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EARLY JURASSIC CORALS FROM KRIM MOUNTAIN, SLOVENIA

SPODNJEJURSKE KORALE S KRIMA, SLOVENIJA

DRAGICA TURNŠEK AND ADRIJAN KOŠIR

ABSTRACT

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Early Jurassic corals from Krim Mountain, Slovenia

A coral assemblage from Lower Jurassic (Liassic) shallow-marine carbonate succession from Krim Mountain, central Slovenia, is presented. Coral and stromatoporoid colonies occur within oolitic-peloidal-bioclastic grainstone and paskstone in the upper part of the "Lithiotid horizon". Seven species of corals are systematically described of which three species are new (*Thecactinastraea krimensis*, *Siderosmilia perithecata* and *Cuifastraea lopatensis*). They are Pliensbachian in age and their structure shows closer affinities with Triassic than with Late Jurassic faunas.

Key words: Early Jurassic, Liassic, corals, Slovenia

IZVLEČEK

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Spodnjejurske korale s Krima, Slovenija

Predstavljena je združba koral iz zaporedja spodjejurskih (liasnih) plitvomorskih karbonatov v Krimskem pogorju. Koralne in stromatoporoidne kolonije se pojavljajo v oolitno-peloidno-bioklastičnih apnencih v zgornjem delu "litiotidnega horizonta". Sistematično je opisanih sedem koralnih vrst, od katerih so tri nove (*Thecactinastraea krimensis*, *Siderosmilia perithecata* and *Cuifastraea lopatensis*). Po starosti spadajo v pliensbachij, po strukturi pa so bolj podobne triasnim kot zgornjejurskim favnam.

Ključne besede: spodnja jura, lias, korale, Slovenija

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INTRODUCTION

Following the end-Triassic extinction, reef development was suppressed during Early Jurassic and the coral fossil record is poor, especially in Hettangian and Sinemurian (STANLEY 1988, STANLEY & BEAUVAIS 1994). A renewed phase of small-scale reef-building started in the

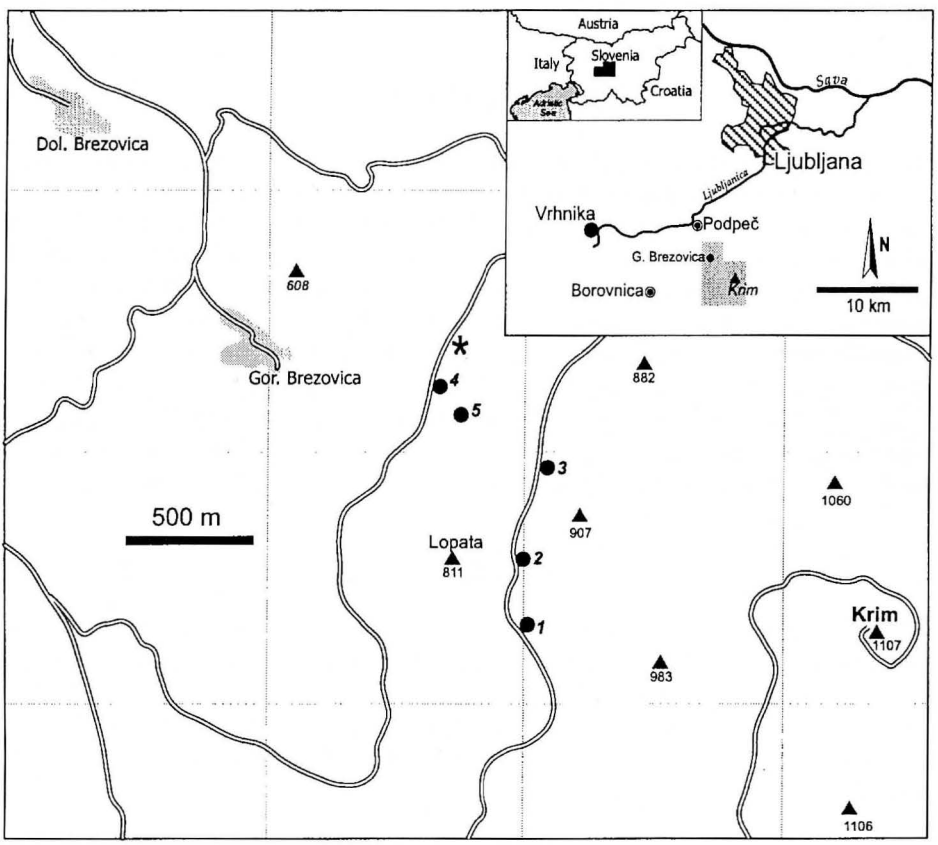

Figure 1. Locality map of Krim Mountain. 1-5: sampling points, *: Gorenja Brezovica locality of TURNŠEK & BUSER (1999).
Slika 1. Položajna skica najdišča v pogorju Krima. 1-5: vzorčevališča. *: lokaliteta Gorenja Brezovica iz TURNŠEK & BUSER (1999).

middle Liassic (Pliensbachian) with increased volume of coral framework within bioherms (STANLEY 1988). By the Pliensbachian, many new reef coral species had evolved (WOOD 1999). All Triassic coral genera had become extinct in, or by, the Early Jurassic (BEAUVAIS 1986). Centered within the Tethys, a major faunal changeover occurred in the Toarcian when all Triassic genera abruptly disappeared (STANLEY 1988).

In this paper we present a coral assemblage from a succession of middle Liassic shallow-marine carbonates of Krim Mountain, central Slovenia. Seven species of corals are described, of which 3 species are new.

Although Liassic corals have been found on several localities in Slovenia (BUSER & DEBELJAK 1996), the coral assemblage from new fossil localities on Krim Mountain, together with a coral from the same area, reported by Buser (1965, 1974) and recently revised by TURNŠEK & BUSER (1999), represent the only systematically studied Liassic coral fauna from the Dinaric Carbonate Platform.

GEOLOGICAL SETTING

The described coral material comes from the outcrops located on the western slopes of Krim Mountain, near Gorenja Brezovica village, about 15 km SSE of Ljubljana (Fig. 1). Limestone with corals is associated with the "Lithiotid horizon", a characteristic stratigraphic unit of Lower Jurassic carbonate platforms. The "Lithiotid horizon" is very widespread in southern Slovenia and attains maximum thickness of 75 meters (BUSER & DEBELJAK 1996). The carbonate succession of the "Lithiotid horizon" is characterized by several facies associations, organized in meter-scale cycles. Coral colonies occur within thick-bedded oolite-peloid-bioclastic grainstone and packstone in the upper part of the "Lithiotid horizon". According to BUSER & DEBELJAK (1996), the Lower Jurassic carbonates of the Krim Mountain area correspond to the outer part of the inner platform sedimentary environments, proximal to the margin of the Dinaric Carbonate Platform (see Fig. 17 in BUSER & DEBELJAK 1996).

MATERIAL

The slopes of Krim Mountain are characterized by densely wooded karst landscape and the outcrops are rather poor. Liassic corals were sampled at five larger outcrops along forest roads and tracks east and north of Lopata Hill (Fig. 1).

A total of 35 thin sections and several polished slabs were prepared from 25 collected samples of limestone. Thin sections were examined and photographed under standard petrographic microscope.

FACIES AND PALEOECOLOGY

Due to poor quality and very limited extent of the outcrops, geometry and facies relationships of the coral-bearing carbonates of Krim Mountain cannot be precisely established. Coral and

stromatoporoid colonies appear to form discrete, meter-scale bodies within the oolitic-peloidal-bioclastic grainstones and packstones. However, no topographic expression of the coral-stromatoporoid facies can be observed in the field. The coral-stromatoporoid facies may form biostromal accumulations or smaller patch-reefs.

The grainstone-packstone facies is represented by light to dark grey oolitic grainstone, fine-grained peloidal packstone, and peloidal-bioclastic grainstone and packstone with a rich association of benthic foraminifers (mostly textulariids), algae and gastropods (Pls. 8 and 9).

Coral and stromatoporoid bafflestone and framestone form patches within the grainstone-packstone facies. The structure is bound by solenoporacean algae, stromatoporoids, microproblematica (*Bacinella*), and serpulids.

According to generalized models of Early Jurassic carbonate platforms (e.g. SEPTFONTAINE 1985, REY 1997), this facies association most probably represents deposits of the outer platform setting. Coral and stromatoporoid colonies build small structures within oolitic and peloidal-bioclastic sand bodies.

Small specimens of coral colonies and solitary corals give evidence for unfavourable conditions for the coral growth. Specimens, exhibiting transition in growth style from massive to branching colonies have been observed. Colonies, showing the same alterations in growth and development between massive and ramose corals in Bajocian "montlivaltiids" of France has been explained by LATHUILIÈRE (1996) as "being stopped in their massive growth because of unfavourable conditions of non-reefal paleoenvironments".

SYSTEMATIC DESCRIPTION OF CORALS

Suborder: Pachythecalina Eliašova 1976
Family: Archaeosmiliidae Melnikova 1983
Genus: *Archaeosmiliopsis* Melnikova 1975
Type species: *Archaeosmiliopsis densus* Melnikova 1975

Archaeosmiliopsis densus Melnikova 1975
Pl. 1, figs. 1-2

1975 *Archaeosmiliopsis densus* gen et sp. n. MELNIKOVA, 114-115, pl. 2, figs. 1-6.

