RAZPRAVE IV. RAZREDA SAZU | XXVII | 3 | 37—64 | Fig. 6 | Pl. 7 | LJUBLJANA 1987

UPPER CARNIAN RFEF LIMESTONE IN CLASTIC BEDS AT PERBLA NEAR TOLMIN (NW YUGOSLAVIA)

ZGORNJEKARNIJSKI GREBENSKI APNENEC V KLASTIČNIH PLASTEH PRI PERBLI NAD TOLMINOM

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ABSTRACT

UDC 551.761.3(497.12-15)

Upper Carnian Reef Limestone in Clastic Beds at Perbla near Tolmin (NW Yugoslavia)

The study deals with reef limestone which occurs within the complex of fine grained clastites in the Zadlaščica valley at Perbla near Tolmin. Limestone contains rich association of corals, stromatoporoids, chaetetids and sponges. On the basis of fauna and position it is attributed to the Upper Carnian as the youngest so far known Carnian reef within the Slovenian trench in western Slovenia.

In the base of the reef limestone beds of biomicrite, biocalcarenite and calcirudite alternate which were deposited in deeper environments. The studied reef presumingly was not built in place, but it slumped in blocks from the margin of the neighbouring reefs. Biocalcarenite was deposited by turbidity currents.

IZVLEČEK

UDK 551.761.3(497.12-15)

ZGORNJEKARNIJSKI GREBENSKI APNENEC V KLASTIČNIH PLASTEH PRI PERBLI NAD TOLMINOM

Raziskave zajemajo grebenski apnenec, ki leži med kompleksom drobnozrnatih klastitov v dolini Zadlaščice v Perbli pri Tolminu. Apnenec vsebuje bogato združbo koral, stromatopor, hetetid in spongij. Po tej favni in po legi je uvrščen v zgornji karnij in je istočasno najmlajši doslej znani karnijski greben znotraj slovenskega jarka zahodne Slovenije.

V talnini grebenskega apnenca se menjavajo plasti biomikrita, biokalkarenita in kalcirudita, ki so se odlagale v globljem okolju. Domnevamo, da raziskani greben ni nastal na mestu, ampak je spolzel v obliki blokov z obrobja blizu rastočih grebenov. Biokalkarenit se je odlagal s turbiditnimi tokovi.

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INTRODUCTION

At Perbla, in the Zadlaščica valley, about 4 km northeast of Tolmin within carbonate clastic beds Upper Carnian reef limestone occurs. These beds have been discovered only in 1977 during geological investigations in the mapping project for the basic geological map of the Tolmin sheet. It has been found that these beds normally underly the Norian Bača dolomite. Until now they were attributed to Jurassic (KOSSMAT 1920) or to Lower Cretaceous (COUSIN 1973).

Special attention has been attributed to the study of reef builders. Until present the reef fauna from the Carnian of Slovenian trench was preliminarily determined from a number of localities, as Celje, surroundings of Mežica, Blegoš and Cerkno region (BUSER & al. 1982). However, fauna was systematically studied only from Hudajužna and surroundings (SENOWBARIDARYAN 1981, TURNŠEK & al. 1982).

The newly discovered locality at Perbla near Tolmin represents the westernmost reef outcrop in the Slovenian trench. From this locality in the present study 16 fossil species are investigated; they belong to corals, stromatoporoids, chaetetids and sponges. They are accompained in places by foraminifers. The found fauna supports the Upper Carnian age of the reef, and it contains even certain Norian elements. By it the youngest part of Carnian reefs in the Slovenian trench, and in Slovenia so far, was discovered.

The reef limestone complet is about 10 meters thick. In the underlying beds layers of biocalcarenite and calcirudite with nodules of chert and marl alternate. It is overlain by shale containing sheets of limestone, and followed directly by the Bača dolomite. A somewhat deeper development of these beds is indicated by microfacies of the listed varieties. Biocalcarenite and intraformational breccias show indications of turbiditic sedimentation. Therefore it is assumed that the mass of the reef limestone slumped in blocks from the margin of the neighbouring reefs. In facies characteristics the reef limestone is quite similar to Carnian reefs from Jesenica and Hudajužna (ČAR & al. 1981, TURNŠEK & al. 1982).

ACKNOWLEDGEMENTS

The manuscript was reviewed by MARIO PLENIČAR. Figures, tables and plates were made by MILOJKA HUZJAN, geological map was drawn by VERA DRAKSLER, photographs of fossils were taken by CARMEN NAROBE, thin sections were prepared by KATA CVETKO and ANDREJ STOPAR. The paper was translated into English by SIMON PIRC. Investigation was supported by the Research Community of Slovenia.

The authors wish to thank all of them.

GEOLOGY OF THE TERRAIN

Stanko Buser

Previous Work

In the Slovenian trench among clastic Carnian beds thicker intercalations of reef limestone containing a rich association of fossils appear. In the area between Gorje, Jesenica and Hudajužna these fossils have been investigated by a number of authors (ČAR & al. 1981, BUSER & al. 1982, TURNŠEK & al. 1982, 1984). However, none of them was able to detect Carnian reefs west of the Bača valley. The newly discovered Carnian beds at Perbla were attributed to Jurassic on the Kossmat's geological map 1 : 75.000 sheet Tolmin (KOSSMAT 1920), and to the same system also on the Italian geological map 1 : 100.000, sheet Tolmin (FABIANI & al. 1937). COUSIN (1973) ranged them into the Lower Cretaceous.

Geological Description of Beds at Perbla

Between Perbla and Tolminske Ravne along the road beds from the Upper Triassic across Jurassic and Lower Cretaceous to Upper Cretaceous Flysch are exposed (Fig. 1). They constitute one of the best uninterrupted outcropping sections of the Mesozoic deep marine development in the foothills of the Julian Alps.

Here the newly discovered Carnian beds occur which attain the thickness of about 100 m. Their lower part is cut by a fault.

In the lower part of this Carnian profile thickly bedded to platy calcarenites and micritic limestones alternate with thin layers of greenish grey marl. In calcarenite rare chert sheets and nodules occur. Upwards the marly beds

Fig. 1 Geological map of the surroundings of Perbla near Tolmin

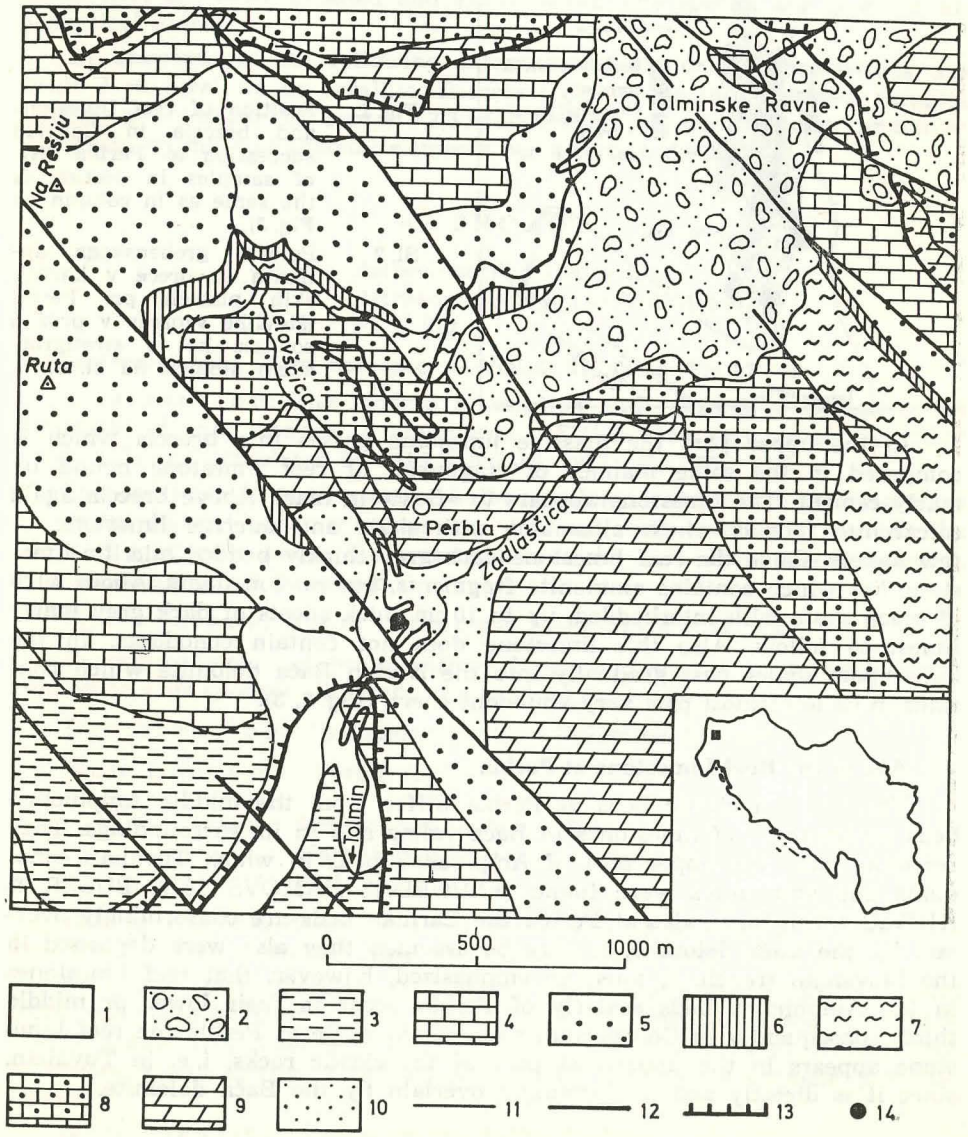
1. Fluvial conglomerate (Quaternary). — 2. Cemented and noncemented moraine (Pleistocene). — 3. Marl and calcarenite in alternation — flysch (Campanian — Maastrichtian). — 4. Bedded limestone with chert and marl (Cenomanian — Santonian). — 5. Alternation of shale (clayey shale) and calcarenite with plates of chert (Aptian — Albian). — 6. Platy limestone of Biancone type (Upper Malm — Berriasian). — 7. Shale and chert in alternation (Lower Malm — Dogger). 8. Platy limestone with chert (Lias). — 9. Platy Bača dolomite with chert (Norian-Rhaetian). — 10. Calcarenite, marl and shale in alternation with intercalation of reef limestone (Carnian). — 11. Geological boundary. — 12. Fault. — 13. Overthrust. — 14. Locality of reefbuilding fossils (Upper Carnian).

Sl. 1 Geološka karta ozemlja okolice Perble pri Tolminu.

1. Rečni konglomerat (kvartar). — 2. Sprijete in nesprijete morene (pleistocen). — 3. Lapor v menjavi s kalkareniti — fliš (campanij-maastrichtij). — 4. Ploščasti apnenec z roženci in lapor (cenomanij-santonij). — 5. Menjavanje glinastega skrilavca in kalkarenita s polami roženca (aptij-albij). — 6. Ploščasti apnenec tipa biancone (zg. malm — berriasij). — 7. Skrilavec v menjavi z roženci (sp. malm — dogger). — 8. Ploščasti apnenec z roženci (lias). — 9. Ploščasti baški dolomit z roženci (norij-retij). — 10. Menjavanje kalkarenita, laporja in skrilavca z vložkom grebenskega apnenca (karnij). — 11. Geološka meja. — 12. Prelom. — 13. Nariv. — 14. Nahajališča grebenotvornih fosilov, obdelanih v razpravi.

within the calcarenite become more frequent and thicker, while the micritic limestone completely disappears.

About 40 m by thickness below the contact of Carnian beds with the Bača dolomite within the clastic rocks a 10 m thick intercalation of massive limestone appears. It consists of well cemented blocks and fragments of reef limestone, and it contains more or less frequent reef fossils.



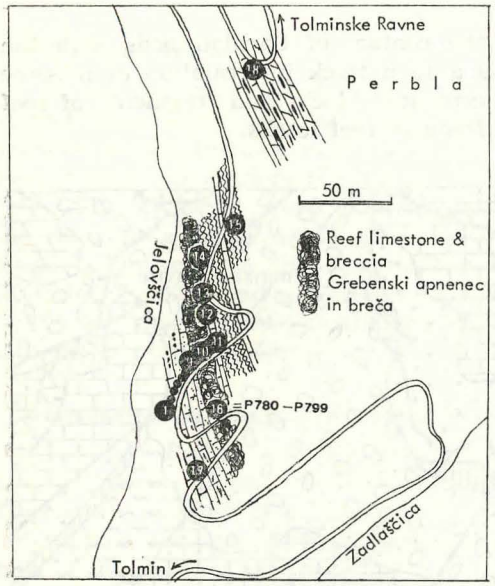


Fig. 2 Position of reef limestone and breccia in Carnian succession at Perbla (No. of samples in section is the same as in column on Fig. 3).

