LOWER CARNIAN REEF BUILDUPS IN THE NORTHERN JULIAN ALPS (SLOVENIA, NW YUGOSLAVIA)

(WITH 7 FIGURES IN TEXT AND 15 PLATES IN ANNEX)

SPODNJEKARNIJSKE GREBENSKE TVORBE V SEVERNIH JULIJSKIH ALPAH

(S 7 SLIKAMI V BESEDILU IN 15 TABLAMI V PRILOGI)

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INTRODUCTION

Reef buildups of Triassic beds occur in Slovenia mostly in the western and northern parts. On the base of paleoecology they are subdivided into reef buildups which thrived on the Julian and the Dinaric carbonate platforms, and into those which occur within the Slovenian trough.

The present treatise represents the first systematic study of the Lower Carnian reef buildups in Julian Alps, i. e. on the Julian carbonate platform. It deals with organisms which built them, their fossil associations and the facies types of rocks. Elsewhere in Slovenia there were no such studies concerning these times, with the exception of a study on peculiar reefs in the Amphiclina beds between Hudajužna and Zakriž, in the Slovenian through.

During six years, from 1977 until 1983, of field investigations of the biostratigraphy of Triassic beds in Northern Julian Alps, A. RAMOVŠ systematically disclosed the reef development in that area between the clastic-limy-volcanogenic Ladinian beds and the partly clastic-carbonate, or solely carbonate development of the Middle and Upper Carnian. He studied facies developments of this time, collected an abundance of various fossils and lithologic samples for paleontological, facies and sedimentological analyses. D. TURNŠEK determined and described fauna from coral buildups. A. RAMOVŠ determined the fauna from algal mats, investigated faunistic communities and facies developments.

Acknowledgements

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REVIEW OF PREVIOUS WORK

The first basic data on stratigraphic conditions of the territory of the Lower Carnian reef buildups were presented by PETERS (1856: 630—686). He assumed also that Špik consists of fossiliferous Hierlatz beds. The limestone with encrinits southeast of Jesenice was attributed by him to the Upper Triassic. On the manuscript geological map sheet Bovec on the scale 1 : 75.000, which contains the results of PETERS' investigations, the ridge

from Škrlatica across Lipnica and Špik, almost to Kurji vrh, consists of the Dachstein limestone, and the ridge of Vitranec of the Muschelkalk.

Interesting and important are results of DIENER (1884: 676—699). According to him in the composition of Mežakla the reef limestone prevails; in the section between Kavče and Planina Mežakla the Cassian dolomite is marked, and from there across Veliki vrh and Jerebikovec to Krma reef limestone of the Dachstein type. At Mojstrana the Cassian dolomite appears. The ridge of Črna gora consists of non-bedded reef mass which is the prolongation of the Cassian dolomite of the Vrtaški vrh. Between Martuljek and Beli potok reef buildups occur which fuse upwards with the dolomite of Vršič (1696 m) into an unseparable unique mass. It appears that the reef formation lasted without interruption to the end of the Buchenstein time, up to the Dachstein limestone. From Velika Pišnica across Vitranec to Mala Ponca below the Raibl beds occurs a broad dolomite zone of westerly direction. Already DIENER was of opinion that the first design of the extended shallow reef appeared during the Upper Muschelkalk time, and that the widening of the reef occured from the east, from an area which he could not better define, and the reef reached the Martuljek potok during its largest extension. The reef development reached its culminating point during the time of deposition of the Cassian beds, the same as in the South Tyrol.

On TELLER'S geological map which appeared in the study of the geology of the Karavanke tunnel (TELLER 1910), from the edge of Mežakla to the Sava valley between Dobrava and Hrušica extends the Main dolomite and the Dachstein limestone, on which leans in the direction towards Mojstrana the Schlern dolomite with limestone equivalents, and it continues farther westwards from Mojstrana towards Martuljek.

On the KOSSMAT'S generalized geological map of the western Slovenia on the scale 1 : 350.000 appear on the major part of the investigated territory the Middle and the Upper Triassic limestone and dolomite without a more detailed subdivision into series and stages. In the summary table to this treatise, KOSSMAT reports in eastern and western Julian Alps the Wetterstein limestone and dolomite above clastic rocks with vulcanites (KOSSMAT 1913).

On the manuscript geological map of the sheet Radovljica on the scale 1 : 75 000 (partly corrections appear on it until 19 May 1916) with results of TELLER'S and KOSSMAT'S investigations, the central part of Mežakla, northwestern part of Pokljuka with Lipanjski vrh, Debela peč, Klečica and Frčkov vrh, as well as Vrtaški vrh north of Mojstrana consist of Main dolomite and Dachstein limestone, only on edges of Mežakla and on the northwestern margin of Pokljuka appears a smal autcrop of Schlern dolomite and its limestone equivalent. West of Krma the entire Srednja gora and Črna gora, the vast territory between Mojstrana and Vrtaški vrh, and belts towards the Peričnik and towards the Upper Martuljek waterfall consist of Schlern dolomite and the limestone equivalent. A belt of same rocks occurs on the map south of the Sava valley from Podkuže towards Martuljek. Both stratigraphic units appear in immediate contact.

WINKLER-HERMADEN (1936: 169—172) reports above the Wengen beds the Diploporal reef of the Schlern dolomite and the sandy farmation of the Cassian beds. The reef facies is from 700 to above 1000 m thick, and it thickens from the Carnian towards the Julian Alps. The Schlern development is representing, according to him, partly also the Anisian stage, and partly the entire Ladinian, and in places also the Carnian.

On the Italian geological map of the sheet Tarvisio, F. 16 (Trbiž) on the scale 1 : 100.000 consist Prisojnik and its continuation northwards of Norian-Rhaetian limestone-dolomite facies which passes towards Vršič laterally into the facies of the characteristical Dachstein limestone.

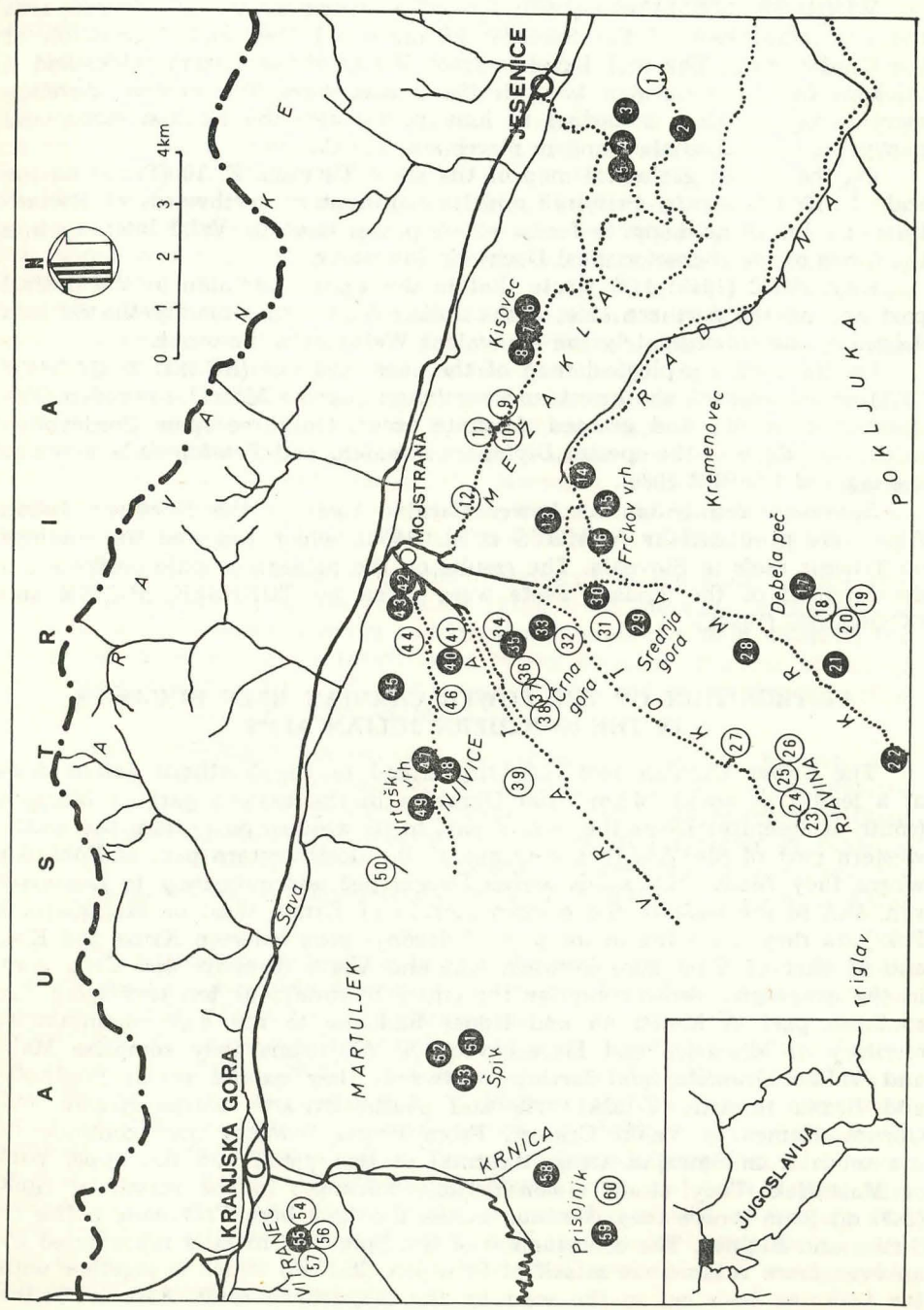
RAKOVEC (1951: 117) wrote that in the Upper Ladinian in the central part and on the northern side of the Julian Alps occurs mainly the Schlern dolomite, and subordinately the equivalent Wetterstein limestone.

On the recent geological map of the sheet Celovec (BUSER & CAJHEN 1977) on the central, southwest and northwest part of Mežakla, massive Cordovolian limestone and grained dolomite occur. On three spots Cordevolian calcareous algae of the species *Diplopora annulata* and *Teutloporella herculea* are marked (BUSER 1980).

Summary results on the Lower Carnian reefs in the Northern Julian Alps were presented by RAMOVŠ et al. (1982), which reported the findings on Triassic reefs in Slovenia. The results on the paleogeographic position and development of the Triassic reefs were given by TURNŠEK, BUSER and OGORELEC (1984).

DISTRIBUTION OF THE LOWER CARNIAN REEF BUILDUPS IN THE NORTHERN JULIAN ALPS

The Lower Carnian reef buildups extend in the Northern Julian Alps at a length of about 26 km from Obranica in the eastern part of Mežakla (south of Jesenice) across the central part to its western part; from the southwestern part of Mežakla they continue to the northwestern part of Pokljuka where they reach southwards across Debela peč approximately to Lipanjski vrh, and in the west to the eastern margin of Krma. West of Mežakla and Pokljuka they cover the major part of Srednja gora between Krma and Kot, and of part of Črna gora between Kot and Vrata (Srednja and Črna gora in the geographic sense comprise the entire mountainous territory from the southern part of Mojstrana and Upper Radovna to the high mountainous territory of Mlinarice and Macesnovec). At Mojstrana they comprise Malo and Veliko Grančiše, and farther westwards they extend across Pogorišče and Brana towards Vrtaški vrh, and southwestwards across Krasje and Gornov Komen to Veliki Črlovec. From Brana onwards they continue in the south from Smrajka across Skočniki in Beli potok and the upper part of Martuljek. They attain a considerable thickness in the massif of Špik (2473 m) from where they continue across the 2268 high Frdamane police to Sušica and Rigljica. The continuation of the Špik reef mass is represented by an even more voluminous massif of Prisojnik (2547 m) which is together with the Ladinian beds cut in the west by the Mojstrovka fault. East of Velika



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Pišnica the Lower Carnian reef buildups continue in Škrbinjek and in both sides of Mala Pišnica, where they are intensively dislocated, and crushed into dolomitic rubble and mylonitic flour, and finally they end in the ridge of Vitranec. There the westernmost occurrings of coral-sponge patch reefs were found. The beds of the same age continue from Vitranec across the western slope of Ciprnik, and appear also in the slope of Mala Ponca.

Separated from this more or less continuous belt occurs the Lower Carnian limestone mass of Rjavina, Visoka Vrbanova špica, Begunjski vrh, Rež and Triglav; it represents an overthrusted nappe on the bedded Norian-Rhaetian Dachstein limestone. The studied localities are shown on Fig. 1. See also Pl. 1—2.

STRATIGRAPHIC POSITION OF REEF BUILDUPS

The reef limestone on Mežakla is underlain by Ladinian beds; they consist in their base of characteristic brownish, poorly layered, bedded or platy limestones; upwards follows dark grey or blackish limestone with teutloporellas, and above it thickly bedded and platy limestone with fine chert nodules are lain. Several thinner sheets of greenish tuffite are interbedded. The platy limestone gradually passes into light grey Cordevolian limestone which is layered in the beginning, and after several ten meters it becomes massive and contains reefbuilding organisms.

Besides the distinct transition boundary from the Ladinian beds into the massive Lower Carnian rocks also normal transitions between the two lithostratigraphic members can be found in several other localities west of Mežakla. In the western part of the Northern Julian Alps the contact between the two lithologic members is often tectonic, the Cordevolian rocks were thrusted over the Ladinian beds.

Also the boundary of the Lower Carnian reef limestone with younger Carnian beds is exposed on several places, and it is gradual as well. The age of the brownish Upper Tuvalian platy limestone is proved by the characteristic conodonts (RAMOVŠ 1984).

In Slovenia the light grey grainy massive limestones which overlie the characteristic and paleontologically proven Upper Ladinian (Langobardian) rocks with *Daonella lomelli, Posidonia wengensis, Pseudofurnishius murcianus, Protrachyceras archelaus,* and which are overlain by Julian beds with important fossil remains (*Myophoria kefersteini, Trigonodus carniolicus,* and others) are attributed to the Cordevolian. This is ranged at present into the lower part of the Julian substage (Lower Carnian). In numerous localities across Slovenia the massive Cordevolian limestone consists of light grey

Fig 1. Map of investigated Lower Carnian localities in Northern Julian Alps
a. Coral patch reefs (black circles)
b. Diploporal limestones (white circles)

Sl. 1. Karta raziskanih spodnjekarnijskih nahajališč v severnih Julijskih Alpah
a. Koralni »patch« grebeni (črni krogci)
b. Diploporni apnenci (beli krogci)

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diploporal limestones with the species *Diplopora annulata*. This alga is considered in the Northern Calcareous Alps to be typical only for the Ladinian stage (cf. OTT 1972). In Northern Julian Alps *Diplopora annulata* is an important reefbuilder of the massive Cordevolian limestone.

Stratigraphical column of Triassic beds with the position of reefs is shown on Fig. 2.

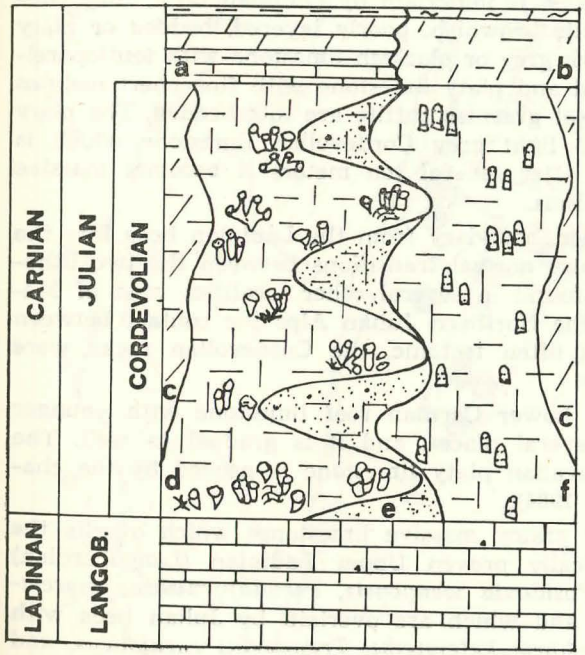


Fig. 2. Schematized stratigraphical column of Triassic beds in Northern Julian Alps with the position of Lower Carnian reef buildups
a. Platy limestone, marl and dolomite
b. Unbedded grained dolomite
c. Dolomitized limestones
d. Coral patch reefs
e. Different limestones between coral patch reefs and diploporal limestones
f. Diploporal limestones
g. Bedded or platy limestones; in uppermost Ladinian with fine chert nodules

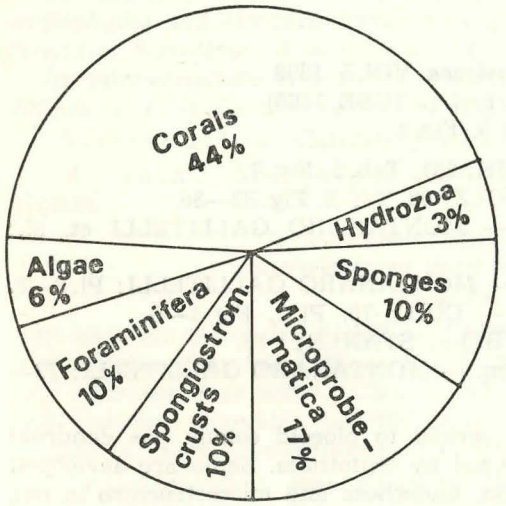
Sl. 2. Shematski stratigrafski stolpec triasnih kamnin v severnih Julijskih Alpah s položajem spodnjekarnijskih grebenskih tvorb
a. Ploščasti apnenec, lapor in dolomit
b. Neplastnati zrnati dolomit
c. Dolomitizirani apnenec
d. Koralni »patch« grebeni
e. Različni apnenci med koralnimi »patch« grebeni in diplopornimi apnenci
f. Diploporni apnenci
g. Skladnati ali plastnati apnenci; v vrhnjem ladiniju vsebujejo tanke gomolje rožencev

PALEONTOLOGICAL PART

The investigated territory contains fossil fauna which is the constituting part of coral buildups, whether being reefbuilding, or accompanying the reefs. Coral reef fossils are described in detail. Along with them appear in lagoons between the reefs exstensive algal mats and within them also other organisms. Flora and fauna of these beds is only listed.

1. Description of Fossils from Coral Reef Buildups

Several hundred samples from 25 finding places are collected and paleontologically determined. There are determined and described the following groups:



Corals	13 species
Hydrozoans	1 species
Sponges	3 species
Microproblematica	5 species
Algae Rhodophyta	2 species
Remaining	3 species
Spongiostromata crusts	3 forms

Fig. 3. Qualitative analyses of samples showing the proportion of fossil species in coral patch reefs

Sl. 3. Kvalitativna analiza vzorcev, ki kaže razmerje fosilnih vrst v koralnih »patch« grebenih

Among the remaining are numbered juvenile ammonites and terebratulid brachiopods, and foraminifers which occur sporadically in thin sections. Important reefbuilders were also spongiostromata algal crusts of types A, B, and C (WURM 1982).

Along the reefs may occur massively also remains of echinoderms: Crinoidea and Echinoidea.

ANTHOZOA

Previous system of Triassic corals are very disunited, and they are based on various criteria. They differ even in highest systematic categories (MELNIKOVA 1968, 1975, 1983; RONIEWICZ 1974, BEAUVAIS 1980, and others). Therefore a final acceptable system could be elaborated only in cooperation with all investigators of the Triassic corals, and by investigating well preserved specimens.

The studied corals are for the moment not attributed to higher systematic categories. They are listed and described according to the alphabetical order of genera.

In species which are in this work for the first time described in Slovenia the synonymy and supplements are given to previous descriptions, as well as comparisons with other localities in the world. With species which were already described in Slovenia (TURNŠEK et al. 1982) only the new comparison and the material are given.