Description: Phaceloid-dendroid colony with irregularly branched round corallites. Budding lateral. Septa compact, hexagonal systems in 2-3 (or 4) cycles. The first two cycles are thick and they sharpen toward the centrum, the third cycle is thiner and shorter, the fourth one is developed in peripheral part only. Septa bear rare lateral pointed granulae or they are smooth. Wall is thick, fibrous, recrystallized. Disseptiments are present. There is no real columella, in some corallites septal prolongations appear. Microstructure is not preserved.

Dimensions: d = (7) 8-9 mm, s = 12+12+s4

Comparison: Our specimens have some corallites with a fourth cycle of septa, otherwise the structure and dimensions fit within the original description (d = 6-8 mm, s = 18-24).

Remarks: MELNIKOVA (1975: 109) ascribed her new genera *Archaeosmilia* and *Archaeosmiliopis* to the new family Archaeosmiliidae, suborder Amphiastraeina. BEAUVAIS (1986) ascribed *Archaeosmilia* to the family Zardinophyllidae, suborder Stylophyllina. RONIEWICZ & STOLARSKI (1999: 138) named Zardinophyllidae a pachythecaline corals. We ascribe *Archaeosmiliopsis* to the Pachythecalina.

Distribution: Hettangian-Sinemurian of SE Pamir.

Material: Lop. 1/1.

Family: Cyclophylliidae Roniewicz 1989
Genus: *Thecactinastraea* Beauvais 1986
Type species: *Thecactinastraea fasciculata* Beauvais 1986

Thecactinastraea krimensis Turnšek, n.sp.
Pl. 2, figs. 1-5; Pl. 3, figs. 1-3

Holotype: Specimen: Lop. 3/2.

Etymology: After Krim Mountain.

Age: Liassic, Pliensbachian.

Type locality: East slope of Lopata Hill below Krim Mountain.

Diagnosis: *Thecactinastraea* with lateral budding and very thick axial projections.

Dimensions: d = 6-9 mm, s = 38-45.

Material: Lop. 1/9, 3/2, ?3/3, 4/2.

Description: Phaceloid colony with subcircular corallites, budding lateral. Septa compact, radial, bearing lateral large and pointed granulae, in some places smooth. In axial part of corallites septa continue into different (large or smaller) trabecular prolongations which form parietal columella. Wall septothecate or epithecate, fibrous in outermost border. Endotheca is composed of numerous vesicular large dissepiments wich are spread all over the corallite. Microstructure: medium-sized to thick trabeculae, in some places with midseptal line.

Comparison: From the Pliensbachian species *T. fasciculata* (BEAUVAIS 1986: 33-34, pl. 5, fig. 1, textfig. 21) from Morocco our new species differs in more outstanding parietal columella.

According to BEAUVAIS (1986), *Thecactinastraea* is also characterised by fissipar division. In fact it is lateral budding which is well visible also in her materials (pl. 5, fig. 1.). The new species is also similar to some other phaceloid genera:

Liassic genus *Phacelophyllia* (see BEAUVAIS 1986: 38) differs in having subcompact septa, synapticulae and penulae, and rare dissepiments. BEAUVAIS ascribed it to Archaeofungiina.

Late Triassic phaceloid genus *Cyclophyllia* (see RONIEWICZ 1989) is very similar, it differs in somewhat thicker wall. It was ascribed by Roniewicz to the "Pachythecalina".

Late Triassic phaceloid *Stylophyllopsis* (FRECH 1890) has axial spines and belongs to the suborder Stylophyllina (see RONIEWICZ 1989). *Stylophyllopsis veneta* (AIRAGHI 1907), the only so far known species from our locality, differs in free axial spines, in much more numerous septa and in larger dimensions (d = 7-13 mm, s = 86-96) (see TURNŠEK & BUSER 1999).

Late Jurassic genus *Rhabdophyllia* MILNE EDWARDS & HAIME 1851 (modern description given by RONIEWICZ 1976, 64) with the Liassic (Late Carixian) species *R. phaceloida* (BEAUVAIS

1986: 43, pl.8, fig. 6, pl. 10, fig. 1, pl. 11, fig. 3) is very simila, but differs in septothecal wall and costate surface, as well as in microstructure. It is ascribed to the family Montlivaltiidae.

Because of the similar structures of septa and wall with *Cyclophyllia* (Roniewicz 1989: 26) we assign *Thecactinastraea* into the family Cyclophylliidae, suborder Pachythecaliina.

Suborder: Stylophyllina Beauvais 1981
Family: Stylophyllidae Frech 1890
Genus: *Epismilia* de Fromentel 1861
Type species: *Epismilia haimei* de Fromentel 1861

Epismilia mauretaniensis Beauvais 1986
Pl. 1, figs. 3-6

1986 *Epismilia mauretaniensis* nov. sp. Beauvais: 17-18, pl. 3, fig. 2, textfig. 10.

Description: Solitary, cylindrical-conical coral with subcircular calice, fossete a little elliptical. Septa compact, numerous, laterally fine granulated. Columella spongy, deep;

endotheca is made of horizontal dissepiments, rather common; wall looks like wide fibrous peritheca. Microstructure poorly preserved, looks like mini- to medium-sized trabeculae.

Dimensions: d = (9-12) x (13-17) mm, s = 0-100.

Comparison: No special difference from the original of Beauvais the dimensions of which are: d = (11-14) x 15, s = 80-124.

Distribution: Domerian of Beni Tadjit (Morocco).

Material: Lop. 1/3, 1/5, 1/8.

Genus: *Heterastraea* Tomes 1888
Type species: *Isastraea tomesi* Duncan 1867

Heterastraea eveshami (Duncan 1867)
Pl. 4, figs. 1-2

1867 *Septastraea eveshami* Duncan. Duncan, 52, pl. 13, figs. 5-7.
1976 *Heterastraea eveshami* (Duncan). Beauvais, 62, pl. 13, fig. 3, pl. 14, fig. 1, textfig. 27.

Description: Our specimens are cerioid partly meandroid colonies. Calices are polygonal to irregularly prolongated. Septa are compact or subcompact, straight, arranged in an irregular radial system. Lateral sharp granulae are somewhere connected with dissepiments. Axial ends are mainly free and slightly thickened. Columella in majority of corallites absent, in some of them some kind of pappilae can be seen. Endotheca is composed of many vesicular dissepiments. Wall is septothecate, compact, fibrous. Microstructure consists of medium-sized trabeculae, sometimes with midseptal line.

Dimensions: d = 3-4 (7) mm, s = ca 48.

Comparison: Our specimen fits within the original description (d = 2-8 mm, s = 35), but belongs to the forms of somewhat thicker septa. In outer arrangement of corallites it is similar to the Liassic species *Isastrocoenia faugeresi* in which BEAUVAIS (1986: 39-40, pl. 9, fig. 3, textfig. 28), mentioned menianes and synapticulae. Specimens determined as *Isastraea explanatula* (McCoy 1848) and *I.* cf. *salinensis* Koby 1885 from Pliensbachian of Chile (see PRINZ 1991: 170-171, pl. 3, figs. 4 and 5) are similar in cerioid form and dimensions (the illustrated material does not allow a more exact comparison). Liassic *Isastraea hourcqi* from Madagascar (see ALLOITEAU 1958: 1-2, pl. 11, figs. 3-4, pl. 22, fig. 11, pl. 33, fig. 5) differs in smaller corallites (d = 1-2 mm , s = 40).

Distribution: Evesham (England), Liassic (Hettangian to Pliensbachian).

Material: Lopata 1/6, 5.

Heterastraea stricklandi (Duncan 1867)
Pl. 4, figs. 3-6

1867 *Isastraea stricklandi* Duncan. DUNCAN, 54, Pl. 13, figs. 1-4.

1976 *Heterastraea stricklandi* (Duncan). BEAUVAIS, 63, pl. 14, fig. 2, pl. 15, figs. 4-7, textfig. 28.

Description: Cerioid colony, intracalicinal budding in two or more directions, corallites polygonal to irregularly elongated. Septa thick, subcompact, stylophyllid, lateral granulae often connected with horizontal dissepiments. Axial septal round trabecular prolongations form some kind of columella. Wall is fibrous septotheca. Microstructure composed of very thick trabeculae and stylophyllid fibres.

Dimensions: d (cc) = 9-10 mm, s = ca 48.

Comparison: BEAUVAIS (1976) noted that there is no columella, but in our specimen axial projections exist as they do in the original material (see DUNCAN 1867: pl. 13, fig. 2). Dimensions are approximately the same (d = 8-10 mm, s = 30-55).

Distribution: Chadbury, Evesham (England), Liassic (Hettangian to Pliensbachian).

Material: Lop. 2/1.

Suborder: Distichophyllliina Cuif 1977
Family: Coryphylliidae Beauvais 1981
Genus: *Siderosmilia* Beauvais 1986
Type species: *Siderosmilia toarciensis* Beauvais 1986

Siderosmilia perithecata Turnšek, n. sp.
Pl. 5, figs. 1-7

Holotype: Specimen: Lop. 2/4.

Etymology: After the perithecate structure in plocoid forms.

Type locality: East slope of Lopata Hill below Krim Mountain.

Age: Liassic, Pliensbachian.

Material: Lop. 2/2abc, 2/4abcd.

Diagnosis: *Siderosmilia* with thick costate septa and numerous dissepiments forming inner and outer walls. Incomplete costate peritheca.

Dimensions: d = (4)5-6(8) mm, cc = 6-10 mm, s = (24)28-34(48).

