New coral genera and species from the Rußbach and Gosau area (Upper Cretaceous; Austria)

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New coral genera and species from the Rußbach and Gosau area (Upper Cretaceous; Austria)

Hannes Löser & Matthias Heinrich

Abstract

From the Coniacian to Santonian of the Gosau Group in Austria, six new genera (*Astraraeatrochus*, *Geroastrea*, *Pachyheterocoenia*, *Pachyphylliopsis*, *Paractinacis*, *Synhydnophora*) within the families Astraraeidae, Heterocoeniidae, Negoporitidae, Phyllosmiliidae, and Synastraeidae, and 12 new species of Scleractinian corals are established (*Astraraeatrochus bachi*, *Crinopora ireneae*, *Crinopora thomasi*, *Geroastrea alexi*, *Gosaviaraea aimeae*, *Nefocoenia seewaldi*, *Nefocoenia werneri*, *Pachyheterocoenia leipnerae*, *Pachyphylliopsis magnum*, *Paractinacis uliae*, *Proplesiastraea rivkae*, and *Synhydnophora wagreichi*). The new taxa emerged during a systematic revision of the coral fauna of the so-called Gosau facies in the area of Rußbach and Gosau (Austria), which was for the first time carried out by the systematic preparation of thin sections and the application of more profound measurements of the corallite dimensions.

Keywords: Cretaceous, Corals, Austria, new taxa.

1. Introduction

During the past ten years, a profound taxonomic revision of the corals of the Gosau group (Upper Cretaceous to Paleocene) in the area of the villages Russbach and Gosau (Salzburg and Oberösterreich states, Austria) was carried out by a team of authors and is in preparation for publication. This revision is mainly based on thin sections, a technique that was hitherto scarcely applied to these coral faunas, probably because of the excellent outer appearance of the corals. More than two thousand specimens were collected in recent years, and nearly ten thousand specimens were reviewed in museum and university collections in Bonn, Jerusalem, Leipzig, Munich, Paris, Tübingen, and Vienna. More than 700 thin sections have been prepared in order to investigate the taxonomy of the coral fauna. The profound examination of the material yielded various new genera and species that will be established and described here in detail.

Collection abbreviations: BSPG, Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany; GPSL, Geologische und Paläontologische Sammlung der Universität Leipzig, Germany; HUJI, National History Museum, Collections of the Hebrew University, Jerusalem, Israel; MHE, Coll. Matthias Heinrich, Eckental, Germany; NHMW, Naturhistorisches Museum Wien, Austria.

Abbreviations of morphological elements: c, corallite outer diameter; cdw, corallite distance in corallite rows; clmin, smaller inner corallite diameter; clmax, larger inner corallite diameter; cmin, smaller outer corallite diameter; cmax, larger outer corallite diameter; colmin, smaller diameter of the columella; colmax, larger diameter of the columella; crd, distance of calicular rows; crl, length of calicular rows; crw, width of calicular rows; md, distance of crests; s, number of septa; sd, density of septa.

Abbreviations of statistical data: n, number of measurements; min-max, range; μ, arithmetic mean; σ, standard deviation; cv, coefficient of variation according to K. Pearson (%); μ±σ, first interval.

2. Study area and material

The study area lies in the limit between the two Austrian federal states of Salzburg and Oberösterreich, in two valleys separated by a pass – Pass Gschütt. West of the pass lies the village Rußbach am Pass Gschütt, and to the east is Gosau village. The fossil bearing beds crop out along slopes and creeks, which often form deeply incised valleys (Fig. 1).

The formation of the Upper Cretaceous to Paleocene sediments of the Gosau Group is closely connected to the formation of the Alps Mountains that started with the opening of the Atlantic Ocean in the Middle Jurassic. In the Austrian phase in the mid-Cretaceous, the rocks deposited during the Mesozoic were folded and the Northern Calcareous Alps were formed. During the Turonian, the Gosau Group started with a transgression resulting in rocks that lies discordantly over Triassic sediments. In the study area, the succession starts with basal conglomerats of the Kreuzgraben Formation; upwards follow marls, sandstones and conglomerates of the Streiteck Formation; argillaceous marls with thin sandstone beds of the Grabenbach Formation; and an intercalation of marls, conglomerates, sandstones and limestones of the Hochmoos Formation. In the study area, the section terminates with marls and sandstones of the Bibereck Formation (Fig. 2). Fossil corals are mainly found in the Streiteck Formation, the Hochmoos Formation, and in a much lower

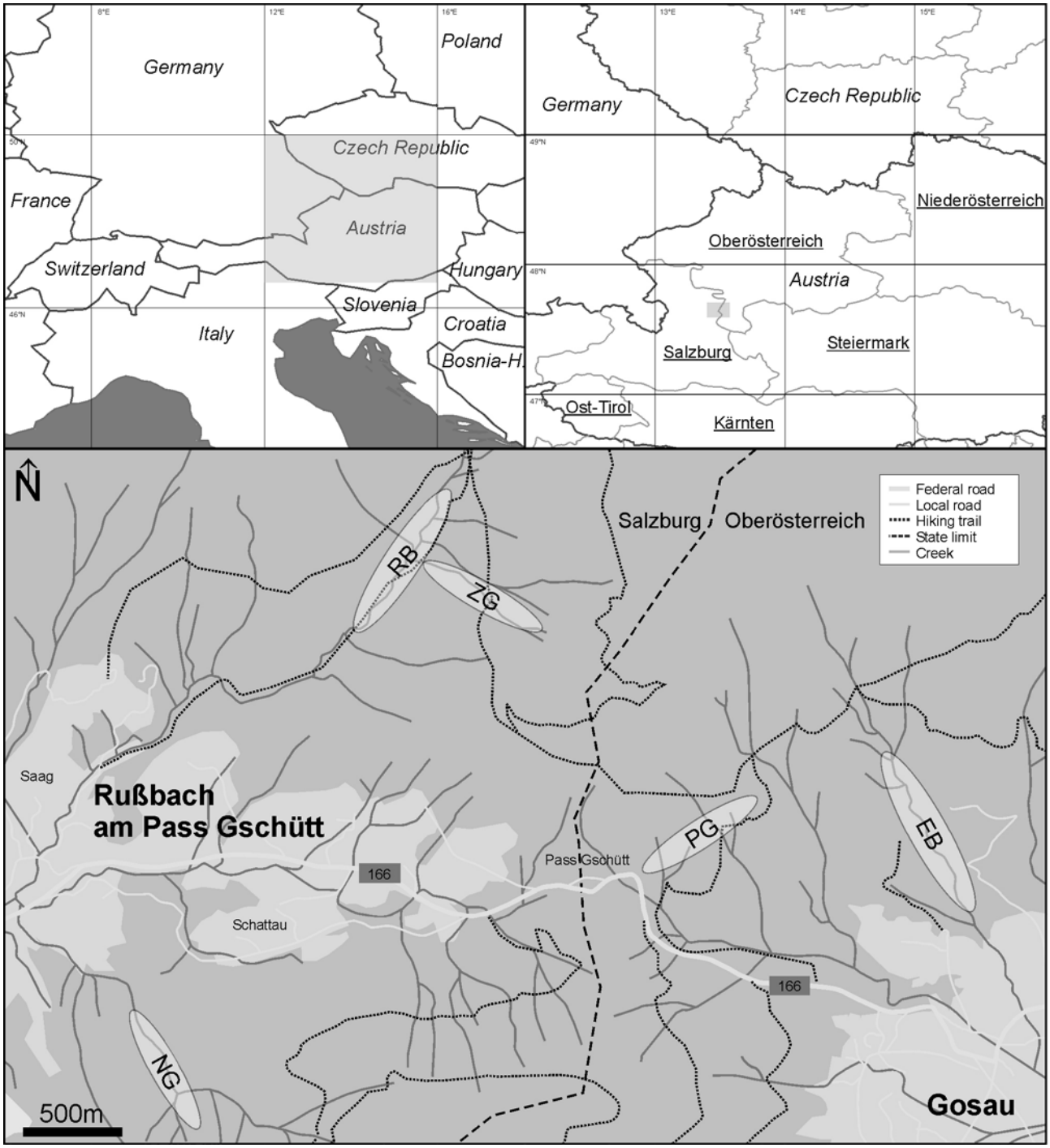

Fig. 1. Study area with important fossil sites. NG, Neffgraben; RB, Randobach; ZG, Zimmergraben; PG, Pass Gschütt; EG, Edlbachgraben.

concentration in the Grabenbach Formation (for more details see SUMMESBERGER et al. 2017 and WAGREICH et al. 2017). The literature lists approximately 60 localities (MOOSLEITNER 2004; LÖSER et al. 2005; ZORN 2016). The material collected for the above mentioned revision comes mainly from the Pass Gschütt area, the Zimmergraben, and the Randobach. Collections provided material from the Neffgraben and Edlbachgraben.

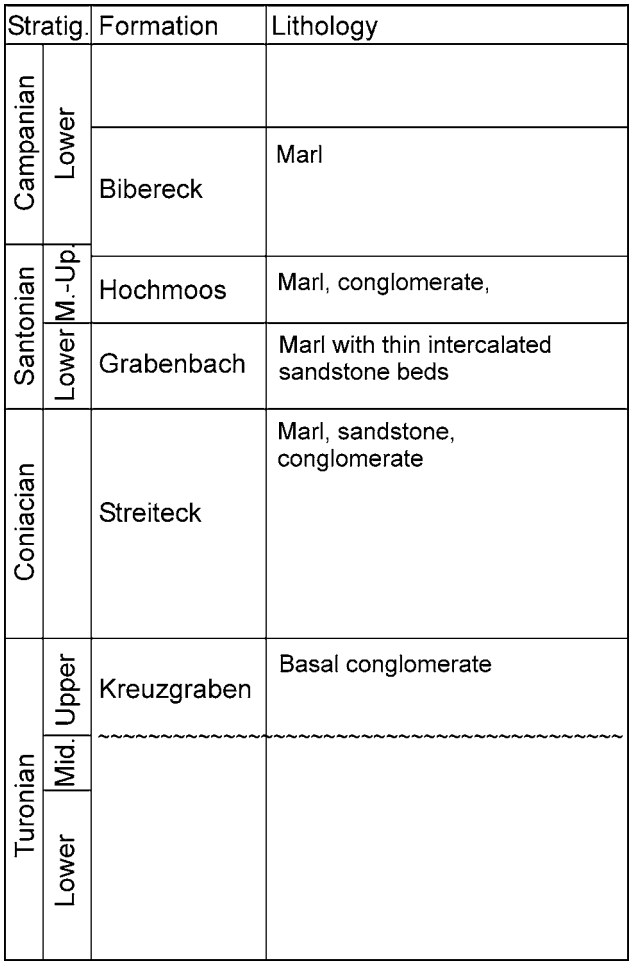

Fig. 2. Lithostratigraphic framework for the study area.

3. Systematic palaeontology

The classification system applied here follows Löser (2016). Suborders are not used anymore for practical reasons. Not all suborders are well defined and/or limited to a relatively small group of genera. The suborders of Amphiastraeina, Heterocoeniina, or Rhipidogyrina are well defined. Others, such as the Archeocaeniina, Faviina, or the Meandrinina, are defined using a conceptual idea or are undefined. When suborders are applied strictly, many families would remain without a suborder. These families would require the creation of new suborders. Hence, the classification system used applies superfamilies that group families together, in place of suborders.

Order Scleractinia Bourne, 1900

Superfamily Cladocoroidea Milne Edwards, 1857

Remarks: The families of this superfamily were formerly assigned to the suborder Faviina Vaughan & Wells, 1943. Because of nomenclatorial problems, the name-giving genus *Favia* is undefined (see Löser & Sklenár, 2016 for further explanation), and so the suborder.

Family Columastraeidae Alloiteau, 1952

Genus *Proplesiastraea* Oppenheim, 1930

Remarks: *Proplesiastraea* is an almost unknown genus. Improved examination methods allowed the establishing of its position in the Columastraeidae (see Löser & Zell 2015 for details). The genus is rare within the Gosau Group. The type species was not mentioned by Beauvais (1982); in other publications (Baron-Szabo 1997, 2014) it was assigned to the genus *Nefocoenia*, which now belongs to the Phyllosmiliidae (see below). Up to now, only the type species was known. Critical comparison of the type material of the type species with newly collected specimens revealed that probably three species exist: the type species, the here as new introduced species, and a species in which corallite dimensions lies between these two species.

Proplesiastraea rivkae spec. nov.
Fig. 3

Etymology: The species is dedicated to Rivka Rabinovich (National History Museum, Collections of the Hebrew University, Jerusalem, Israel), who allowed us to examine the corals of the collection of Paul Leo Oppenheim.

Type: Holotype BSPG 2018 II 1000, with two thin sections.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Randobach.

Type horizon: Gosau Group, Streiteck to Hochmoos formations, Coniacian–Santonian.

Diagnosis: *Proplesiastrea* with an inner small corallite diameter of 1.2–1.5mm, an inner larger corallite diameter of 1.4–1.9mm, and 24 septa in hexameral symmetry.

Material: Holotype with two thin sections, and another five colonies (MHE A0555, A0993, A0994, A1292, A2049).

Dimensions (BSPG 2018 II 1000):

	n	min–max	μ	σ	cv	μ±σ
clmin	25	1.14–1.59	1.34	0.13	10.1	1.20–1.48
clmax	25	1.32–2.08	1.66	0.24	14.5	1.41–1.90
ccd	25	1.47–2.14	1.80	0.15	8.6	1.65–1.96
s	25	18–24	22.32	1.72	7.7	21–24

Comparisons: The new species differs from *P. edelbachensis* Oppenheim, 1930 by smaller dimensions of the corallites.

