GEOLOGICA CARPATHICA, OCTOBER 2005, 56, 5, 415–432

Upper Jurassic shallow-water scleractinian corals from the Pieniny Klippen Belt (Western Carpathians, Slovakia)

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(Manuscript received October 15, 2004; accepted in revised form March 17, 2005)

Abstract: Oxfordian shallow-water scleractinian coral association from the biohermal limestones of the Mt Vršatec (Czorsztyn Succession, Slovak sector of the Pieniny Klippen Belt, Western Carpathians) comprises 18 species (among them 2 new) plus 3 taxa determined on the generic level only. They represent 13 genera and 10 (or 11) families. The most common are phaceloid coral growth forms from the genus *Thecosmilia* Milne Edwards et Haime (family Montlivaltiidae). The studied fauna appears similar, though less diversified taxonomically, as compared to those known from the Upper Jurassic shallow-water facies of many other parts of Europe. In the Pieniny Klippen Belt this type of coral fauna occurs only in Western Slovakia.

Key words: Oxfordian, Slovakia, Pieniny Klippen Belt, paleogeography, taxonomy, Scleractinia.

Introduction

The Upper Jurassic scleractinian corals described here come from biohermal limestones in the Vršatec klippe (Czorsztyn Succession) in the Slovak sector of the Pieniny Klippen Belt (PKB), Western Carpathians (Figs. 1, 2). Scleractinians occur sporadically in Callovian-Oxfordian pink and grey peribiohermal limestones and reef breccias, but quite frequently in Oxfordian, shallow-water, mainly white biohermal limestones. The lithological and biostratigraphical characteristics of the Jurassic coral-bearing sediments of the Czorsztyn Unit in the Slovak sector of the PKB were given by Mišík (1979). Some of the coral specimens from these sediments identified by the first author were listed in Mišík's paper (1979: p. 19). The corals from the Vršatec limestones, although not so numerous in specimens and species furnish some data for paleogeographical and paleoecological reconstruction of the Late Jurassic in the PKB.

Scleractinian corals representing 22 taxa (Table 1) were identified in the shallow-water carbonate facies of the Vršatec klippe. The coral assemblage appears similar, though less species-diversified, to those known mainly from the shallow-water Upper Jurassic facies of the European Tethyan and epicontinental deposits.

Almost all material described here is housed in the Slovak National Museum, Bratislava, under the acronyme SNM Z 24183-24230/n.

Geological setting

Upper Jurassic biohermal limestones with scleractinian corals of the Czorsztyn Succession in the PKB (Western Slovakia) occur within a 17 km stretch enclosing four neighbouring localities: Dolná Súča, Krivoklát, Vršatec and Mikušovce (Fig. 1B). The corals described here come from the Vršatec limestones occurring in the Vršatec Castle klippe area (Figs. 1, 2).

The Vršatec klippe has long been known, cited and described in many geological papers (e.g. Andrusov 1953: p. 28). This is a tectonic klippe (lens) consisting of Jurassic and Lower Cretaceous limestones and enveloped by plastic marls of Late Cretaceous age. The detailed lithological, microfacies and biostratigraphical characteristics of these sediments were presented by Mišík (1979: Fig. 3). Mišík (l.c.) distinguished ten lithostratigraphical members within the klippe, with ages (Bathonian–Albian) determined on the basis of microfossils (Mišík 1979) and macrofossils, mainly brachiopods (Siblík 1978) and bivalves (Kochanová 1978).

The biohermal limestones (30 m thick), white, pink and grey, with corals, calcareous sponges and thick-shelled bivalves, were presented by Mišík (1979) as a new member of the Czorsztyn Succession and named the "Vršatec Limestone" (the stratotype of the Vršatec Limestone; Mišík 1979: p. 49). The Oxfordian age of these limestones is shown mainly by the bivalves (Kochanová 1978). The limestones are considered to be the "reef core" proper. They pass laterally into a fore-reef facies, consisting of reef breccias (peribiohermal limestones; Mišík 1979), with rare corals. This facies is situated ca. 800 m SW of Vršatec Castle.

Material and methods

The Oxfordian specimens examined here have been collected by the second author from the Vršatec klippe area (Fig. 1C). The collection is composed of about 50 mainly fragmentary colonial (lamellar and massive) and pseudocolonial (phaceloid-dendroid) coral skeletons embedded

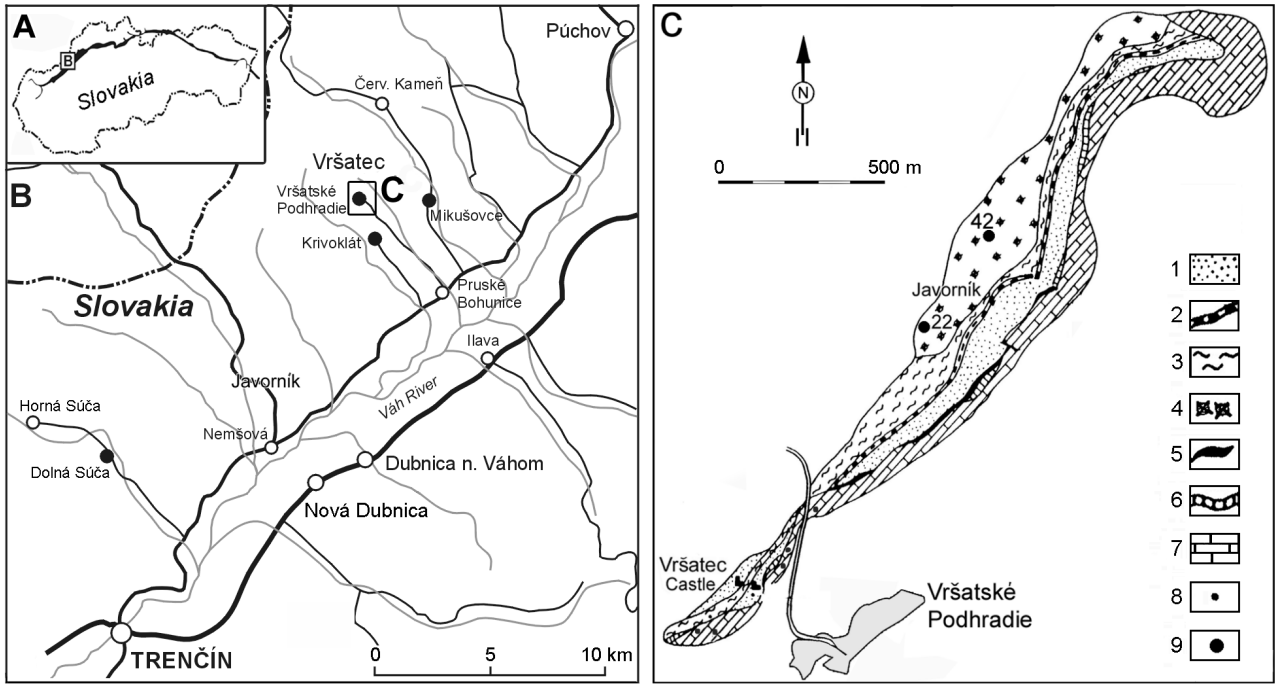

Fig. 1. A — Position of the Vršatec klippe (rectangle figure) relative to the Pieniny Klippen Belt (black irregular line). **B** — Topographic map of the Váh valley region (Western Slovakia) showing the localities (black dots) limiting the area where Vršatec Limestone occurs and where the location of the Vršatec klippe (square shape) is situated. **C** — Geological map of Vršatec klippe with the sites in which the studied scleractinian corals occur (Nos. 22 and 42). After Mišík 1979, simplified. **1** — Bajocian: white crinoidal limestones, **2** — Bathonian: pink crinoidal limestones, **3** — Callovian-Oxfordian: pink and red (peribiohermal) limestones, **4** — Oxfordian: Vršatec Limestone, **5** — Oxfordian-Kimmeridgian: pink limestones with bivalves, **6** — mainly Kimmeridgian: red, nodular Czorsztyn limestones, **7** — Upper Tithonian-Lower Cretaceous white and pink limestones with calpionellids, pink, crinoidal limestones with *Pygope*, pinkish, slightly crinoidal limestones, **8** — Albian, in places to Lower Cenomanian: relics of transgressive, red muddy limestones, **9** — black dots — explication—Fig. 1B.

in limestone. Their dimensions (height and width) are from several millimeters to at most 30 cm. About 60 transverse and longitudinal thin sections were used for microstructural and micromorphological analyses of the coral skeletons. In spite of their generally strong recrystallization, the remains of primary microstructure (traces of the trabecular centers and their arrangement) and microarchitectural structure ("ornamentation") are preserved in places in less altered parts of septa.

The microarchitecture and microstructure of radial elements were described by a conventional method — using thin sections. The SEM micrograph method is not effective on account of diagenetic alterations of skeletons.

Oxfordian coral assemblage from the Vršatec Limestone

From the Oxfordian biohermal limestones (the Vršatec Limestone) 18 species (among them 2 new) and 3 taxa on generic level were identified, as well as one taxon as genus and species indeterminate (Table 1). They represent 13 genera, 10 (or 11) families and 5 suborders. The most common among them are colonial and pseudocolonial (phaceloid) forms from the family Montlivaltiidae. Other families are rather poorly represented. Thus the corals are low in species-diversity and have rather wide-ranging stratigraphic distribution (Table 1). The stratigraphic distribution based on 12 species identified with certainty is large, from Bajocian to Tithonian (and perhaps even to Early Cretaceous), but 11 of them are known from the interval Oxfordian–Tithonian, and 3 (or 4) occur only in the interval Oxfordian–Kimmeridgian. Among all 18 species, 4 of them represent surviving Bajocian-Callovian taxa.

The small coral fauna from the Slovak part of the PKB appears similar, though less diversified in species, to those known from the Upper Jurassic shallow-water facies from the Western and Central European Tethyan and epicontinental provinces. Some, but not numerous, species are also common in Eastern Europe (Crimea, Caucasus), Asia (Tibet, central Iran, western India, Japan) and Northern Africa (Morocco, Algeria).

Coral-bearing sediments and depositional environment

The coral-bearing biohermal limestones from the Vršatec klippe are predominantly white, fine-grained (predominantly biomicrite, biomicrosparite, biosparite) with abundant microfossils as calcified radiolarians, sponge spicules, microfossils *incertae sedis* and macrofossils such as sponges, polychaetous annellids, bivalves, rare gastropods, bryozoans, brachiopods and echinoderm grains. In

Table 1: Geographical and stratigraphic distribution of the Oxfordian scleractinian species from the Vršatec Limestone in Western Slovakia. ▲ — species identified as certain, △ — geographical distribution of those species, which were determined here as affinis and conformis, - - - — uncertain stratigraphic distribution of species.

