Notes on taxonomy and taphonomy of two Upper Maastrichtian (Upper Cretaceous) scleractinian corals from Limburg, The Netherlands

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Key words — Scleractinia, *Galaxea fasciculata*, *Placosmilia robusta*, Maastrichtian, Meerssen Member, ichnofossil.
A lectotype has been assigned for *Placosmilia? robusta* Umbgrove, 1925. This taxon, although fitting into the original diagnosis of *Placosmilia*, is not defined by the emended diagnosis of Alloiteau and later authors. Specimens from the Upper Maastrichtian of The Netherlands, that were formerly wrongly attributed to *Galaxea fasciculata* (Lamarck, 1816), a homonym of the extant species *Galaxea fascicularis* (Linnaeus, 1758), belong to *Placocoenia macrophthalma* (Goldfuss, 1826). The specimen depicted as *P. macrophthalma* by Umbgrove does not belong to this taxon and is placed in open nomenclature.

Contents

Introduction

The most recent and most complete taxonomical overview of the Upper Maastrichtian coral faunas from the Maastrichtian type area was by Umbgrove (1925). This taxonomy is outdated and now in the process of revision so that more correct comparisons with coeval faunas will be possible. The revision is hampered by the mouldic preservation in the Maastrichtian type area. Two species, of which Umbgrove depicted specimens from the same limestone block (RGM 29036), are dealt with in this paper (Pls 1-5).

Material

Institutional abbreviations — DGP (De Groene Poort/Ammonietenhoeve in Boxtel, The Netherlands), IPB (Institut für Paläontologie, Rheinische Friedrich Wilhelms-Universität Bonn, Goldfuss Museum), NHMM (Natuurhistorisch Museum Maastricht,

The Netherlands; extra prefix MK is for ex-collection W. M. Felder, extra prefix K is for ex-collection M. Kuypers), RGM (National Museum of Natural History, Leiden, The Netherlands), TM (Teylers Museum, Haarlem, The Netherlands).

Geographic and stratigraphic origin of the studied material — Figures 1 and 2 display the localities and stratigraphic distribution of the studied material. RGM 29036 contains the specimens depicted by Umbgrove (1925, pl. 10, fig. 15; pl. 11, fig. 13). It is a limestone block which was found by Umbgrove in the St. Pietersberg, south of Maastricht, Limburg, The Netherlands. No stratigraphic level was given on the label, but the lithology of the limestone suggests that it originates somewhere from the top of the Nekum Member up to the middle part of the Meerssen Member. RGM 29044 is from the Upper Maastrichtian of Limburg, The Netherlands.

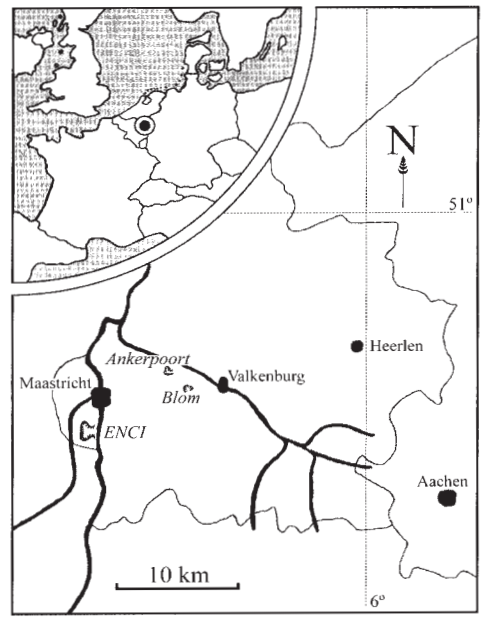

Fig. 1. Geographic relationships of the scleractinian localities mentioned in the text, also showing borders with Germany (east) and Belgium (west and south). Inset map shows position of main map in northern Europe.

NHMM K 552 was found in the now abandoned Blom Quarry (50°51′23.55″-50°51′32.26″N 5°47′21.64″-5°47′39.83″E) in Berg en Terblijt, Limburg, The Netherlands, in the top of IV-f4 to base of IV-f5 of the Meerssen Member in the Maastricht Formation. NHMM K 197, also from the Blom Quarry, is from the top of bed Ivf-4 (Meerssen Member).

NHMM MK 4168 is from the Meerssen Member Ivf-3 to f-5 from the ENCI Quarry. According to its label NHMM MK 4208 is from the highest part of the Meerssen Member in the Ankerpoort quarry. Although this should mean that it would come from Meerssen Member IV f-7, which is lowest Danian, the lithology of the limestone block clearly points to the middle part of the Meerssen Member (J.W.M. Jagt, pers. comm., June 11, 2003), an interpretation with which I concur. Since the lithostratigraphic presence of *Placosmilia robusta* in Meerssen Member Ivf-7 in Leloux (1999, fig. 2) was based on this specimen, this should be corrected.

Specimens housed at Museum De Groene Poort in Boxtel were all found in the middle part of the Meerssen Member in the ENCI Quarry at the St. Pietersberg.

Specimens from Teylers Museum are from "Fauquemont" (TM 12588, TM 24397) or "Maestricht" (TM 10806, TM 10807). The exact lithostratigraphic position of these specimens is unknown, but their lithology suggests it came from the top of the Nekum Member or the lower and middle part of the Meerssen Member.

IPB GOLDFUSS 236 is probably found at the St. Pietersberg, in the Upper Maastrichtian of Zuid Limburg.

According to Dhondt (1973, p. 22) the original material of Faujas-St.Fond (1799) is