Description: Plocoid colony. Circular to elliptical corallite outline. Septa compact. Septa and costae in outline thick in the area of the wall, tapering towards the corallite centre. Symmetry of septa radial and regularly hexameral. Septal cycles differ in length and thickness. The first cycle reaches 35% of the corallite diameter, the septa of the second and third cycle are shorter. Septa of the first two cycles can be connected to each other. Septal lateral faces with fine thorns. Pali occasionally occur at septa of the second cycle. Septa can be attached to the columella. Costae confluent or sub-confluent. Synapticulae absent. Columella consists of two lamellar blades. Endotheca consists of tabulae. Wall compact and septothecal. The width of

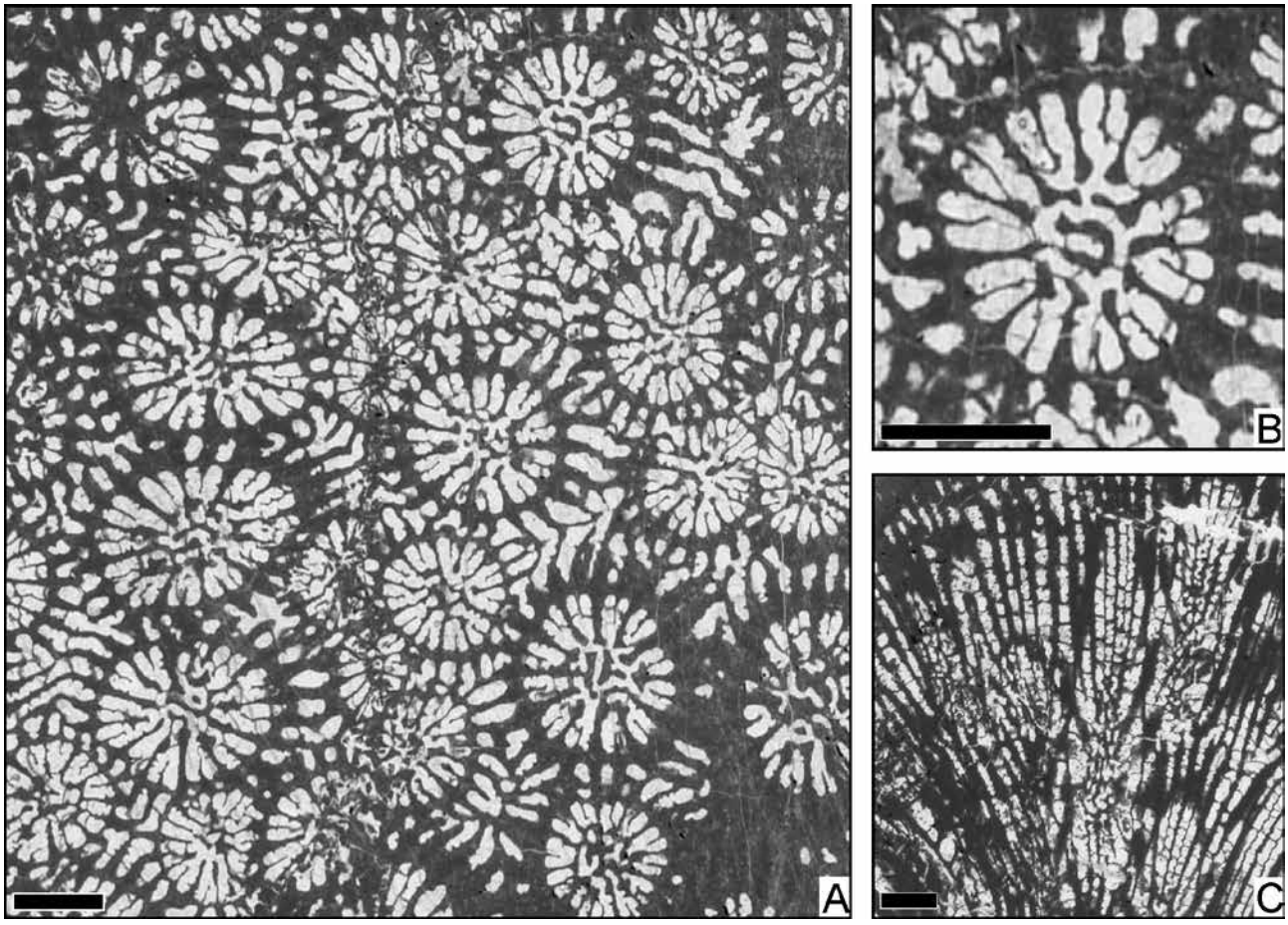

Fig. 3. *Proplesiastraea rivkae* spec. nov.; holotype, BSPG 2018 II 1000; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

the coenosteum measures about half of the corallite diameter and consists of costae and exothecal tabulae.

Occurrences: Coniacian-Santonian (Streiteck to Hochmoos formations) of the Randobach (Salzburg, Austria); Middle to Upper Santonian (Hochmoos Formation) of the Pass Gschütt area near Gosau (Oberösterreich, Austria).

Superfamily Cyclolitoidea Milne Edwards & Haime, 1849

Remarks: This superfamily corresponds to the suborder Microsolenina Morycowa & Roniewicz, 1995. The name-giving genus *Microsolena* itself is poorly defined; the type material of the type species is not available.

Family Negoporitidae Eliášová, 1995

Remarks: Eliášová (1995) established the new family without indicating a suborder, but placed it close to families where members are characterized by having pennulae – a balcon-like ornamentation of the septal lateral faces. The family is hitherto only known by its type genus *Negoporites* Eliášová, 1989, occurring throughout the Cenomanian.

Genus *Paractinacis* nov.

Type species: *Paractinacis uliae* spec. nov.

Etymology: After "*para"* in the sense of equal, referring to the very similar outer appearance of the new genus and the genus *Actinacis*.

Diagnosis: Astreoid colony with a strong, at the inner margin slightly perforated septa that stand in a bilateral symmetry. The septal lateral faces are ornamented with pennulae. The columella is small and styliform. The wall is synapticulothecal, in places septothecal, subcompact. Endothek with tabulae.

Description: Astreoid colony with regular circular corallites with a small diameter (less than 5mm). The corallite margins are slightly elevated. The septal symmetry is bilateral; the septa appear in three different size orders and at a number between 18 and 25. The septa of the different size orders differ in length and thickness. The septa of the first generation are thicker than that of the second and third generation. The septa of the

first two generations are longer than that of the third generation and almost reach the corallite centre. The septa of the third generation are shorter and about one third of the corallite radius. The septa are slightly perforated at the inner margins. They are thick in the wall and taper towards the corallite centre. The maximum thickness of the septa of the first two generations is 0.3mm whereas those of the third generation reach a thickness of 0.2mm. The septal upper border is granulated. The septal microstructure consists of large trabeculae. The septal lateral faces show pennulae. The costae are well developed and non-confluent. The columella is small and styliform. In places it cannot be well separated from a septum that is connected to it. The endotheca consists of tabulae. The wall is subcompact and is made of synapticulae, and in some places also by septa. The synapticulae are abundant and may form regular rings around the corallite in the wall area. A marginarium and holotheca do not exist. The coenosteum consists of costae and bold isolated trabeculae. The coenosteum is narrow; the space between the costae that is occupied by isolated trabeculae, does not measure more than five percent of the corallite diameter. The budding is extracalicinal.

Comparisons: Within the pennular corals – that are gathered here in the superfamily Cyclolitoidea – only the members of the familie Negoporitidae present a bilateral symmetry. In all other genera of the superfamily, the septal symmetry is irregular. The new genus is the second in the family and it is distinguished from *Negoporites* by the absence of pali, more compact septa, and the presence of synapticulae that form regular circles around the corallite. *Paractinacis* has a stouter skeleton and larger corallites than *Negoporites*. The outer appearance of *Paractinacis* resembles *Actinacis*, but differs from this genus by the presence of penulae, the formation of the wall, and the absence of pali. Septa and costae are thicker and the corallites larger than in *Actinacis*.

Species included: *P.* ? *elegans* (Reuss, 1854), *P. uliae* and another species in open nomenclature. The species only differ by their calicular dimensions.

Remarks: The here as newly described material was in the past assigned to *Actinacis*, as for instance *Actiniums elegans* in Reuss (1854, pl. 24, fig. 16-18); Oppenheim (1930, pl. 1, fig. 1 and pl. 10, fig. 1); and Beauvais (1982, pl. 48, fig. 4). Since thin sections were only occasionally prepared from corals of the Gosau area, the morphological difference between *Actinacis* and the new genus was never realized. The most striking difference – the stronger septa and costae – was interpreted as characteristic of one *Actinacis* species. *Paractinacis* mainly forms branches with a diameter of two to six centimetres. Large and massive colonies are very rare; the type of the type species, BSPG 2018 II 2000, is exceptionally large and measures 33 x 25 x 15 cm.

Occurrences: Lower Cenomanian (Altamira Formation) of Cobreces near Santander (Cantabria, Spain; Wilmsen 1997). Middle Cenomanian (Branderfleck Formation) of the Roßsteinalmen (Bavaria, Germany; Löser et al. 2013). Coniacian to Santonian (Streiteck to Hochmoos formations) around the villages Rußbach am Pass Gschütt (Salzburg), and Gosau (Oberösterreich, Austria).

Paractinacis uliae spec. nov.
Fig. 4

Etymology: The species is dedicated to Ulrike "Uli" Schuster, who has greatly supported the project of the revision of the Gosau corals, mainly through fieldwork.

Types: Holotype BSPG 2018 II 2000 (with two thin sections), paratypes BSPG 2018 II 0860 (with one thin section) and 0868 (with one thin section).

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Randobach.

Type horizon: Gosau Group, Streiteck to Hochmoos formations, Coniacian–Santonian.

Material: Types and another 11 specimens (MHE A0643, A1141, A1574, A1700, A1718, A1732, A1760, A1924, NHMW 2006z0391/0001, 0002, 0006).

Dimensions (BSPG 2018 II 2000):

	n	min–max	μ	σ	cv	μ±σ
clmin	30	1.14–1.89	1.51	0.19	12.8	1.31–1.70
clmax	30	1.30–2.07	1.63	0.22	13.6	1.41–1.85
cmin	30	2.92–3.66	3.33	0.22	6.7	3.10–3.55
cmax	30	2.95–3.86	3.52	0.21	6.0	3.31–3.74
ccd	25	2.74–4.47	3.60	0.39	10.8	3.21–4.00
s	20	21–25	23.50	1.05	4.4	22–25

Description: As for the genus.

Comparisons: The new species differs from *P. elegans* by a smaller calicular diameter. *P. elegans* is poorly defined since the type material is not available.

Occurrences: Middle Cenomanian (Branderfleck Formation) of the Roßsteinalmen (Bavaria, Germany). Coniacian–Santonian (Streiteck to Hochmoos formations) of the the Zimmergraben and Randobach (Salzburg, Austria).

Family Synastraeidae Alloiteau, 1952

Genus *Geroastrea* nov.

Type species: *Geroastrea alexi* spec. nov.

Etymology: After Gero Moosleitner (Salzburg), who has been a private collector for a long-time in the Gosau area and who provided significant sample material and advice for the present project.

Diagnosis: Thamnasterioid colony with corallites arranged in rows. The septal symmetry is irregular, but thick and thin septa alternate very regularly. Only thin septa have rare perforations. Septal lateral faces bear pennulae. Columella lamellar. Without wall. Endotheca with dissepiments and tabulae.

Description: Thamnasterioid colony with corallites arranged in regular rows. The septa run only between rows, not between corallites of the same row. Rows can easily be recognized. In places, the colony may be thamnasterioid without forming rows. The septa (as biseptal blades) appear in two types: thick compact and thin, irregularly perforated septa. The types alternate as, for instance, in the genus *Dimorphocoenia*. There is no septal symmetry. Most septa reach to the corallite centre. They are rarely connected to each other in the corallite centre. The number of septa is generally low. The septa microstructure probably consists of small trabeculae. The septa upper margin is smooth (or not preserved), the septal septal face bears pennulae and fine thorns. Synapticulae are rare. The columella is small and lamellar. There is no wall between the corallites. The endotheca consists of tabulae and subtabular dissepiments. Its development varies from specimen to specimen.

Comparisons: Within all families of the superfamily Cyclolitoidea, the new genus differs by the septa alternating in

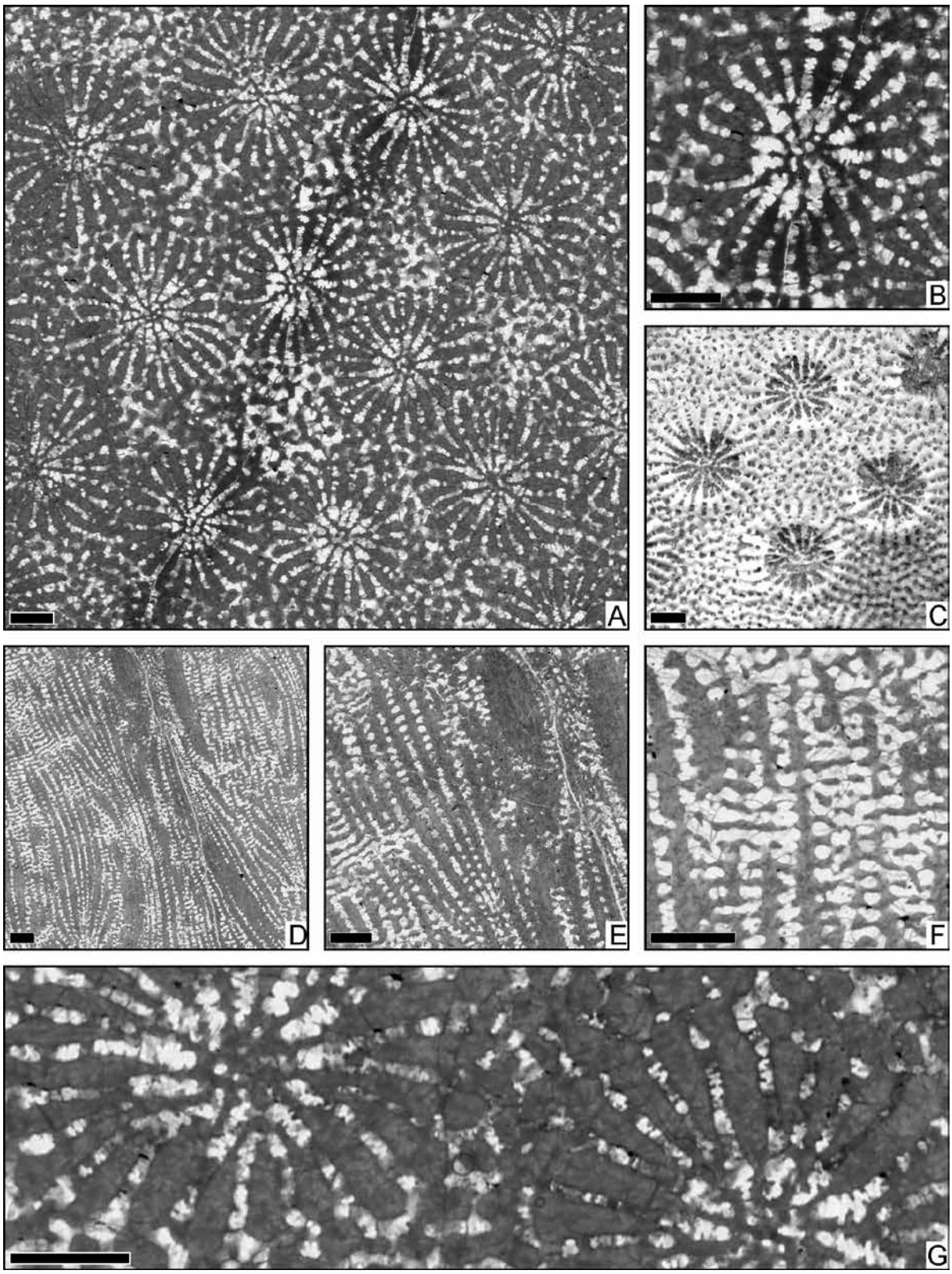

Fig. 4. *Paractinacis uliae* gen. nov. spec. nov.; holotype, BSPG 2018 II 2000; **a**: transversal thin section; **b**: detail; **c**: NHMW 2006z0391/0002, coral surface; **d**: BSPG 2018 II 2000; longitudinal thin section; **e**: detail; **f**: detail; **g**: microstructural details in a transversal thin section. – Scale bar equals 1 mm.

thickness. Such pronounced alternation is only known within the superfamily Montlivaltioidea.