Species \ Distribution	Portugal	Spain	Italy	France	England	Switzerland	Germany	Czech Rep.	Poland	Ukraine	Romania	Hungary	Slovenia	Serbia	Croatia	Greece	Georgia	Turkmenistan	Azerbaijan	Iran	Tibet	Japan	India	Morocco	Algeria	Middle Jurassic	Oxfordian	Kimmeridgian	Tithonian/Portl.	Berriasian	Valanginian	Hauterivian	Barremian	Aptian	Albian
Stylosmilia corallina Koby, 1881		▲		▲		▲	▲	▲	▲	▲	▲		▲	▲	▲		▲		▲		▲														
Enallhelia vrsatecis n. sp.																																				
Cladophyllia rollieri (Koby, 1888)		▲		▲		▲			▲		▲		▲				▲				△														
Cladophyllia sp.																																				
Placophyllia tenuis Roniewicz, 1976		▲									▲																									
Placophyllia cf. *dianthus* (Goldfuss, 1826)	△			△			△	△	△				△		△																				
Atelophyllia aff. *clermontei* Lathuilière, 2000				△																																
Thecosmilia trichotoma (Goldfuss, 1826)	▲	▲		▲	▲	▲	▲	▲	▲	▲			▲	▲		△	▲																		
Thecosmilia dichotoma Koby, 1884	▲					▲	▲	▲	▲	▲			▲			△	▲																		
Thecosmilia aff. *dichotoma* Koby, 1884	△					△	△	△	△	△			△			△	△																		
Thecosmilia sp.																																				
Complexastrea carpathica Morycowa, 1974								▲	▲																											
?Complexastrea sp.																																				
Complexastraeopsis kouteki Eliášová, 1976								▲																												
Isastrea helianthoides (Goldfuss, 1826)		▲		▲			▲	▲	▲	▲	▲		▲				▲		▲	▲	△														
Isastrea robusta n.sp.																																				
Calamophylliopsis stockesi (M. Edw. et H., 1851)	▲	▲	▲	▲	▲	▲	▲		▲	▲	▲	△	▲	▲			▲			□															
Calamophylliopsis moreauana (Michelin, 1843)		▲		▲		▲	▲		▲		▲										▲	▲													
Kobyastraea bourgeati (Koby, 1887)	▲	▲		▲					▲																▲										
Periseris elegantula (d'Orbigny, 1850)				▲																▲			▲												
Dendraraea cf. *dendroidea* (Ferry, 1870)				△																△				△											
Gen. et sp.indet. (Microsolenidae)																																				

addition these limestones include inorganic components (cf. Mišík 1979: p. 19) such as: intraclasts and pellets. Coral growth forms are mostly branching (phaceloid and dendroid), less frequently lamellar and massive. Some of the colonies in places form an overgrowth on other colonies (Fig. 8.1).

The environmental interpretation of the discussed corals, based on the sediment features and associated fossils, including the coral species typical of the Jurassic shallow-water reef and reef-like buildups as well as on the coral growth forms, suggests that these corals developed in shallow, low-dynamic water, with a rather low sedimentation rate (presence of small boring traces). However, the calcareous green algae, so characteristic of the shallow-water Upper Jurassic coral limestones of the Tethys are almost absent here, it suggests that the depositional environment could represent slightly deeper water. The predominance of branching coral skeletons could also show that they developed in a slightly deeper shallow-water environment, within a carbonate platform or the upper part of its slope.

Taxonomy

The classification of scleractinian corals used here generally follows Alloiteau (1952, 1957) and Wells (1956) with emendations and supplements introduced by Eliášová (1976c, 1990), Lathuilière (1990), Morycowa & Roniewicz (1990, 1995a), Roniewicz (1976, 1979) and Roniewicz & Stolarski (2001).

Fig. 2. Vršatec Castle klippe. Biohermal limestones occur in its higher part (to left from the broken line — arrow).

Abbreviations and some terms used in the present paper:

D — corallum diameter (two perpendicular diameters); H — corallum height; Cor-cor — distance between corallites; d cor — corallite diameter; d cal — calice diameter; d l — corallite lumen diameter (in thin transverse section); c-c — distance between centers of neighbouring corallites; h — corallite height; S — number of septa in the corallite; S1-nS — septa of the succeeding size orders; th s — septum thickness; C — number of costae in the corallite; den s — density of septa (costosepta or radial elements, measured at the wall or in peripheral part of corallite); den c — density of costae; den d — density of dents (distal edge of radial elements); den tr c — density of trabecular centers (per μm or mm, measured along the septal plate, in transverse section); den car — density of carenae (in mm in transverse section); den pen (long. sect.) — density of pennules (per mm in longitudinal section); den end — density of endothecal elements; (...) — less frequent values are presented in brackets; ((...)) — sporadic values.

The year of publication in the synonymy lists is in italics if the species is mentioned but not described or illustrated.

Corallite terminology is applied after Alloiteau (1952, 1957) and Wells (1956) with some additional terms concerning microstructure and microarchitecture of skeletons (i.a. Jell 1969; Gill 1967).

The microstructure descriptions do not refer to scleractinian skeletal genesis interpretations, as recently presented in Stolarski 2003 (layered model of skeletal growth, organic and mineral phase deposits). Instead of the traditional trabeculae and centres of calcification, Stolarski (2003: p. 497) proposes "a distinction between deposits of the Rapid Accretion Front (dRAF); which in particular cases can be organized into Centers of Rapid Accretion (CRA), and Thickening Deposits (TD)…".

In the descriptions of the microstructure of thin sections we use traditional "centres of trabeculae" (instead of CRA). From the distances between them and their arrangement in the radial elements the type of microstructure, characteristic of suprageneric taxa has been established.

Diameters of trabeculae (measured in transverse sections) are used here after Morycowa & Roniewicz (1995b). The classification is arbitrary and is used for convenience only.

Minitrabeculae — trabeculae of diameters up to 50 μm. In some cases they coalesce with each other and form mid-septal line;

medium-size trabeculae — trabeculae of diameters from ca. 50 to 100 μm;

thick trabeculae — trabeculae of diameters over 100 μm.

Order: **Scleractinia** Bourne, 1900
Suborder: **Stylinina** Alloiteau, 1952
Family: **Stylinidae** d'Orbigny, 1851
Genus: *Stylosmilia* Milne Edwards et Haime, 1848
Type species: *Stylosmilia michelini* Milne Edwards et Haime, 1848

Stylosmilia corallina Koby, 1881
Fig. 3.4

v1881 *Stylosmilia corallina* Koby, p. 62-63, Pl. 14, Figs. 3-7
1982 *Stylosmilia corallina* Koby — Bendukidze, p. 18
1991 *Stylosmilia corallina* Koby — Lauxmann, p. 126 (here supplementary synonymies)
1991 *Stylosmilia corallina* Koby — Lebanidze, p. 13, Pl. 3, Fig. 1a,b
1991 *Stylosmilia corallina* Koby — Errenst, p. 176, Pl. 5, Fig. 4a,b
1997 *Stylosmilia corallina* Koby — Turnšek, p. 196, Pl. 196, Figs. A-F
2003 *Stylosmilia corallina* Koby — Helm et al., p. 82, 83, Fig. 8E

Material: Several fragments of branches and 2 thin sections: SNM Z 24186/1,2.

Dimensions (in mm): d cor = 2.0-3.5; d l = 1.5-2.5; c-c ca. = 4.5-6; S = 12-24 (S1 + S2 + nS3).

Remarks: The morphological features of skeleton including diameter of the corallites, number of costosepta and the type of budding, suggest it belongs to *Stylosmilia corallina*.

Occurrence: The species is known from the age interval *middle Oxfordian–early Kimmeridgian*: France, Switzerland, NW Spain, Poland (Holy Cross Mts), Romania (Dobruja (Dobrogea)), Slovenia, Czech Republic (Moravia), Georgia (Caucasus), Croatia, Azerbaijan (Lesser Caucasus (Maly Kavkaz)) and Ukraine (Crimea); from *Tithonian*: Czech Republic (Štramberk region) and Serbia, as well as generally from the *Upper Jurassic* in SW Germany and China (Tibet). Recently, the species has been cited by Helm et al. (2003) from the *middle Oxfordian* of NW Germany (Lower Saxony).

Family: **Cladophylliidae** Morycowa et Roniewicz, 1990
Genus: *Cladophyllia* Milne Edwards et Haime, 1851
Type species: *Lithodendron dichotomum* Goldfuss, 1826

Cladophyllia rollieri (Koby, 1888)

v1888 *Schizosmilia rollieri* Koby, p. 436-437, Pl. 114, Fig. 4
1905 Schizosmilia rollieri Koby — Koby, p. 848
1972 *Schizosmilia rollieri* Koby — Turnšek, p. 44, 100, Pl. 25, Figs. 3, 4
v1976 *Schizosmilia rollieri* Koby — Roniewicz, p. 110, Pl. 3, Fig. 5a,c
1997 *Cladophyllia rollieri* (Koby) — Turnšek, p. 35, Pl. 35, Figs. A-D (here older and complementary synonymies)
2003 Cladophyllia rollieri (Koby) — Helm et al., p. 82

Material: Several fragment of corallites: SNM Z 24213/1,2 (2 thin sections); SNM Z 24217/1 (1 thin section, together with *Dendraraea* cf. *dendroidea*).

Dimensions (in mm):

Specimen SNM Z 24213: d cor = 2.5×3.5; 2.3×3.5; c-c = 3.5-ca. 7.5; S = 24 (12S1-S2).

Koby (1888: p. 437): d cor = 2.5-3; S = 24.

Description and remarks: Several fragments of branches in transverse and longitudinal sections. Corallites straight, densely packed. Radial elements subequal. Septotheca. Epitheca thick. Corallite division visible.

All the corallites investigated are rather similar in diameter and number of radial elements to those presented in Koby (1888: p. 436-437, Pl. 114, Fig. 4) and also discussed in Morycowa & Roniewicz (1990).

Occurrence: The species is known from the age interval *late Oxfordian–late Kimmeridgian*: Switzerland, northwestern Spain; Romania (Dobruja), Poland (Pomerania), southern Slovenia and Georgia; from *Kimmeridgian/Tithonian*: France (Alpes Maritimes; Koby 1905) and generally from *Upper Jurassic* from former Yugoslavia, as well as China (Tibet).

Cladophyllia sp.
Fig. 6.3

Material: Transverse section of corallites (thin section: SNM Z 24210, together with *Thecosmilia dichotoma* Koby).

Dimensions (in mm): d cor = 5×6; S = ca. 40 (S1-S3 + nS4).