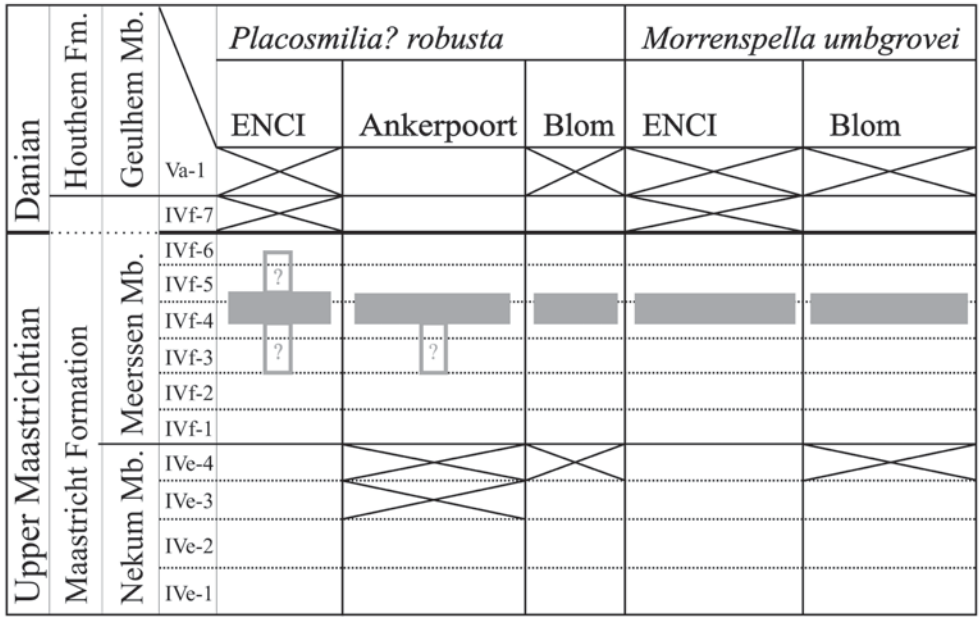

Fig. 2. Lithostratigraphic distribution of the species treated herein. Key: grey blocks — occurrence is certain; blocks with question marks — stratigraphic position of material is uncertain and it could also originate from these intervals. Lithostratigraphy after Jagt *et al*. (1996).

in principle in the Muséum National d'Histoire Naturelle (MNHN) in Paris, but no original Faujas labels are extant and only direct comparison with Faujas' figures could in some cases reveal the original specimen. In January 2004 I examined the coral collections of the Laboratoire Paléontologie (MNHN) and Paris 6 Université, but did not find these specimens.

Note on terminology

A note on the use of the words positive, negative, steinkern, mould and cast in the context of fossil preservation is necessary. The skeleton of the coral is regarded as the original positive. The structure may or may not be diagenetically altered during life or before it is deposited in the sediment. When it is deposited in the sediment, most cavities of the skeleton can be filled with mud. The mud consolidated and the original skeleton is dissolved leaving a mould or negative. The fillings of the skeleton cavities are called steinkerns or internal moulds, being thus a special part of the mould. A cast would be the secondary filling of the mould by, for instance, calcite crystallization or new filling of mud and could be regarded as a secondary positive.

The coral specific terminology is followed after Moore *et al*. (1956). Two terms that were not mentioned therein, but are used in the present paper, are:

- *denticulae*: small sharp protrusions on the surface of a septum.
- *granulae*: more or less hemispherical protrusions on a surface.

The peritheca, although often used as a synonym for the coenosteum, is here confined to the upper surface of the colony between the corallites (see, for example, Wood, 1983). The use of the terms lumen and calice can also be confusing; the calice is the oral surface of the corallite (Moore *et al*., 1956), while the lumen is the empty space in the corallite (that part when filled becomes a steinkern). The term dRAF (deposit of Rapid Accretion Front) is adopted from Stolarski (2003).

A question mark before the year in the citation lists means that it is only tentatively included into the mentioned species. The classification is followed after Wells (1956) and Chevalier & Beauvais (1987).

Systematic Palaeontology

Order Scleractinia Bourne, 1900
Suborder Faviina Vaughan & Wells, 1943
Family Montlivaltiidae Dietrich, 1926
Subfamily Placosmiliinae Alloiteau, 1952
Genus *Placosmilia* Milne Edwards & Haime, 1848a

Type species — *Turbinolia cymbula* Michelin, 1847, as designated by Milne Edwards & Haime (1850-1855, p. xxiv).

Original diagnosis — Milne Edwards & Haime (1848a) defined *Placosmilia* as the third genus of the "Eusmiliens proprement dits," where it "distingue des deux précédents" (*Cylicosmilia* Milne Edwards & Haime, 1848a, a junior synonym of *Parasmilia* Milne Edwards & Haime, 1848a, and *Trochosmilia* Milne Edwards & Haime, 1848a), "par l'existence d'une columelle lamellaire. Exemple: *Turbin. rudis* et *Cymbula*, Michelin." *Cylicosmilia* was defined as "Polipier simple, fixe et élevé; épithèque rudimentaire ou nulle. Côtes distinctes dès la base et non ramifiées. Columelle spongieuse. Cloisons nombreuses et minces; endothèque très-abondante," while *Trochosmilia* differed from *Cylicosmilia* by the absence of a columella. The "Eusmiliens proprement dits" were described as belonging to the family of the "Astréides," where the "bord libre ou caliculaire des cloisons" is "entier et tranchant" and the individual "polypier" is distinct.

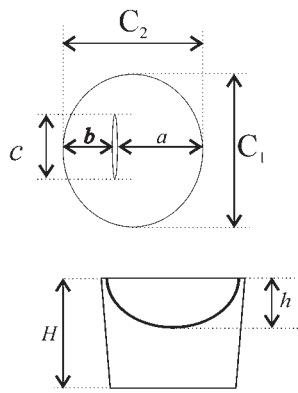

Fig. 3. *Placosmilia*? *robusta* (Umbgrove, 1925). Dimensions measured: C_1 = width of calyx parallel to the largest width of the columella; C_2 = width of calyx perpendicular to the largest width of the columella; *c* = largest width of columella; *a* = distance between columella and most peripheral part of wall; *b* = distance between columella and least peripheral part of wall; *H* = height of coral; *h* = depth of calyx.

Emended diagnoses — Alloiteau (1952, p. 613) defined his new family Placosmiliidae as having the same structure as the Montlivaltiidae, but with a lamellar

columella. He described *Placosmilia* as "un polypier flabelloïde, fortement comprimé, une muraille parathécale, multilamellaire, épicostale; des faces latérales septales subcarénées. Microstructure s'emblable à celle de *Montlivaltia*." He also depicted drawings of thin sections and a picture of the holotype of the type species. Since the microstructure resembles that of the Montlivaliidae, it is logical that Wells (1956, p. F400) made Placosmiliinae a subfamily of the Montlivaliidae. Currently, some authors consider *Placosmilia* as colonial, solitary flabellate in early ontogeny, meandroid when adult (for example, Baron-Szabo, 2002, p. 52).

Placosmilia? robusta (Umbgrove, 1925)

Pl. 5; Fig. 3.

