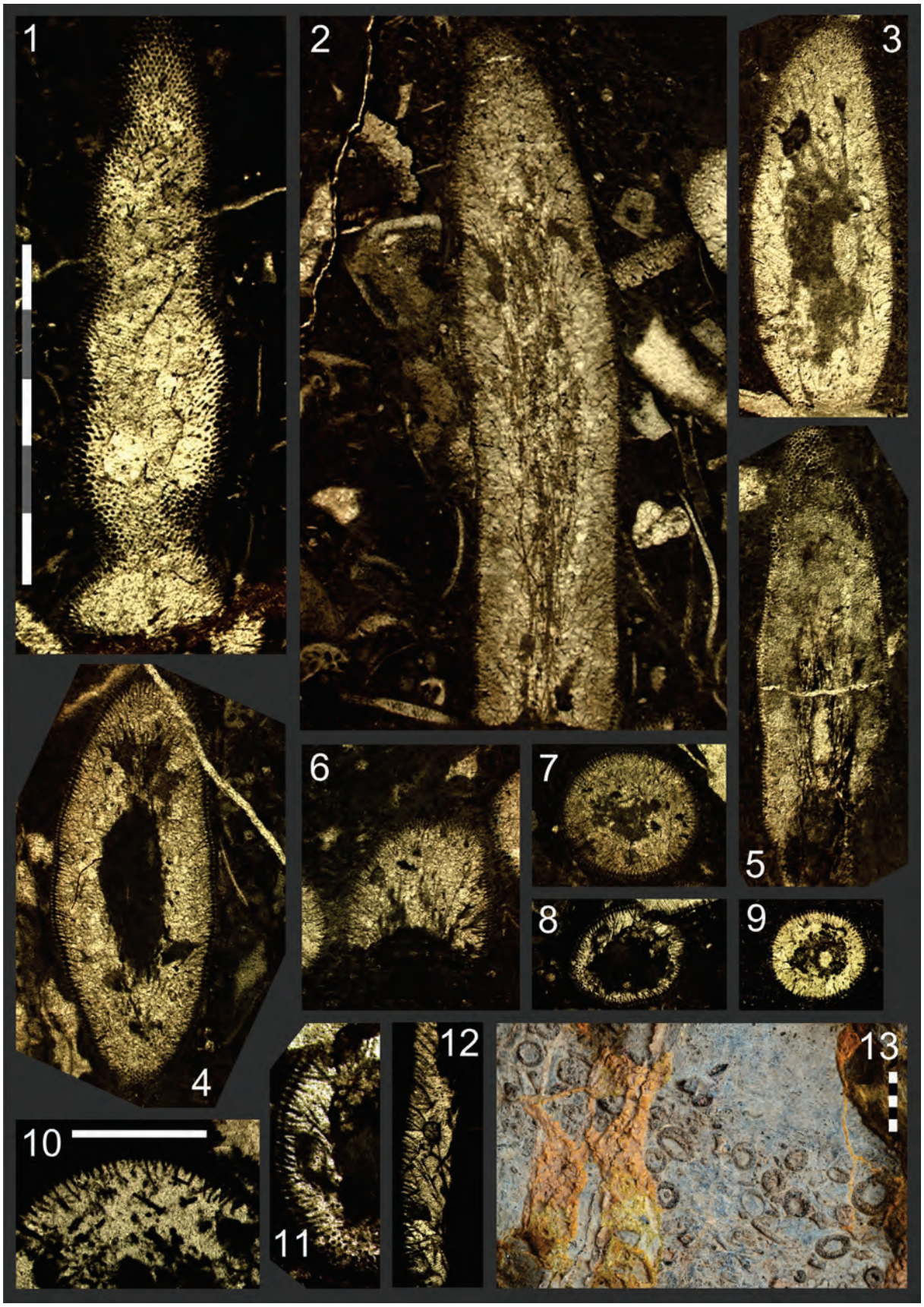
Figure 7 (previous page): New genus of lanciculoid algae of locality 3.
Thalli regularly segmented; individuals consist of up to 25 bowl-shaped elements (articuli, chalices) surrounding a straight or slightly bent stem (rhachis). Occasionally thallus ramifications are observed (see 1).
The internal assembly of four central filaments pervades the whole thallus. They apparently do not vary considerably in diameter, but may be slightly curved or undulating. From medullary filaments a great number of cortical filaments branch off radially and perpendicularly to the central axis decreasing their angles with growth. Each tapered segment contains two rows of cortical filaments and increases its diameter towards growth direction. These segments resemble the bell of a trumpet and are densely stacked one above the other.