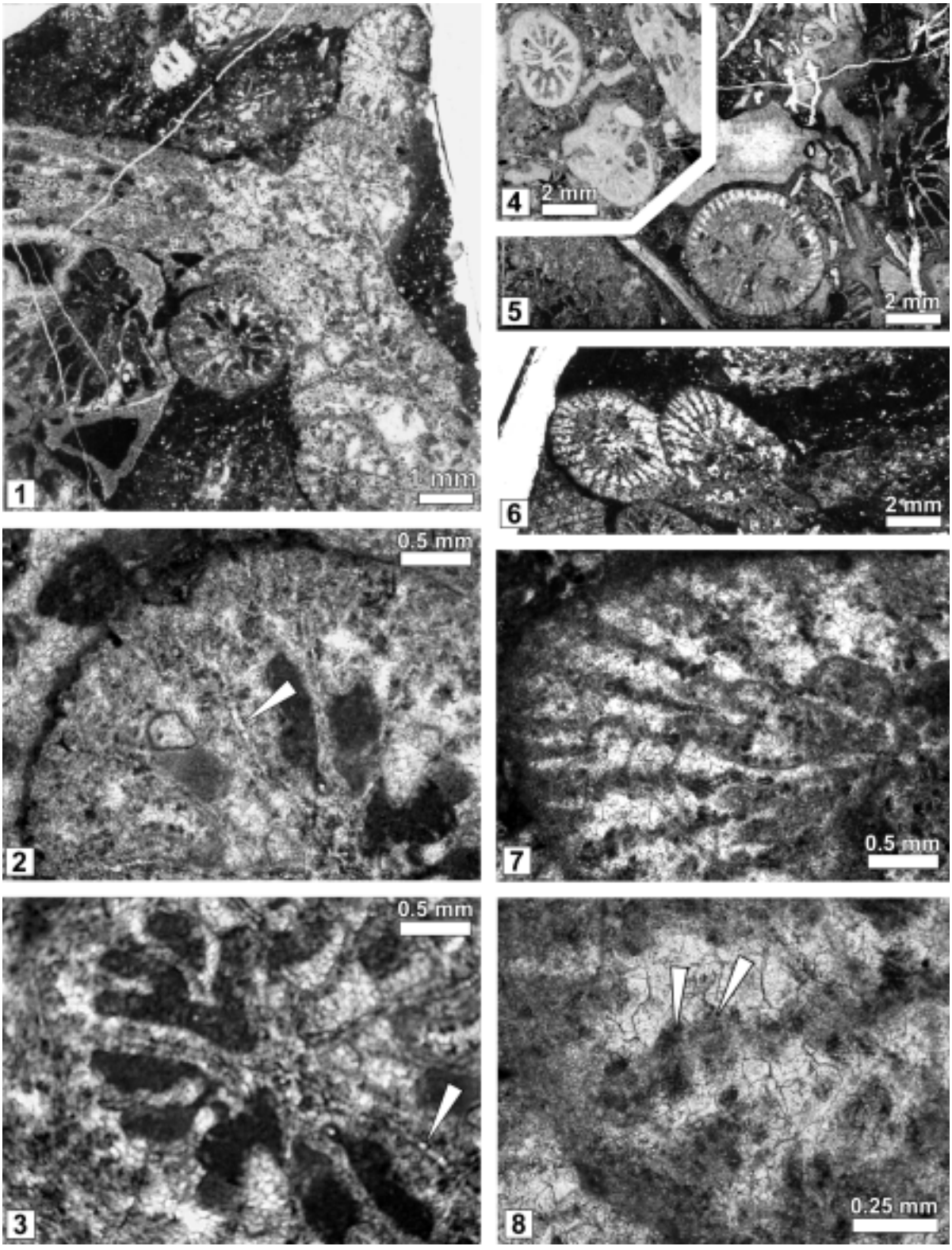

Fig. 3. 1–3 — *Enallhelia vrsatecis* n. sp., holotype, SNM Z 24223: 1 — longitudinal section of a branch, and transverse section of corallites occurring in two rows along the branch. The section of the branch shows large dissepiments; 2–3 — enlarged septal portions from Fig. 3.1, show (arrows) closely spaced trabecular centers (white dots) forming rather straight septal mid-line. Note also smooth lateral septal faces. **4** — *Stylosmilia corallina* Koby, SNM Z 24186/1. Transverse section of corallites. **5** — *Placophyllia* aff. *dianthus*, SNM Z 24195/1, transverse section of corallite. **6–8** — *Placophyllia tenuis* Roniewicz, SNM Z 24225: 6 — transverse section of corallites; 7–8 — enlarged septa of the one of the corallites presented in Fig. 3.6, showing vestiges of origin septal microstructure (main and lateral trabecula centers — arrows) and distinct septal "ornamentation".

Remarks: Small fragment of phaceloid corallum belonging to the genus *Cladophyllia*, from which only one transverse thin section could be made. The material is insufficient for precise taxonomic identification of this specimen. In corallite diameters the specimen resembles *Cladophyllia excelsa* Koby from the "Astartian" of the Jura Mts (Koby 1888) and *Cladophyllia* aff. *excelsa* Koby from the Kimmeridgian of Czarnogłowy in Poland (see Morycowa & Roniewicz 1990).

Family: **Euheliidae** de Fromentel, 1861
Genus: *Enallhelia* Milne Edwards et Haime, 1849
Type species: *Lithodendron compressum* Goldfuss, 1829

Enallhelia vrsatecis n. sp.
Fig. 3.1–3

Holotype: Specimen: SNM Z 24223, Fig. 3.1.

Type locality: Vršatec klippe near Vršatské Podhradie, Slovak part of the PKB, Western Carpathians (site No. 22).

Type horizon: Vršatec Limestone (Oxfordian), Czorsztyn Succession.

Name derivation: *vrsatecis* — from the area of origin.

Diagnosis: *Enallhelia* with a corallite diameter ranging from about 3 to 4.5 mm and number of costosepta reaching maximum 40–48 (cycles I–III and mainly incomplete cycle IV).

Material: The holotype only (No. SNM Z 24223) composed of several fragments of branches embedded in limestone, from which two thin sections were made.

Microfacies type of coral-bearing limestones: biomicrite with sponge spicules and radiolarians.

Dimensions (in mm): D of branches = 3–5; d cor = 3–4×3.5–4.5 (5); c–c in one range = 4–6.5; S = 24 + nS4; (6S1 + 6S2 + 12S3 + nS4); den s = 6/2; den c = 6–8/2.

Description: Several branches of dendroid corallum with short, subcylindrical corallites arranged in two rows subalternatively along a branch. Corallites are thickened by peritheca. Radial and simultaneously subbilateral symmetry in the arrangement of septa can be seen. Bilaterality results from joining two opposite septa (sometimes slightly thicker than other septa S1) with the columella. Septa S1 reach to the centre, septa S2 long but with differentiated length, septa S3 short and some septa S4 only in the wall. Columella small, styliform. Septothecal wall. Endotheca composed of large, oblique vesicular dissepiments coming from the wall (Fig. 3.1). Budding extracalicinal, lateral, subalternative.

Microstructure: Simple, straight row of trabecula centres can be observed in some septa (Fig. 3.2–3).

Remark: The new species differs from the other Jurassic and Cretaceous species from the genus *Enallhelia* in larger corallite diameters and more numerous septa. The new species is most similar to *E. multiradiata* described by Zlatarski (1966) from the Lower Cretaceous in Bulgaria. Therefore, it also differs from the latter in larger corallite diameter (in *E. multiradiata*: d = ca. 2 mm, S = more than 48 mm).

Suborder: **Rhipidogyrina** Roniewicz, 1976
Family: **Placophylliidae** Eliášová, 1990
Genus: *Placophyllia* d'Orbigny, 1948
Type species: *Lithodendron dianthus* Goldfuss, 1826

Placophyllia tenuis Roniewicz, 1976
Fig. 3.6–8

v1976 *Placophyllia tenuis* Roniewicz, p. 68, Pl. 13, Fig. 5a,b
?1990 *Placophyllia tenuis* Roniewicz — Errenst, p. 196, Pl. 11, Fig. 5

Material: One fragment of corallum: SNM Z 24225 (1 thin section, together with *E. vrsatecis* n. sp. and *A.* aff. *clermontei* Lath.).

Dimensions (in mm):
Vršatec specimen: d cor = 4–5; S = 24 + nS4.
Holotype: (Roniewicz 1976: p. 68): d cor = 4–5; S = 12 + 12 + nS4.

Description: Phaceloid corallum. Corallites subcircular in transverse sections. Septa arranged in radial, hexameral, but not clearly regular symmetry. They are differentiated in two to four size orders depending on calicular diameters. Septa S1 reach the corallite centre, other septa gradually shorter, S4 short and occurring irregularly. Lateral surfaces of septa with large granules, wall thin, epicostal. Columella small, round or elongated. Thin epitheca can be seen in transverse thin section. Budding extracalicinal, lateral.

Microstructure: Despite an advanced diagenetic alteration the neorhipidacanth septal microstructure can be seen (Fig. 3.7–8).

Remarks: *P. tenuis* has similar corallite diameters and number of septa as *P. minima* Geyer from the Upper Jurassic of Portugal (Geyer 1955b; Rosendahl 1985). However, it differs from the latter in lacking one better-developed septum (see Roniewicz 1976).

The specimen described by Errenst (1990) as ?*Placophyllia tenuis* Roniewicz differs from the Romanian specimens (Roniewicz 1976) in smaller corallite diameters and less numerous radial elements.

Occurrence: *lower Kimmeridgian*: Romania (Dobruja) and ?northwestern Spain.

Placophyllia cf. *dianthus* (Goldfuss, 1826)
Fig. 3.5

1826 *Lithodendron dianthus* Goldfuss, p. 45, Pl. 3, Fig. 8
1875 *Placophyllia dianthus* Goldf. sp. — Becker, p. 140, Pl. 36, Figs. 9a,b, 10
1970 *Placophyllia dianthus* (Goldfuss) — Beauvais, p. 1122–1123
v1976b *Placophyllia dianthus* (Goldfuss) — Eliášová, p. 338–339, Pl. 1, Fig. 3; Pl. 2, Figs. 1, 2
v2003 *Placophyllia dianthus* (Goldfuss) — Kołodziej, p. 213, Fig. 27 (here older and complementary synonymies)

Material: Two thin sections of corallites: SNM Z 24195/1,2 (with Montlivaltiidae).

Dimensions (in mm): d cor = 5–6.5; S = 24–ca. 40 (S1–S3 + nS4).