Sl. 2 Položaj grebenskega apnenca in breče v karnijskih plasteh pri Perbli (številke vzorcev v profilu so iste kot v stratigrafskem stolpcu na sl. 3).

In the upper part the massive limestone passes into breccia which is composed in the same manner of fragments of reef limestone bound by marly cement. The limestone appears to »float« in marl. Above breccia again calcarenite follows which alternates with shale and micritic limestone. A few meters above the reef limestone dark grey thickly bedded micritic limestone lies which contains ammonite fragments, but no conodonts. About 30 m of black shale with interbedded, up to 10 cm thick sheets of dark grey marly limestone follow. Also this limestone does not contain conodonts. In the upper part shales pass gradually into the Norian Bača dolomite which contains in its lowermost part very abundant chert. (Fig. 2, 3).

Age of the Reef Limestone at Perbla

The Carnian clastic beds at Perbla differ from the middle Amphiclina beds containing reef limestones in Bača valley and in its surroundings. They resemble more the upper part of Amphiclina beds in which Tuvalian conodonts and ammonites were found (FLÜGEL & RAMOVŠ 1970, BUSER & KRIVIC 1979). Since also at Perbla the Carnian beds are conformingly overlain by the Bača dolomite, it may be assumed they also were deposited in the Slovenian trench. It must be emphasized, however, that reef limestones in the Amphiclina beds easterly of Perbla occur in their lower or middle third, consequently in Cordevolian and Julian, while at Perbla the reef limestone appears in the uppermost part of the clastic rocks, i. e. in Tuvalian, since it is directly and conformingly overlain by the Bača dolomite.

THE PALEONTOLOGICAL PART

Dragica Turnšek

Description of Fossil Species

The fossil species already described in Slovenia are here cited only with respect to their new locality. The description of species which have been found first are more detailed and systematical. The species are given in alphabetical order.

In descriptions the following international standard abbreviations are used: d = corallum or corallite diameter; c-c = distance between corallite centers, s = number of septa, s 2,3 = succession of septal cycles, nr/mm = = density (number of skeletal elements per a certain distance).

ANTHOZOA

Genus: *Astraeomorpha* Reuss 1854
Astraeomorpha pratzi Volz 1896
Pl. 1, Fig. 1

1896 *Astraeomorpha Pratzi* nov. spec. — VOLZ: 61, Taf. 6, Fig. 17—19.

Description: The modern description and revision of the genus on the basis of type species *A. crassisepta REUSS* 1854 was given by CUIF (1975: 117) and completed by MELNIKOVA 1971: 25, 1975: 115).

Our specimen is small massive bulbous colony with uneven thamnasteriid septa. Lateral ornamentations are pennulae and menianae, seen at the edges of specimens where the preservation is the best. Columella is massive, microstructure is not preserved.

Dimensions: d = ca 1 mm, c-c = 1,5–2 mm, s = 12 + s.

Comparison: *A. pratzi* differs from type species in numerous dissepiments. Our specimen fits with the original of the species.

Distribution: "S. Cassian" beds in Dolomites in Italy.

New Locality: Perbla (P-794).

Genus: *Margarophyllia* Volz 1896
Margarophyllia capitala (Münster 1841)
Pl. 1, Fig. 2

This species was described from Hudajužna (TURNŠEK & al. 1982: 67), and from northern Julian Alps (RAMOVŠ & TURNŠEK 1984: 176).

Specimens from Perbla are identical with those known so far. VOLZ (1896) compared *M. capitata* with "*Thecosmilia*" *tirolensis* described by WÖHRMANN (1889: 190) from the "Raibler" beds of Northern Tyrol. Nevertheless *M. tirolensis* has smaller corallites (d = 5 mm) than our specimens (d = 10—15 mm).

New locality: Perbla (P-789, P-798, P-803).

Margarophyllia crenata (Münster 1841)
Pl. 1, Fig. 3

The species was described from Hudajužna (TURNŠEK & al., 1982: 68) and from northern Julian Alps (RAMOVŠ & TURNŠEK 1984: 176).

New specimen with d = more than 20 mm corresponds to the species.

New locality: Perbla (P-786).

Genus: *Margarosmilia* Volz 1896
Margarosmilia zieteni (Klipstein 1843)
Pl. 1, Fig. 4

The species is known from Hudajužna (TURNŠEK & al. 1982: 68). New specimen is a ramose colony with rare large corallites (d = 17–20 mm) identica with this species.

New locality: Perbla (P-795).

Genus: *Pamiroseris* Melnikova 1971
Pamiroseris zitteli (Wöhrmann 1889)
Pl. 1, Fig. 5

1889 *Thamnastraea Zitteli* n. sp. — WÖHRMANN: 189, Taf. 5, Fig. 4, 4a.

Description: Encrusting colony has thamnasteriid confluent septa with lateral dents, not pennulae. Synapticulae are common, dissepiments vesicular Columella is parietal to massive, depending on recrystallization. Microstructure is trabecular.

Dimensions: c-c = 3,5–5 mm, s – 24–28.

Comparison: Wöhrmann's species "*Thamnasteria*" *zitteli* with lateral dents, sinapticulae and dissepiments is typical *Pamiroseris*. Similar genus *Thamnotropis* (CUIF 1976) differs in having menianae. *Thamnasteriamorpha* (MELNIKOVA 1971, 1975) has menianae, but it differs in concentrically arranged series (see also TURNŠEK 1985).

Our specimen belongs to the biggest among Wöhrmann's descriptions (c-c = 2,5–3,5(4), s = 26–27). Similar "*Thamnasteria*" *loretzi* (VOLZ 1896: 59) has smaler dimensions.

Distribution: Cardita-Oolith (Upper Carnian) of Haller Salzberg. After VOLZ (1896) *Thamnasteria zitteli Wöhrmann* belongs to the same group as his *Thamnasteria frechi* which is limited to the Upper part of Cassian beds.

New locality: Perbla (P-787).

Genus: *Retiophyllia* Cuif 1966
Retiophyllia tolminensis n. sp.
Pl. 2, Fig. 1–6; Pl. 3, Fig. 1–2

?1974 *Retiophyllia* type II. — CUIF: 383—391, Fig. 37d, 40—41.

Derivatio nominis: After the town of Tolmin.
Holotypus: Specimen P-785.
Stratum typicum: Upper Carnian (?Julian-Tuvalian).

Locus typicus: Perbla near Tolmin.
Material: Holotype and specimens P-781, P-792, P-793, P-797.
Diagnosis: *Retiophyllia* with rare corallites. Septa are costate, laterally dentate, thick at periphery and thin in the axial part. Columella is spongy, the wall is septotheca. Microstructure with central ondulate line. Dimensions: d = 6—8 (10) mm, s = 48 + s (48—60).

Description: Colony is phaceloid, corallites are rare and grow in several directions. In cross section they are round with extracalicinal lateral budding. Septa are compact, costate, in periphery thick, toward centrum very thin, laterally strongly dentate. Wall is septoheca in more layers. Columella is spongy, in deeper parts of corallites only. Microstructure is of simple trabeculae with axial ondulate line.

Comparison: Our specimens fit in with he Cuif's specimens of *Retiophyllia* type II (CUIF 1974), especially in inner septotheca. From *R. fenestrata* (REUSS 1854) in differs in thinner thecal area. In dimension it approaches *R. clathrata* (EMMRICH 1853), but differs in thinner axial septa.

Distribution: *Retiophyllia* type II is known from Upper Carnian of Turkey.

Genus: *Thamnotropis* Cuif 1975
Thamnotropis rakoveci Turnšek 1986

This species was described separately (TURNŠEK 1986).

Genus: *Volzeia* Cuif 1966
Volzeia badiotica (Volz 1896)
Pl. 4, Fig. 1–2

This species was described from Hudajužna (TURNŠEK & al. 1982: 69), and from northern Julian Alps (RAMOVŠ & TURNŠEK 1984: 178).

Specimen found in Perbla is well preserved phaceloid colony with frequent corallites of d = 7–12 mm, and s = 48–60. By dimensions of corallites and strong wall it is similar to "*Thecosmilia*" *rariseptata* (WÖHRMANN (1892: 169) which differs in smaller number of septa (s = 36).

New locality: Perbla (P-788).

STROMATOPOROIDEA

Genus: *Disjectopora* Waagen & Wentzel 1887
Disjectopora dubia Vinassa de Regny 1915
Pl. 4, Fig. 3

The species was described from Hudajužna (TURNŠEK & al. 1982: 74).

New locality: Perbla (P-799, Pe-10).

Genus: *Stromatomorpha* Frech 1890
Stromatomorpha sp.
Pl. 4, Fig. 4.

Small fragment of coenosteum shows vertical orthogonal and transverse vermiculate reticulum, typical for *Stromatomorpha*.

New locality: Perbla (P-784).

CHAETETIDA

Genus: *Atrochaetetes* Cuif & Fischer 1974
Atrochaetetes alakirensis Cuif & Fischer 1974
Pl. 5, Fig. 1–2

1974 *Atrochaetetes alakirensis* nov. sp. — CUIF & FISCHER: 9—10, Pl. 12, Fig. 4—5.

Description: The specimen is massive coenosteum built of parallel and radial tubes. In cross section they are polygonal to roundish. In tubes there are tabulae forming some kind of laminae.

Dimensions: d of tubes = ca 0.15 mm, c-c = 0.25–0.30 mm, the density of tubes = 11/1 mm^2, and fit in completely with originals.

Distribution: Upper Carnian of Alakir in Turkey.

New locality: Perbla (P-791).

Genus: *Blastochaetetes* Dietrich 1919
Blastochaetetes karashensis Cuif & Fischer 1974
Pl. 5, Fig. 3–4

1974 *Blastochaetetes karashensis* nov. sp. — CUIF & FISCHER: 11—12, Pl. 3, Fig. 2—5; Pl. 4, Fig. 1.

Description: The modern description and revision were given by CUIF & FISCHER (1974). According to their opinion the characteristics of this genus are porous walls of tubes. In transverse section the skeleton therefore appears meandroid.

Dimensions: d of tubes = 0.3–0.4 mm, the density of tubes = 4–6/1 mm^2.

Comparison: Almost the same dimensions has *B. meandricus* Bojko 1979, in which walls are still more porous. Our specimens fit in with *B. karashensis* (d = 0.3–0.6 mm, 3–12/1 mm^2).

Distribution: Upper Carnian of Karash in Turkey.

Material: Perbla (P-782, P-798, P-800)

Genus: *Pamirochaetetes* Bojko 1979
Pamirochaetetes stromatoides Bojko 1979
Pl. 5, Fig. 5–6

1979 *Pamirochaetetes stromatoides* sp. nov. — BOJKO: 81, Tab. 24, Fig. 1—3.

Description: Fragment of tubular colony was found. The tubes in transverse section are round or irregular because neighbouring tubes join together at their pores. Inside, in tubes, pseudosepta are visible, explained by BOJKO as thickenings of trabecular structure of the wall.

Dimensions: d of tubes = 0.2–0.4 mm, density = 5–6/2 mm^2.

Distribution: Norian of Pamir.

New localiy: Perbla (P-797).

SPONGIA

Genus: *Corynella* Zittel 1879
Corynella ritae Vinassa de Regny 1907
Pl. 6, Fig. 1

1907 *Corynella Ritae* n. f. — VINASSA de REGNY: 7—8, Taf. 2, Fig. 2—5.

Description: Cylindrical to bulby sponge with central canal of uneven edge. Toward periphery it is connected with numerous lateral tubes which are parallel to central canal. In trasverse section these tubes are round or irregularly prolonged because of their lateral tubules.

Dimensions: D of sponge = ca 12 mm, d of central canal = 2 mm, d of lateral tubes = ca 0.5 mm. Almost the same dimensions can be measured on pictures of the original.

Distribution: Upper Carnian ("Raibl") in the surroundings of Veszprem, Bakony, Hungary (see also KOLOSVÁRY 1966).

New locality: Perbla (P-799).

Genus: *Precorynella* Dieci & Antonacci & Zardini 1968
Precorynella pyriformis (Klipstein 1843)
Pl. 6, Fig. 2

1843 *Cnemidium pyriformis*. — KLIPSTEIN: n. v.
1968 *Precorynella pyriformis* (Klipstein). — DIECI & al.: 129—130, Tav. 24, Fig. 4—6.

Description: In our collection fragments of cylindrical or pyriform colonies were found. Axial system of more tubes is typical. Numerous smaller tubes run radially towards the surface. Between the tubes orthogonal reticulum is developed, similar to that of *Disjectopora*. Nevertheless, the last has no central canal.

Dimensions: D of colony = ca 30 mm, d of canal = 1.2–1.5 mm.

Distribution: S. Cassian beds of Dolomites in Italy.

New locality: Perbla (P-790).