Description: Plocoid to phaceloid colony, budding marginal, circumoral, corallites become free or stay together by two, three, four or more. Calices circular to subcircular. Septa radial, costate, thick, compact, with lateral sharp rare granulae. Endotheca of numerous vesicular dissepiments. They sometimes form inner and outer rings which make the colony appearance plocoid when corallites stay together. Costae between corallites are thick, confluent (septa of valleys?) or subconfluent and in some places they form incomplete costate peritheca. Columellar structure can be parietal or lamelar or absent. In isolated corallites the peripheral part is fibrous. Microstructure composed of ?minitrabeculae with midseptal line, poorly preserved.

Comparison: *Siderosmilia perithecata* n. sp.differs from *Siderosmilia toarciensis* (Beauvais 1986: 50-51, pl. 13, fig. 2) in thicker costae, more numerous dissepiments and smaller dimensions (d = 7-13 mm, s = 60-90). It resembles the Late Triassic *Palaeastraea* (Kühn 1936) and *Kühnastraea* (Cuif 1976) but differs in more dendroid form and less developed endotheca and/or wall.

Remarks: Beauvais (1986) ascribed genus *Siderosmilia* to the family Siderastraeidae, Fungiina. Because of thick compact septa, vesicular disepiments, minitrabecular microstructure with midseptal line (see Roniewicz 1989: 35) and similarities with *Palaeastraea* and *Kuhnastraea* we ascribe it to the family Coryphylliidae.

Suborder: Archaeofungiina Beauvais 1981
Family: Cuifastraeidae Melnikova 1983
Genus: *Cuifastraea* Melnikova 1983
Type species: *Cuifastraea granulata* Melnikova 1983

Cuifastraea lopatensis Turnšek, n. sp.
Pl. 6, figs. 1-5; Pl. 7, figs. 1-4

Holotype: Specimen: Lop. 2/3.

Etymology: After Lopata Hill.

Type locality: East slope of Lopata Hill below Krim Mountain.

Age: Liassic, Pliensbachian.

Material: Lop. 2/3, 2/4, 4/1.

Diagnosis: *Cuifastraea* with rare dissepiments and dimensions: cc in serie = 3-5 mm, cc between two series = 5-7 mm, s = 32-40 (7/2 mm).

Description: Massive bulbous colony with thamnasteriid serial corallites. Septa are compact, (sometimes they appear to be subcompact because of oblique sections), confluent. Lateral

ornamentations are menianes which are granulated at their edges. Endotheca consist of rare vesicular dissepiments, columella parietal (in some spaces it looks lamellar, depending on the axial septal prolongations). Microstructure of medium-sized to thick trabeculae.

Comparison: *Cuifastraea lopatensis* n. sp. differs from Norian and Rhaetian species of *Cuifastraea* (C. *granulata*, *C. incurva, C. tenuiseptata* and *C. arthaberi*) (see MELNIKOVA 1983: 47, RONIEWICZ 1989: 92) mainly in less developed endotheca. Similar Rhaetian *Thamnasteria rhaetica* (see MELNIKOVA 1996) differs among others in smaller dimensions (cc = 1.3-2.5 mm, s = 12-22). *C. lopatensis* is similar to Liassic (Domerian) "*Dimorphastraea menchikoffi*" described by BEAVUAIS (1986: 51-52, pl. 13, figs. 3ab) which differs in smaller dimensions (cc = 2-4 mm), and less regular series of corallites. It is also similar to the Liassic (late Sinemurian - early Pliensbachian) specimens from Spain which were by TURNŠEK et al. (1975: 141, pl. 24, figs. 3-4) determined as *Synastraea* cf. *walfordi* (see also TOMES 1882), but differs in shorter distances between series (cc between series = 3.5-4.5 mm). Similar is as well the specimen described as *Alakiria sphaeroidea* Cuif 1976, from Pliensbachian of Chile (PRINZ 1991: 160, pl. 1, fig. 9) which has smaller corallites (cc = 1.5-3 mm).

Remarks: We assign this species to the genus *Cuifastraea* because of compact septa and "typical" granulated menians as defined by MELNIKOVA (1983). Because of poorly preserved microstructure, it is very difficult to differenciate some Triassic and Jurassic "thamnasteriid" genera.

DISCUSSION

STANLEY & BEAUVAIS (1994) provide a detailed review of Liassic corals, their regional and stratigraphic distribution, abundance, diversity, paleoecology, extinctions and survival, and biogeographic trends. A brief summary of Lower Jurassic coral biogeography was also given by BEAUVAIS (1980).

Four of the described coral species have been previously found in the following regions: *Archaeosmiliopsis densus* is known from Hettangian and Sinemurian of Pamir (MELNIKOVA 1975); *Epismilia mauretaniensis* from Domerian of Morocco (BEAUVAIS 1986); *Heterastraea eveshami* and *H. stricklandi* have been described from Lower Liassic of England (see BEAUVAIS 1976, NEGUS 1991). Three species are new.

Many similar Liassic coral species are known from Pliensbachian and Toarcian of Morocco (BEAUVAIS 1986), Pliensbachian of Chile (PRINZ 1991), Sinemurian and Pliensbachian of Spain (TURNŠEK et al. 1975), and also from Liassic of Madagascar (ALLOITEAU 1958).

Other benthic fossils which confirm Early Jurassic age of the coral bearing carbonate succession of the Krim Mountain are: a stromatoporoid *Stromatomorpha lamellosa* Le Maitre , an alga *Solenopora liasica* Le Maitre, both originally described from Morocco (LE MAITRE 1935), and a foraminifer *Pseudocyclammina liasica* Hottinger which has been found in Morocco, Dinarides and elsewhere (HOTTINGER 1967, GUŠIĆ 1977, SEPTFONTAINE et al. 1991). Based on the benthic fossil assemblage and on the stratigraphic position within or directly above the "Lithiotid horizon", the coral-bearing deposits are most probably Pliensbachian in age (Table 1; see BUSER & DEBELJAK 1996, DEBELJAK & BUSER 1998, GEYER 1977, TURNŠEK & BUSER 1999).

Seven coral species from the Krim locality are attributed to six genera, of which five genera are Liassic and one Triassic. All genera are assigned to suborders Pachythecalina, Distichophylliina and Archeofungiina which are the prevalent coral groups in the Triassic. The described coral fauna shows closer affinities with Triassic corals than with Late Jurassic faunas.

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POVZETEK

Spodnjejurske korale s Krima, Slovenija

Po zgornjetriasnem izumiranju je rast grebenov v spodnji juri zamrla. Pojavi koral so redki, posebno v hettangiju in sinemuriju (Stanley 1988, Stanley & Beauvais 1994). Obnovljena faza rasti majhnih grebenov se začne v pliensbachiju in ob koncu tega obdobja poznamo razmeroma bogate koralne biostrome (Wood 1999). Večina triasnih koralnih rodov je izumrla spodnji juri (Beauvais 1986). Na področju Tetide se je tudi večina drugih favnističnih sprememb zgodila v toarciju, ko je izginila večina triasnih rodov (Stanley 1988).

Čeprav so bile liasne korale najdene na več mestih v Sloveniji (Buser 1965, 1974, Buser & Debeljak 1996), predstavlja najdišče pod Krimom s pred kratkim opisano vrsto (Turnšek & Buser 1999) in združbo, predstavljeno v tem članku, edino sistematično obdelano liasno koralno favno na Dinarski karbonatni platformi.

Opisani material izvira iz izdankov na zahodnem pobočju Krima pri Gorenji Brezovici, okoli 15 km jugojugovzhodno od Ljubljane (sl. 1). Apnenec s koralami je del "litiotidnega horizonta", ki je značilna stratigrafska enota spodnjejurskih karbonatnih platform. "Litiotidni horizont" je zelo razširjen v južni Sloveniji in obsega debelino do 75 m (Buser & Debeljak 1996). Karbonatno zaporedje "litiotidnega horizonta" vsebuje različne faciesne asociacije, ki se ponavljajo v metrskih ciklih. Solitarne korale in koralne kolonije se pojavljajo v debelo skladovitih oolitno-peloidno-bioklastičnih apnencih (grainstone in packstone) v zgornjem delu "litiotidnega horizonta". Po Buserju pripadajo spodnjejurski karbonati Krima sedimentacijskemu okolju zunanjega dela notranje platforme, proksimalno robu Dinarske karbonatne platforme (glej sl. 17 v Buser & Debeljak 1996).

Zaradi slabih izdankov ne moremo natančno določiti geometrije in faciesnih odnosov apnencev s koralami. Korale in stromatoporoidi se pojavljajo posamezno ali v nekaj metrov velikih telesih znotraj oolitno-peloidno-bioklastičnih grainstonov in packstonov. Topografija koralno-stromatoporoidnega faciesa se na terenu ne vidi; korale in stromatoporidi tvorijo bodisi biostromne akumulacije bodisi majhne kopaste (patch) grebene. Kot vezivo se pojavljajo solenoporne alge, stromatoporoidi, mikroproblematika (*Bacinella*) in serpulidi. Glede na model spodnjejurskih karbonatnih platform (Septfontaine 1985, Rey 1997), te faciesne asociacije po

vsej verjetnosti prestavljajo sedimente zunanjega dela karbonatne platforme. Majhni primerki koral kažejo na neugodne pogoje rasti. Našli smo tudi primerke, ki med rastjo kažejo prehode od masivnih k vejnatim oblikam. Podobne oblike v bajociju Francije LATHUILIÈRE (1996) razlaga z ustavitvijo rasti masivnih koral zaradi razmer, ki so bile neugodne za rast grebenov.

