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Middle Triassic (Anisian) Limestones from Bled, Northwestern Slovenia: Microfacies and Microfossils

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Abstract

Microfacies types (predominantly intrabioclastic grainstones) and microfossils (predominantly dasycladacean algae and diverse foraminifera) characterize the Anisian carbonates near Bled (Castle Hill) and in the area westnorthwest of Bled as subtidal to intertidal shelf sediments deposited in the inner part of the Julian carbonate platform. The age of the carbonates is Middle Anisian (Pelsonian) according to the biozonation based on foraminifera and dasycladaceans.

Introduction

The recovery of the "carbonate factory" after the Permian/Triassic crisis is still poorly understood. It is generally assumed that carbonate producers started to recover during the Anisian forming biogenic carbonate buildups as well as huge carbonate platforms. Some of these platforms are found in the Southern Alps (e. g., Senowbari-Daryan et al., 1993) and in the Dinarides, other in Southern China. There are only a few studies dealing with the microfacies and the distribution of facies-diagnostic microfossils.

One of these Anisian platforms is the early Julian Platform. To the north and northeast, this platform was bounded by a reef zone (Ramovš, 1987), and to the south by a deeperwater trough (Slovenian Trough), separating the Julian Platform from the Dinaric Platform (Buser et al., 1982).

Geological Framework

The studied area is located in northwestern Slovenia near Bled at the foothills of the Julian Alps. This area was first studied by Diener (1884, p. 694): "Das älteste Gebilde, das an dem Bau dieses Gebietes noch Antheil nimmt, ist der obere Muschelkalk, der hier durchaus in der Facies des Mendola-Dolomits erscheint und die malerischen Hügelgruppen der Umgebung von Veldes zusammensetzt. Der Vintigar Hrib (840 m) bei Asp, die kleinen Kuppen von Ober-Göriach, Retschitz und Pogelschitz, der Sirov und Visoinica Vrh (459 Meter) im Westen, die Straza (648 Meter), der Kosarc, Obroc und Pastrgannek (591 Meter) im Süden des Veldeser Sees, die beiden Höhen endlich, auf welchen die "Villa Rikli" und das Alte Schloß Veldes stehen, gehören diesem Dolomit des oberen Muschelkalkes an."

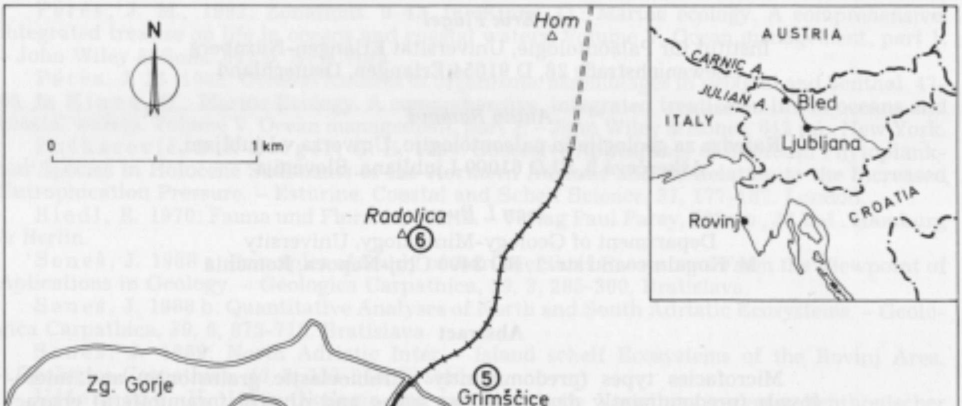

Fig. 1. Anisian carbonates near Bled, northwestern Slovenia: Location of the sampling localities. Most samples studied are from locality 1 (Castle Hill cliff in Bled)

Teller (1908) described Werfen Beds from the northern margin of the Bled Lake.

Seidl (1929, p. 10) published a geological map, based on studies of Teller, Kossmat, Haertel and Winkler. The Castle Hill in Bled was believed to consist of Permian and Permocarboniferous. The occurrence of Werfen Beds is indicated at the northern margin of the Lake Bled and Middle and Upper Triassic strata north of this area. Permian and Permocarboniferous are reported from the southern flank of the Straža Mountain whereas other parts of this mountain are regarded as Middle and Upper Triassic. Lower Triassic and Middle Triassic strata occur west of the Lake Bled as well as in the Poljšica and Krnica area. In contrast, only Schlern Dolomite and limestone equivalents are shown in this area in the provisional map prepared by Vetters (1933).

According to Buser (1980, p. 24), Middle Permian Neoschwagerina limestones occur at the Castle Hill in Bled, at the Bledec Hill as well as in several localities west of the village Recica. These limestones are separated by several northwest-southeast trending faults from massive Anisian dolomites and Ladinian sediments (see Buser & Cajhen, 1977).

On the north side of the Mežakla Plateau, Buser (1980, p. 26) mentioned gray, massive limestones with *Physoporella pauciforata, P. minutoloidea* and *Macroporella alpina* from Baba north of Kočna.

The reinvestigation of the carbonates in the neighbourhood of Bled was initiated by the study of the Middle Permian reef carbonates of the Straža quarry (Flügel et al., 1984).

Sampling localities

Fig. 1 shows the sampling localities in and near Bled (1 – cliff of the Castle Hill in Bled, cf. Pl. 7, Fig. 2; 2 – above the road south of the Bledec Hill, 3 – 100 m northwest of the crossroads Bled-Recica-Castle Hill; 4 – Crossroads Bled-Grimščice and Bled-Castle Hill) as well westnorthwest of Bled (5 – Grimščice, 6 – southern flank of the Radoljca Mountain, 7 – several localities south of Poljšica, 8 – Stojiče).

The Castle Hill cliff was sampled by Flügel and Ramovš in 1983, the other localities by Ramovš in 1984. Our study is focused on the Castle Hill cliff: About 40 large thin-sections have been prepared (up to 10x15 cm in size). Samples B-0 and B-1 to B-10 were collected at the top of the cliff within the court yard of the castle, sample B-0 is from the rock forming the foundation of the castle's chapel. Samples B-11 to B-30 were taken at the path connecting the castle with Bled, samples B-33 to B-37 were collected near the parking lot. Most of the grey, indistinctly bedded carbonates are biolithoclastic grainstones (microfacies type 1). Other microfacies types (algal fenestral bindstones, MF 2; lithoclastic-peloidal floatstones and rudstones, MF 3) are rare (see Fig. 2) and restricted to the higher and the lower parts of the cliff, respectively.

Microfacies

Microfacies Types

The samples from the Castle Hill cliff as well the other samples represent three microfacies types:

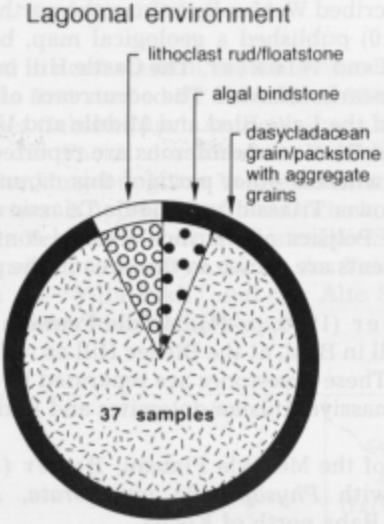

Fig. 2. Frequency of the microfacies types recognized in the carbonates of the Castle Hill cliff in Bled

MF 1: **Biointraclastic grainstones with aggregate grains, dasycladacean algae and foraminifera** (Pl. 6, Figs. 1-5, Pl. 7. Fig. 4, 7): This microfacies is characterized by aggregate grains (predominantly lumps, Pl. 7, Fig. 5), dasycladacean algae (Pl. 1; Pl. 2, Figs. 1-4) and a diverse foraminifera fauna (Pl. 2, Figs. 9-14; Pl. 3; Pl. 4; Pl. 5, Figs. 1-11). The grains are surrounded by isopachous rim cements (Pl. 7, Fig. 5). Interparticle voids are filled by drusy calcite cement.