Standard abbreviations for dimensions are used:

d = diameter of corallum or corallite
c-c = distance between the centres of corallites
s = number of septa
sl, s2, s3 ... = septal cycles

Genus: *Cassianastraea* VOLZ 1896
Cassianastraea reussi (LAUBE 1865)
Pl. 3, Fig. 1

1865 *Stylina Reussii* LAUBE. — LAUBE: 261, Tab. 5, Fig. 7.
1896 *Cassianastraea Reussi* LBE. — VOLZ: 96, Taf. 2, Fig. 32—36.
1973 *Cassianastraea reussi* LAUBE. — MONTANARO GALLITELLI et. al.: Tab. 1.
1974 *Cassianastraea reussi* (LAUBE) — MONTANARO GALLITELLI: Pl. 6—8.
1976 *Cassianastraea reussi* (LAUBE) — CUIF: 70, Pl. 1, Fig. 1—6.
1979 *Cassianastraea* cf. *C. reussi* (LAUBE) — STANLEY: 18.
1979 *Cassianastraea reussi* (LAUBE) em. — MONTANARO GALLITELLI: 73—74.

Description: Small massive cerioid to plocoid colony has dendroid form. Corallites are very small, enveloped by septotheca. Septa are developed in two uncomplete cycles. No columella. Endotheca and microstructure in our specimens are unclear.

Dimensions: d = 0,5—1 mm, s = ca 6—10 mm, colony = 3 × 5 × 20 mm.

Comparison and system: Owing to the systematical attribution of *C. reussi* the researchers had different oppinions. VOLZ (1896: 95) compared genus *Cassianastraea* with stylinids. ALLOITEAU (1952, 1957) did not mention it at all. WELLS (1956: F375) attributed it to Cyathophorinae. *CUIF* (1976: 70) named it among Stylinidae, nevertheless he compared it with the genus *Volzeia* as well, and demanded for *Cassianastraea* some new higher systematic category. MONTANARO GALLITELLI (1979) attributed it to Hydrozoa, new family Cassianastraeidae.

I suppose that *Cassianastraea reussi* belongs to Archaeocoeniina, like similar genera *Cyathocoenia* and *Koilocoenia*. It seems that *Cyathocoenia milchi* (VOLZ 1896: 94) revised by CUIF (1972: 274—277, 288) and ascribed to his new genus *Elasmophyllia* (ocupied), belongs to *Cassianastraea reussi*.

Distribution: S. Cassian beds in Dolomites in Italy, Ladinian-Cordevolian-Julian beds in Nevada, Carnian in Turkey.

Material: Kisovec on Mežakla (SJA-6/1) and Zg. Radovna (SJA-14/3), Lower Carnian.

Genus: *Coryphyllia* CUIF 1974
Coryphyllia regularis CUIF 1974
Pl. 4, Fig. 1

1974 *Coryphyllia regularis* n. sp. — CUIF: 380—383, Fig. 37—38.

Description: was given by CUIF. In our collection there are two specimens of solitary corals which are relatively large and fit in with the CUIF'S description.

Dimensions: d = 30—35 mm, s = 96 + s6 (ca 160).

Comparison: The comparison with the similar solitary genera *Distichophyllia* and *Margarophyllia* were given by CUIF. They differ in microstructure. Sometimes it is difficult to distinguish all the mentioned genera, if the microstructure is not well preserved. So there are some very similar solitary corals in Carnian as well as in Norian-Rhaetian beds.

Distribution: Carnian of Turkey.

Material: Srednja gora (SJA-29/3), Frčkov vrh (SJA-15/12), Lower Carnian.

Genus: *Gumbelastraea* CUIF 1976
Gumbelastraea guembeli (LAUBE 1865)
Pl. 3, Fig. 3—4

1865 *Isastraea Gümbeli* LAUBE. — LAUBE: 263, Tab. 7, Fig. 2.
1896 *Isastraea Gümbeli* LBE. — VOLZ: 50, Taf. 4, Fig. 1—5.
1975 *Isastraea guembeli* LAUBE. — CUIF: 102—104, Pl. 14, Fig. 1—6.
1976 *Isastraea guembelii* LAUBE (il est proposé l' espèce *guembelii* désigner par le terme *Gumbelastraea*). — CUIF: 105—108, Pl. 8, Fig. 1—6.

Description: was given by CUIF. In our collection there is one cerioid colony with polygonal to oval corallites which show no differences with the previous descriptions.

Dimensions: d = 2—5 mm, s = 30—35.

Distribution: S. Cassian beds in Dolomites in Italy.

Material: Krnica (SJA-58/1), Lower Carnian (resedimented).

Genus: *Koilocoenia* DUNCAN 1884 (= *Coelocoenia* VOLZ 1896)
Koilocoenia decipiens (LAUBE 1865)
Pl. 3, Fig. 2

1865 *Phyllocoenia decipiens* LAUBE. — LAUBE: 264, Tab. 6, Fig. 1.
1884 *Koilocoenia decipiens* LAUBE. — DUNCAN: n. v.
1896 *Coelocoenia decipiens* LAUBE. — VOLZ: 84, Taf. 10, Fig. 5—13.
1952 *Koilocoenia decipiens* (LAUBE). — ALLOITEAU: 600.
1956 *Koilocoenia decipiens* (LAUBE). — WELLS: F370, Fig. 262/4.
1972 *Coelocoenia decipiens* (LAUBE). — CUIF: 270—277, Fig. 27—29.
1973 *Koilocoenia decipiens* (LAUBE). — MONTANARO GALLITELLI et. al.: 148, Tab. 1.

1974 *Koilocoenia decipiens* (VOLZ). — MONTANARO GALLITELLI: Pl. 5, Fig. 1.

Description: In our colony only a fragment of massive colony with subplocoid corallites is presented. Septa are subconfluent, peritheca narrow, no columella, tabulate dissepiments. The detailed modern description was given by CUIF (1972: 270).

Dimensions: d = 2—2,5 mm, s = ca 20.

Comparison: LAUBE stated the diameter of corallites as 1—1,5 mm, which in fact means the diameter of an inner ring, inside the second cycle septa. The distance between the centres is 2—2,5 mm, and this coincides with our measurements.

Distribution: S. Cassian beds in Dolomites, Italy.

Material: Mojstrana (SJA-43/2), Lower Carnian.

Genus: *Margarophyllia* VOLZ 1896
Margarophyllia capitata (MÜNSTER 1841)
Pl. 4, Fig. 5—6

The species was described from Hudajužna (TURNŠEK et al. 1982: 67).

Material: Krnica (SJA-58/1), Zg. Radovna (SJA-14/2), Frčkov vrh (SJA-15/1, 9, 10, 11, 15), Krma (SJA-17/1), and Brezovec on Mežakla (SJA-2/1). Lower Carnian

Margarophyllia crenata (MÜNSTER 1841)
Pl. 4, Fig. 4

The species was described from Hudajužna (TURNŠEK et al. 1982: 68).

Material: Mojstrana (SJA-43/3), Lower Carnian.

Genus: *Margarosmilia* VOLZ 1896
Margarosmilia cf. *M. richthofeni* VOLZ 1896
Pl. 5, Fig. 1—2

cf. 1896 *Margarosmilia Richthofeni* nov. spec. — VOLZ: 36, Taf. 1, Fig. 13—14.

Description: Phaceloid colony has long windingly grown corallites, which in cross section are round or irregularly prolongated. Septa are numerous and equally thick. In centre they prolongate irregularly. There are no lateral ornamentations except in the thickened parts of trabeculae at tabulae. Endotheca is tabulate and has wavy dissepiments. Microstructure is of sclerodermites which are arranged close one to another forming some kind of simple trabeculae.

Dimensions: d = 12—20 mm, s = ca 160.

Comparison: Our specimens are larger than those of VOLZ (d = 10—15 mm). In dimensions they are closer to the species *M. zieteni* but in typical irregular form of corallites they fit in with *M. richthofeni.* In round regular sections of corallites their structure is similar to that of *Trophiphyllum ornatum* (CUIF 1975) which is solitary.

Distribution: S. Cassian bed in Dolomites in Italy.

Material: Petelin on Mežakla (SJA-8/2, 3), Frčkov vrh on Pokljuka (SJA-15A), Mojstrana (SJA-43/2a), Lower Carnian.

Margarosmilia septanectens (LORETZ 1875)
Pl. 5, Fig. 3

1875 *Cladophyllia septanectens* LORETZ. — LORETZ: n. v.
1896 *Margarosmilia septanectens* LORETZ. — VOLZ: 37—39, Taf. 2, Fig. 20—23, Fig. 12.
1974 *Margarosmilia septanectens* (LORETZ). — CUIF: 366—368, Fig. 32.

Description: Modern description was given by CUIF. Our specimens are dendroid phaceloid colonies with many corallites. Septa are dentate, all cycles of the same thickness. Tabulate dissepiments are numerous. Microstructure is of sclerodermites.

Dimensions: d = 4—7 mm, s = 36—48.

Comparison: *M. septanectens* is similar to *M. confluens* (described from Hudajužna, TURNŠEK et al. 1982) from which it differs in having more regular nonconfluent corallites and denser septa.

Distribution: S. Cassian beds in Dolomites in Italy.

Material: Debela peč on Pokljuka (SJA-17/4) and Pri turnih between Vrata and Kot (SJA-33). Lower Carnian.

Genus: *Myriophyllum* CUIF 1975 (= *Myriophyllia* VOLZ 1896)
Myriophyllum gracilis (VOLZ 1896)
Pl. 4, Fig. 2—3

1896 *Myriophyllia gracilis* LBE. — VOLZ:76—77, Taf. 9, Fig. 10—15.
1975 *Myriophyllum* n. g. (= *Myriophyllia* VOLZ 1896). — CUIF: 61.

Description: was given by CUIF. Our specimens are solitary corals with numerous thin compact septa which in some samples grow from more centres. They are lateraly dentate. Dissepiments and synapticulae are rare. No columella. Microstructure is of small sclerodermites whose centres are arranged axially.

Dimensions: d = 8—10 mm, s = ca 150.

Comparison: LAUBE (1865) described the species *Omphalophyllia gracilis Münster* and represented it in three Figures (Tab. 3, Fig. 5, 5a, 5b). VOLZ (1896) revised this specimens and ascribed them to *Omphalophyllia gracilis* (Fig. 5), *Craspedophyllia gracilis* (Fig. 5a) and *Myriophyllia gracilis* (Fig. 5b). The last is only a schematic drawing (LAUBE 1865, Explanation to Tab. 3, Fig. 5b). Therefore it cannot be a holotype of the species. The holotype is the specimen of VOLZ (1896: Taf. 9, Fig. 10—13, 15), and VOLZ is the author of species. The name *Myriophyllia* was occupied by an other coral. so CUIF (1975) gave to it the new name *Myriophyllum,* which he distinguished from *Omphalophyllia* in columella and microstructure.

Distribution: S. Cassian in Dolomites in Italy.

Material: Mežakla (SJA-6/2), Zg. Radovna (SJA-14/1a), Krma (SJA-21/1), Mojstrana (SJA-43/2a), Njivice W of Mojstrana (SJA-48/2c), Lower Carnian.

Genus: *Tropidendron* CUIF 1975
Tropidendron rhopalifer CUIF 1975
Pl.6, Fig. 1—5, Pl. 7, Fig. 1—2

1975 *Tropidendron rhopalifer* n.g.n.sp. — CUIF: 94—97, 126, Pl. 12, Fig. 1—6, Text-fig. 13.

Description: Our specimens have rare lateral menians. Columella is styliform, preserved in some corallites only.

Dimensions: d = 3—5 mm, s = ca 40.

Comparison: Dimensions in our specimens vary a lot, depending on the stage of budding. Frequency of corallites also varies. Menians are not preserved as well as Cuif's specimens.

This species is very similar to the specimens which VOLZ (1896) described as colonial species of *Omphalophyllia: O. recondita, O. zitteli, O. bittneri.* All these species most probably belong to the genus *Tropidendron.* Into the same subfamily they are arttributed also by BEAUVAIS (1980: 355),

Distribution: S. Cassian in Dolomites in Italy.

Material: Mežakla (SJA-7/3, 8/4); Zg. Radovna (SJA-14/2, 4, 11); Frčkov vrh (SJA-15/4, 14); W of Mojstrana (SJA-40, 45); Vitranec (SJA-55/3). Lower Carnian.

Tropidendron sp.
Pl. 7, Fig. 3—4

Among our specimens there are some reef building phaceloid colonies with small corallites. In cross section they are round. Septa are dense, laterally dentate with menians (?). Columella is styliform. Structural elements are similar to those of *T. rhopalifer* but the corallites are smaller (d = 1—2 mm). In dimensions of coralites they fit in with the species *Protoheterastraea* sp. (cf. TURNŠEK et al. 1982: 72) or »*Volzeia*« *fritzchi* (CUIF 1974: 352—354, Fig. 25—26), which however have thick wall and show stronger main septum. The number of septa in our specimens can not be established and the species can not be identified.

Material: Njivice west of Mojstrana (SJA-48), and Frčkov vrh (SJA-15/13), Lower Carnian.

Genus: *Volzeia* CUIF 1966
Volzeia badiotica (VOLZ 1896)
Pl. 8, Fig. 1

The species was described from Hudajužna (TURNŠEK et al. 1982: 69).

Material: Mojstrana (SJA-43/1), Vitranec (SJA-55/2), Lower Carnian.

Volzeia sublaevis (MÜNSTER 1841)
Pl. 8, Fig. 2—3

The description of species from Hudajužna was given by TURNŠEK et al. (1982: 70).

Material: Mežakla (SJA-7/2, 4, 5, 6, 7), Zg. Radovna (SJA-14/2, 12), Debela peč on Pokljuka (SJA-17/1, 2, 3), Črna gora between Kot and Vrata (SJA-33), Vitranec (SJA-55/1, 5), Lower Carnian.

HYDROZOA

Genus: *Balatonia* VINASSA de REGNY 1907
Balatonia kochi VINASSA de REGNY 1907
Pl. 9, Fig. 1—2

The species was described from Hudajužna (TURNŠEK et al. 1982: 74). In Northern Julian Alps the coenostea occur which have the same vermiculate reticulum, but coenostea are prolongated bulbs. The growth of reticulum is radial which in transverse section differs into the axial vermiculate one and the peripheral longitudinal one.

Material: Mežakla (SJA-4/1), Zg. Radovna (SJA-14/9), Frčkov vrh (SJA-15/2, 6, 7), Debela peč on Pokljuka (SJA-17), Mojstrana (SJA-42), west of Mojstrana (SJA-48, 49), Lower Carnian.

CHAETETIDA

Genus: *Atrochaetetes* CUIF et FISCHER 1974
Atrochaetetes sp.
Pl. 10, Fig. 1—2

Description: Bulbous colony consists of tubes which are in transverse section round to polygonal. The walls are thin. In some levels they are thickened and look like latilaminae.

Dimension: colony = ca 20 × 30 × 40 mm, 40 tubes/1 mm^2.

Comparison: The tubes are thinner than those of all the other species of this genus. In *A. alakiriensis (*CUIF et FISCHER 1974: 9) which possesses the most narrow tubes, the density is 8—12/1 mm^2. Our specimen indicates it could be a new species. There is not enough material and the new species cannot be described.

Distribution: The species of the genus *Atrochaetetes* are known from the Carnian of Taurus Lycien in Turkey.

Material: Mežakla (SJA-8), Lower Carnian.

SPONGIA

Genus: *Colospongia* LAUBE 1865
Colospongia dubia (MÜNSTER 1841)
Pl. 9, Fig. 4

In Slovenia this species was described from Hudajužna by SENOWBARI-DARYAN (1981: 107). The specimen from Northern Julian Alps is the single one. It is strongly widened in its upper part, as it is described by OTT (1967). In transverse section pores in walls are observed.

Distribution: S. Cassian in Italy, Carnian in Slovenia.

Material: Frčkov vrh (SJA-15/2), Lower Carnian.

Genus: *Dictyocoelia* OTT 1967
Dictyocoelia manon (MÜNSTER 1841)
Pl. 9, Fig. 3

The species was found in Hudajužna by SENOWBARI-DARYAN (1981: 107). In material of Northern Julian Alps the small fragments only and individual segments were found.

Distribution: S. Cassian in Italy, Carnian in Austria.

Material: West of Mojstrana (SJA-47/3, 48), Vitranec (SJA-55/2), Lower Carnian.

Genus: *Follicatena* OTT 1967
Follicatena cautica OTT 1967
Pl. 9, Fig. 4—5

1967 *Follicatena cautica* n.sp. — OTT: 22, Taf. 1, Fig. 1—7.
?1981 *Follicatena cautica* OTT. — SENOWBARI-DARYAN: 107, Taf. 6, Fig. 2.

Specimens from the investigated area are large ramose cylindrical or bulbous irregular colonies with very thick walls and large segments and fit in with the OTT's figures. The specimen from Hudajužna described by SENOWBARI-DARYAN has encrusting growth.

Distribution: Carnian in Austria, Slovenia.

Material: Zg. Radovna (SJA-14/7), Frčkov vrh (SJA-15/3), Krma (SJA 28), west of Mojstrana (SJA-49), Lower Carnian.

MICROPROBLEMATICA

Baccanella floriformis PANTIĆ 1971

In our material this microfossil is rare. It is known from the Ladinian-Carnian beds of Dinarids (PANTIĆ 1975), and from Rhaetian beds of Gruberrif (SENOWBARI-DARYAN 1980).

Material: Zg. Radovna (SJA-14/1), west of Mojstrana (SJA-47) and Vitranec (SJA-55/1), Lower Carnian.

Bacinella ordinata PANTIĆ 1972

1972 *Bacinella ordinata* n. sp. — PANTIĆ: 152—154, Taf. 1—4.
1975 *Bacinella ordinata* PANTIĆ. — PANTIĆ: 36, Taf. 51, Fig. 1—2.
?1980 *Problematicum* 3 E. FLÜGEL 1964. — SENOWBARI-DARYAN: 90—91, Taf. 19, Fig. 4.
non 1980 *Bacinella ordinata* PANTIĆ. — SENOWBARI-DARYAN: 89, Taf 21, Fig. 5.

In some samples of Northern Julian Alps this problematicum is very well preserved and of large dimensions. It is of encrusting form, grows in more horizontal lamellae which are sometimes layered one upon another in big thickness.

Distribution: Ladinian-Carnian of Dinarids, ?Rhaetian of Gruberrif.

Material: Mežakla (SJA-6/2, SJA-8/2), Zg. Radovna (SJA-14/7, 12, 13), Frčkov vrh (SJA-15/15), Debela peč on Pokljuka (SJA-17/1, 2), Vitranec (SJA-55/2), Lower Carnian.

Macrotubus babai FOIS & GAETANI 1981
Pl. 12, Fig. 2

The fossil is known from Hudajužna (TURNŠEK et al. 1982: 77).

Material: in almost all samples. The most frequent it is on Mežakla (SJA-7/5), Zg. Radovna (SJA-14/2, 12), Frčkov vrh (SJA-15/12), Lower Carnian.

Ladinella porata KRAUS & OTT 1968
Pl. 12, Fig. 3

1968 *Ladinella porata* n. g. et n. sp. — KRAUS & OTT: 273—274, Taf. 18, Fig. 1—6; Taf. 20, Fig. 1.
1975 *Ladinella porata* KRAUS & OTT. — PANTIĆ: 16, 20, 23, Tab. 53, sl. 1—2.
1981 *Ladinella porata* OTT. — SENOWBARI-DARYAN: 133, Taf. 7, Fig. 3—4.