Genus: *Paradeningeria* Senowbari-Daryan & Schäfer 1979
Paradeningeria alpina Senowbari-Daryan & Schäfer 1979
Pl. 6, Fig. 3–4

1979 *Paradeningeria alpina* n. sp. — SENOWBARI-DARYAN & SCHÄFER: 22—24, Taf. 2, Fig. 2, 4—5; Taf. 4, Fig. 6; Taf. 5, Fig. 6.
1979 *Paradeningeria alpina* Senowbari-Daryan & Schäfer. — SCHÄFER: 60.
1980 *Paradeningeria alpina* Senowbari-Daryan & Schäfer. — SENOWBARI-DARYAN: 50—51, Taf. 9, Fig. 1—4; Taf. 11, Fig. 7.

In our thin sections several transverse sections of cylindrical sponges with axial canal and vermiculate reticulum were found. Their dimensions: D of segments = 5–8 mm, d of axial canal = 2–4 mm, are the same as in originals (D = 5–9 mm, d = 2–3 mm).

Distribution: Norian-Rhaetian of Salzburg region.

New locality: Perbla (P-801, 802)

Genus: *Walteria* Vinasa de Regny 1915
Walteria sp.
Pl. 6, Fig. 5–6

Sponge has large dimensions and sparce skeleton.

New locality: Perbla (P-796).

FORAMINIFERA

In reef limestone of Perbla in some thin sections numerous foraminifers were found:

Alpinophragmium perforatum Flügel 1967 Pl. 7, Fig. 1.

New locality: Perbla (P-788).

Duostomina sp. (*Diplotremina* sp. *Endothyra* sp.) Pl. 7, Fig. 2.

New locality: Perbla (P-781, 782, 784, 785, 788 789, 790, 794, 797).

Involutina sp. Pl. 7, Fig. 3

New locality: Perbla (P-782, 785, 793, 797).

Galeanella panticae Brönnimann & al. 1973 Pl. 7, Fig. 4

New locality: Perbla (P-783, 790).

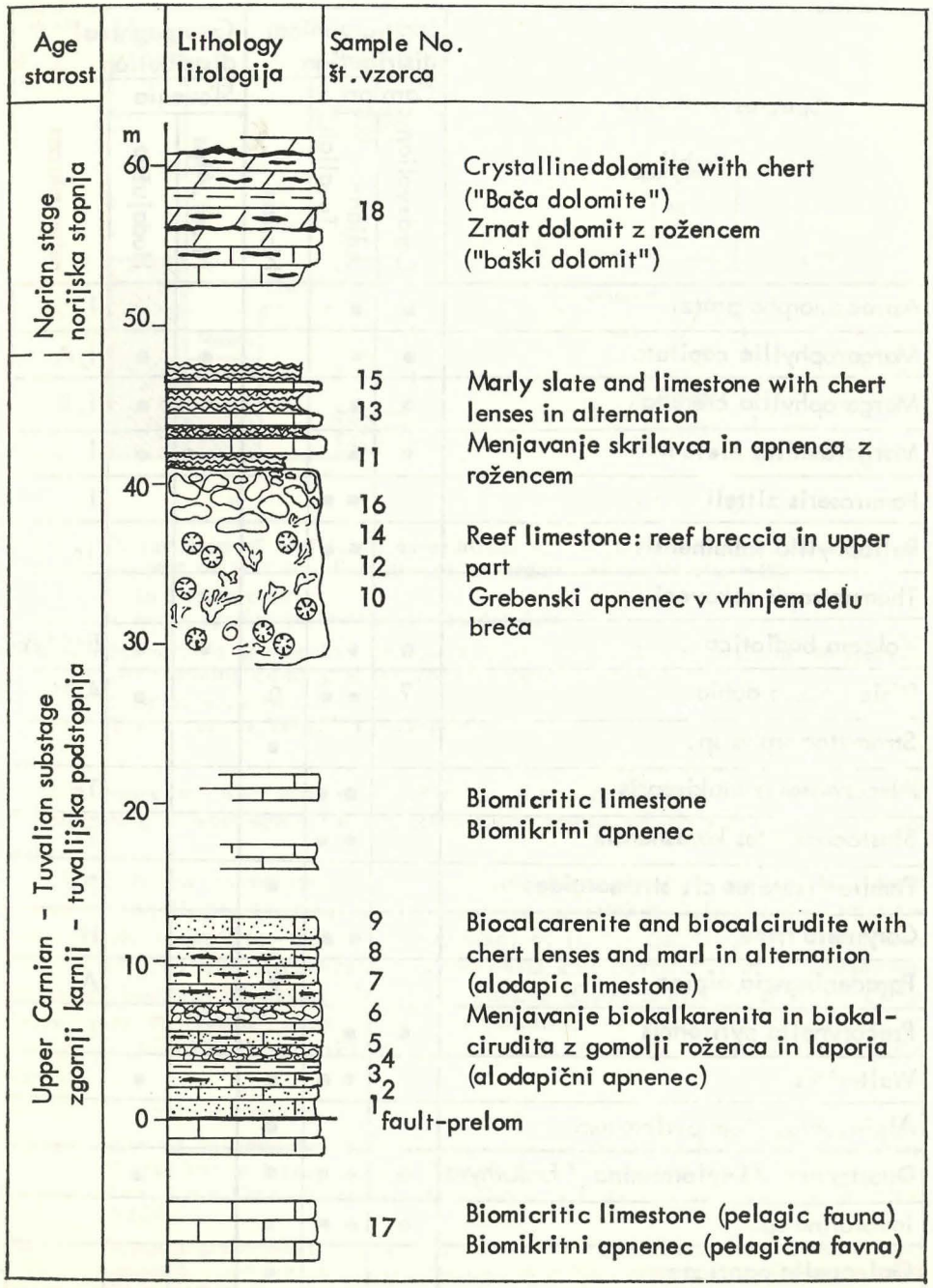
Stratigraphical Comparison of Fossils

The reef fauna at Perbla is only partly similar to that from the locality at Hudajužna and surroundings (TURNŠEK & al. 1982) (Fig. 4). It contains the same fossil groups of corals, stromatoporoids, sponges, more than 60 % of their species are different. A drastic difference appears with chaetetids which are very abundant at Perbla, and absent at Hudajužna (Fig. 5). Inversely, the microproblematica are frequent at Hudajužna, and not detected at Perbla.

Also the age of the fossils at Perbla is different from that at Hudajužna. The coral species of genera *Margarophyllia, Margarosmilia* and *Volzeia,* as well as the sponge *Precorynella,* are known from the "Cassian beds", and they have been attributed in former locatities to Cordevolian and Julian. In

Fig. 3 Shematical lithological column of investigated Carnian beds at Perbla (Numbers of samples in column are the same as in section in Fig. 2).

Sl. 3 Shematski litološki stolpec raziskanih karnijskih plasti pri Perbli (številke vzorcev so iste kot v profilu na sl. 2).



Species at Perbla Vrste v Perbli	Stratigraphical distribution			Geographical distribution		
	Carnian			Slovenia		
	Cordevolian	Julian-Tuvalian	Norian	N Jul. Alps	Hudajužna	other places
Astraeomorpha pratzi	•	•				I
Margarophyllia capitata	•	•		•	•	I, A
Margarophyllia crenata	•	•		•	•	I, R
Margarosmilia zieteni	•	•			•	I
Pamiroseris zitteli		• •				I
Retiophyllia tolminensis		• •				Tr
Thamnotropis rakoveci						
Volzeia badiotica	•	•		•	•	I,H,CS,Pa
Disjectopora dubia	?	• •	?		•	A, H, T
Stromatomorpha sp.			•			
Atrochaetetes alakirensis		• •				Tr
Blastochaetetes karashensis		• •				Tr
Pamirochaetetes cf. stromatoides			•			Pa
Corynella ritae		• •				H
Paradeningeria alpina			•			A
Precorynella pyriformis	•	•				I
Walteria sp.		• •	•		•	
Alpinophragmium perforatum			•			
Duostomina / Diplotremina / Endothyra	•	• •	•		•	
Involutina sp.	•	• •	•			
Galeanella panticae			•			

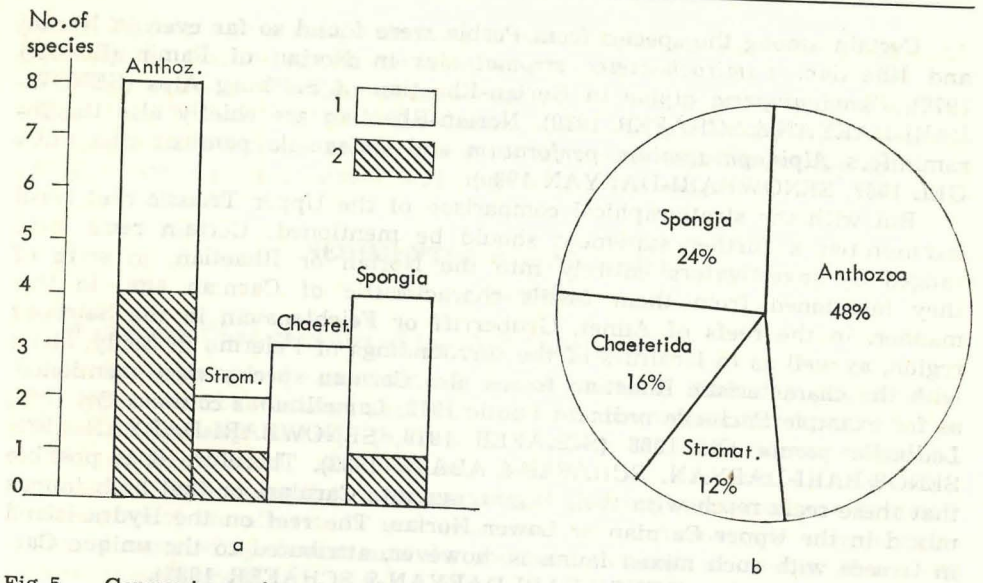


Fig. 5 Comparison of reef fossil associations at Perbla and Hudajužna = (a), and percent of reef building groups of organisms at Perbla = (b).
1. In Perbla only
2. Same species in Perbla and Hudajužna

Sl. 5 Primerjava grebenske združbe v Perbli in Hudajužni (a), in medsebojni procentualni delež grebenotvornih organizmov v Perbli (b).
1. Samo v Perbli
2. Iste vrste v Perbli in Hudajužni

Perbla, however, also species of *Retiophyllia, Pamiroseris, Stromatomorpha, Paradeningeria* and some foraminifers were found which indicate a younger age.

Retiophyllia tolminensis n. sp. (=Cuif's *Retiophyllia* type II) has been found in the Upper Carnian beds in Taurus in Turkey (CUIF 1974), *Pamiroseris zitteli* in Cardita - Oolith (U. Carnian) of Haller Salzberg (WÖHRMANN 1889, KRAUS 1969), *Atrochaetetes alakirensis* and *Blastochaetetes karashensis* in Upper Carnian of Lycian Taurus of Turkey (CUIF & FISCHER 1974), *Corynella ritae* in "Raibl" beds in the surroundings of Veszprem in Bakony in Hungary (VINASSA de REGNY 1907, FLÜGEL & SY 1959, KOLOSVARY 1966).

Fig. 4 List of investigated reef building fossils from Perbla with their stratigraphical and geographical distribution (I = Italy, A = Austria, H = Hungary, CS = Czechoslovakia, Pa = Pamir, T = Timor, Tr = Turkey, R = Romania).

Sl. 4 Seznam grebenskih fosilov iz Perble s stratigrafsko in geografsko razširjenostjo. (I = Italija, A = Avstrija, H = Madzarska, CS = Češkoslovaška, Pa = Pamir, T = Timor, Tr = Turčija, R = Romunija).

Certain among the species from Perbla were found so far even in Norian and Rhaetian. *Pamirochaetetes stromatoides* in Norian of Pamir (BOJKO 1979), *Paradeningeria alpina* in Norian-Rhaetian of Salzburg Alps (SENOWBARI-DARYAN & SCHÄFER 1979). Norian-Rhaetian are chiefly also the foraminifers *Alpinophragmium perforatum* and *Galeanella panticae* (see FLÜGEL 1967, SENOWBARI-DARYAN 1980).

But with the stratigraphical comparison of the Upper Triassic reef fossil communities a further statement should be mentioned: Certain reefs were ranged by investigators entirely into the Norian or Rhaetian, in spite of they mentioned from them fossils characteristic of Carnian age. In this manner, in the reefs of Adnet, Gruberriff or Feichtenstein in the Salzburg region, as well as in localities of the surroundings of Palermo in Sicily, along with the characteristic Rhaetian fossils also Carnian species were mentioned, as for example *Bacinella ordinata* Pantić 1972, *Lamellitubus cauticus* Ott 1968, *Ladinella porata* Ott 1968 (SCHÄFER 1979, SENOWBARI-DARYAN 1980, SENOWBARI-DARYAN, SCHÄFER & ABATE 1982). Therefore it is possible that these reefs reach with their beginnings into Carnian, or that both faunas mixed in the Upper Carnian or Lower Norian. The reef on the Hydra island in Greece with such mixed fauna is, however, attributed to the unique Carnian-Norian complex (SENOWBARI-DARYAN & SCHÄFER 1982).