The biota, studied in more than 20 samples, consist of foraminifera (occurring in 85 % of the total samples), dasycladaceans (in 60 % of the samples), thin-shelled ostracods (45 %), echinoderm fragments (35 %), gastropods (15 %), encrusting organisms (*Bacinella*, Pl. 7, Fig. 4, 15 %), solenoporacean algae (15 %), brachiopods (10 %) and porostromate algae (5 %).

In some samples the grainstone fabric grades into a packstone (Pl. 6, Figs. 2 and 4) and even a wackestone fabric. Many larger bioclasts, e.g., dasycladacean thalli, are strongly micritized (Pl. 6, Fig. 1). The size of the aggregate grains varies between 200 and 2500 µm. Most lumps exhibit the characteristic lobular shape caused by protruding particles (Pl. 7, Fig. 5); many grains are fixed by encrusting organisms. There are, however, also larger aggregate grains, which have been cemented prior to final deposition. These grains are angular, protruding inclusions are truncated.

MF 2: **Fenestral algal bindstone** (Pl. 7, Fig. 3). This type, only known from the higher part of the Castle Hill cliff, is characterized by open-space structures developed as irregularly-shaped, spar-filled fenestrae between pelmicritic laminae. These laminae consist of densely-packed peloids and vague, poorly preserved algal filaments. Coalescing laminae may grade into large, irregularly shaped aggregate grains. Interspace voids are filled with drusy and recrystallized blocky calcite cements. Fossils are small agglutinated foraminifera, thin-walled ostracods and small tube-like microfossils.

MF 3: **Lithoclastic-peloidal rudstone and floatstone** (Pl. 6, Figs. 6, 7; Pl. 7, Fig. 6). The main characteristic of this facies type ia a multiple deposition of small pelmicritic and micritic litho- and intraclasts, followed by the formation of lithoclastic floatstones which were later affected by tectonical brecciation. Stylocontacts between larger clasts are common. The size of the lithoclasts varies between 1 and about 25 mm. Together with pelmicritic and pelsparitic lithoclasts, clasts exhibiting fenestral fabrics (MF 2) have been deposited. Some of the clasts are encrusted by foraminifera.

Interpretation

The microfacies types are characteristic of subtidal and intertidal shelf carbonates. Microfacies 1 corresponds to the Standard Microfacies Types 17 and 18 (shelf lagoons with tidal flats), and microfacies 2 to the Standard Microfacies Type 19 (restricted ponds within the tidal flats). MF 3 may represent SMF type 24 (lag deposits in tidal channels).

The possible occurrence of **reefal facies** is indicated by *Olangocoelia otti* Bechstädt & Brandner (1970) (Pl. 5, Figs. 12-14; samples B-10B and B-15), a common frame-building organism in Anisian (and Ladinian) reef mounds (cf. Senowbari-Daryan et al., 1993) and by *Anisocellula fecunda* Senowbari-Daryan et al. (Poljšica, Pl. 7, Fig. 1), originally described from Anisian reef limestones of the Northern Dolomites.

Most of the samples from the Castle Hill cliff indicate the existence of sand shoals. Microfacies 2 includes grainstones as well packstones and samples with different amounts of dasycladacean algae and foraminifera. A differentiation of the samples according to texture types and the frequency of algae and foraminifera may exhibit similar features as described from the Camorelli Carbonate Bank of Lombardy (Gaetani & Gorza, 1989). This Anisian platform is characterized by dasycladacean limestones, reefal limestones and foraminiferal limestones. Dasycladacean limestones and the overlying foraminiferal limestones are interpreted as deposits of different water depth, reflecting a transgressive event.

Because of the tectonical complications in the Bled area, the samples of the Castle Hill cliff probably do not describe a normal stratigraphic section. It is not possible, therefore, to transfer the model described from the Camorelli Platform zu the Anisian carbonates studied. On the other hand, the subdivision of the Castle Hill samples in about the same number of samples containing dasycladaceans and foraminifera and samples containing only foraminifera may indicate the existence of comparable depositional patterns. Alternating dasycladacean/foraminiferal grainstones and foraminiferal packstones, interpreted as the results of different water depths are also known from the Dinaric Platform (Pantić, 1970), the Southern Alps (Bechstädt & Brandner, 1970) and the Tatra Mountains (Belka & Gaździcki, 1976).

Microfossils

List

Not all microfossils could be determined due to random sections or poor preservation. Many taxa, therefore, have been handled as cf. and aff. forms. Considering also these forms as individual taxa, about 40 foraminiferal taxa and about 12 algal taxa were recognized in the studied thin-sections. The following microfossils were identified in the limestones from the Castle Hill cliff and in other localities:

Algae: *Macroporella alpina* Pia (Pl. 1, fig. 4–6), *Macroporella beneckei* (Salomon) (Pl. 1, fig. 2, 3), ? *Teutloporella* sp., *Physoporella cf. pauciforata* (Gümbel) (Pl. 1, fig. 10), *Physoporella* cf. *varicans* Pia, *Physoporella* cf. *minutula* (Gümbel) (Pl. 2, fig. 4), *Physoporella* cf. *intusannulata* Hurka, *Oligoporella pilosa pilosa* Pia (Pl. 2, fig. 3), *Oligoporella pilosa varicans* Pia (Pl. 2, fig. 1), *Oligoporella* cf. *pilosa* Pia (Pl. 2, fig. 2), ? *Oligoporella* sp., ? *Diplopora* sp., ? *Kantia* sp., *Poncetella hexaster* (Pia) (Pl. 1, fig. 7–9), *'Griphoporella'* sp. (Pl. 1, fig. 11, 12), *Solenopora* sp. (Pl. 2, fig. 5–7), ? *Stenoporidium* sp. (Pl. 2, fig. 8).