?1773 "Lamelleuse fungiet" — Walch, p. 193, supplement-pl. 6d, fig. 8.
?1799 Fongites — Faujas de Saint Fond, p. 199, pl. 38, figs. 3, 7.
?1804 Fungieten — Pasteur, p. 267, pl. 38, fig. 3, 7.
?1828 *Fungia patellaris* Lamarck — Morren, p. 49.
1864 *Cyclolites* sp.? (*Cyathina*?) — Winkler, p. 164. [*Pro parte*.]
1868 *Cyclolites* sp. — Winkler, p. 8.
1925 *Placosmilia robusta* spec. nov. — Umbgrove, p. 115-116, pl. 11, fig. 33.
1926 *Placosmilia robusta* sp. nov. — Umbgrove, p. 415.
1981 *Placosmilia robusta* Umbgrove — Kuzmicheva, p. 69.
1987 *Placosmilia robusta* Umbgrove — Kuzmicheva, p. 60.
1999 *Placosmilia robusta* — Leloux, p. 193.
2002 *Placosmilia robusta* Umbgrove, 1925 — Löser, p. 540-541.
2002 *Placosmilia robusta* Umbgrove, 1925 — Baron Szabo, p. 52.
2002 *Placosmilia robusta* Umbgrove, 1925 — Leloux, p. 14, pl. 1, fig. 3.

Lectotype — RGM 29036.

Additional material — RGM 33226, RGM 76766, TM 10806, TM 10807, TM 12588a, TM 24397a and e, NHMM MK4208b, NHMM MK 4168c, NHMM K 197a, RGM 212462a, RGM 212463, RGM 212464a.

Type locality — St. Pietersberg, south of Maastricht, Zuid Limburg, The Netherlands.

Other localities — ENCI Quarry; Valkenburg; Ankerpoort Quarry, west of Berg en Terblijt; and Blom Quarry, east of Berg en Terblijt. They all were found at bed IVf-4 to IVf-5.

Description — Solitary coral. The first growth-stage is turbinate, but later stages are cylindrical. First four cycles of septa complete, the fifth and sixth cycles are incomplete. Higher order septa are approximately twice as thin as lower order septa. Calice tends to be ellipsoidal, while the lamellar columella is eccentrically positioned. Endothecal dissepiments well developed. The wall is poorly preserved. It seems that the wall has a regular pattern of holes that occur between the septa and the dissepiments. The mould of the coral shows the costa in pairs. (See Fig. 3 and Table 1 for dimensions of the material.)

Table 1. Dimensions of *Placosmilia*? *robusta* (Umbgrove, 1925). Key: s/cm = septal density, amount of septa pro 10 mm; s/s = thickness of a lower order septum divided by the thickness of a septum of the next order measured at the same distance from the columella. See the caption of Figure 3 for explanation of other abbreviations.

all in mm	C1	C2	a	b	c	h	H	s/cm	s/s
RGM 29036a	26.0	23.0			6.8	11.7			1.9
RGM 29036b	23.0							14	1.7
RGM 33226	16.7	14.6	8.5	6.2	6.0			14	2.4
RGM 76766	29.7	23.7	15.5	11.8	6.3	10.2		10	2.1
NHMM MK 4208b	17.0	11.3	6.8	5.5	4.7	8.1	30.3	14	1.7
NHMM MK 4168	59.9	42.9	24.9	14.9	8.8	24.8		10	2.0
TM 10807a	22.4	19.2	10.3	7.8	6.0	3.7		14	
TM 10807b	22.1	20.9	10.5	9.4	3.0	6.9		16	
TM 10807c	21.8	14.8	8.4	5.8	4.9	6.3		18	
TM 12588a	37.7	27.3	15.2	12.2	12.3	8.6		12	2.0
TM 24397a	32.0	26.0	20.5	12.2	8.4				
TM 24397e	20.0	16.7	10.1	6.0	7.6	9.6	33.4		
TM 24397z	18.0						67.6		
NHMM K 197a	34.4	28.0	19.6	15.0	7.2		38.0	12	1.6
Jx 1117a					5.1		22.0	10	
Jx 1815	31.0						65.8	18	
mean	27.4	22.4	13.7	9.7	6.7	10.0	42.9	14	1.9
standard deviation	10.7	8.0	5.7	3.5	2.2	5.7	19.5	3	0.3
max	59.9	42.9	24.9	14.5	12.3	24.8	67.6	18	2.4
min	16.7	11.3	6.8	5.5	3.0	3.7	10.0	10	1.6
n	15	12	11	11	13	9	9	12	8

Discussion — Only moulds are preserved of this taxon. Umbgrove (1925, p. 115) clearly based his description on several specimens, but depicted only one (RGM 29036). No other type specimens were found with certainty. The collection of the NNM yields one other specimen, which was labelled "*Trochosmilia faujasi*" (RGM 76766, ex-collection Umbgrove) and was bought by the museum in 1955. The whereabouts of the other type specimens is unknown. Teylers Museum possesses five specimens, most of which were regarded as *Cyclolite*s by Winkler (1864, p. 164; 1868, p. 8). One of the specimens (TM 10706d) is accompanied by a handwritten note from Umbgrove, "Brokstukken v. *Dimorphastraea solida* n. sp.," which can thus be regarded as a syntype for that species, although it is definitely not that species. *Dimorphastraea solida* and *P. robusta* both have steinkerns that suggest a 'perforated wall,' but the former is a colonial coral without columella. As Umbgrove (1925, p. 115) stated, the steinkerns are in some aspects similar to *Trochosmilia faujasii* Milne Edwards & Haime, 1848b, *sensu* Umbgrove (1925, pp. 114-115). *Placosmilia robusta* differs from *T. faujasii* in having a clear lamellar columella and a 'perforated' wall. Also, the shape of the steinkern is different for both species: the steinkern of the lumen in *T. faujasi* is V-shaped, while *P.? robusta* is more or less U-shaped.

Taxonomic position — Umbgrove corrrectly placed this taxon in *Placosmilia* as he knew it from his literature. This taxon fits perfectly into the original diagnosis of the

genus, but it does not at all fit into the emended diagnosis of Alloiteau (1952) and later authors. A transfer to another genus seems inevitable. The question as to which genus is beyond the scope of this paper. Basic questions arise about the microstructure of this taxon, determination of which requires better preserved material. One possibility would be *Peplosmilia* Milne Edwards & Haime, 1850, which also belongs to the Placosmiliinae. The mouldic preservations of *P.? robusta* suggests that there is no epitheca. This is in contrast to the diagnosis of the Montlivaltiidae as given in Wells (1956, p. F398). According to Baron Szabo (June, 2003, pers. comm.), the dimensions of *P.? robusta* correspond to *Peplosmilia latona* from the Austrian Gozau group. A further comparison between *Peplosmilia latona* and *Placosmilia? robusta* is necessary. When the original diagnosis is interpreted as a "*Parasmilia* with a lamellar columella," bigger problems occur; according to Wells (1956, pp. F421-F433), no lamellar columella occurs in the suborder to which *Parasmilia* belongs.