It can therefore be stated that the reef fauna in the Perbla locality near Tolmin belongs to the uppermost Carnian (?Upper Julian and Tuvalian). The

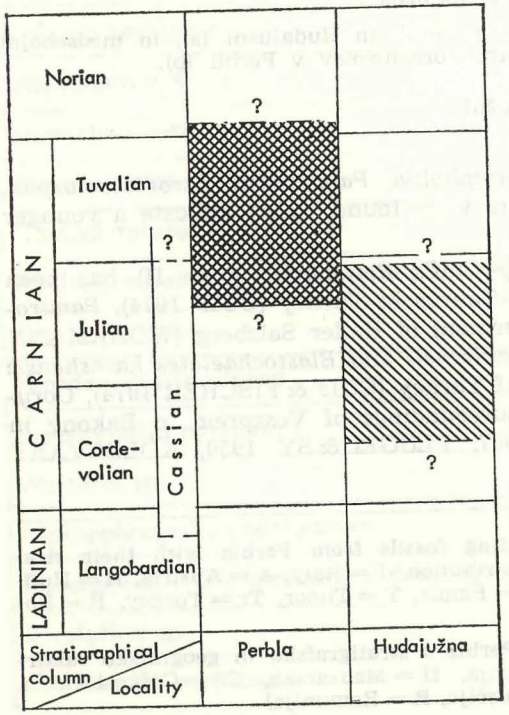


Fig. 6 Stratigraphic comparison between buildups at Perbla and Hudajužna, based on fossils.

Sl. 6 Stratigrafska primerjava grebenskih tvorb v Perbli in Hudajužni., na podlagi fosilov.

Upper Carnian age corresponds well to the conclusions reached in the field, and with the position of this reef limestone (Fig. 3, 6).

The locality at Perbla indicates that in the Slovenian trench or on the edges of carbonate platforms the Carnian reef fauna thrived largely during Cordevolian and Julian, but in places it continued uninterruptedly into Tuvalian where it started mixing with the Norian elements.

SEDIMENTOLOGICAL PART

Bojan Ogorelec

Microfacies Characteristics of the Reef Limestone

In the investigated succession of Carnian beds at Perbla in general four rock types can be distinguished: (a) layered biomicritic limestone in the footwall of the reef buildup, (b) beds of biocalcarenite and biocalcirudite, (c) reef limestone, and (d) overlying beds (shale, limestone and dolomite with chert — the Bača dolomite). Sedimentological investigation concerns in detail the complex of biocalcarenites and accompanying reef limestone only. The location of sampled specimens and the shematic lithological column of the investigated beds are shown in Fig. 2 and 3.

(a) The underlying beds of the reef complex are represented by finely to medium layered biomicritic and biosparitic limestone (specimen Pe-17) which was deposited, according to its fossil association, in a deeper and quiet environment. Limestone is homogenous and of medium grey color. The micritic groundmass is weakly recrystallized. Fossils are represented by calcitized radiolarians, detritus of pelagic foraminifers and by echinoderm plates. Fossils are not adequate for stratigraphic determination. The carbonate proportion in limestone is high, ranging between 95 and 98 %. Among the noncarbonate grains clay minerals occur which appear as pigment in the micritic groundmass, and rare quartz grains which measure about 50 μm in diameter. Quartz is partly of detrital origin, and partly authigenic; the latter occurs in crystals up to 100 μm in diameter. The energy index is low to moderate.

(b) Above the complex of biomicritic limestone about 15 m of biocalcarenite and fine grained breccia appear (specimens Pe 1—9). The contact between the two lithological members is tectonical, and it follows a smaller local fault. Individual biocalcarenite beds are 5 to 70 cm thick. In places between them marl sheets appear, up to several cm thick. Macroscopically in certain biocalcarenite and breccia beds graded bedding can be observed which is an indication of the normal position of beds. They in their present setting dip steeply towards northeast. Typical for biocalcarenite and breccia are also chert nodules.

Biocalcarenite is composed of well rounded intraclasts which contain numerous echinoderm plates. Sorting is good. Individual fragments measure from 0.5 to 2 mm. Intraclasts are of micritic composition, only in few of them skeletons of undeterminable algae and foraminifers occur. Echinoderm plates often show at margins micritic envelopes and syntaxial sparitic cement. Ce-

ment in biocalcarenite is largely represented by weakly recrystallized micrite, and about 20 % of interstices between fragments are also filled by fine grained sparitic cement. In certain samples diagenetic carbonate dissolut on of carbonate and stylolitic sutures may be observed, so that in places individual clasts interfinger one with other. Among the diagenetic processes in biocalcarenite specimens mainly silicification, and to a smaller degree also dolomitization are important.

Fragments in the limestone breccia (calcirudite) measure up to 0.5 cm. They mostly belong to lithic particles, and numerous among them are also echinoderm plates and fragments of pelecypod shells. Lithic fragments are according to their texture micritic, biomicritic and biosparitic; among the fossils fragments of skeletal algae prevail. Groundmass between the fragments and fossils is represented by micrite with admixture of clay minerals. Contacts between them are often bound by stylolitic sutures. Beds of limestone breccia are often intensively silicified. The source of silica in forming of chert is believed to be solution of radiolarian skeletons and spicules. Both may be observed in the biomicritic limestone (e. g. specimen Pe-5b) which occurs within biocalcarenite.

Biocalcarenite and fine limestone breccia were deposited in deeper environment by submarine turbidity currents. Such submarine flows were often active on the slopes of the Slovenian trench which was during the Carnian times still well expressed (BUSER & al. 1982, TURNŠEK & al. 1984). Beds of breccia and calcarenite of the same development as observed in the Perbla section occur in the Carnian succession also in the Vršič area (JURKOVŠEK & al. 1984).

(c) The complex of biocalcarenite and fine grained breccia is followed by an approximately 15 m thick package of massive reef limestone and accompanying breccia (specimens P-10, 12, 14, 16) which, due to abundant contents of fossils, especially of reef builders, initially attracted the attention of the present authors. The lower contact between the two members is covered, and upwards the reef limestone passes into biomicritic limestone and shale (Fig. 3).

Limestone with reef fauna is of dark grey color. Facially it is very similar to the limestone from Hudajužna (TURNŠEK & al. 1982). Limestone is built of several reef building organisms, and of other allochems, intraclasts of various types of Carnian limestones, as well as of individual ooids. The reef limestone is to a quite high degree recrystallized so that the original texture of corals and other organisms is largely effaced. Corallites are mostly overgrown by envelopes of nonskeletal algae up to several mm thick.

Intraclasts are attributed according to their composition chiefly to micritic and biomicritic limestone, and less to pelmicritic limestone. Especially interesting are fragments of marly biomicritic limestone which contain numerous shells of lamellibranchs, plates of echinoderms and detritic admixture of quartz; they represent a characteristic microfacies variety of the Carnian limestone (compare PANTIĆ-PRODANOVIĆ 1975). This limestone was deposited on the shallow shelf of both carbonate platforms.

Cement between remains of organisms and intraclasts belongs mostly to medium grained sparite, and in places also nests of micrite occur. In certain samples also structural Stromatactis forms and irregularly shaped cavities up to several cm large appear. They occur in the internal micritic sediment and sparitic calcite. The forming of Stromatactis structures is associated with dead nonskeletal organisms.

(d) In the hanging wall of the reef breccia first beds of marly biomicritic limestone and shale alternate (Pe-11, 13, and 15) having characteristics of deeper marine facies (radiolarians, thin shells of lamellibranchs, low energy index, admixture of clay and detrital quartz, pyritic pigment, chert nodules). Above the complex of shale and limestone the thick series of layered gray dolomite follows with chert nodules, known as the Bača dolomite. The rock is of Norian age and it is exposed in a wider belt between Tolmin and Škofja Loka. In the lower part of the Bača dolomite succession at Perbla rare limestone sheets appear which were not affected by dolomitization.

Diagenetic Characteristics

Among the diagenetic processes which affected the investigated succession of sedimentary rocks at Perbla cementation, recrystallization, silicification and dolomitization should be mentioned.

Recrystallization affected to a lower or higher degree the entire package of the carbonate rocks. The micritic groundmass recrystallized into microsparite. Especially intensively skeletons of corals and sponges are recrystallized; these organisms can often be recognized only by their outlines.

Cement may be observed mainly in the limestone of the reef, while in biocalcarenitic beds micritic groundmass occurs. By its texture the cement is represented by calcite with subhedral grain shape. In certain samples two generations of cement could be seen – fibrous calcite A and concretional calcite of generation B which shows increase of crystal size towards pore centers, and which is characteristic for environments of long lasting stable chemical conditions of pore solutions.

Chert which appears in the carbonate complex is of late diagenetic origin. It occurs in irregular nodules up to 15 cm in diameter, in distinct contacts with the surrounding rocks. Quartz is microcrystalline. In several samples in spite of silicification the primary texture of the rock is visible. Especially frequent are chert nodules in beds of biocalcarenite in which during diagenesis the porosity was more favorable for penetration of silica, in comparison to the micritic calcite.

Besides chert nodules silicification is locally manifested also in replacement of calcite by quartz in skeletons of mollusks and in rare thin grains of authigenic quartz.

Also the dolomitization of beds is late diagenetic. Dolomite occurs in isolated rhomboedrons, up to 200 μm large, and its proportion varies between traces to about 15 %. Dolomitization affected primarily micritic intraclasts and micritic groundmass in calcarenite, and in places also septa of corals are dolomitized.

Zgornjekarnijski grebenski apnenec v klastičnih plasteh pri Perbli nad Tolminom

POVZETEK

UVOD

Pri Perbli, v dolini Zadlaščice okoli 4 km severovzhodno od Tolmina, se med karbonatnimi klastičnimi plastmi pojavlja zgornjekarnijski grebenski, deloma brečasti apnenec. Te plasti smo odkrili šele leta 1977 pri geoloških raziskavah za izdelavo geološke karte lista Tolmin. Ugotovili smo, da leže te plasti normalno pod norijskim baškim dolomitom. Doslej so bile uvrščene v juro (KOSSMAT 1920) oziroma v spodnjo kredo (COUSIN 1973).

Posebno pozornost smo posvetili raziskavam grebenskih organizmov. Iz karnijskega slovenskega jarka smo doslej preliminarno determinirali grebensko favno iz več nahajališč, tako iz Celja, okolice Mežice, Blegoša in Cerkljanskega (BUSER & al. 1982). Sistematično pa smo obdelali le grebensko favno iz Hudajužne in okolice (SENOWBARI-DARYAN 1981, TURNŠEK & al. 1982).

Novoodkrito nahajališče v Perbli je najzahodnejši grebenski izdanek v slovenskem jarku. Iz tega nahajališča smo v pričujoči razpravi obdelali 16 vrst fosilov, ki pripadajo koralam, stromatoporoidom, hetetidam in spongijam. Ena koralna vrsta je nova. Mestoma jih spremljajo foraminifere in drugi organizmi. Najdena favna potrjuje zgornjekarnijsko starost grebenskega apnenca, vsebuje celo nekatere elemente norija. S tem je odkrit doslej najmlajši del karnijskih grebenov v slovenskem jarku in v zahodni Sloveniji sploh.

Kompleks grebenskega apnenca je debel okrog 10 m. V njegovi talnini se menjavajo plasti biokalkarenita in kalcirudita z gomolji roženca in laporja, v krovnini pa se sprva javlja skrilavec s polami apnenca, tik nad njim pa baški dolomit. Po mikrofaciesu vseh teh različkov sklepamo na nekoliko globlji razvoj plasti. Biokalkarenit in vmesne breče kažejo na znake turbiditne sedimentacije. Zato domnevamo, da je gmota grebenskega apnenca v blokih zdrsela z roba kakega blizu rastočega grebena. Po facialnih značilnostih je grebenski apnenec pri Perbli precej sličen karnijskim grebenom iz okolice Jesenice in Hudajužne (ČAR & al. 1981, TURNŠEK & al. 1982).

ZAHVALA

Rokopis je pregledal MARIO PLENIČAR. Slike, razpredelnice in table je pripravila MILOJKA HUZJAN, geološko karto je narisala VERA DRAKSLER. Fotografije je izdelala CARMEN NAROBE. Zbruske sta izdelala KATA CVETKO in ANDREJ STOPAR. Tekst je prevedel v angleščino SIMON PIRC. Raziskave je financirala Raziskovalna skupnost Slovenije.

Avtorji se vsem najlepše zahvaljujejo.