Foraminifera: *Earlandia* cf. *tintinniformis* Mišik, *Earlandinita grandis* Salaj (Pl. 3, fig. 1, 2), *Earlandinita elongata* Salaj (Pl. 2, fig. 10), *Reophax* aff. *asper* Cushman & Waters (Pl. 3, fig. 3), *Nodosinella* cf. *libera* (Trifonova) (Pl. 3, fig. 4), ? *Valvulina* sp. (cf. *Valvulina azzouzi* Salaj) (Pl. 2, fig. 11), ? *Textularia* sp., *Trochammina almtalensis* Koehn-Zaninetti (Pl. 2, fig. 12, 14), *Trochammina jaunensis* Brönnimann & Page (Pl. 2, fig. 13), *Glomospira irregularis* (Möller) (Pl. 5, fig. 4), *Glomospira* cf. *articulosa* (Plummer) (Pl. 5, fig. 2), ? *Glomospira* sp. cf. *Glomospira? micans* He & Yue (Pl. 5, fig. 1), *Glomospira* div. sp., *Glomospirella* cf. *triphonensis* Baud et al., *Glomospirella* sp., *Pilammina densa* Pantić (Pl. 5, fig. 7, 8), *Meandrospira dinarica* Kochansky-Devide & Pantić (Pl. 3, fig. 12–15), *Meandrospira* aff. *dinarica* Kochansky-Devide & Pantić (Pl. 3, fig. 16, 17; Pl. 4, fig. 1, 2), *Meandrospira deformata* Salaj (Pl. 4, fig. 4, 5), *Meandrospira* sp. aff. *Meandrospira pusilla* (Ho) (Pl. 3, fig. 5–7), *Meandrospira insolita* (Ho) (Pl. 3, fig. 9), *Meandrospira* sp. aff. *Meandrospira insolita* (Ho) (Pl. 3, fig. 8, 10, 11), ? *Meandrospira* sp., ? *Agathammina* sp. (Pl. 4, fig. 14), *Endothyra* cf. *brassica* (Trifonova), *Endothyra kuepperi* Oberhauser (Pl. 4, fig. 10, 13), *Endothyra* sp., *Endothyranella wirzi* (Koehn-Zaninetti) (Pl. 4, fig. 11), *Endothyranella robusta* Salaj (Pl. 4, fig. 6), *Endothyranella lombardi* Zaninetti et al. (Pl. 4, fig. 7, 9), *Endothyranella* cf. *alpina* Zaninetti et al. (Pl. 4, fig. 8), *Parendothyra* sp., ? *Endothyranopsis* sp., ? *Planiinvoluta* sp., ? *Aulotortus* sp. cf. *Aulotortus pragsoides* (Oberhauser) (Pl. 4, fig. 12), ? *Aulotortus* sp., *Diplotremina astrofimbriata* Kristan-Tollmann (Pl. 5, fig. 9, 10), *Duostomina alta* Kristan-Tollmann, *Nodosaria* aff. *ordinata* Trifonova, ? *Austracolomia* sp. (Pl. 5, fig. 11).

Incertae sedis: *Olangocoelia otti* Bechstädt & Brandner (Pl. 5, fig. 12–14), *Anisocellula fecunda* Senowbari-Daryan et al. (Pl. 7, fig 1).

Biostratigraphic significance

1. Foraminifers

The most frequent foraminifers in the Castle Hill carbonates are species of the genera *Meandrospira, Glomospira-Pilamina* and *Diplotremina.*

Meandrospira dinarica is particularly frequent in some levels (Samples B-3, B-5, B-22, B-23, B-25, B-26). It is frequently accompanied by a form showing similar morphological features but smaller dimensions. Such specimens were reported by Oravecz-Scheffer (1987) as *Meandrospira* aff. *dinarica.*

The *Glomospira-Pilamina* species are frequent in the samples B-3, B-11, B-29, *Diplotremina astrofimbriata* in the samples B-24, B-26 and B-27.

Many of the identified species have a relatively large stratigraphical range covering almost all Triassic stages. However, some species are restricted to specific time intervals:

Pilamina densa was frequently described from the whole Anisian (Pantić, 1970; Pantić-Prodanović, 1975; Trifonova, 1978; Salaj et al., 1983; Oravecz-Scheffer, 1987), or only from parts of the Anisian (Illyrian: Salaj, 1969; Late Anisian: Zaninetti et al., 1972; Pelsonian to Early Illyrian: Gazdzicki et al., 1975; Pelsonian: Ramovš, 1975; Middle to Late Anisian: Zaninetti, 1976, 1977; Pelsonian to Early Illyrian: Strutinski et al., 1987). Only Dager (1978) mentions this species from the Late Scythian to the Middle Anisian.

Meandrospira dinarica is known from the Middle Anisian (Pelsonian; Gaździcki et al., 1975, Zaninetti, 1977), and from Middle to Late Anisian (essentially Pelsonian to Early Illyrian: Pantić, 1970; Ramovš, 1972; Zaninetti et al., 1972; Zaninetti, 1976; Dager, 1978; Trifonova, 1978: Salaj et al., 1983 and Strutinski et al., 1987).

Meandrospira deformata was reported from the Late Scythian to Pelsonian (Gaździcki et al., 1975; Zaninetti, 1977; Trifonova, 1978; Salaj et al., 1983).

Meandrospira pusilla is predominantly known from the Scythian to Early Anisian (»Hydaspian«), but the species was also reported from the Pelsonian (Gaździcki et al., 1975) or, rarely, also from the Illyrian (Salaj et al., 1983).

Meandrospira insolita, a poorly known species, it is reported from the Early Anisian (Aegean) and rarely also from the Pelsonian (Salaj et al., 1983).

Other species of stratigraphic importance are ***Endothyranella wirtzi*** known mostly from the Middle to Late Anisian, and (rarely) also from the Lower Ladinian, ***Endothyranella lombardi,*** (known from the same time interval), and ***Trochammina almtalensis*** (Middle Anisian to Early Ladinian: Zaninetti et al., 1972; Gaździcki et al., 1975; Zaninetti, 1976, 1977; Trifonova, 1978; Salaj et al., 1983; Oravecz-Scheffer, 1987).

Based on foraminifers, several zonations have been proposed for the Early to Middle Triassic: Salaj (1969), Zaninetti et al. (1972), Gaździcki et al. (1975); Trifonova (1978, 1983); Salaj et al. (1983) and Salaj et al. (1988). Salaj et al. (1988) established seven biozones:

7) *Aulotortus pragsoides* zone (Illyrian)
6) *Meandrospira dinarica* zone (Pelsonian to Illyrian)
5) *Pilammina densa* zone (part of Bithynian to Pelsonian)
4) *Meandrospira deformata* zone (Aegean to part of Bithynian, hypersaline environment)
3) *Meandrospira insolita* zone (Aegean to part of Bithynian)
2) *Meandrospira pusilla* zone (Early Triassic corresponding to Spathian)
1) *Meandrospira cheni* zone (Early Triassic corresponding to Smithian-Lowermost Spathian).

The foraminiferal assemblage from Castle Hill carbonates corresponds, to the biozones 4, 5 and 6 of Salaj et al. (1988), i. e. the *Meandrospira deformata, Pilammina densa* and *Meandrospira dinarica* zones. It is difficult to say whether all the 3 zones are presented in the Castle Hill carbonates but, as a whole, the foraminiferal assemblage points to an (Early ? to) Middle Anisian age of all samples studied.

2. Algae

The most frequent dasycladacean species is *Macroporella alpina* Pia (Samples B-8, B-10, B-13, B-19, B22, B-23A, B-25), followed by *Poncetella hexaster* (Samples B-5, B-23A, B-27) and species of the *Physoporella-Oligoporella* group (Samples B-3, B-5, B-10B, B12).

This association is typical for the Middle Anisian (more precisely for the Pelsonian to Early Illyrian: Pia, 1912; 1920; 1935; Bystricky, 1964; 1986; Ott, 1972; 1974; Dragastan et al., 1982; Senowbari-Daryan et al., 1993).

Based on dasycladacean algae, Bystricky (1986) distinguished three Middle Triassic biozones:

3) *Diplopora annulata* zone (Ladinian)
2) *Diplopora annulatissima* zone (Late Illyrian)
1) *Physoporella pauciforata-Oligoporella pilosa* zone (Late Bithynian to Early Illyrian).