Opisanih je sedem vrst koral, od katerih so tri nove. Poleg koral so najdeni tudi drugi "grebenotvorni" fosili (glej tabelo 1).

STANLEY & BEAUVAIS (1994) sta podala detajlen pregled liasnih koral, njihovo regionalno in stratigrafsko razširjenost, množičnost, raznolikost, paleoekologijo ter dinamiko izumiranja in preživetja. pregledno paleogeografsko sliko mezozojskih koral pa tudi BEAUVAIS (1980) Štiri opisane vrste so bile doslej najdene v naslednjih krajih: *Archaeosmiliopsis densus* v hettangiju in sinemuriju Pamirja (MELNIKOVA 1975), *Epismilia mauretaniensis* v domeriju Maroka (BEAUVAIS 1986), *Heterastraea eveshami* in *H. stricklandi* v spodnjem liasu Anglije (glej BEAUVAIS 1976, NEGUS 1991). Mnogo pa je zelo podobnih liasnih vrst, ki so znane iz pliensbachija in toarcija Maroka (BEAUVAIS 1986), iz pliensbachija Chileja (PRINZ 1991), iz sinemurija in pliensbachija Španije (TURNŠEK et al. 1975), pa tudi iz liasa Madagascarja (ALLOITEAU 1958). Od ostalih bentičnih fosilov liasno starost najdišča pod Krimom potrjujeta *Stromatomorpha lamellosa* Le Maitre in alga *Solenopora liasica* Le Maitre, ki sta bili originalno opisani iz Maroka (LE MAITRE 1935) ter foraminifera *Pseudocyclammina liasica* Hottinger, ki prav tako izhaja iz Maroka, najdena pa je bila tudi v Dinaridih in drugje (HOTTINGER 1967, GUŠIĆ 1977). Nahajališče Lopata pod Krimom je na podlagi fosilne združbe in stratigrafske lege znotraj ali tik nad "litiotidnim horizontom" z veliko verjetnostjo uvrščeno v pliensbachij (glej Tabelo 1, ter BUSER & DEBELJAK 1996, DEBELJAK & BUSER 1998, GEYER 1977, TURNŠEK & BUSER 1999). Sedem vrst iz Krimskega pogorja pripada šestim rodovom, od katerih je pet liasnih in eden triasen. Vsi rodovi spadajo k podredovom Pachythecalina, Distichophylliina in Archeofungiina, ki so koralne skupine triasa. Opisana koralna favna kaže torej večjo afiniteto do triasnih koral kot do zgornjejurskih. To dejstvo se ujema z ugotovitvijo na področju celotne Tetide, kjer je večina koralnih rodov izumrla v spodnji juri (BEAUVAIS 1986) in se je tudi večina drugih favnističnih sprememb zgodila v toarciju, ko je izginila večina triasnih rodov (STANLEY 1988).

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Table 1: List of fosil species from the Lopata locality and stratigraphic comparison. * Lopata sampling points [1-5] (See fig 1). ** HE – Hettangian; SI - Sinemurian; PL - Pliensbachian; TO - Toarcian.
Tabela 1: Seznam fosilnih vrst z Lopate s stratigrafsko primerjavo. * Lokalitete na Lopati [1-5] (gl. sliko 1). ** HE - hettangij; SI - sinemurij; PL - pliensbachij; TO - toarcij.

	Lopata * Pliensbachian	***Stratigraphic distribution elsewhere*****
CORALS - KORALE		
Archaeosmiliopsis densus Melnikova	1	HE SI
Thecactinastraea krimensis Turnšek, n. sp.	1,3,4	/
Epismilia mauretaniensis Beauvais	1	PL
Heterastraea eveshami (Duncan)	1,5	HE SI PL
Heterastraea stricklandi (Duncan)	2	HE SI PL
Siderosmilia perithecata Turnšek, n. sp.	2	/
Cuifastraea lopatensis Turnšek, n. sp.	2,4	/
OTHER FOSSILS - DRUGI FOSILI		
Stromatomorpha lamellosa Le Maitre	1	PL
Solenopora liasica Le Maitre	1	PL
Bacinella irregularis Radoičić	1,2	
Thaumatoporella parvovesiculifera Rainer	1	
Pseudocyclammina liasica Hottinger	1	SI PL
small foraminifers	1,3	
gastropods	1,2,3	
annelids	2	

PLATES - TABLE

PLATE 1

Figs. 1-2. *Archaeosmiliopsis densus* Melnikova 1975
1. Transverse section of two corallites. Thin section Lop. 1/1a, x 4.
2. Microstructure, showing part of thick wall and septa. Recrystallized. Detail from Fig. 1, x 30.

Figs. 3-6. *Epismilia mauretaniensis* Beauvais 1986
3. Surface of corallum from above. Specimen Lop. 1/8, x 1.
4. Transverse section of corallum. Thin section Lop. 1/5a, x 4.
5. Transverse and longitudinal sections of corallums. Note thick wall. Thin section Lop. 1/5b, x 4.
6. Fibrous microstructure of wall and septa. Detail from Fig. 5, x 30.

TABLA 1

Sl. 1-2. *Archaeosmiliopsis densus* Melnikova 1975
1. Prečni presek dveh koralitov. Zbrusek Lop. 1/1a, x 4.
2. Mikrostruktura stene in sept, prekristaljena. Detajl s sl. 1, x 30.

Sl. 3-6. *Epismilia mauretaniensis* Beauvais 1986
3. Površina koraluma od zgoraj. Vzorec Lop. 1/8, x 1.
4. Prečni presek koraluma. Zbrusek Lop. 1/5a, x 4.
5. Prečni in podolžni presek koralumov. Debela stena. Zbrusek Lop. 1/5b, x 4.
6. Vlaknata mikrostruktura stene in sept. Detajl s sl. 5, x 30

PLATE 1 – TABLA 1

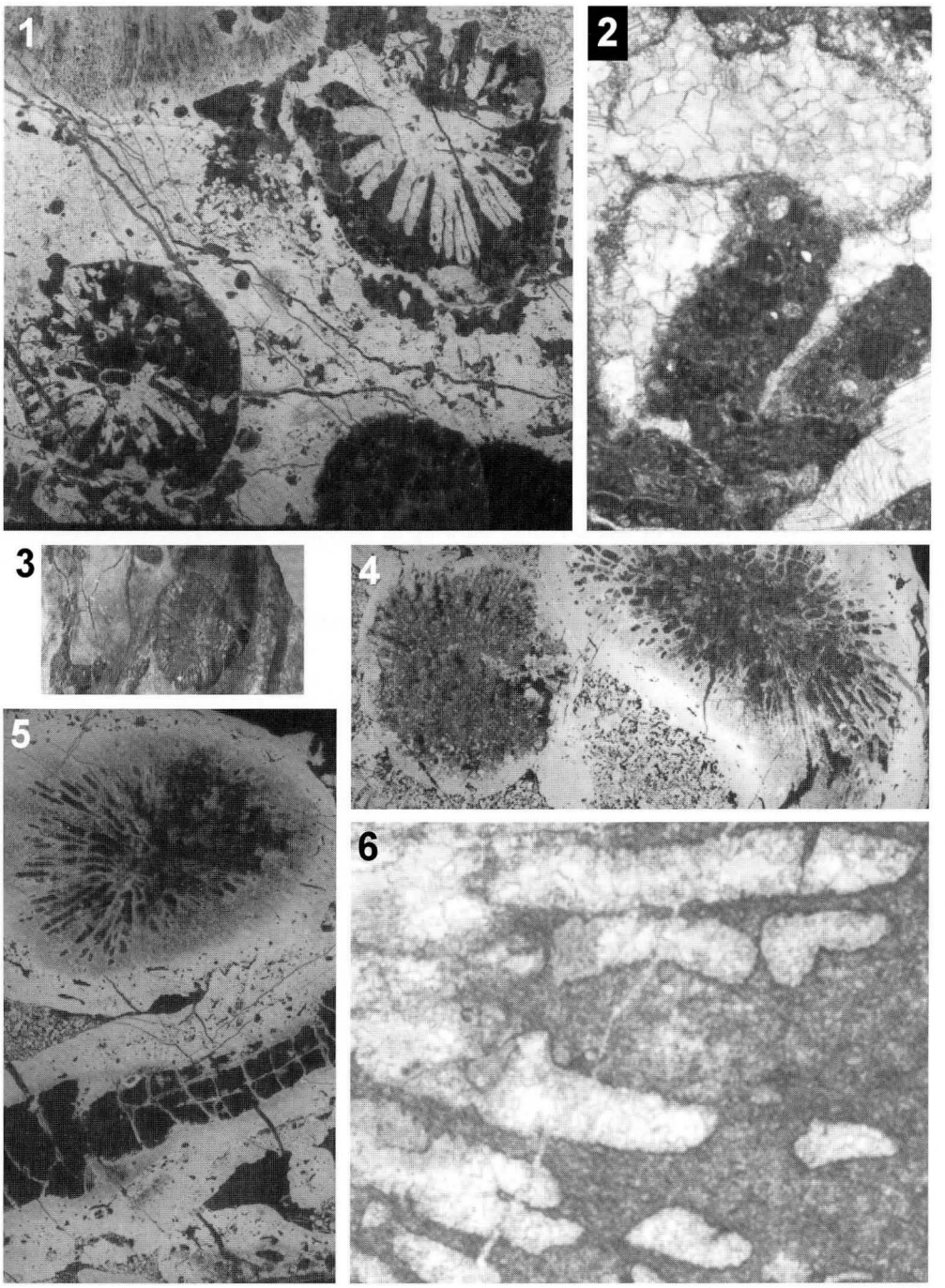

PLATE 2

Figs. 1-5. *Thecactinastraea krimensis* Turnšek, n.sp.