Remarks: Fragmentary specimens, known from only two cross-sections. They differ from those described in

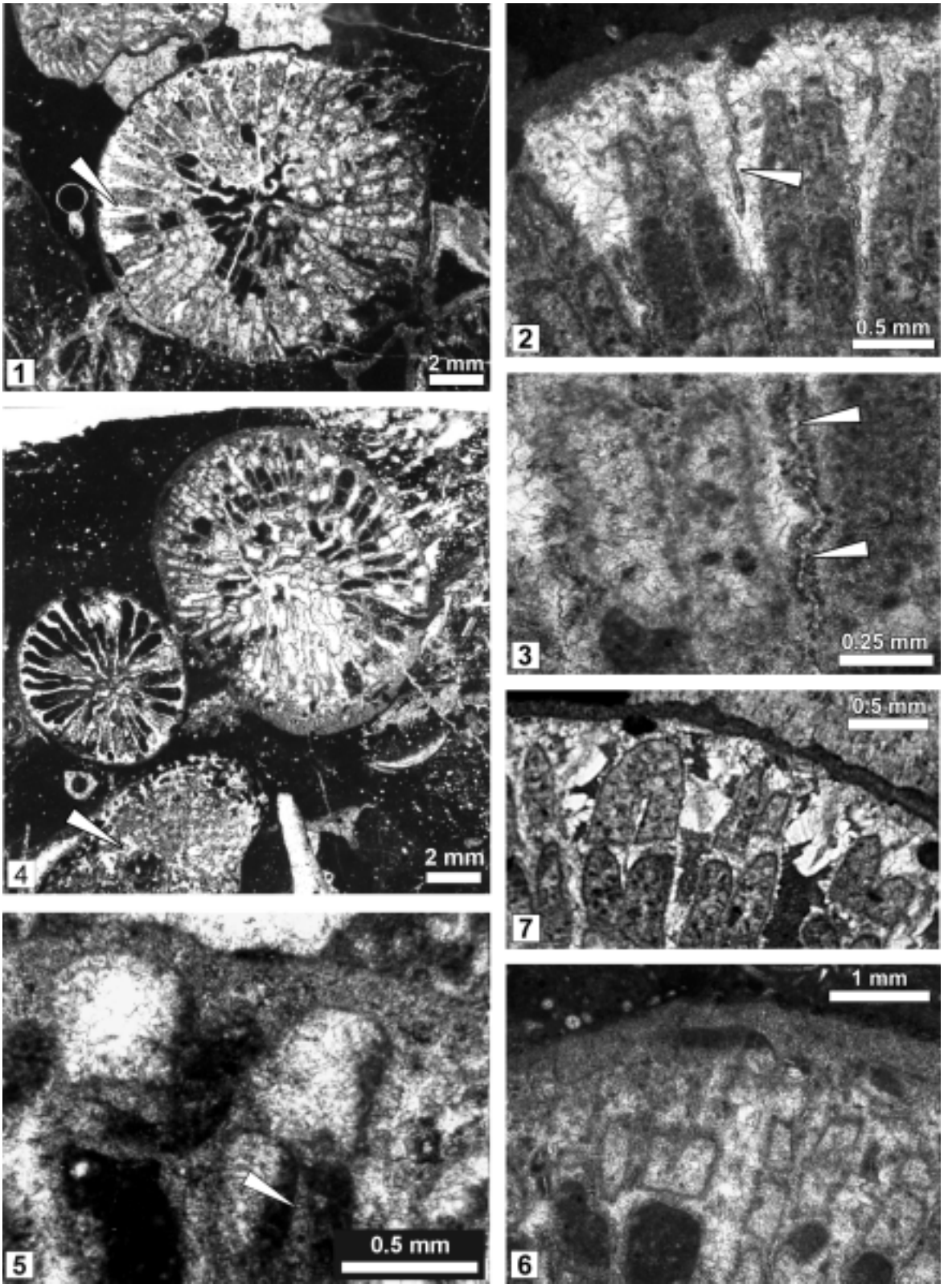

Fig. 4. 1–7 — *Atelophyllia* aff. *clermontei* Lathuilière. **1** — corallite in transverse section (SNM Z 24226). Arrow shows the septum presented in Fig. 4.2. **2** — enlarged septal portion from Fig. 4.1 showing slightly wavy mid-septal line (arrow). **3** — enlarged fragment of septa from Fig. 4.1 showing minitrabecular centers (white spots) forming mid-septal line (arrows). **4** — transverse section of corallites *A*. aff. *clermontei* (SNM Z 24229) and thin section of branch fragment of *Dendraraea dendroidea* (arrow). **5–7** — enlarged fragments of corallites *A*. aff. *clermontei* presented in Fig. 4.4, illustrating the build of the wall and lonsdaleoid-like septa of the higher order (Fig. 4.5 — arrow).

the literature as *P. dianthus* in slightly smaller corallite diameter (i.e. d in Becker 1875 = 8–9 mm; in Beauvais 1970 = 4.5–9.5 mm). However, recently Lauxmann (1991) and Kołodziej (2003) have treated *Placophyllia rugosa* Becker, 1875 (having slightly smaller corallite diameter as in Roniewicz 1966: d = 5–6 (6.5) mm) as a younger synonym of *Placophyllia dianthus*. On this view our specimens fit within the range of corallites diameter for this species.

Occurrence: *upper Oxfordian:* Poland (Holy Cross Mts); *lower Kimmeridgian*: France (Jura), Germany (Nattheim), Portugal; *upper Oxfordian–lower Kimmeridgian*: South Slovenia; *Tithonian–lower Berriasian*: Czech Republic (Štramberk reg.); *Tithonian–Berriasian*, ?*Valanginian*: Poland (exotic limestones in Outer Carpathians); *Upper Jurassic*: South Germany and Croatia.

Suborder: ?**Pachythecaliina** Eliášová 1976, emend. Roniewicz et Stolarski 2001
Family: **Incertae sedis**
Genus: *Atelophyllia* Lathuilière, 2000
Type species: *Atelophyllia clermontei* Lathuilière, 2000

Atelophyllia aff. *clermontei* Lathuilière, 2000
Fig. 4.1–7

2000 *Atelophyllia clermontei* Lathuilière, p. 165, 167, Figs. 21: 4–8

Material: Two fragments of corallum: SNM Z 24226 (1 thin section) and SNM Z 24229 (1 thin section) imbedded in reddish biomicritic limestone with radiolarians and sponge spicules.

Dimensions (in mm):

Specimens from Vršatec Limestone: d cor small = 6×6; d cor larges = 8–10×10–12; S = 30–ca. 50; th s (max. thickness, in middle part): S1 small corallite = 0.1; S1 large corallite = 0.1–0.2; S1 wall zone, small corallite = 0.2–0.3, 0.3–0.5; S1 wall zone, large corallite = 0.4–0.7, 0.3–0.5; den tr c = 3–5/100 μm.

Holotype: (Lathuilière 2000: p. 167): d cor small = 5.8; d cor larges = 11–13; S = 26–30; 37–48; th s (max. thickness) = 150–375 μm, 75–325 μm.

Description: Phaceloid coralla. Corallites subcircular in transverse sections. Radial elements arranged in radial, not clearly regular symmetry. Septa are differentiated in two to four size orders depending on calice diameter. They are compact, generally thin, straight, flexuous or crooked, thickened in the wall zone, gradually thinning towards the axial zone, except septa S1 and S2, which are generally thickened at their internal end where they sometimes form paliform structures. Short septa resembling lonsdaleoid ones can be observed in some corallites (Fig. 4.5). Lateral surfaces of septa are smooth, large irregular granules occur in places. Columella parietal, weak. Wall thin, in continuation with septa. Thin epitheca can be seen in transverse thin section.

Microstructure of septa finely trabecular with closely packed centres (white dots), forming in places straight or slightly wavy (see Fig. 4.2) septal mid-line. The fibres in transverse wall section are similar in structure and arrangement to those in the septa.

Remarks: The specimens presented here show close similarity in the morphology and microstructure to *Atelophyllia clermontei* Lathuilière (Lathuilière 2000). As the specimens are incomplete, a precise identification was not possible.

On account of its minitrabecular microstructure of septa, character of the wall and occurring lonsdaleoid (or ?lonsdaleoid-like) septa, this genus has been included with reservation in the suborder Pachythecaliina.

Occurrence: *lower Bajocian*: North-East France (Flacé).

Suborder: **Astraeoina** Alloiteau, 1952
Family: **Montlivaltiidae** Dietrich, 1926
Genus: *Thecosmilia* Milne Edwards et Haime, 1848
Type species: *Lithodendron trichotomum* Goldfuss, 1826

Thecosmilia trichotoma (Goldfuss, 1826)
Fig. 5.1–8

1826 *Lithodendron trichotomum* Goldfuss, p. 45, Pl. 13, Fig. 6
v1884 *Thecosmilia trichotoma* Münster — Koby, p. 168–169, Pl. 45, Figs. 1, 1a, 2
1905 *Thecosmilia trichotoma* Münster — Koby, p. 848
?v1960 *Thecosmilia trichotoma* (Goldfuss) — Roniewicz, p. 454–456, Pl. 1, Figs. 1, 2; Pl. 2, Figs. 1–4; Pl. 3, Figs. 1, 2
1979 *Thecosmilia trichotoma* (Goldfuss) — Mišík, p. 19, Pl. 20, Fig. 1
1982 *Thecosmilia trichotoma* (Goldfuss) — Bendukidze, p. 43–44, Pl. 15, Fig. 5
1991 *Thecosmilia trichotoma* (Goldfuss) — Lauxmann, p. 146–148 (here supplementary synonymies)
1991 *Thecosmilia trichotoma* (Goldfuss) — Lebanidze, p. 22–23, Pl. 7, Fig. 3a,b
1993 *Thecosmilia trichotoma* (Goldfuss) — Bertling, p. 90–91, Pl. 2, Figs. 3, 4
v1994 *Thecosmilia trichotoma* (Goldfuss) — Eliášová, p. 67, Pl. 2, Figs. 1–4
?1996 *Thecosmilia* cf. *trichotoma* (Goldfuss) — Baron-Szabo & Steuber, p. 13, Pl. 5, Figs. 3, 6
1997 *Thecosmilia trichotoma* (Goldfuss) — Turnšek, p. 206, Pl. 206, Figs. A–C
2003 *Thecosmilia trichotoma* (Goldfuss) — Helm et al., p. 81, 82

Material: 8 fragmentary coralla and 12 thin sections: SNM Z 24183 (1 thin section), SNM Z 24185/1,2,3 (3 thin sections), SNM Z 24193 (1 thin section), SNM Z 24194 (1 thin section), SNM Z 24196 (1 thin section), SNM Z 24202/1,2 (1 thin section), SNM Z 24203/1,2 (2 thin section), SNM Z 24204 (1 thin section).

Dimensions (in mm):

Specimens described here: d adults = (14) 15–20 (22) ((25)); d during increase = ca. 20–25 (28) ((32)); S = ca. 70–90 (100); th s (max. thickness between carenes): S1 and S2 = (0.2) 0.3–0.5 (0.6), S3 = 0.3–0.4, S4 = 0.1–0.15 (0.2); den c = ca. (5) 7–8 (9)/5; den car = 3–5(6)/2; den end (central part) = ca. 5–6/5.

Koby (1884: p. 16): d cal (adults) = 15–18; S = 80–90; den c = 9–10/5.