Species included: *G. alexis*, *G. audiensis* (Reig Oriol, 1992), *G. haueri* (Reuss, 1854), *G. parvistella* (Oppenheim, 1930). See Table 1 for distinction of the species.

Remarks: The material described here as new was in the past assigned to *Dimorphastrea*. The small trabeculae makes the assignation to the Synastraeidae questionable.

Occurrences: Lower Coniacian of Bugarach (Les Corbière, Aude, France). Coniacian and Santonian of the Streiteck,

Table 1. Dimensions within the species included in *Geroastrea* gen nov.

Species	crd (mm)	cdw (mm)	s
alexis	5.4 – 6.9	3.8 – 6.7	16 – 20
audiensis	6.5 – 8.6	5.3 – 6.9	25 – 30
haueri	4.4 – 5.5	3.4 – 4.9	14 – 20
parvistella	2.7 – 3.6	1.7 – 2.8	17 – 22

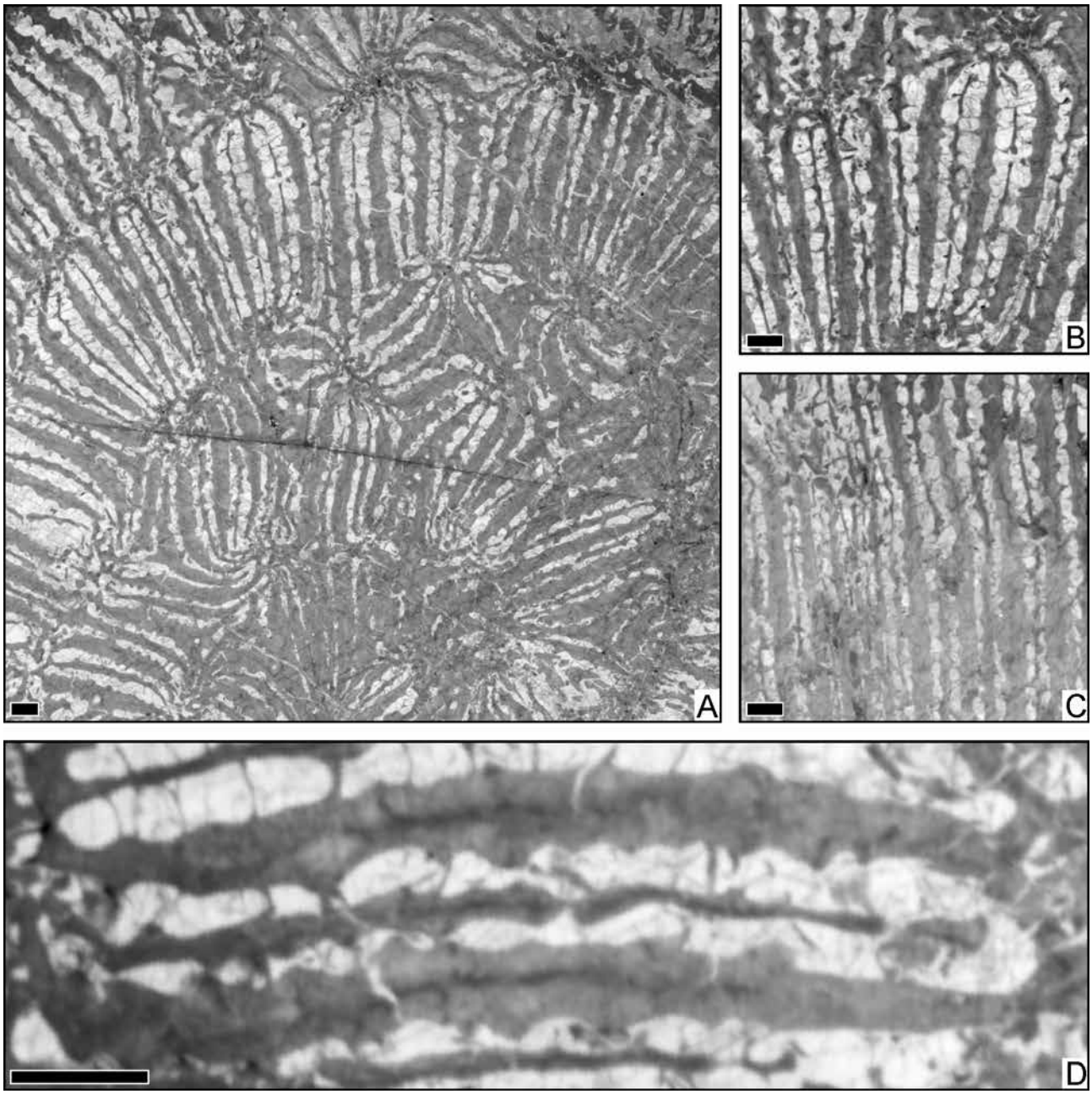

Fig. 5. *Geroastrea alexi* gen. nov. spec. nov.; holotype, GPSL FLX 8097; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section; **d**: microstructural details in a transversal thin section. – Scale bar equals 1 mm.

Grabenbach and Hochmoos formations in the area of the villages Rußbach am Pass Gschütt (Salzburg) and Gosau (Oberösterreich, Austria). Maastrichtian of the Tarbur Formation at Gerdbisheh (Parnezami mountain, Chahar mahal and Bakhtiyari, Iran).

Geroastrea alexi spec. nov.
Fig. 5

Etymology: The species is dedicated to Alexander (Alex) Lukeneder (Vienna), who supported our project as curator for Mesozoic fossils at the Natural History Museum Wien by giving access to the collections and allowing multiple loans.

Type: Holotype GPSL FLX 8097.

Type locality: Austria, Oberösterreich, Wegscheidgraben.

Type horizon: Gosau Group, Grabenbach or Hochmoos Formation, Santonian.

Material: Holotype with two thin sections and specimen HUJI 24581.

Dimensions (GPSL FLX 8097):

	n	min-max	μ	s	cv	μ±s
crd	10	4.85–6.98	6.12	0.76	12.5	5.35–6.88
cdw	20	3.12–7.86	5.21	1.43	27.5	3.78–6.65
s	20	15–21	18.0	1.94	10.8	16–20

Description: As for the genus.

Comparisons: The new species distinguishes from *G. audiensis* by small corallite dimensions and a smaller number of septa. It distinguishes from *G. parvistella* by much larger dimensions. It is closest related to *G. haueri* but has slightly larger dimensions.

Occurrences: Coniacian to Santonian (Streiteck to Hochmoos formations) of the area between Rußbach (Oberösterreich, Austria) and Gosau (Salzburg, Austria).

Genus *Synhydnophora* nov.

Type species: *Synhydnophora wagreichi* spec. nov.

Etymology: A combination of *Synastrea* and *Hydnophora*.

Diagnosis: Hydnophoroid colony. Septal symmetry irregular radial. Septa with few perforations. Septal lateral faces with pennulae. Columella difficult to identify. No wall. Endotheca made of dissepiments.

Description: Hydnophoroid colony with conical, rarely polygonal crests. The crests are irregularly distributed, but can be also arranged in rows. Corallite centres cannot be identified. The crests group a variable number of septa around them. The septa are generally compact, more perforated in their inner margins. The septa are made of thick trabeculae and have a thickness of about 0.4 mm in the type species. The septal symmetry is irregular, even size orders or generations that may differ in length or thickness, can hardly be identified. The number of septa per crest is variable. The septal upper margins are coarsely granulated. The septal lateral faces bear pennulae. An essential columella does not exist. Between the crests are isolated septa or trabeculae that can be considered part of the septa or remains of a columella. The endotheca consists exclusively of dissepiments. A wall does not exist. Synapticulae are present, but are not common. A coenosteum does not exist. The budding is extracalicinal.

Comparisons: The new genus distinguishes from all other genera of the family by its colony type. The new genus differs from *Hydnophoromeandraraea* by more compact and thicker septa. It differs from *Eohydnophora* and *Hydnophororaraea* by the presence of pennulae, synapticulae and septal perforations.

Species included: Type species and *S. multilamellosa* (Reuss, 1854).

Remarks: Material here assigned to *Synhydnophora* was in the past assigned to *Hydnophororaraea* or *Hydnophora*. The negligence of making sections and thin sections did not reveal the existence of septal perforations and pennulae.

Occurrences: Coniacian–Santonian (Streiteck to Hochmoos formations) of the area of the villages Rußbach am Pass Gschütt (Salzburg) and Gosau (Oberösterreich, Austria). Most material was found in the Middle to Upper Santonian (Hochmoos Formation) in the Pass Gschütt area near the village Rußbach am Pass Gschütt (Oberösterreich, Austria).

Synhydnophora wagreichi spec. nov.
Fig. 6

Etymology: The species is dedicated to Michael Wagreich (Vienna), who contributed much to the geology, sedimentology and stratigraphy of the Gosau Group.

Type: Holotype BSPG 2018 II 1164.

Type locality: Austria, Oberösterreich, Rußbach am Pass Gschütt, Pass Gschütt.

Type horizon: Gosau Group, Hochmoos Formation, Middle to Upper Santonian.

Material: Holotype with two thin sections and specimen MHE A1148.

Dimensions (BSPG 2018 II 1164):

	n	min–max	μ	σ	cv	μ±σ
md	20	3.32–5.41	4.48	0.61	13.7	3.86–5.10
s	15	17–30	22.26	3.75	16.8	19–26

Description: As for the genus.

Comparisons: The new species distinguishes from *S. multilamellosa* by larger distances of the crests and a slightly higher septal number.

Occurrences: Middle to Upper Santonian (Hochmoos Formation) of the Pass Gschütt area close to the village Rußbach am Pass Gschütt (Oberösterreich, Austria).

Gosaviaraea-Group

Remarks: The genus *Gosaviaraea* did not receive much attention after its creation. Although mentioned in systematic revisions (Vaughan & Wells 1943, Alloiteau 1952, Wells 1956, Alloiteau 1957), after Oppenheim (1930) it was only figured by Beauvais (1982). Oppenheim (1930) placed the genus close to the genus *Astraraea*; the above-mentioned authors placed the genus in the family Microsolenidae. Beauvais (1982) included

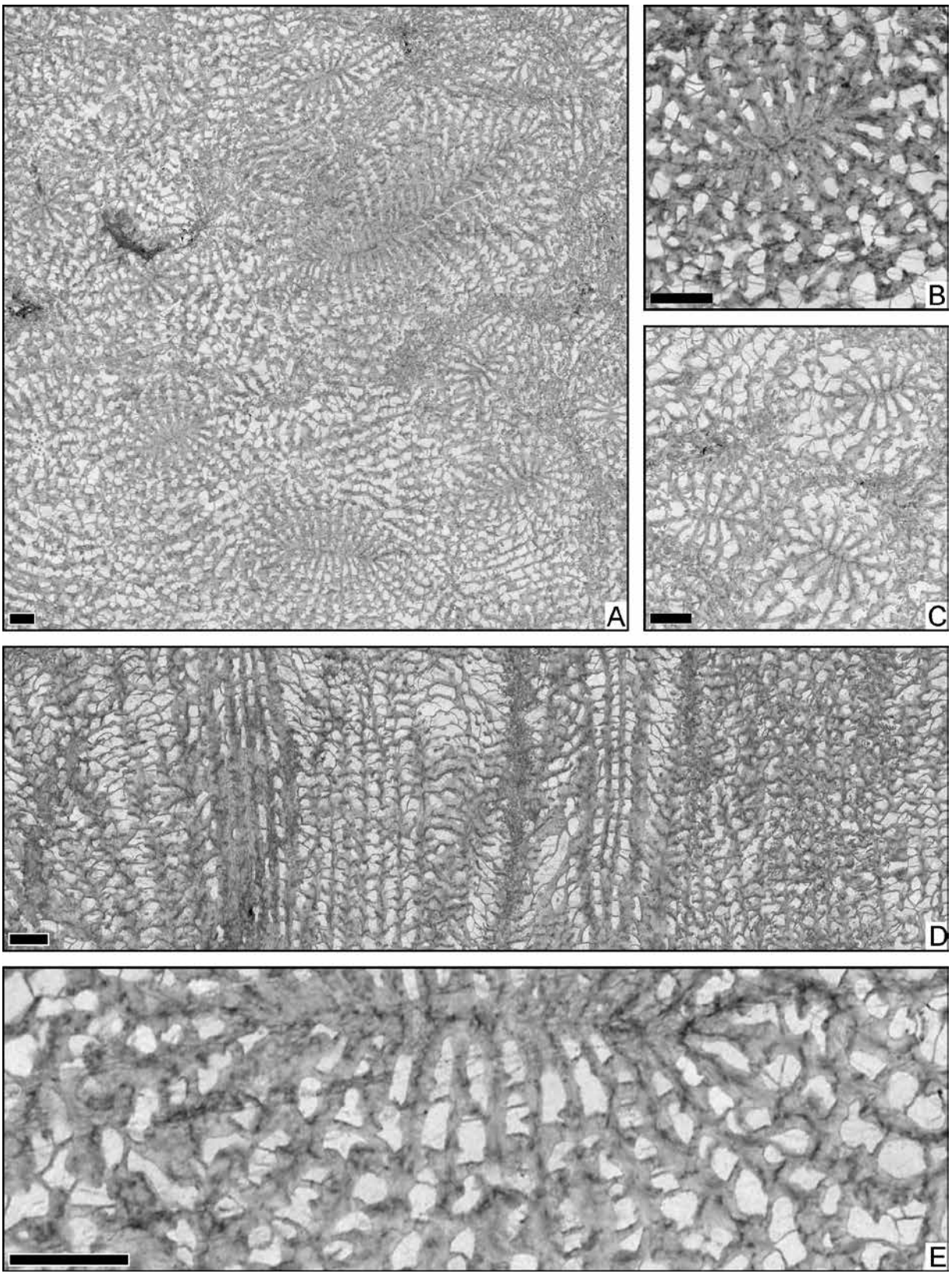

Fig. 6. *Synhydnophora wagreichi* gen. nov. spec. nov.; holotype, BSPG 2018 II 1164; **a**: transversal thin section; **b**: detail; **c**: detail; **d**: longitudinal thin section; **e**: microstructural details in a transversal thin section. – Scale bar equals 1 mm.

