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PALEOCENE CORALS FROM THE NORTHERN ADRIATIC PLATFORM

Dragica Turnšek and Katica Drobne

Abstract

1. From the northern margin of the Adriatic platform 22 species of Paleocene corals belonging to 15 genera were systematically described. Two species (*Rhizangia padricensis* and *Goniopora hrpeljensis*) are new.

2. The most convinient circumstances for the beginning of coral growth were at the edge of the platform near to the open sea. Here in Dolenja vas as first the local dendroid-phaceloid coral association thrived. Then, toward the hinterland, perhaps in more stages, toward Sopada, Padriciano, Hrpelje–Kozina, Golež to Breg, new generations of massive and phaceloid corals settled which built smaller or larger patch reefs.

3. Corals found in Adriatic platform can be compared with similar findings of species in the wide area from Greenland to Volga and Egypt.

Izvleček

1. Iz severnega obrobja Jadranske platforme je sistematsko opisanih 22 vrst paleocenskih koral, ki pripadajo 15 rodovom. Dve vrsti (*Rhizangia padricensis* in *Goniopora hrpeljensis*) sta novi.

2. Najbolj ugodni pogoji za začetek rasti koral so bili na obrobju platforme blizu odprtega morja, kjer je v Dolenji vasi nastala samosvoja dendroidno-faceloidna koralna združba. Potem so morda v več fazah v zaledju od Sopade preko Padrič, Hrpelja–Kozine, Goleža do Brega sledile naselitve z novimi generacijami masivnih in faceloidnih koral, ki so gradile večje ali manjše "patch" grebene.

3. Najdene korale z Jadranske platforme lahko primerjamo z najdbami enakih vrst od Grenlandije do Volge in Egipta.

Key words: Dendroid-faceloid corals, Paleocene, zonation, NW Adriatic platform, Karst, Slovenia, Italy.

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INTRODUCTION

The northern part of the Adriatic carbonate platform is one of the few regions in the world where shallow carbonate deposits of Early Paleocene age may be preserved as an exceptionally complete series of strata documenting the rise of carbonate producers after the Cretaceous-Tertiary boundary event. In this context, the nature and composition of the first coral communities contributing a major part of the biomineralized carbonate are of particular interest in order to understand the processes of recovery of the carbonate producing communities. Comparing the pattern of biostratigraphic first appearences, in the common framework of the Shallow Benthic (SBZ) zonation, of coral, algal and foraminiferan taxa may provide additional insight of their respective role in the recovery of environments dominated by K-strategists producing the carbonate.

So far, only 9 taxa from a single locality Dolenja vas in Slovenia (Drobne *et al.*, 1988), were identified. During subsequent field work, new coral bearing localities were discovered and sampled. They are Sopada, Hrpelje–Kozina, Breg, Golež (all Slovenia) and Padriciano (Italy). Thus, the inventary grows to 22 species belonging to 15 genera. Only 2 species recognized in Dolenja vas reappear at the new sites.

The specimens from Slovenia are kept in the Ivan Rakovec Paleontological Institute ZRC SAZU in Ljubljana, those from Italy in the Paleontological Institute of the University in Trieste.

The systematical research of corals was made by Dragica Turnšek, the detailed field work with stratigraphical position of the coral bearing samples from the Paleocene sections, and their paleoecological explanation was prepared by Katica Drobne.

LOCATION AND STRATIGRAPHIC POSITION OF THE CORAL BEARING LOCALITIES

Coral assemblages from the Adriatic carbonate platform were collected in SW Slovenia and on a part of the Trieste Karst on Italian territory. The deposits providing corals represent the extreme, northwestern part of the Outer Dinaric tectonic unit (Placer, 1996). The exposed carbonates are of Cretaceous to Paleogene age. The Paleogene limestones with their Late Cretaceous substrate crop out in four parallel belts corresponding to four tectonic subunits extending roughly from North-West to South-East. Sections were selected for study in each belt in order to register the stratigraphic distribution and the composition of subsequent assemblages of corals, algae and foraminifera in their respective facies (Drobne *et al.*, 1991; Ogorelec *et al.*, 1995; Pugliese *et al.*, 1995; Jurkovšek *et al.*, 1996; Barattolo in print).

Corals in particular (Fig. 1, 2) occur in all four Paleogene belts. They are always firmly cemented in the limestones and therefore had to be studied exclusively in thin-sections. The coral bearing limestones were collected in the selected and measured sections (Fig. 3).

1. Padriciano, located at the southernmost margin of the Trieste–Komen Plateau. The series of limestones crop out along the high-way leading to the settlement of Padriciano (Brazatti *et al.*, 1996).

2. Hrpelje in the Hrpelje–Kozina belt, where the corresponding beds are crossed by the forest road to the Slavnik mountain, at the foot of the hill behind the village. The samples were collected in the ditch for supply between the forest road and the railway Divača–Koper and Pula. The thickness of the Paleocene beds amounts here to cca 90 m, and of the Ilerdian beds to an additional 20 m (Figs 1, 2). This section corresponds to the section described on the hill Golež some km forward to Slavnik (Drobne *et al.*, 1991).

3. The Golež section is situated along the road leading from Kozina to the summit of Slavnik. After 5 km a path branches off towards the east. The Paleocene beds outcrop along this way, about 400 m. On the contact between Cretaceous and Paleocene limestone the bauxite occurs. The lowest part of the Paleocene is developed in the lagoonal, shallow and restricted environment. During the Thanetian marine influences prevailed, bearing the frequent foraminifers and partly also corals (Drobne & Pavlovec, 1991).

4. Sopada hill (580 m SE of Štorje) where outcrops along the road document the sedimentation of carbonates from the Cretaceous-Tertiary boundary to the limit of the Paleocene-Eocene (Pugliese *et al.*, 1995).

5, 6. Dolenja vas East and West (DvE, DvW), at km 6 of the road from Senožeče to Vrabče, on the slopes towards the Vipava valley (Drobne *et al.*, 1988, 1996).

7. An isolated outcrop at Breg IV and V provided additonal coral specimens. There outcrops are located in the eastern part of Brkini range, at km 3.5 on the road from Ilirska Bistrica to Knežak. Here, Paleogene beds are isolated from their stratigraphic context by thrust folds. Thickness of the Paleocene beds attains about 45 m, laying in the inverse position (Kahn, 1976; Kahn *et al.*, 1975).

The stratigraphic range of corals is indicated here according to the distribution of the foraminifera observed in the sections studied and their zonation recently revised (Shallow Benhtic SBZ zonation) (Serra-Kiel *et al.*, in print). Tentatively, the SBZ1 zone corresponds to the Danian stage, the SBZ2 zone may be to the Selandian stage, SBZ3 and SBZ4 to the Thanetian and SBZ5-9 to the Ilerdian stage (Fig. 3).

The zonation of foraminifera and corals mainly corresponds to the distribution of dasycladacean algae, studied partly from the same sections on the Karst area by Filippo Barattolo (this volume).

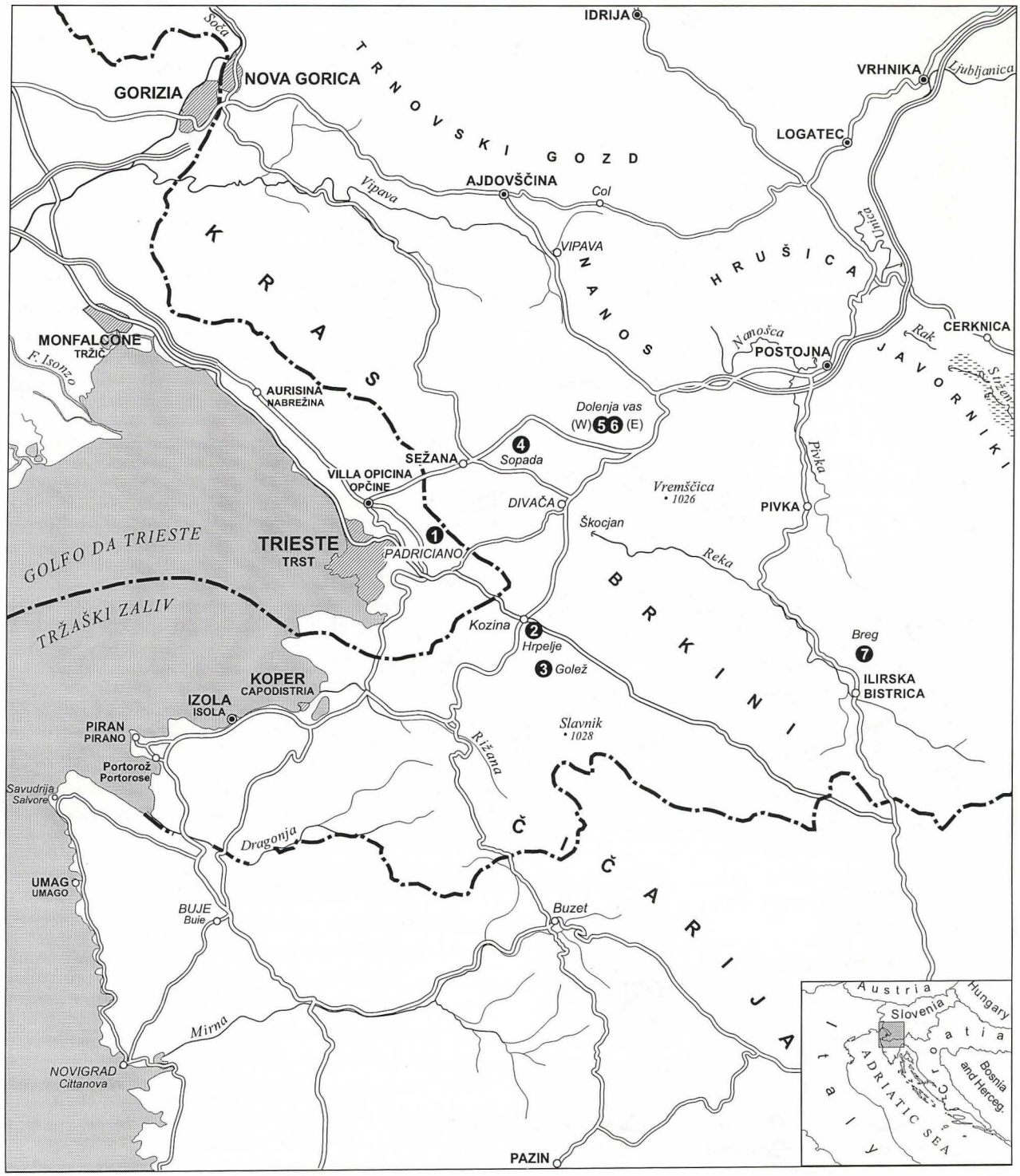

Fig. 1: Geographical position of the Paleocene sections and localities:

1 Padriciano

2 Hrpelje

3 Golež

4 Sopada

5 Dolenja vas West

6 Dolenja vas East

7 Breg

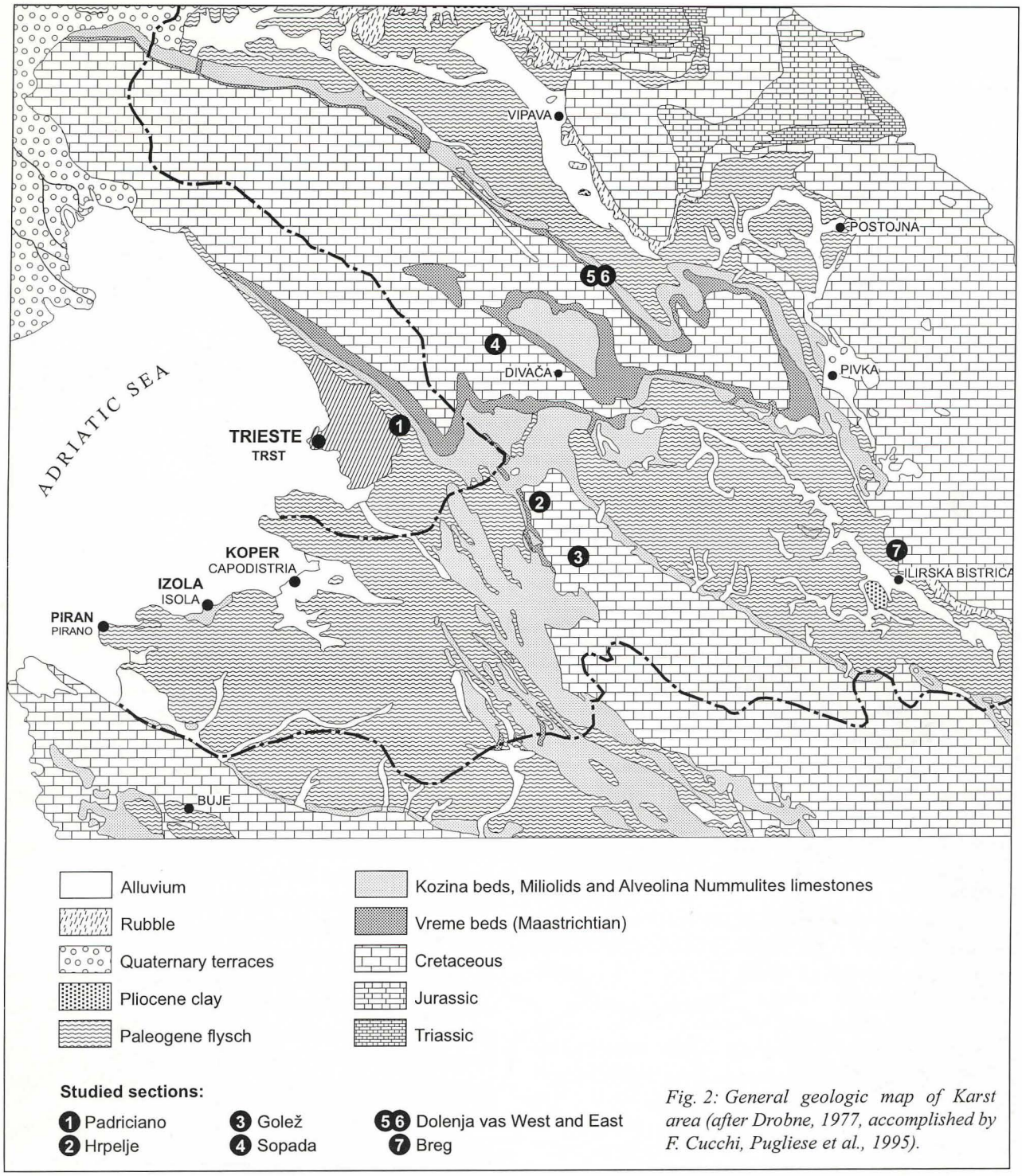

Fig. 2: General geologic map of Karst area (after Drobne, 1977, accomplished by F. Cucchi, Pugliese et al., 1995).