The first zone corresponds to the *Meandrospira dinarica-Pilammina densa* occurrence, and within this zone, the appearance of *Diplopora hexaster (= Poncetella hexaster)* indicates the lower part of the Pelsonian.

In conclusion, the algal-foraminiferal assemblage from the Castle Hill in Bled indicates an Anisian age, most probably an (Early?)-Middle Anisian (= Aegean(?)-Pelsonian) age. The composition of the assemblage is very similar to those described from the Alps and Prealps (Pia, 1920; Zaninetti et al., 1972; Zaninetti, 1976, 1977); Hungary (Oravecz-Scheffer, 1987); Carpathians (Slowakia, Poland, Romania) (Bystricky, 1964, 1986; Gaździcki et al., 1975; Salaj et al., 1983; Strutinski et al., 1987); Apuseni Mountains (Romania) (Dragastan et al., 1982); Balkans (Bosnia, Serbia, Bulgaria; Pia, 1935; Pantić, 1970; Trifonova, 1978, 1983) and Turkey (Dager, 1978).

Microfossil Associations

Dasycladacean algae and foraminifera are common microfossils in Middle Triassic platform carbonates. The study of about 35 large thin-sections offers the possibility to discuss the numerical diversity and the composition of the associations.

Regarding the total number of taxa belonging to foraminifera, algae and microproblematica, the numerical diversity varies between 1 and 19. Samples exhibiting a very hight diversity (> 10 species per sample; B-3 and B-5 from the top of the Castle Hill cliff; B-24), however, are rare (4 samples out of the total of 35 samples). 17 samples are low-diverse (1 to 4 species), 14 samples higher diverse (5 to 9 species).The taxonomic composition of the associations exhibits no distinct patterns except for the absence of dasycladaceans in about 40 % of the samples. Samples with dasycladacean algae and foraminifera are characterized by the frequent occurrence of *Earlandinita, Glomospira* and *Meandrospira*. These taxa, however, occur also in the samples which contain no dasycladacean algae.

Conclusions

Age: Based on dasycladacean algae and foraminifera, the age of the studied carbonates is Middle Anisian, most probably Pelsonian.

Facies: Microfacies types (predominantly intrabioclastic grainstones and packstones; a few algal fenestral bindstones and lithoclastic floatstones and rudstones) correspond to those of subtidal (and intertidal) platform carbonates which might have been deposited in slightly different water depths. There are only a few indications *(Olangocoelia, Anisocellula)* for the existence of reefal facies in the Bled area.

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Plate 1

Anisian carbonates from the Castle Hill cliff, Bled, northwestern Slovenia: Dasycladacean algae

1 *Macroporella beneckei* (Salomon). Sample B10, ×10

2, 3 *Macroporella* cf. *beneckei* (Salomon)
2 Sample B19, ×22
3 Sample B25, ×22

4–6 *Macroporella alpina* Pia
4 Sample B8, ×11
5 Sample B8, ×10.5
6 Sample B10B, ×15

7–9 *Poncetella hexaster* (Pia). Sample B3
7, 9 ×22
8 ×10

10 *Physoporella* cf. *pauciforata* (Gümbel). Sample B5, ×11

11, 12 »*Griphoporella*« sp. Sample B27, ×22

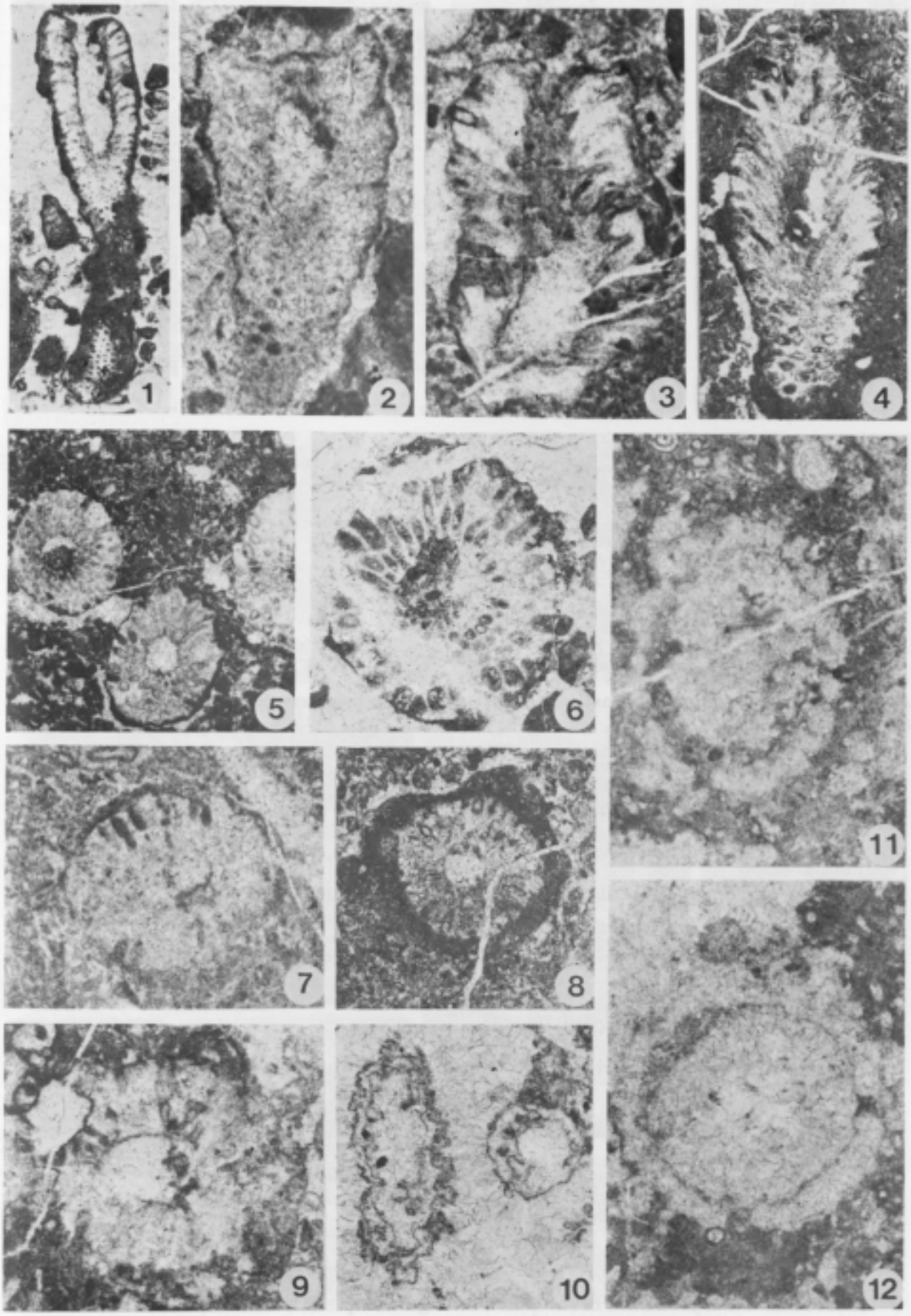
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Plate 2

Anisian carbonates from the Castle Hill cliff, Bled, northwestern Slovenia: Calcareous algae and foraminifera