Family Faviidae Gregory, 1900
Subfamily Montastreinae Vaughan & Wells, 1943
Genus *Placocoenia* d'Orbigny, 1849

Type species — *Placocoenia macrophthalma* (Goldfuss, 1826) by original designation.

Discriminative diagnosis — Plocoid Montastreinae with lamellar columella and a coenosteum consisting of perforated costae and exotheca.

Placocoenia macrophthalma (Goldfuss, 1826)

Pls. 1-4; Figs. 4, 5.

Selected synonymy — See Löser (2002, pp. 319, 528-529) for more references.

?1799 "Polypes du genre des Alveolites" — Faujas de Saint- Fond, pp. 212-213, pl. 42.
?1804 "Polype van het geslacht der Alveoliten" — Pasteur, pp. 284-286, pl. 42.
1826 *Astrea macrophthalma* nobis — Goldfuss, pp. 70-71, pl. 24, figs. 2a, b.
?1828 *Caryophyllia fasciculata* Lamarck — Morren, p. 48.
1828 *Astrea macrophthalma* Goldfuss — Morren, p. 65.
1925 *Galaxea fasciculata* (Morren spec. gen. nov. nom.) — Umbgrove, p. 106, pl. 10, fig. 15.
1925 *Placocoenia macrophthalma* Goldfuss — Umbgrove, p. 101 (*non* pl. 11, fig. 30).
1926 *Placocoenia macrophthalma* Goldfuss — Umbgrove, p. 415.
1926 *Galaxea fasciculata* Morren sp. — Umbgrove, p. 415.
1952 *Placocænia macrophthalma* — Alloiteau, p. 626
1964 *Galaxea fasciculata* (Morren) — Voigt, p. 296.
1982 *Placocoenia macrophthalma* — Beauvais, p. 107.
1999 *Galaxea fasciculata* — Leloux, p. 193, fig. 2.
2002 *Galaxea fascicularis* — Löser, p. 319.
2002 *Placocoenia macrophthalma* (Goldfuss, 1826) — Löser, pp. 528-529.

Holotype — The specimen depicted by Goldfuss (1826, pl. 24, fig. 2a, b). IPB GOLDFUSS 236 is considered to be this specimen (for example, Beauvais, 1982, p. 107; Löser, 2002, p. 528; Baron-Szabo, 2002, p. 296), but it does not resemble the drawing (Fig. 4). Until now no specimen resembling the plate of Goldfuss has been found in

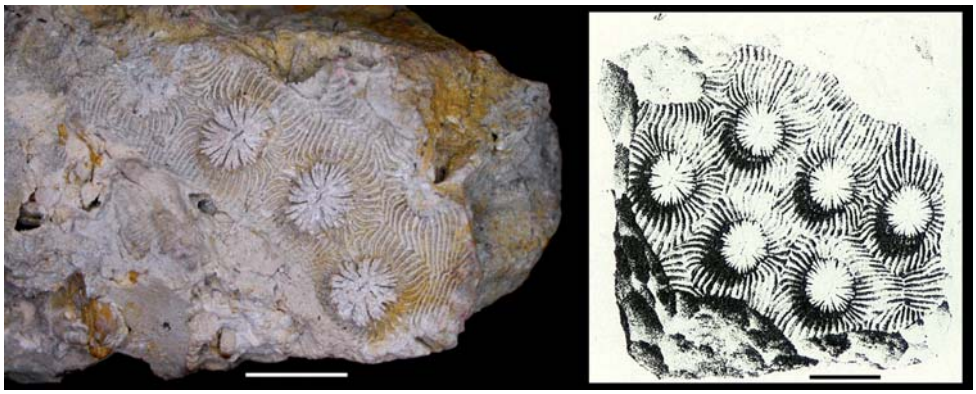

Fig. 4. *Placocoenia macrophthalma* (Goldfuss, 1826). Left: IBP GOLDFUSS 236. Right: Goldfuss (1826, pl. 24, fig. 2a). The specimen on which the right figure is based is the holotype. The left specimen has been generally considered as the holotype, but the poor resemblance is obvious.

Bonn. It could be that the artist of the plates of Goldfuss was attempting to reconstruct the specimen in part or that the original specimen was later broken. The latter possibility seems unlikely since, in that case, fresher fractures would be visible on IPB 236. The drawing suggests that this specimen and IPB 236 belong to the same taxon, and have a comparable state of preservation.

Studied material — IPB GOLDFUSS 236, NHMM K 552, RGM 29036, DGP 1398, DGP 1399, DGP 3117, DGP 3118, DGP 3119, DGP 3120. (For dimensions, see Fig. 5; Table 2.)

Type locality — St. Pietersberg, south of Maastricht, Zuid Limburg, The Netherlands.

Localities of the studied material — IPB GOLDFUSS 236 is from St. Pietersberg. NHMM K 552 is from the middle part of the Meerssen Member (IV f-3 till IV f-5) at the Blom Quarry. The other additional material is from the same lithostratigraphic interval, but from the ENCI Quarry.

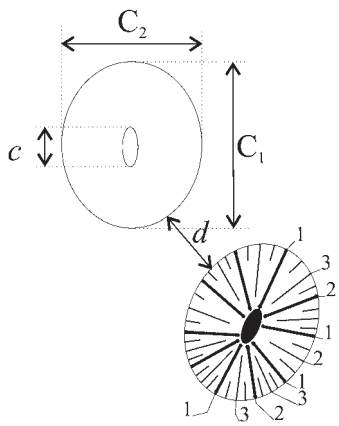

Fig. 5. *Placocoenia macrophthalma* (Goldfuss, 1826). Dimensions measured on the two specimens: C_1 = width of calyx parallel to the largest width of the columella; C_2 = width of calyx perpendicular to the largest width of the columella; *c* = largest width of columella; *d* = closest distance between two calices. Also present in one of the calices is the septal arrangement in cycles, where the thicker septa of the first and second cycle represent the first order.