SYSTEMATIC DESCRIPTION OF CORALS

Dragica Turnšek

The systematics in this paper are based mainly on a combination of the revisions published by Alloiteau, 1952, 1957; Wells, 1956; Floris, 1972; Barta Calmus, 1973; Frost & Langenheim, 1974; Kuzmicheva, 1975; Russo, 1979; Beauvais, 1982; Turnšek in Drobne *et al.*, 1988, where detailed explanations were given. A difference arises as to the systematic position of the genus *Rhizangia*, attributed here to the Meandriina as explained in the text, and as to *Litharaea* previously attributed to *Litharaeopsis*. For those species already described from Dolenja vas (Drobne *et al.*, 1988) the synonymy and eventual complements to the description are given here. The microstructure is very poorly preserved; the centers

of calcification and growth of the fibres are wiped out. I was not able to recognize their pattern according to the microstructural groups proposed by Roniewicz & Morycowa (1993) and Morycowa & Roniewicz (1994).

With the description on the species level, the following measures are given: d = inner diameter of corallite, D = diameter of corallite including wall, cc = distance between the centres of the neighbouring corallites, s = number of septa or density of septa (= number of septa or skeletal elements in definite distance), s1+s2+s3 = septal cycles, () = very rare.

Subordo: Archaeocoeniina Alloiteau, 1952
Fam.: Stylocoeniidae Alloiteau, 1952

Genus: *Astrocoenia* Milne Edwards & Haime, 1848

***Astrocoenia bistellata* (Catullo, 1856)**
Pl. 1, figs 1–6

1856 *Astraea bistellata* n. sp. Catullo: n. v.
1973 *Astrocoenia bistellata* (Catullo). Barta Calmus: 215–217, Pl. 8, figs 7–8.

A modern description was given by Barta Calmus (1973). The subcerioid colony has polygonal to round corallites. Septa are compact, developed in a hexameral system, laterally sharply granulated, in their axial part thickened or having auriculae. The columella is styliform, it is sometimes joined with the septa because of recrystalization and therefore appearing very large. Wall is septothecal, wide, because the septa are touching each other over a wide region. Endotheca consists of the vesicular dissepiments. Microstructure is very poorly preserved.

Dimensions of our specimens: d = (0.8)1–1.3 mm, D = 0.9–1.5 mm, s = 12 (6+6).

Comparison: All features of our specimens fit with the Barta's description of the species, but our specimens are smaller in size (Barta-Calmus, 1973): d = 1.2–1.5 mm, D = 1.2–1.8 mm, s = 12 (6+6).

Systematic position: *Astrocoenia* was put into the suborder Meandriina by Alloiteau (1952). Barta-Calmus (1973) ascribed it to the Archaeocoeniina what is accepted here.

Previously indicated occurrences: Brendola in Venetia, Eocene.

New occurrences on the Adriatic carbonate platform: Padriciano: Pad-11 (11002, 11003), Pad-28 (11005, 11006); Breg: Br-IV/4. Zone SBZ4.

Genus: *Stylocoenia* Milne Edwards & Haime, 1848

Stylocoenia was compared to *Astrocoenia* by Alloiteau (1957), and Barta-Calmus (1973). They emphasize the presence of "colonnettes murales" as a typical characteristic to distinguish this genus from *Astrocoenia*. Our specimens of these two genera differ also in their endotheca, *Stylocoenia* having tabulate and *Astrocoenia* vesicular dissepiments.

***Stylocoenia montium* (Oppenheim, 1912)**
Pl. 2, fig. 1

1912 *Stylophora montium* n. sp. Oppenheim: 132, Taf. 14, figs 14–14a.
1975 *Stylocoenia montium* (Oppenheim). Kuzmicheva: 18, Tab. 1, fig. 1.
1988 *Stylocoenia montium* (Oppenheim). Drobne *et al.* 184, Pl. 29, figs 1–3.

A description, comparison and distribution of this species were given by Turnšek in Drobne *et al.* (1988).

Previously indicated occurrences: Paleocene of Rosići in Majevica in northern Bosnia, Montian-Thanetian of Luzanovka in Ukraine.

Occurrence on the Adriatic platform: Dolenja vas: DvW-22 (4683). Zone SBZ2.

***Stylocoenia neutra* Barta-Calmus, 1973**
Pl. 2, figs 2–5

1973 *Stylocoenia neutra* sp. n. Barta-Calmus: 200–202, Pl. 10, figs 10–13.

A description was given by Barta-Calmus (1973). Our specimens form bulbous subcerioid colonies with polygonal corallites, and produce new buds extracalicinally. Septa are compact, developed in a hexameral system, the first cycle joining with the styliform columella. Their lateral granulations are small. Wall is septothecate, endotheca is consisting of tabulate dissepiments. Microstructure is very poorly preserved.

Dimensions of our specimens: d = 1–1.2 mm, s = 12 (6+6).

Comparison: Our specimens are almost identical to those of Barta as to their structural features and their dimensions d = 1–1.5 mm, s = 12 (6+6). They differ a little as to their columella, which in our specimens is more irregularly joined with the septa and endotheca better preserved.

Previously indicated occurrences: Sud de Blieux in Basses Alpes, France, Eocene.

Occurrences on the Adriatic carbonate platform: Dolenja vas: DvW-29. Zone SBZ3; Sopada Sop-6/0 (10463, 10456, 10457, 10459, 10461, 10462). Zone SBZ4.

Subordo: Dendrophylliina Vaughan & Wells, 1943
Fam.: Acroporidae Verrill, 1902

Genus: *Haimesastraea* Vaughan, 1900

***Haimesastraea peruviana* Vaughan, 1922**
Pl. 3, fig. 1

1922 *Haimesastraea peruviana* n. sp. Vaughan: n. v.
1974 *Haimesastraea peruviana* Vaughan. Frost & Langenheim: 193–194, Pl. 29, figs 1–5.
1988 *Haimesastraea peruviana* Vaughan. Drobne *et al.*: 186, Pl. 30, fig. 3.

Description and distribution were given by Turnšek in Drobne *et al.* (1988).

Previously indicated occurrences: Paleocene-Lower Eocene of Mexico and NW Peru.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-9 (979). Zone SBZ1.

Genus: Astraeopora de Blainville, 1830

***Astraeopora pseudopanicea* Oppenheim, 1912**
Pl. 3, figs 2–6

1912 *Astraeopora pseudopanicea* n. sp. Oppenheim: 101–102, Pl. 10, figs 1–1a.

Description: The coral colony is massive, bulbous, plocoid, composed of round corallites and large peritheca. In cross section corallites have rounded outline. Septa are compact corresponding to an hexameral system. First cycle septa are thickened in their axial part, sometimes joined with each other. Second cycle is much shorter. Lateral ornamentations are consisting of rare granulae. An important part of the colony consists of a peritheca, named coenenchyme by Eliašova (1974). In the centre of the peritheca there are big round spaces which could be very large centres of calcification. Some of them could also be explained as new buds of young corallites. In our specimens the corallites appear as if they were surrounded by a paratheca. Endotheca is composed of very abundant tabulate and vesicular dissepiments. In the relevant literature it is emphasized that there is no columella. In our specimens the septa reach the centre and often join each other forming some kind of axial structure. The microstructure can be compared with the one described in *Astraeopora decaphyllia* by Eliašova (1974, 141, text-fig. 17) i. e. some kind of large trabeculae in the wall, and mini trabeculae with median line in the septa. In our specimens it is much more recrystalized.

Dimensions of our specimens: d = (1.2)1.5–1.8 (2) mm, cc = 1.5–2 mm, s = 12–14 (6+6+s3).

Comparison: Oppenheim (1912) mentioned somewhat larger corallites (d = ca 2 mm), but if we measure diameter of corallites on his figures it also shows 1.5 mm. The exact value of the diameter of corallite depends on the degree of wall recrystalzation. There is no real columella, but recrystalized and thickened axial endings of septa form some kind of axial structure.

The similar genus *Parastraeopora* Eliašova (1974) differs in being cerioid, and *Pseudastraeopora* (Russo, 1979) in having "septocostae and reticulated coenenchim".

Previously indicated occurrences: Probable Paleocene in Rosići (northern Bosnia).

New occurrences on the Adriatic carbonate platform: Sopada: Sop-7 (11133, 11134, 11136, 11137, 57734, 57735, 57736). Zone SBZ4.

Fam.: Dendrophylliidae Gray, 1847

Genus: *Dendrophyllia* de Blainville, 1830

***Dendrophyllia candelabrum* Hennig ,1899**
Pl. 4, figs 1–2

1899 *Dendrophyllia candelabrum* n. sp. Hennig: n. v.
1972 *Dendrophyllia candelabrum* Hennig. Floris: 92–93, Pl. 6, figs 35–37, Pl. 7, figs 2, 5, 6, (synonymy).
1988 *Dendrophyllia candelabrum* Hennig. Drobne *et al.*: 185, Pl. 29, figs 4–6.
1990 *Dendrophyllia candelabrum* Hennig. Bernecker & Weidklich: 113, Pl. 26, figs 1–2, Pl. 29, figs 1–4, Pl. 30, figs 1–2.

Description and distribution were given by Floris (1972) and also by Turnšek in Drobne *et al.* (1988, 185).

Previously indicated occurrences: Danian of Denmark, Lower Danian of Greenland, Lower and Middle Danian of Sweden, Paleocene of Medvednica.

Occurrences on the Adriatic carbonate platform: Dolenja vas: DvW-1, -7, -8, -15, -16, -18, -21, -22, -23, -28, -K/5986, DvE-31, -32, -37, -38. Zones SBZ1, SBZ2, SBZ3, SBZ4.

***Dendrophyllia dendrophylloides* Milne Edwards & Haime, 1850**
Pl. 4, fig. 5

1850 *Dendrophyllia dendrophylloides* M. Edwards & Haime: 36–37, Tab. 6, figs 2, 2a–c.
1975 *Dendrophyllia dendrophylloides* M. Edw. & Haime. Kuzmicheva: 28, Tab. 4, figs 2–3.
1988 *Dendrophyllia dendrophylloides* M. Edw. & Haime. Drobne *et al.*: 185–186, Pl. 30, figs 1–2.

Description and distribution were given by Kuzmicheva (1972) and also by Turnšek in Drobne *et al.* 1988.

Previously indicated occurrences: Lower Eocene of England, Montian-Thanetian of Luzanovka in Ukraine, Paleocene of Middle Volga region.

Occurrences on the Adriatic carbonate platform: Dolenja vas: DvW-7, -8, DvE-32, -37. (Not DvW-28 as mentioned in Drobne *et al.*, 1988. 186, text-fig. 16). Zone SBZ1.

***Dendrophyllia* sp.**
Pl. 4, fig. 4

In almost all investigated localities individual corallites were found which, in their structure, resemble the genus *Dendrophyllia*. The whole colonies are not known, so they are designated as *Dendrophyllia* sp.

Occurrences on the Adriatic carbonate platform: Dolenja vas: DvW-28; Sopada: Sop-5 (11141), Sop-8/2 (10367), Sop-12 (11120, 11121), Sop-13 (11112, 11113), Sop-14 (11105), Sop-16 (11068), Sop-18 (11062), Sop-28 (10881); Hrpelje–Kozina: Hrp-23 (11343), Hrp-25 (11333), Hrp-40 (11288, 11890); Breg: Br-IV/10, -IV/16, -V/30; Golež: Go-6, Go-10); ?Padriciano: Pad-G12. Zones SBZ2, SBZ3, SBZ4.

Fam.: Oculinidae Gray, 1847

Genus: *Oculina* Lamarck, 1816

***Oculina conferta* Milne Edwards & Haime, 1850**
Pl. 5, figs 1–4

1850 *Oculina conferta*. Milne Edwards & Haime: 27–28, Tab. 2, figs 2, 2a–b.

Description: Dendroid-phaceloid colony has cylindrical corallites, wich bud under an almost right angle. Corallites are in some places set very closely but in some become free and long after budding. Septa are compact, they are developed in irregular septal cycles, with strong lateral granulae. Wall is some kind of septotheca, but it has no costae outwards. Axial ends of septa thicken or join with pali to produce a papillose columella. Endotheca is consisting of thin rare dissepiments. Microstructure is very poorly preserved.

Dimensions of Adriatic specimens: d = 1.5–2 mm, s = ca 24.

Comparison: Our specimens show the characteristics of the species as originally described by all their structures, all patterns and even in their dimensions. Only adult corallites can be something longer. In dimensions they are also similar to *O. oziris* Wanner (1902, 100, Pl. 14, figs 8–9) from the Paleocene of Libya, but differ by having irregular septal cycles.

Previously indicated occurrences: London Clay at Bracklesham Bay, England, Lower Eocene.

New occurrences on the Adriatic carbonate platform: Sopada: Sop-8 (10334–10343), Sop-8/H (11239–11256), ?Sop-6/0 (10460, 10464); Hrpelje–Kozina: Hrp-23. Zone SBZ4.