In thin sections of Northern Julian Alps this species is well noticable because of its grey colour in what it differs from other organisms.

Distribution: Ladinian and Carnian of Alps and Dinarids.

Material: Mežakla (SJA-4, SJA-6/2, SJA-7/3, SJA-8/3, 4), Zg. Radovna (SJA-14/3, 4, 5, 8, 10, 12), Frčkov vrh (SJA-15/1, 8, 11, 14), Vrata (SJA-40), west of Mojstrana (SJA-45, 48), Vitranec (SJA-55/2, 3), Lower Carnian.

Tubiphytes obscurus MASLOV 1956
Pl. 12, Fig. 1

This species is already mentioned from Hudajužna (SENOWBARI-DARYAN 1981: 113). In the material of Northern Julian Alps it occurs in several forms and dimensions. We find single organisms, or they encrust other organisms, or they are accumulated and rockbuilding.

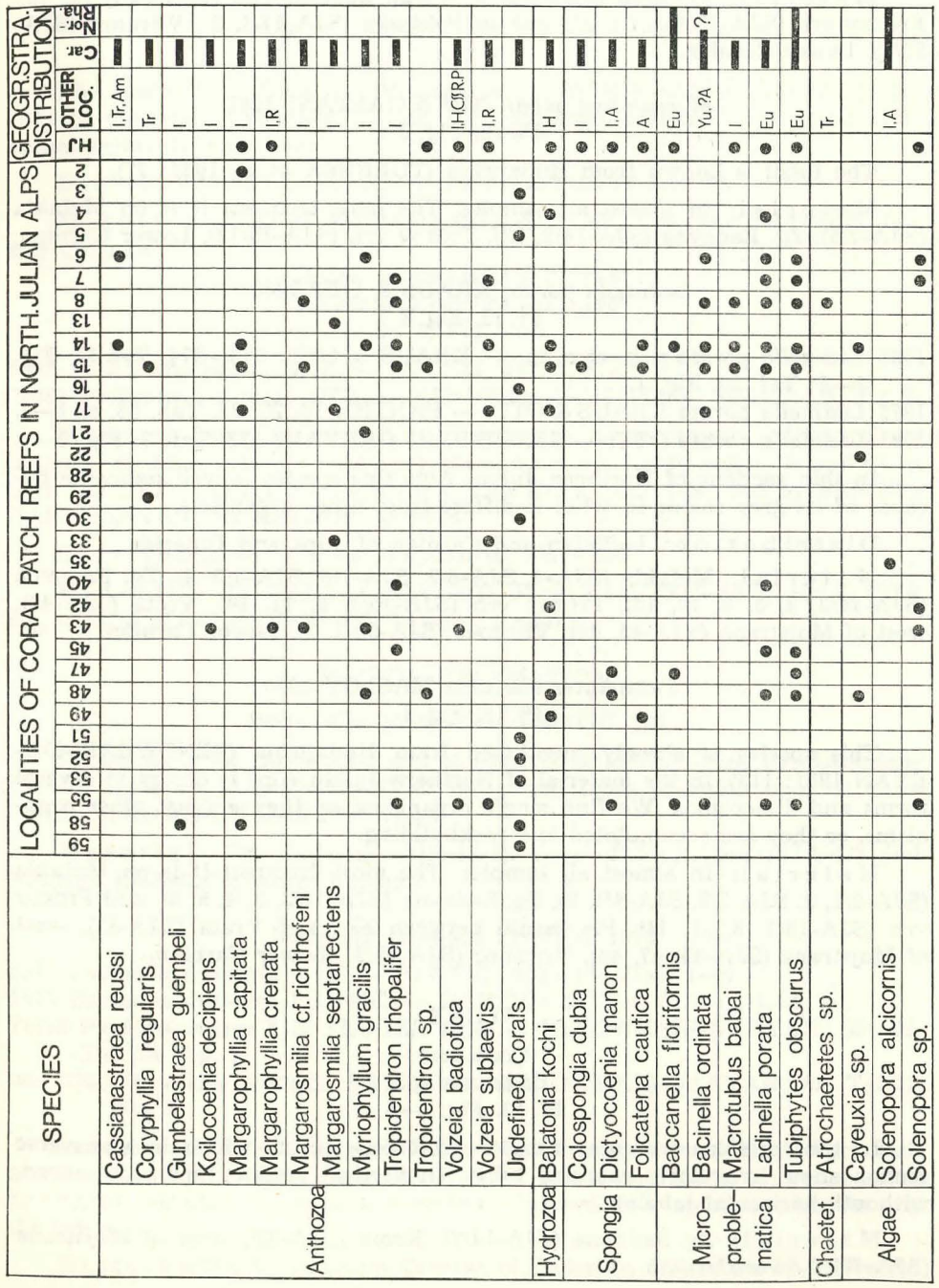
Material: In almost all samples. The most frequent it is on Mežakla (SJA-6/1, 2, SJA-7/3, SJA-8/1, 2), Zg. Radovna (SJA-14/2, 3, 4, 5, 6), and Frčkov vrh (SJA-15/1, 8, 11, 14), Pri turnih between Kot and Vrata (SJA-33), west of Mojstrana (SJA-45, 47, 48), Vitranec (SJA-55/2), Lower Carnian.

ALGAE

Codiaceae
Cayeuxia sp.
Pl. 10, Fig. 3—4

In thin sections irregular tubular »colonies« occur, which in transverse section show irregularly rounded tubes. In vertical section they are uneven, withouth horizontal tabulae.

Material: Zg. Radovna (SJA-14/2), Krma (SJA-22), west of Mojstrana (SJA-48), Lower Carnian.



Solenoporaceae

Solenopora alcicornis OTT 1967

Pl. 10, Fig. 6

1966 *Solenopora alcicornis* n.sp. — OTT: 157—161, Taf. 13, Fig. 1—4.

1980 *Solenopora alcicornis* OTT. — SENOWBARI-DARYAN: 61—62, Taf. 14, Fig. 2 (non Taf. 2, Fig. 1).

Thin tubulate »colony« differs from the other solenopores in ramose growth. Our specimen fits in with Ott's description.

Distribution: S. Cassian in Italy, Rhaetian in Gruberrif in Austria.

Material: Zatrep between Kot and Vrata (SJA-35).

Solenopora sp.

Pl. 10, Fig. 5

In thin sections we find ncmerous tubulate bulbous solenopores, which have concentrical and reticulate structures. In dimensions and forms they vary a lot.

Material: Mežakla (SJA-6/1, SJA-7/3, 6), Mojstrana (SJA-42/1, SJA-43/1, 2), Vitranec (SJA-55/3), Lower Carnian.

2. Stratigraphical and Paleoecological Comparison of Fossils from Coral Reef Buildups

In Slovenia Carnian reef buildups occur in numerous places. They grew in two distinct paleogeographical environments, on carbonate platforms and in the deeper trough (BUSER et al. 1982).

Finding places in the Northern Julian Alps represent patch reefs on the shallow carbonate platform which were surrounded by carbonate deposits.

The fauna from coral patch reefs in the Northern Julian Alps (Fig. 4) can be compared to the fauna of the »S.Cassian« and in part to the »Wetterstein« beds in the Dolomites of Italy, in the Northern Calcareous Alps in Austria, in Germany, and some species are known in Hungary, Czecho-Slovakia, Greece, and also in Pamir Mountains, and in the western part of America. It is mainly attributed to Cordevolian, and sometimes it is mentioned in Langobardian or in Julian (cf. BRANDNER & RESCH 1980, FOIS & GAETANI 1980, DULLO & LEIN 1982, FLÜGEL 1982, DRONOV et al. 1982, WENDT 1982, SCHÄFER & SENOWBARI-DARYAN 1982, STANLEY 1982, TURNŠEK et al. 1984, in print, and others)

Fig. 4. List of fossils from coral patch reefs in several localities of Northern Julian Alps; their regional and stratigraphical distribution

A = Austria, Am = America, ČSSR = Szechoslovakia, Eu = Europe, H = Hungary, I = Italy, P = Pamir, R = Romania, Tr = Turkey, YU = Jugoslavia

Sl. 4. Seznam fosilnih vrst iz koralnih »patch« grebenov v raznih nahajališčih severnih Julijskih Alp; njihova regionalna in stratigrafska razširjenost

A = Avstrija, Am = Amerika, ČSSR = Češkoslovaška, Eu = Evropa, H = Mažarska, I = Italija, P = Pamir, R = Romunija, Tr = Turcija, YU = Jugoslavija

In Slovenia similar fossils were already described from Hudajužna where 12 identical species were found; they were attributed to the Upper Cordevolian-Julian substages of Carnian. (SENOWBARI-DARYAN 1981; TURNŠEK et al. 1982).

Detailed study and comparison of profiles in the Northern Julian Alps shows that the »Cassian« and »Wetterstein« fossil corals and sponges lived at the same time, and are lateral time equivalents. In the Northern Julian Alps they may be attributed to the Lower Carnian (Cordevolian).

Some of the described Carnian fossils were established in Rhaetian Gruberrif in Austria (SENOWBARI-DARYAN1980) which is an indication of the connection of some Carnian and Rhaetian reef formations.

3. Fossils from Algal Mats

In lagoonal areas between coral patch reefs thrived algal mats and formed the so called diploporal limestones. Algae are mostly rockbuilding. Fossils from beds are as follows:

Algae: *Diplopora annulata* SCHAFHÄUTEL 1853 (Pl. 13, Fig. 1)
Teutloporella herculea (STOPPANI 1857) (Pl. 13, Fig. 3—4)
Cayeuxia sp.

Foraminifers: *Agathammina* sp.
Duostominidae
Involutinidae
Nodosariidae
Ophthalmidium sp.
Reophax sp.
Trochammina sp.

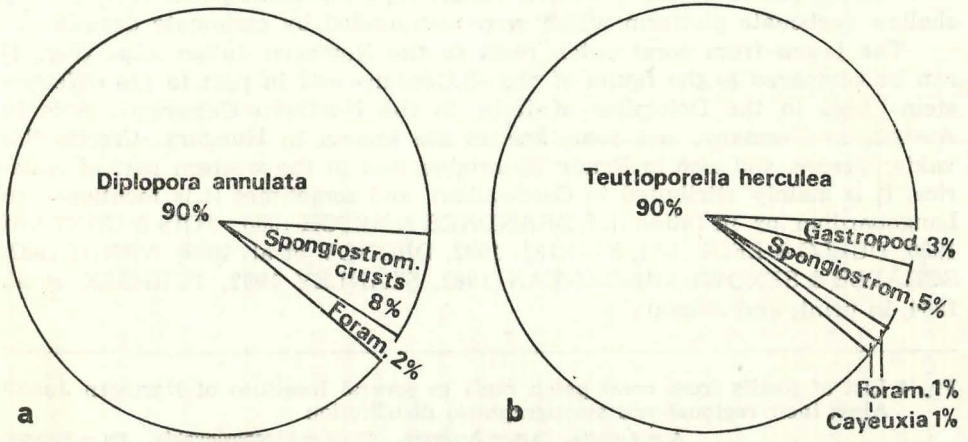


Fig. 5. Diagram of abundance of fossils in limestones with:
a. Diplopora annulata, b. Teutloporella herculea

Sl. 5. Diagram pogostnosti fosilov v apnencih z
a. Diplopora annulata, b. Teutloporella herculea

Pelecypods: unidentified fragments in thin sections
Gastropods: *Omphalophycha* sp.
unidentified fragments in thin sections
Spongiostromata crusts: Type D — new form

REEF COMMUNITIES

Organisms which built smaller patch reefs on the Julian carbonate platform during the Lower Carnian time, listed in the precedent section, lived in various biologic associations which is impossible to separate in nature. Most often one group is predominating, or even a single genus, which build the major part of the framework. These are above all individual species of corals, the sponge *Follicatena cautica,* the hydrozoan *Balatonia kochi,* and the algal mats built of the Dasycladacean *Diplopora annulata.* Other fossils were subordinate in contribution to these buildups. Besides these primary patch reef building organisms an essential contribution was offered also by spongiostromate algal crusts of types A and B, and various other problematica which encrusted the primary framework. Very frequent are also *Tubiphytes* and *Macrotubus* which either themselves partly built small buildups, or they partly cemented the fine lime mud and biogenic fragments as sediment binding organisms. (Fig. 6).

In the Lower Carnian limestone of the Northern Julian Alps the following 16 more important and interesting communities could be distaguished. The most frequent are the coral communities among which predominate those of ramose corals. Communities of massive corals, sponges and hydrozoans are not common.

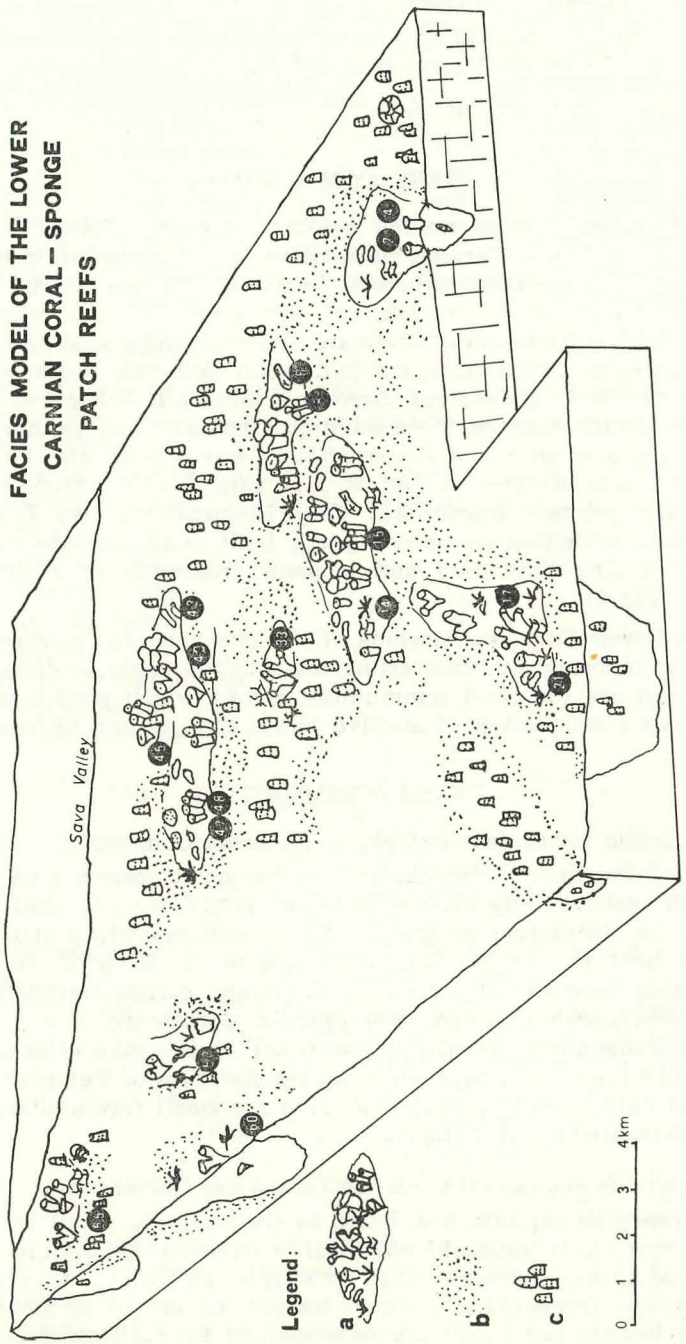
Coral COMMUNITIES

1. *Margarosmilia richthofeni-Tubiphytes/Bacinella* Community

North of Petelin on Mežakla and on the northwestern part of Pokljuka small patch reefs entirely consist of large, irregularly branched corallites of *Margarosmilia richthofeni* as primary frame builders which stand with little interspaces next to one another, and build up to 70 % of the framework. In the locality west of Grančiše near Mojstrana occurs *Margarosmilia richthofeni* together with *Myriophyllum gracilis.* Corals are densely surrounded by spongiostromate algal crusts of type A and B. Sometimes *Bacinella ordinata* occurs. The interspaces between corallites skeletons of *Tubiphytes* are crowded as secondary framebuilders. Very rare are small foraminifers. This community is presented on Pl. 5, figs. 1—2.

2. *Margarophyllia capitata-Macrotubus/Tubiphytes* Community

Margarophyllia capitata was found in six localities, in all of them as the only coral species. It builds 25—60 % of framework. Corallums are strongly overgrown by spongiostromate crusts. *Tubiphytes* and *Macrotubus* appear locally as secondary framebuilders. Small individuals of sphinctozoans are rare. In a single locality the corals are accompanied by *Follicatena cautica.* Fora-



minifers are very rare; individual terebratulid shells are wholly preserved. This community is presented on Pl. 4, figs. 5—6.

3. *Margarosmilia septanectens-Macrotubus/Tubiphytes* Community

This community shown on Pl. 5, figs. 3. was found in three localities. Corallites build 30—70 % of the biolithite. A part of the spaces between corallites in the micrite are filled by densely packed microproblematica, especially *Macrotubus* and *Tubiphytes*. They are partly connected in individual levels by filiform cryptalgal forms.

4. *Myriophyllum gracilis-Macrotubus/Tubiphytes* Community

This large solitary coral, shown on Pl. 4, figs. 2—3, was found in four localities as the only coral, and west of Grančiše near Mojstrana it occurs with the species *Margarosmilia richthofeni*. Corals build up to 40 % of the framework, and they are thickly overgrown by spongiostromate crusts (Pl. 4, Fig. 3). In interspaces *Macrotubus* and *Tubiphytes* are thickly packed. One of the two usually strong predominates, or occurs even alone, only in one locality do both occur equally. In one instance the *Tubiphytes* and *Macrotubus* accumulation is covered by a thicker crust of *Bacinella ordinata* which is clearly distinguishable from spongiostromate crusts around the corals. Foraminifers are very rare.

5. *Tropidendron rhopalifer-Macrotubus/Bacinella/Ladinella* Community

This very frequent community shown on pl. 6, figs. 1—5, pl. 7, figs. 1—2 is characterized mostly by the merely coral species *Tropidendron rhopalifer* which contributes in several finding places to 60 % of framework, and in others 25—40 %. Thin corallities are overgrown by thick spongiostromate crusts, mostly of type A, and seldom of type B. They contribute an additional 5 % to the framework. On Pokljuka the corallites are bound by *Bacinella ordinata* (Pl. 11, fig. 3) into a firm skeletal reef framework. Below Petelin on Mežakla and on northwestern Pokljuka on Frčkov vrh beside the predominating *Tropidendron* also *Margarosmilia richthofeni* occurs. In interspaces between the corallites *Macrotubus, Tubiphytes* and *Ladinella porata* appear as secondary framebuilders. Among the sessile foraminifers *Planiinvoluta* was found. Small foraminifers are rare. In Vitranec appear also small sphinctozoans.

Fig. 6. Facies model of the Lower Carnian coral patch reefs and diploporal limestones in Northern Julian Alps
a. Coral patch reefs with several fossil communities
b. Different detritogenous limestones between coral patch reefs and diploporal limestones
c. Diploporal limestones

Sl. 6. Facialni model spodnjekarnijskih koralnih »patch« grebenov in diplopornih apnencev v severnih Julijskih Alpah
a. Koralni »patch« grebeni z raznimi fosilnimi združbami
b. Razni detritogeni apnenci med koralnimi »patch« grebeni in diplopornimi apnenci
c. Diploporni apnenci

6. *Tropidendron* sp. Community

Very frequent framebuilding corals belong to the genus *Tropidendron* sp. which is characterized by thin ramose corallites shown on Pl. 7, figs. 3—4. They build numerous tufty frameworks, and contribute 40—50 % to the biolithite. They build smaller patch reefs. Corallites are surrounded by thick crusty spongiostromate crusts of type A. In interspaces either *Tubiphytes or Macrotubus* occur but never as abundantly as in the above described communities. Isolated *Ladinella porata* occurs.