GEOLOGIJA TERENA

Stanko Buser

Dosedanje geološke raziskave

Karnijske klastične plasti sestavljajo med Selško in Baško dolino obsežna območja. Njihovo najbolj zahodno pojavljanje smo zasledili sedaj še pri Perbli in med Kozlovim robom ter Gabrjem zahodno od Tolmina. V facialnem pogledu

pripadajo karnijske plasti v širši okolici Bače amfiklinskim plastem in so nastale v slovenskem jarku. V njih prevladuje menjavanje glinastega skrilavca in peščenjaka. Med Gorjami, Jesenico in Hudajužno so med temi kamninami debelejši vložki grebenskega apnenca z bogato združbo koral, spongij in drugih grebenotvornih fosilov, ki so bili že obdelani (SENOWBARI-DARYAN 1981, ČAR & al. 1981, BUSER & al. 1982, TURNŠEK & al. 1982). Nihče pa doslej še ni zasledil karnijskih plasti zahodneje od doline Bače oziroma Sel nad Podmelcem.

Na novo odkrite karnijske plasti pri Perbli so bile na Kossmatovi geološki karti lista Tolmin 1 : 75.000 (KOSSMAT 1920) uvrščene v juro. Enako so prikazane tudi na italijanski geološki karti lista Tolmin 1 : 100.000 (FABIANI & al. 1937). COUSIN (1973) pa jih je zaradi podobno razvitih plasti v bližini uvrstil v spodnjo kredo.

Geološki opis plasti pri Perbli

Med Perblo na jugu in Tolminskimi Ravnami na severu so ob cesti lepo odkrite plasti od zgornjega triasa preko jure in spodnje krede do vključno zgornjekrednega fliša (sl. 1). To je tudi eden najlepše ohranjenih sklenjenih presekov skozi mezozojske plasti globljemorskega razvoja v predgorju Julijskih Alp. Plasti vpadajo konstantno proti severovzhodu in si slede od juga proti severu vedno mlajše kamenine. Pri sotočju Zadlaščice in Jelovščice meje karnijske plasti ob prelomu na spodnjekredne flišne plasti, ki jih sestavljajo glinasti skrilavci in laporji v menjavi s kalkareniti, ki vsebujejo gomolje roženca.

Debelina na novo odkritih karnijskih plasti je okoli 100 m, vendar je njihov spodnji del odrezan ob prelomu. V ohranjenem spodnjem delu profila se menjavata skladoviti do ploščasti temno sivi kalkarenit in mikritni apnenec s tankimi plastmi zelenkasto sivega laporja. V kalkarenitu so redke pole in gomolji roženca. Navzgor postajajo lapornate plasti med kalkarenitom pogostnejše in debelejše, mikritni apnenec pa skoraj docela izgine.

Približno 40 debelinskih metrov pod stikom karnijskih plasti z baškim dolomitom je med klastičnimi kameninami okoli 10 m debel vložek masivnega apnenca. Sestavljajo ga trdno sprijeti bloki in kosi grebenskega apnenca s koralami, hetetidami in drugimi grebenotvornimi organizmi. Grebenski apnenec je odkrit v cestnem vseku na dveh mestih med dvema ovinkoma (sl. 2). Zaradi pokritosti terena z moreno in površinsko preperino je grebenski apnenec odkrit le ob cesti. Masivni apnenec moremo slediti proti zahodu še na strmem pobočju tik pod cesto okoli 200 m od potoka Jelovščice.

V zgornjem delu prehaja masivni apnenec v brečo, ki jo sestavljajo prav tako kosi grebenskega apnenca z lapornatim vezivom. Stik med brečo in krovnim laporjem je neraven oziroma se kosi in bloki grebenskega apnenca zajedajo v lapor, kar daje videz kot da bi ti v njem »plavali«. Nad laporjem sledi zopet kalkarenit v menjavi z glinastim skrilavcem in mikritnim apnencem, vendar je del profila pokrit z moreno. Nekaj metrov nad grebenskim apnencem leži temno siv skladovit mikritni apnenec, ki vsebuje nedoločljive preseke amonitov. Vzorci tega apnenca niso vsebovali konodontov. Nad mikritnim apnencem z amoniti sledi okoli 30 m debela skladovnica črnega glinastega skrilavca, ki vsebuje do 10 cm debele plasti temno sivega lapornatega apnenca. Tudi vzorci tega apnenca niso vsebovali konodontov. V vrhnjem delu prehaja skrilavec postopoma v norijsko-retijski baški dolomit, ki vsebuje v najnižjem delu ogromne količine roženca (sl. 3).

Starost grebenskega apnenca

Karnijske plasti pri Perbli se litološko razlikujejo od karnijskih amfiklinskih skladov v dolini Bače in njeni širši okolici. Glede na to, da leže karnijske plasti

pri Perbli normalno pod baškim dolomitom, moremo sklepati, da so nastale prav tako kot amfiklinski skladi, v slovenskem jarku. Možno je, da so bili v globljih delih profila pri Perbli razviti tudi pretežno glinasti skrilavci v menjavi s peščenjaki, podobni srednjim amfiklinskim plastem iz doline Bače, vendar so le-ti odrezani ob prelomu. Zgornji del amfiklinskih plasti pa je tudi vzhodneje od Perble razvit pretežno apnenčevo, v njem pa so najdeni tuvalski konodonti in amoniti (FLÜGEL & RAMOVŠ 1970, BUSER & KRIVIC 1979). Poudariti namreč moramo, da se pojavljajo grebenski apnenci v amfiklinskih plasteh vzhodneje od Perble v njihovi spodnji in srednji tretjini (TURNŠEK & al. 1982) in so torej starejši ter pripadajo cordevolu in julu. Pri Perbli pa zavzema grebenski apnenec med klastičnimi kameninami najvišji del in pripada zgornjemu karniju — tuvalu. V norij verjetno ne sega, saj se je pričela sedimentacija baškega dolomita, ki leži nad grebenskim apnencem, v najnižjem delu norija.

PALEONTOLOŠKI DEL

Dragica Turnšek

Iz grebenskega apnenca pri Perbli je določenih in obdelanih 16 vrst grebenotvornih organizmov, ki pripadajo koralam, stromatoporoidom, hetetidam in spongijam. Mestoma jih spremljajo številne foraminifere. Natančnejši opis vrst je podan v angleškem besedilu. Vrste posameznih skupin so podane po abecednem redu:

ANTHOZOA:

Astraemorpha pratzi VOLZ 1896 — Tab. 1, sl. 1.
Margarophyllia capitata (MÜNSTER 1841) — Tab. 1, sl. 2.
Margarophyllia crenata (MÜNSTER 1841) — Tab. 1, sl. 3.
Margarosmilia zieteni (KLIPSTEIN 1843) — Tab. 1, sl. 4.
Pamiroseris zitteli (WÖHRMANN 1889) — Tab. 1, sl. 5.
Retiophyllia tolminensis n. sp. — Tab. 2 in 3
Thamnotropis rakoveci (TURNŠEK 1985)
Volzeia badiotica (VOLZ 1896) — Tab. 4, sl. 1—2

STROMATOPOROIDEA:

Disjectopora dubia VINASSA de REGNY 1915 — Tab. 4, sl. 3
Stromatomorpha sp. — Tab. 4, sl. 4

CHAETETIDA:

Atrochaetetes alakirensis CUIF & FISCHER 1974 — Tab. 5, sl. 1—2
Blastochaetetes karashensis CUIF & FISCHER 1974 — Tab. 5, sl. 3—4
Pamirochaetetes stromatoides BOJKO 1979 — Tab. 5, sl. 5—6

SPONGIA:

Corynella ritae VINASSA de REGNY 1907 — Tab. 6, sl. 1
Paradeningeria alpina SENOWBARI-DARYAN & SCHÄFER 1979 — Tab. 6, sl. 3—4
Precorynella pyriformis (KLIPSTEIN 1843) — Tab. 6, sl. 2
Walteria sp. — Tab. 6, sl. 5—6

FORAMINIFERA:

Alphinophragmium perforatum FLÜGEL 1967 — Tab. 7, sl. 1
Duostomina sp. / *Diplotremina* sp. — Tab. 7, sl. 2
Galeanella panticae BRÖNNIMANN & al. 1973 — Tab. 7, sl. 4
Involutina sp. — Tab. 7, sl. 3

Stratigrafska primerjava fosilov najdenih v Perbli

Grebenska favna v Perbli je le delno podobna oni iz podobnega nahajališča v Hudajužni in okolici (TURNŠEK & al. 1982). Vsebuje iste fosilne skupine, to je korale, stromatopore, spongije, vendar je nad 60 % njihovih vrst drugačnih. Velika razlika pa so hetetide, ki so v Perbli zelo pogostne, v Hudajužni pa jih ni. Prav obratno so mikroproblematika v Hudajužni pogostna, v Perbli pa jih nismo našli (sl. 4 in 5).

Tudi starost najdenih fosilov je drugačna od Hudajužne. Koralne vrste rodov *Margarophyllia, Margarosmilia* in *Volzeia* ter spongija *Precorynella* so značilne za »kasijansko« obdobje in so v dosedanjih nahajališčih uvrščene v cordevol in jul. V Perbli pa smo našli tudi primerke rodov *Retiophyllia, Pamiroseris, Stromatomorpha, Paradeningeria* in nekatere foraminifere, ki kažejo na mlajšo starost.

Retiophyllia tolminensis n. sp. (= *Retiophyllia* type II, CUIF 1974) je najdena v zgonjekarnijskih skadih Taurusa v Turčiji, *Pamiroseris zitteli* v »rabeljskih« skladih v Schlernu v Dolomitih Italije (WÖHRMANN 1889, KRAUS 1969), *Atrochaetetes alakirensis* in *Blastochaetetes karashensis* v Taurusu, v karniju Turčije (CUIF & FISCHER 1974) *Corynella ritae* v »rabeljskih« skladih v okolici Veszprema v Bakony na Madžarskem (VINASSA de REGNY 1907, FLÜGEL & SY 1959, KOLOSVÁRY 1966).

Nekatere vrste iz Perble so bile doslej najdene celo v noriju ali retiju, tako *Pamirochaetetes stromatoides* v noriju Pamirja (BOJKO 1979), *Paradeningeria alpina* v noriju-retiju Salzburških Alp v Avstriji (SENOWBARI-DARYAN & SCHÄFER 1979). Norijsko-retijske so tudi foraminifere *Alpinophragmium perforatum* in *Galeanella panticae* (glej FLÜGEL 1967, SENOWBARI-DARYAN 1980).

Pri stratigrafski primerjavi grebenskih zgornjetriadnih fosilnih združb lahko omenimo še neko ugotovitev. Nekatere grebene raziskovalci uvrščajo v celoti v norij ali retij, toda v njih omenjajo tudi fosile, ki so značilni za karnijske sklade. Tako so na primer v grebenih Adnet, Gruberriff in Feichtenstein na Salzburškem, kakor tudi v nahajališčih v okolici Palerma na Siciliji poleg tipičnih norijsko-retijskih fosilov najdene tudi karnijske fosilne vrste, kot so *Bacinella ordinata* PANTIĆ 1972, *Lamellitubus cauticus* OTT 1968, *Ladinella porata* OTT 1968 in druge (SCHÄFER 1979, SENOWBARI-DARYAN 1980, SENOWBARI-DARYAN, SCHÄFER & ABATE 1982). Zato je možno, da ti grebeni s svojimi začetki segajo v karnij, ali pa se v zgornjem karniju ali spodnjem noriju mešata obe favni. Podobno mešano favnistično združbo ima greben na otoku Hydra v Grčiji, ki je uvrščen v enoten karnijsko-norijski kompleks (SENOWBARI-DARYAN & SCHÄFER 1982).

Po primerjavi lahko torej ugotovimo, da je favna iz nahajališča v Perbli pri Tolminu zgornjekarnijske starosti (? zg. jul in tuval). Zgornjekarnijska starost favne se lepo ujema s terenskimi ugotovitvami in z lego tega grebenske apnenca (sl. 3 in 6).

Nahajališče v Perbli obenem dokazuje, da so se karnijski grebeni v slovenskem jarku ali na robovih karbonatnih platform mestoma neprekinjeno nadaljevali iz cordevola in jula v tuval, kjer so se favne že začele mešati z norijskimi elementi.