Description and remarks: Fragments of phaceloid coralla, composed of short, subcylindrical corallites, oval or subcircular in transverse sections. Costosepta generally thin, differentiated in four to five size orders. Septa of two first size orders are subequal and reach corallite centre. Septa

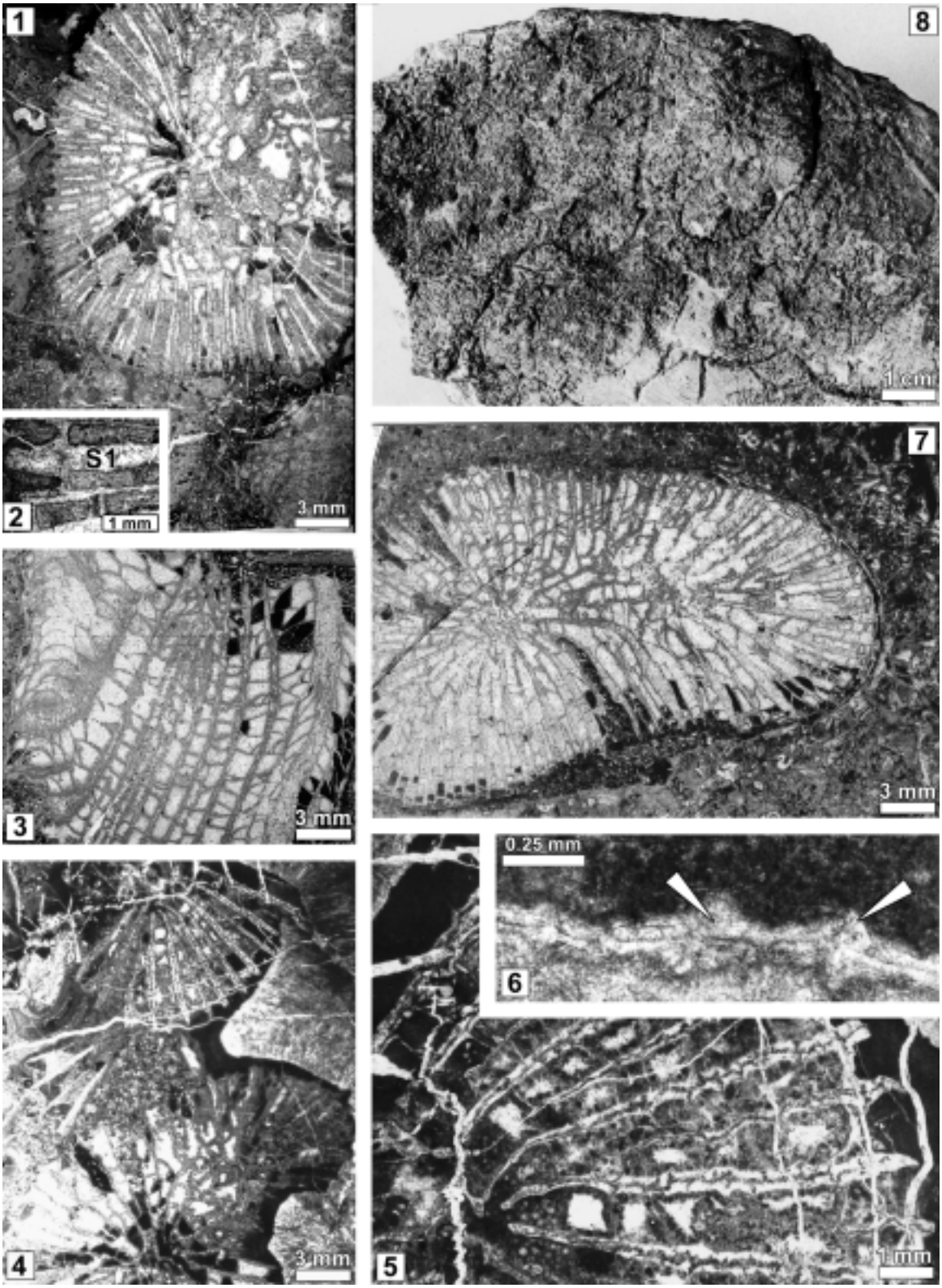

Fig. 5. 1–8 — *Thecosmilia trichotoma* (Goldfuss). **1–2** — SNM Z 24194: 1 — transverse section of corallite; 2 — enlarged fragment of septa from Fig. 5.1 shows the difference in thickeness between septum S1 and S3 (below). **3, 7** — SNM Z 24202/1,2: 3 — thin longitudinal corallite section (2) showing dense endothecal dissepiments; 7 — transverse section of corallite (1) during the budding. **4–6** — SNM Z 24203/1: 4 — transverse section of corallites; 5 — enlarged portion of the corallite presented in upper part of Fig. 5.4, showing relics of original septal microstructure (black line); 6 — more enlarged septum fragment of the same specimen, showing montlivaltiid type microstructure. Arrows show centres of lateral trabeculae and simultaneously the transverse carena sections. **8** — fragment of limestone with poorly preserved (damaged) calicular surfaces of *Th. trichotoma (*SNM Z 24202).

of the highest order are very short, thin and of varying number. Structure of septa, wall and endotheca does not differ from those described from Upper Jurassic of many other European regions. Some differences concern only the slightly lower costal density in the Slovak species in comparison with Swiss or other specimens (Koby 1884, costal density: 9–10/5). However some specimens described as *Th. trichotoma* have also lower costal density, including those described by Morycowa (1974) from Tithonian exotic limestones of Polish Outer Carpathians (den c = 7–8/5 mm) and from South Portugal (Rosendahl 1985: den c = 8–9/5 mm).

Th. trichotoma described by some authors from Early Cretaceous (including the Aptian; Baron-Szabo & Steuber 1996) require verification.

Occurrence: Almost cosmopolitan in the *upper Oxfordian-Kimmeridgian* shallow water marine deposits of the European regions: Switzerland (also *middle Oxfordian*), France, England, Slovenia, South Portugal, Spain, Germany (Würtemberg, Lower Saxony), Poland (Holy Cross Mts), Ukraine (Crimea), Georgia (Caucasus), and rarely in the *Tithonian*: Czech Republic (Štramberk reg.), Poland (Outer Carpathians; exotic limestone) and Serbia, as well as in the ?*Lower Cretaceous* in Greece.

Thecosmilia dichotoma Koby, 1884
Fig. 6.1–3

v1884 *Thecosmilia ?dichotoma* Koby, p. 175, Pl. 46, Figs. 4–8
1954 *Thecosmilia ?dichotoma* Geyer, p. 182, Pl. 14, Fig. 15
1955a *Thecosmilia dichotoma* Koby — Geyer, p. 200
v1966 *Thecosmilia dichotoma* Koby — Roniewicz, p. 212, Pl. 12, Fig. 3a,b
1972 *Thecosmilia dichotoma* Koby — Turnšek, p. 175–176, Pl. 13, Figs. 3, 4
v1974 *Thecosmilia dichotoma* Koby — Morycowa, p. 466, Pl. 5, Fig. 1
v1976a *Thecosmilia dichotoma* Koby — Eliášová, p. 169, Pl. 1, Fig. 2
v*1979* *Thecosmilia dichotoma* Koby — Mišík, p. 19
1982 *Thecosmilia dichotoma* Koby — Bendukidze, p. 50
1985 *Thecosmilia dichotoma* Koby — Rosendahl, p. 47, Pl. 1, Fig. 7
1991 *Thecosmilia dichotoma* Koby — Lauxmann, p. 149, Pl. 6, Fig. 10
1991 *Thecosmilia dichotoma* Koby — Lebanidze, p. 21–22, Pl. 7, Fig. 2a,b
1997 *Thecosmilia dichotoma* Koby — Turnšek, p. 204, Pl. 204, Figs. A–D

Material: 5 incomplete coralla and 8 thin sections: SNM Z 24184/1,2 (2 thin sections), SNM Z 24189 (1 thin sections), SNM Z 24190 (1 thin section), SNM Z 24206 (1 thin section), SNM Z 24207 (1 thin section), SNM Z 24208 (1 thin section), SNM Z 24210 (1 thin section, together with *Cladophyllia* sp.).

Dimensions (in mm):

Vršatec specimens: D (SNM Z 24190) = 45×110; H (SNM Z 24190) = ca. 80; d young = (8) 10; d adults = 11–13–15 (16); c–c = 13–30; cor–cor = 1–10; S = 36–40–ca. 50; th s (max. thickness) = S1 and S2 = (0.25) 0.3–0.43, S3 = 0.12–0.2; den c = 6–8/5; den car (transv. sect., peripheral) = 3 (4)/2; den end (central part) = 5–6/5.

Koby (1884): d young = 5–10; d adults = 10–15; S = 4 cycles and some of 5 cycle; den c = 8/5.

Description and remarks: Fragments of phaceloid coralla belonging to the genus *Thecosmilia*. On account of corallite diameters and the number of radial elements they were included into *Thecosmilia dichotoma* Koby.

According to some authors *Th. dichotoma* Koby survived until the Early Cretaceous (Baron-Szabo & Steuber 1996: p. 14).

Occurrence: Age interval: *late Oxfordian–late Kimmeridgian*: Switzerland, South Portugal, Germany (Würtemberg), Poland (Holy Cross Mts), Slovenia, Ukraine (Crimea), Georgia (Caucasus); *Tithonian*: Czech Republic (Štramberk region) and Poland: Outer Carpathians (exotic limestone); ?*Aptian*: Central Greece.

Thecosmilia aff. *dichotoma* Koby, 1884
Fig. 6.4

v1884 *Thecosmilia ?dichotoma* Koby, p. 175, Pl. 46, Figs. 1–8 (synonymy as in the description of *Th. dichotoma* Koby above)

Material: One incomplete corallum: SNM Z 24205 (1 thin section).

Dimensions (in mm): d adults = 16.5–18; S = ca. 40–50; den c = 7–8/5.

Remarks: Specimen described here resembles those of *Th. dichotoma* at the adult stage, in number and arrangement of septa. However, it differs in having larger corallite diameters.

Occurrence: *Th. dichotoma* occurs in the *Oxfordian–Tithonian* of European regions.

Thecosmilia sp.

Material: Fragments of corallites: SNM Z 24218/1,2 (2 thin sections).

Dimensions (in mm): d adults = 8–13; den s = 6–8/5.

Remarks: Poorly preserved fragments of phaceloid coralla. On account of the morphology of corallites and micromorphology of radial elements they are included in the genus *Thecosmilia* Milne Edwards et Haime.

Genus: *Complexastrea* d'Orbigny, 1849
Type species: *Astrea rustica* Defrance, 1826

Complexastrea carpathica Morycowa, 1974
Fig. 6.6,7

v1974 *Complexastraea carpathica* Morycowa, p. 470–472, Text-Fig. 7, Pl. 7, Fig. 1; Pl. 10, Fig. 3; Table 2
v1976a *Complexastraea carpathica* Morycowa — Eliášová, p. 174
v1979 *Complexastraea carpathica* Morycowa — Mišík, p. 19, Pl. 20, Fig. 2

Material: Two incomplete colonies and 3 thin sections: SNM Z 24216 (1 thin section), SNM Z 24214/1,2 (2 thin sections).

Dimensions (in mm):

Slovak specimens: d cor = 8–13; c–c = 8–12; S = ca. 36–38 + nS4; den s = 10–11/5; th s (max. thickness) = S1 = 0.16–0.20, S2 = 0.09–0.15, S3 = 0.08–0.09; den car = (4) 5–7/2; den end = ca. 10–12/5.