1. Transverse section of the phaceloid corallites. Note thick axial projections left above. Thin section Lop. 3/2a, x 4.
2. Transverse section of corallites. Thin section Lop. 3/2d, x 4.
3. Longitudinal section of two corallites. Note large vesicular dissepiments. Thin section Lop. 3/2b x 4.
4. Longitudinal section of one corallite. Thin section Lop. 3/2c, x 4.
5. Transverse section of one corallite, showing as well thick axial trabecular projections. Thin section Lop. 1/9a, x 4.

Specimen Lop. 3/2 (Figs. 1-4) with all thin sections is the holotype.

TABLA 2

Sl. 1-5. *Thecactinastraea krimensis* Turnšek, n.sp.

1. Prečni presek phaceloidnih koralitov. Levo zgoraj glej močne aksialne podaljške. Zbrusek Lop. 3/2a, x 4.
2. Prečni presek koralitov. Zbrusek Lop. 3/2d, x 4.
3. Podolžni presek dveh koralitov. Glej velike vezikularne disepimente. Zbrusek Lop. 3/2b, x 4.
4. Podolžni presek enega koralita. Zbrusek Lop. 3/2c, x 4.
5. Prečni presek enega koralita, kaže prav tako močne trabekularne aksialne podaljške. Zbrusek Lop. 1/9a, x 4.

Vzorec Lop. 3/2 (sl. 1-4) z vsemi zbruski je holotip.

PLATE 2 – TABLA 2

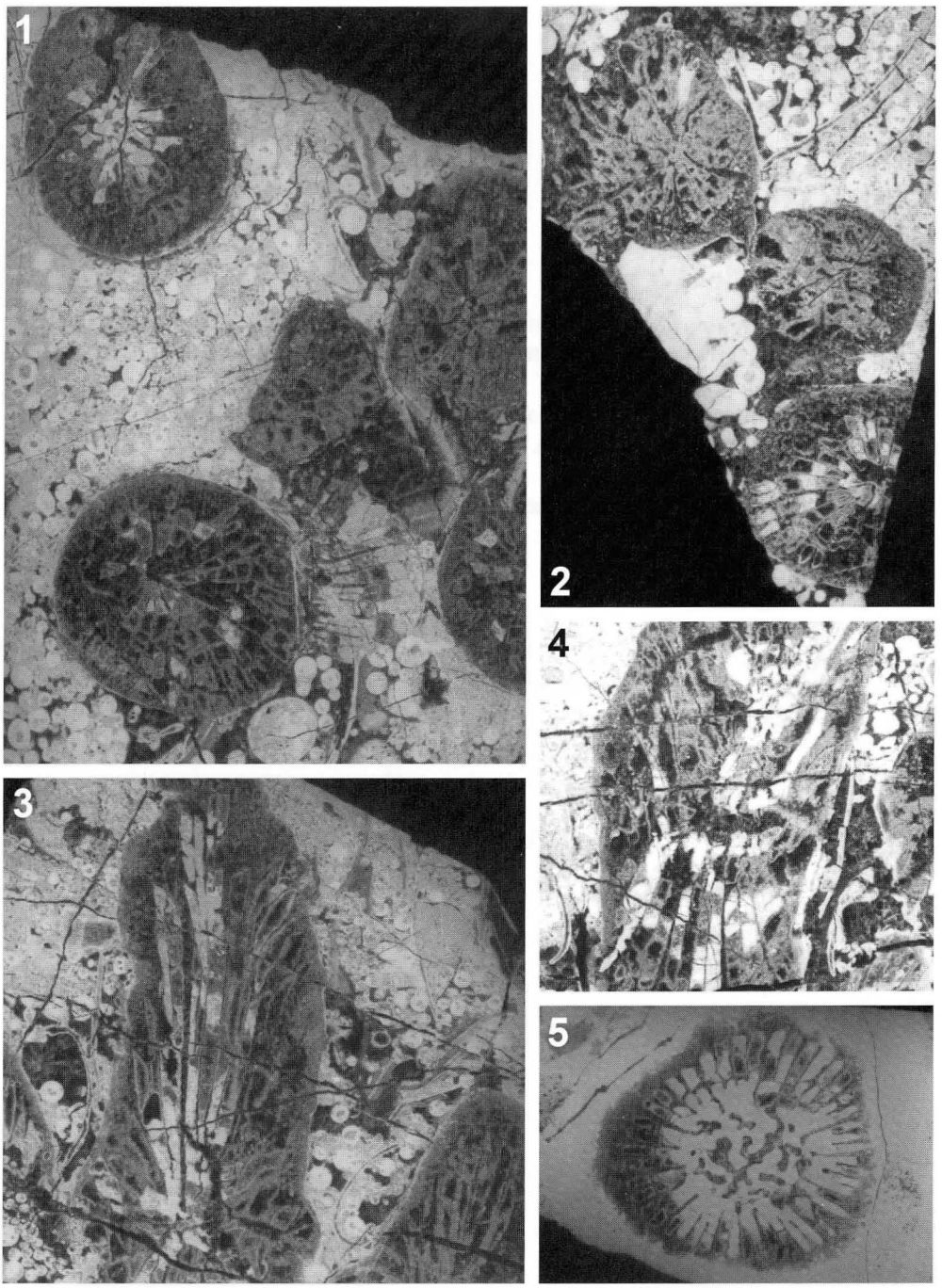

PLATE 3

Figs. 1-3. *Thecactinastraea krimensis* Turnšek, n.sp.

1. Part of transverse corallite showing thick wall and very thick axial projections. Thin section Lop. 3/2a, x 12.
2. Microstructure of axial columellar formation. Thin section Lop. 1/9a, x 35.
3. Microstructure of wall and septa. Detail from Fig. 1, x 35.

Specimen Lop. 3/2 (Figs. 1, 3) is the holotype.

TABLA 3

Sl. 1-3. *Thecactinastraea krimensis* Turnšek, n.sp.

1. Del prečnega koralita, ki kaže debelo steno in zelo močne aksialne podaljške. Zbrusek Lop. 3/2a, x 12.
2. Mikrostruktura aksialne kolumelarne tvorbe. Zbrusek Lop. 1/9a, x 35.
3. Mikrostruktura stene in sept. Detajl s sl. 1, x 35.

Vzorec Lop. 3/2 (sl. 1, 3) z vsemi zbruski je holotip.