SEDIMENTOLOŠKI DEL

Bojan Ogorelec

Mikrofacialne značilnosti grebenskega apnenca

V preiskanem zaporedju karnijskih plasti pri Perbli ločimo v grobem štiri tipe kamnin: a) plastovit biomikritni apnenec v talnini grebenske tvorbe, b) plasti biokalkarenita in biokalcirudita, c) grebenski apnenec d) krovne plasti (skrilavec, apnenec

in dolomit z rožencem — baški dolomit). Sedimentološke raziskave zajemajo podrobneje le kompleks biokalkarenitov in grebenskega apnenca. Lokacija vzetih vzorcev ter shematski litološki stolpec preiskanih plasti sta prikazana na sl. 2 in 3.

a) Talnino grebenskega kompleksa sestavlja tanko do srednje plastovit biomikritni in biosparitni apnenec (vzorec P-17), ki se je sodeč po fosilni združbi odlagal v globljem in mirnem okolju. Apnenec je homogen in srednje sive barve. Mikritna osnova je rahlo rekristalizirana, med fosili pa so zastopani kalcitizirani radiolariji, drobir pelagičnih foraminifer ter ploščice ehinodermov. Za stratigrafsko determinacijo so fosili nedoločljivi. Delež karbonata v apnencu je visok in se giblje med 95 in 98 %. Med nekarbonatnimi zrni so prisotni minerali glin, ki so kot pigment pomešani v mikritni osnovi, ter redka, okrog 50 μm velika zrna kremena. Pigment je deloma detritičnega izvora, del pa ga je avtigenega in se javlja v do 100 μm velikih kristalih. Energijski indeks apnenca je nizek do srednji.

b) Nad kompleksom biomikritnega apnenca se javlja okrog 15 m debela skladovnica biokalkarenita in drobnozrnate breče (vzorci Pe 1—9). Sam kontakt med obema litološkima členoma je tektonski in poteka ob manjšem lokalnem prelomu. Posamezne plasti biokalkarenita so debele od 5 do 70 cm, mestoma pa se med njimi javljajo do nekaj cm debele pole laporja. Že makroskopsko opazujemo v nekaterih plasteh biokalkarenita in breče postopno zrnavost, po kateri sklepamo na normalno lego plasti. Te sicer strmo vpadajo proti severovzhodu. Za biokalkarenit in brečo so značilni tudi gomolji roženca.

Biokalkarenit sestavljajo dobro zaobljeni intraklasti, med katere so pomešane številne ploščice ehinodermov. Tudi sortiranost je dobra. Posamezni odlomki merijo od 0,5 do 2 mm. Intraklasti so po sestavi mikritni, v redkih pa opazujemo skelete nedoločljivih alg in foraminifer. Ploščice ehinodermov kažejo ob robovih pogosto mikritne ovoje ter sintaksialni sparitni cement. Vezivo v biokalkarenitu je večidel rahlo rekristaliziran mikrit, okrog 20 % medprostorov med odlomki pa zapolnjuje tudi drobnozrnati sparitni cement. V nekaterih vzorcih opazujemo, da je prišlo do raztapljanja karbonata pri diagenezi ter do stilolitnih šivov, tako se ponekod posamezni klasti med seboj zajedajo eden v drugega. Med diagenetskimi procesi v vzorcih biokalkarenita sta pomembni predvsem silicizacija in v manjši meri dolomitizacija.

Odlomki v apnenčevi breči (kalciruditu) merijo do 0,5 cm. Večidel pripadajo litičnim drobcem, številne pa so med njimi zopet ploščice ehinodermov in odlomki školjčnih lupin. Litični drobci pripadajo po strukturi mikritu, biomikritu ter biosparitu; med fosili prevladujejo v drobcih skeletne alge. Osnova med odlomki in fosili je mikrit s primesjo mineralov glin, pogosto pa so omejeni kontakti med njimi s stilolitnimi šivi. Plasti apnenčeve breče so večkrat močno silicizirane. Izvor kremenice za nastanek roženca predvidevamo v raztopljenih skeletih radiolarijev in spikul spongij. Oboje opazujemo v biomikritnem apnencu (npr. vzorec Pe-5b), ki se javlja med biokalkarenitom.

Biokalkarenit in drobna apnenčeva breča sta se sedimentirala v globlje okolje s podvodnimi tokovi. Taki podvodni plazovi so bili večkrat aktivni na pobočjih slovenskega jarka, ki je bil v karnijskem obdobju že izrazit (BUSER & al. 1982, TURNŠEK & al. 1984). Enako razvite plasti breče in kalkarenita, kot jih opazujemo v profilu Perble, se v karnijskem zaporedju javljajo tudi na območju Vršiča (JURKOVŠEK & al. 1984).

c) Kompleksu biokalkarenita in drobnozrnate breče sledi ca 15 m debel paket masivnega grebenskega apnenca in spremljajoče breče (vzorci PE 10—12, 14 in 16). Ta apnenec je zaradi bogate vsebine fosilov, predvsem grebenskih organizmov, pri-

tegnil pozornost naših raziskav. Spodnji kontakt med obema členoma je prekrit, navzgor pa grebenski apnenec prehaja v biomikritni apnenec in skrilavec (sl. 3).

Apnenec z grebensko favno je temnosive barve. Po faciesu je zelo podoben apnencu iz Hudajužne (TURNŠEK & al. 1982). Gradijo ga do nekaj cm veliki skeleti koral, poleg njih se javljajo številni drugi grebenski organizmi, od drugih alokemov pa še intraklasti raznovrstnih tipov karnijskih apnencev ter posamezni ooidi. Grebenski apnenec je precej rekristaliziran, zato je prvotna struktura koral in drugih organizmov že močno zabrisana. Organizmi so povečini obraščeni z do nekaj mm debelimi ovoji neskeletnih alg.

Intraklasti pripadajo po sestavi večidel mikritnemu apnencu, manj je pelmikritnih. Posebno zanimivi so odlomki lapornatega biomikritnega apnenca, ki vsebuje številne lupine školjk, ostrakodov, ploščic ehinodermov in detritično primes kremena ter so značilni mikrofacialni različek karnijskega apnenca (primerjaj tudi PANTIĆ-PRODANOVIĆ 1975). Tak apnenec se je odlagal v plitvem šelfu na platformah.

Cement med organizmi in intraklasti pripada večidel srednjezrnatemu sparitu, mestoma pa se javljajo gnezda mikrita. V nekaterih vzorcih opazujemo tudi teksturne vrste Stromatactis, do nekaj cm velike kaverne nepravilnih oblik. Te zapolnjujejo interni mikritni sediment in sparitni kalcit. Nastanek tekstur Stromatactis je vezan na odmrle neskeletne organizme.

d) V krovnini grebenskega apnenca se sprva menjavajo plasti lapornatega biomikritnega apnenca in skrilavca (Pe 11, 13 in 15) z značilnostmi globljemorskega faciesa (radiolariji, tanke školjčne lupine, nizek energijski indeks, primes gline in detritičnega kremena, piritni pigment, gomolji roženca). Nad kompleksom skrilavca in apnenca pa nastopa debela serija plastovitega zrnatega dolomita z gomolji roženca, znana kot baški dolomit. Ta je že norijske starosti in se javlja v širšem pasu med Tolminom in Škofjo Loko. V spodnjem delu zaporedja baškega dolomita se med dolomitom pri Perbli javljajo še redke pole apnenca, ki ga dolomitizacija ni zajela.

Diagenetske značilnosti

Med diagenetskimi procesi, ki so zajeli raziskano sedimentno skladovnico pri Perbli, omenjamo cementacijo, rekristalizacijo, silicizacijo in dolomitizacijo.

Rekristalizacija je v večjem ali manjšem obsegu zajela celotni kompleks karbonatnih kamnin. Mikritna osnova je rekristalizirana v mikrosparit, posebno močno pa so rekristalizirani skeleti fosilov. Te organizme večkrat prepoznamo samo še po njihovih konturah.

Cement opazujemo predvsem v apnencu grebenske breče, medtem ko je v plasteh biokalkarenita mikritna osnova. Po strukturi je cement zrnat kalcit s subhedralno obliko zrn. V nekaterih vzorcih sta opazni dve generaciji cementa — vlaknat kalcit A in druzast kalcit generacije B, ki kaže večanje kristalov proti središču por in je značilen za okolje z dolgotrajnimi stabilnimi kemičnimi pogoji pornih raztopin.

Roženec, ki se javlja v karbonatnem kompleksu, je kasnodiagenetskega nastanka. Nastopa v do 15 cm velikih nepravilnih gomoljih z ostrimi kontakti s prikamnino. Kremen je mikrokristalen, v več vzorcih pa je kljub silicizaciji še opazna prvotna struktura kamnine. Posebno pogostni so roženčevi gomolji v plasteh biokalkarenita, kjer je bila v primerjavi z mikritnim kalcitom v času diageneze ugodnejša poroznost za pretok kremenice.

Razen roženčevih gomoljev se silicizacija lahko javlja tudi kot nadomeščanje kalcita s kremenom v skeletih moluskov ter kot redki drobni kristali avtigenega kremena.

Tudi dolomitizacija plasti je kasnodiagenetska. Dolomit se javlja v izoliranih največ do 200 μm velikih romboedrih, njegov delež pa se giblje od sledov do 15 %. Dolomitizacija je zajela predvsem mikritne intraklaste in mikritno osnovo v kalkarenitu, mestoma pa so dolomitizirana tudi septa koralnih skeletov.

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PLATES—TABLE

PLATE 1

Fig. 1. *Astraeomorpha pratzi* Volz 1896
Thin section P-794, 4 x.
Fig. 2. *Margarophyllia capitata* (Münster 1841)
This section P-789, 4 x.
Fig. 3. *Margarophyllia crenata* (Münster 1841)
Thin section P-786, 4 x.
Fig. 4. *Margarosmilia zieteni* (Klipstein 1843)
Transverse thin section of one corallite from phaceloid colony. P-795, 4 x.
Fig. 5. *Pamiroseris zitteli* (Wöhrmann 1889)
Thin section P-787, 4 x.

TABLA 1

Sl. 1. *Astraeomorpha pratzi* Volz 1896
Zbrusek P-794, 4 x.
Sl. 2. *Margarophyllia capitata* (Münster 1841)
Zbrusek P-789, 4 x.
Sl. 3. *Margarophyllia crenata* (Münster 1841)
Zbrusek P-786, 4 x.
Sl. 4. *Margarosmilia zieteni* (Klipstein 1843)
Prečni presek enega koralita iz vejnate kolonije
Zbrusek P-795, 4 x.
Sl. 5. *Pamiroseris zitteli* (Wöhrmann 1889)
Zbrusek P-787, 4 x.

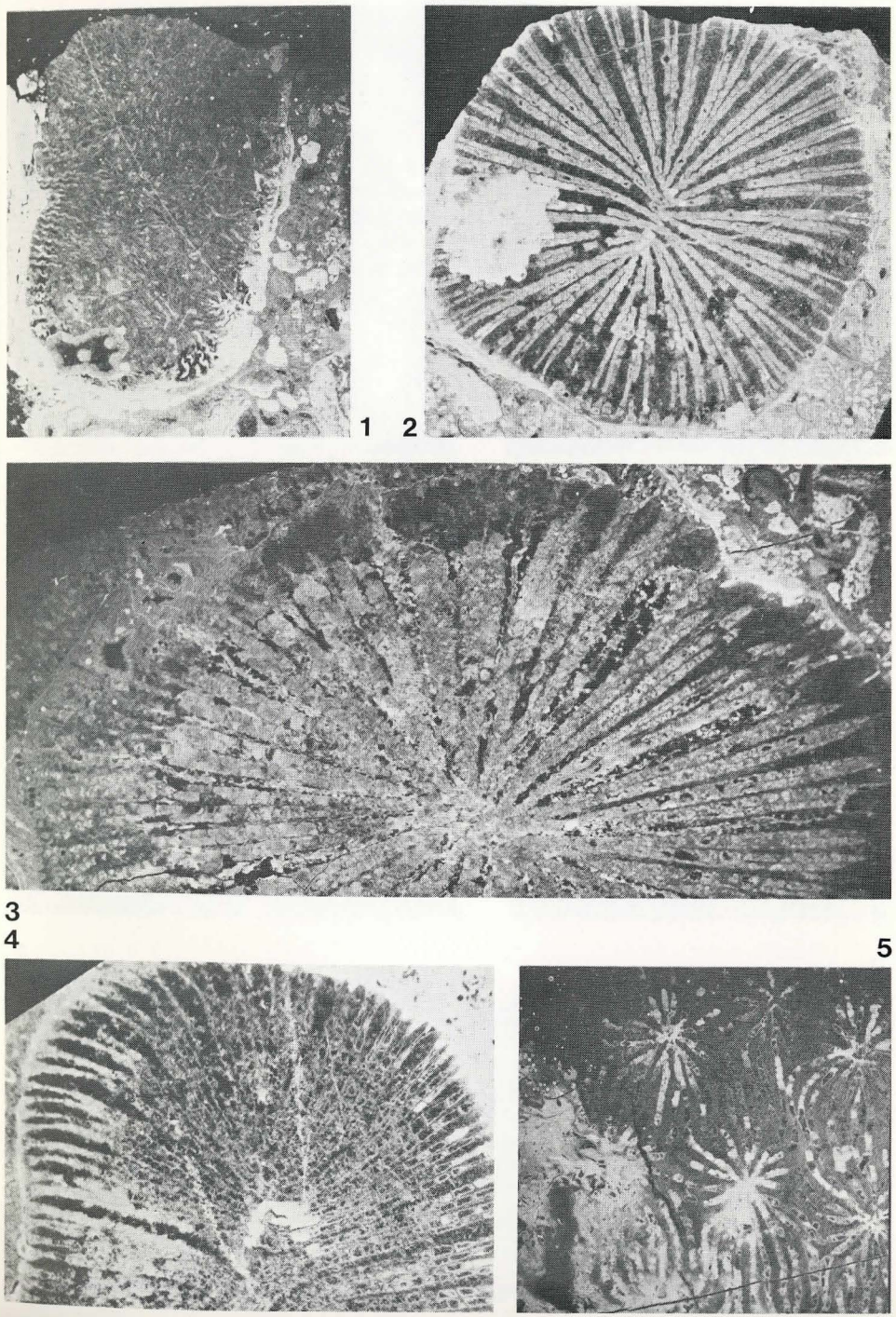


PLATE 2

Fig. 1—6. *Retiophyllia tolminensis* n.sp.