it in the synonymy of the genus *Kobya* and assigned this genus to the family Astraraeidae. *Kobya* is a pennular form and has an uncertain position between *Dimorpharaea* and *Dimorphastrea*: it shows calicular rows and septa that are irregularly perforated. The quantity of perforations that just lies in between *Dimorpharaea* and *Dimorphastrea* makes it difficult to designate it as a synonym of one of the two genera. *Gosaviaraea* cannot be a synonym of *Kobya* because it has much stronger septa, which are more regularly perforated. At a first glance, *Gosaviaraea* is very similar to both *Synastrea* and *Microsolena* because of the very thick septa on the one hand, and the numerous perforations on the other. The members of the family Microsolenidae have regularly perforated septa but the septa are thinner and the space between septa is broader than in *Gosaviaraea*. Compared to the Microsolenidae, the family Latomeandridae is similar but has more compact septa, whereas the family Synastraeidae is characterized by almost compact and very thick septa that leave less space between them. We conclude that *Gosaviaraea* cannot be assigned to the families Microsolenidae or Synastraeidae, and we separate it here in an informal group.

Genus *Gosaviaraea* Oppenheim, 1930

Type species: *Gosaviaraea camerina* Oppenheim, 1930, subsequently designated in Vaughan & Wells (1943).

Remarks: The genus *Scaniostroma* Brood, 1972 was originally established as a Hydrozoa, but is considered a junior synonym of *Gosaviaraea*.

Species included: Oppenheim (1930) originally included three species in the new genus: the type species *Gosaviaraea camerina*, the species *Thamnaraea lithodes* Felix, 1903, now the type species of *Siderocoenia* Beauvais, 1982, and *Thamnaraea cladophora* Felix, 1903. The latter is a problematic taxon that is more closely related to *Synastrea*. Here, we include besides the type species the species *Leptophyllia balthica* Hennig, 1900, *Actinaraea morycowae* Reig Oriol, 1995 and *Scaniostroma gracilis* Brood, 1972. *Leptophyllia balthica* and *Scaniostroma gracilis* are very probably synonymous but the available type material of both species is represented by small and fragile specimens that make comparison difficult. *Actinaraea morycowae* is considered a junior synonym of *G. camerina*. Species, that were assigned to *Kobya* by Beauvais (1982), belong to *Astraraea* (*Astraraea columellata* Oppenheim, 1930) or cannot be assigned to any genus, because the illustrations in Beauvais (1982) are insufficient and the type material ist not available (*K. rigausensis* Beauvais, 1982). The *Gosaviaraea* species are distinguished on the basis of the corallite distances and number of septa.

Gosaviaraea aimeae spec. nov.
Fig. 7

Etymology: The species is dedicated to Aimée Orcí (Hermosillo, Sonora, Mexico), who works as a technician in the Universidad Nacional Autónoma de México and supported the present project significantly through the preparation of numerous thin sections.

Types: Holotype BSPG 2018 II 1033, Paratype GPSL FLX 942, each with three thin sections.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Zimmergraben.

Type horizon: Gosau Group, Streiteck Formation, Coniacian.

Material: Type material and another three specimens (GPSL FLX 135, 255, 8111).

Diagnosis: *Gosaviaraea* with a corallite distance of four to six millimetres and a septal number of 26 to 38.

Dimensions (BSPG 2018 II 1033):

	n	min–max	μ	σ	cv	μ±σ
cdw	15	2.93–5.51	4.28	0.76	17.9	3.51–5.05
crd	5	4.21–5.11	4.67	0.34	7.3	4.33–5.02
ccd	25	4.14–6.26	4.90	0.59	12.0	4.31–5.49
s	10	26–34	29.50	2.27	7.7	27–32

(GPSL FLX 942)

	n	min–max	μ	σ	cv	μ±σ
ccd	15	3.70–5.46	4.69	0.46	9.9	4.23–5.16
s	6	29–38	33.66	3.14	9.3	31–37

Description: Thamnasterioid colony. As the type species, the new species tends to have corallites arranged in rows. This characteristic may vary depending on the position in the colony. The septa have numerous perforations. The single trabeculae are visible on the colony surface. The septal lateral faces bear pennulae. The septa occur in an irregular radial symmetry. The columella is difficult to define: the septa tend to be less perforated in the corallite centre and it cannot be decided whether a styliform columella exists or whether it is only simulated by a perforate septum. A wall does not exist. The endotheca consists of few thin tabulae. The budding is extracalicinal.

Comparisons: The new species differs from *G. camerina* by clearly smaller calicular dimensions and a lower number of septa.

Occurrences: Conaciac to Santonian (Streiteck- to Hochmoos formations) in the area between Rußbach am Pass Gschütt (Salzburg) and Gosau (Oberösterreich, Austria).

Superfamily Haplaraeoidea Vaughan & Wells, 1943

Remarks: The families of this superfamily were formerly assigned to the suborder Fungiina Verill, 1865. The suborder was applied by Alloiteau (1952) and subsequent authors in a very broad sense for any coral with perforate septa and/or synapticulae (except Dendrophylliina). The suborder collected numerous families that vary considerably in their septal microstructure. Fungiina sensu stricto are corals with futurae, e.g. only the Fungiidae, and perhaps the Asteroseriidae. All other families cannot remain in this suborder. Some families were already separated into the suborder Microsolenina.

Family Astraraeidae Beauvais, 1982

Remarks: We separate here the family Astraraeidae within the superfamily Haplaraeoidea. The family encompasses solitary and colonial corals with strong, irregularly perforated septa. Compared to the Haplaraeidae, the septa are thicker, and the space between them narrower.

Genera: *Astraraea* Felix, 1900, *Elephantaria* Oppenheim, 1930, and *Astraraeatrochus* gen. nov.

Range: Turonian to Maastrichtian.

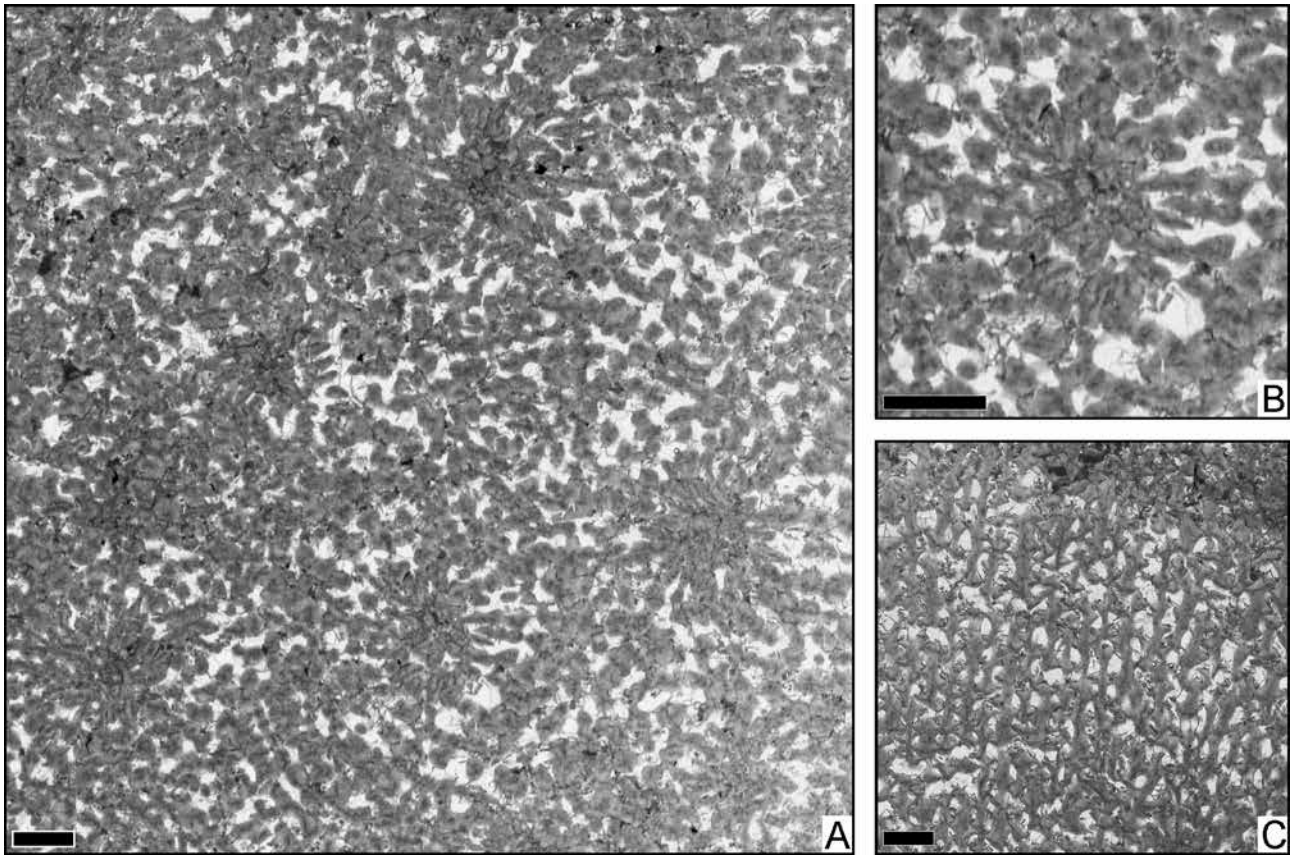

Fig. 7. *Gosaviaraea aimeae* gen. nov. spec. nov.; holotype, BSPG 2018 II 1033; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

Genus *Astraraeatrochus* nov.

Type species: *Astraraeatrochus bachi* spec. nov.

Etymology: *Astraraea*- in relation to the genus *Astraraea* and *trochus*, greek for spinner, a commonly used name for solitary corals.

Diagnosis: Solitary coral with an inverse conic form with a circular to elliptical corallite outline. Septa are subcompact without symmetry. Columella parietal. Synapticulae present. Wall probably epithecal. Endotheca with few dissepiments.

Description: Solitary coral with a regular shape in the form of an inverted cone. The corallite outline is circular, or slightly elliptical. The corallite diameter increases regularly with the height of the corallum resulting in a patellate form. The height of the corallum corresponds approximately to the radius of the corallite. The diameter of the corallite varies between 20 and 30 mm. The lumen is slightly deepened. A septal symmetry does not exist. Four size orders of septa can be hardly distinguished. The septa of the different generations distinguishes length, almost not thickness. Their number varies between 130 and 200. Half the septa reach to the corallite centre, the remaining septa are shorter. In places, septa of later generations are attached with their inner margins to the lateral faces of septa of earlier generations. The septa have few and irregular perforations, that are more common at the inner margin of septa. The maximum thickness of septa measures 0.4mm. The septal upper margin is coarsely dentated and mainly follows the location of perforations. The microstructure of septa is not preserved. In places clear lines are visible that are probably of a diagenetic nature and that can be also found in *Astraraea*. The septal lateral faces are smooth. Costae do not exist or are not distinguishable from the septa. The columella is parietal and consists of numerous large isolated trabeculae. The endotheca consists of few dissepiments. The wall is probably epithecal. Synapticulae are rare.

Comparisons: Collection material of the new genus is mostly assigned to *Gyroseris patellaris* Reuss, 1854. Indeed, both genera are similar in their outer appearance but differ in the structure of their septa: *Gyroseris* has pennulae and belongs to the family Synastreidae.

Species included: Only the type species.

Occurrences: Upper Turonian of St. Gilgen (Salzburg), and Coniacian–Santonian (Streiteck to Hochmoos formations) of the Randobach, (Salzburg, Austria).