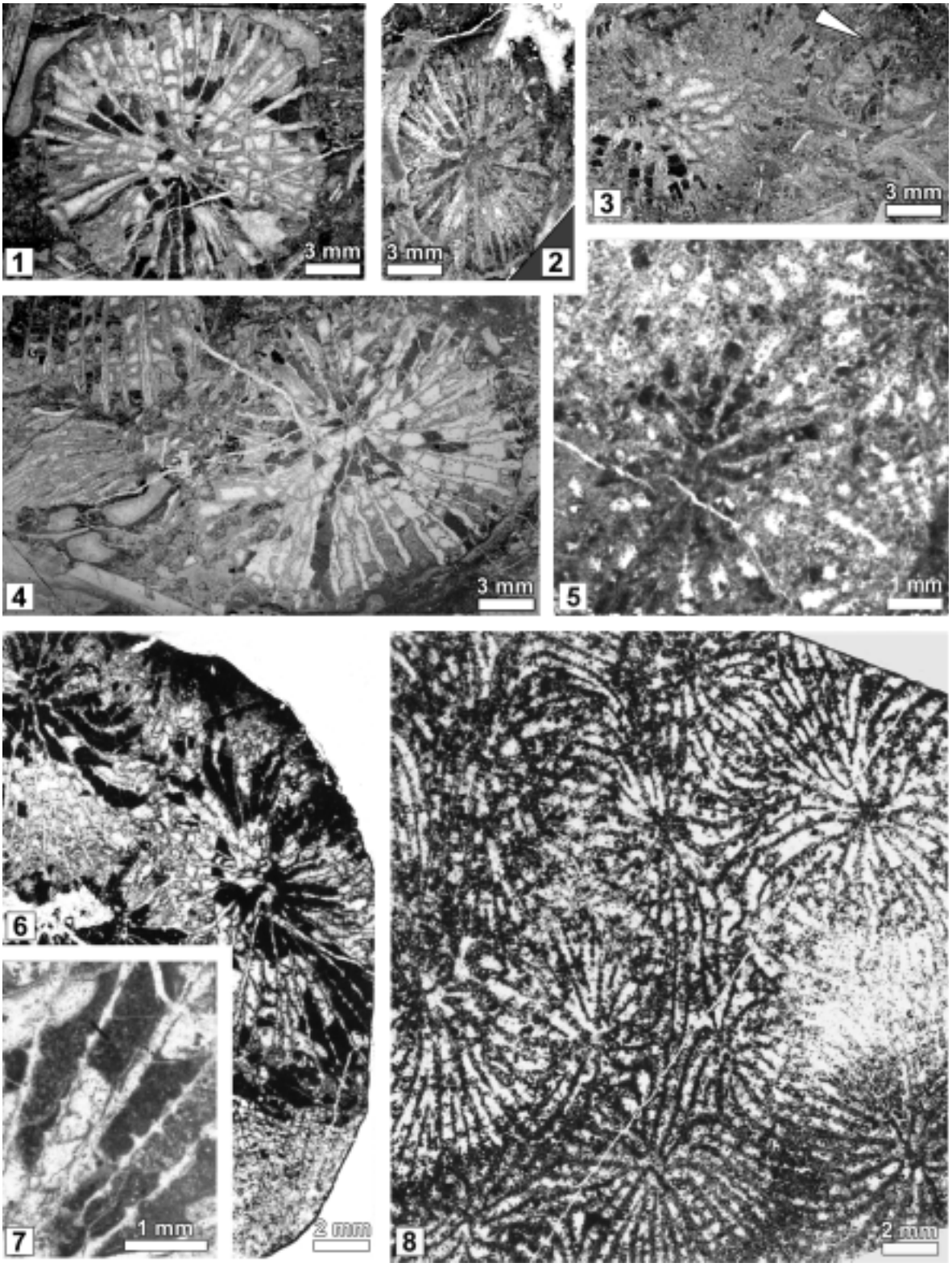

Fig. 6. 1–3 — *Thecosmilia dichotoma* Koby, transverse section of corallites (1 — SNM Z 24184/1; 2 — SNM Z 24190; 3 — SNM Z 24210). In Fig. 6.3 corallite *Th. dichotoma* during increase and transverse section of *Cladophyllia* sp. showed by arrow. **4** — *Thecosmilia* aff. *dichotoma* Koby, SNM Z 24205, transverse section of corallite. **5** — ?*Complexastrea* sp., SNM Z 24187 presenting transverse thin section of corallites. **6–7** — *Complexastrea carpathica* Morycowa, SNM Z 24214/1: 6 — transverse section of corallites (see Mišík 1979, Pl. 20); 7 — enlarged fragment of some septa from Fig. 6.6 showing characteristic montlivaltiid septal microarchitecture. **8** — *Complexastraeopsis kouteki* Eliášová, SNM Z 24199, transverse section of colony fragment showing corallites singles and arranged in series (see Mišík 1979: Pl. 20).

Polish specimens (Morycowa 1974): d cor = 7–12 (13); c–c = 7–12 (13); S = 36–46; den s = 10–12/5; th s (max. thickness) = S1 — 0.15–0.20 (0.3), S2 — ca. 0.1, S3 — ca. 0.08; den car = 4–6/2; den end = 11–13/5.

Description: Massive, incomplete colonies. Corallites subpolygonal with subcircular calices. Columellar space small, slightly elongated. Costosepta non- or subconfluent, 36–38 in number, very thin, but with length and thickness depending on size orders. 10 to 12 of them almost reach the centre of corallites. Septa S3 and S4 occur irregularly and in varying numbers. Lateral septal faces with well developed carenae. Endotheca composed of tabuloid elements, concave in the central part of corallites and convex in their peripheral parts. Vesicular dissepiments present mainly in peripheral corallite zones.

Remarks: Slovak specimens coming from the Oxfordian biohermal white limestones (Mišík 1979: p. 19) are almost identical with those described from the Polish Carpathians (Morycowa 1974). *C. carpathica* shows similarity to other Late Jurassic species such as *Complexastrea thevenini* Etallon and *C. carinata* Roniewicz, but differs from these species mainly in smaller corallite diameters and slightly lower number of costosepta (see Morycowa 1974: Table 2).

Occurrence: *upper Tithonian*: Czech Republic (Štramberk region), Poland (Outer Carpathians (exotic limestones)).

?*Complexastrea* sp.
Fig. 6.5

Material: One thin section: SNM Z 24187.

Dimensions (in mm): d cor = 4–7; d l = 2.5–3.5; c–c = 5–7; S = 24S1–S3 + nS4; den s = 10–12/5; den car = 4–5/1.

Description: Subpolygonal corallites with subcircular or oval lumen. Septa differentiated in three size orders, septa S1 and S2 (ca. 12) subequal and with auricula-like forms. The remaining septa gradually shorter and occurrring less regularly. Traces of the montlivaltiid-type microstructure visible in some septa. Paraseptotheca, incomplete.

Remarks: The specimen is studied only on the basis of the one transverse thin section, thus it could be only, with reserve, placed in the genus *Complexastrea*.

Genus: *Complexastraeaopsis* Morycowa, 1974
Type species: *Complexastraea lobata* Geyer, 1965

Complexastraeopsis kouteki Eliášová, 1976
Fig. 6.8

1976a *Complexastraeopsis kouteki* Eliášová, p. 175–176, Pl. 8, Fig. 1a,b
1979 *Complexastraeopsis kouteki* Eliášová — Mišík, p. 19, Pl. 20, Fig. 3

Material: One specimen SNM Z 24199 (1 thin section).

Dimensions (in mm):

SNM Z 24199: d cor individual = ca. 10–11; width of series = 7–11; c–c in series = 5–9; c–c between series = 6–14; S (cor adults) = ca. 38–56; den s = 9–11/5; den end (axial zone) = 9–10/5.

Eliášová (1976a): d calices = 10–12; width of series = 8–10; c–c in series = 4–11; c–c between series = 10–14; S (cor adults) = 43–ca. 50; den s = 8–10/5; den end = 9–12/5.

Description and remarks: Massive, incomplete colony. Corallites subpolygonal with subcircular calices, in places forming short series within which the corallites are connected by one to four "septes de vallée". Generally, its description fully corresponds to that given by Eliášová (1976a).

Occurrence: *Tithonian*: Czech Republic (Šramberk region).

Family: **Isastraeidae** Koby, 1889, emend. Alloiteau, 1952
Genus: *Isastrea* Milne Edwards et Haime, 1851
Type species: *Astrea helianthoides* (Goldfuss, 1826)

Isastrea helianthoides (Goldfuss, 1826)
Fig. 7.6,7

1826 *Astrea helianthoides* Goldfuss, p. 65, Pl. 22, Fig. 4a (not Fig. 4b)
1990 *Isastraea helianthoides* (Goldfuss) — Errenst, p. 193–194, Pl. 11, Fig. 2a–2c. (here older and supplementary synonymies)
1973 *Isastraea helianthoides* (Goldfuss) — Babaev, p. 102, Pl. 9, Fig. 2
1982 *Isastrea helianthoides* (Godfuss) — Bendukidze, p. 58, Pl. 13, Fig. 5; Pl. 18, Figs. 3, 4
1991 *Isastrea helianthoides* (Goldfuss) — Lauxmann, p. 154–155, Pl. 7, Figs. 4, 5
1993 *Isastrea helianthoides* (Goldfuss) — Pandey & Fürsich, p. 54, Pl. 14, Figs. 4, 5
1993 *Isastrea helianthoides* (Goldfuss) — Bertling, p. 94–95, Pl. 2, Figs. 3, 4
1994 *Isastraea helianthoides* (Goldfuss) — Eliášová, p. 67, Pl. 1, Fig. 2
1994 *Isastraea helianthoides* (Goldfuss) — Liao & Xia, p. 165, Pl. 47, Figs. 4–6
1997 *Isastraea helianthoides* (Goldfuss) — Turnšek, p. 107, Pl. 107A–E
2003 *Isastrea helianthoides* (Goldfuss) — Pandey & Fürsich, p. 54
2003 Isastrea helianthoides (Godfuss) — Helm et al., p. 83

Material: 5 fragments of colonies and 7 thin sections: SNM Z 24197/1,2 (2 thin sections), SNM Z 24198 (1 thin section), SNM Z 24192 (1 thin section), SNM Z 24215/1,2 (2 thin sections), SNM Z 24219 (1 thin section).

Dimensions (in mm): d = 5–9; c–c = 4.5–8; S = 30–60; th s (max. thickness between carenae) = 0.2–0.3; den s = 9–12/5; den car (near wall) = 6–8/2.

Description and remarks: Incomplete, massive and lamellar, cerioid colonies. Corallites polygonal in transverse section. Columella parietal, weak. The diameter of corallites, number and density of septa show that they represent *I. helianthoides* (Goldfuss). The species discussed is very well known from the Upper Jurassic deposits of Europe and does not need detailed description.

The specimen *Isastrea helianthoides* from the lower Callovian of Iran (see Pandey & Fürsich 2003: Pl. 14, Fig. 5b) has "Septa of adjacent corallites generally confluent", which raises doubts about their belonging to the genus *Isastrea*.