Subordo: Meandriina Alloiteau, 1952
Fam.: Phyllocoeniidae Alloiteau, 1952

Genus: *Plocophyllia* Reuss, 1868

***Plocophyllia carstica* Turnšek, 1988**
Pl. 6, fig. 1

1988 *Plocophyllia carstica* n. sp. Drobne *et al.*: 187, Pl. 31, figs 1–3, Pl. 32, figs 1–3.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-23B (981a, b, c, d). Zone SBZ2.

Fam.: Dendrogyridae Alloiteau, 1952

Genus: *Orbignygyra* Alloiteau, 1952

***Orbignygyra* sp.**
Pl. 6, figs 2–3

Description: A fragment of the meandroid colony shows corallites in a single meandroide serie. Septa are compact, costate, differentiated in 3–4 cycles. They are axially thickened, and laterally granulated. The type of wall is paraseptotheca. Endotheca consists of thin tabular and vesicular dissepiments placed in thecal region only. The columella is thin, lamellar, continuous, sometimes joining with the axial prolongations of septa. Microstructure in septa and wall is recrystalized.

Dimensions: d of series = 4 mm, s = 6–7/2 mm (at wall).

Comparison: In the Eocene of Mexico the very similar coral *Placosmilia copoyensis* was found (Frost & Langenheim, 1974: 240–242, Pl. 83, figs 1–7). Our specimen could be compared with one of the meandroid parts of it, where they would fit in structure and dimensions. Nevertheless, the Mexican coral is more angular. Because of the presence of several meanders, the latter could perhaps be ascribed to *Orbignygyra*. Very similar is also the Upper Cretaceous *Orbignygyra daedalea* (Reuss) found also in Slovenia (Turnšek, 1994, 12, Pl. 6, figs 1–3) which differs from Paleocene form by loosely spaced skeletal elements (4/2 mm) and much shorter septa of the third cycle.

Occurrence on the Adriatic carbonate platform: Padriciano: (Pad-G/11). Zone SBZ4.

Fam.: Rhizangiidae d'Orbigny, 1851

Genus: *Rhizangia* Milne Edwards & Haime, 1848

According to Beauvais (1982) *Rhizangia* was attributed to the Fungiina (Turnšek & Drobne *et al.*, 1988). Nevertheless, its compact septa and synapticulotheca as well as its lateral granulations without pennulae indicate a closer relationship to the Meandriina.

***Rhizangia* sp.**
Pl. 7, fig. 1

Description was given by Turnšek in Drobne *et al.* (1988, 188, Pl. 33, fig. 5).

We can compare our specimen with *Rhizangia* sp. described by Frost & Langenheim (1974: 285–287, Pl. 109, figs 1–7) from the Eocene beds of Mexico. Our specimen differs from the latter by its somewhat larger corallites (our specimen: d = 3–4 mm, s = 6+6+s; Mexican material: d = 2–3 mm, s = 12–24). *Rhizangia brevissima* Deshayes, 1834, described in Oppenheim, 1901 (224–225, Taf. 19, fig. 8) and 1912 (116–117, Taf. 13, figs 8–8a (not Taf. 14, fig. 1) is even larger in size and exhibits regularly spaced corallites.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-9 (979a, 4654). Zone SBZ1.

***Rhizangia padricensis* n. sp. /Turnšek/**
Pl. 7, figs 2–4

Name: after its type locality Padriciano (Northern Italy).

Holotypus: Pad-28 (11008).

Age: Upper Thanetian

Diagnosis: *Rhizangia* with cylindrical corallites of irregular hexameral septa, diameter of inner calice = 1.5– 2 mm, diameter including wall = 1.5–2.5 mm, s = 24 (6+6+12).

Description: Colony is reptoid with the phaceloid corallites connected by the stolonal offsets. Septa are compact, arranged in an irregular hexameral system. First cycle is thick, second and third cycles thinner and shorter. Lateral ornamentations are consisting of sharp granulae. Columella is very variable: different, parietal if built by prolongations of septa, lamellar if two oposite septa touch, lacking in some sections, taking a papillose appearance when axial structure is built of pali. the pali may appear in front of every septum or fuse with the septa to thickened axial endings. The wall is represented by a septotheca or synapticulotheca, in some places by an epitheca. Endotheca is consisting of rare tabulate dissepiments. The stolonal offsets exhibit a vermiculate costate and tabulate structure. Budding is extracalicinal lateral or circumoral with larger mother corallite and some smaller daughter corallites around. Microstructure is very poorly preserved: in transverse sections of the wall, only some kind of irregularly placed, middle trabeculae, can be observed; in transverse section of the septa short median lines occur sometimes.

Comparison: The Upper Cretaceous species of *Rhizangia* were revised by Beauvais (1982 II, 213–218). All are larger than ours (d = ca 10 mm, s = 48–100). Also the Eocene *Rhizangia brevissima* Deshayes, 1834 (see Oppenheim, 1901, 1912) is larger (d = 4–5 mm, s = 48).

New occurrences on the Adriatic carbonate platform: Padriciano: Pad-28 (11006, 11007, 11008), Hrpelje–Kozina: Hrp-16 (11366). Zone SBZ4; Dolenja vas: DvW-29, -5676, Golež: Go-9. Zone upper part of SBZ3.

Subordo: Fungiina Verrill, 1865
Fam.: Siderastraeidae Vaughan & Wells, 1943

Genus: *Siderastraea* Blainville, 1843

***Siderastraea* sp.**

The only thamnasteriid fragment of an encrusting colony (with d = 2–3 mm, s = 3–4 cycles) was described by Turnšek in Drobne *et al.* (1988, 187).

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvE-32/1). Zone SBZ1.

Genus: *Pironastraea* d'Achiardi, 1875

***Pironastraea discoides* d'Achiardi, 1875**
Pl. 8, figs 1–2

1875 *Pironastraea discoides* n. sp. d'Achiardi: 197–198, Pl. 18, figs 2–3.
1956 *Pironastraea discoidea* d'Ach. Wells: F385, fig. 276, 3.
1957 *Pironastraea discoidea* d'Ach. Alloiteau: 324.

Description: Circumoral thamnasteriid colony has porous, confluent, laterally granulated septa. Synapticulae are common, columella is not distinct, appearing as composed of a single separate pillae. Microstructure is very poorly preserved.

Dimensions: d in series ca 2 mm, d between series ca 2.5 mm, s = 10–11/2 mm (d'Achiardi: 30/5)

Comparison: In dimensions (d = 1–3 mm) *Cyathoseris parvistella* Oppenheim, 1912 (110–111, Taf. 13, fig. 3) is similar, however it differs from our species by its irregular, not circumoral series.

Previously indicated occurrences: Eocene (Lutetian) of Frioul, Italia.

New occurrence on the Adriatic carbonate platform: Padriciano: Pad-11/K-1 (11001). Zone SBZ4.

Fam.: Actinacididae Vaughan & Wells, 1943

Genus: *Actinacis* d'Orbigny, 1849

***Actinacis cognata* Oppenheim, 1901**
Pl. 8, figs 3–4

1901 *Actinacis cognata* n. sp. Oppenheim: 182, Taf. 12, fig. 7, Taf. 14, fig. 5.
1988 *Actinacis cognata* Oppenheim. Drobne *et al.*, 188, Pl. 33, figs 2–4.
1995 *Actinacis cognata* Oppenheim. Boselinni & Russo: 218–220, Pl. 1, figs 1–4, text-figs 1–2 (with complete synonymy).
1996 *Actinacis cognata* Oppenheim. Schuster, 73, Pl. 14, figs 8–9.

A modern description and revision were made by Bosellini & Russo (1995).

The dimensions of our specimens (d = 1.2–1.3 mm, cc = 1.3–2.5 mm, s = 20–24) fit with their descriptions.

Previously indicated occurrences: Paleocene of Medvednica in Croatia, Luzanovka in Ukraina, Majevica in Bosnia, Egypt, Eocene in Italy, Czech. R., Hungary etc. (see also: Bosellini & Russo, 1995).

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-23). Zone SBZ2.

Fam.: Poritidae Gray, 1842

Genus: *Goniopora* Blainville, 1830

***Goniopora elegans* (Leymerie, 1846)**
Pl. 8, fig. 5

1846 *Porites elegans*. Leymerie: n. v.
1875 *Stephanocoenia elegans* Leymerie. d'Achiardi: 184.
1912 *Goniaraea elegans* Leymerie. Oppenheim: 98–100, Taf. 12, figs 2–3, text-fig. 2.
1975 *Goniopora elegans* (Leymerie). Kuzmicheva: 26–27, Tab. 3, fig. 6.
1988 *Goniopora elegans* (Leymerie). Drobne *et al.*: 188–189, Pl. 34, figs 1–3.
1988 *Goniopora* sp. Drobne *et al.*: 189, Pl. 34, fig. 4.
1996 *Goniopora elegans* (Leymerie). Schuster, 73–74, Pl. 15, fig. 4.

Description, revision and distribution were given by Kuzmicheva (1975) and Turnšek in Drobne *et al.*, 1988.

Dimensions of our specimens: d = 2 mm, cc = 2–2.5 mm, s = ca 20 (11–13/2 mm).

Previously indicated occurrences: Paleocene of Rosići on Majevica in northern Bosnia, Montian-Thanetian of Luzanovka in Ukraine, Early Eocene of Egypt, Lower and Middle Eocene of Corbières in southern France.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-18, -20, -22. Zone SBZ2.

***Goniopora* sp.**
Pl. 8, figs 6,7

One specimen is very similar to *G. elegans*, but has a scarser skeleton.

Dimensions: d = (1.5) 2 mm, s = ca 16 (7–8/2 mm).

Because of its poor preservation it is not specifically determined.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-29). Upper part of the zone SBZ3.

***Goniopora hrpeljensis* n. sp. /Turnšek/**
Pl. 9, figs 1–4

Name: after the locality Hrpelje

Holotypus: Hr. 15 (thin sections: 11373, 11374, 11375)

Locus typicus: At the road Hrpelje–Kozina

Age: Upper Thanetian

Diagnosis: *Goniopora* with very small corallites of diameter 1–1.3 mm, cc = ca 2 mm, s = 20–24, density of vertical elements 15–18/2 mm.

Description: large bulbous or irregularly encrusting colonies have plocoid corallites. Porous septa are developed in 2–3 irregular cycles. They bear lateral pennulae. Columella is trabecular. Endotheca is consisting of synapticulae and rare thin dissepiments. The wall is incomplete synapticulotheca. Between corallites there is wide porous spongy peritheca. Microstructure is very poorly preserved. Transverse sections of septa reveal irregularly dispersed middle or large trabeculae (ca 50–100 mm).

Comparison: The new species has the smallest corallites within this genus. Their diameter is similar to the one observed in *G. copoyensis* (Frost & Langenheim, 1974, 238, Pl. 81, figs 5–6), but our specimens have much denser vertical skeletal elements. In *G. copoyensis* the density of the vertical elements is according to the picture ca 10/2 mm. In its description it is even mentioned, that the "vertical rods" were spaced 0.3–0.5 mm apart.

New occurrences on the Adriatic carbonate platform: Hrpelje–Kozina: Hrp-15 (11373, 11374, 11375) = holotype, Hrp-16 (11368, 11369), Hrp-23 (11345); Sopada: Sop-5/3 (10307), Sop-6/12 (10411, 10412, 10413), Sop-6 (57732), Sop-7/5 (57737); Breg: Br-IV/9, Br-IV/11, Br-IV/12, Br-IV/17); Padriciano: Pad-G-11, Pad-11/K (11000). All in zone SBZ4.

Genus: *Litharaea* Milne Edwards & Haime, 1851

***Litharaea subepithecata* Oppenheim, 1912**
Pl. 10. figs 1–2

1912 *Litharaea subepithecata* n. sp. Oppenheim: 103–104, Taf. 11, figs 7–8, Taf. 12, figs 12–12a.
1988 *Litharaeopsis subepithecata* (Oppenheim). Drobne *et al.*: 189–190, Pl. 35, figs 1–4.

Description was given by Turnšek & Drobne *et al.*, 1988. Then it was put by mistake into the genus *Litharaeopsis* Beauvais, 1982. Additional studies of more material show that there is no reason to exclude this species from the genus *Litharaea*, as the differences in width of the peritheca and the number of dissepiments may vary to a considerable extent.

Previous indicated occurrences: Paleocene of Rosići on Majevica in northern Bosnia.

Occurrence on the Adriatic carbonate platform: Dolenja vas: DvW-24. Uppermost part of the zone SBZ2.

***Litharaea websteri* (Bowerbank, 1840)**
Pl. 10, figs 3–4

1840 *Astraea websteri*. Bowerbank: n. v.
1850 *Litharaea Websteri*. Milne Edwards & Haime: 38–39, Tab. 7, figs 1–1c.
1975 *Goniopora websteri* (Bowerbank). Kuzmicheva: 26, Tab. 3, fig. 5.

A modern description was worked out by Kuzmicheva (1975). Our specimens are massive nodules with subplocoid corallites. Septa are very porous and irregularly developed in 2–3 cycles, laterally pennulated. Peritheca and wall are synapticulothecate. Columella is spongy. Microstructure is poorly preserved, but apparently characterized by large trabeculae. Often also a median line can be observed.

Dimensions: d = ca 4–5, s = ca 24+s (= 6–7/2 mm).

Remarks: *L. websteri* differs from *L. subepithecata* Oppenheim by its somewhat denser skeletal elements. Because of loosely spaced skeletal elements I attribute this species into *Litharaea* instead of *Goniopora*.

Previously indicated occurrences: Lower Eocene of England, Paleocene of the Middle Volga region.

New occurrence on the Adriatic carbonate platform: Hrpelje–Kozina: Hrp-23 (11344); Padriciano: Pad-GK, Pad-11/K (11004). Both in zone SBZ4.