7. *Volzeia sublaevis/badiotica-Macrotubus/Bacinella Community*

This community represented on Pl. 8, figs. 1—3 consists of the more abundant *Volzeia sublaevis* which shares about 50 % or somewhat less of the primary framework, and *V. badiotica.* Commonly they build patch reefs separately, only on Vitranec do they occur together. Corallites of both species are overgrown by spongiostromate crusts of the type A. Among microproblematica the most frequent is *Macrotubus,* seldom *Tubiphytes* is predominating. On Vitranec it is accompanied also by *Bacinella ordinata, Baccanella floriformis,* and *Radiomura cf. cautica,* a very rare problematicum in Lower Carnian reef limestone of the Northern Julian Alps. Isolated are solenoporacean algae. Small foraminifers appear only sporadically.

The following three communities of massive corals have less importance in the investigated territory, since they occur only in smal areas, and should be therefore considered as very small patch reefs, or even isolated specimens on the carbonate platform.

8. *Cassianastraea reussi* Community

This community shown on Pl. 3, fig. 1 was found on Mežakla, and in Zg. Radovna. The massive ramose collonies are overgrown by spongiostromate algal crusts, which bind also microproblematica and unclear structures similar to thrombolites of organic origin. Frequent are *Tubiphytes* and *Macrotubus.* In this community also individual foraminifers, solenoporaceans, small sponges, and *Ladinella porata* occur.

9. *Gumbelastraea guembeli* Community

The massive cerioid colony (Pl. 3, figs. 3—5) builds a small buildup. On the margin of the colony occur in dark gray micrite quite abundant juvenile ammonitic shells.

10. *Koilocoenia decipiens-Solenopora* Community

This community shown on Pl. 3, fig. 2 and Pl. 10, fig. 5, was found in one locality only west of Grančiše near Mojstrana. It consists of a massive nodular colony of cerioidal corallites. Along with the coral solenoporas occur which are in the primary position. Fragments of molluscs are not rare.

Calcisponge COMMUNITIES

In the Lower Carnian reef development in the Northern Julian Alps the calcisponge biocoenoses were of subordinate importance. Among the sphinctozoans only the *Follicatena cautica* colony often occurs, the others appear sporadically. Inozoans were not abserved as independent framebuilding organisms. It is interesting that in Carnian coral sponge reefs in the Amphiclina beds between Hudajužna and Zakriž in western Slovenia (TURNŠEK et al. 1982) they are represented with 22 species, and they amount 40,7 % of all reef building species. Corals are there represented by merely 25 %.

11. *Follicatena cautica-Tubiphytes/Macrotubus* Community

Follicatena cautica occurs as the lonely sponge in five localities, and it builds up to 50 % of the reef framework. It is rarely grown on corallites. In interspaces between sponge skeletal remains *Tubiphytes* and *Macrotubus* are very frequent. Sponges are relatively poorly overgrown by spongiostromate algal crusts; they are often completely free of them. This community is shown on Pl. 9, figs. 5—6.

Hydrozoan COMMUNITIES

The hydrozoan communities are represented by a single biocoenose which is, however, quite frequent, and it represents a characteristical element of the Lower Carnian reef associations.

12. *Balatonia kochi-Macrotubus/Tubiphytes Community*

Thick rodlike coenostea build up to 50 % of the biolithite. Overgrowings with the spongiostromate crusts are abundant. In places such crusts contribute to more than half the volume of the rock. In the hydrozoan patch reef on the northwestern side of Pokljuka *Balatonia* builds only 25 %, and the spongiostromate crusts about 60 % of the rock mass. These crusts bind the coenostea together. Besides the algal crusts of type A also type B is visible. Interspaces between overgrown coenostea are filled with closely packed *Macrotubus.* In other similar localities of this community as secondary framebuilding organisms *Macrotubus* and *Tubiphytes* and sometimes only *Macrotubus* occur. This community is shown on Pl. 6, figs. 1—2.

Algal COMMUNITIES

In the Lower Carnian development in the Northern Julian Alps, as well as elsewhere in Slovenia, algal limestones are very abundant, and they form considerable thicknesses. Most abundant are the dasycladacean algae, less Codiaceae (*Cayeuxia*), occur also *Solenopora* and the porostromate blue-green algae. Four algal communities are distinguished.

13. *Diplopora annulata-Foraminifera* Community

The characteristic monoculture of the single *Diplopora annulata* is very abundant in the reef limestone, especially on Mežakla, northwestern Pokljuka, Srednja and Črna gora between Krma and Vrata, and west of Mojstrana (Pogorišče, Gornov komen). It builds 30—40, in places even up to 60 percent of the biolithite. Algal skeletons are mostly very well preserved, and often complete (Pl. 13, fig. 1). They occur in the primary place of the growth of algal mats. Algal skeletons are surrounded by blackish dense crusts, in part

of tubular shapes. These crusts are distinguished of spongiostromate algal crusts which surround only corals, sponges and hydrozoans. No doubt, also these forms are the consequence of activities of some cryptalgal organisms which lived in quieter lagoonal environments. This type of overgrowing crusts was up to now unknown in reefs of the Northern Julian Alps, and it may be called Spongiostromate crust type D, with respect to the previous types, A, B, C (WURM 1982: 221). Individually occur rather large, dark grey or blackish thrombolites. Among fine detritogenous material between the diploporal skeletons often large specimens of *Tubiphytes* appear. *Macrotubus* is less frequent. Within the detritogenous material we can find small foraminifers *Trochammina* sp., Rotalidae, *?Reophax,* Nodosariidae, Textulariidae. In one thin section on an average 5—15 well preserved foraminifers appear.

During the growth of algae empty spaces remained between individuals, and they are mostly filled by early diagenetic cement A and the late diagenetic cement B, which frequently occurs also in the interior of the algal skeleton. Cement A and B fill up to 50 % of the algal biolithite. Someplace the algal biolithite is entirely recrystalized.

Diplopora annulata occurs individually also beyond the compact lagoonal algal mats together with other fossil remains.

14. *Teutloporella herculea-Foraminifera* Community

In this community shown on Pl. 13, figs. 3—4 occurs of the calcareous algae only *Teutloporella herculea* with very well preserved skeleton up to four centimeters long. It builds to about 70 % of the algal biolithite. This community was found only at the Kovinarska pot on the eastern slope of Krma. S. BUSER (1980: 29) reported it also from Mežakla, but without citing any other data. Algal skeletons are surrounded by thinner or thicker dark grey to blackish crusts with intermediate tubular forms, most probably remains of some problematical organisms. These crusts are similar to those overgrowing skeletons of the alga *Diplopora.* Together with *Teutloporella* appear porostromate blue-green algae. Foraminifera are less frequent than in diploporal limestone but they are the same. Together with algae occur individual gastropods of the genera *Omphaloptycha* and *Gradiella.*

Between the algal skeletons there are in part large empty spaces filled with cement A and B. Cement largely fills also the interior of the skeletons. In some spaces intraclasts appear, mostly bioclasts which are, however, coarser than in the diploporal community. This indicates that *Teutloporella herculea* grew in a somewhat more dynamic water than *Diplopora annulata* did.

15. *Solenopora alcicornis-Tubiphytes*-Foraminifera Community

This community shown on Pl. 10, Fig. 6, is known only from a single finding place but it is very characteristic and worth while recording. The alga has irregularly branched thalluses which are moderately incrusted. The space between thalluses is filled by very fine detritogenous material in which there are largest the numerous *Tubiphytes.* In the area of one thin section 20 small foraminifers appear. The community lived in a very quiet water.

16. »*Cayeuxia*« Biocoenose

In two localities a very interesting biocoenose was found (Pl. 10, figs. 3—4). It consists of thiny *Cayeuxia* which grew in tufts (fig. 4). They became petrified in their growth position. Densely packed tubules branch under sharp angles. The entire biocoenose consist of about 10 cm high forms which are surrounded by relatively fine biodetritus. During the growth of this algal biocoenose remained numerous irregular empty spaces which became cemented during the early diagenesis. In the immediate surrounding of these codiaceans any framebuilding organisms did not grow.

Microproblematica COMMUNITIES

In the investigated Lower Carnian reef limestones share various microproblematica a very important part of secondary framebuilders. These are next to spongiostromate algal crusts of types A, B, C and D also *Bacinella ordinata, Tubiphytes* and *Macrotubus* which occur in almost all described biological communities. They appear, however, also in places where primary framebuilders are absent, and they are justifiedly considered independent biological communities.

17. *Bacinella ordinata* Community

Typical bacinellan narrow crusts are packed closely one above another, and form structures up to 15 mm thick. These crusts are in places interrupted by dark dense spongiostromate crusts. After shorter or longer intervals bacinellan belts appear again, and they are fitted in shape to the foundation. Between thin bacinellan crusts fine biogenous detritus appears, with *Tubiphytes* and *Macrotubus,* as well as irregular dense forms which are perharps the results of activity of some cryptalgal organisms. Within the biomicrite small individual foraminifers appear.

Bacinella ordinata occurs often in low abundances together with various corals, especially with *Volzeia sublaevis* and *Tropidendron rhopalifer.* This community is shown on Pl. 11, figs. 1—3.

18. Spongiostromata algal crust-*Tubiphytes-Macrotubus* Community

Tubiphytes is in almost all faunistic communities a secondary framebuilder. It is partly found also in absence of primary framebuilders, forming buildups together with spongiostromata algal crusts (Pl. 12, fig. 1). In individual parts of the buildup often occur numerous tubular *Macrotubus* (Pl. 12, fig. 2; see also *Tubiphytes* between corallites of *Volzeia sublaevis* on Pl. 8, fig. 3). Both microproblematica form buildups in areas of low water energy environments between patch reefs, and in the lagoonal environment with diploporas. Individual foraminifers occur.

PRINCIPAL FACIES TYPES ON THE LOWER CARNIAN PLATFORM

Considered are only the main facial types which were distinguished in the reef development on the Lower Carnian platform of the Northern Julian Alps. (Fig. 7).

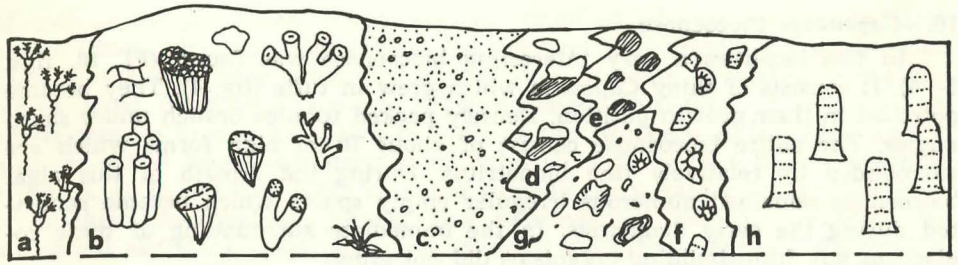


Fig. 7. Paleoecological position of the main Lower Carnian facies units of the Julian carbonate platform, in Northern Julian Alps

a. Crinoidal facies
b. Coral/Calcisponge/Stromatoporoid biolithite facies
c. Bioclastic grainstone facies
d. Bird's eye grain packstone facies
e. Thrombolite limestone facies
f. Dasycladacean bioclastic grainstone
g. Grapestone grainstone facies (wackstone/packstone facies)
h. Dasycladacean biolithite facies

Sl. 7. Paleoekološki položaj glavnih spodnjekarnijskih facij na julijski karbonatni platformi v severnih Julijskih Alpah

a. Krinoidna facija
b. Koralno/kalcispongijska/stromatoporoidna biolititna facija
c. Bioklastična »grainstone« facija
d. »Grain packstone« facija s stukturo ptičjega očesa
e. Trombolitna apnenčeva facija
f. Dasikladacejski bioklastični »grainstone«
g. »Grapestone grainstone« facija (»wackstone/packstone« facija)
h. Dasikladacejska biolititna facija

1. Biolithite Facies

In the biolithite facies several types can be distinguished. This facies formed in the area of the patch reef environment consists of coral-, calcisponge- and hydrozoan framestone (Pl. 3—8; Pl. 11, fig. 3; Pl. 13, fig. 3); with strong spongiostromata algal crusts overgrowth. Coral framestone consists of framework of various coral communities which contribute 20—50 %, exceptionally up to 70 % material to the biolithite. Spongiostromata algal crusts contribute up to about 5 %. Also *Tubiphytes* and *Macrotubus* often fill a considerable part of intermediate spaces as secondary framebuilders which are often reinforced by spongiostromata algal crusts. Spaces between corals, sponges and hydrozoans are filled by moderately to well sorted arenitic biodetritus and intraclasts. In all coral, calcisponge and hydrozoan framestones the type of matrix and of clasts is largely the same, so that there is no need to distinguish microfacial types. Considerably large cavities of coral framestones are filled by A and B cement.

The second type of biolithitic facies is represented by the algal crust boundstone with spongiostromata and *Tubiphytes-Macrotubus* crusts boundstone as well as with *Bacinella ordinata* boundstone (Pl. 11, 12).

As a peculiarity of the biolithitic facies appears on the Lower Carnian carbonate platform the *Diplopora* biolithitic facies in which *Diplopora annulata* is rockbuilding. The algae are encrusted with spongiostromata algal crusts

of type D (Pl. 13, fig. 1). This facies is very frequent and charasteristic. Less frequent is the *Teutloporella* biolithitic facies with the rockbuilding *T. herculea* and with the same incrustation (Pl. 13, figs. 2—4).

A further algal biolithitic microfacies is represented by the *Solenopora alcicornis* facies and by the codiacean facies (Pl. 10, figs. 3—6). In almost all biolithitic facies occur abundant sparitic cementations, up to 60 % filling up the spaces between framebuilders, and partly also spaces within them. These are mostly the primary empty spaces. The most common is the A and B type of cement.

2. *Thrombolite Bird's Eye Limestone Facies*

In the area between the *Diplopora annulata* community and the area of oncolithic crusty detritogenous limestone (oncolithic grainstone) the thrombolites occur. They consist of sphaerical or irregularly oval clots. The clots are loosely bound by cryptalgal forms in the manner of small bridges, or the clots are closely packed one next to another.

Two types of thrombolites occur; type A: clots appear to be mainly homogenous dense forms of cryptalgal activity (Pl. 14, Fig. 1) without the characteristic concentric lamination; type B: in the dense mass of cryptalgal activity occur poorly sorted debris of Microproblematica, among which frequent irregular tubular forms of Macrotubus occur (Pl. 15, Fig. 2). The largest clots measure about 10 mm in diameter.

Thrombolites as cryptalgal structures (AITKEN 1967: 1164) belong according to WURM (1982: 221) to the type C of spongiostromata algal crusts. In spite of lack of evidence on the presence of filamental blue-green algae, the activity of cyanobacteria/ fungi is, however, probable. They could catch and bind the sediment, and play a part in carbonate precipitation. FLÜGEL (1978) believes the thrombolites could be formed also during oxidation of dead algal colonies, during overgrowing of algal colonies, and by internal dissolution of algal colonies.

In individual agglomerations irregular many times interrupted small crusts can also occur, often appearing in several levels.

Thrombolite bird's eye limestone facies is relatively common in the areas of the Črna and Srednja gora and on Dolgi plazi west of Krma. It occurs in the vicinity of the diploporal facies, where types A and B of this microfacies are distinguished. Thrombolitic clots together with fine biodetritus often form patchy crusts and small patch reefs which are in places over one meter thick. Very common are the shrinkage pores which occur in belts. They are an indication of very shallow water and periodical subaerier exposure. AITKEN (1967: 1173) maintains that thrombolites most probably were formed in the environment of the lower part of the intertidal zone up to a fathom (182 cm depth or more) in clear, possibly very agitated water.

Among the investigated Lower Carnian rocks the characteristic oolite facies is absent, but frequent is the thrombolite facies. »Normal ooids« which in the Norian Dachstein limestone of the Northern Julian Alps form oolitic beds several meters thick and lenses, do not occur here.

3. Bird's Eye Grain Packstone Facies

The thrombolite bird's eye limestone of type B laterally passes into the laminated grain packstone (Pl. 14, fig. 2) with numerous dessication pores. It represents a moderately frequent facial type in the Lower Carnian development. Fragments of fossils are extremely rare, among the allochemical components pellets predominate, intraclasts are less frequent. In certain dessication pores, geopetal textures are formed by the internal cement.

4. Crinoidal Facies

It consists of bioclastic grainstone in which packed crinoidal stems up to five centimeters long and about one centimeter thick predominate. The crinoidal facies forms a 50 cm thick undifferentiated layer at the Kovinarska pot to the Planina Lipanca east of Krma, and it was found also on Pokljuka.

5. Spongiostromata-Echinoidal-Foraminiferal Grainstone Facies

In sparitic matrix long spicules of urchins occur overgrown by thick spongiostromate algal crusts and sessile foraminifers, by thrombolites, *Tubiphytes* and other microproblematica. This facies occurs Pri turnih between Vrata and Kot.

6. Dasycladacean Bioclastic Grainstone Facies

In the vicinity of diploporal limestone (*Diplopora* biolithite facies) on Mežakla, northwest Pokljuka and west of Mojstrana algal detritogenous limestone occurs which consists almost entirely of closely packed fragments of Diplopora annulata and individual bioclasts of solenoporaceans (Pl. 14, fig. 3). Bioclasts of primary reef framebuilders vere not found.

A variety of the dasycladacean bioclastic grainstone facies is represented by algal bioclastic grainstone with very frequent fragments of *Diplopora annulata,* fragments of Solenoporaceae, thrombolites with tubular microproblematica *(Macrotubus)* in redeposited clots. Bioclasts are overgrown by spongiostromate crusts to a considerable degree. This microfacies type of the Lower Carnian reef limestone passes into biomicrite with accumulation of *Macrotubus,* Codiaceae and rare foraminifers.

7. Grapestone Grainstone Facies

In the area between the spongiostromata-*Tubiphytes-Macrotubus* biotope and the dasycladacean bioclastic grainstone facies frequently the grapestone facies occurs (Pl. 15, Fig. 3). Poorly sorted and loosely packed particles in the sparitic cement of A and B type, (up to 50 %), consist of fragments of Dasycladaceae and Solenoporaceae, and of small clods of aggregate grains largely of microproblematica and thrombolites. The particles are mostly surrounded by thin spongiostromata crusts. Foraminifers are rare.

A second type, as common as the first, of this facies is represented by a better sorted grapestone grainstone with finer aggregates of largely the same composition. They occur next to one another.

8. Bioclastic Grainstone Facies

It is represented by a well sorted limestone with sparitic groundmass. Fine crushed particles are well rounded. The amount of bioclasts varies, their composition alternates. *Tubiphytes* is often present. (Pl. 15, fig. 1).

9. Wack/Packstone Facies

Limestone is partly washed out, and in places graded bedding occurs. The allochemic components belong mostly to biomicrite, biopelmicrite and partly to biosparite. Intraclasts are partly incrusted by thin cryptalgal crusts. Fossil remains in places predominate among fragments (foraminifers, gastropods, lamellibranchs, echinoderms). Fragments of the primary reefbuilders are absent.

Locally alternations of wackstone and packstone facies, or packstone and grainstone facies may be observed.

10. Mudstone Facies

This facies was very rarely observed in thin sections.

It is typical that on the Lower Carnian platform the rudstone floatstone facies from the high energy parts of the fore-reef area were never established. Basin sediments of this age are not known in the Northern Julian Alps as well. To the south, between Medvedje brdo and Idrija basin deposits of this age are known: dark grey and black platy limestones with *Trachyceras aon, Badiodites eryx, Polycyclus* sp.