Astraraeatrochus bachi spec. nov.
Fig. 8

Etymology: The new species is dedicated to Frank Bach, curator at the geological-palaeontological collection of the

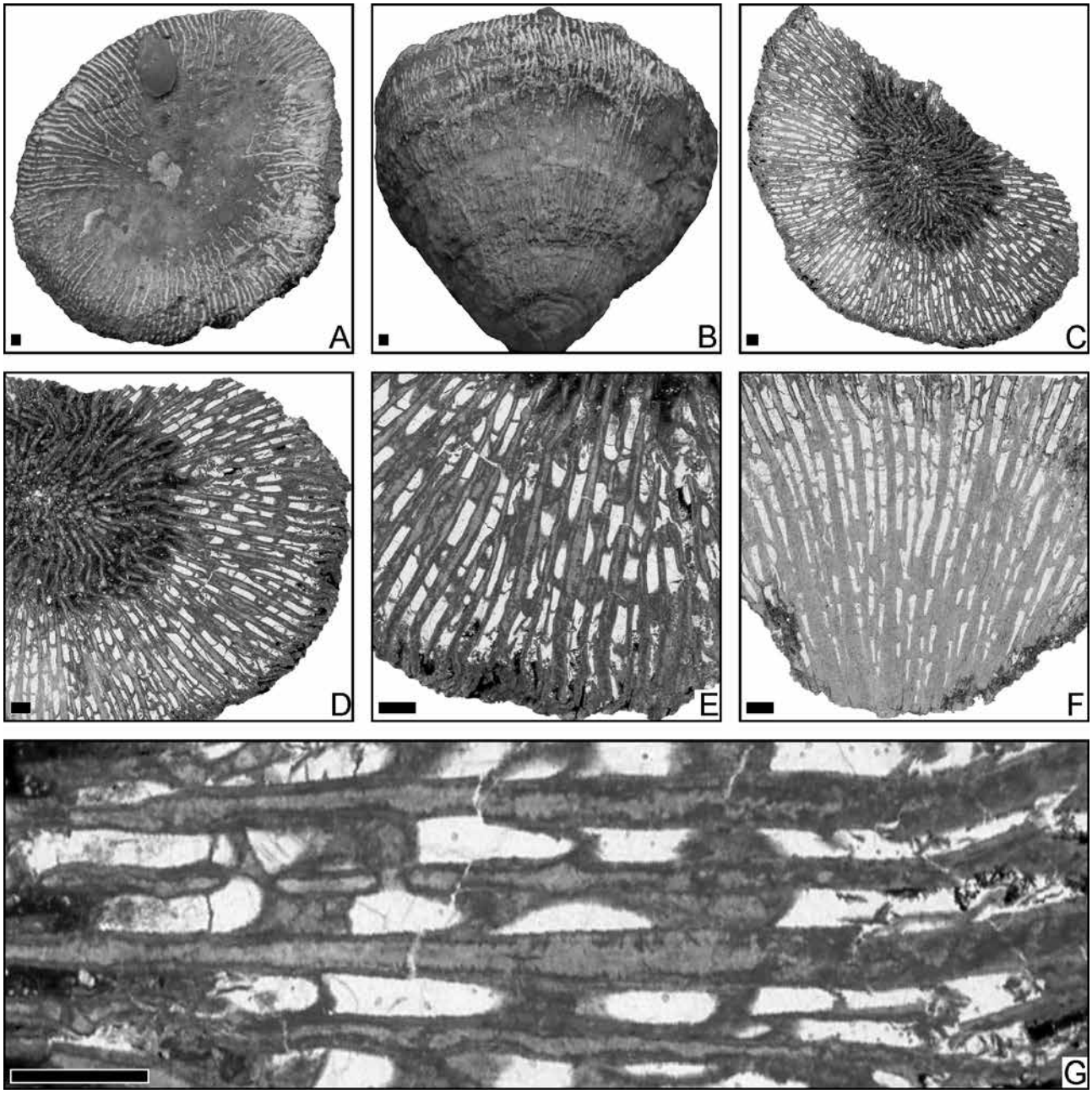

Fig. 8. *Astraraeatrochus bachi* gen. nov. spec. nov.; holotype, BSPG 2018 II 1599; **a**: oral coral surface; **b**: lateral coral surface; **c**: transversal thin section; **d**: detail; **e**: detail; **f**: longitudinal thin section; **g**: microstructural details in a transversal thin section. – Scale bar equals 1 mm.

University Leipzig (Germany), where the collection of JOHANNES FELIX is stored. FRANK BACH supported the revision of the Gosau coral faunas by giving permission to use the corals of the FELIX collection for destructive preparation.

Type: Holotype BSPG 2018 II 1599 with two thin sections.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Randobach.

Type horizon: Gosau Group, Streiteck to Hochmoos formations, Coniacian to Santonian.

Material: Type and another seven specimens with six thin sections (GPSL FLX 1541 [four specimens], 8035, 8036, 8053).

Diagnosis: *Astraraeatrochus* with a calicular diameter of 20 to 30 mm and a septal number of 130 to 200 septa.

Dimensions (BSPG 2018 II 1599):
c 23.1 x 30.7 mm
s 199
(GPSL FLX 8035)
c 23.8 x 29.4 mm
s 134

Description: As for the genus.

Remarks: The species seems to be rare in the Gosau area, whereas it was more common in the Upper Turonian of St. Gilgen. The locality at St. Gilgen ("Postanger") was already reported as not being accessible by Oppenheim (1930).

Occurrences: Upper Turonian of St. Gilgen (Salzburg), and Coniacian–Santonian (Streiteck to Hochmoos formations) of the Randobach, (Salzburg, Austria).

Superfamily Heterocoenioidea Oppenheim, 1930

Remarks: Most families of this superfamily were formerly assigned to the suborder Heterocoeniina Beauvais, 1974. This suborder, based on a family originally assigned to the suborder Stylinina, was relatively well-limited and defined.

Family Carolastraeidae Eliášová, 1976

Genus *Crinopora* Orbigny, 1849

Type species: *Alveopora massiliensis* Michelin, 1847, by monotypy.

Description: Plocoid colony with corallites having an irregular outline, elliptical with a rectangular tendency. The corallites are small and below two millimetres, a smaller and a larger diameter can easily be distinguished. The corallite margins can be elevated. The septa are compact, in a bilateral symmetry. The microstructure of septa is made by small trabeculae. There is a strong main septum, often another three septa, and fine septal thorns. The septa are externally thick and taper towards the corallite centre. The septa are not connected to each other. Their upper margin is smooth, the septal lateral faces bear small thorns, and the inner margins may show fine apophysal branching ornamentations. Costae, pali, a columella and synapticulae are absent. The endotheca consists of fine and regular tabulae. The wall is compact and trabecular. The coenosteum consists of large dissepiments and vertical trabeculae that are visible as fine granulations at the surface of the coral. The budding is extracalicinal.

Comparisons: The genus distinguishes from *Comalia* Wells, 1932 and *Pleurocoenia* Orbigny, 1849 by the plocoid arrangement of corallites and the general presence of four septa. *Pleurodendron* has more septa and is phaceloid. *Latusastrea* Orbigny, 1849 and *Elasmocoenia* Milne Edwards & Haime, 1851 have more septa, which are arranged in two opposite groups in the corallite. Moreover, these genera have larger calicular dimensions.

Remarks: The description of the genus in Orbigny is short compared to today's standards: "Generally dendroid; corallites numerous, tightly arranged, elevated, outerly surrounded by six projections, inside hollow with tabulae." The type material of the type species comes from the collection Matheron, not the collection Michelin. The location of the collection Matheron is unknown. At our disposal was only a topotypical specimen (BSPG 1961 II 84), which compares well to the illustration in Michelin (1847) on the one hand, and to material from the study area on the other. After Orbigny (1849) the genus was included in the synonymy of the genus *Heterocoenia*. *Crinopora* material from the study was mainly ignored in the literature: only Felix (1903) illustrates material and assigns it to *Heterocoenia reussi* Milne Edwards, 1857. *H. reussi* is based on the material illustrated as *H. provincialis* by Reuss (1854). The illustration (the type is not available) shows a *Heterocoenia* with six septa in a trimeral septal symmetry. Neither Oppenheim (1930) nor Beauvais (1982) illustrate or describe material that is here considered *Crinopora*, although the genus is common in the study area, even if not easily recognizable as a coral.

Species included: Only the type species is formally described. Another two species are here described as new. The species are distinguished on the basis of the dimension of the (smaller and larger) inner diameter. The small diameter is always measured in direction of the main septum; the larger one in a rectangular angle to it.

Occurrences: Coniacian to Campanian of France, Austria and the USA (Texas).

Crinopora ireneae spec. nov.
Fig. 9

Etymology: The species is dedicated to Irene Zorn (Vienna, Austria), curator of the collection of the Geologische Bundesanstalt who allowed the examination of important type material over a long time span what helped in solving numerous taxonomic problems of the Gosau corals.

Types: Holotype BSPG 2018 II 1240, Paratypus BSPG 2018 II 527, each with one thin section.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Pass Gschütt.

Type horizon: Gosau Group, Hochmoos Formation, Middle to Upper Santonian.

Material: Type material and another 18 colonies with another two thin sections (BSPG 2003 XX 6788, 6794, MHE A0701, A0935, A0938, A0941, A0943, A1156, A1159, A1161, A1236, A1241, A1288, A1636, A2027, A2028, A2086, A2120).

Diagnosis: *Crinopora* with a corallite diameter of 0.6–0.7 mm (smaller diameter) and 0.75–0.9 mm (larger diameter).

Dimensions (BSPG 2018 II 1240):

	n	min–max	μ	σ	cv	μ±σ
clmin	35	0.60–0.74	0.67	0.03	4.9	0.63–0.70
clmax	35	0.77–0.97	0.85	0.05	6.6	0.80–0.91

(BSPG 2018 II 0527)

	n	min–max	μ	σ	cv	μ±σ
clmin	20	0.58–0.76	0.66	0.04	7.4	0.61–0.71
clmax	20	0.71–0.92	0.82	0.06	7.3	0.76–0.88

Description: As for the genus.

Comparisons: *C. massiliensis* has larger corallite dimensions and *C. thomasi* has smaller dimensions.

Occurrences: Conaciac to Santonian (Streiteck to Hochmoos formations) of Zimmergraben, Pass Gschütt and Randobach (Salzburg, Austria).

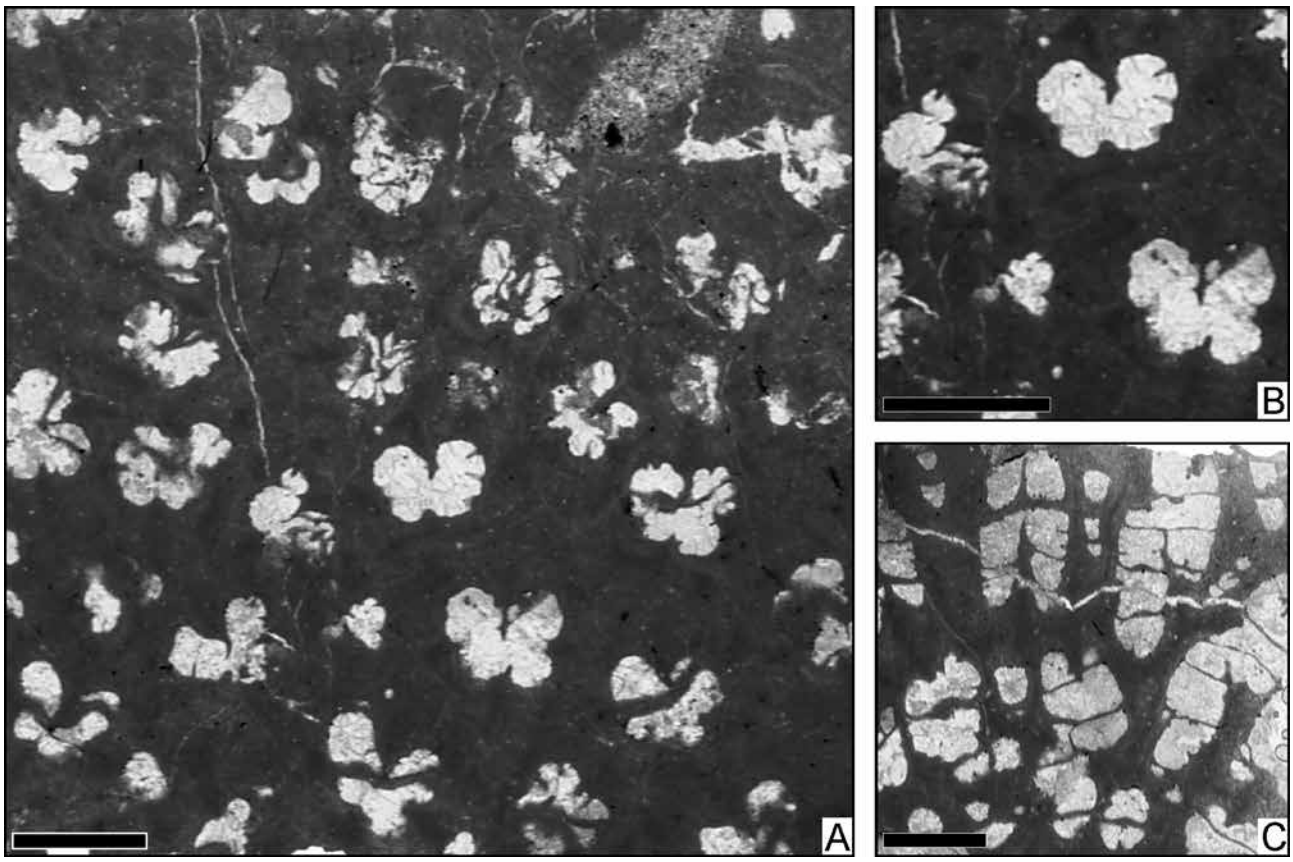

Fig. 9. *Crinopora ireneae* spec. nov.; holotype, BSPG 2018 II 1240; **a**: transversal thin section; **b**: detail transversal thin section; **c**: longitudinal thin section. – Scale bar equals 1 mm.

Crinopora thomasi spec. nov.
Fig. 10

Etymology: The species is dedicated to Thomas Nichterl (Vienna, Austria), who supported our work as collection assistant at the Natural History Museum, making loans and destructive examination of material possible.

Types: Holotype BSPG 2018 II 0702, Paratype BSPG 2018 II 1635, each with two thin sections.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Zimmergraben.

Type horizon: Gosau Group, Streiteck Formation, Coniacian.

Material: Type material and another 37 colonies (MHE A0265, A0552, A0553, A0696-A0700, A0703, A0707, A0933, A0934, A0936, A0939, A1017, A1157, A1158, A1160, A1162, A1163, A1218, A1234, A1235, A1248, A1258, A1289, A1299, A1301, A1302, A1421, A1657, A1799, A1983, A2090, A2093, A2154, NHMW 2006z0391/0021).

Diagnosis: *Crinopora* with a corallite diameter of 0.5–0.6 mm (smaller diameter) and 0.65–0.85 mm (larger diameter).

Dimensions (BSPG 2008 II 702):

	n	min–max	μ	σ	cv	μ±σ
clmin	40	0.45–0.70	0.56	0.06	12.0	0.49–0.62
clmax	40	0.63–0.97	0.76	0.09	12.6	0.66–0.86

(BSPG 2018 II 1635)

	n	min–max	μ	σ	cv	μ±σ
clmin	30	0.50–0.61	0.56	0.03	5.3	0.53–0.59
clmax	30	0.62–0.78	0.69	0.04	6.2	0.65–0.74

Description: As for the genus.