Fam.: ?Thamnasteriidae Vaughan & Wells, 1943

Genus: *Mesomorpha* Pratz, 1883

***Mesomorpha* sp.**
Pl. 10. figs 5–6

Description: One single specimen is represented by a fragment having the characteristics of the genus. It looks like a piece of an encrusting, massive colony with subthamnasterid corallites, and compact, confluent septa. The synapticulae are very common, especially in the peripheral part of corallites. Peritheca is recrystalized. Columella looks styliform. Microstructure is not preserved.

Dimensions: d = 0.8–1 mm, s = 8–10, (in centrum= 7), density of costae in peripheral part = 5/1 mm.

Comparison and remarks: Our specimen is very similar to *Mesomorpha andrusovi* (Kuzmicheva, 1975, 24, Tab. 2, fig. 10, Tab. 3, fig. 1), nevertheless it is too poorly preserved for species determination. The revision and comparison of the genus *Mesomorpha* was worked out by Alloiteau (1957) and others but its systematic position is questionable and should be discused.

New occurrence on the Adriatic carbonate platform: Breg: Br-V/30. Zone SBZ4.

THE SUCCESSION OF CORALS WITHIN THE INVESTIGATED AREA

The stratigraphic zonation of the localities where coral specimens have been collected on the northern Adriatic platform is based on other fossils, mainly foraminifers and other stratigraphic arguments summarized in the following table:

		Paleocene			
		SBZ1	SBZ2	SBZ3	SBZ4
Dolenja vas W	(DvW)	1–16	18–24	25–30	
Dolenja vas E	(DvE)	38–31			
Sopada	(Sop)	–	28–23	22–9	8–3
Hrpelje–Kozina	(Hrp)	–	–	–	15–23
Breg	(Br)	–	–	–	IV/4–17
Golež	(Go)	–	–	6–10	–
Padriciano	(Pad)	–	–	–	11,12,28
		Dan/Selandian		Thanetian	

Remarks: Stages "Danian/Selandian and Thanetian" can be compared with shallow benthic zones SBZ1, SBZ2, SBZ3, SBZ4 after Serra-Kiel *et al.*, in print.

The earliest Paleocene corals on the northern Adriatic platform were found in the Dolenja vas section, beds 1–16 and 38–31 (Drobne & al., 1988) interpreted as of the SBZ1 zone. In this layers branching phaceloid and dendroid forms of the species *Dendrophyllia candelabrum* and *D. dendrophylloides* prevail. Small specimens or fragments of *Haimesastraea peruviana*, *Rhizangia* sp. and *Siderastraea* sp. are associated to the *Dendrophyllia*. Both *Dendrophyllia* species and many broken branches of unidentified *Dendrophyllia* sp. were found also in younger horizons.

The development of massive plocoid and thamnasterid corals in Dolenja vas started in levels 18–24 attributed to the SBZ2 zone. These were identified as *Actinacis cognata*, *Goniopora elegans*, *Litharaea subepithecata*. In the horizon 23b we found also the phaceloid form *Plocophyllia carstica*.

In the beds 25–30 in the Dolenja vas section the species *Stylocoenia neutra*, *Rhizangia padricensis* and *Goniopora* sp. were found. Theese beds are assigned to the SBZ3 zone.

In the other investigated localities (Sopada, Breg, Golež, Hrpelje and Padriciano) the corals emerged later than in Dolenja vas. In Sopada we found individual fragments of *Dendrophyllia* sp. in SBZ2 zone, forms of the species *Stylocoenia neutra* are known from the SBZ3 zone. To the same SBZ3 zone belongs the locality Golež with *Rhizangia padricensis* and *Dendrophyllia* sp. The majority of massive corals in all these localities appear in the SBZ4 zone: *Pironastraea discoides, Astraeopora pseudopanicea, Astrocoenia bistellata, Litharaea websteri, Orbignygyra* sp., *Oculina conferta*, particularly abundant is *Goniopora hrpeljensis*.

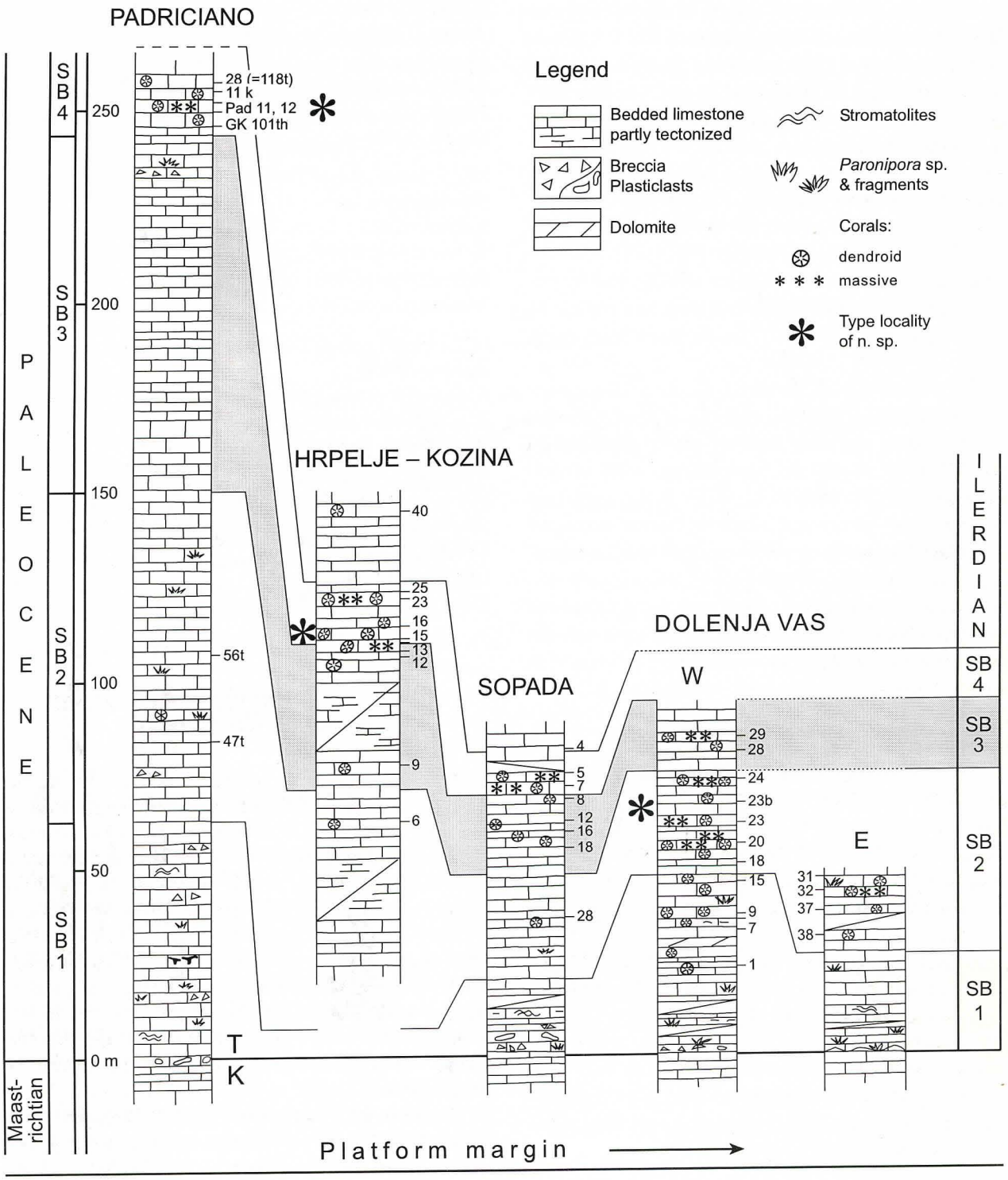

Fig. 3: Geologic columns with display of beds containing corals. Asterisk (*) marks the type horizon of the new species Goniopora hrpeljensis *n. sp.,* Rhizangia padricensis *n. sp. and* Placophyllia carstica *Turnšek, 1988. The thickness of the beds in the sections on the platform margin is considerably lower as in its interior part. There, the thickness of the sediments is particularly high during the Danian, owing to lagoonal-lacustrine depositional conditions. (Drobne* et al., *1996, Pugliese* et al., *1995, Brazzati* et al., *1996).*

From the paleoecological point of view it can be indicated that the oldest Paleocene corals in the Dolenja vas, located in the northernmost margin of the Adriatic platform are the first small coral specimens which appeared after the K/T crysis. They are mainly dendroid-phaceloid forms and cannot be considered as reef builders. They can be compared with group II of non-reefal az-like (azooxantellate) corals (see Rosen & Turnšek, 1989; Macleod *et al.*, 1997). Some of polyp individuals found their satisfactory place for surviving. The first patch reef building colonial corals settled the northern Adriatic platform in the Uppermost Danian (?Selandian) and in Thanetian. The phaceloid corals are accompanied by prevailing massive forms (*Actinacis* and others), and can be compared with group I of z-like (zooxantellate) corals (MacLeod, 1997). It seems that reef growth mooved from the north toward the south, i.e. from Dolenja vas toward Sopada, and further to Padriciano, Hrpelje–Kozina, Golež to Breg, and most probably can be explained by the following up the sea transgression wich as well widened from the north to the south. In the most convinient phases of the sea water oscilations connected with other favourable environments (sea level, temperature, nutrient supply, sunshine energy, water energy etc.) the corals for short periods found their living places and settled the local ecological nishes. By the same way the short term growth of patch reefs during Paleocene in middle Italy was explained by Moussavian & Vecsei (1995), as "controlled primarily by fluctuations of relative sea-level" within the eustatic cycles.

Very interesting is the variety of coral species in investigated localities. There are 15 of total 22 taxa limited to the one locality only, 4 taxa were found in two localities, one species in three, and two species in four localities. The most widespread are corals of the genera *Dendrophyllia*, *Rhizangia* and *Goniopora*. These types can be found in all so far known localities in Adriatic platform, but also in the wide area of Paleogene Tethys. The other species in Paleocene are rare and restricted to single localities. Such kind of local restriction can also be explained by the short term convinient environments which enabled the expansion of several individual colonies or species but lasted too short time to enable them to grow and multiply. Very soon corals were superseeded by less sensitive organisms.

Paleocene corals on the northern Adriatic platform appear as follows:

SBZ1 (Danian)
Haimesastraea peruviana Vaughan, 1900
Dendrophyllia dendrophylloides Milne Edwards & Haime, 1850 *Rhizangia* sp.
Siderastraea sp.
Dendrophyllia candelabrum Hennig, 1899

SBZ2 (Selandian/upper part of Danian)
Dendrophyllia candelabrum Hennig, 1899
Stylocoenia montium (Oppenheim, 1912)
Actinacis cognata Oppenheim, 1901
Goniopora elegans (Leymerie, 1846)
Litharaea subepithecata Oppenheim, 1912
Placophyllia carstica Turnšek, 1988
Dendrophyllia sp.

SBZ3 (lower part of Thanetian)
Dendrophyllia sp.
Goniopora sp.
Stylocoenia neutra Barta-Calmus, 1973
Rhizangia padricensis n. sp.
Mesomorpha sp.

SBZ4 (upper part of Thanetian)
Dendrophyllia sp.
Stylocoenia neutra Barta-Calmus, 1973
Rhizangia padricensis n. sp.
Pironastraea discoides d'Achiardi, 1875
Astraeopora pseudopanicea Oppenheim, 1912
Astrocoenia bistellata (Cattulo, 1856)
Oculina conferta Milne Edwards & Haime, 1850
Orbignygyra sp.
Goniopora hrpeljensis n. sp.
Litharaea websteri (Bowerbank, 1840)

WORLDWIDE DISTRIBUTION OF THE CORALS DESCRIBED

The corals from the investigated localities on the Adriatic carbonate platform have a world-wide distribution. The same and similar species are known from the Paleocene in Scandinavia (including Denmark, Sweden and Greenland) (Floris, 1972; Bernecker & Weidlich, 1990), from Pyrenees (Alloiteau & Tissier, 1958), Central Italy (Vecsei & Moussavian, 1997), Croatia (Polšak, 1985; Babić & Zupanič, 1981), North Africa (Wanner, 1902; Schuster, 1996), from Ukraina and Volga region (Kuzmicheva, 1975), and even Alabama (Bryan, 1991). Most probably, Oppenheim's (1912) so-called Eocene locality in Majevica in northern Bosnia is also of Paleocene age (Bulić *et al.*, 1978; Radoičić, 1991). Similar are genera *Oculina* and *?Cladocora* from Antarctica (Filkorn, 1994). Many other localities of Paleocene reefs are known from Europe, northern Africa, the Middle East, America (see compilations of Bryan, 1991; Schuster, 1996) where the corals have not been identified yet.

Some of the species found in the Paleocene strata of the Adriatic platform are also known from the Eocene of northern Italy, France, England, Czech R., Carpathians, Spain, Mexico and elsewhere (see: Barta Calmus, 1973; Frost & Langenheim, 1974; Eliašova, 1974; Drobne *et al.*, 1988, Bosellini & Russo, 1995; Schuster, 1996).

List of the described coral species with their Karst area and world stratigraphic zonation:

Species	Locality	Stratigraphic distribution						
		Adriatic platform Paleocene (Dan/Seland Thanet)				world		
		SBZ1	SBZ2	SBZ3	SBZ4	D	T	E
Dendrophyllia dendrophylloides	DvE-W	SBZ1				D	T	E
Rhizangia sp.	DvW	SBZ1				–		
Siderastraea sp,	DvE	SBZ1				–		
Haimesastraea peruviana	DvW	SBZ1				D	T	E
Dendrophyllia candelabrum	DvE-W	SBZ1	SBZ2			D		
Stylocoenia montium	DvW		SBZ2			D	T	
Actinacis cognata	DvW		SBZ2			D	T	E
Goniopora elegans	DvW		SBZ2			D	T	E
Litharaea subepithecata	DvW		SBZ2			D	T	
Plocophyllia carstica	DvW		SBZ2			D		
Dendrophyllia sp.	Pad, Sop, Hrp, Br, Go		SBZ2	SBZ3	SBZ4	–		
Goniopora sp.	DvW			SBZ3		–		
Stylocoenia neutra	DvW, Sop			SBZ3	SBZ4			E
Rhizangia padricensis	DvW, Pad, Hrp, Go			SBZ3	SBZ4		T	
Pironastraea discoides	Pad				SBZ4			E
Astraeopora pseudopanicea	Sop				SBZ4		T	
Astrocoenia bistellata	Pad				SBZ4			E
Oculina conferta	Sop, Hrp				SBZ4			E
Orbignygyra sp.	Pad				SBZ4	–		
Goniopora hrpeljensis	Hrp, Sop, Br, Pad				SBZ4		T	
Litharaea websteri	Hrp, Pad				SBZ4	D	T	E
Mesomorpha sp.	Br				SBZ4	–		

LEGEND:

Stratigraphy: Paleocene zonation (SBZ1, SBZ2, SBZ3, SBZ4) after the Shallow Benthic zones (Serra-Kiel et al., 1998).