Scale for 1 to 6: length of measuring bar 5 mm; 7: length of bar 2 mm; 8: length of bar 5 mm.
1 … Ramification of thallus; longitudinal section with approx. 30 articuli. 2 … Longitudinal section of a benting individual. 3-7 … Cross sections of articuli showing frazzled terminations. 5 … Microphotograph of thin-section illuminated by darkfield condensator exhibiting four, respectively 5 coarse medullary filaments. 8 ... Weathered surface containing densely packed thalli of the new of lanciculoid algae. Location for 5, 8: Ulrichsberg near Rein.

Figure 8 (next page): *Maslovina* sp. A of locality 4.
Thalli of a straight, cylindrical shape, occasionally undulated. Internally organised into a generally poorly calcified medullar area and a cortical zone. The medullar part consists of a high number (>40) of interwoven filaments which give rise to finer, cortical filaments. They divide up dichotomously at an acute angle and reach a third order dichotomy at the outermost cortical part. At this stage cortical filaments develop towards densely packed amphora-shaped utricles which constitute the thallus surface. The outermost cortical filaments develop into a layer of tightly packed amphora-shaped utricles.
Scale for 1 to 9: length of measuring bar 5 mm; 10-12: length of bar 1 mm; 13: length of bar 5 mm.

1 … Peripheral longitudinal section showing undulant shape of thallus . 2 … Central longitudinal section exhibiting numerous medullar filaments. 3, 4 … Oblique transversal sections exhibiting delicate cortical filaments. 5 … Slightly oblique longitudinal section showing peripheral layer of tightly packed utricles. 6 … Apical ending of thallus in longitudinal section. 