PLATE 3 – TABLA 3

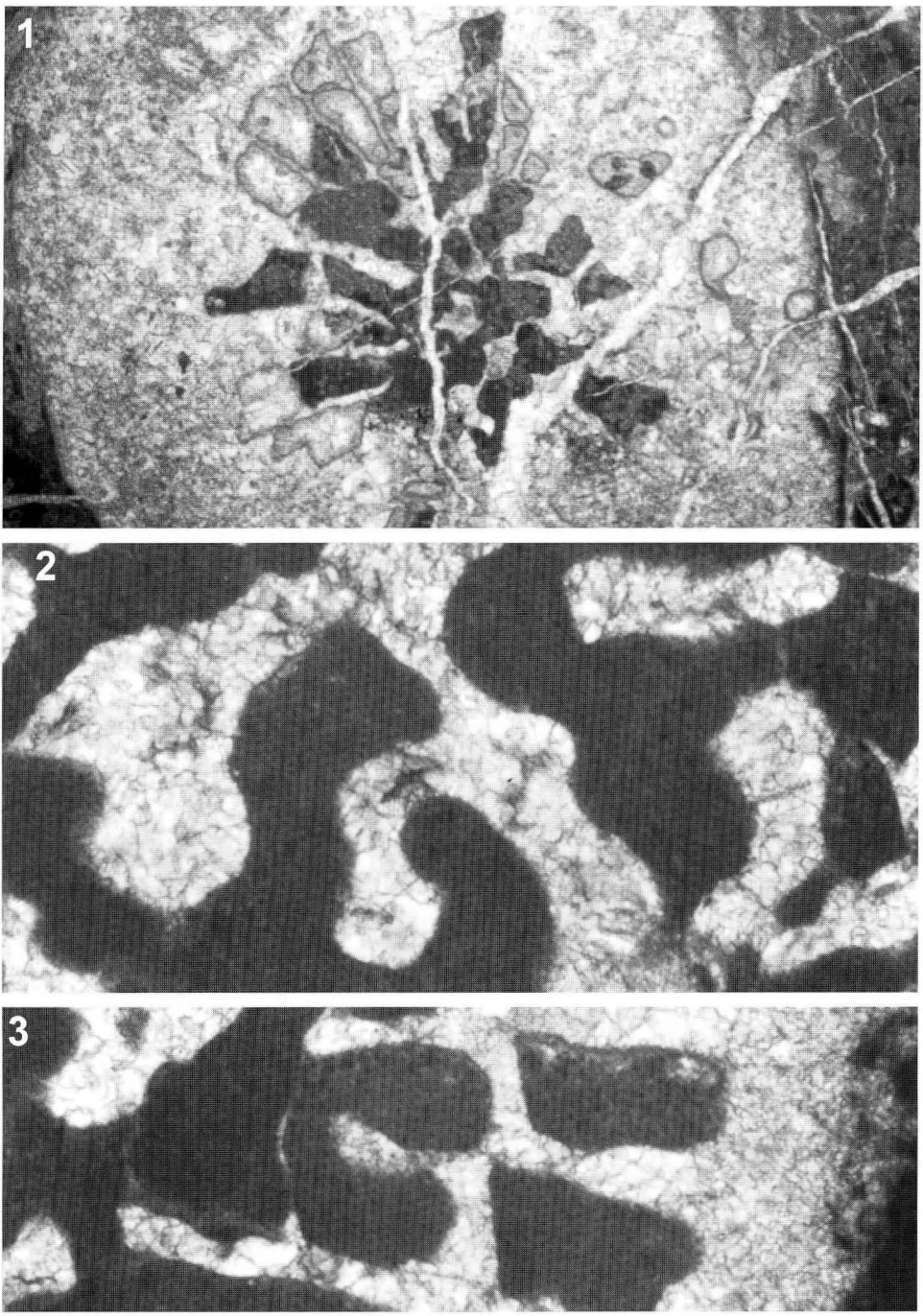

PLATE 4

Figs. 1-2. *Heterastraea eveshami* (Duncan 1867)
1. Transverse section of three cerioid corallites. Thin section Lop. 1/6a, x 4.
2. Detail from Fig. 1, showing microstructure of wall and septa, x 25.

Figs. 3-6. *Heterastraea stricklandi* (Duncan 1867)
3. Surface of the cerioid colony from above. Specimen Lop. 2/1, x 1.
4. Transverse section of corallites. Thin section Lop. 2/1c, x 4.
5. Longitudinal section of the colony. Thin section Lop. 2/1b, x 4.
6. Detail from Fig. 4, showing axial part of corallum, x 10.

TABLA 4

Sl. 1-2. *Heterastraea eveshami* (Duncan 1867)
1. Prečni presek treh cerioidnih koralitov. Zbrusek Lop. 1/6a, x 4.
2. Detajl s sl. 1 kaže mikrostrukturo stene in sept, x 25.

Sl. 3-6. *Heterastraea stricklandi* (Duncan 1867)
3. Površina cerioidne kolonije od zgoraj. Vzorec Lop. 2/1, x 1.
4. Prečni presek koralitov. Zbrusek Lop. 2/1c, x 4.
5. Podolžni presek kolonije. Zbrusek Lop. 2/1b, x 4.
6. Detajl s sl. 4 kaže aksialni del koraluma. x 10.

PLATE 4 – TABLA 4

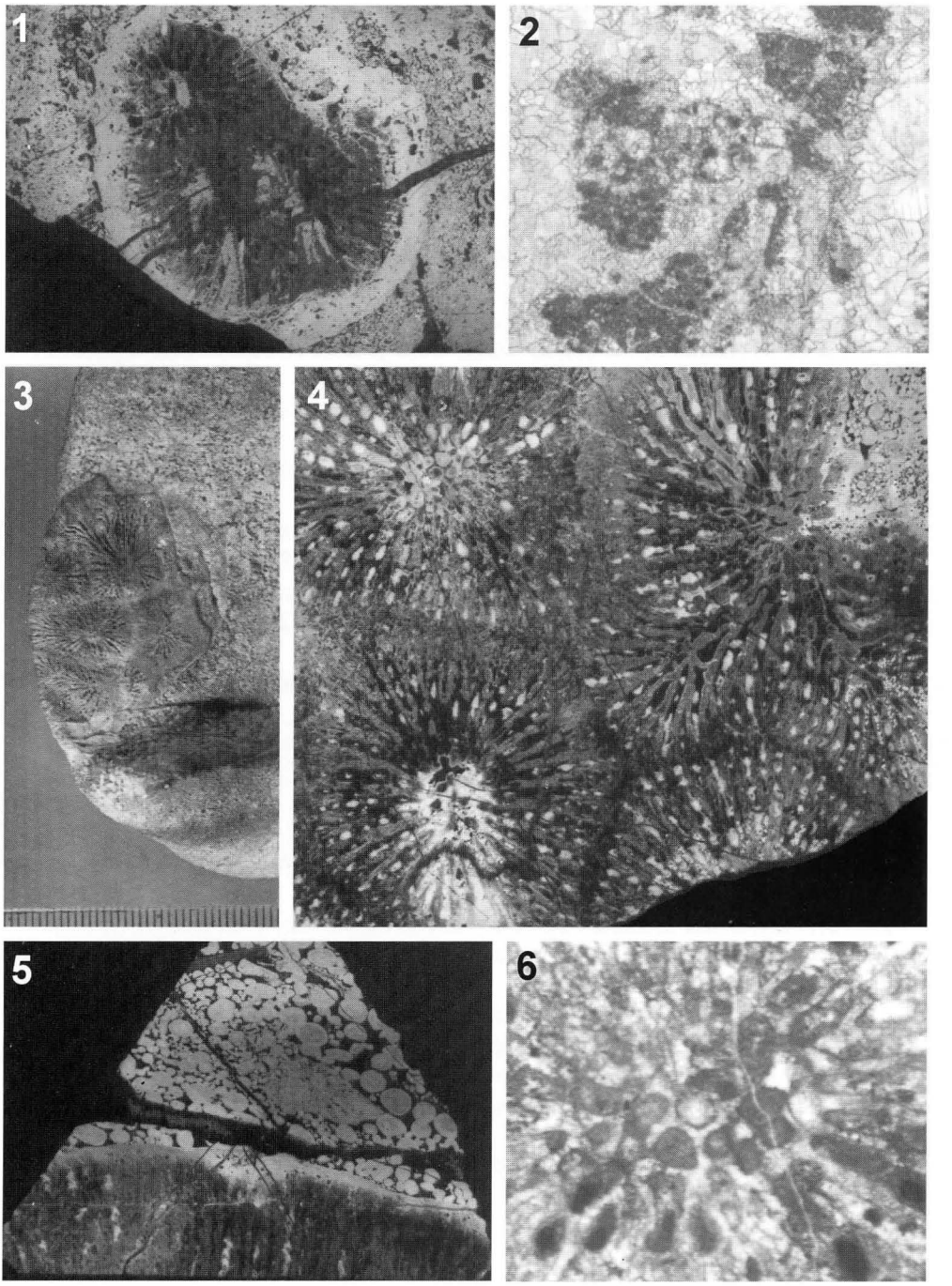

PLATE 5

Figs. 1-7. *Siderosmilia perithecata* Turnšek, n. sp.

1. Transverse section of the colony which looks plocoid (corallites stay together). Note costate peritheca. Thin section Lop. 2/2a, x 4.
2. Transverse section of the same colony with corallites in one row. Thin section Lop. 2/2b, x 4.
3. Transverse section of the same colony which looks phaceloid, with free corallites. Thin section Lop. 2/2c, x 4.
4. Detail from Fig. 2, showing microstructure of wall and septa, x 25.
5. Detail from Fig. 1, showing microstructure of septa, x 35.
6. Longitudinal section of another colony. Thin section Lop. 2/4a, x 4.
7. Transverse section of another colony. Thin section Lop. 2/4b, x 4.

Specimen Lop. 2/2 (Figs. 1-5) with all thin sections is the holotype.

TABLA 5

Sl. 1-7. *Siderosmilia perithecata* Turnšek, n. sp.

1. Prečni presek kolonije, ki zgleda plokoidno (koraliti ostanejo skupaj). Glej kostatno periteko. Zbrusek Lop. 2/2a, x 4.
2. Prečni presek iste kolonije s koraliti v nizu. Zbrusek Lop. 2/2b, x 4.
3. Prečni presek iste kolonije, ki zgleda phaceloidna, koraliti so prosti. Zbrusek Lop. 2/2c, x 4.
4. Detajl s sl. 2 kaže mikrostrukturo stene in sept, x 25.
5. Detajl s sl. 1 kaže mikrostrukturo sept, x 35.
6. Podolžni presek druge kolonije. Zbrusek Lop. 2/4a, x 4.
7. Prečni presek druge kolonije. Zbrusek Lop. 2/4b, x 4.

Vzorec Lop. 2/2 (sl.1-5) z vsemi zbruski je holotip.