Also in the neighbouring South Karavanke in the Lower Carnian only light massive limestones and dolomites are known which, however, were not studied in detail yet. The diploporal biolithitic facies was found in a number of localities.

CONCLUSIONS

On the Lower Carnian carbonate platform of the Northern Julian Alps an up to 1000 m thick mass of reef limestone deposited which attains its maximum thickness in the massife of Prisojnik and Špik mountains. Limestone is not bedded, with the exception of the contact with the Ladinian platy limestone. On the platform a continual and uninterrupted deposition of reef growth occured, which was relatively fast. The growth of reef building organisms approximately kept part with the subsidence of the platform. The carbonate platform extended to the Southern Karavanke mountains and to the Southern Julian Alps.

The reef development was represented by smaller patch reefs consisting of primary reefbuilders: corals, sponges and stromatoporoids. Corals resolutely dominate above other organisms. Fauna from patch reefs was paleontologically investigated in detail.

Very important secondary framebuilders are spongiostromata algal crusts of A, B, C and D types, and microproblematica: *Bacinella ordinata, Tubiphytes* and *Macrotubus,* which share a considerable proportion of the biolithite. Sessile algae are less frequent. In two localities crinoid remains are an important lithogenetic element.

A special type of the Lower Carnian deposition in the quieter part of the platform are extensive algal mats of the monocultural species *Diplopora annulata*, and to a smaller extent the algal mats with *Teutloporella herculea*. Both build masive limestones.

Determined were ten coral communities, one spongian and one stromatoporoid (primary reefbuilders), four algal communities, and three communities of predominating microproblematica (secondary framebuilders).

Ten facies were determined. The most important is the biolithitic facies with several types. Interesting is the thrombolitic facies. The oolithic facies was nowhere found. Also the fore-reef development and basin deposits were not observed in the investigated territory.

POVZETEK

SPODNJEKARNIJSKE GREBENSKE TVORBE V SEVERNIH JULIJSKIH ALPAH

Uvod

Grebenske tvorbe triasnih skladov so v Sloveniji razširjene v različnih paleogeografskih okoljih. Uspevale so na julijski in dinarski karbonatni platformi in tudi znotraj slovenskega jarka.

Pričujoča razprava je sistematična obdelava spodnjekarnijskih (cordevolskih) grebenskih tvorb v Julijskih Alpah, to je na julijski karbonatni platformi. Obravnava organizme, ki so grebene ustvarjali, fosilne združbe in facialne tipe kamnin. Drugje v Sloveniji še ni bilo takih raziskav iz tega obdobja, če seveda izvzamemo

študije o svojevrstnih grebenskih tvorbah na Jesenici (ČAR et al. 1981) ter v amfiklinskih skladih med Hudajužno in Zakrižem (TURNŠEK et al. 1982), to je v slovenskem jarku.

Pri šestletnih terenskih raziskavah, od leta 1977 do 1983, o biostratigrafiji triasnih plasti v severnih Julijskih Alpah, je A. RAMOVŠ sistematično odkrival tudi tamkajšnji grebenski razvoj med klastično-vulkanogenimi ladinijskimi plastmi in deloma klastično-karbonatno deloma samo karbonatno razvitim srednjim in zgornjim karnijem. Raziskoval je facialne razvoje tega obdobja, zbral obilico različnih okamnin in litoloških vzorcev za paleontološke, facialne in sedimentološke analize. D. TURNŠEK je določila in opisala favno iz koralnih grebenov, A. RAMOVŠ je določeval favno iz alginih trat, raziskoval favnistične združbe in facialne razvoje.

Nekaj zbruskov apnenčevih alg je pregledal akad. M. HERAK, nekaj sedimentoloških analiz je napravil D. SKABERNE. Fotografije sta izdelala K. NARODE in M. GRM, grafične priloge in table M. HUZJAN in zbruske K. CVETKO. Tekst je v angleščino prevedel dr. S. PIRC, jezikovno ga je pregledala še R. WOOD. Terensko in kabinetno delo so omogočili Raziskovalna skupnost Slovenije, Tehniški muzej Železarne Jesenice in Kulturna skupnost občine Jesenice. Vsem lepa hvala.

Sklepi

Na spodnjekarnijski karbonatni platformi severnih Julijskih Alp se je sedimentirala do okoli 1000 m debela gmota grebenskega apnenca in dosegla največjo debelino v masivu Prisojnika in Špika. Apnenec je neskladnat, razen ob kontaktu z ladinijskim ploščastim apnencem. Na platformi se je vršila v času rastí grebenov neprekinjena sedimentacija, ki je bila razmeroma hitra. Pogrezanje platforme je bilo približno enako hitrosti rastí grebenotvornih organizmov. Karbonatna platforma se je nadaljevala še v Južne Karavanke in južne Julijske Alpe.

Grebenski razvoj predstavlja manjše »patch« grebene, ki so jih kot primarni tvorci sestavljali korale, spongije, stromatoporoidi. Korale močno prevladujejo nad ostalimi organizmi. Zelo pomembni sekundarni tvorci grebenov so spongiostromatne algalne skorje tipov A, B, C in D ter mikroproblematika, ki imajo velik delež v biolititu. Sesilne foraminifere imajo manjši delež. Na dveh krajih so krinoidni ostanki pomemben litogenetski element. Poseben tip grebenske sedimentacije na mirnejšem delu platforme so obsežne algine trate monokulturne vrste *Diplopora annulata*, v manjši meri pa algine trate z vrsto *Teutloporella herculea*. Oboje so gradile masivne apnence. Razširjenost in stratigrafski položaj grebenskih »patch« tvorb in diplopornih trat sta prikazana na sl. 1 in 2.

Iz koralnih »patch« grebenov je paleontološko obdelanih 11 vrst koral, 1 stromatoporoid, 1 hetetida, 3 vrste spongij, 5 vrst mikroproblematik in 3 vrste alg solenoporacej in kodiacej. Seznam teh grebenskih fosilov in njihov procentualni odnos sta prikazana na sl. 3 in 4; procentualni odnos fosilov v »diplopornih« tratah pa na sl. 5. Fotografije fosilov so podane na tablah 3—12.

Ugotovljenih je bilo 10 koralnih favnističnih združb, ena spongijska in ena hidrozojska (vse so primarni tvorci grebenov). Nadalje so ugotovljene 4 algine floristične združbe in tri združbe prevladujočih mikroproblematik, ki so bile sekundarni tvorci grebenov. Model grebenskih združb v »patch« grebenih in alginih trat je prikazan na sl. 6.

Ugotovljenih je bilo 10 facij. Najbolj pomembna je biolititna facija z več tipi. Zanimiva je trombolitna facija. Nikjer pa ni bila ugotovljena oolitna sedimentacija. Tudi predgrebenski razvoj in bazenski sedimenti na raziskovanem ozemlju niso ugotovljeni. Glavni facialni tipi in njihov paleogeografski položaj so podani na sl. 7.

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PLATES—TABLE

Explanation to plates

All the photographs of thin sections (taken by C. Narobe) are negatives, enlarged directly onto the photographic paper. Photograps of Plates 1—2 are taken by A. Ramovš.
All specimens are of Lower Carnian age.

Razlaga k tablam

Vse fotografije zbruskov (izdelala C. Narobe) so negativi, zbrusek je povečan direktno na fotografski papir. Fotografije na tablah 1—2 je izdelal A. Ramovš.
Vsi vzorci so spodnjekarnijske starosti.

PLATE 1

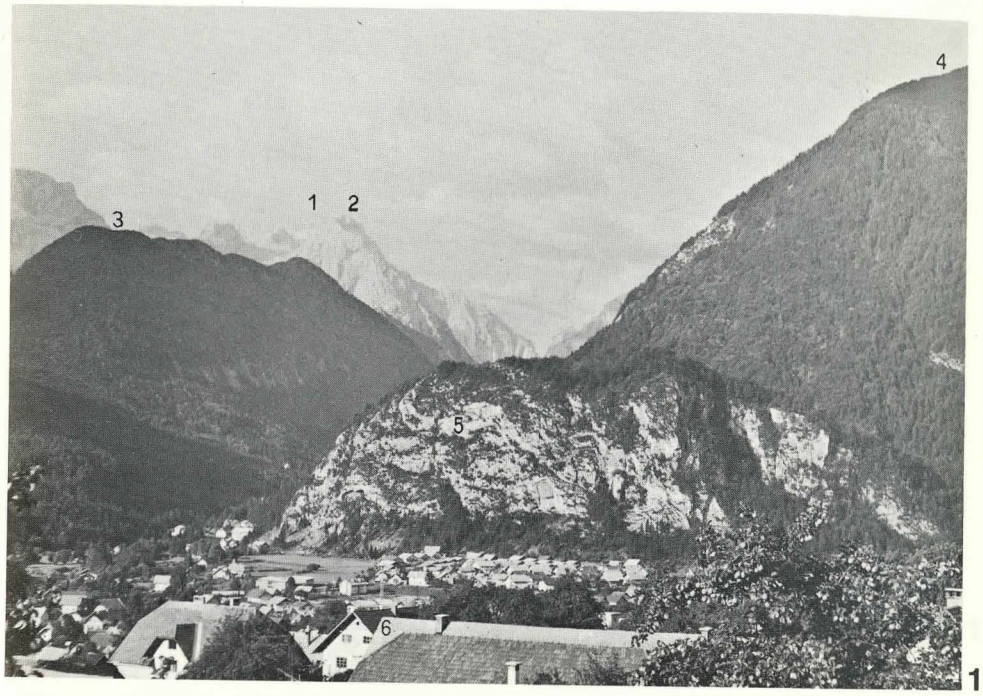
Fig. 1. The view from Mojstrana through Vrata valley toward Triglav. Grančiše (5) consists of Lower Carnian reef limestone with corals and other reef builders; Pri turnih (3) (in wider meaning the whole ridge is named Črna gora) is consisting partly of Diplopora limestone and partly of coral-sponge reef limestone. Brana (4) is also built of the same rocks. The top of Triglav is overthrust of Lower Carnian reef limestone. Cmir (2) is of bedded Dachstein limestone.

Fig. 2. The mighty massive of Lower Carnian reef limestone of Prisojnik (2 and 3). Jalovec (1), Mojstrovka (4) and Ponce (5) are of bedded Dachstein limestone.

TABLA 1

Sl. 1. Pogled iz Mojstrane po dolini Vrat proti Triglavu. Grančišče (5) je iz grebenskega spodnjekarnijskega apnenca, deloma s koralami deloma z drugimi tvorci grebenov; Pri turnih (3) (v širšem smislu je ves greben Črna gora) je deloma iz diplopornega apnenca deloma iz koralno-spongijskega apnenca. Iz enakih kamnin je tudi Brana (4). Vrh Triglava (1) je nariv grebenskega spodnjekarnijskega apnenca, Cmir (2) je skladnati dachsteinski apnenec.

Sl. 2. Mogočen masiv spodnjekarnijskega grebenskega apnenca Prisojnika (2 in 3); Jalovec (1), Mojstrovka (4) in Ponce (5) so iz skladnatega dachsteinskega apnenca.



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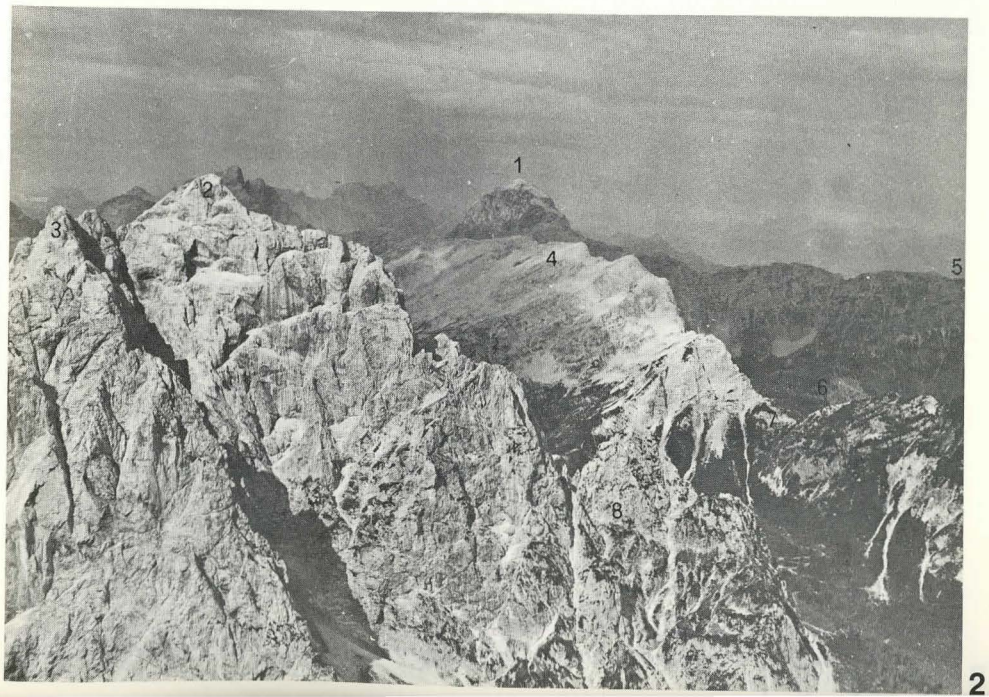

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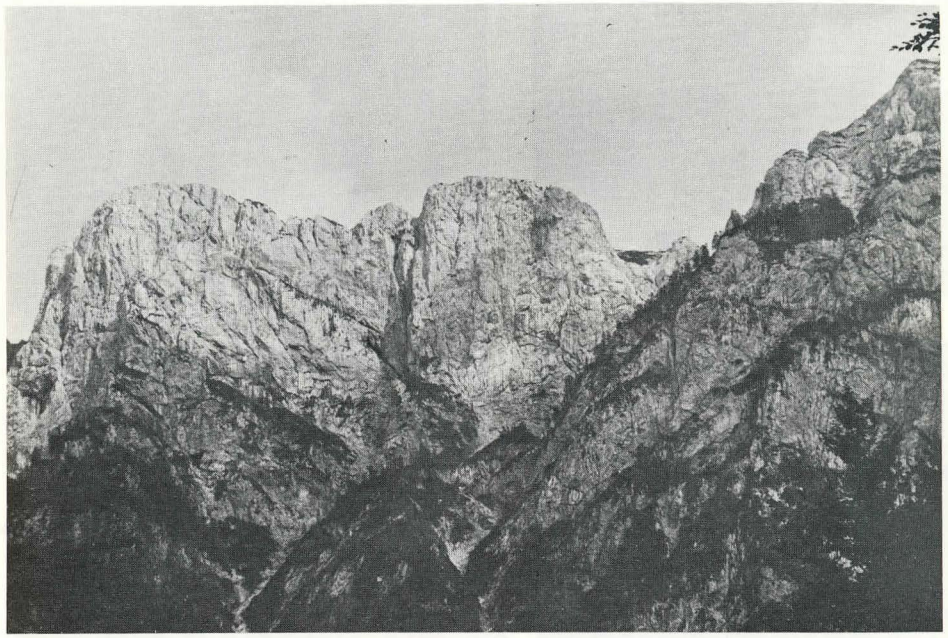

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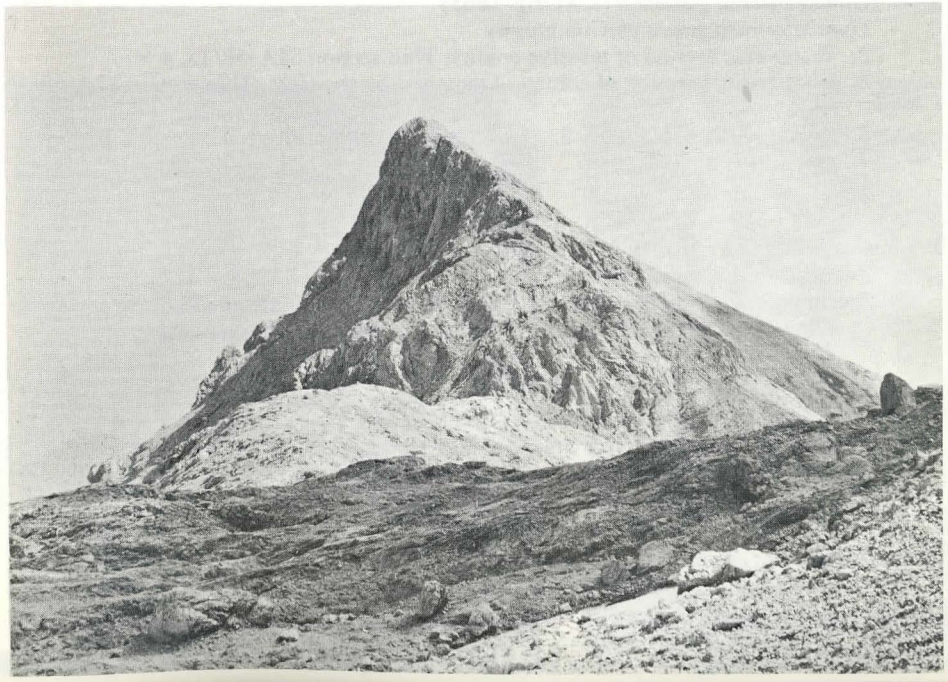

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PLATE 2

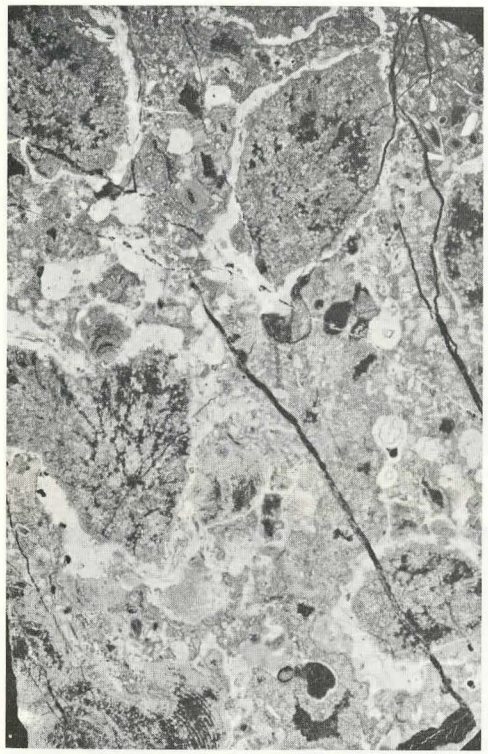
Fig. 1. Debela peč, built of Lower Carnian reef limestone.

Fig. 2. Rjavina is of predominating massive Diplopora limestone and of organogenic detritogenous limestone.

TABLA 2

Sl. 1. Debela peč, iz grebenskega spodnjekarnijskega apnenca.