7-9 ... Various cross sections of *Maslovina* sp. A. 10-12 ... Sections through cortical parts. Note globular and irregular spaces within the outer cortex. 13 … Weathered surface of a sample showing prostrate orientation of *Maslovina* thalli.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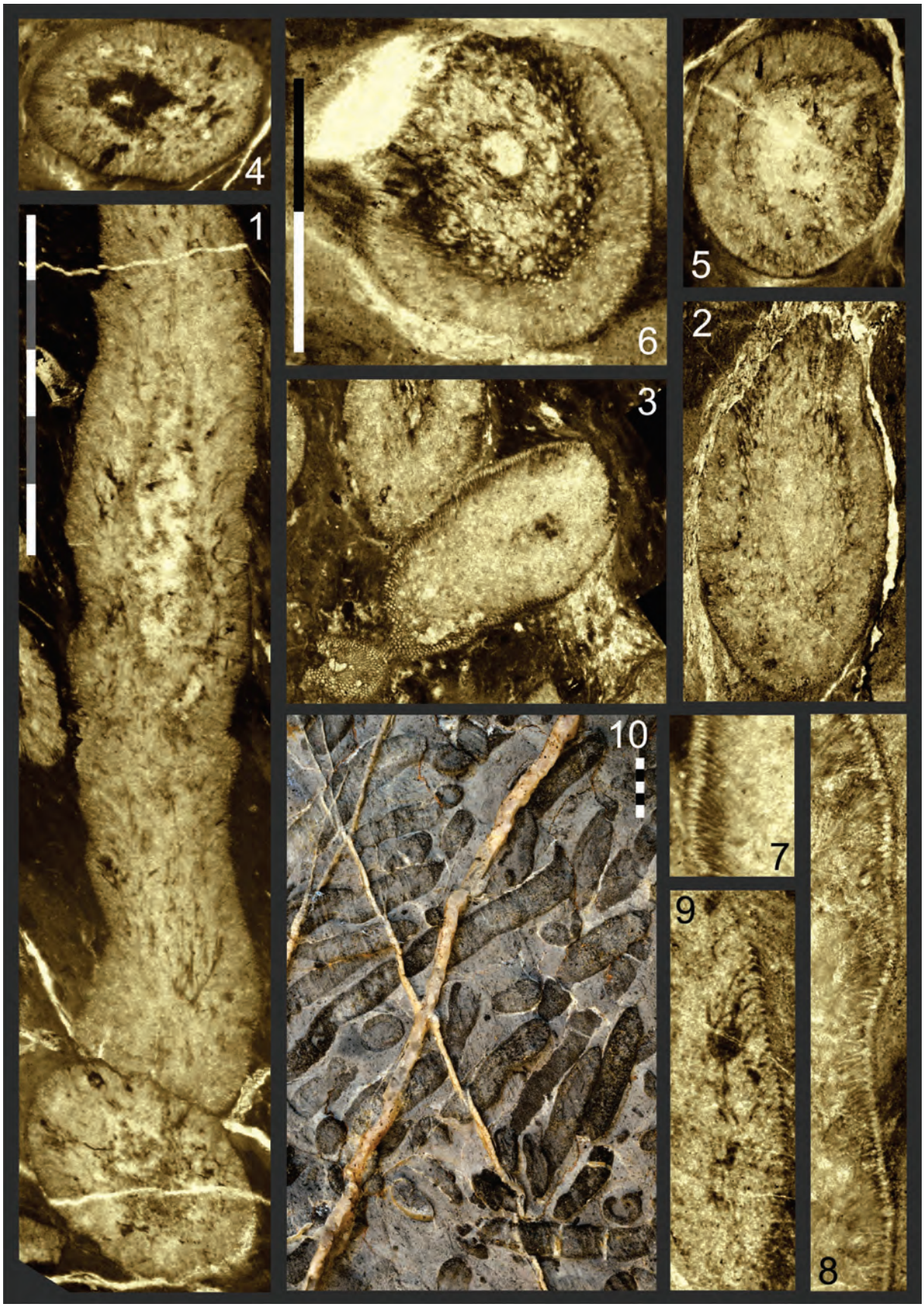
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Figure 9 (previous page): *Maslovina* sp. B of locality 5.
Straight cylindrical thalli, occasionally undulated. In very few individuals a high number of central filaments are observable in the poorly calcified medullar zone. Medullar filaments give rise to finer, cortical filaments which dichotomously ramify at the outermost cortical part forming an irregular 'epiderm'. *Maslovina* sp. B differs from *Maslovina* sp. A in having fine cortical filaments from which tightly packed utricles branch off forming a tight layer at thallus terminations. Utricles are inverted pear-shaped. Additionally, *Maslovina* sp. B has greater thallus dimensions.
Scale for 1 to 5: length of measuring bar 5 mm; 6-9: length of bar 2 mm; 10: length of bar 5 mm.

1 … Longitudinal and transverse section. 2 … Oblique longitudinal section exhibiting cortical filaments at the periphery of the medullar zone. 3-6 … Cross sections showing arrangement of cortical filaments. 6 … Cross section; albeit calcification of the central zone is rather poor an internal arrangement of numerous very fine filaments may be 'foreshadowed'. 7-9 Longitudinal sections through peripheral cortical parts. Note last ramifications of filaments forming an 'epiderm'. 10 ... Weathered rock surface with *Maslovina* sp. B of locality 5.

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