1 *Oligoporella pilosa* Pia var. *varicans* Pia. Sample B3, ×11

2 *Oligoporella* cf. *pilosa* Pia. Sample B12, ×17

3 *Oligoporella pilosa* Pia var. *pilosa* Pia. Sample B10B, ×9

4 *Physoporella* cf. *minutula* (Gümbel). Sample B12, ×30

5–7 *Solenopora* sp.
5 Sample B24, ×22
6, 7 Sample B28, ×15

8 ?*Stenoporidium* sp. Sample B26, ×45

9 *Trochammina alpina* Kristan-Tolmann (lower part of the photo), and *Glomospira* sp. Sample B3, ×90

10 *Earlandinita elongata* Salaj. Sample B2, ×37

11 *Valvulina*? sp. cf. *Valvulina azzouzi* Salaj. Sample B24, ×90

12, 14 *Trochammina almtalensis* Koehn-Zaninetti
12 Sample B26, ×150
14 Sample B11, ×90

13 *Trochammina jaunensis* Brönnimann & Page. Sample B3, ×90

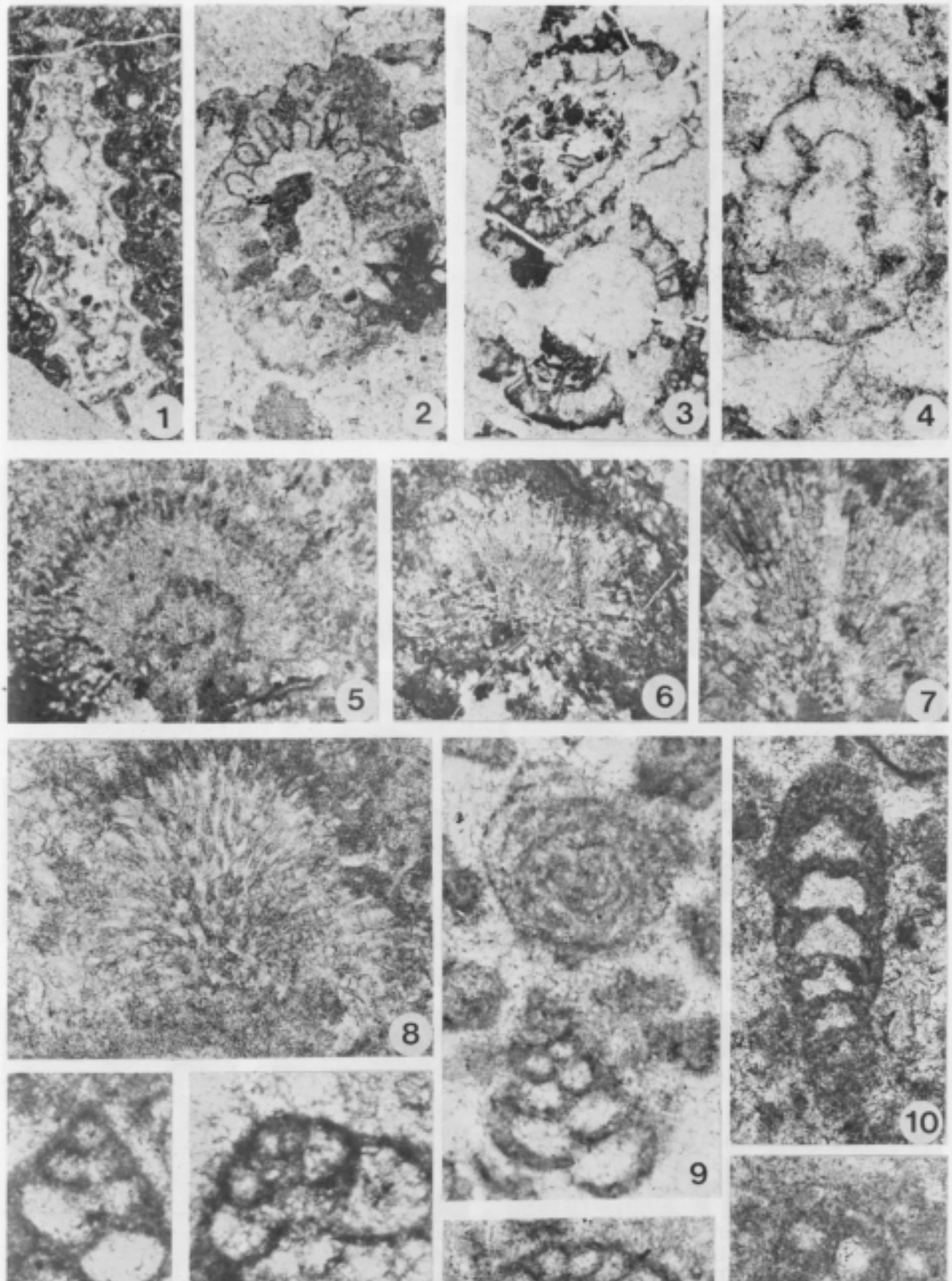
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Plate 3

Anisian carbonates from the Castle Hill cliff, Bled, northwestern Slovenia: Foraminifera

1, 2 *Earlandinita grandis* Salaj
1 Sample B25, ×37
2 Sample B20, ×26

3 *Reophax* aff. *asper* Cushman & Waters: Sample B15, ×45

4 *Nodosinella* cf. *libera* Trifonova. Sample B15, ×22

5–7 *Meandrospira* aff. *pusilla* Ho
5 Sample B26, ×120
6, 7 Sample B5, ×90

8, 10, 11 *Meandrospira* aff. *insolita* Ho
8 Sample B34A, ×82
10 Sample B5, ×150
11 Sample B30, ×120

12–15 *Meandrospira dinarica* Kochansky-Devide & Pantić
12 Sample B4B, ×96
13 Sample B4B, ×82
14 Sample 84b-R, ×75
15 Sample B5, ×96