D = Danian, T = Thanetian, E = Eocene

Localities: DvW-E = Dolenja vas West and East, Sop = Sopada, Br = Breg, Hrp = Hrpelje–Kozina, Pad = Padriciano, Go = Golež.

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REFERENCES

Achiardi, A. d', 1874: Coralli Eocenici del Friuli. — Atti Soc. Toscana Sci. Nat., 1, 70–221, Tav. 1–19, Pisa.

Alloiteau, J., 1952: Madréporaires post-paléozoiques. In: Piveteau, J. (ed.). — Traité de Paléontologie. 1, 539–782, Pl. 1–10, Paris.

Alloiteau, J. 1957: Contribution à la systématique des Madréporaires fossiles. — Centr. Nat. Rech. Sci., pp. 1–462, 286 figs, Pl. 1–20, Paris.

Alloiteau, J. & Tissier, J., 1958: Les Madréporaires du Montien des Petites Pyrénées. Comparison avec ceux du Montien de Mons. — Bull. Soc. Hist. Nat., 93, 241–293, Toulouse.

Babić, Lj., Gušić, I. & Zupanič, J., 1976: Grebenski paleocen u Baniji (središnja Hrvatska) /Paleocene reef-limestone in the region of Banija, Central Croatia/. — Geol. vjesnik, 29, 11–47, pls. 1–10, Zagreb.

Babić, Lj. & Zupanič, J., 1981: Sediments and paleogeography of the *Globotruncana calcarata* zone (Upper Cretaceous) in Banija and Kordun (Central Croatia). — Geol. vjesnik 29, 49–73, 4 figs, 1 pl, Zagreb.

Barta-Calmus, S., 1973: Révision de collections de

Madréporaires provenant du Nummulitique du Sud-Est de la France, del'Italie et de la Yougoslavie septentrionales. — Thèse de Doctorat, pp. 1–694, Pl. 1–59, Paris.

Barattolo, F., (in print): Dasycladacean green algae and microproblematica of the uppermost Cretaceous-Palaeocene in the Karts Area (NE Italy and Slovenia). — DELA-OPERA SAZU, 34, Ljubljana.

Beauvais, M., 1982: Révision systématique des Madréporaires des couches de Gosau (Crétacé supérieur, Autriche). — Trav. Lab. Univ. Curie, Tomes I–IV, 710 pp., 71 pls., Paris.

Bernecker, M. & Weidlich, O., 1990: The Danian (Paleocene) Coral Limestone of Fakse, Denmark: A model for Ancient Aphotic, Azooxanthellate Coral Mounds. — Facies, 22, 103–138, Taf. 26–33, Erlangen.

Bosellini, F.R., Russo, A., 1995: The Scleractinian genus *Actinacis*. Systematic revision and stratigraphic record of the Tertiary species with special regard to Italian occurrences. — Riv. Ital. Paleont. Stratigr., 101, 2, 215–230, Tav. 1–3, Milano.

Brazzatti, T., Caffau, M., Cozzi, A., Cucchi, F., Drobne, K., Pugliese, N., 1996: Padriciano section (Karst of Trieste, Italy). In: The role of impact processes in the geological and biological evolution of planet Earth (Eds., Drobne, K., Goričan, Š., Kotnik, B.), 189–198, Ljubljana.

Bryan, J. R., 1991: A Paleocene coral-algal-sponge reef from southwestern Alabama and the ecology of Early Tertiary reefs. — Lethaia, 24, 423–438, Oslo.

Bulić, J., Bauer, V. & Jelaska, V., 1978: O paleocenskim naslagama sjevernoistočne Majevice /Paleocene deposits of the north-eastern part of Mt. Majevica (north Bosnia, Yugoslavia)/. — Geol. vjesnik, 30, 453–458, Zagreb.

Drobne, K., 1977: Alvéolines paléogène de la Slovénie et de l' Istrie. — Mém. suiss. Paléont., 99, 132 pp, 21 pls, carte géol., Bâle.

Drobne, K., Ogorelec, B., Pleničar, M., Zucchi-Stolfa, M.L., Turnšek, D. 1988: Maastrichtian, Danian and Thanetian beds in Dolenja vas (NW Dinarides, Yugoslavia). Mikrofacies, foraminifers, rudists and corals. — Razprave SAZU, IV. razr., 29, 147–224, 16 figs, Pl. 1–35, Ljubljana.

Drobne, K., Ogorelec., B., Pavlovec, R., Pavšič, J., 1991: Golež, Danian-Cuisian. IGCP 286, Early Paleogene Benthos, 2nd meeting, Postojna, Introduction to the Paleogene SW Slovenia and Istria. — Field-trip Guidebook, 61–68, Ljubljana.

Drobne, K. & Pavlovec, R., 1991: Paleocene and Eocene beds in Slovenia and Istria. — IGCP Project 286, Early Paleogene Benthos, 2nd Meeting Postojna. 7–17, 4 figs, Ljubljana.

Drobne, K., Ogorelec, B., Dolenec, T., Marton, E. & Palinkaš, L., 1996: Biota and abiota at the K/T boundary in the Dolenja vas section, Slovenia. — Drobne, K., Goričan, Š. & Kotnik, B., (eds), Int. workshop Postojna '96: The role of impact processes in the geological and biologial evolution of planet Earth, 163–181, 12 figs, 1 pl. Ljubljana.

Eliašova, H., 1974: Hexacorallia et Octocorallia du Paléogène des Carpates externes. — Sbornik geol. ved, Paleontologie, 16, 105–156, Pl. 1–7, Praha.

Filkorn, H.F., 1994: Fossil Scleractinian Corals from James Ross Basin, Antarctica. — Antarctic Research Series, 65, I–XIII, 1–96, text-figs. 1–30, Washington.

Floris, S., 1972: Scleractinian Corals from the Upper Cretaceous and Lower Tertiary of Nûgssuaq, West Greenland. — Meddelelser Grønl. Geol. Undersøg., 100, 1–132, Pl. 1–8, København.

Frost, S.H. & Langenheim, R.L.Jr., 1974: Cenozoic Reef Biofacies. Tertiary Larger foraminifera and Scleractinian Corals from Chiapas, Mexico. — North Illionois Univ. Press, I–XIm 1–388, Pl. 1–123, De Kalb.

Jurkovšek, B., Toman, M., Ogorelec, B., Šribar, L., Drobne, K., Poljak, M. & Šribar, L., 1996: Geological map of the southern part of the Trieste–Komen plateau. Cretaceous and Paleogene carbonate rocks, 1 : 50.000. Inšt. za geologijo, geotehniko in geofiziko, 1–143, 10 figs, 23 pls, map 1 : 50.000, Ljubljana.

Kahn, M.R., 1975: The preliminary result of the biostratigraphic investigation at Ilirska Bistrica (Western Yugoslavia). — Bull. Sci., Sec. A, 20, 137–138, Zagreb.

Kahn, M.R., 1976: Biostratigraphy of the Paleogene beds of Ilirska Bistrica area. — Ph.D. Thesis, unpublished, 1–239, 17 figs, 2 tabs, 43 pls, Dpt. of Geology, Univ. of Ljubljana.

Kuzmicheva, E.I., 1975: Ranne i srednepaleogenovye korally nekotoryh rajonov Evropejskoj chasti SSSR. — Novoe o faune. Akad. nauk SSSR, pp. 15–31, Tab. 1–4, Moskva.

Milne Edwards, H. & Haime, J., 1850: A Monography of the British Fossil Corals. Corals from the Tertiary and Cretaceous formations. — Palaeontolographical Society, 3/2 (1849), 1–71, Pl. 1–11, London.

Macleod, N., Rawson, P.F., Forey, P.L., Banner, F.T., Boudagher-Fadel, M.K., Bown, P.R., Burnett, J.A., Chambers, P., Culver, S., Evans, S.E., Jeffery, C., Kaminski, M.A., Lord, A.R., Milner, A.C., Milner, A.R., Morris, N., Owen, E., Rosen, R.B., Smith, A.B., Taylor, P.D., Urquhart, E, & Young, J.R., 1997: The Cretaceous-Tertiary biotic transition. — Journal Geol. soc., 154, 265–292, London.

Morycowa, E. & RONIEWICZ, E., 1994: Scleractinian septal microstructures; taxonomical aspect. Coral Reefs, Abstracts, p. 94, Luxembourg.

Moussavian, E. & VECSEI, A., 1995: Paleocene Reef Sediments from the Maiella Carbonate Platform, Italy. — Facies, 32, 213–222, 4 figs, Pl. 42, Erlangen.

Ogorelec, B., Dolenec, T., Cucchi, F., Giacomich, R.,

Drobne, K. & Pugliese, N., 1995: Sedimentological and geochemical characteristics of carbonate rocks from the K/T boundary to Lower Eocene in the Karst Area (NW Adriatic Platform). — Vlahović, I., Velić, I. & Šparica, M. (eds), Proc. 1st Croatian Geol. Congr., 2, 415–421, 4 figs, 1 pl, Zagreb.

Oppenheim, P., 1901: Über einige alttertiäre faunen der Österr. Ungar. Monarchie. — Beiträge Paläont. Geol. Österr, Ung. Orients, 13, 145–227, Taf. 12–19, Wien–Leipzig.

Oppenheim, P., 1912: Neue Beiträge zu Eozänfauna Bosniens. — Beiträge Paläont. Geol. Österr., Ung. Orients, 25, 87–149, Taf. 10–17, Wien–Leipzig.

Polšak, A., 1985: The boundary between the Cretaceous and Tertiary in terms of the stratigraphy and sedimentology of the biolithitic complex in Mt. Medvednica (Northern Croatia). — Prir. istraž. 51, Acta geologica 15, 1–23, 13 pls, Zagreb.

Pugliese, N., Drobne, K., Barattolo, F., Caffau, M., Galvani, R., Kedves, M., Montenegro, M.E., Pirini-Radrizzani, C., Pleničar, M. and Turnšek, D., 1995: Micro- and Macrofossils from K-T Boundary through Paleocene in the Northern Adriatic Platform. — Vlahović, I., Velić, I. & Šparica, M. (eds), Proceed. 1st Croatian Geological Congr., 2, 505–513, 2 figs, Zagreb.

Radoičić, R., 1991: *Acicularia tavnae* sp. nov. and other Acetabulariaceae from the Palaeocene of eastern Majevica (NE Bosnia, dinarides). — Geologija, 34, 57–75, Pl. 1–6, Ljubljana.

Roniewicz, E. & Morycowa, E., 1993: Evolution of the Scleractinia in the light of microstructural data. — Cour. Forsch. Inst. Senckenberg, 164, 233–240, 2 figs, Frankfurt am Main.

Rosen, B.A. & Turnšek, D., 19989: Extinction patterns and biogeography of scleractinian corals across the Cretaceous/ Tertiary boundary. — Mem. Ass. Australas. Palaeontols., 8, 355–370, Brisbane.

Russo, A., 1979: Studio monografico sui Coralli dell' Eocene di Possagno (Treviso, Italia). — Mem. Accad. Naz. Sci. Lett. Art., ser. 6, 21, 1–87, Tav. 1–15, Modena.