Table 2. Dimensions of *Placocoenia macrophthalma*. Key: *c* = largest width of columella; C_1 = width of calyx parallel to the largest width of the columella; C_2 = width of calyx perpendicular to the largest width of the columella; *d* = closest distance between two calices; *m* = mean; *SD* = standard deviation; *n* = number of columellas measured. The last column (dents/10 mm) presents the amount of dents per 10 mm that are counted in the costae. See also Figure 5 for further explanations.

	c			***C_1***			***C_2***			***d***			dents/10 mm
	$\bar{m}$	*SD*	*n*	$\bar{m}$	*SD*	*n*	$\bar{m}$	*SD*	*n*	$\bar{m}$	*SD*	*n*	
NHMM K 552	1.5	0.4	5	7.2	0.6	5	6.7	0.6	5	2.3	1.3	14	24
RGM 29036	1.4	0.3	14	7.6	0.8	14	6.9	0.7	14	2.2	1.0	11	-
DGP 1398	1.4	0.4	8	8.6	0.7	10	8.3	0.9	10	6.3	1.3	10	28
DGP 1399	1.4	0.3	3	8.1	0.6	3	6.7	0.3	3	3.5	1.0	10	28
DGP 2072	1.5	0.1	3	7.8	0.3	4	6.5	0.3	3	5.7	2.5	10	23
DGP 3117	1.3	0.2	4	6.7	0.3	4	7.2	0.6	4	2.5	0.3	3	21
IBP GOLDFUSS 236	1.6	0.1	3	7.6	0.1	3	6.6	0.2	3	4.0	0.5	4	26

Description based on the additional studied specimens, which hitherto were called Galaxea fasciculata — Colony approximately circular, massive, with a slight convex to a flat upper surface. Plocoid. Budding extracalicinal. Coralites elliptical, leaving cylindrical steinkerns slightly concentrated in rows.

Septal arrangement in three orders, 10-10-20, which can be interpreted as a four cycle formula, 6-6-12-16, in which the fourth cycle is not developed in the two systems along the minor axis of the ellipse (Fig. 5). Septa are almost massive, some pores are present and seems to concentrate near the wall, with rows of denticulae, approximately 50º to 60º to the central axis. Columella lamellar; it is not sure if this structure is a real massif columella or a densely packed spongy one (Pl. 2, fig. 2-4; Pl. 3, fig. 2). Endotheca present as arc-shaped structures, 1 mm long, extending from the wall about every *c*. 3 mm along the corallite. Wall not preserved. It could be synapticulothecate, parathecate or septothecate. Some structures in the steinkern can be interpreted, doubtfully, as moulds of synapticulae. Costae consist of rods that are continuations of the trabeculae in the septa, but they get more separated and form outward pointing spines (Pl. 2, figs. 4, 5). Exotheca is well developed. Dimensions are presented in table 2.

Description of NHMM K 552 — Fragment (110 × 95 mm) of a colony, consisting of three layers of subsequent growth stadia. The first two layers are about 1 cm, while the last is about 2 cm high. Some secondary positive preserved skeleton material is present as thin white material. More precise (destructive) study of this material is out of the question, which is one of the most complete specimens known. The colony is built of several growth-layers. The transition from an old layer to a new one can be seen in the steinkerns of the corallites. The steinkerns are cylindrical, except when an old layer is finished and a new one begins; here the steinkern is suddenly smaller and returns to its original diameter over a few millimeters. The cross-section of a steinkern is slightly elliptical. The secondary positive fossil material is concentrated around the zone of rejuvenation.

Description of RGM 29036 — Fragment (50 × 60 mm) of a colony, preserved as 15 steinkerns of corallites diverging from the bottom to the top and a small fragment

(15 × 9 mm) of the mould from the outside of the wall of the colony. The orientation of this columella aligns with the total radius of the colony.

Description of DGP 1398 — Mould of a fragment (80 × 70 mm) of an upper surface of coral colony with 16 steinkerns of lumens. The costa margins are indented (Pl. 4, fig. 1).

Description of thin section of DGP 1399 — Thin section of about 30 μm thick, taken from a fragment (about 90 × 40 × 50 mm) of a colony, partly preserved as steinkern/internal mould, partly preserved as cast of the colony. A cross-section of an internal mould of a lumen is visible. The mould is clearly filled with mud and small bioparticles, including foraminifers (Pl. 4, fig. 4). Plate 4, figure 2, depicts a series of 'green' clusters of spots more or less along the axes of the costosepta. These spots are considered as ghosts of the dRAFs. On these spots and the internal moulds of the lumen calcite crystals (Pl. 4, fig. 3) have been growing after sedimentary deposition and dissolution.

Discussion — *Galaxea fasciculata* (Lamarck, 1816) *sensu* Morren (1828) and Umbgrove (1925, p. 106) is a homonym of *Galaxea fascicularis* (Linnaeus, 1758). *Galaxea fascicularis* was originally described by Linaeus (1758) as *Madrepora fascicularis*, "M. Composita, stellis cylindricis rectis glabris: superne distinctis fastigiatis. Habitat in O. Africano." Lamarck named it "Caryophyllie fasciculée" and translated that into Latin as *Caryophyllia fasciculata*, living in the Indian Ocean. Lamarck mentioned that fossils of this species are found in Europe.

Galaxea fascicularis is an extant species that originated in Indonesian waters during the Miocene, from where it expanded to its present realm from the Red Sea throughout the Indian Ocean into the Pacific ocean (Chevalier, 1971, p. 58). The skeleton of the genus *Galaxea* Oken, 1815, is characterized as follows (after Wood, 1983, p. 182); "numerous strongly exsert septa arranged in cycles. They protude several millimeters as thin, sharp blades. Smooth, granular or minutely dentate septal margins. Costae continue a short way down the outside of the corallite wall but are absent from perithecal areas. The peritheca is slightly rough due to the presence of irregular low vesicles. Columella is weak or absent." The Maastrichtian taxon differs most obviously from this by the presence of a strong columella, continuing costae over the peritheca and only slightly protruding septa.

"*Galaxea fasciculata*" specimens from Maastricht and *Placocoenia macrophthalma* have been considered as separate species until now. This is probably due to their different preservations. "*Galaxea fasciculata*" can be considered as the preservation of the steinkerns in the bottom of a colony, while *P. macrophthalma* was restricted to moulds of the upper surface of the colony. The variety of lengths of the steinkerns (and thus the lumens) can be explained by the varying moment in the growth stages at which the colony was when it died.

The present material does not permit description of the wall of this taxon. Alloiteau (1952, p. 626) found better preserved specimens of this species in the Upper Cretaceous of Charente and Dordogne (France), and based on that material he described the wall as septothecate. He also described the coenosteum, observations confirmed by the present material.

Montastreinae sp. indet.
Fig. 6.

1925 *Placocoenia macrophthalma* — Umbgrove, pl. 11, fig. 30 (*non* p. 106)

Material — RGM 29044.

Description — RGM 29044 is part of a mould of a colony. This fragment measures 56 × 56 × 24 mm (height × width × depth). It represents the edge of a probably massive hemispherical colony and consists of two growth layers, the lower about 29 mm high and containing three steinkerns of calices or lumens. The second layer has overgrown the older layer. The three steinkerns are different is size from each other (6.6 mm, 7.4 mm and 11.3 mm in diameter). The smallest look circular in cross-section, while the large steinkern is oval in cross-section. Due to the shape of the fossil only one axis of the steinkerns could be measured. For the large one it is the major axis. The number of septa cannot be counted with certainty on this fossil. It seems that the small steinkerns have three orders of septa (probably 10-10-20), while the big one has four orders (probably 10-10-20-40). The surfaces of the septa are granulated and these granules are sometimes ordered in lines. The mould suggests a columella consisting of twisted rods. The coenosteum consists of perforated costae and exotheca comprised of horizontal (not vesicular) dissepiments.