Occurrence: The species is known from the age interval *middle Oxfordian–late Kimmeridgian* in France, Germany, Northwestern Spain, SW and NW Germany, Poland (Holy Cross Mts), Romania (Dobruja), Slovenia, Czech Rep. (Moravia), Georgia (Caucasus), Azerbaijan (Lesser Caucasus) and Ukraine (Crimea), as well as generally from the *Late Jurassic* in China (Tibet). This species was described recently from the *lower Callovian* of East-central Iran.

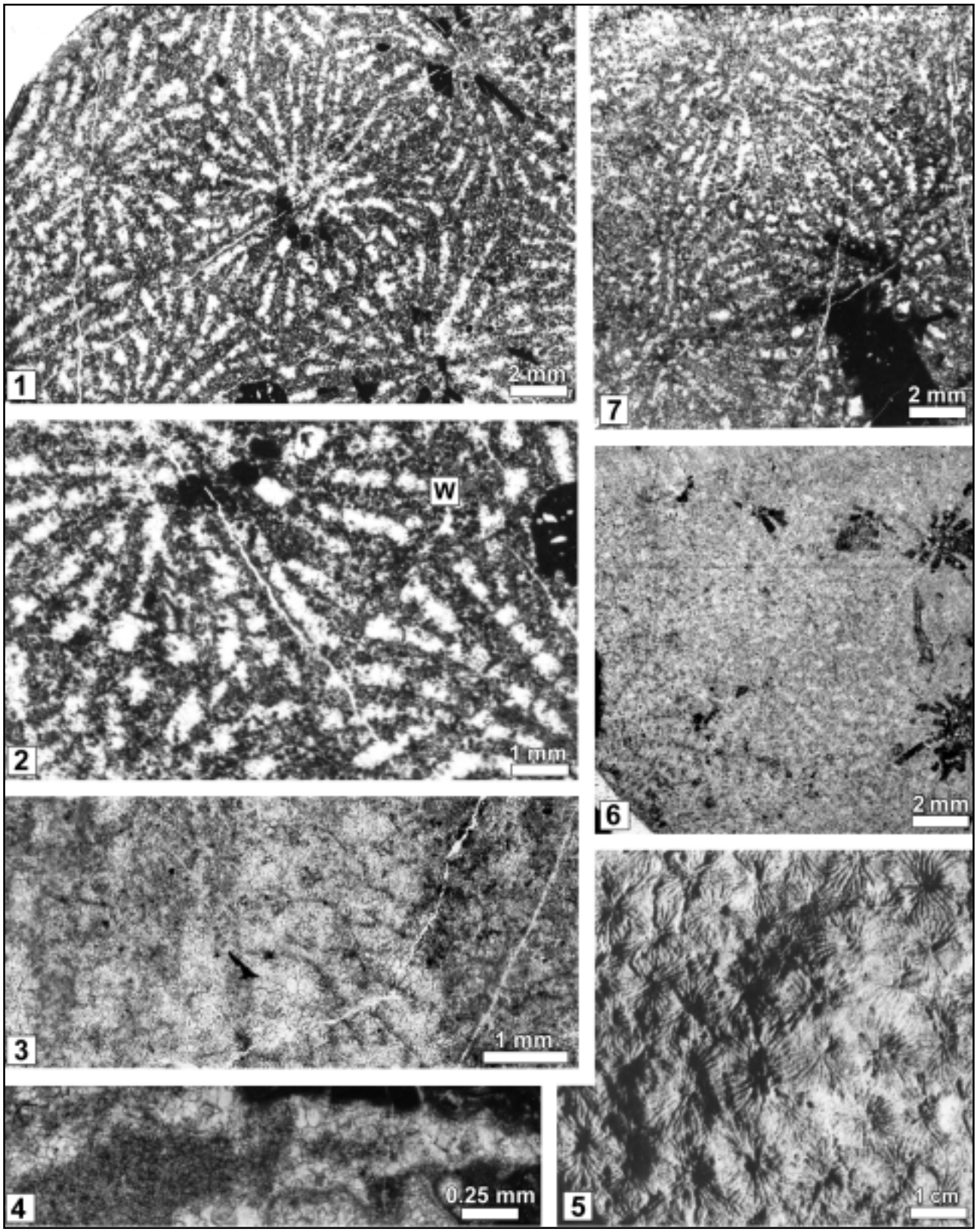

Fig. 7. **1–5** — *Isastrea robusta* n. sp., holotype, SNM Z 24200: 1 — transverse section of corallites (SNM Z 24200/1); 2 — enlarged portion of Fig. 7.1 showing corallites with thick radial elements and well-developed septo-parathecal wall (w); 3 — longitudinal section of corallite (SNM Z 24200/2) showing vesicular endothecal dissepiments; 4 — enlarged septum S2 from the thin transverse section presented in Fig. 7.1, showing traces of the centres of thick trabeculae; 5 — fragment of the calicular surface of colony (see Mišík 1979: Pl. 9, Fig. 1). **6–7** — *Isastrea helianthoides* (Goldfuss): transverse section of corallites (6 — SNM Z 24192; 7 — SNM Z 24198).

Isastrea robusta n. sp.
Fig. 7.1–5

Holotype: SNM Z 24200; Fig. 7.1–5.

Derivatio of name: *robusta* (Lat.) — after strong septa.

Type locality: Vršatec, Vršatec Limestone; Oxfordian.

Diagnosis: *Isastrea* with up to 40 thick septa subequal in thickness, at 8–10 mm corallite diameters. Septal density near wall zone is 5–6 per 5 mm and density of carenae — 5 per 2 mm.

Material: Two colonies and 4 thin sections: SNM Z 24200/1,2 (2 thin section), SNM Z 24201/1,2 (2 thin section).

Dimensions (in mm): D = ca. 100×150; H = ca. 30; d = 8–10; c–c = 8–11; S = ca. 24–32(40); th s (max. thickness between carenae) S1 and S2 = 0.5–0.6; den s = 5–6/5; den car (near wall) = 3–5/2; car-car = 0.3–0.5.

Description: Lamellar, cerioid colonies. The holotype shows altered upper colony surface. Corallites rather regularly polygonal in transverse section. Gemmation intracalicinal with lamellar linkages. Septa thick, arranged in three rarely four, size orders. Septa S1 and S2 subequal, S3 and S4 thinner and usually considerably shorter. Lateral septal faces with granules fuse to form carinae. Axial cavity narrow, in some corallites weak parietal columella can be formed. Septothecal wall well marked. Dissepiments vesicular, slightly inclined in peripheral zone and subtabuloid in corallite axial zone.

Microstructure: The skeletons are recrystallized but vestiges of primary microstructure and lateral septal microarchitecture are preserved in places. The microstructure is characteristic of the montlivaltiids.

Remarks: Variety in the number of septa and corallite diameters is important for the species identification. These two specimens have fewer and thicker septa than other known *Isastrea* with the same corallite diameters. Thus they are described as a new species *Isastrea robusta* n. sp.

I. robusta n. sp. differs from the *Isastrea helianthoides* in larger corallite diameter, thicker and less dense septa. It is most similar to *I. crassiseptata* Becker from the Kelheim (Becker 1875), which has 6–8 mm corallite diameters and 40–50 strong, subequal in thickness, septa.

Family: **Dermosmiliidae** Koby, 1889
Genus: *Calamophylliopsis* Alloiteau, 1952
Type species: *Calamophyllia flabellata* de Fromentel, 1861

Calamophylliopsis stockesi (Milne Edwards et Haime, 1851)

1850–1854 *Calamophyllia stockesi* Milne Edwards et Haime, p. 89–91, Pl. 16, Fig. 1, 1a–d
1857 *Calamophyllia stockesi* Milne Edwards et Haime — Milne-Edwards & Haime, t. II, p. 344
1888 *Calamophyllia stockesi* Milne Edwards et Haime — Solomko, p. 134–135, Pl. 2, Fig. 11
1913 *Calamophyllia* cf. *stokesi* Milne Edwards et Haime — Speyer, p. 222, Pl. 22, Fig. 25
1937 *Calamophyllia stockesi* Milne Edwards et Haime — Mirchink, p. 70–71, Pl. 1, Fig. 6
1949 *Calamophyllia stockesi* Milne Edwards et Haime — Bendukidze, p. 80–81
non 1964 *Calamophyllia stockesi* Milne Edwards et Haime — Kolosvary, p. 220, Pl. 1, Figs. 8, 25; Pl. 9, Fig. 3
1991 *Calamophylliopsis stockesi* (Milne Edwards et Haime) —Lebanidze, p. 30, Pl. 11, Fig. 1a; Pl. 12, Fig. 1a,b
1997 *Calamophylliopsis stockesi* (Milne Edwards et Haime) —Turnšek, p. 30, Fig. 30 (here complementary synonymies)
2003 *Calamophylliopsis stockesi* (Milne Edwards et Haime) —Helm et al., p. 83, Fig. 8C

Material: Corallum fragments and 1 thin sections: SNM Z 24191.

Dimensions (in mm): d cor = 3.5–6.5 (7); c–c = 6–10; S = ca. 40–60.

Remarks: Fragments of phaceloid corals with round or slightly oval corallites in cross-sections. Character of skeleton strongly suggests they belong to *Calamophylliopsis stockesi (*Milne Edwards et Haime).

Occurrence: *middle Oxfordian–Kimmeridgian*: France, England, Germany (e.g. Kelheim, Lower Saxony), Poland (Holy Cross Mts), Slovenia, Romania (Dobruja), northwestern Spain, south Portugal, Ukraine (Crimea) and Georgia (Caucasus); *Tithonian*: Serbia. It seems that *Calamophylliopsis stockesi* from the Upper Jurassic of Hungaria (Transylvania; Kolosvary 1964) does not represent this species (see Kolosvary 1964: Pl. 1, Fig. 25).

Calamophylliopsis moreauana (Michelin, 1843)
Fig. 8.9

1843 *Lithodendron moreausiacum* Michelin, p. 95, Figs. 3, 4
1990 *Calamophylliopsis moreauana* (Michelin) — Errenst, p. 202, Pl. 12, Fig. 8a,b (here older and complementary synonymies)
1994 *Calamophylliopsis moreauana* (Michelin) — Liao et Xia, p. 116, Pl. 22, Figs. 6–9
1997 *Calamophylliopsis moreauana* (Michelin) — Turnšek, p. 29, Fig. 29A–E
2002 *Calamophylliopsis moreauana* (Michelin) — Löser et Mori, p. 97–99, Fig. 8.6,7
2003 Calamophylliopsis moreauana (Michelin) — Helm et al., p. 82, 83

Material: One small fragment of corallum (thin section: SNM Z 24220).

Dimensions (in mm): d cor = 3.5–5; d l = 2.2–3.5; c–c = ca. 6–8; S = to 40–50; den c = ca. 8–9/2.

Remarks: Fragment of a branching corallum representing *Calamophylliopsis moreauana* (Michelin).

Occurrence: *upper Oxfordian–Kimmeridgian*: Spain, France, Switzerland, Poland (Holy Cross Mts), Slovenia, Romania (Dobruja), China (Xizang); *Oxfordian* to *Kimmeridgian*: Japan. The species is cited (Helm et al. 2003) from the *middle Oxfordian* of NW Germany (Lower Saxony).