Sl. 2. Rjavina, iz prevladujočega masivnega diplopornega apnenca in organogenega detritogenega apnenca.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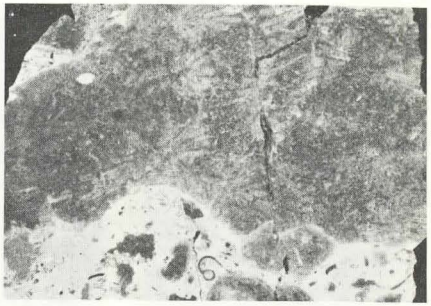
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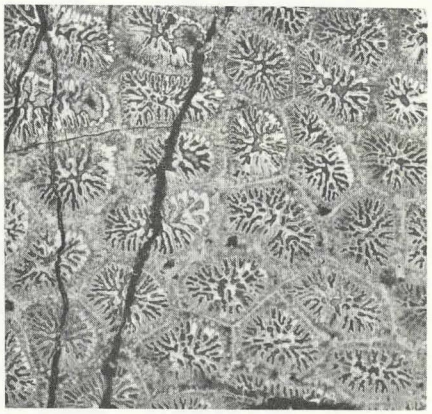
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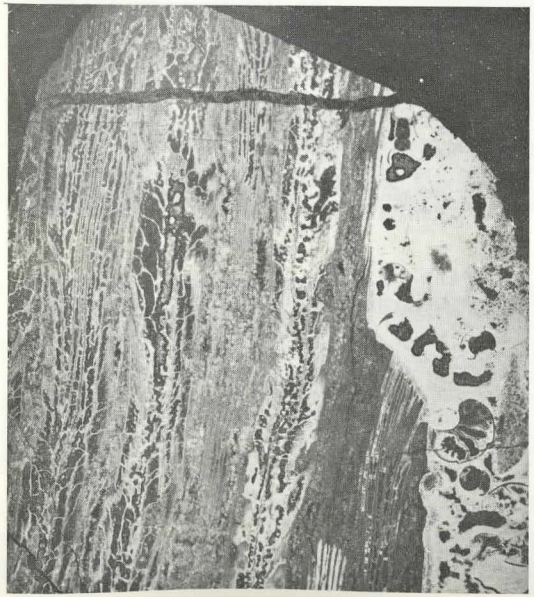
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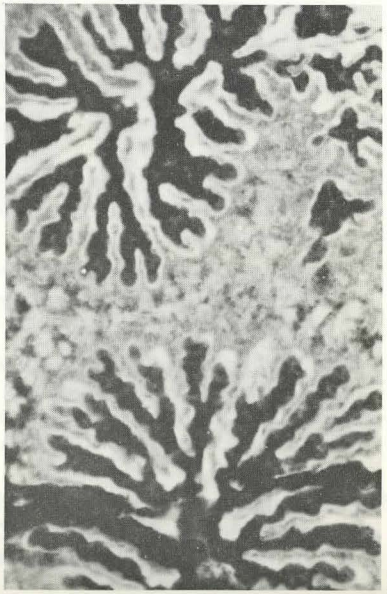
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PLATE 3

Fig. 1. *Cassianastraea reussi* (LAUBE 1865)
Cassianastraea reussi Community
Transverse section of cerioid-plocoid colonies which are of ramose shape. Left bellow *Solenopora* sp. Between corals there are thrombolites and several microorganisms. Thin section SJA-6, 4 ×.

Fig. 2. *Koilocoenia decipiens* (LAUBE 1865)
Koilocoenia decipiens-Solenopora Community
Transverse section of subplocoid colony. Peritheca is unclear.
Thin section SJA-43/2b. (*Solenopora* sp. from the same thin section is shown on Pl. 10, fig. 5.), 4 ×.

Figs. 3—5. *Gumbelastraea guembeli* (LAUBE 1865)
Gumbelastraea guembeli Community
3. Transverse section of massive colony. Thin section SJA-58/1a, 4 ×.
4. Longitudinal section of colony. Ammonite on the right. Thin section SJA-58/1b, 4 ×.
5. Enlarged detail from fig. 3. Two corallites with peritheca inbetween, 15 ×.

TABLA 3

Sl. 1. *Cassianastraea reussi* (LAUBE 1865)
Združba s *Cassianastraea reussi*
Prečni presek cerioidno-plokoidnih kolonij, ki imajo vejnate oblike. Levo spodaj *Solenopora* sp. Med koralami so tromboliti in razni mikroorganizmi.
Zbrusek SJA-6, 4 ×.

Sl. 2. *Koilocoenia decipiens* (LAUBE 1865)
Združba s *Koilocoenia decipiens-Solonopora*
Prečni presek subplokoidne kolonije. Periteka nejasna.
Zbrusek SJA-43/2b (*Solenopora* sp. iz istega zbruska je prikazana na tab. 10, sl. 5), 4 ×.

Sl. 3—5. *Gumbelastraea guembeli* (LAUBE 1865)
Združba z *Gumbelastraea guembeli*
3. Prečni presek masivne kolonije. Zbrusek SJA-58/1a, 4 ×.
4. Podolžni presek kolonije. Na desni amonit.
Zbrusek SJA-58/1b, 4 ×.
5. Povečan detajl s sl. 3. Dva koralita z vmesno periteko. 15 ×.

PLATE 4

Fig. 1. *Coryphyllia regularis Cuif* 1974
Transverse section of corallum. Smooth septa with simple trabeculae in younger cycles. Thin section SJA-29/3, 4 ×.

Fig. 2. *Margarophyllia crenata* (MÜNSTER 1841)
Part of transverse section of corallum. Septa are slightly dentate, microstructure of sclerodermites. Thin section SJA-43/3, 4 ×.

Figs. 3—4. *Myriophyllum gracilis* (VOLZ 1896)
Myriophyllum gracilis-Macrotubus/Tubiphytes Community
3. Transverse section of corallum with more centres of growth. Coral is overgrown by spongiostromata algal crusts. Thin section SJA-14/1a, 4 ×.
4. Detail from fig. 3., 15 ×.

Figs. 5—6. *Margarophyllia capitata* (MÜNSTER 1841)
5. Transverse section of corallum. Thin section SJA-15/15, 4 ×.
6. Transverse section of corallum overgrown by spongiostromata algal crust. Thin section SJA-58/1, 4 ×.

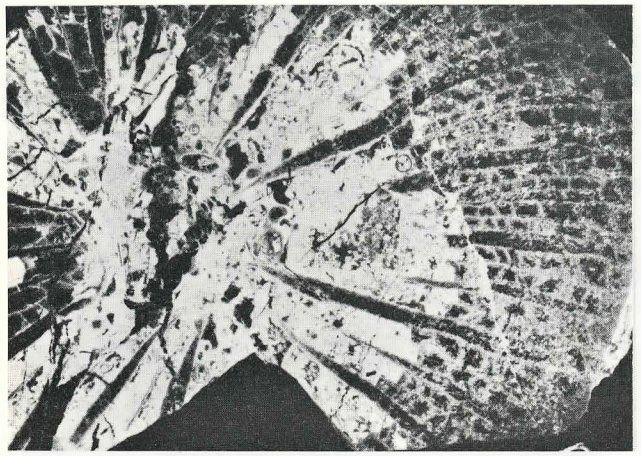
TABLA 4

Sl. 1. *Coryphyllia regularis* CUIF 1974
Prečni presek koraluma. Gladka septa z enostavnimi trabekulami v mlajših ciklih. Zbrusek SJA-29/3, 4 ×.

Sl. 2. *Margarophyllia crenata* (MÜNSTER 1841)
Del prečnega preseka koraluma. Septa so rahlo nazobčana, mikrostruktura je iz sklerodermitov. Zbrusek SJA-43/3, 4 ×.

Sl. 3—4. *Myriophyllum gracilis* (VOLZ 1896)
Združba z *Myriophyllum gracilis-Macrotubus/Tubiphytes*
3. Prečni presek koraluma z več centri rasti. Koralo preraščajo spongiostromatne algalne skorje. Zbrusek SJA-14/1a, 4 ×.
4. Detajl s sl. 3, 15 ×.

Sl. 5—6. *Margarophyllia capitata* (MÜNSTER 1841)
5. Prečni presek koraluma. Zbrusek SJA-15/15, 4 ×.
6. Prečni presek koraluma, ki ga preraščajo spongiostromatne algalne skorje. Zbrusek SJA-58/1, 4 ×.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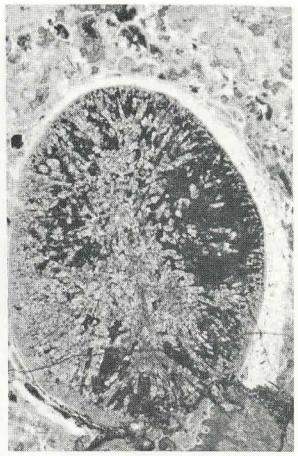
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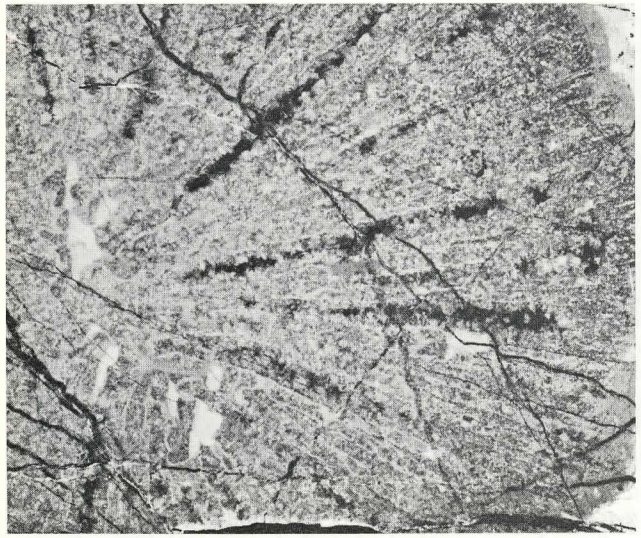
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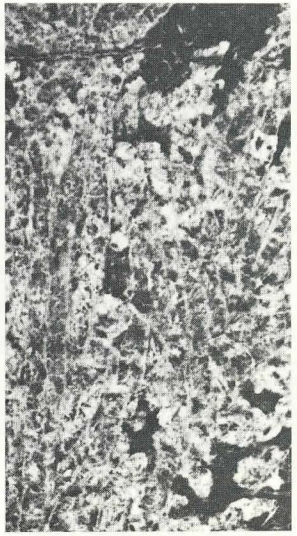
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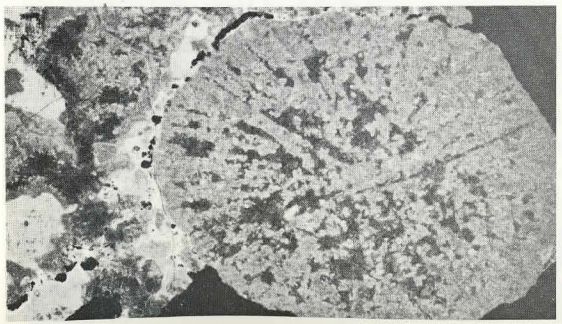
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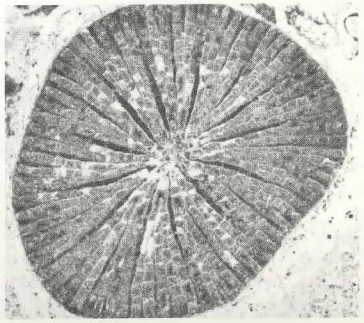
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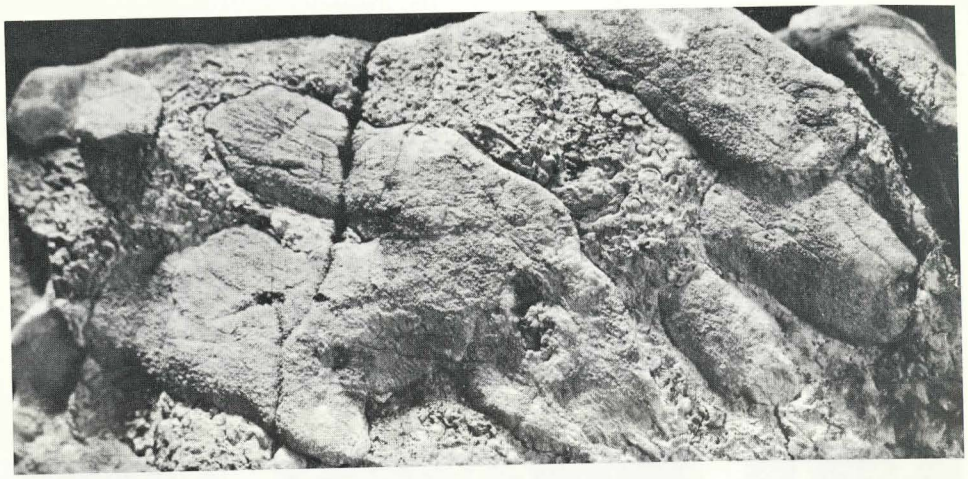

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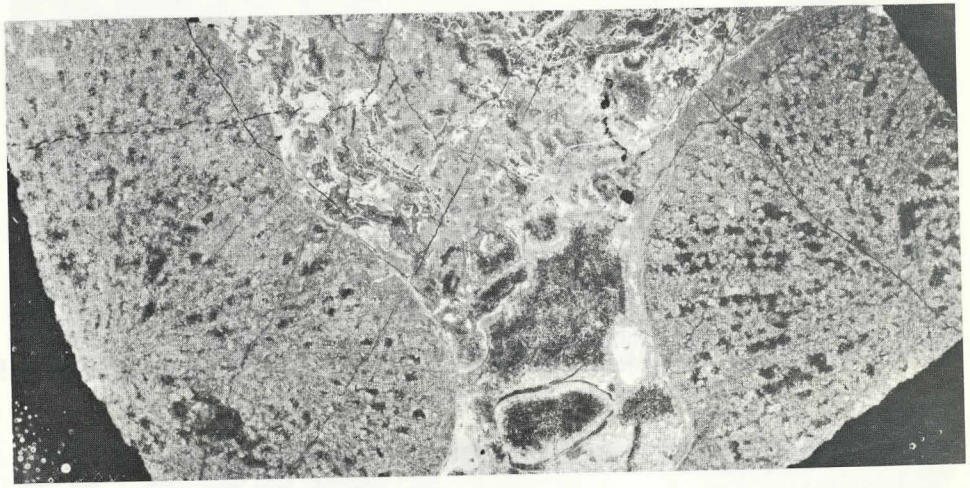

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PLATE 5

Figs. 1—2. *Margarosmilia* cf. M. *richthofeni* VOLZ 1896
Margarosmilia richthofeni-Tubiphytes/Bacinella Community
1. The surface of rock sample with irregularly prolongated corallites. Specimen SJA-8, 1 ×.
2. Transverse section of corallites. Between them *Bacinella* and *Tubiphytes* are crowded. Thin section SJA-8/2b, 4 ×.

Fig. 3. *Margarosmilia septanectens* (LORETZ 1875)
Margarosmilia septanectens-Macrotubus/Tubiphytes Community
Transverse section of corallites. In interspaces in the micrite microproblematica are densely packed. Thin section SJA-33, 4 ×.

TABLA 5

Sl. 1—2. *Margarosmilia* cf. M. *richthofeni* VOLZ 1896
Združba z *Margarosmilia richthofeni-Tubiphytes/Bacinella*
1. Površina vzorca z nepravilno razpotegnjenimi koraliti. Vzorec SJA-8, 1 ×.
2. Prečni presek koralitov. Med njimi so natrpani *Bacinella* in *Tubiphytes*. Zbrusek SJA-8/2b, 4 ×.

Sl. 3. *Margarosmilia septanectens* (LORETZ 1875)
Združba z *Margarosmilia septanectens-Macrotubus/Tubiphytes*
Prečni presek koralitov. V vmesnih prostorih so v mikritu pogostna mikroproblematika. Zbrusek SJA-33, 4 ×.


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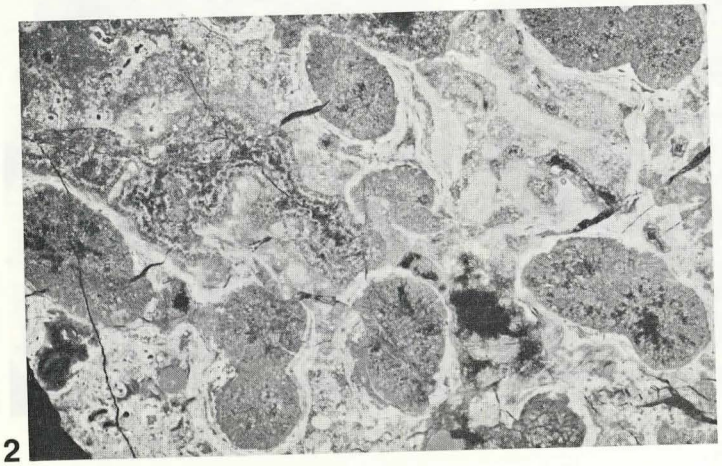
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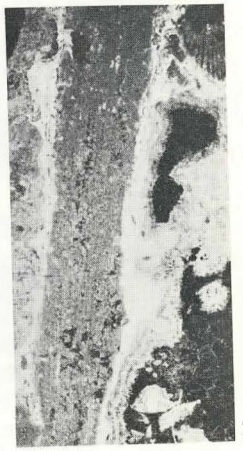
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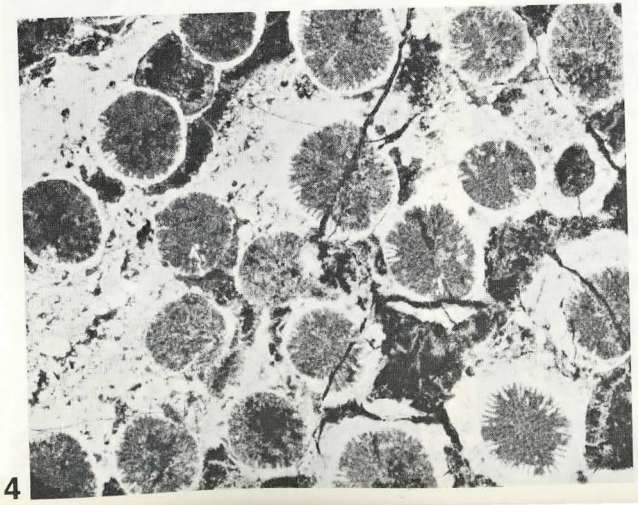
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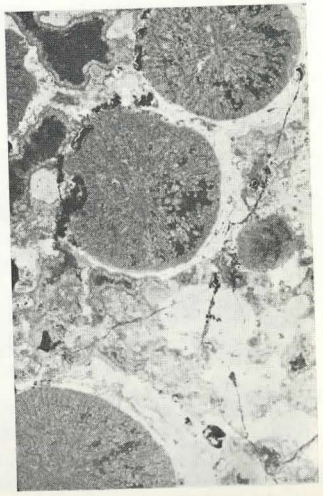
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PLATE 6

Figs. 1—5. *Tropidendron rhopalifer* CUIF 1975
Tropidendron rhopalifer-Macrotubus/Bacinella/Ladinella Community

1. The surface of rock sample with transverse section of phaceloid colony. Specimen SJA-8, 1 ×.
2. Transverse section of corallites overgrown by several structures. Thin section SJA-8/4a, 4 ×.
3. Longitudinal section of one corallite. Thin section SJA-8/4c, 4 ×.
4. Transverse section of colony with dense corallites, overgrown by thick spongiostromate algal crusts. Thin section SJA-40, 4 ×.
5. Transverse section of colony with larger corallites. Thin section SJA-7/3, 4 ×.

TABLA 6

Sl. 1—5. *Tropidendron rhopalifer* CUIF 1975
Združba s *Tropidendron rhopalifer-Macrotubus/Bacinella/Ladinella.*

1. Površina vzorca s prečnim presekom faceloidne kolonije. Vzorec SJA-8, 1 ×.
2. Prečni presek koralitov, ki jih preraščajo razne strukture. Zbrusek SJA-8/4a, 4 ×.
3. Podolžni presek enega koralita. Zbrusek SJA-8/4c, 4 ×.
4. Prečni presek kolonije z gostimi koraliti, ki jih obraščajo debele spongiostromatne algalne skorje. Zbrusek SJA-40, 4 ×.
5. Prečni presek kolonije z velikimi koraliti. Zbrusek SJA-7/3, 4 ×.