Discussion — RGM 29044 was depicted by Umbgrove (1925, pl. 11, fig. 30) as *Placocoenia macrophthalma* (Goldfuss, 1926). This specimen differs from *P. macrophthalma* in not having a clear lamellar columella and in having different sized corallites on one colony. It is therefore left in open nomenclature herein.

Preservation and association

The *Placocoenia macrophthalma* fossils are preserved mainly as moulds of fragments of allochtonous colonies in yellow boundstones. NHMM K 552 contains some positive structures, although recrystallised. The kind of limestone and the other corals on that block suggest that it was found in the middle part of the Meerssen Member. Clear evidence of recrystallisation can be observed in the thin section of DGP 1399 (Pl. 4, fig. 3).

Chemical analysis (using x-ray fluorescence analysis with EDAX µ-probe, a technique best suited to elements from Na and higher, but able to analyse a surface of only 10 mm^2 in width) of thin section DGP 1399 resulted in 98.5% CaO or more for all areas that are 'green' (Pl. 4, fig. 2). One exception is the 'brown' area (indicated by a white arrow in Pl. 4, fig. 2), which only contained 84.4% CaO and 12.3% FeO. The local higher iron content is consistent with the macroscopic red outside colour of the sample. The absence of significant iron content in the bulk of the sample may have been caused by the low porosity of these limestones. It is possible that the iron can only infiltrate through small cracks. The green colour in Plate 4, figure 2, is caused by the use of polarized light. Using unpolarized light the colour becomes brown. This chemical analysis is not discriminative for organic content and it remains very doubtful if any original organic matter is preserved.

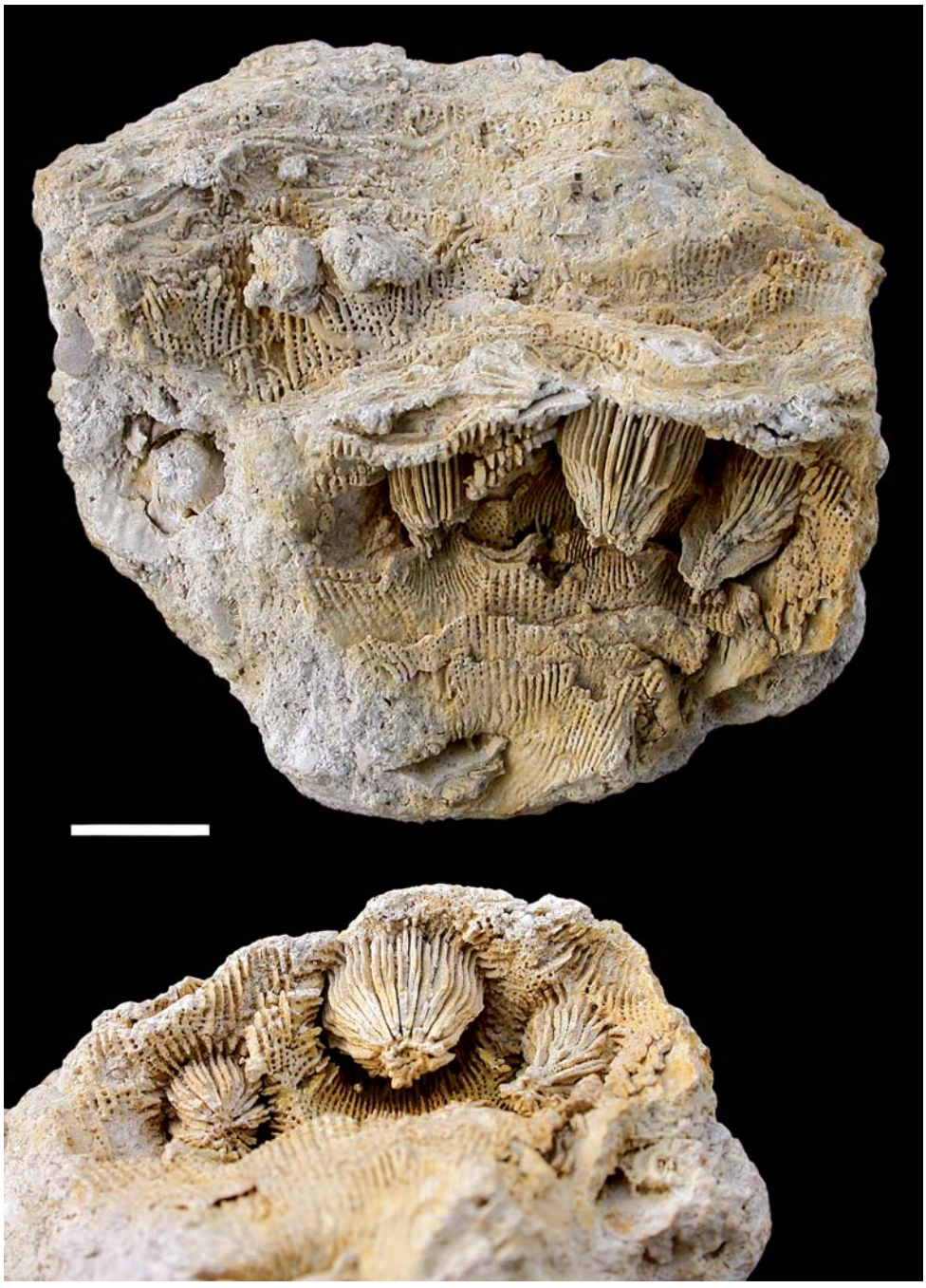

Fig. 6. Montastreinae sp. indet., RGM 29044, from the Upper Maastrichtian of Limburg, The Netherlands. This specimen was depicted by Umbgrove (1925, pl. 11, fig. 30) as *Placocoenia macrophthalma*.

Other fossils on limestone block Kuypers 552 are the large benthic foraminifers *Lepidorbitoides minor* (Schlumberger, 1901) and *Siderolites calcitrapoides* Lamarck, 1801, the red alga *Lithothamnium mammilosum* Gümbel, 1871, sponge *Spirastrella (Acanthochaetetes) favosites* (Oppenheim, 1899), steinkerns of the scleractinians *Actinastrea faujasi* (Quenstedt, 1881), *Caryophyllia bredai* (Milne Edwards & Haime, 1850) and *Synastrea geometrica* (Goldfuss, 1826), fragment of the coral *Actinhelia elegans* (Goldfuss, 1826), and fragments and steinkerns of bivalves, gastropods and echinoderms.