1. Transverse thin section of holotype.
   P-785a, 4 x.
2. Longitudinal thin section of holotype.
   P-785b, 4 x.
3. Transverse thin section of specimen P-792, 4 x.
4. Longitudinal thin section of specimen P-793, 4 x.
5. Transverse thin section of one corallite in the calice region, i.e. in its upper part where septa are shorter P-781a, 4 x.
6. Transverse thin section of one corallite in its lower part, where septa are longer.
   P-781b, 4 x.

TABLA 2

Sl. 1—6. *Retiophyllia tolminensis* n.sp.

1. Prečni presek holotipa z dvema koralitoma. Zbrusek P-785a, 4 x.
2. Podolžni presek holotipa. Zbrusek P-785b, 4 x.
3. Prečni presek drugega koralita. Zbrusek P-792, 4 x.
4. Podolžni presek koralitov. Zbrusek P-793, 4 x.
5. Prečni presek koralita v njegovem zgornjem delu v področju čaše, kjer so septa kratka.
   Zbrusek P-781a, 4 x.
6. Prečni presek koralita v njegovem nižjem delu, kjer so septa že daljša.
   Zbrusek p-781b, 4 x.

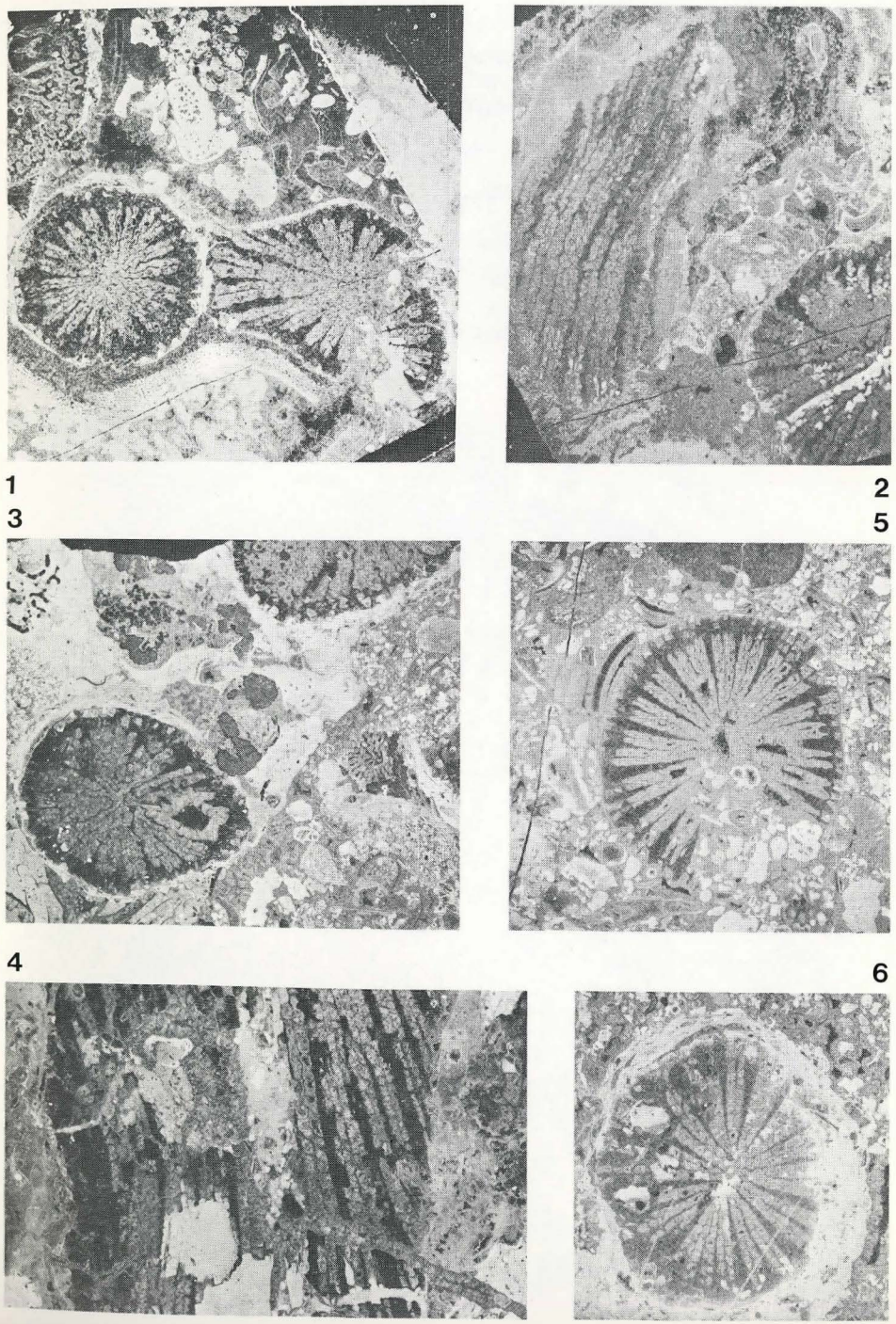
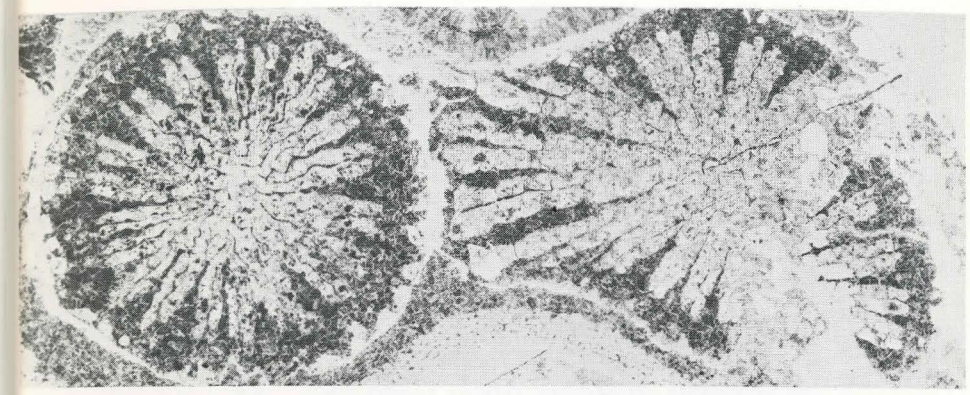


PLATE 3

Fig. 1—2. *Retiophyllia tolminensis* n.sp.
1. Transverse section of two corallites.
Thin section P-785a, holotype, 8 x.
2. Transverse section of one corallite, in the same thin section.
P-785a, holotype, 20 x.

TABLA 3

Sl. 1—2. *Retiophyllia tolminensis* n.sp.
1. Prečni presek dveh koralitov.
Zbrusek P-785a, holotip, 8 x.
2. Prečni presek enega koralita, z istega zbruska.
Zbrusek P-785a, 20 x.



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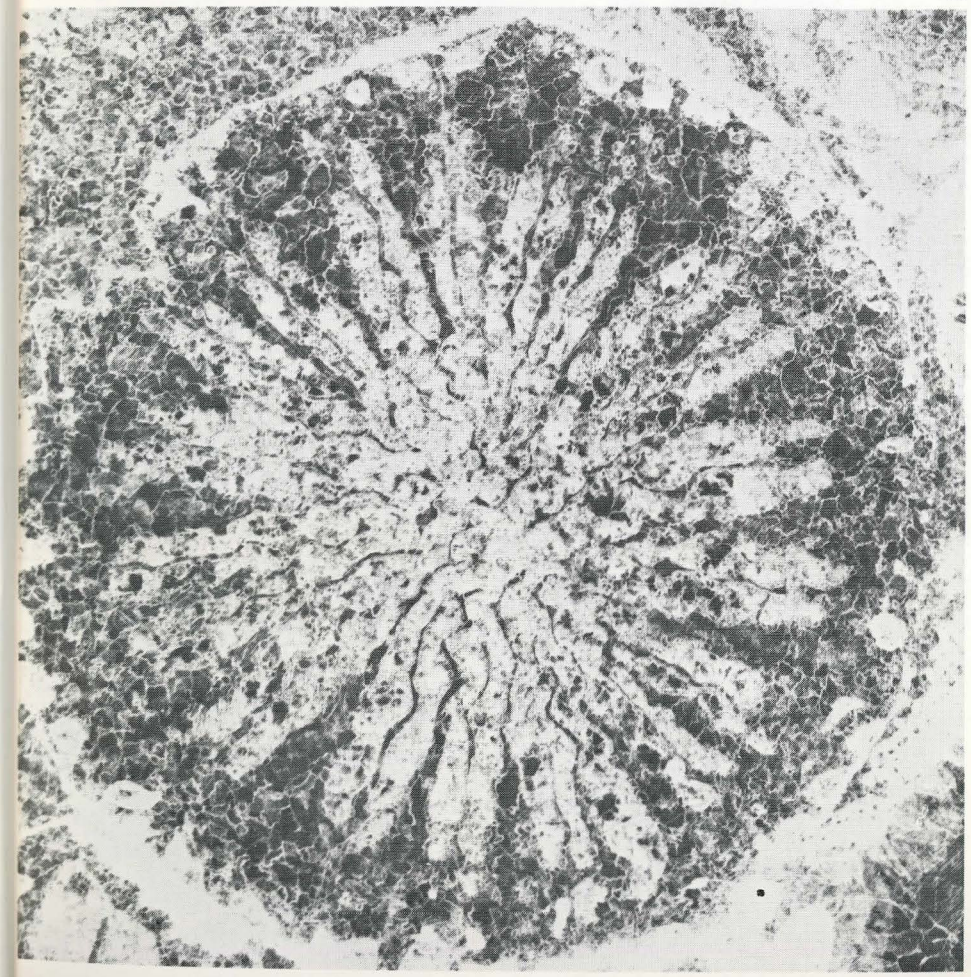


PLATE 4

Fig. 1—2. *Volzeia badiotica* (Volz 1896)
1. Transverse thin section P-788a, 4 x.
2. Longitudinal thin section of the same colony P-788b, 4 x.

Fig. 3. *Disjectopora dubia* Vinassa de Regny 1915.
Thin section P-799, 4 x.

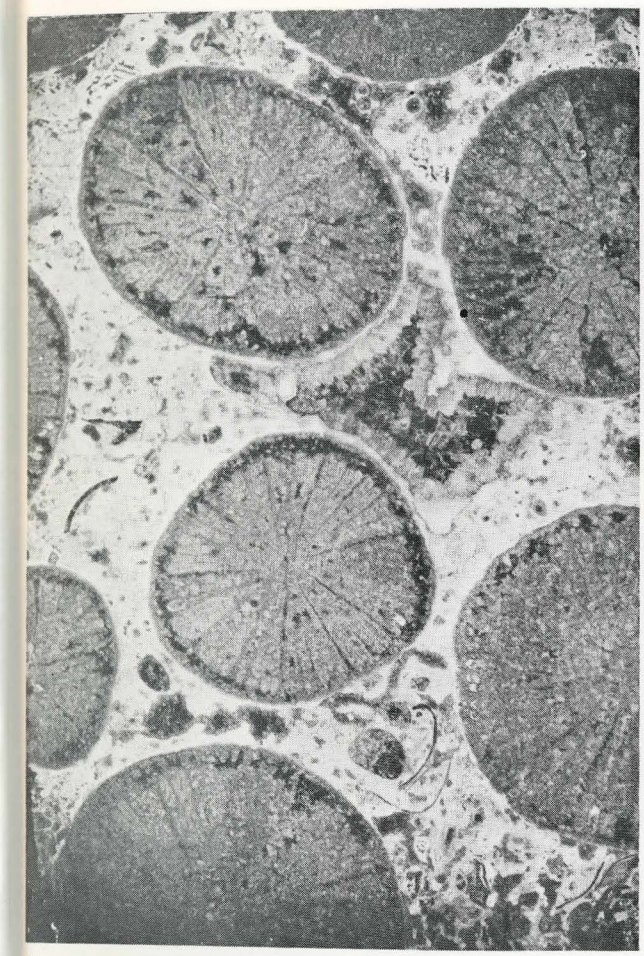
Fig. 4. *Stromatomorpha* sp.
Thin section P-784, 4 x.