PLATE 5 – TABLA 5

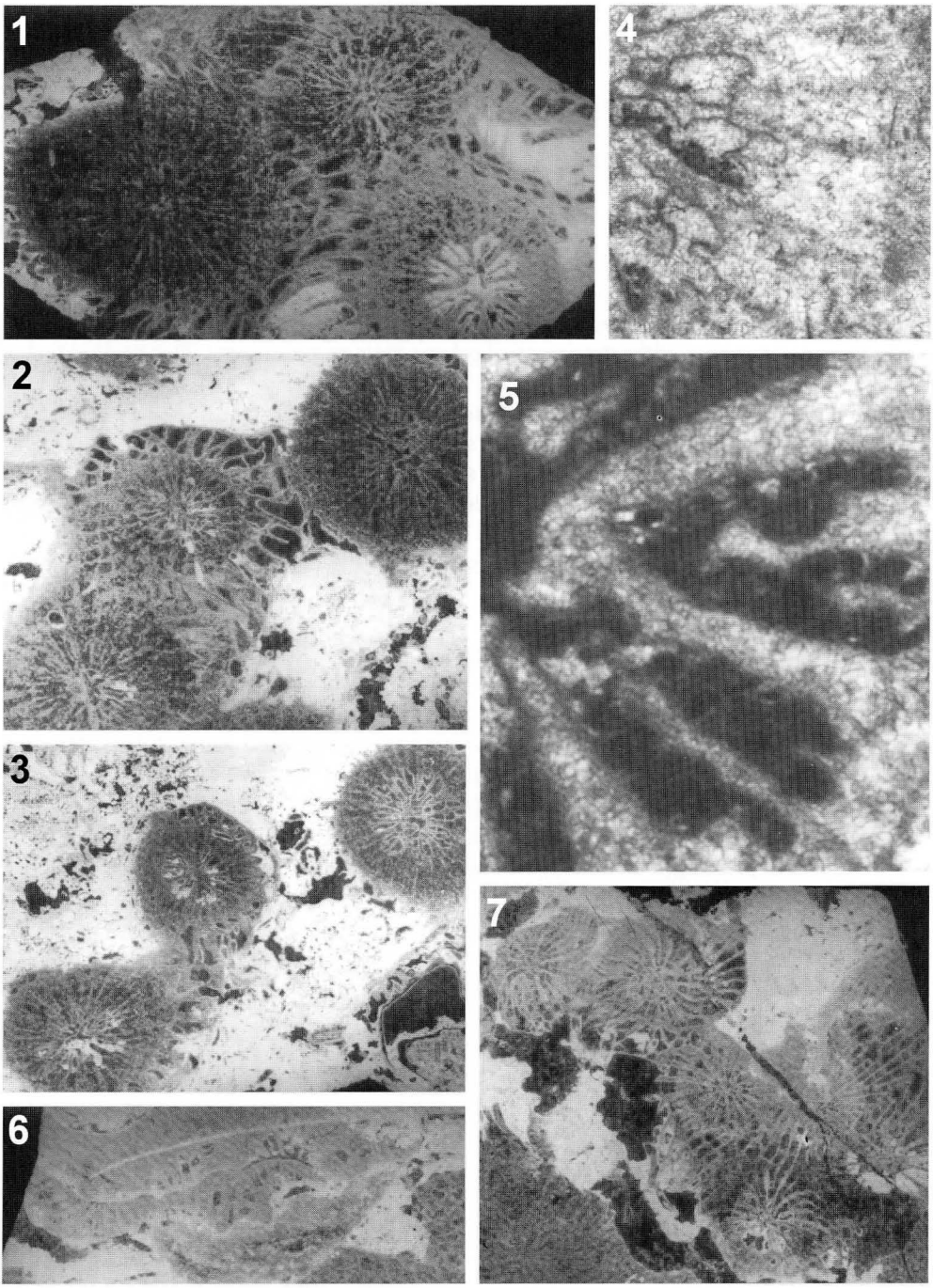

PLATE 6

Figs. 1-5. *Cuifastraea lopatensis* Turnšek, n. sp.

1. Transverse section of the thamnasterid colony. Note compact septa. Thin section Lop. 2/3a, x 4.
2. Longitudinal section of the colony. Thin section Lop. 2/3d, x 4.
3. Transverse section of the colony. Thin section Lop. 2/3c, x 4.
4. Transverse section of the colony. Thin section Lop. 2/4b, x 4.
5. Oblique and transverse section of the colony. Thin section Lop. 2/4a, x 4.

Specimen Lop. 2/3 (Figs. 1-3) with all thin sections is the holotype.

TABLA 6

Sl. 1-5. *Cuifastraea lopatensis* Turnšek, n. sp.

1. Prečni presek thamnasteridne kolonije. Glej kompaktna septa. Zbrusek Lop. 2/3a, x 4.
2. Podolžni presek kolonije. Zbrusek Lop. 2/3d, x 4.
3. Prečni presek kolonije. Zbrusek Lop. 2/3c, x 4.
4. Prečni presek kolonije. Zbrusek Lop. 2/4b, x 4.
5. Poševni in prečni presek kolonije. Zbrusek Lop. 2/4a, x 4.

Vzorec Lop. 2/3 (sl. 1-3) z vsemi zbruski je holotip.

PLATE 6 – TABLA 6

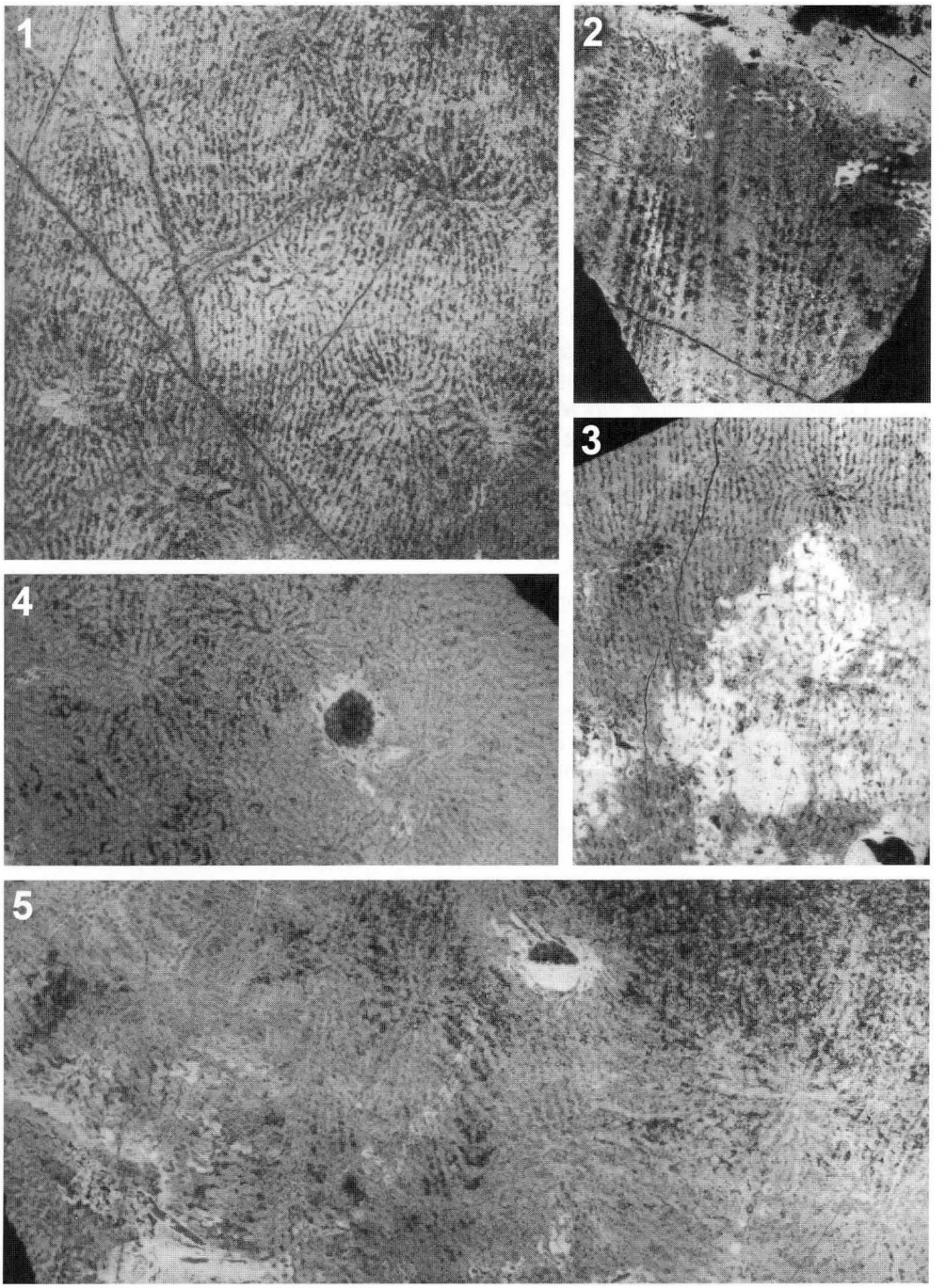

PLATE 7

Figs. 1-4. *Cuifastraea lopatensis* Turnšek, n. sp.
1. Transverse thin section. Lop. 2/3a, x 8.
2. Longitudinal thin section. Lop. 2/3d, x 8.
3. Longitudinal to oblique thin section. Lop. 2/4a, x 8.
4. Microstructure showing granular menians. Detail from Fig. 2, x 28.

The specimen Lop. 2/3 (Figs. 1,2,4) with all thin sections is the holotype.

TABLA 7

Sl. 1-4. *Cuifastraea lopatensis* Turnšek n.sp.
1. Prečni presek. Zbrusek Lop. 2/3a, x 8.
2. Podolžni presek. Zbrusek Lop. 2/3d, x 8.
3. Podolžno poševni presek, Zbrusek Lop. 2/4a, x 8.
4. Mikrostruktura z zrnatimi menianami. Detajl s sl. 2, x 28.

Vzorec Lop. 2/3 z vsemi zbruski je holotip.