Apart from *Placocoenia macrophthalma*, RGM 29036 also contains the figured syntype of *Placosmilia robusta* Umbgrove, 1925, now selected as lectotype, a fragment of *Dimorphastrea solida* Umbgrove, 1925, a steinkern of *Heterocoenia bacillaris* (Goldfuss, 1826), an eroded steinkern of *Heliastrea arachnoides* (Schröter, 1778), and some internal and external moulds of trochoid to turbinate solitary corals. This block also contains several fragments of bryozoa, gastropods, bivalves and echinoderms.

Ichnofossils

The skeletons of the examined corals were infested by various bioeroders. NHMM K 552 is treated here as an example. The *P. macrophthalma* specimen on that limestone block contains several growth layers. The last (and youngest layer) is massively infested by a camerate entobian fossil with chambers of *c*. 2 to 4 mm, and showing some intercameral canals and apophyses (*Entobia* cf. *ovula* Bromley & d'Alessandro, 1984) (Pl. 6, fig. 1). In the older layer one can see exploratory threads and two different kinds of entobian fossils. The first one, *Entobia* isp. (Pl. 6, fig. 5), consists of ovoid concentrations (Ø 3-8 mm) of small chambers (Ø 0.2 mm). This taxon is clearly connected to the exploratory threads. The total ovoid shape is connected with the outside of the coral colony by one to several apertures (Ø "0.8 mm). The second sponge boring in the older layers is forming large solitary chambers, which look 'spikish' (Pl. 6, fig. 4) when they are about 3-4 mm, but become 'bulbish' in later stages (Pl. 6, fig. 3; Pl. 4, figs. 1, 2). It is interpreted as *Uniglobites glomerata* (Morris, 1851).

Apart from the sponge borings, several 3 mm thick channels have perforated the coral, more or less parallel to the coral surface (Pl. 1, figs. 1, 3; Pl. 6, fig. 3). They probably belong to polychaete borers and are provisionally referred to *Trypanites* isp.

On another fossil of an undetermined colonial coral on the same limestone block, one may recognise the bivalve boring remains *Gastrochaenolites* cf. *lapidicus* Kelly & Bromley, 1984. It is about 11 mm long and it measures 7.4 mm as largest diameter. The neck and aperture are not visible. The base is smooth and slightly pointed (Pl. 6, fig. 2).

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Plate 1

MHMM K 552. *Placocoenia macrophthalma* (Goldfuss, 1826).

Fig. 1. Distal view of colony (scale bar represents 10 mm).
Fig. 1a. Drawing of the colony, distal view.
Fig. 2. Steinkern of one corallite, showing moulds of granulations arranged in rows and dissepiments (*diss*). The central axis shows the mould of a possible lamellar columella surrounded by moulds of the paliform lobes. Also showing *Entobia* cf. *ovula* on the left and *Entobia* sp. 1 to the right (scale bar represents 2 mm).
Fig. 3. Detail of the colony, showing the boundary of the youngest growth layer and the older layer. In the older layer, a three mm thick boring, probably of a polychaete worm, is marked with (a). (b) marks the rejuvenation of the corallite; the steinkern is abruptly thinner and increases to its original diameter in the next few mm (scale bar represents 2.5 mm)
Fig. 4. Lateral view of the colony (scale bar represents 10 mm).
Fig. 4a. Drawing of the lateral view of the colony, seen from the side; same scale as Figure 1a.