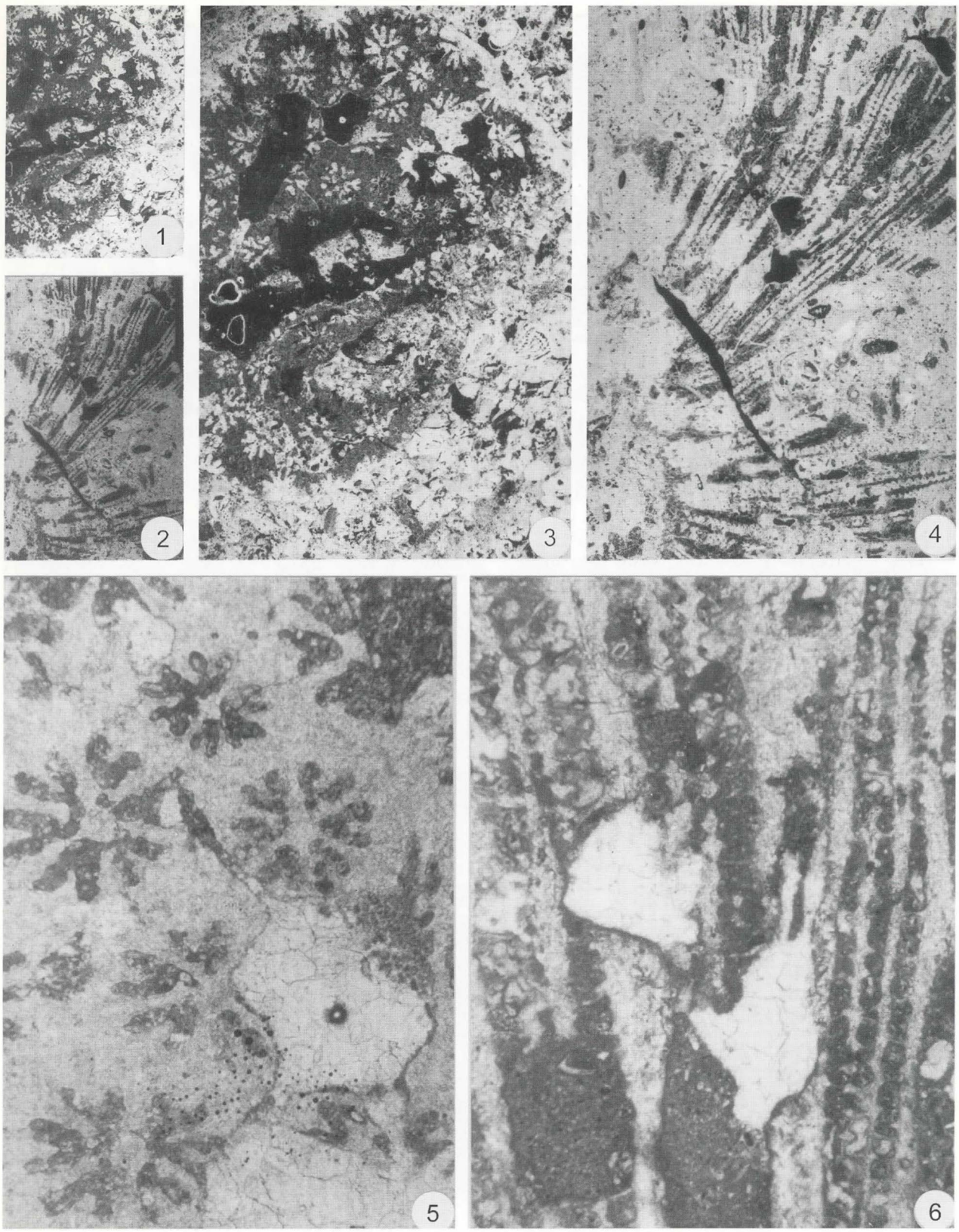
Schuster, F., 1996: Paleoecology of Paleocene and Eocene Corals from the Kharga and Farafra Oases (Western Desert, Egypt) and the Depositional History of the Paleocene Abu Tartur Carbonate Platform, Kharga Oasis. — Tübinger Geowissenschaftliche Arbeiten, A, 31, 1–96, Pl. 1–21, Tubingen.

Serra-Kiel, J., Hottinger, L., Caus, E., Drobne, K., Ferrandez, C., Jauhri, A.K., Less, G., Pavlovec, R., Pignatti, J., Samso, J.M., Schaub, H., Sirel, E., Strougo, A., Tambareau, Y., Tosquella, J. Zakrevskaya, E.: Larger Foraminiferal Biostratigraphy of the Tethyan Paleocene and Eocene. — Bull. Soc. Geol. France, 169/2, 281–299, Paris, 1998.

Vecsei, A. & Moussavian, E., 1997: Paleocene reefs on the Maiella platform margin, Italy: An example of the effects of the Cretaceous/Tertiary boundary events on reefs and carbonate platforms. — Facies 36, 123–140, 6 figs, pl. 35–37, 1 tab., Erlangen.

Wanner, J., 1902: Die Fauna der obersten weissen Kreide der Libyschen Wüste. — Palaeontographica, 30, 2, 91–106, Taf. 13–15, Stuttgart.

Wells, J.W., 1956: Scleractinia. — Treatise on Invertebrate Paleontology, Part F Coelenterata, pp. F328–F444, Figs 222–339, Lawrence, Kansas.



Figs **1–6:** *Aastrocoenia bistellata* (Catullo, 1856)
1, 3, 5: Pa-11 (11003); 2, 4, 6: Pa-28 (11005),
1–2 =× 4, 3–4 = × 8, 5–6 = × 30, U. SBZ3–SBZ4.

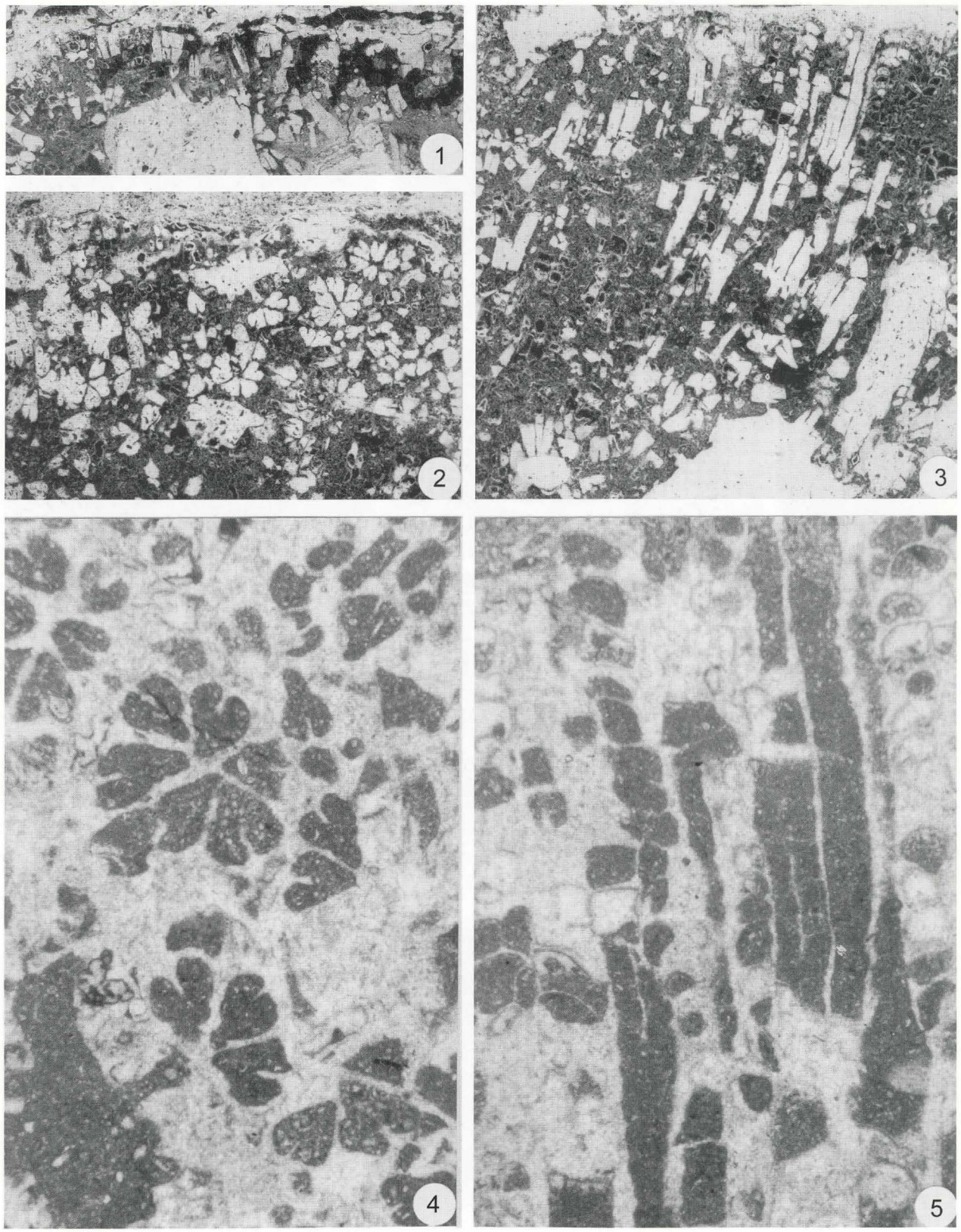


Fig. 1: *Stylocoenia montium* (Oppenheim, 1912)
DvW-22, × 6, SBZ2.

Figs 2–5: *Stylocoenia neutra* Barta Calmus, 1973
So-6 (10456); 2–3 = × 8, 4–5 = × 30, SBZ4.

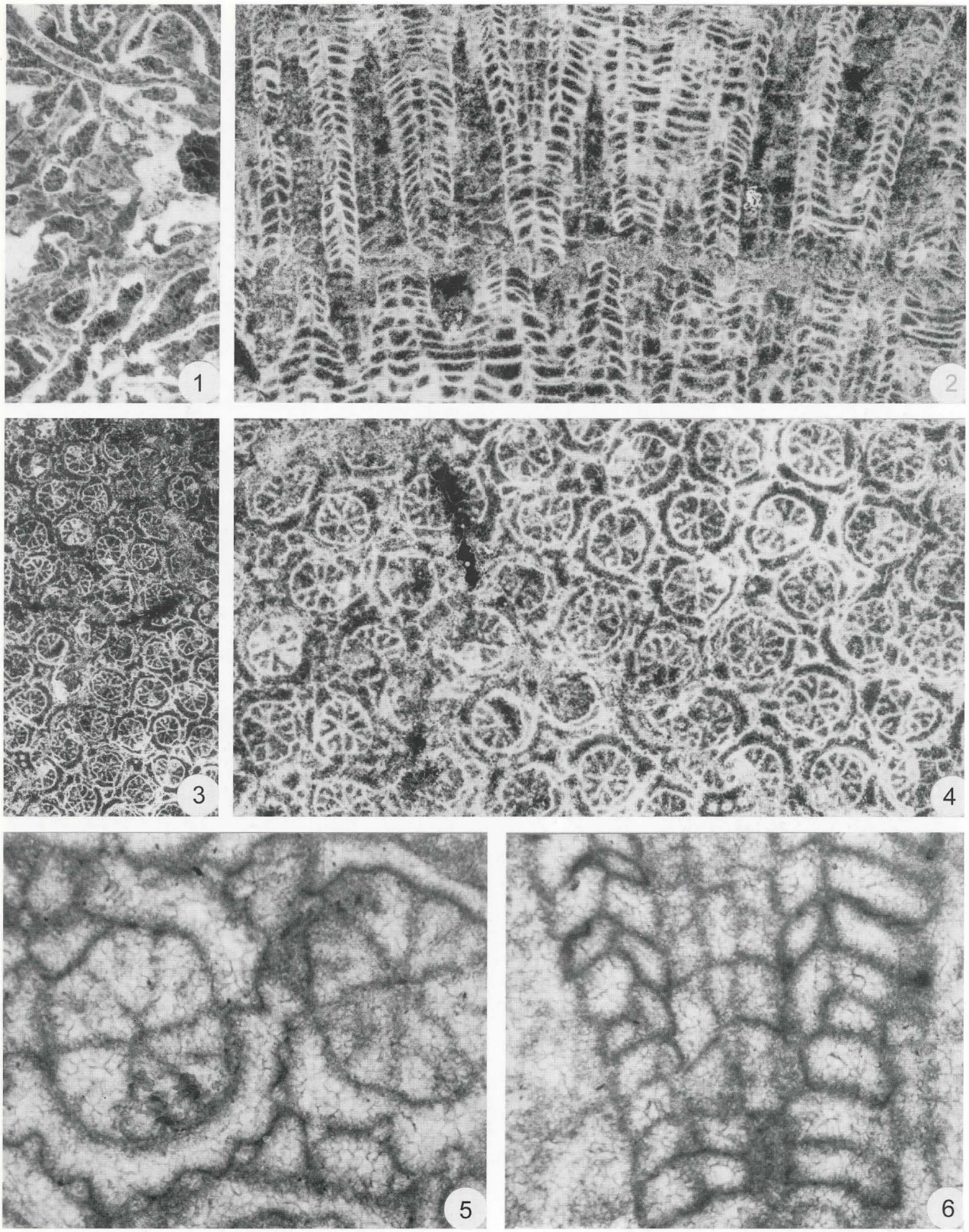
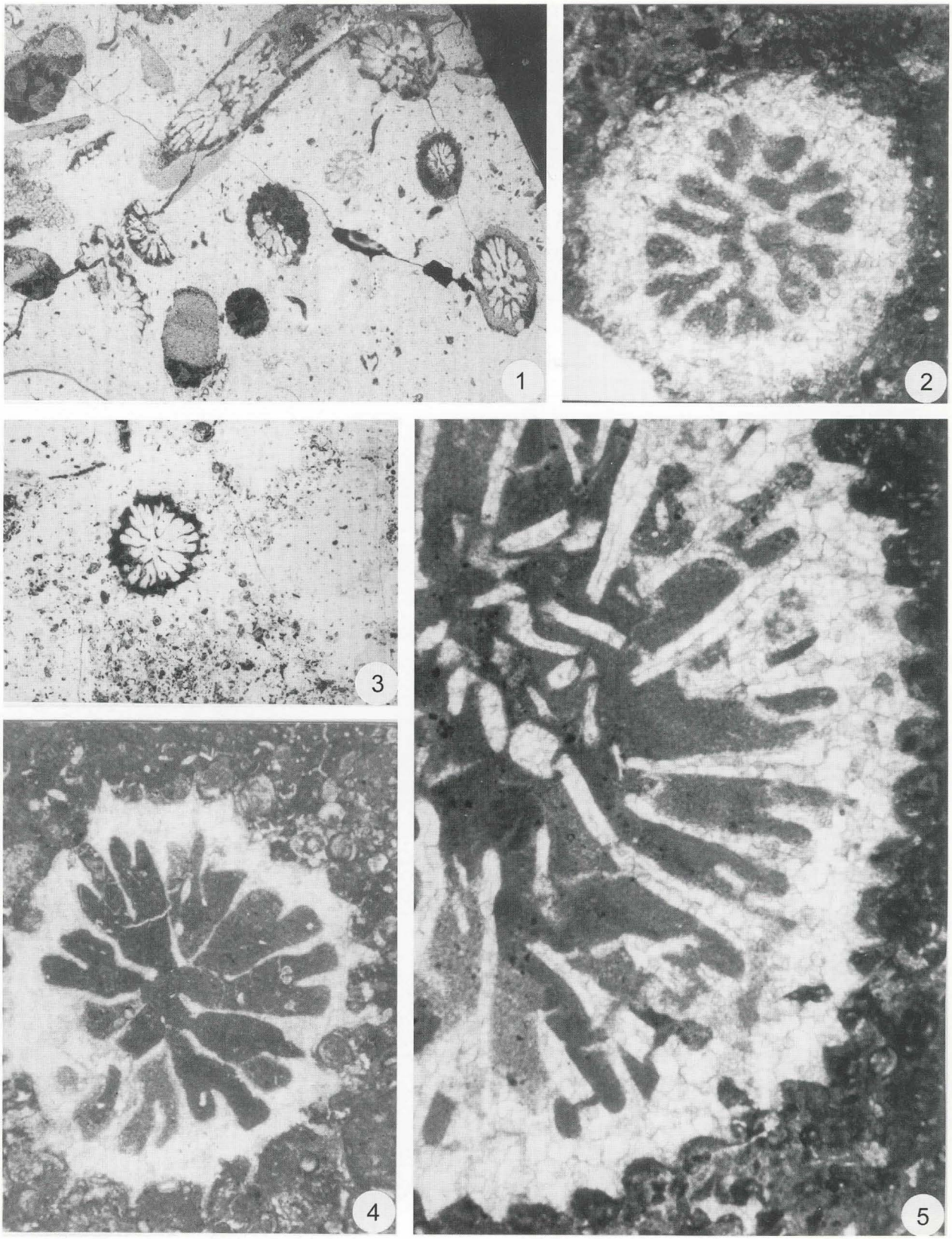


Fig. 1: *Haimesastraea peruviana* Vaughan, 1922
DvW-9, × 20, SBZ1.