Family: **Kobyastraeidae** Roniewicz, 1979
Genus: *Kobyastraea* Roniewicz, 1979
Type species: *Kobyastraea lomontiana* Étallon, 1864

Kobyastraea bourgeati (Koby, 1887)
Fig. 8.5,6

1887 *Thamnastrea Bourgeati* Koby, p. 369, Pl. 100, Figs. 5, 6
1969 *Kobyastraea bourgeati* (Koby) — Caratini & Beauvais, p. 27, Pl. 2, Fig. 8a,b

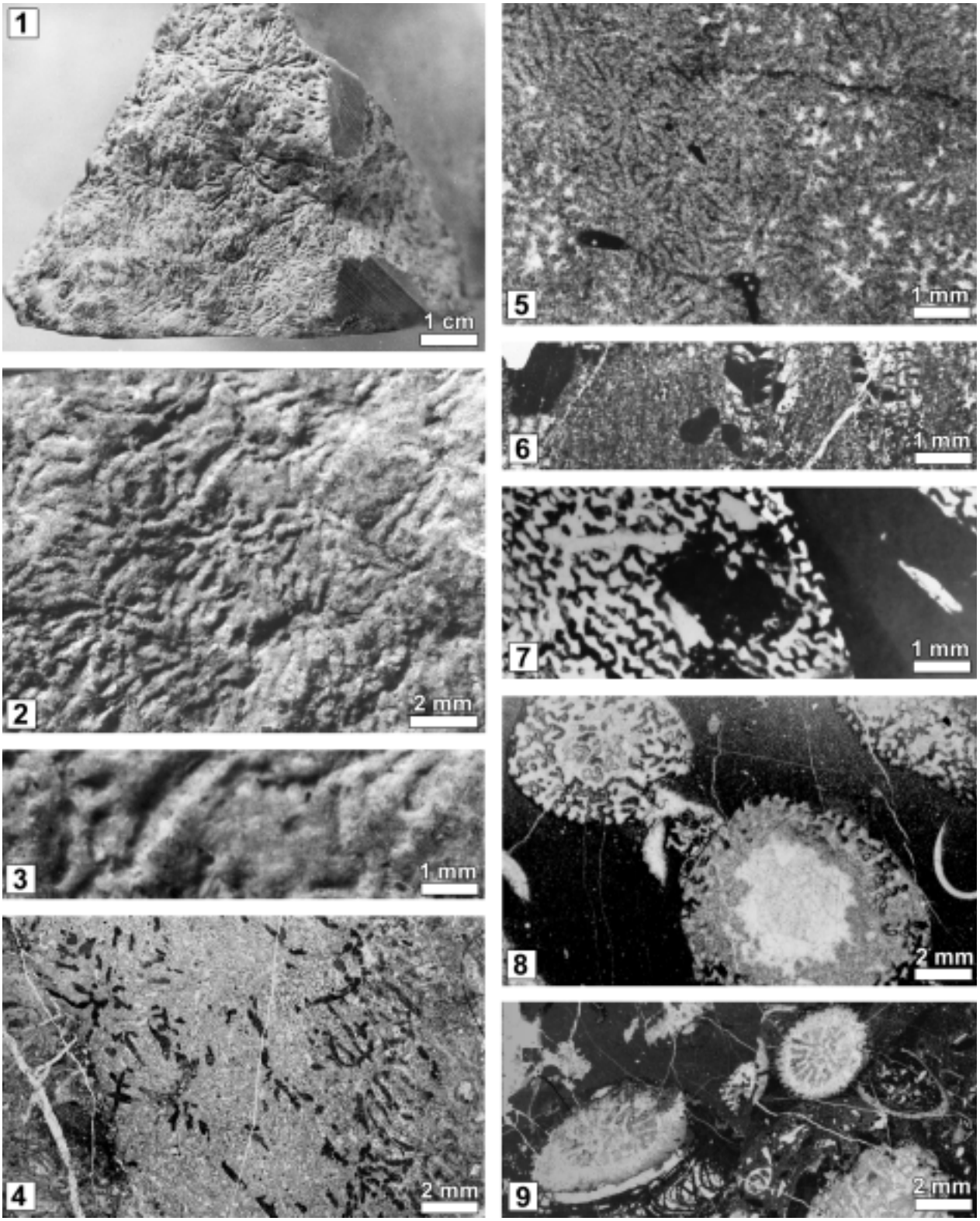

Fig. 8. **1–4** — *Periseris elegantula* (d'Orbigny), SNM Z 24212: 1 — specimen composed of two different coral colonies. *Isastrea* colony (upper part) and *Periseris* colony (lower part); 2 — calicular surface of the colony *Periseris elegantula*, presented in Fig. 8.1; 3 — enlarged fragment of thamnasteroid colony *Periseris elegantula* from Fig. 8.2 showing septa with well developed menianes; 4 — transverse section of colony fragment. **5–6** — *Kobyastraea bourgeati* (Koby), SNM Z 24211/1,2: 5 — transverse section (1); 6 — longitudinal section (2). Note tabuloid endothecal elements. **7** — Microsolenidae, gen. et sp. indet., SNM Z 24209, longitudinal section. **8** — *Dendraraea dendroidea* (Ferry), SNM Z 24230, transverse section of some branches (see Mišík 1979: Pl. 10, Fig. 2). **9** — *Calamophyllopsis moreauana* (Michelin), SNM Z 24220, tranverse section of corallites.

1991 *Kobyastraea bourgeati* (Koby) — Errenst, p. 13–14, Pl. 16, Fig. 1a–e, (here older synonymies)

Material: 1 colony SNM Z 24211/1,2 (2 thin sections).

Dimensions (in mm): c–c = 1.2–2.5 (3); S = 20–28; den tr c = 5–6/1.

Remarks: Small thamnasterioid colony. Septa thick, all subequal in thickness, confluent, arranged most frequently in three size orders; 10 to 12 reach to the centre. Anastomosis present. Lateral septal faces with flattened granules. Axial cavity small, with parietal columella formed of styliform, slightly oval form and septal paliform teeth. Synapticulotheca incomplete. Dissepiments subtabular, concave in corallite centre and with vesicular elements in peripheral zone.

Occurrence: *upper Oxfordian–lower Kimmeridgian*: Poland (Holy Cross Mts); *lower Kimmeridgian*: Portugal, France, Algeria; *Kimmeridgian*: NE Spain.

Suborder: **Microsolenina** Morycowa et Roniewicz, 1995
Family: **Latomaeandridae** Alloiteau, 1952
Genus: *Periseris* Ferry, 1870
Type species: *Agaricia elegantula* d'Orbigny, 1850

Periseris elegantula (d'Orbigny, 1850)
Fig. 8.1–4

1850 *Agaricia elegantula* d'Orbigny, t. 1, p. 293
1990 *Periseris elegantula* (d'Orbigny) — Lathuilière, p. 38, Pl. 1–5 (here older and complementary synonymies)
1993 *Periseris elegantula* d'Orbigny — Pandey & Fürsich, p. 37, Text-Fig. 22, Pl. 11, Fig. 2
2000 *Periseris elegantula* (d'Orbigny) — Lathuilière, p. 157, Fig. 13.1,2
2001 Periseris elegantula d'Orbigny — Pandey & Fürsich, p. 486
2003 *Periseris elegantula* d'Orbigny — Pandey & Fürsich, p. 94–96

Material: 1 colony: SNM Z 24212 and 1 thin section.

Dimensions (in mm): c–c = 3–6; S = 20–30; th S1 (thickness with menianes, in middle part) = 0.5–0.6; den s = 4–7/3; den d (distal edge) = 3–4/1.

Remarks: Small colony sublamellar, thamnasterioid. The specimen agrees well with *Periseris elegantula* (d'Orbigny). The species is very well known mainly from the Bajocian deposits. Recently it has been described in detail by Lathuilière (1990).

Occurrence: *lower Bajocian*: northeastern France (Flacé); *upper Bathonian–upper lower Callovian*: Western India (Pandey & Fürsich 2001), *Middle Jurassic*: Iran.

Family: **Microsolenidae** Koby, 1889
Dendraraea d'Orbigny, 1849
Type species: *Alveopora racemosa* Michelin, 1843

Dendraraea cf. *dendroidea* (Ferry, 1861)
Fig. 8.8

1998 *Dendraraea dendroidea* (Ferry) — Lathuilière & Gill, p. 150, Pl. 1, Figs. 3–8; Pl. 2, Figs. 1–7; Pl. 3, Figs. 2, 4–6; Pl. 4, Figs. 5, 6; Pl. 6, Figs. 1, 3
2000 *Dendraraea dendroidea* (Ferry) — Lathuilière, p. 155–157, Fig. 12.4,6,8, (here older synonymies)
2003 *Dendraraea dendroidea* (Ferry) — Pandey & Fürsich, p. 116, Pl. 33, Fig. 4

Material: Several fragmentary branches in 8 thin sections: SNM Z 24217/1 (together with *Cladophyllia rollieri*), SNM Z 24217/2, SNM Z 24221, SNM Z 24224 together with branche fragment of the *E. vrsatecis* n. sp. and ?*Isastrea* sp.), SNM Z 24227, SNM Z 24228, ?SNM Z 24229 (together with *Atelophyllia* aff. *clermontei*), as well as one thin section SNM Z 24230 (in Mišík 1979: Pl. 10, Fig. 2; Loc. 42).

Dimensions (in mm): D of branches = 6–9.5; den s (long. sect.) = 4–6/2; den pen (longit. sect.) = 3–4/1; S = to 30; c-c = ca. 5.

Remarks: The scarce and poorly preserved coral branch fragments do not allow its precise taxonomic identification. They can only be classified as *Dendraraea* cf. *dendroidea*. Detailed study of the species *D. dendroidea* and its comparison with other species of this genus (including the Upper Jurassic *D. racemosa* (Michelin)) were presented *in* Lathuilière & Gill (1998) and Lathuilière (2000).

Occurrence: This species is rather widely distributed in the *Middle Jurassic* (Bajocian: Eastern France, Morocco; *lower Callovian*: Iran), but it also occurs in the *Upper Jurassic* (personal communication from E. Roniewicz).

Gen. et sp. indet.
Fig. 8.7

Material: Fragments of lamellar colonies: SNM Z 24188 (1 thin section), SNM Z 24209 (1 thin section), SNM Z 24222 (1 thin section, together with Porifera).

Dimensions (in mm): den s (longit. sect.) = 5/2; den pen (longit. sect.) = 5/2.

Remarks: Longitudinal sections of a microsolenid can be observed in one longitudinal section. Their more precise identification is impossible, as transverse sections cannot be obtained.

Acknowledgments: We would like to express our sincere thanks to the reviewers, Prof. Ewa Roniewicz, Dr. Dragica Turnšek and one other unknown Reviewer, for their helpful comments and corrections of the manuscript. We are grateful to Ms Janina Ozga for linguistic corrections and Mr Waldemar Obcowski for his help in computer graphics.

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