16, 17 *Meandrospira* aff. *dinarica* Kochansky-Devide & Pantić. Sample B5, ×96

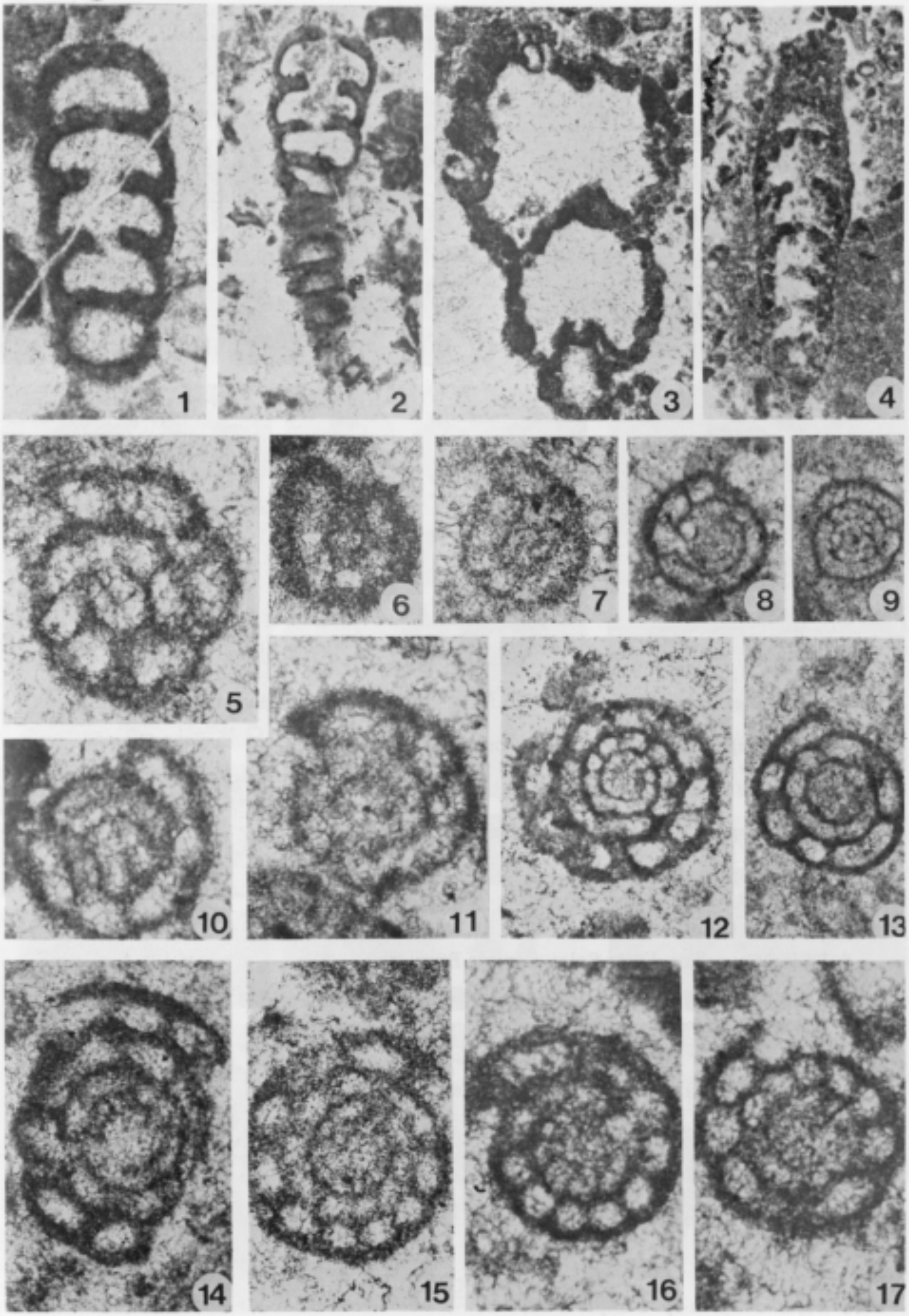
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Plate 4

Anisian carbonates from the Castle Hill cliff, Bled, northwestern Slovenia: Foraminifera

1, 2 *Meandrospira* aff. *dinarica* Kochansky-Devide & Pantić
1 Sample B26, × 120
2 Sample B5, × 120

3 *Meandrospira* aff. *samueli* Salaj. Sample B5, × 120

4, 5 *Meandrospira deformata* Salaj
4 Sample B6, × 82
5 Sample B24, × 82

6 *Endothyranella robusta* Salaj. Sample B5, × 18

7, 9 *Endothyranella lombardi* Zaninetti et al.
7 Sample B5, × 45
9 Sample B22, × 48

9 *Endothyranella* cf. *alpina* Zaninetti et al. Sample 84c-R, × 75

10, 13 *Endothyranella kuepperi* Oberhauser
10 Sample B6, × 90
13 Sample B22, × 100

11 *Endothyranella wirzi* Koehn-Zaninetti. Sample B0A, × 90

12 ?*Aulotortus* cf. *pragsoides* Oberhauser. Sample B22, × 22

14 ?*Agathammina* sp. Sample B 26, × 90

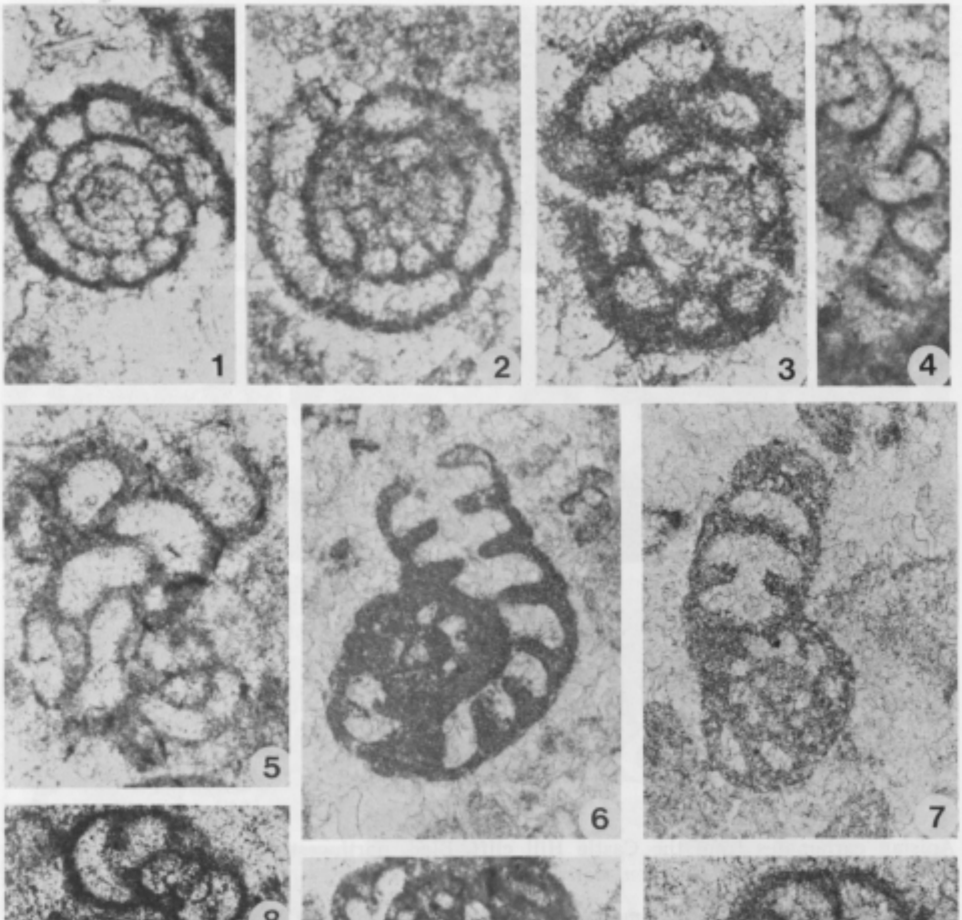
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Plate 5

Anisian carbonates from the Castle Hill cliff, Bled, northwestern Slovenia: Foraminifera and *Olangocoelia* sp.