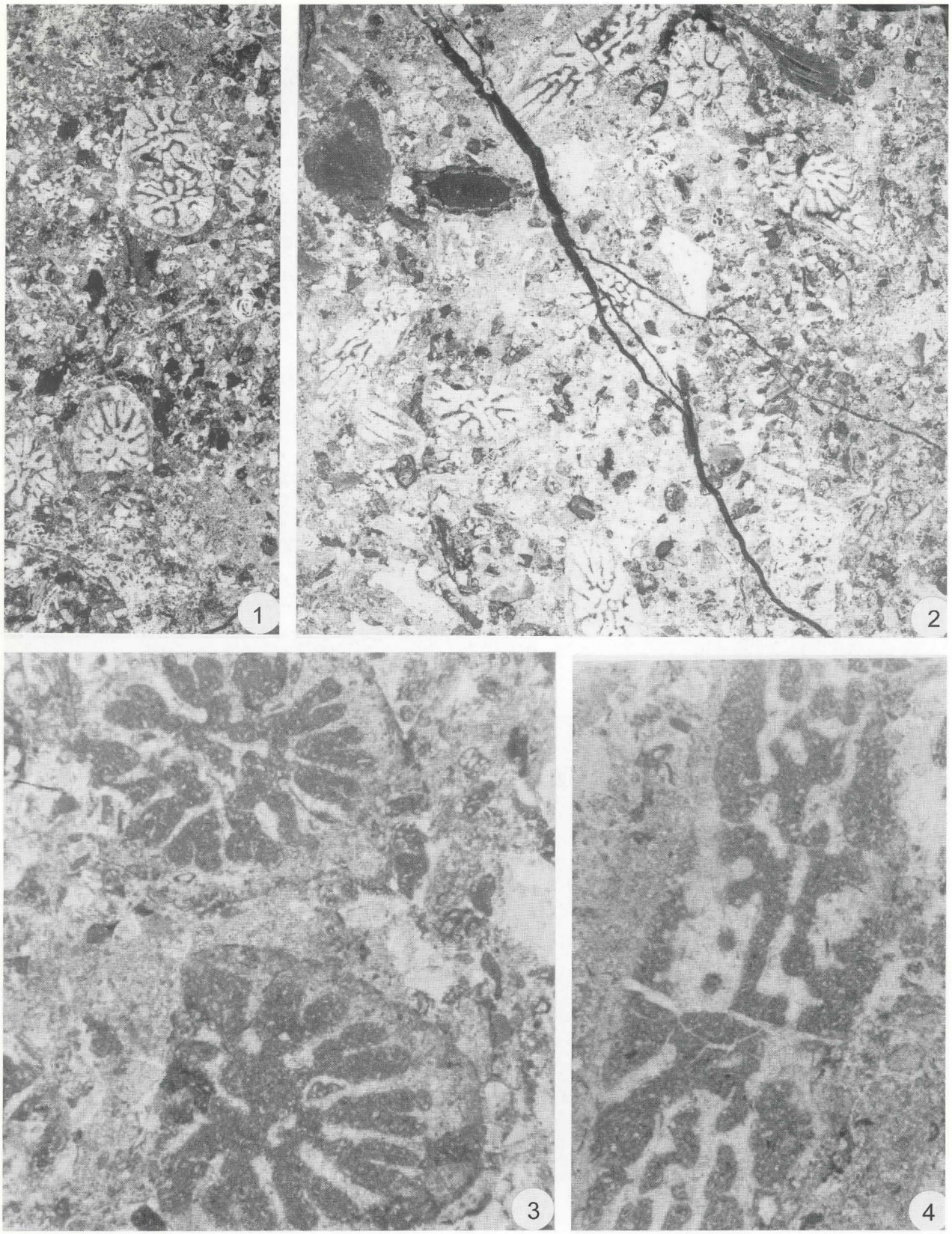
Figs 2–6: *Astraeopora pseudopanicea* Oppenheim, 1912
2, 6: So-7 (11137), 3, 4, 5: So-/ (11136);
2, 4 = × 8, 3 = × 4, 5–6 = × 30, SBZ4.



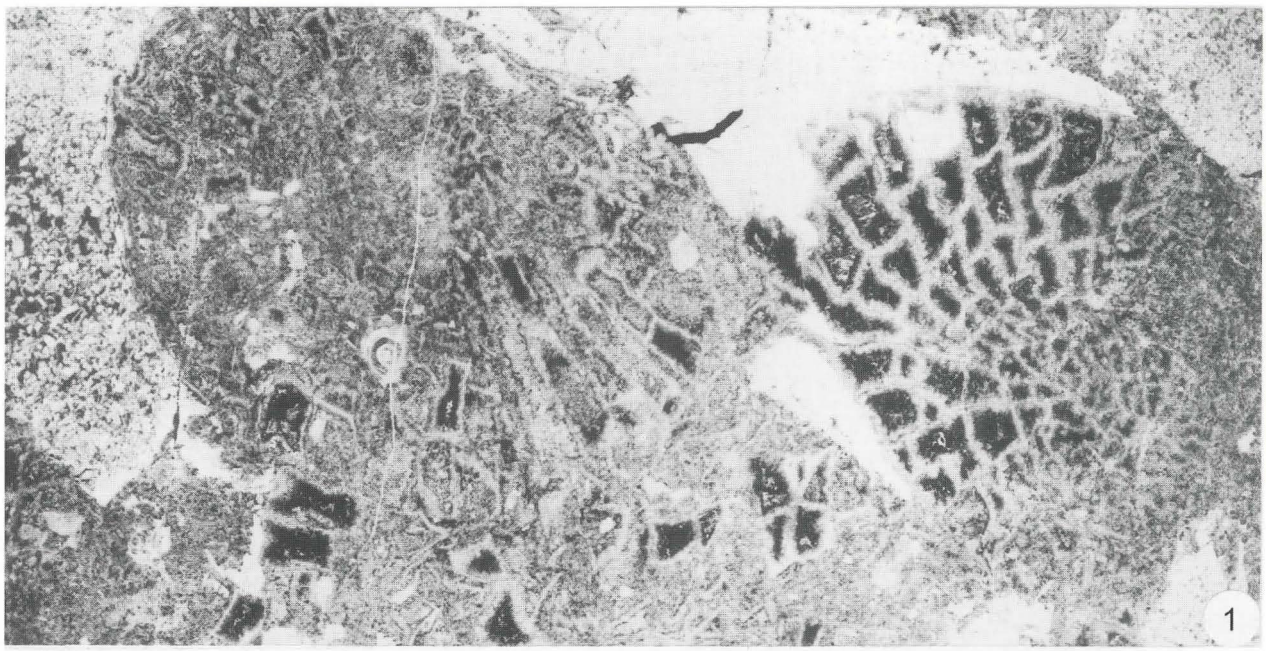
Figs 1–2: *Dendrophyllia candelabrum* Hennig, 1899
1: DvW-21 (4679), 2: DvW-7 (978a);
1 = × 6, 2 = × 30, SBZ1–SBZ2.

Figs 3–4: *Dendrophyllia* sp.
So-28 (10881); 3 = × 8, 4 = × 30, SBZ2.

Fig. 5: *Dendrophyllia dendrophylloides* M. Edw. & H., 1850
DvW-7 (978b); × 30, SBZ1.



Figs 1–4: *Oculina conferta* M.-Edw. & H., 1850
1, 3: So-8 (11245), 2, 4: So-8 (11239);
1–2 = × 8, 3–4 = × 30, SBZ4.



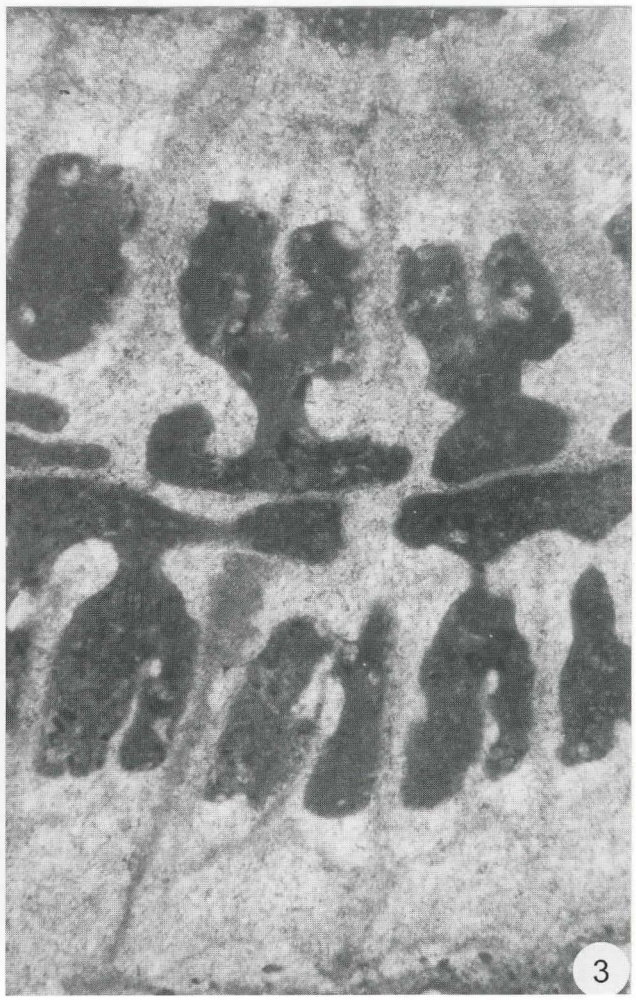


Fig. 1: *Plocophyllia carstica* Turnšek, 1988
DvW-23B (981a), × 8, SBZ2.

Figs 2–3: *Orbignygyra* sp.
Pa-11, 2 = × 8, 3 = × 30, SBZ4.