PLATE 7

Figs. 1—2. *Tropidendron rhopalifer* CUIF 1975
Tropidendron rhopalifer-Macrotubus/*Bacinella* /*Ladinella* Community

1. Transverse section of corallites. In some places well preserved columella. Between the corallites *Macrotubus, Tubiphytes, Ladinella* and other microorganisms appear as secondary reefbuilders. (Compare also Pl. 11, fig. 3 and pl. 12, fig. 3.) Thin section SJA-15/14, 4 ×.
2. Transverse section of coralites in sparitic type of sediment. Thin section SJA-55/3b, 4 ×.

Figs. 3—4. *Tropidendron* sp.
Tropidendron sp. Community

3. The surface of colony with small corallites. Specimen SJA-15/13, 1 ×.
4. Transverse section of corallites. Septal structure is poorly preeserved. Thin section SJA-15/13a, 4 ×.

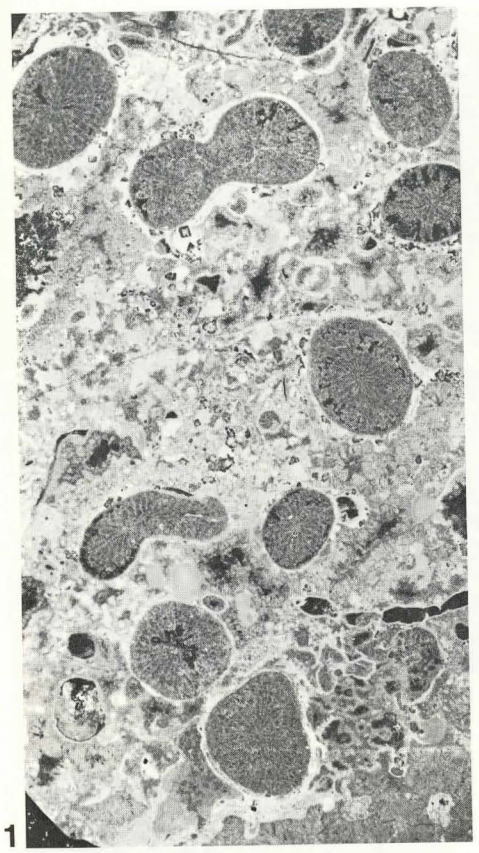
TABLA 7

Sl. 1—2. *Tropidendron rhopalifer* CUIF 1975
Združba s *Tropidendron rhopalifer-Macrotubus/ Bacinella/ Ladinella*

1. Prečni presek koralitov. V nekaterih dobro ohranjena kolumela. Med koraliti so *Macrotubus, Tubiphytes, Ladinella* in drugi mikroorganizmi kot sekundarni tvorci grebena. (Primerjaj še tab. 11, sl. 3 in tab. 12, sl. 3).
Zbrusek SJA-15/14, 4 ×.
2. Prečni presek koralitov v sparitnem tipu sedimenta. Zbrusek SJA-55/3b, 4 ×.

Sl. 3—4. *Tropidendron sp.*

3. Površina kolonije z drobnimi koraliti. Vzorec SJA-15/13, 1 ×
4. Prečni presek koralitov. Septalna struktura je slabo ohranjena. Zbrusek SJA-15/13a, 4 ×.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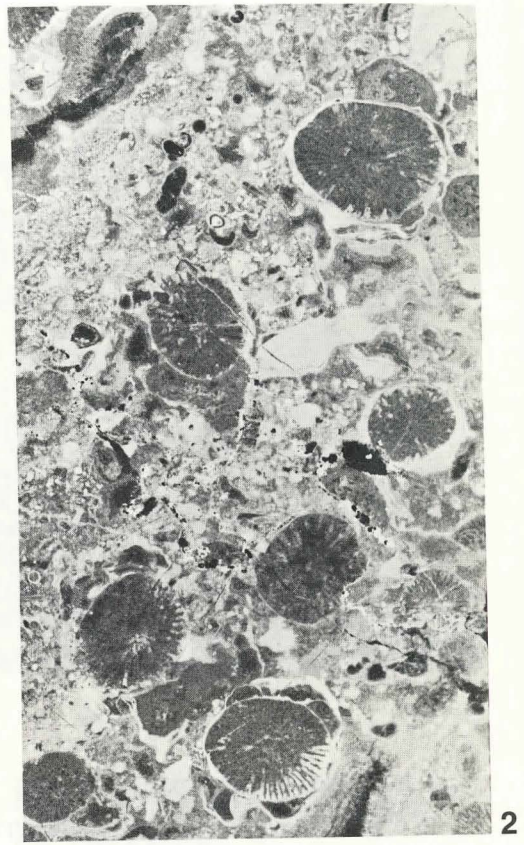
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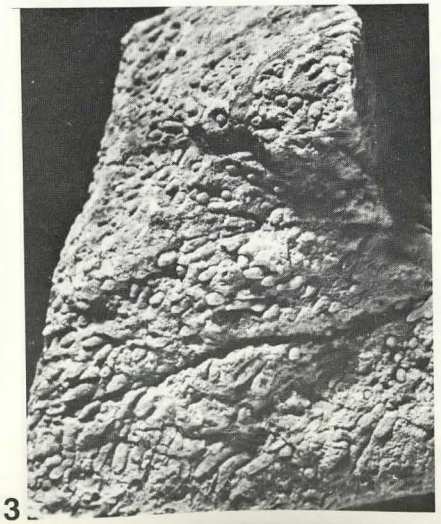
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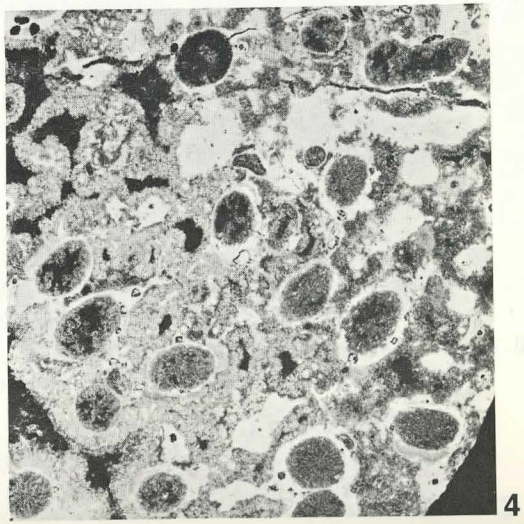
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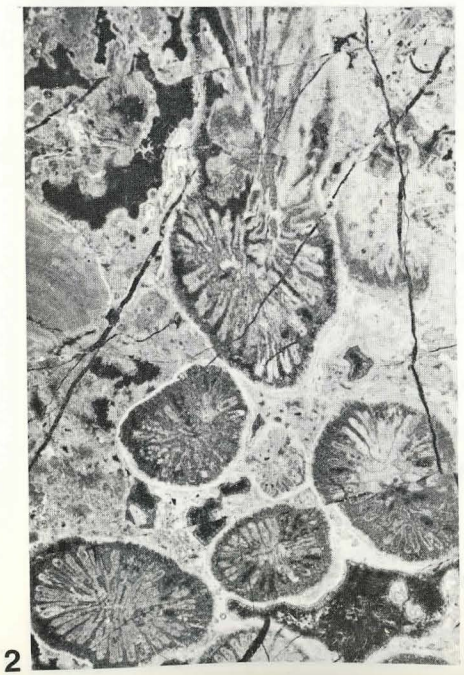

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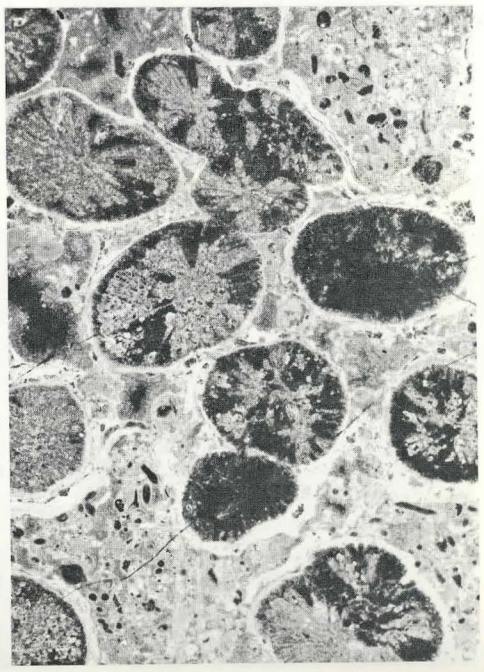

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PLATE 8

Fig. 1. *Volzeia badiotica* (VOLZ 1896)
Volzeia sublaevis/badiotica-Macrotubus/Bacinella Community
Transverse section of corallites. Thin section SJA-55/2a, 4 ×.

Figs. 2—3. *Volzeia sublaevis* (MÜNSTER 1841)
2. Transverse and partly longitudinal section of corallites which divide in many directions. Left *Solenopora* sp. Thin section SJA-7/6a, 4 ×.
3. Transverse section of another colony. Between corallites spongiostromata algal crusts, *Macrotubus* and *Tubiphytes*. Thin section SJA-14/12a, 4 ×.

TABLA 8

Sl. 1. *Volzeia badiotica* (VOLZ 1896)
Združba z *Volzeia sublaevis/badiotica-Macrotubus/Bacinella*
Prečni presek koralitov. Zbrusek SJA-55/2a, 4 ×.

Sl. 2—3. *Volzeia sublaevis* (MÜNSTER 1841)
2. Prečni in delno podolgovati presek koralitov, ki se delijo v več smereh. Levo *Solenopora* sp.
Zbrusek SJA-7/6a, 4 ×.
3. Prečni presek druge kolonije. Med koraliti so spongiostromatne algalne prevleke, *Macrotubus* in *Tubiphytes*.
Zbrusek SJA-14/12a, 4 ×.

PLATE 9

Figs. 1—2. *Balatonia kochi* VINASSA de REGNY 1907
Balatonia kochi-Macrotubus/Tubiphytes Community
1. Transverse section of coenostea, overgrown by thick spongiostromata algal crusts and Tubiphytes.
Thin section SJA-14/9a, 4 ×.
2. Longitudinal section of coenosteum. Thin section SJA-14/9b, 4 ×.

Fig. 3. *Dictyocoelia manon* (MÜNSTER 1841)
Section of sponge with central canal and two segments.
Thin section SJA-47/3, 4 ×.

Fig. 4. *Colospongia dubia* (MÜNSTER 1841)
Longitudinal section of sponge showing strongly widened younger segments. The wall is porous. Thin section SJA-15/2, 10 ×.

Figs. 5—6. *Follicatena cautica* OTT 1967
Follicatena cautica-Tubiphytes/Macrotubus Community
5. Section of segmented sponges. Abundance of secondary framebuilders as *Macrotubus* and *Tubiphytes* and others. Thin section SJA-28, 4 ×.
6. Section of larger specimen of segmented sponge. No overcrustings. Thin section SJA-14/7, 4 ×.

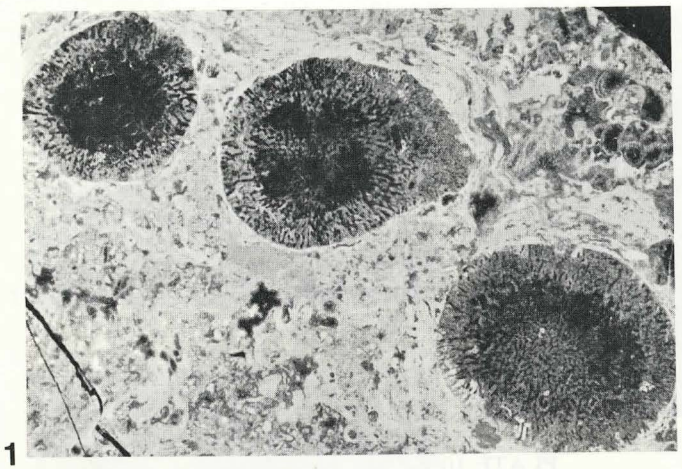
TABLA 9

Sl. 1—2. *Balatonia kochi* VINASSA de REGNY 1907
Združba z *Balatonia kochi-Macrotubus/Tubiphytes*
1. Prečni preseki cenostejev, ki so prerasli s spongiostromatnimi algalnimi skorjami in Tubiphytes. Zbrusek SJA-14/9b, 4 ×.
2. Podolžni presek cenosteja. Zbrusek SJA-14/9b, 4 ×.

Sl. 3. *Dictyocoelia* manon (MÜNSTER 1841)
Presek spongije s centralno cevjo in dvema segmentoma.
Zbrusek SJA-47/3, 4 ×.

Sl. 4. *Colospongia dubia* (MÜNSTER 1841)
Podolžni presek spongije kaže močno razširjene mlajše segmente. Stena je porozna.
Zbrusek SJA-15/2, 10 ×.

Sl. 5—6. *Follicatena cautica* OTT 1967
Združba s *Follicatena cautica-Tubiphytes/Macrotubus*
5. Preseki segmentiranih spongij. Mnogo sekundarnih grebenotvorcev kot so *Macrotubus, Tubiphytes* in drugi. Zbrusek SJA-28, 4 ×.
6. Presek večjega primerka segmentirane spongije. Ni obrasla.
Zbrusek SJA-14/7, 4 ×.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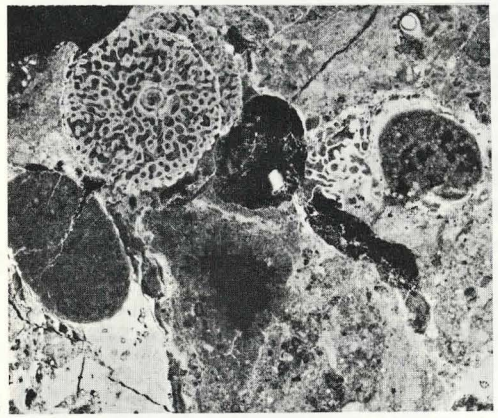
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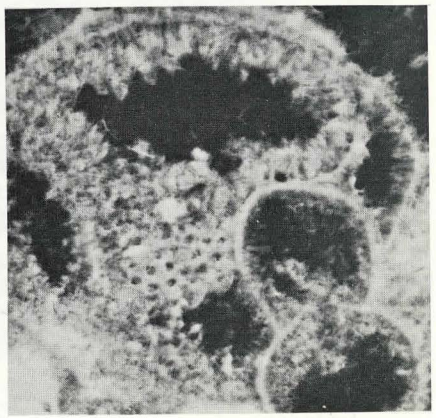
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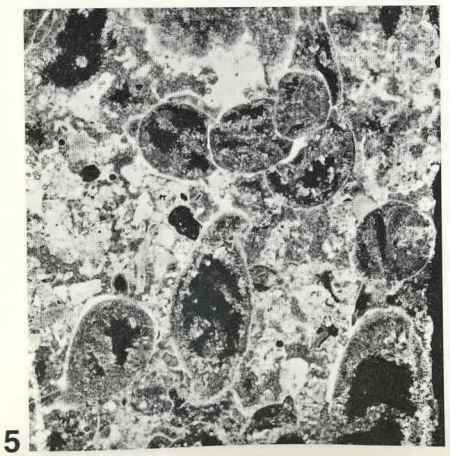
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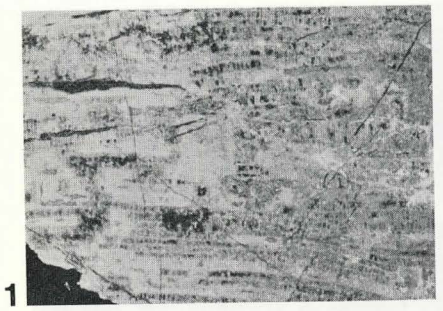
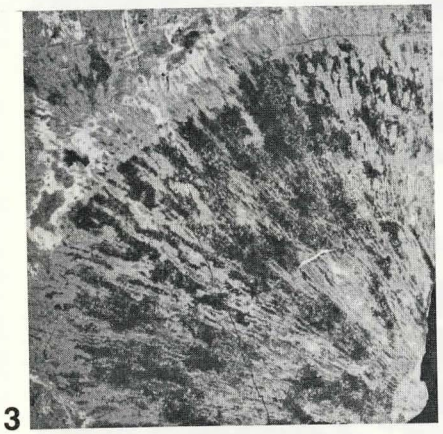
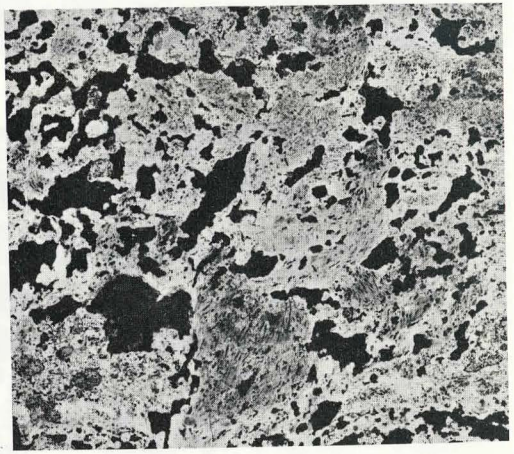






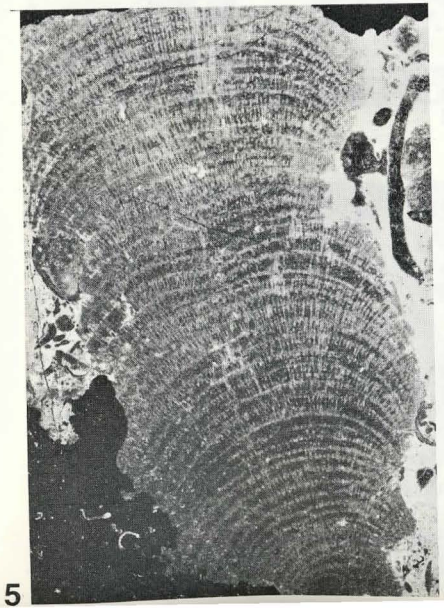


PLATE 10

Figs. 1—2. *Antrochaetetes* sp.
1. Longitudinal section of tubular coenosteum with many tabulae. Thin section SJA-8/1a, 4 ×.
2. Transverse section of coenosteum showing small tubules. Thin section SJA-8/1c, 4 ×.

Figs. 3—4. *Cayeuxia* sp.
3. Longitudinal section of one large coenosteum with many tubules. Thin section SJA-14/2a, 4 ×.
4. Small coenostea with irregular growth of skeleton. Thin section SJA-22/b, 4 ×.

Fig. 5. *Solenopora* sp.
Longitudinal section of skeleton with concentric growth. Alga grows in community with coral *Koilocoenia decipiens* (shown on Pl. 3, fig. 2.). Thin section SJA-43/2b, 6 ×.

Fig. 6. *Solenopora alcicornis* OTT 1966
Solenopora alcicornis-Tubiphytes-Foraminifera Community. Ramose »colonies« are sometimes rockbuilding. Thin section SJA-35a, 8 ×.