1 *Glomospira*? sp. cf. *Glomospira*? *micas* He & Yue. Sample B15, ×130

2 *Glomospira* cf. *articulosa* (Plummer). Sample B11, ×50

3 *Glomospira* sp. Sample B29, ×50

4 *Glomospira irregularis* (Moeller). Sample B3, ×96

5, 6 *Pilammina* cf. *densa* Pantić. Sample B11, ×85

7, 8 *Pilammina densa* Pantić. Sample B29, ×62

9, 10 *Diplotremina astrofimbriata* Kristan-Tolman
9 Sample B26, ×90
10 Sample B24, ×67

11 ?*Austracolomia* sp. Sample B15, ×110

12–14 *Olangocoelia otti* Bechstädt & Brandner
12 Sample B10B, ×11
13, 14 Sample B15, ×22

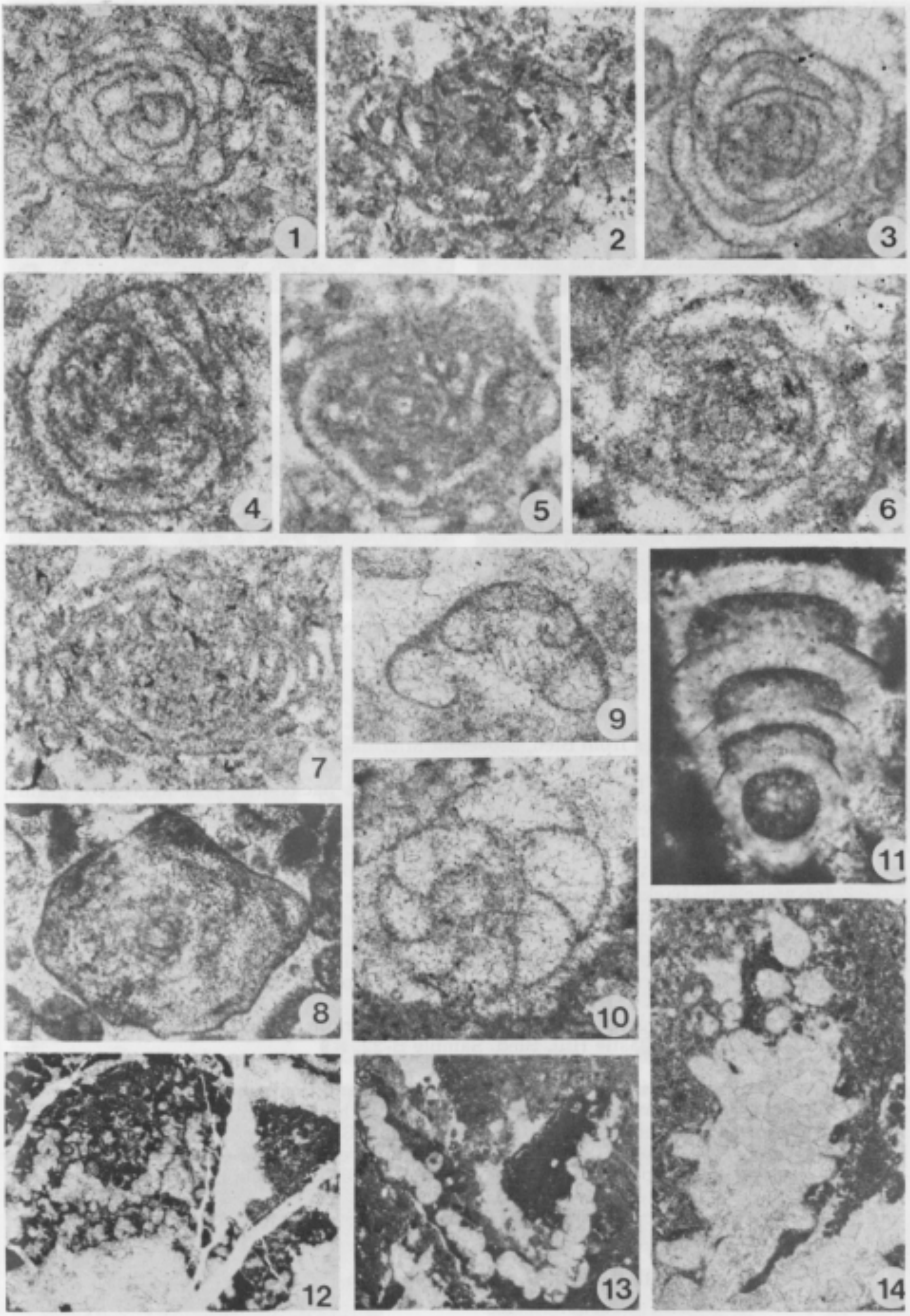
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Plate 6

Anisian platform carbonates from Bled, Slovenia: Microfacies types and microfossils

1–5 Microfacies Type 1. Intrabioclastic grainstone and packstone with aggregate grains, foraminifera and dasycladacean algae.

1 Intrabioclastic grainstone with aggregate grains, dasycladacean algae, ostracods and foraminifera. Note the strong micritization of the bioclasts. Castle Hill Bled. Top of the cliff. Sample B-3. ×11

2 Intrabioclastic packstone with dasycladacean algae (*Macroporella alpina* Pia) and fine-grained aggregate grains. Castle Hill cliff, Bled; upper part. Sample B-8. ×4

3 Intrabioclastic grainstone with agglutinated foraminifera. Castle Hille Bled. Sample B-8. The same sample as in Fig. 2! Note the difference in the depositional texture. ×19

4 Sediment-filled burrows in intrabioclastic packstone. Castle Hill Bled. Sample B-15. ×19

5 Detail of a large aggregate grain. The individual grains are bound together by micritic laminations (arrow). Castle Hill, Bled. Sample B-22. ×9

6, 7 Microfacies Type 3. Lithoclastic-peloidal rudstones and floatstones

6 Lithoclastic rudstone, consisting of pelmicritic lithoclasts with few foraminifera and dasycladacean fragments. Castle Hill, Bled. Sample B-29. ×11

7 Detail of a lithoclastic floatstone. Note the difference in the microfacies of the subrounded clast as compared with Fig. 6. Castle Hill, Bled. Sample B-24. ×5

8 *Meandrospira dinarica* Kochansky-Devidé & Pantić. Bioclastic grainstone. South of Poljšica northwest of Bled. Sample 20-P-G. ×75

9 *Earlandinita* sp. Bioclastic grainstone, MF Type 1. South of Poljšica northwest of Bled. Sample 20-P-G. ×75

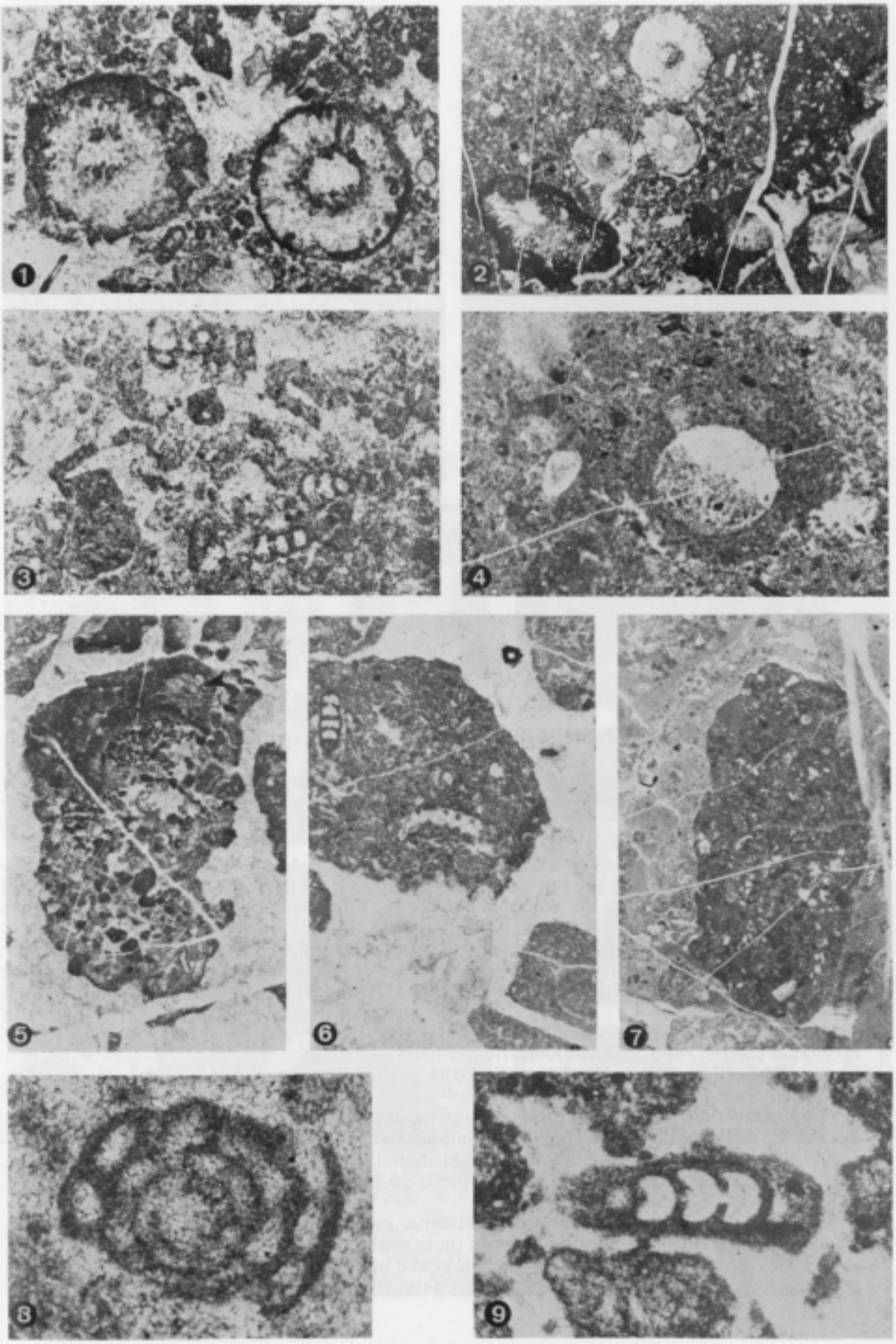
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Plate 7