PLATE 7 – TABLA 7

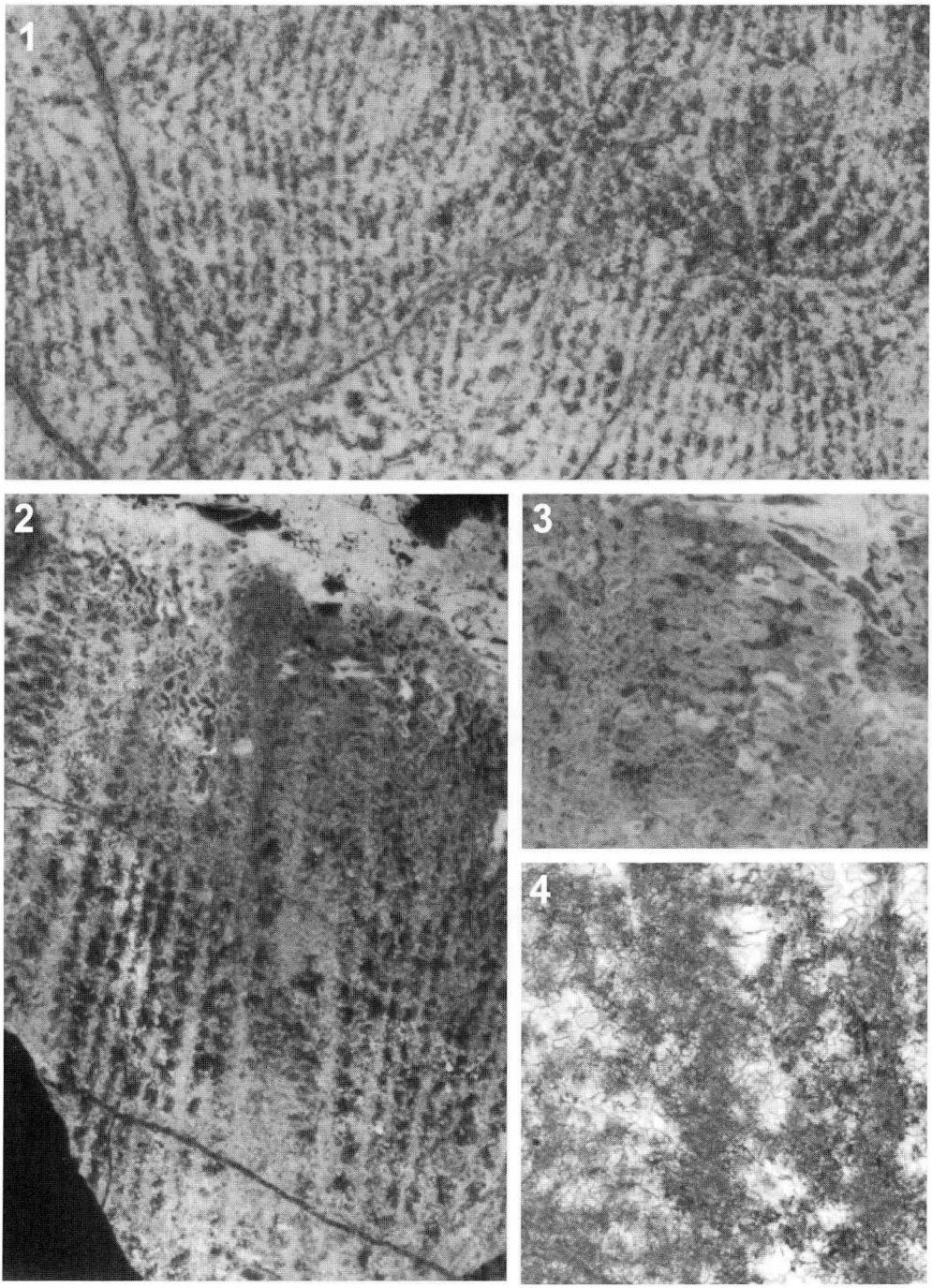

PLATE 8

Figs. 1, 4-5. *Stromatomorpha lamellosa* Le Maitre 1935

1. Longitudinal and oblique to transverse section of the coenosteum. Note fan-shaped growth. Thin section Lop. 1/7a, x 4.
4. Microstructure in oblique section, detail from Fig. 1, x 22.
5. Microstructure in transverse section, detail from Fig. 1, x 27.

Figs. 2-3. *Solenopora liasica* Le Maitre 1935

2. Longitudinal thin section. Lop. 1/9b. x 4.
3. Detail from Fig. 2, showing concentric growth, x 25.

TABLA 8

Sl. 1, 4-5. *Stromatomorpha lamellosa* Le Maitre 1935

1. Prečni ter poševno podolžni presek cenosteja, ki kaže pahljačasto rast. Zbrusek Lop. 1/7a, x 4.
4. Mikrostruktura v poševnem preseku, detajl s sl. 1, x 22.
5. Mikrostruktura v prečnem preseku, detajl s sl. 1, x 27.

Sl. 2-3. *Solenopora liasica* Le Maitre 1935

2. Podolžni presek, zbrusek Lop. 1/9b, x 4.
3. Detajl s sl. 2, kaže koncentrično rast, x 25.

PLATE 8 – TABLA 8

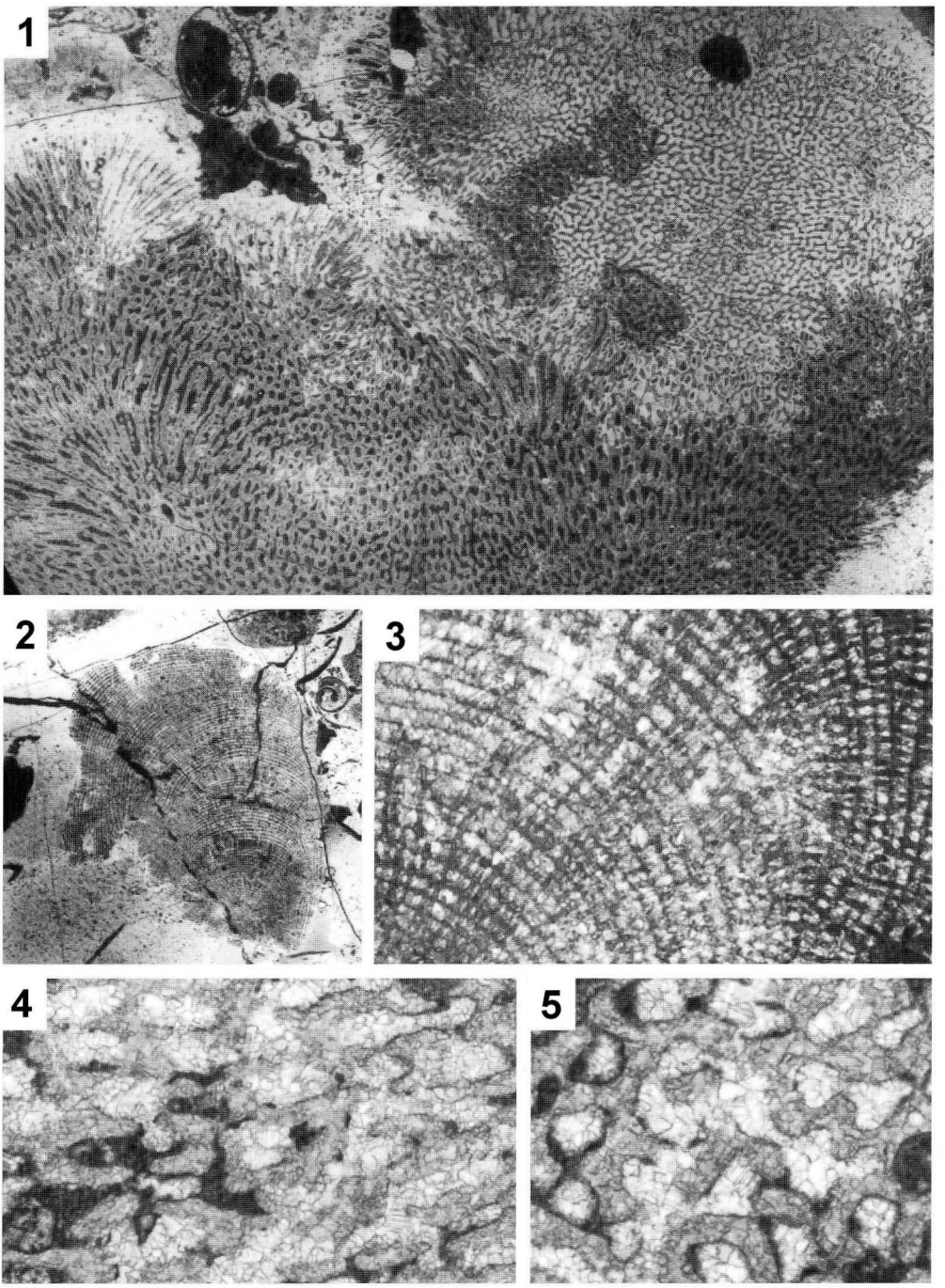

PLATE 9

Fig. 1. *Pseudocyclammina liasica* Hottinger 1967. Thin section Lop. 1/7a. x 32.
Fig. 2. Gastropods. Thin section Lop. 1/7b, x 32.
Fig. 3. Annelids. Thin section Lop. 2/2b, x 32.

TABLA 9

Sl. 1. *Pseudocyclammina liasica* Hottinger 1967. Zbrusek Lop. 1/7a, x 32.
Sl. 2. Polži. Zbrusek Lop. 1/7b, x 32.
Sl. 3. Anelidi. Zbrusek Lop. 2/2b, x 32.

PLATE 9 – TABLA 9