Comparisons: Both *C. massiliensis* and *C. ireneae* have larger corallite dimensions.

Occurrences: Conaciac to Santonian (Streiteck to Hochmoos formations) of Zimmergraben, Pass Gschütt and Randobach (Salzburg, Austria).

Family Heterocoeniidae Oppenheim, 1930

Genus *Pachyheterocoenia* nov.

Type species: *Pachyheterocoenia leipnerae* spec. nov.

Etymology: After *pachy* from the greek word for thick in reference to the stout structure of the septa, and *heterocoenia* to relate the new genus to *Heterocoenia*.

Diagnosis: Plocoid colony with compact septa in an irregular radial symmetry. A main septum is often present, as well as a marginarium and lonsdaleoid septa. Septothecal wall present or absent. Endotheca well-developed. Columella, pali and synapticulae absent. Budding intracalicinal, marginal, in the wall.

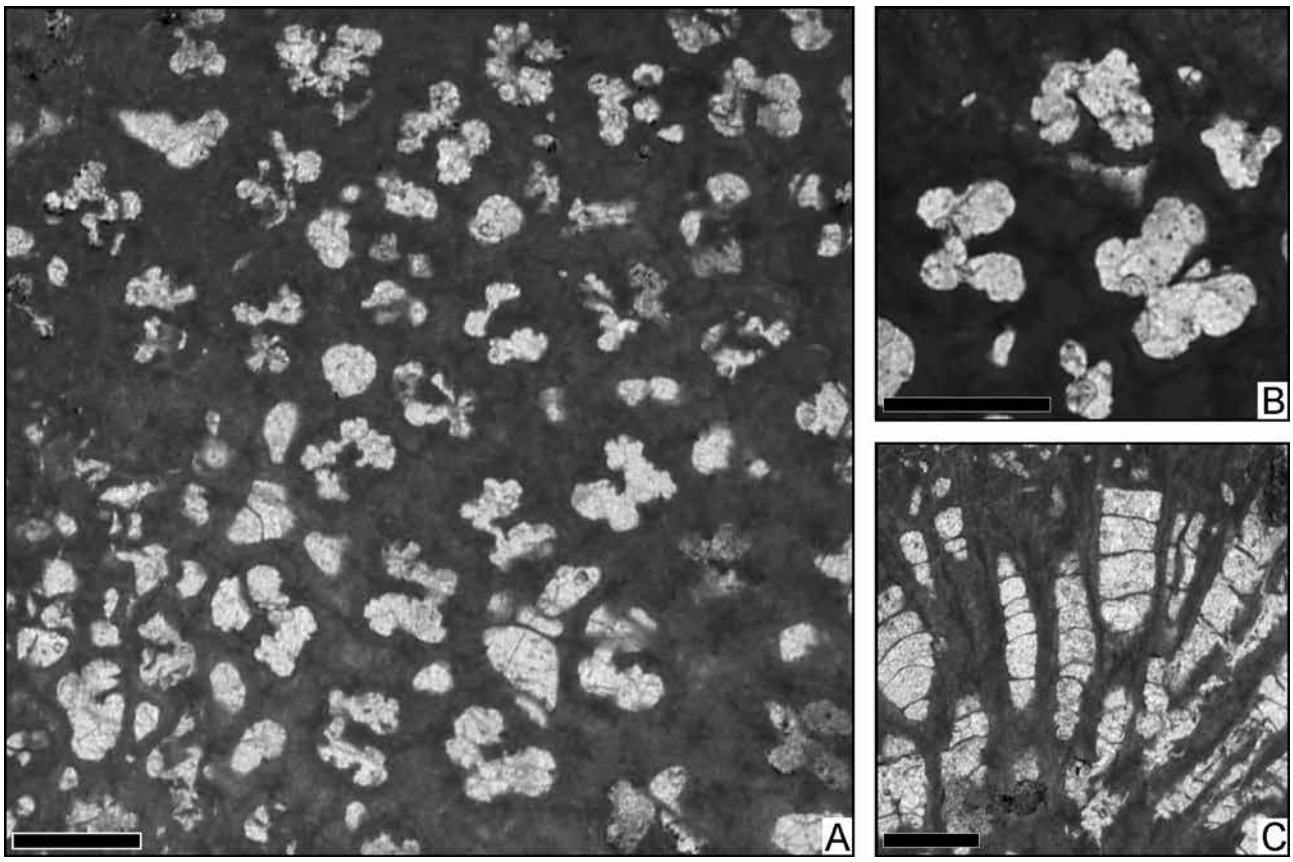

Fig. 10. *Crinopora thomasi* spec. nov.; holotype, BSPG 2018 II 702; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

Description: Plocoid colony. The corallites have an irregular shape and reach an outer diameter of 6 mm in the type species. They are elevated above the surface of the colony. The septa are compact, with a radial symmetry that is difficult to decipher. In the type species the symmetry is hexameral with one to two septal cycles, but other species show a tetrameral or trimeral symmetry. The septa are made of small trabeculae. In their outline, they are thick, often in the form of a water drop. Often only one calcification centre is visible. In the wall, the septa are very thick and taper towards the corallite centre. One septum may be larger and thicker than the other. Besides the septa that communicate with the wall area, short and thin lonsdaleoid septa in a varying amount exist. The septa are never connected to each other. The septal upper margin is smooth, the septal faces bear fine thorns, and the inner margins often have fine apophysal ornamentations. The costae are short and non-confluent. Columella, pali and synapticulae are absent. The endotheca is well developed and consists of marginal dissepiments and central tabulae. The septothecal wall is irregularly developed and often lacks. It is formed by the thick external parts of the septa and additional abortive septa, which are reduced to a circle like a large trabecula. Often a collective trabecular wall encloses corallites that originated through budding from the same corallite. A marginarium and lonsdaleoid septa are often present. The coenosteum consists of dissepiments and fine trabeculae that result in a fine granulation of the colony surface. The budding is intracalicinal; new corallites are formed within the wall (Fig. 11).

Comparisons: The new genus distinguishes from *Heterocoenia* by the presence of a marginarium, lonsdaleoid septa, the intracalicinal budding and the subcompact wall. *Pachycaenia* Alloiteau, 1952 could be a senior synonym but the description is incomplete, and the type material of the type species *P. rugosa* Alloiteau, 1952 is not available. The detailed description of the genus by Beauvais (1982) was probably not based on the type species (its type should be strongly recrystallised) but on *Heterocoenia fuchsi* Felix, 1903, which was assigned by Beauvais to *Pachycaenia*. Beauvais (1982, III: 19) assigns *Heterocoenia stachei* Felix, 1903 to *Baryhelia*, but this genus is undefined (see Löser 2016 for details). A part of the *Heterocoenia* and *Pachycaenia* phaceloid colonies exist only in the family Heterocoeniidae.

Species included: *P. grandis* (Reuss, 1854), *P. fuchsi* (Felix, 1903), *P. leipnerae* spec. nov., *P. stachei* (Felix, 1903) as a synonym of *P. grandis*, and several species in open nomenclature. The species are distinguished on the basis of the septal symmetry and the outer corallite diameter. The total number of septa (without lonsdaleoid septa) is given less priority because this value increases with the diameter of the corallite and varies significantly within one colony. In colonies with a hexameral septal symmetry, corallites with six, eight, ten or twelve septa can be found.

Remarks: The material that is here assigned to a new genus was formerly assigned to the genus *Heterocoenia*, ignor-

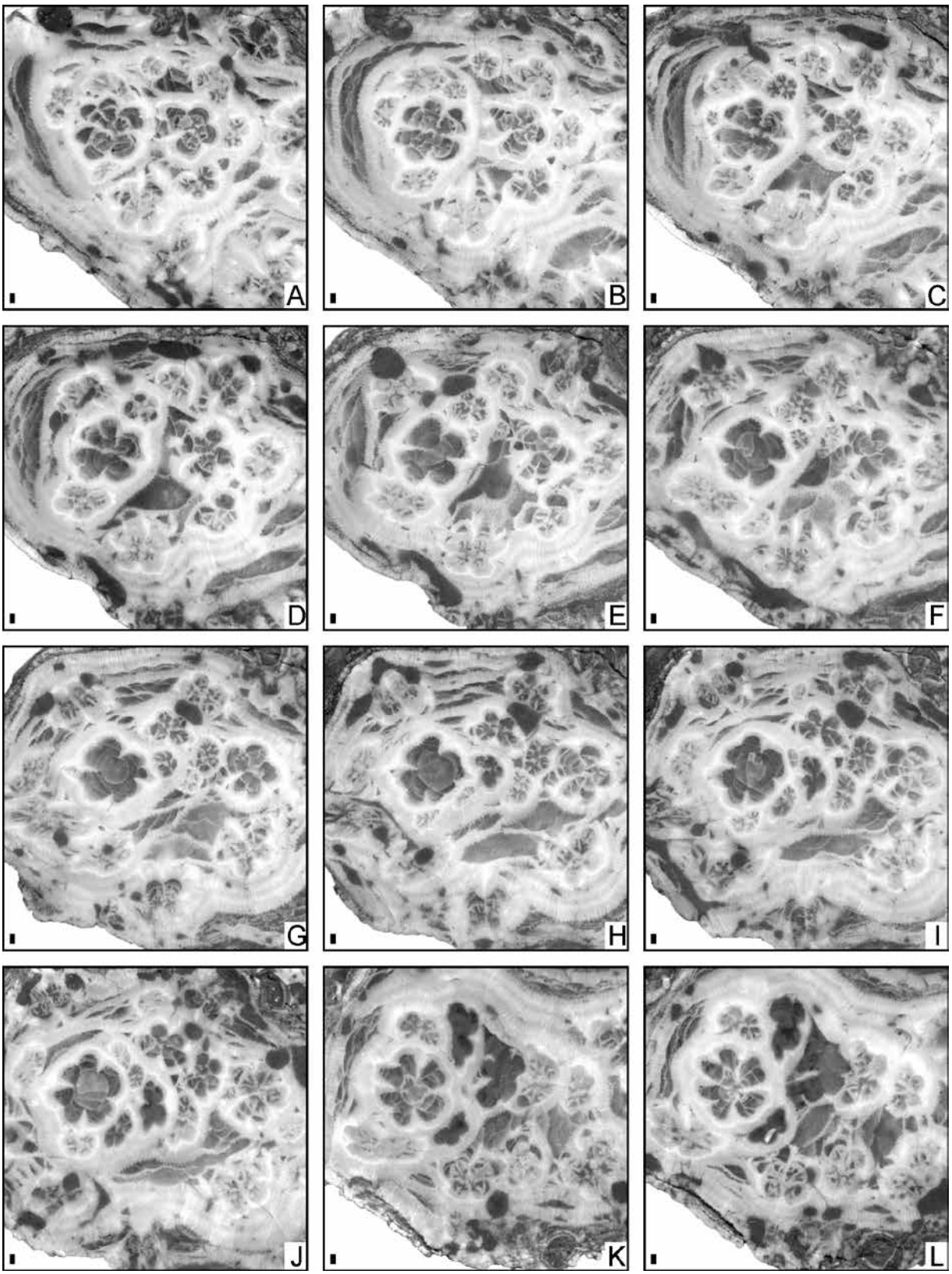

Fig. 11. *Pachyheterocoenia leipnerae* gen. nov. spec. nov.; MHE A1903; serial section, from **a** (bottom) to **l** (top). Distance between **a-j** and **k-l** approximately 1.2 mm, and 6 mm between **j** and **k**. – Scale bar equals 1 mm.

ing that the type species of *Heterocoenia*, *Lithodendron exiguum* MICHELIN, 1847 shows completely different characteristics: the corallites have a regular circular outline, the wall is compact, the septal symmetry is regular, a marginarium and lonsdaleoid septa are absent.

Occurrences: Coniacian to Santonian of Austria and Campanian of Spain.

Pachyheterocoenia leipnerae spec. nov.
Figs. 11, 12

Etymology: The new species is dedicated to BIRGIT LEIPNER-MATA, preparator at the Palaeontological Institute of the University Erlangen-Nürnberg. BIRGIT LEIPNER-MATA has the present project kindly supported by the preparation of particularly large thin sections of fossil corals, including various thin sections of the new species.

Types: Holotype BSPG 2018 II 547, Paratypes BSPG 2018 II 325, BSPG 2018 II 592, BSPG 2018 II 1023 with ten thin sections.

Type locality: Austria, Oberösterreich, Pass Gschütt area between Rußbach and Gosau.

Type horizon: Gosau Group, Hochmoos Formation; Middle to Upper Santonian.

Material: Type material and another 19 specimens with another four thin sections (GPSL FLX 1833, MHE A0304, A0593, A0647, A0685, A0688, A1089, A1121, A1387, A1388, A1410, A1630, A1655, A1662, A1788, A1825, A1903, A2126, NHMW 1864/0040/1290B).

Dimensions (Holotype BSPG 2018 II 547):

	n	min–max	μ	σ	cv	μ±σ
clmin	20	1.09–1.59	1.29	0.13	10.2	1.16–1.43
clmax	20	1.40–1.98	1.70	0.16	9.6	1.53–1.86
cmin	15	3.02–4.82	3.79	0.60	15.9	3.18–4.39
cmax	15	3.70–5.89	4.73	0.64	13.7	4.08–5.38
s	10	6–12		8.60	2.17	25.2 6–11

(Paratype BSPG 2018 II 592)

	n	min–max	μ	σ	cv	μ±σ
clmin	17	1.06–1.84	1.41	0.25	18.3	1.15–1.67
clmax	17	1.60–2.44	1.97	0.22	11.2	1.74–2.19
cmin	17	3.54–5.99	4.95	0.64	13.0	4.30–5.59
cmax	17	4.96–6.42	5.73	0.45	7.9	5.28–6.18
s	6	12		12	0	0 12

(the number of septa without lonsdaleoid septa)

Description: As for the genus.

Remarks: The specimen illustrated by FELIX (1903, pl. 19, fig. 12) as *Heterocoenia stachei* belongs to *P. leipnerae*. Because it is not the lectotype (pl. 19, fig. 2), the name *stachei* cannot be applied to the material that constitutes the new species.