TABLA 4

Sl. 1—2. *Volzeia badiotica* (Volz 1896)
1. Prečni presek, zbrusek P-788a, 4 x.
2. Podolžni presek iste kolonije, zbrusek P-788b, 4 x.

Sl. 3. *Disjectopora dubia* Vinassa de Regny 1915
Zbrusek P-799, 4 x.

Sl. 4. *Stromatomorpha* sp.
Zbrusek P-784, 4 x.



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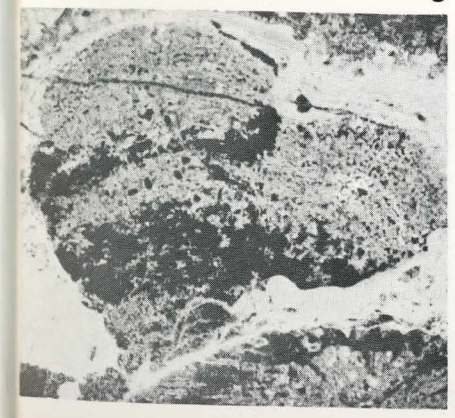

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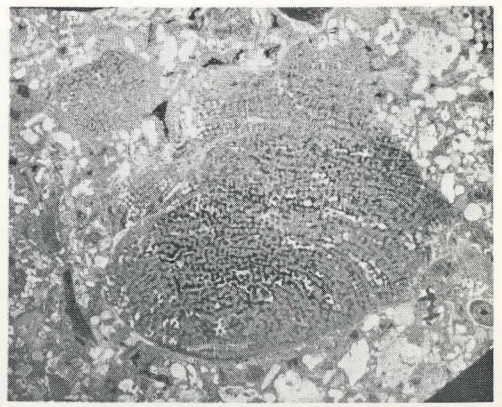


PLATE 5

Fig. 1—2. *Atrochaetetes alakirensis* Cuif & Fischer 1974
1. Thin section P-791, 4 x.
2. The same thin section, 8 x.

Fig. 3—4. *Blastochaetetes karashensis* Cuif & Fischer 1974
3. Thin section P-782, 4 x
4. The same thin section, 8 x.

Fig. 5—6. *Pamirochaetetes stromatoides* Bojko 1979
5. Thin section P-797, 4 x.
6. The same thin section, 8 x.

TABLA 5

Sl. 1—2. *Atrochaetetes alakirensis* Cuif & Fischer 1974
1. Zbrusek P-791, 4 x.
2. Isti zbrusek, 8 x,

Sl. 3—4. *Blastochaetetes karashensis* Cuif & Fischer 1974
3. Zbrusek P-782, 4 x.
4. Isti zbrusek, 8 x.

Sl. 5—6. *Pamirochaetetes stromatoides* Bojko 1979
5. Zbrusek P-797, 4 x.
6. Isti zbrusek, 8 x.

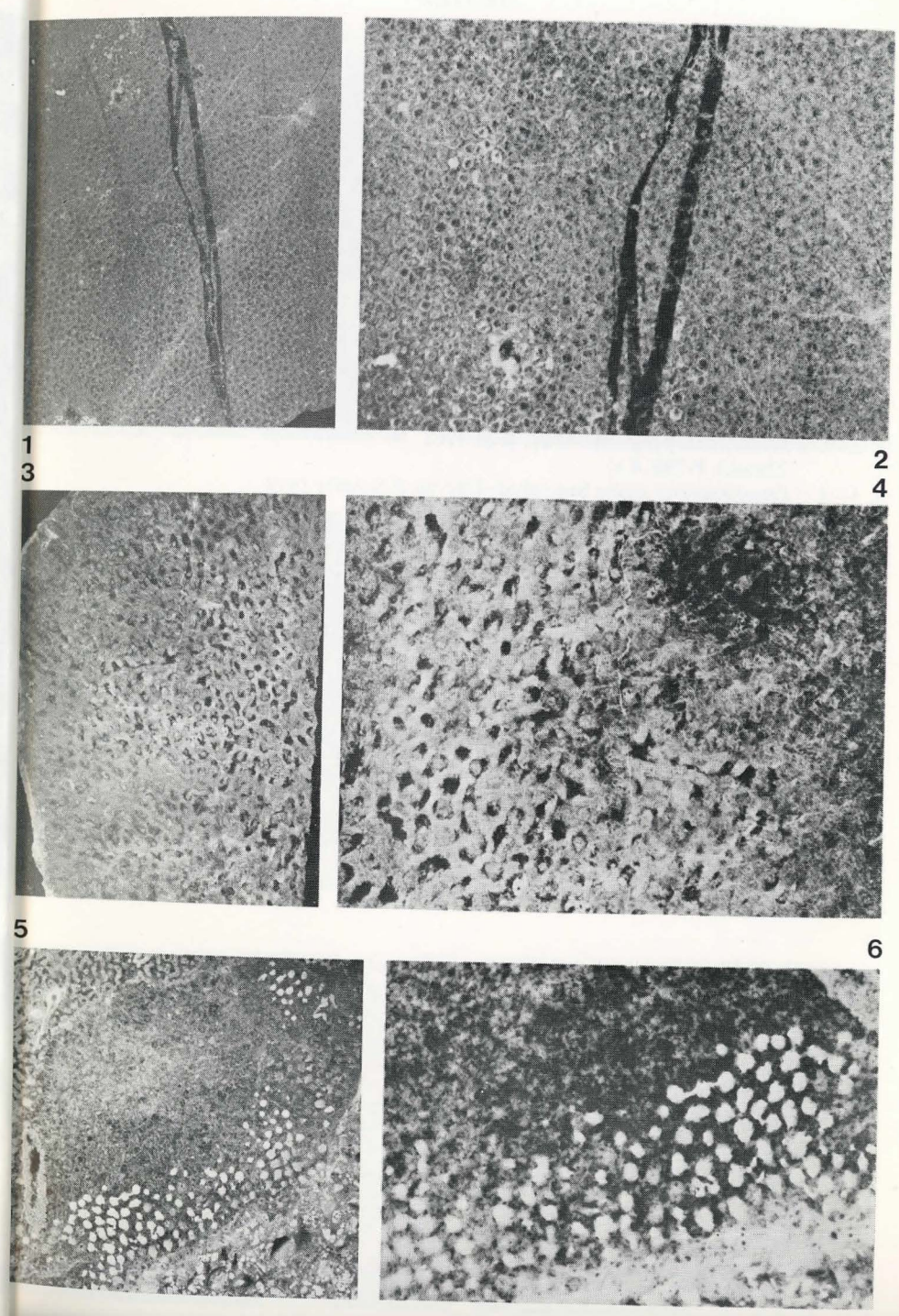
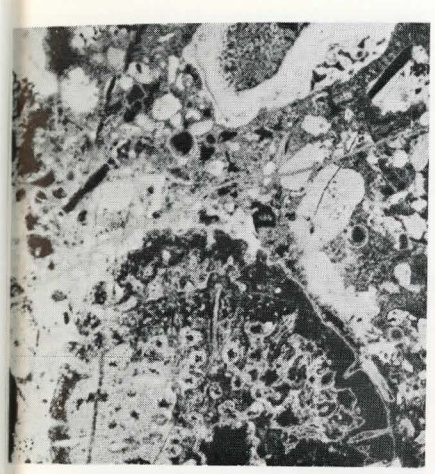


PLATE 6

Fig. 1. *Corynella ritae* Vinassa de Regny 1907
Thin section P-799, 4 x.
Fig. 2. *Precorynella pyriformis* Dieci & al. 1968
Thin section P-790, 4 x.
Fig. 3—4. *Paradeningeria alpina* Senowbari-Daryan & Schäfer 1979
3. Thin section P-801, 4 x.
4. Thin section P-802, 4 x.
Fig. 5—6. *Walteria* sp.
5. Thin section P-796a, 4 x.
6. Thin section P-796b, 4 x.

TABLA 6

Sl. 1. *Corynella ritae* Vinassa de Regny 1907
Zbrusek P-799, 4 x.
Sl. 2. *Precorynella pyriformis* Dieci & al. 1968
Zbrusek P-790, 4 x.
Sl. 3—4. *Paradeningeria alpina* Senowbari-Daryan & Schäfer 1979
3. Zbrusek P-801, 4 x.
4. Zbrusek P-802, 4 x.
Sl. 5—6. *Walteria* sp.
5. Zbrusek P-796a, 4 x.
6. Zbrusek P-796b, 4 x.



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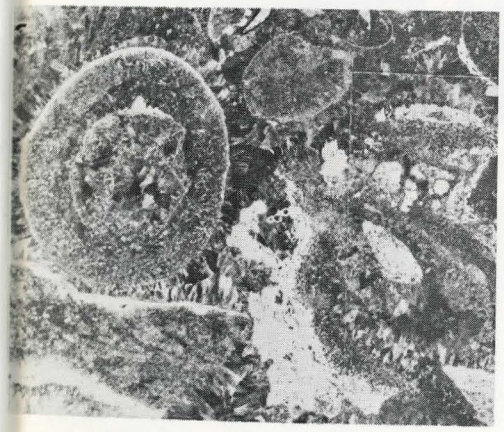

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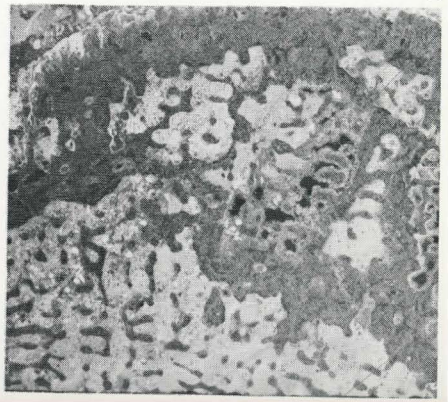
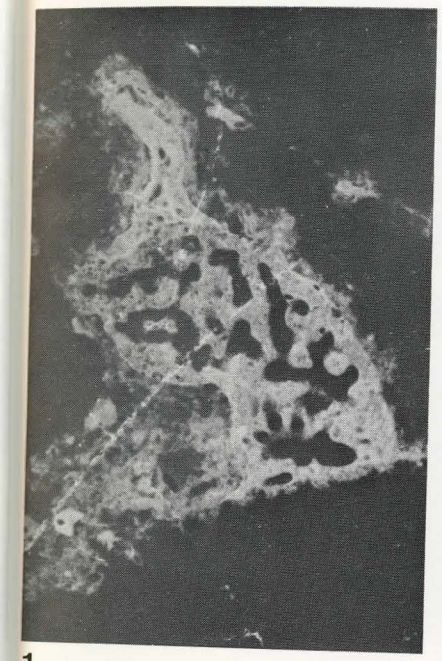


PLATE 7

Fig. 1. *Alpinophragmium perforatum* Flügel 1967
Thin section P-788, 20 x.
Fig. 2. *Duostomina* sp. *(Diplotremina* sp. *Endothyra* sp).
Thin section P-784, 20 x.
Fig. 3. *Involutina* sp.
Thin section P-782, 20 x.
Fig. 4. *Galeanella panticae* Brönnimann & al. 1973
Thin section P-783, 20 x.

TABLA 7

Sl. 1. *Alpinophragmium perforatum* Flügel 1967
Zbrusek P-788, 20 x.
Sl. 2. *Duostomina* sp. *(Diplotremina* sp. *Endothyra* sp.)
Zbrusek P-784, 20 x.
Sl. 3. *Involutina* sp.
Zbrusek P-782, 20 x.
Sl. 4. *Galeanella panticae* Brönnimann & al. 1973
Zbrusek P-783, 20 x.



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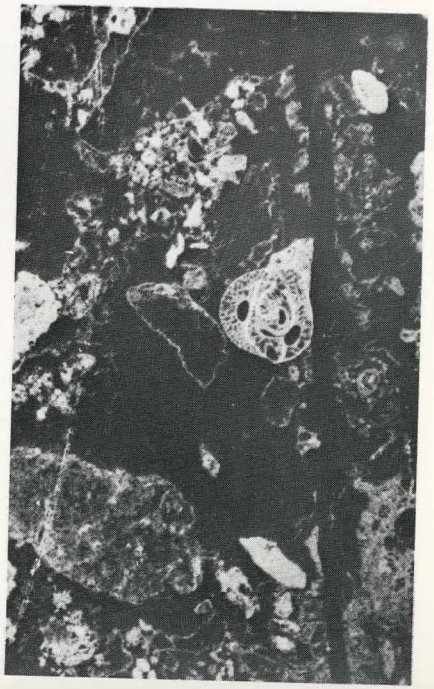

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