Anisian platform carbonates from Bled, Slovenia: Microfacies types and microfossils

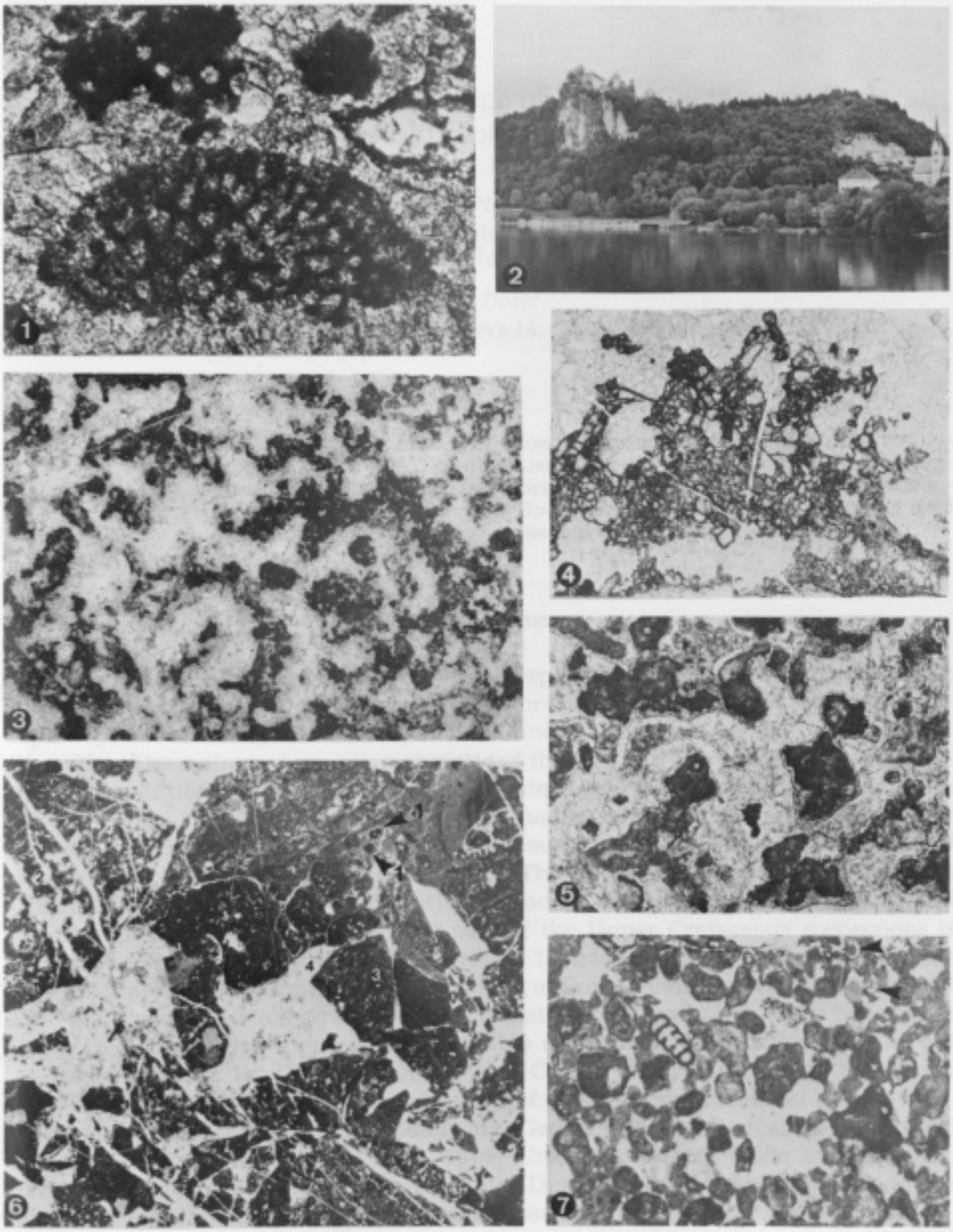
1 *Anisocellula fecunda* Senowbari-Daryan et al., an enigmatic microfossil, first described from the reef facies of the Northern Dolomites. South of Poljšica. Sample 20-P-C. ×40

2 The Castle Hill at the Lake Bled. Samples B-0 and B-1 to B-10 were collected within the court yard area at the top of the cliff, samples B-11 to B-30 at the path between the castle and the parking lot. Samples B-33 to B-37 are from the area near the parking lot

3 Microfacies Type 2. Algal fenestral bindstone. Irregularly distributed micritic structures with relicts of filamentous algae border large interspace voids filled with drusy and recrystallized blocky calcite cement. Upper part of the Castle Hill cliff, Bled. Sample B-34A. ×4

4, 5, 7 Microfacies Type 1. Intrabioclastic grainstone
4 *Bacinella* sp. forms crusts within the grainstones attributed to MF1. Castle Hill, Bled. Sample B-5. ×7
5 Intraclastic grainstone, predominantly composed of lumps, surrounded by isopachous rim cements. Castle Hill, Bled. Sample B-12. ×11
7 Intrabioclastic grainstone with agglutinated foraminifera and small dasycladaceans (arrows). Castle Hill cliff, Bled. Sample B-25. ×7.

6 Microfacies Type 3. Lithoclastic rudstone, composed of brecciated limestone clasts exhibiting various microfacies types (note the fenestral fabric of the clast, top left, 2, MF2). Small lithoclasts and peloids (1) have been several times reworked, resulting in the formation of composite clasts (3). Castle Hill cliff, Bled. Sample B-21. ×2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