Occurrences: Coniacian to Santonian of Austria.

Superfamily Phyllosmilioidea FELIX, 1903

Remarks: The family of this superfamily was formerly assigned to the suborder Meandrinina. The definition of the suborder Meandrinina was rather conceptual when it was established. No data were provided on the septal microstructure. Subsequently, a large amount of material with very small trabeculae was assigned to this suborder. The name-giving genus *Meandrina* LAMARCK, 1801 possesses rather large trabeculae, and is therefore much closer allied to the suborder Faviina in its traditional understanding.

Family Phyllosmiliidae FELIX, 1903

Genus *Nefocoenia* OPPENHEIM, 1930

Type species: *Araeacis lobata* REUSS, 1854, subsequently designated by WELLS (1936).

Description: Plocoid colony. Corallite outline elliptical but elongated, corallite pit depressed. The corallites are small (< 5 mm). Septa compact. Microstructure of small-sized trabeculae, septa with a median dark zigzag line. Septa in cross section externally thick, taper towards the centre. Symmetry of septa radial, in varying systems. Cycles of septa regular; they differ in length and thickness. The first septal cycle reaches close to the corallite centre, later cycles are shorter. The septa are not connected to each other. Their upper margin is smooth; the lateral face bear fine thorns, the inner margin swollen in places. Pali absent. Costae present, but short, non-confluent. Their surface is not observable because they are too short. Synapticulae absent. Columella lamellar. The endotheca consists of a few tabulae. The wall is compact, septothecal. The coenosteum is medium broad and consists of thick tabulae, with coarse granulations on its surface. Budding extracalicinal.

Remarks: Type material of the type species is not available, but the illustration in REUSS is good enough that newly collected material can be compared to it. The only difference is that the illustration in REUSS does not show a columella that is found in all species assigned to the genus.

Species included: Twelve species are currently assigned to this genus, but not all belong to *Nefocoenia* and some are synonymous:

Favia ammergensis SÖHLE, 1899 – The species belongs to *Nefocoenia*.

Nefocoenia batalleri REIG ORIOL, 1992 – The species belongs to *Pachynefocoenia* REIG ORIOL, 1989.

Nefocoenia casanovai REIG ORIOL, 1992 – The species belongs to *Nefocoenia*, but is a synonym of *N. ammergensis*.

Nefocoenia decussata OPPENHEIM, 1930 – The species is represented by two syntypes that are poorly preserved and probably belong to different genera.

Nefocoenia edelbachensis OPPENHEIM, 1930 – The species belongs to *Proplesiastrea*.

Nefocoenia favosites OPPENHEIM, 1930 – The species may belong to family Actinastraeidae.

Nefocoenia lobata (REUSS, 1854) – The species belongs to *Nefocoenia*.

Nefocoenia microcalyx OPPENHEIM, 1930 – There exist four poorly preserved syntypes of which the best provided morphometric data that would assign the specimen to *N. organum*.

Nefocoenia nefiana OPPENHEIM, 1930 – The species may belong to family Columastraeidae.

Nefocoenia oppenheimi BEAUVAIS, 1982 – The species a nom. nov. pro *Nefocoenia montuosa* OPPENHEIM, 1930. The species is unknown because the type material is not available.

Nefocoenia organum (OPPENHEIM, 1930) – The species belongs to *Nefocoenia*.

Nefocoenia viaderi (REIG ORIOL, 1989) – The species belongs to *Nefocoenia*, but is a synonym of *N. lobata*.

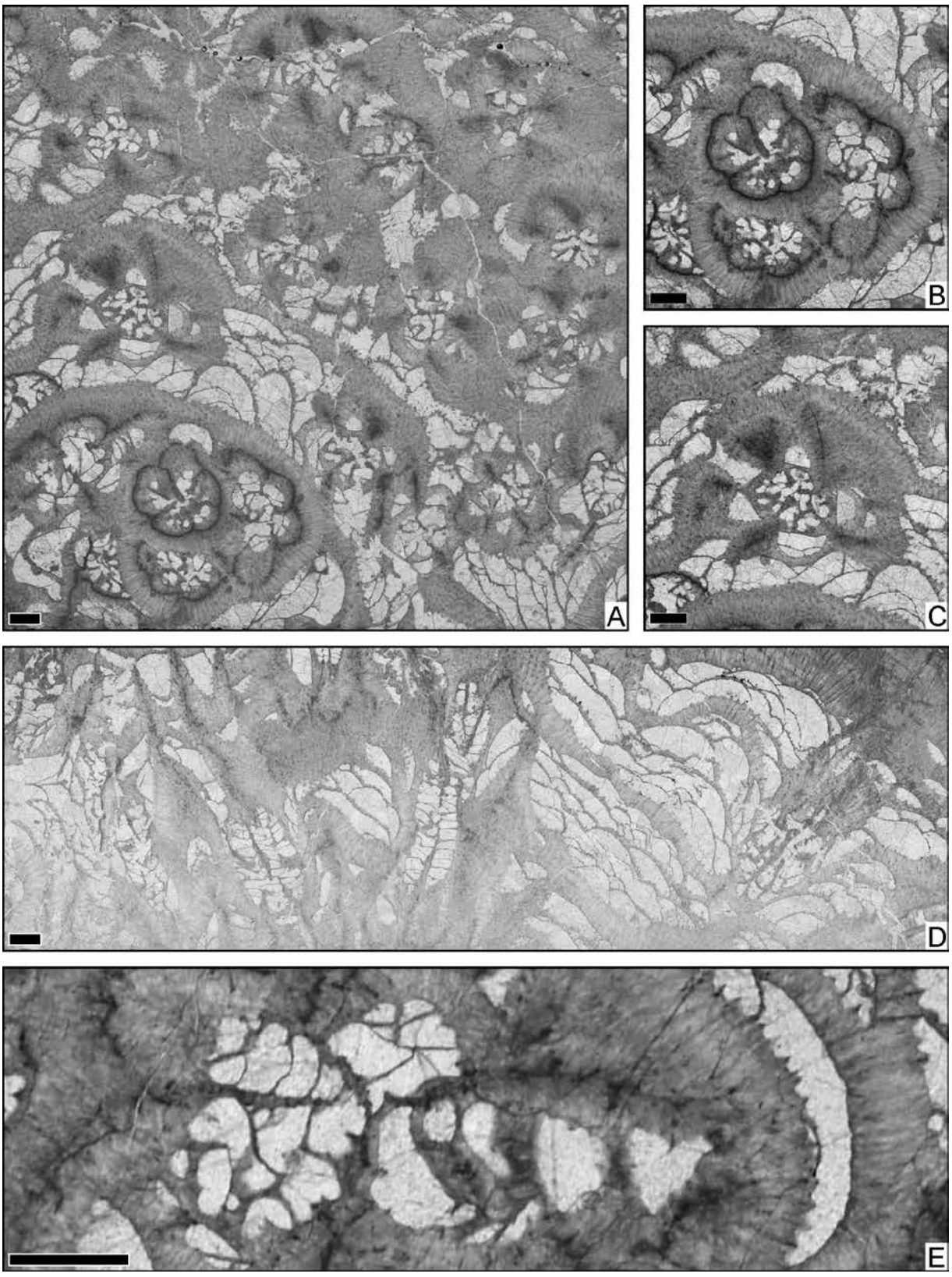

Fig. 12. *Pachyheterocoenia leipnerae* gen. nov. spec. nov.; holotype, BSPG 2018 II 547; **a**: transversal thin section; **b**: detail; **c**: detail; **d**: longitudinal thin section; **e**: microstructural details in a transversal thin section. – Scale bar equals 1 mm.

There remain three species (*ammergensis*, *lobata*, *organum*). We found another two abundant species that could not be compared to existing ones and that are here described as new. The species are distinguished on the basis of the small inner corallite diameter and the number of septa.

Nefocoenia seewaldi spec. nov.
Fig. 13

Etymology: The species is dedicated to Fritz Seewald (Rußbach am Pass Gschütt, Austria), who is responsible for a small museum called Fossilienkabinett in Rußbach. Fritz Seewald deserves much respect for his effort to recognise the geological relevance of Rußbach as a place that is pari passu to the village Gosau that name the lithostratigraphic group and coral fauna.

Types: Holotype BSPG 2018 II 646, paratype NHMW 2006z0409/0106 with three thin sections.

Type horizon: Austria, Salzburg, Rußbach am Pass Gschütt, Zimmergraben.

Type horizon: Gosau Group, Streiteck Formation, Coniacian.

Material: Type material and another 15 specimens with another two thin sections (BSPG 2003 XX 4798, MHE A0276, A0656, A0669, A0821, A1196, A1202, A1278, A1378, A1379, A1571, A1682, A1705, A1706, A1883).

Diagnosis: *Nefocoenia* with a corallite diameter of 1.4–1.8 mm (smaller diameter) and 2.0–2.7 mm (larger diameter) and a septal number of 16 to 26.

Dimensions (BSPG 2018 II 0646):

n	min–max		μ	σ	cv	μ±σ
clmin	20	1.34–1.71	1.47	0.11	7.6	1.35–1.58
clmax	20	1.74–2.82	2.30	0.29	12.9	2.00–2.59
s	15	14–23	18.86	2.58	13.7	16–21

(NHMW 2006z0409/0106)

	n	min–max	μ	σ	cv	μ±σ
clmin	20	1.39–1.93	1.61	0.17	10.5	1.44–1.78
clmax	20	1.72–3.05	2.32	0.40	17.3	1.92–2.72
s	20	14–26	21.15	4.38	20.7	17–26

Description: The morphology corresponds to the type species. As in all *Nefocoenia* species, the corallite is elongated with a length that measures approximately one and a half times of the small diameter. The septal symmetry is radial but irregular. Their number rarely exceeds three septal cycles, mainly in large corallites.

Comparisons: The new species has larger corallite dimensions than *N. organum* and *N. werneri*, and smaller dimensions than *N. lobata* and *N. ammergensis*.

Occurrences: Conaciac to Santonian (Streiteck to Hochmoos formations) of Zimmergraben and Randobach, Rußbach am Pass Gschütt, (Salzburg, Austria).

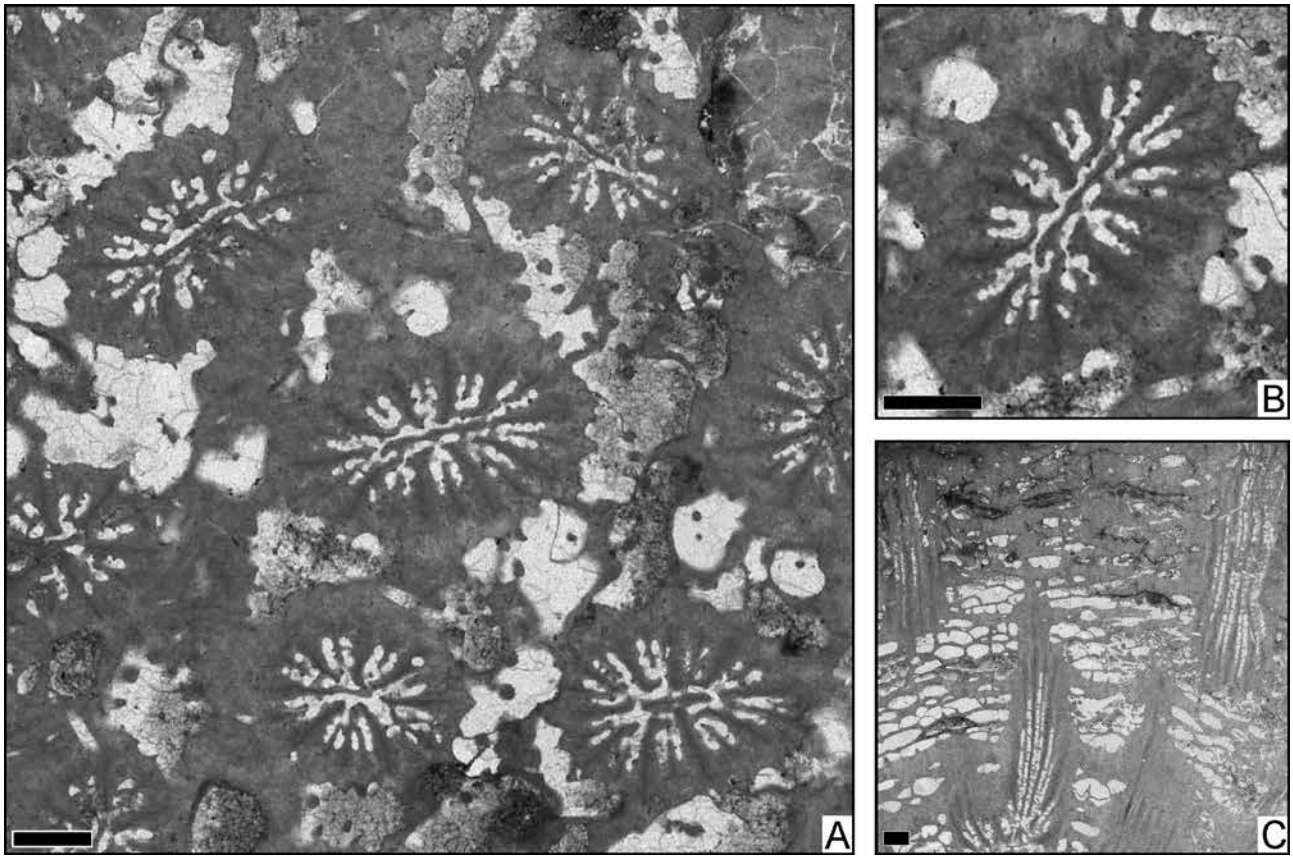

Fig. 13. *Nefocoenia seewaldi* spec. nov.; holotype, BSPG 2018 II 646; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

Nefocoenia werneri spec. nov.
Fig. 14

Etymology: The species is dedicated to Winfried Werner (Munich) who worked for a long-time as curator at the Bayerische Staatssammlung für Paläontologie und Geologie in Munich. He supported the current project much in offering the use of the laboratory, library and collection.

Types: Holotype BSPG 2018 II 1409, paratypes BSPG 2018 II 0580, BSPG 2018 II 1349 with four thin sections.

Type locality: Austria, Oberösterreich, Gosau, Pass Gschütt area.

Type horizon: Gosau Group, Hochmoos Formation, Middle to Upper Santonian.