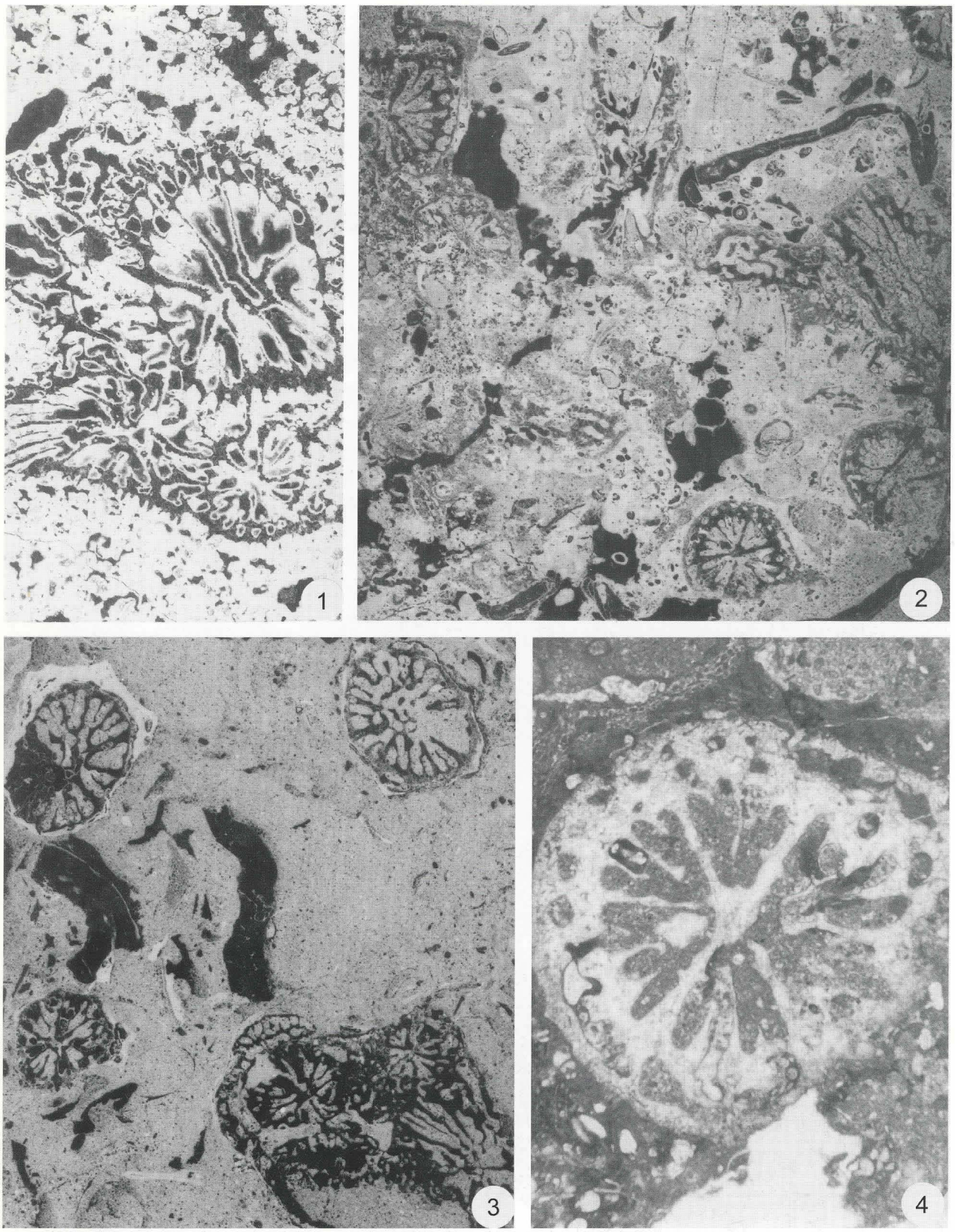
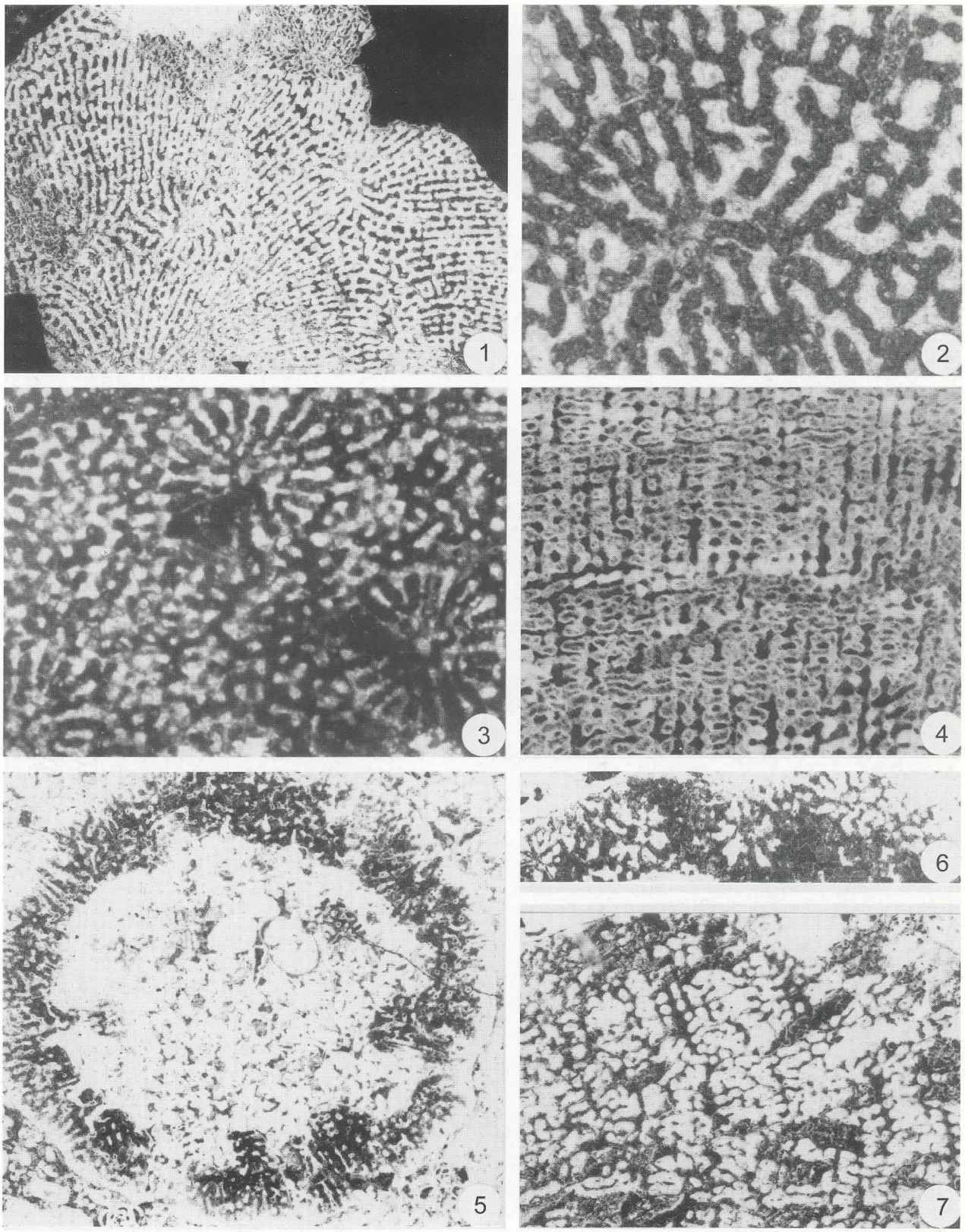


Fig. 1: *Rhizangia* sp.
DvW-9 (4654), × 8, SBZ1.

Figs 2–4: *Rhizangia padricensis* n. sp.
2, 4: Pa-28 (11008) (holotype), 2 = × 8, 4 = × 30, SBZ4,
3: DvW-29 (5676), × 10, SBZ3.

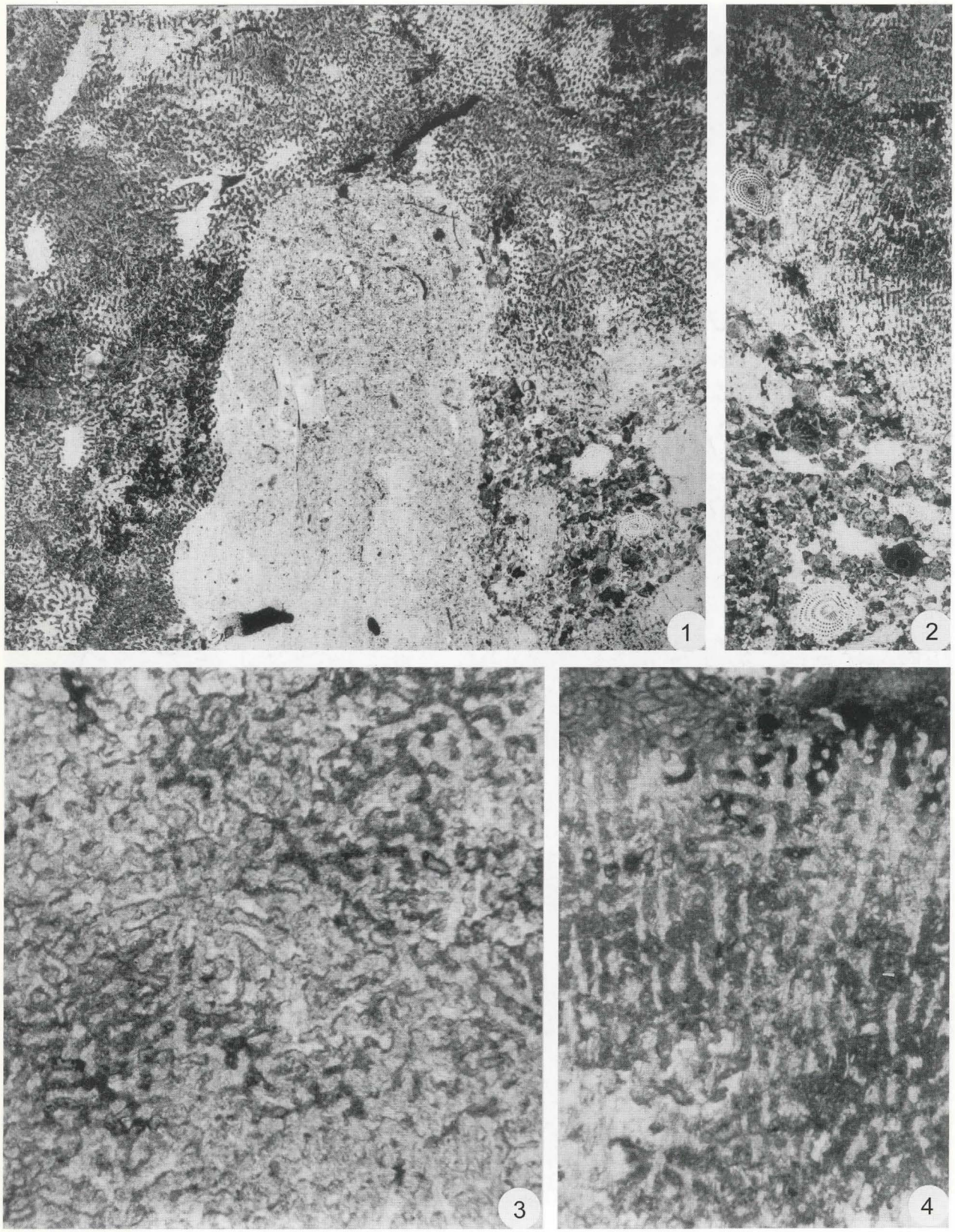


Figs 1–2: *Pironastraea discoides* d'Achiardi, 1875
Pa-11 (11001b), 1 = × 8, 2 = × 30, SBZ4.

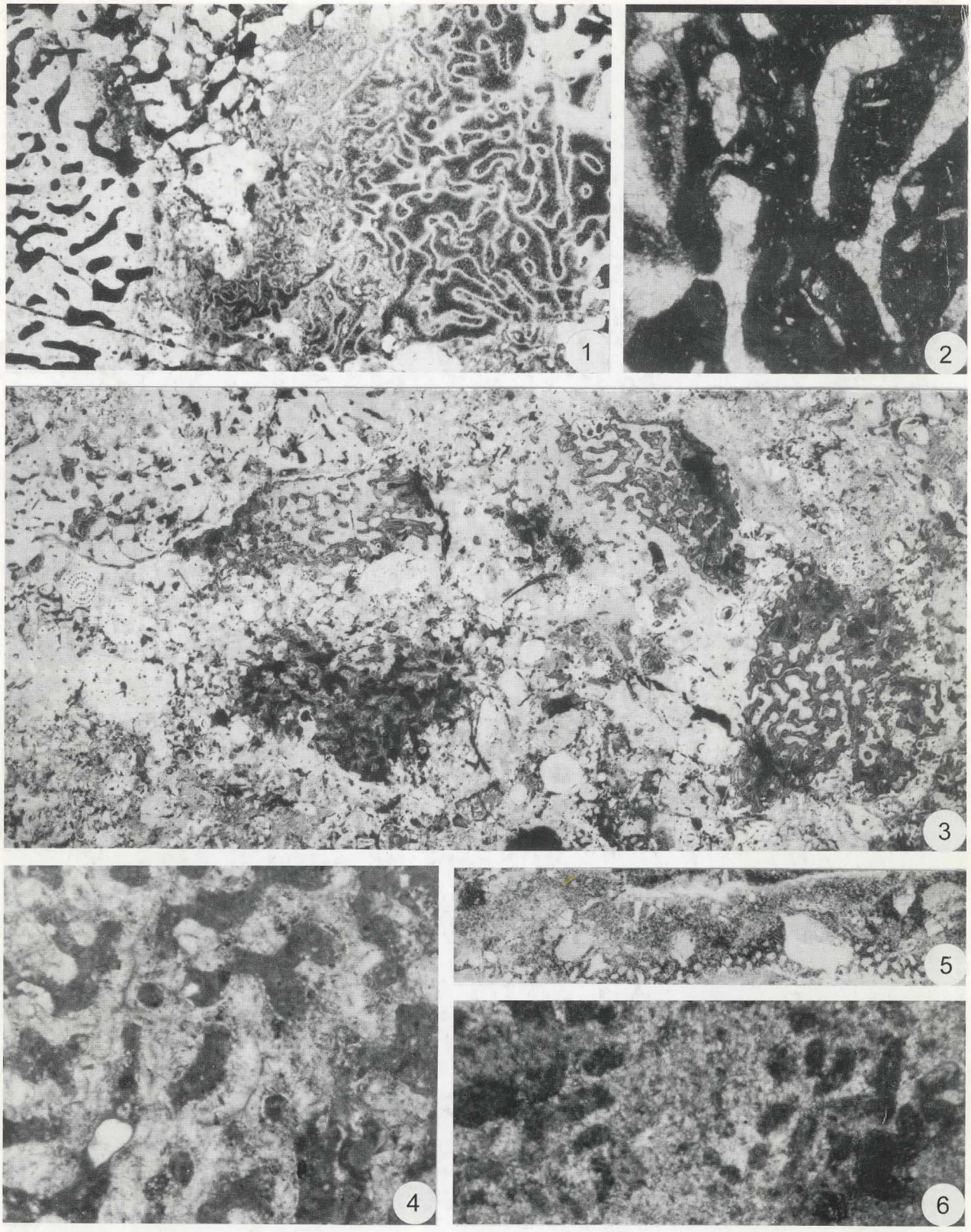
Figs 3–4: *Actinacis cognata* Oppenheim, 1901
3: DvW-23 (4684), 4: DvW-23 (4685), 3–4 =× 20, SBZ2.

Fig. 5: *Goniopora elegans* (Leymerie, 1846)
DvW-18 (4673), × 8, SBZ2.

Figs 6–7: *Goniopora* sp.
6: DvW-29 (983c), 7: DvW-29 (4695), 6–7 = × 8, SBZ3.



Figs 1–4: *Goniopora hrpeljensis* n. sp.
1, 3, 4: Hr-16 (11368) holotype, 2: Hr-16 (11369),
1–2 = × 8, 3–4 = × 30, SBZ4.



Figs 1–2: *Litharaea subepithecata* Oppenheim, 1912
DvW-24 (982a), 1 = × 8, 2 = × 30, SBZ2.

Figs 3–4: *Litharaea websteri* (Bowerbank, 1840)
Pa-11 (11004), 3 = × 8, 4 = × 30, SBZ4.

Figs 5–6: *Mesomorpha andrusovi* Kuzmicheva, 1975
Br-V/30, 5 = × 8, 6 = × 30, SBZ4.