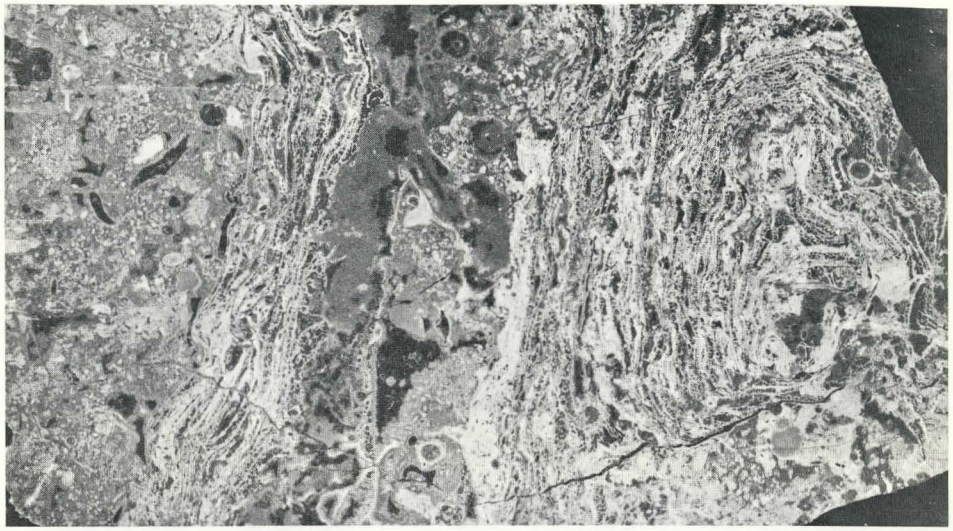
TABLA 10

Sl. 1—2. *Atrochaetetes* sp.
1. Podolžni presek cevastega cenosteja z mnogimi tabulami. Zbrusek SJA-8/1a, 4 ×.
2. Prečni presek cenosteja kaže številne drobne cevčice. Zbrusek SJA-8/1c, 4 ×.

Sl. 3—4. *Cayeuxia* sp.
3. Podolžni presek enega velikega cenosteja z mnogimi cevkami. Zbrusek SJA-14/2a, 4 ×.
4. Majhni cenosteji z nepravilno rastjo skeleta. Zbrusek SJA-22b, 4 ×.

Sl. 5. *Solenopora* sp.
Podolžni presek skeleta s koncentrično rastjo. Alga živi v združbi s koralo *Koilocoenia decipiens* (Tab. 3, sl. 2). Zbrusek SJA-43/2b, 6 ×.

Sl. 6. *Solenopora alcicornis* OTT 1966
Združba s *Solenopora alcicornis-Tubiphytes*-Foraminifera
Vejnate »kolonije« so včasih kamenotvorne. Zbrusek SJA-35a, 8 ×.



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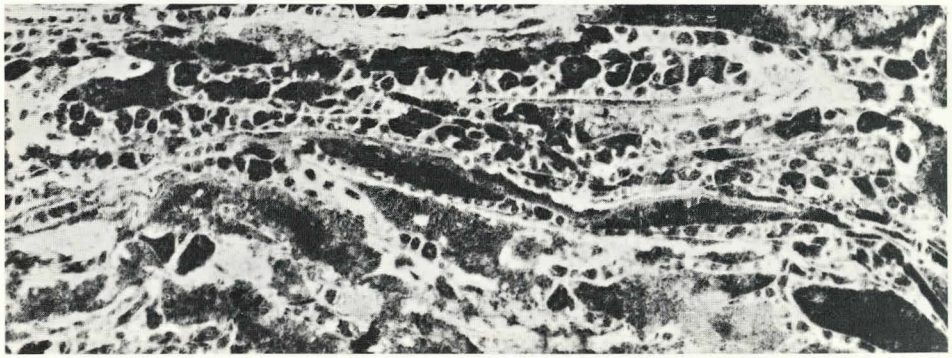

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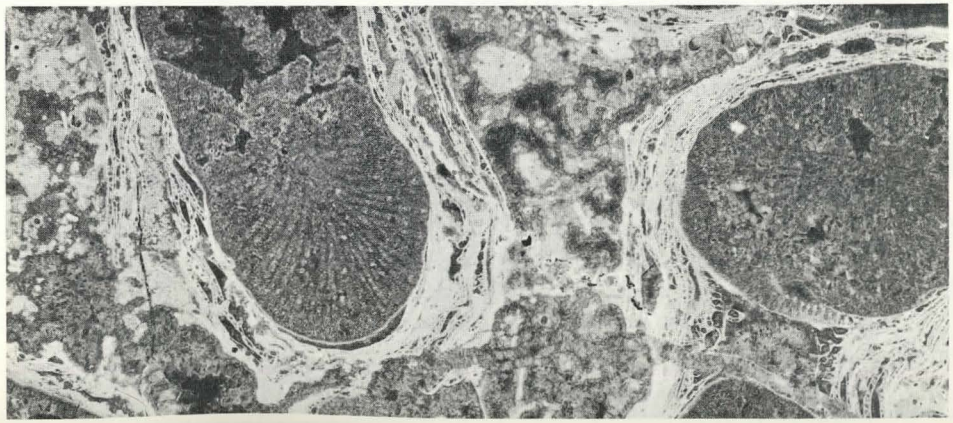

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PLATE 11

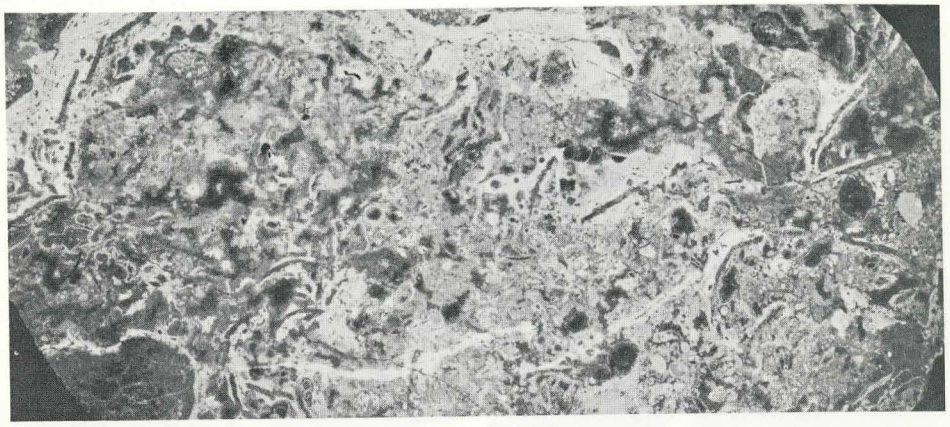
Figs. 1—3. *Bacinella ordinata* PANTIĆ 1972
Bacinella ordinata Community

1. Large massive concentric skeleton (on right side) and encrusting smaller (in the left). Thin section SJA-14/8, 4 ×.
2. Detail from fig. 1. 20 ×.
3. *Bacinella ordinata* is overgrowing corallites of *Tropidendron rhopalifer*. Thin section SJA-14/13, 6 ×.

TABLA 11

Sl. 1—3. *Bacinella ordinata* PANTIĆ 1972
Združba z *Bacinella ordinata*

1. Velik masiven koncentričen skelet na desni in skorjasti manjši na levi. Zbrusek SJA-14/8, 4 ×.
2. Detajl s sl. 1., 20 ×.
3. *Bacinella ordinata* obrašča koralite *Tropidendron rhopalifer*. Zbrusek SJA-14/13, 6 ×.



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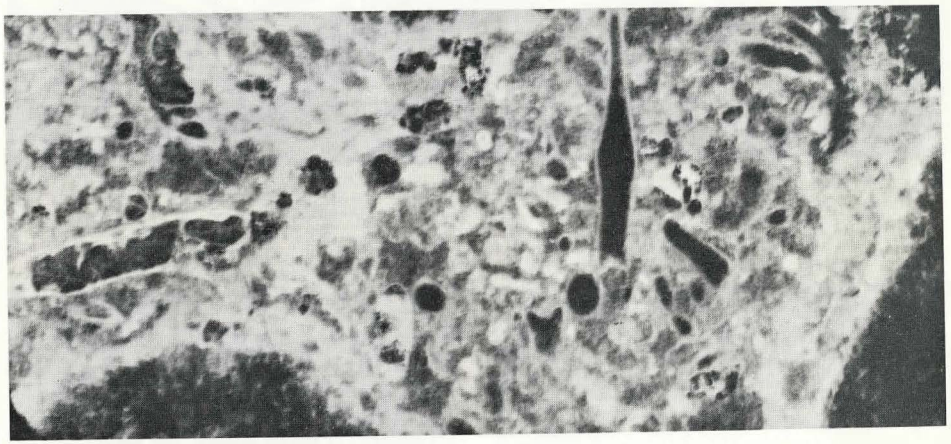

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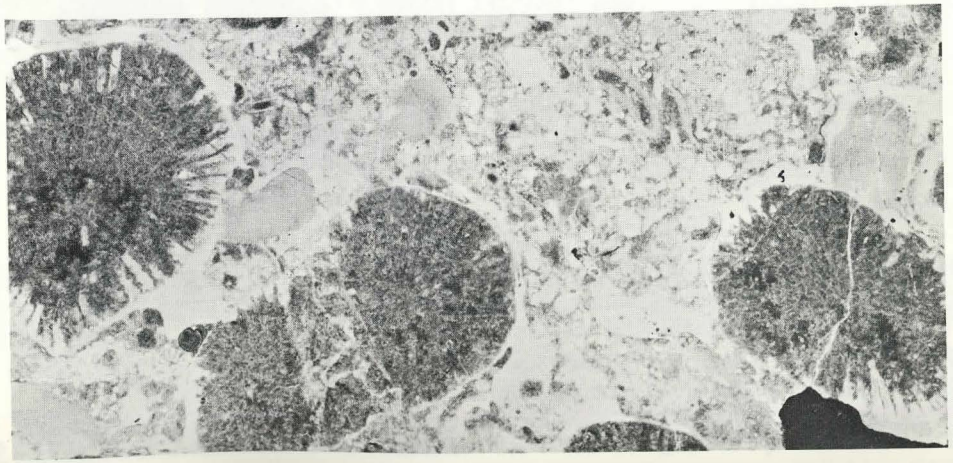

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PLATE 12

Fig. 1. *Tubiphytes obscurus* MASLOV 1956
Various shapes and sizes of individuals. Thin section SJA-14/6b, 4 ×.

Fig. 2. *Macrotubus babai* FOIS & GAETANI 1981.
Transverse and longitudinal sections of tubes. Thin section SJA-14/12b, 20 ×.

Fig. 3. *Ladinella porata* OTT 1967
Microproblematica growing on corallites of *Tropidendron rhopalifer*. Thin section SJA-55/3a, 8 ×.

TABLA 12

Sl. 1. *Tubiphytes obscurus* MASLOV 1956
Različne oblike in velikosti osebkov. Zbrusek SJA-14/6b, 4 ×.

Sl. 2. *Macrotubus babai* FOIS & GAETANI 1981
Prečni in podolgovati preseki cevčic. Zbrusek SJA-14/12b, 20 ×.

Sl. 3. *Ladinella porata* OTT 1967
Mikroproblematika rastejo na koralitih korale. *Tropidendron rhopalifer*. Zbrusek SJA-55/3a, 8 ×.

PLATE 13

Fig. 1. *Diplopora annulata* SCHAFHÄUTEL 1853
Diplopora annulata-Foraminifera Community
Longitudinal and transverse sections of algae. Thin section SJA-18/1, 4 ×.

Figs. 2—3. *Teutloporella herculea* (STOPPANI 1857)
Teutloporella herculea-Foraminifera Community
2. Longitudinal and oblique section of algae. Thin section SJA-21/5, 4 ×.
3. Transverse section of algal thali. Thin section SJA-21/2, 4 ×.

TABLA 13

Sl. 1. *Diplopora annulata* SCHAFHÄUTEL 1853
Združba z *Diplopora annulata*-Foraminifera
Podolžni in prečni preseki alg. Zbrusek SJA-18/1, 4 ×.

Sl. 2—3. *Teutloporella herculea* (STOPPANI 1857)
Združba s *Teutloporella herculea*-Foraminifera
2. Podolžni in poševni preseki alg. Zbrusek SJA-21/5, 4 ×.
3. Prečni preseki alginih talusov. Zbrusek SJA-21/2, 4 ×.


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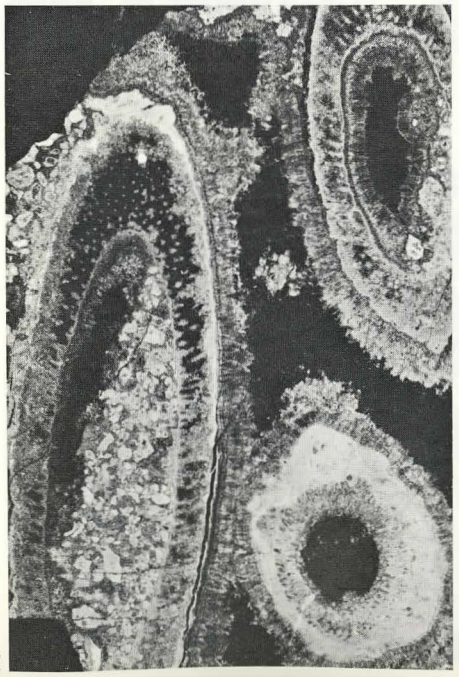
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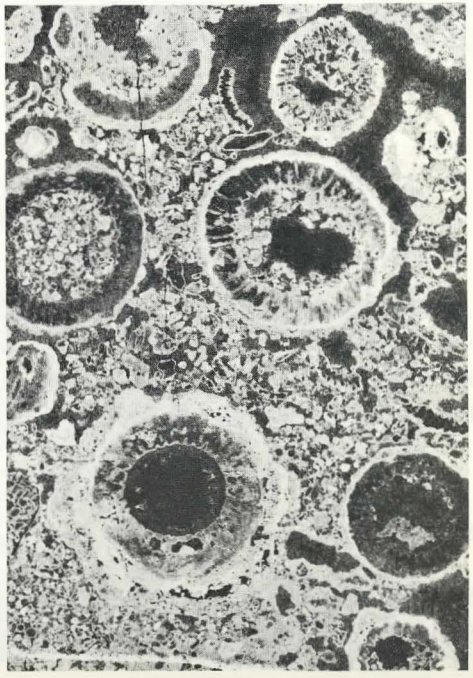
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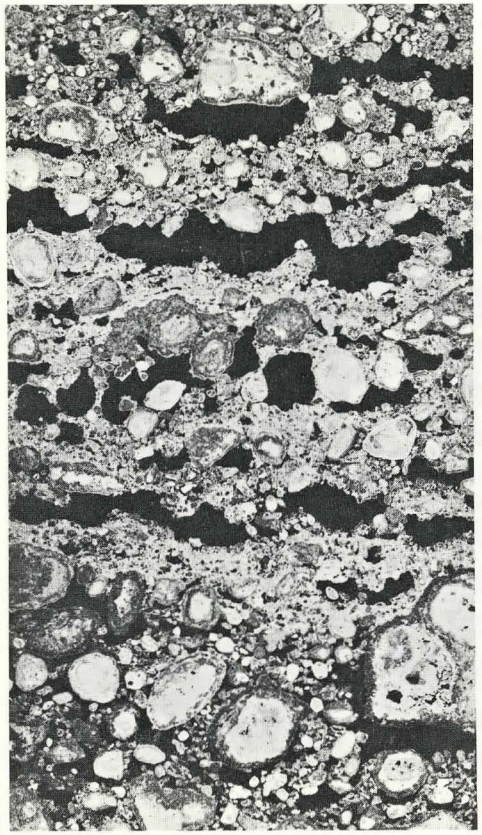

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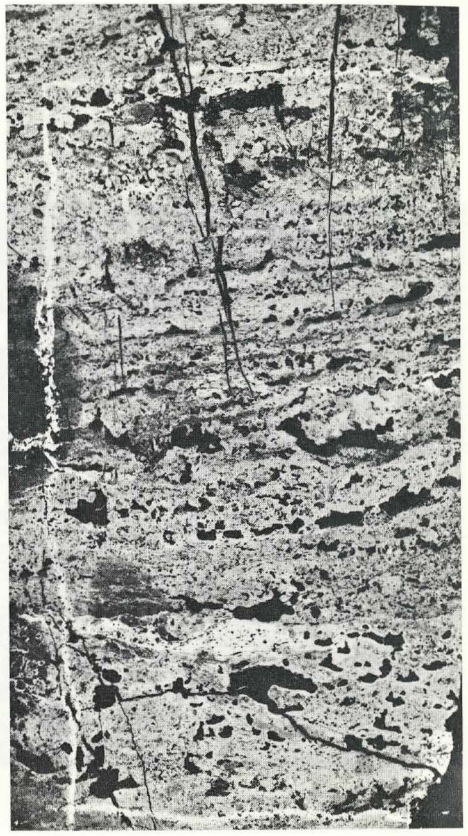

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PLATE 14

Fig. 1. Thrombolite bird's eye limestone. Type A of thrombolites. Thin section SJA-22, 4 ×.

Fig. 2. Bird's eye grain packstone. Thin section SJA-28b, 4 ×.

Fig. 3. Dasycladacean *(Diplopora annulata)* bioclastic grainstone. Thin section SJA-43/2, 4 ×.

TABLA 14

Sl. 1. Trombolitni apnenec s strukturo ptičjega očesa. Trombolitni tip A. Zbrusek SJA-22, 4 ×.

Sl. 2. »Grain packstone« s strukturo ptičjega očesa. Zbrusek SJA-28b, 4 ×.

Sl. 3. Dazikladacejski *(Diplopora annulata)* bioklastični »grainstone«. Zbrusek SJA-43/2, 4 ×.

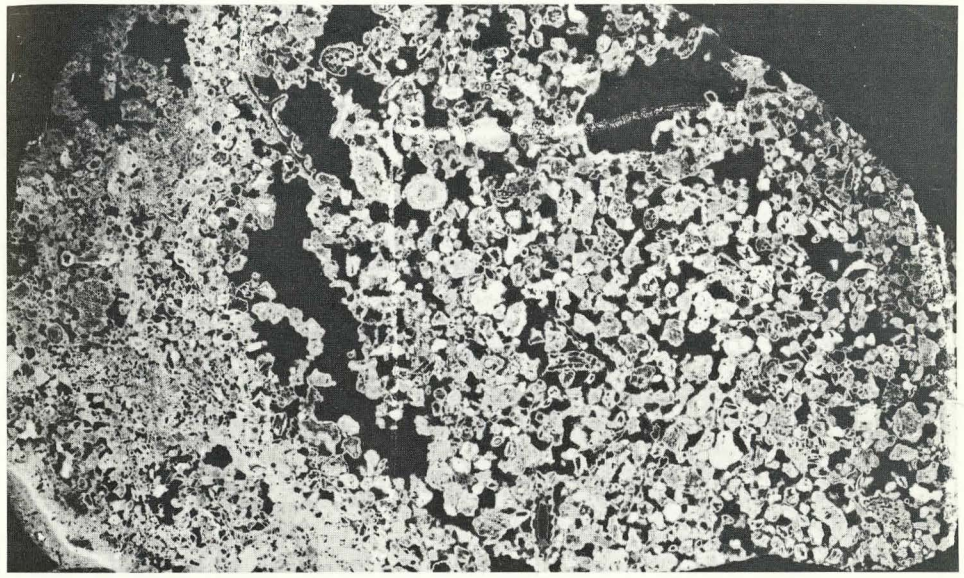

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PLATE 15

Fig. 1. Bioclastic grainstone. Thin section SJA-21/3a, 4 ×.

Fig. 2. Thrombolite bird's eye limestone. Type B of thrombolites. Thin section SJA-28/9a, 4 ×.

Fig. 3. Grapestone grainstone. Thin section SJA-21/3, 4 ×.

TABELA 15

Sl. 1. Bioklastični grainstone. Zbrusek SJA-21/3a, 4 ×.

Sl. 2. Trombolitni apnenec s strukturo ptičjega očesa. Tromboliti tipa B. Zbrusek SJA-28/9a, 4 ×.

Sl. 3. Grapestone grainstone. Zbrusek SJA-21/3, 4 ×.