Material: Type material and another 18 specimens with another two thin sections (GPSL FLX 8024, HUJI 20712, MHE A0275, A0657, A0659, A0757, A1270, A1277, A1362, A1386, A1397, A1400, A1417, A1623, A1650, A1704, A1774, A1896).

Diagnosis: *Nefocoenia* with a corallite diameter of 1.2–1.6 mm (smaller diameter) and 1.8–2.5 mm (larger diameter) and a septal number of 22 to 32.

Dimensions (BSPG 2018 II 1409):

	n	min–max	μ	σ	cv	μ±σ
clmin	20	1.02–1.82	1.38	0.23	16.7	1.15–1.61
clmax	20	1.47–2.71	2.14	0.38	17.8	1.75–2.52
s	10	22–36	30.90	4.53	14.6	26–35

(BSPG 2018 II 580)

	n	min–max	μ	σ	cv	μ±σ
clmin	30	1.10–1.76	1.43	0.21	14.8	1.22–1.64
clmax	30	1.61–2.69	2.11	0.31	15.1	1.79–2.43
ccd	20	1.77–3.53	2.57	0.44	17.2	2.13–3.02
s	10	22–35	26.40	4.52	17.1	22–31

(BSPG 2018 II 1349)

	n	min–max	μ	σ	cv	μ±σ
clmin	30	1.09–1.75	1.33	0.17	13.2	1.15–1.50
clmax	30	1.61–2.44	2.00	0.24	12.1	1.76–2.24
s	10	20–36	27.30	4.27	15.6	23–32

Description: The morphology corresponds to the type species. As in all *Nefocoenia* species, the corallite is elongated with a length that measures approximately one and a half times of the small diameter. The septal symmetry is radial but irregular. Three septal cycles occur normally, and large corallites may show the beginning of a fourth cycle. The wall is surprisingly thick in this species.

Comparisons: The species has very small corallite dimensions. Only *N. organum* shows much smaller dimensions. *N. seewaldi* has slightly larger dimensions. The new species also distinguishes from these two species by a higher number of septa.

Occurrences: Coniacian to Santonian (Streiteck to Hochmoos formations) of Austria.

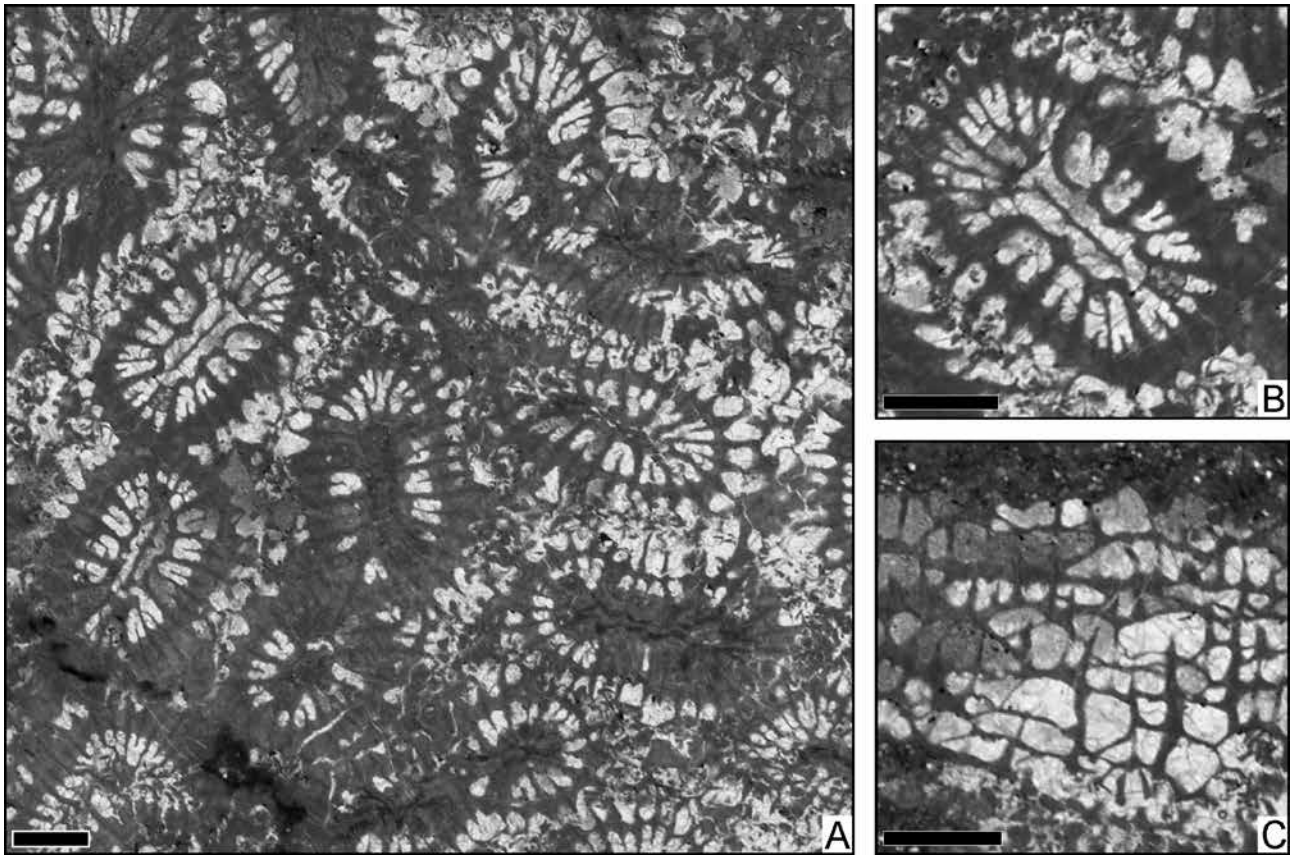

Fig. 14. *Nefocoenia werneri* spec. nov.; holotype, BSPG 2018 II 1409; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

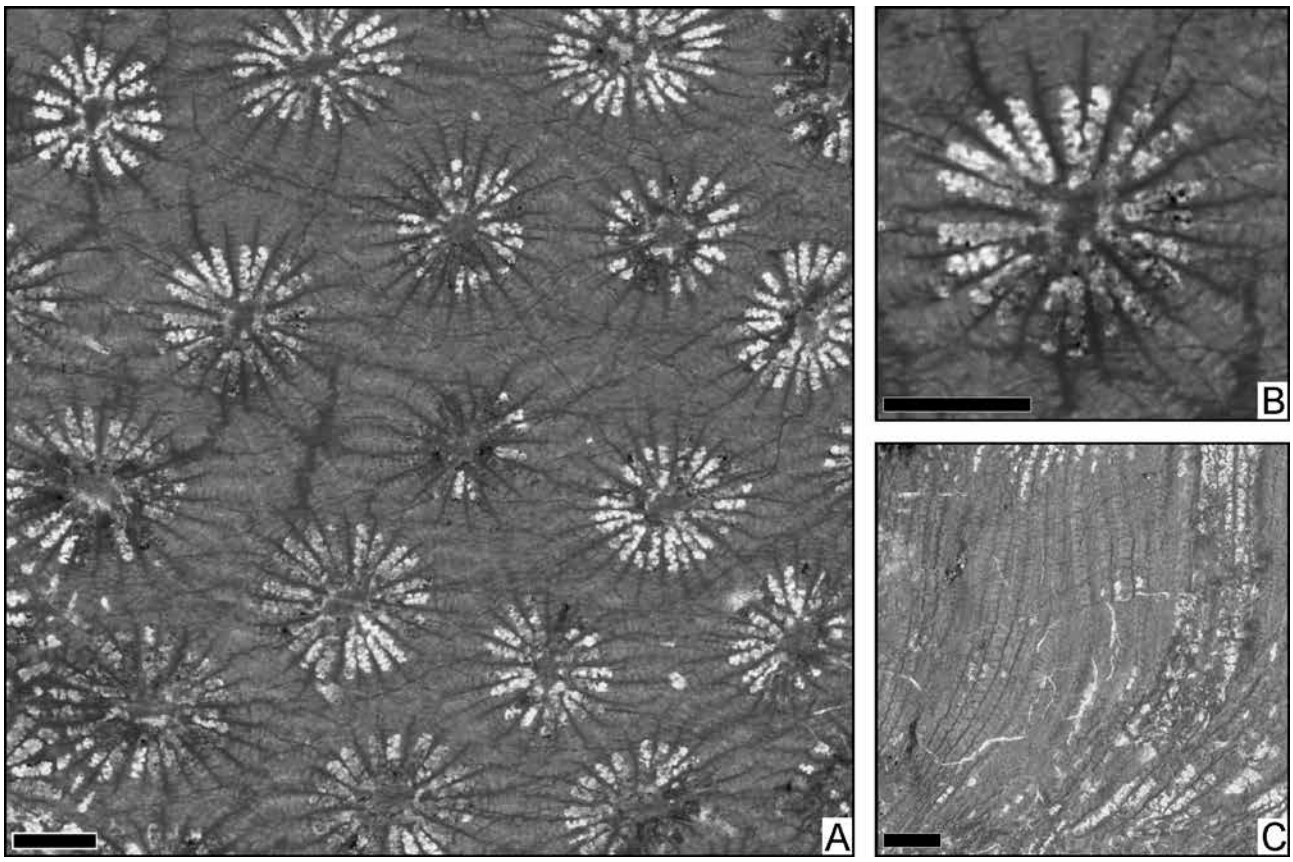

Fig. 15. *Pachyphylliopsis magnum* gen. nov. spec. nov., holotype, BSPG 2018 II 1609; **a**: transversal thin section; **b**: detail; **c**: longitudinal thin section. – Scale bar equals 1 mm.

Genus *Pachyphylliopsis* nov.

Type species: *Pachyphylliopsis magnum* spec. nov.

Etymology: In relation to the similar genus *Pachyphyllia*.

Diagnosis: Plocoid coral colony with compact septa in a radial symmetry. The septal microstructure is made of small trabeculae. The columella is extremely large, styliform, and circular to elliptical in outline. The wall is compact and septothecal. The endotheca consists of few tabulae. The budding is extracalicinal.

Description: Plocoid, small colony with regular, circular to slightly elliptical corallites. The corallite margins are slightly elevated. The septa are compact and consist of small trabeculae that are visible as a narrow dark line in the centre of the septum. The symmetry is radial, in most species hexameral, but rarely also decameral, in three septal cycles. The septa of the different cycles differ in length and thickness. They are externally thick and taper towards the corallite centre. In the type species, the septal thickness measures 0.27 and 0.18 mm in the first and second generation. The septa of the first cycle reach about 40% of the corallite diameter, whereas the septa of the remaining two cycles are shorter. Septa of the third cycle are occasionally connected with their inner margin to the lateral face of septa of the second generation. The ornamentation of the septal upper margin is unknown. The septal lateral faces bear thorns. The septal inner margins can be swollen. Septa of the first and second cycle are ocassionally connected to the columella. Costae are present; they are rarely confluent, mostly sub-confluent or non-confluent. Pali and synapticulae are absent. The columella is styliform, circular to elliptical, and in comparison to the corallite diameter, very large. The endotheca consists of few tabulae. Lonsdaleoid septa and a marginarium do not exist. The wall is septothecal and compact. The coenosteum is narrow and consists of costae. The budding is extracalicinal, in exceptional cases also intracalicinal.

Comparisons: Externally and also in the section, the new genus compares well to genera of the family Columastraeidae. But it differs from this family by small trabeculae. The new genus also shows a swollen septal inner margin, as it is typical for the family Phyllosmiliidae. Within this family only *Hydnophoropsis* and *Pachyphyllia* have a plocoid corallite arrangement and circular corallites as in the new genus. *Hydnophoropsis* has a lamellar columella, an extended coenosteum with isolated trabeculae (or external pali). *Pachyphyllia* is poorly documented, but the holotype as well as topotypical material have a small or absent columella. In *Barysmilia* and *Nefocoenia* the corallites are enlarged resulting in a less regular septal symmetry.

Species included: Only the type species. Material that belongs to the new genus was reported under the names *Actinastrea bastidensis* Alloiteau, 1954, *Columastrea dubia* Alloiteau, 1958 and *Diplocoenia* cf. *parvistella* Alloiteau,

1958 by Baron-Szabo (2000) from the Campanian/Maastrichtian of the United Arab Emirates. Moreover, we had at our disposal unpublished material from the Masstrichtian of Iran. The geology of the area is described in Khazaei et al. (2010). In the Gosau area, several specimens were found that differ in their corallite dimensions.

Occurrences: Coniacian to Santonian (Streiteck to Hochmoos formations) of Austria. Campanian/Maastrichtian (Simsima Fm.) close to Al Madam and Al Ain (Al Ain, United Arab Emirates). Maastrichtian (Tarbur Fm.) from the Ejdehai valley (Esfahan, Iran).

Pachyphylliopsis magnum spec. nov.
Fig. 15

Etymology: *Magnum* (Latin) for large, because of the extraordinary size of the columella.

Type: Holotype BSPG 2018 II 1609 with two thin sections.

Type locality: Austria, Salzburg, Rußbach am Pass Gschütt, Randobach.

Type horizon: Gosau Group, Streiteck to Hochmoos formations, Coniacian to Santonian.

Diagnosis: *Pachyphylliopsis* with a smaller corallite diameter of 1.5–1.8 and larger corallite diameter of 1.7–2 mm, hexameral septal symmetry and three septal cycles.

Material: Holotype.

Dimensions (BSPG 2018 II 1609):

	n	min–max	μ	σ	cv	μ±σ
clmin	30	1.32–1.84	1.60	0.14	8.9	1.46–1.75
clmax	30	1.54–2.23	1.87	0.17	9.1	1.70–2.04
ccd	45	1.76–3.47	2.62	0.41	15.7	2.21–3.03
s	20	20–24	22.50	1.53	6.8	21–24
colmin	15	0.19–0.30	0.25	0.03	13.2	0.21–0.28
colmax	15	0.31–0.51	0.43	0.06	14.9	0.37–0.50

Description: As for the genus.

Remarks: In *P. magnum* the columella is almost always elliptical, whereas in the material not yet described the columella may be circular or may have an irregular outline.

Occurrences: Coniacian (Streiteck to Hochmoos formations) Rußbach am Pass Gschütt, Randobach (Salzburg, Austria).

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