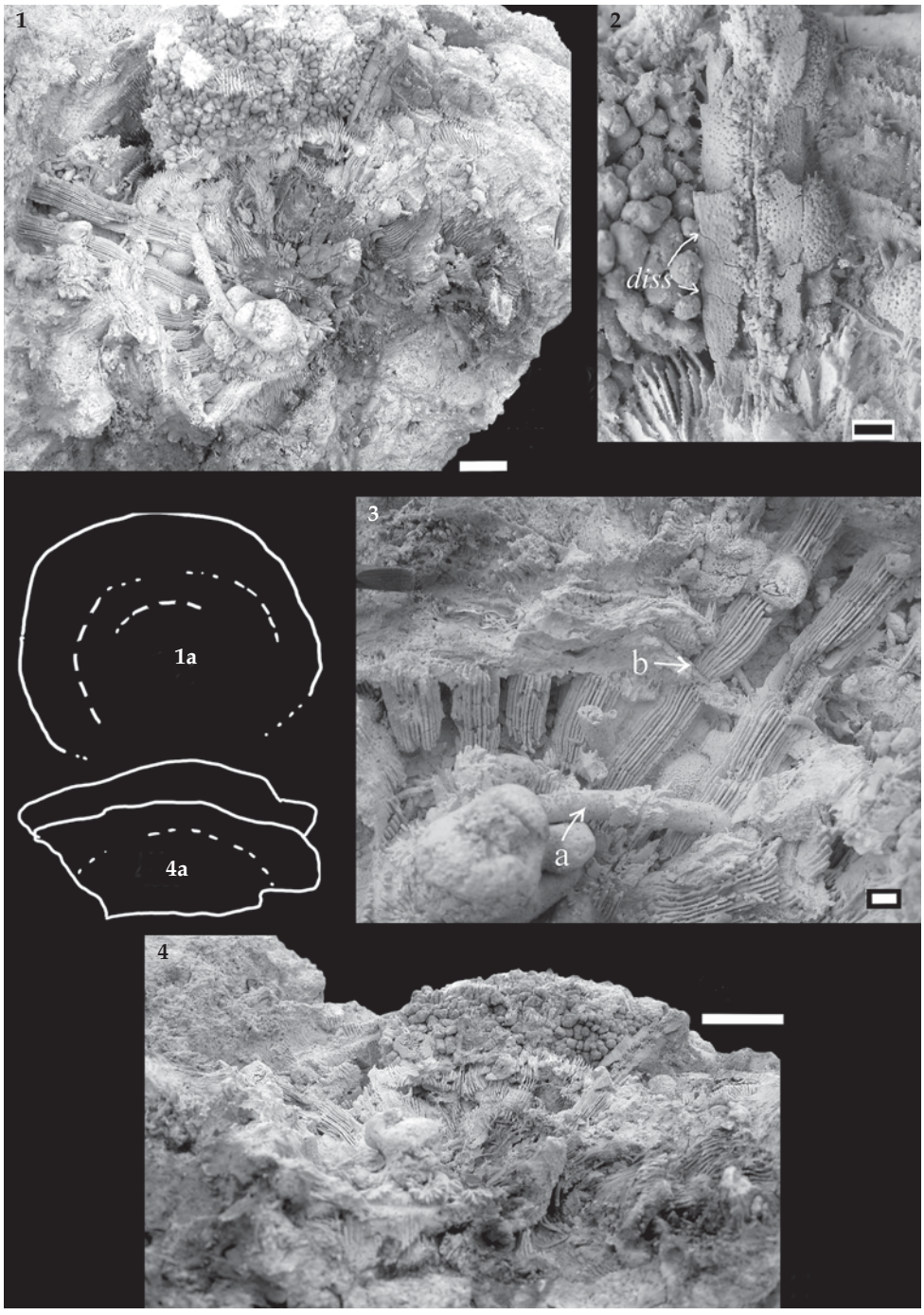

1
2
diss
3
b
a
1a
4a
4

Plate 2

MHMM K 552. *Placocoenia macrophthalma* (Goldfuss, 1826) (all scale bars represent 1 mm).

Fig. 1. Detail of a corallite (on the right in Pl. 1, fig. 3). Moulds of the dissepiments (*dis*), each separated from each other by about 4 to 5 mm. The surface of the second youngest layer of growth, slightly out of focus, has rows of granules curving upwards and forming the spines of the costae (just left from the corallite in the boundary layer). The corallite is surrounded by two *Trypanites solitarius* borings and, in the top right of the picture, is a spiny sponge chamber of *Uniglobites glomerata*.
Fig. 2. Detail from Plate 2, fig. 1, showing a fragment of an original septum and columella, in an almost dissolved state and partly recrystallised.
Fig. 3. View from above on the surface in the middle of Plate 2, fig. 1.
Fig. 4. View of a cross-section of a steinkern of a corallite.
Fig. 5. Side view of the structure in the upper left corner of Plate 2, fig. 3. Directly above the scale bar is the central part of a corallite. Some original septal material is preserved and it shows the trabeculae curving upwards to form the spiky costae.
Fig. 6. View from above on the upper surface of the youngest growth layer, showing the costae. Also visible are chambers of *Entobia* cf. *ovula* almost completely filling the (former) youngest layer in this part of the colony.

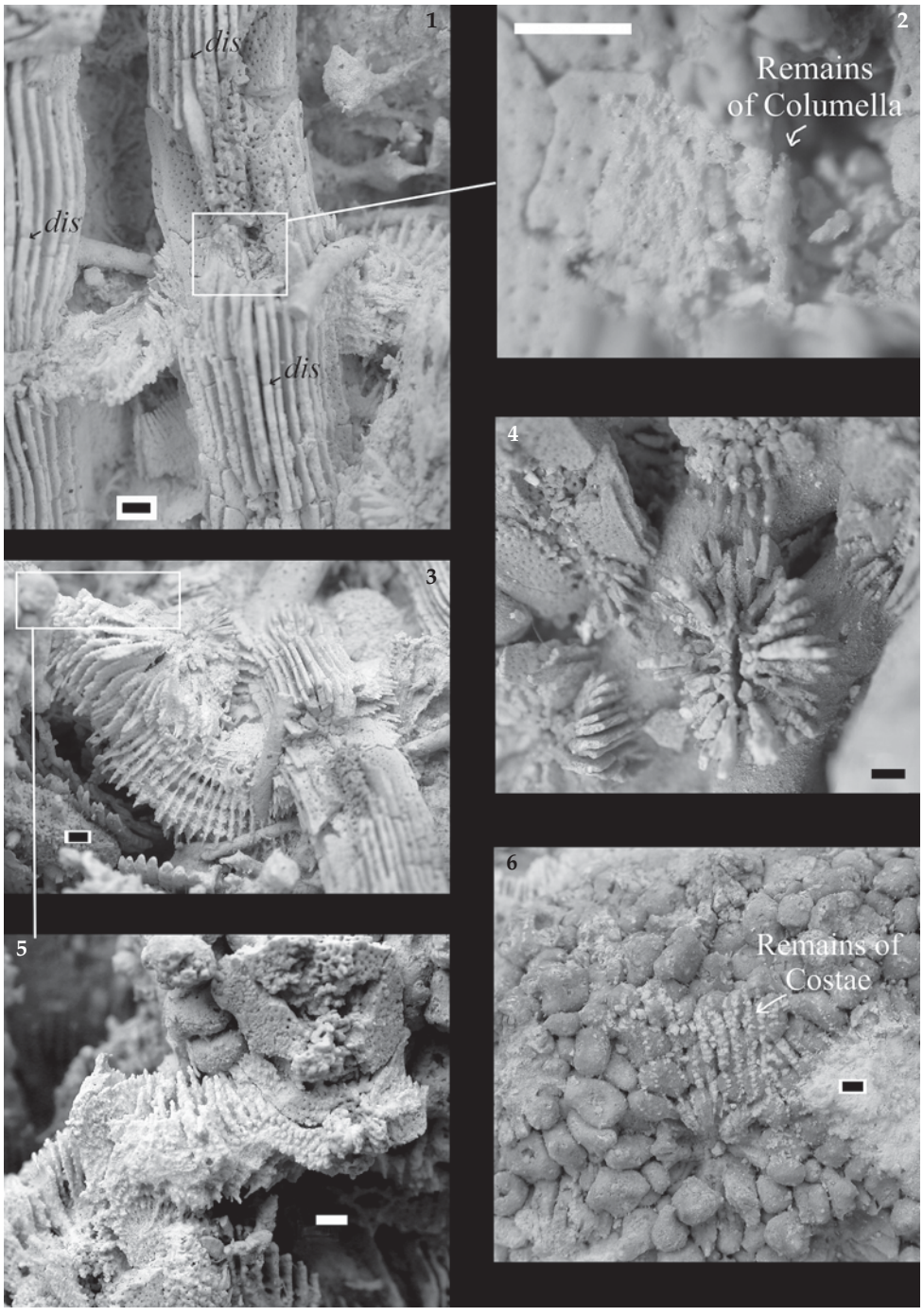

1
dis
dis
dis
2
Remains
of Columella
3
4
5
6
Remains of
Costae

Plate 3

RGM 29036. *Placocoenia macrophthalma* (Goldfuss, 1826), specimen that was depicted as *Galaxea fasciculata* Morren *in* Umbgrove (1925).

Fig. 1. Distal view, showing the steinkerns of the corallites surrounded by what may be *Uniglobites glomerata*.
Figs. 2, 3. Details of corallites.

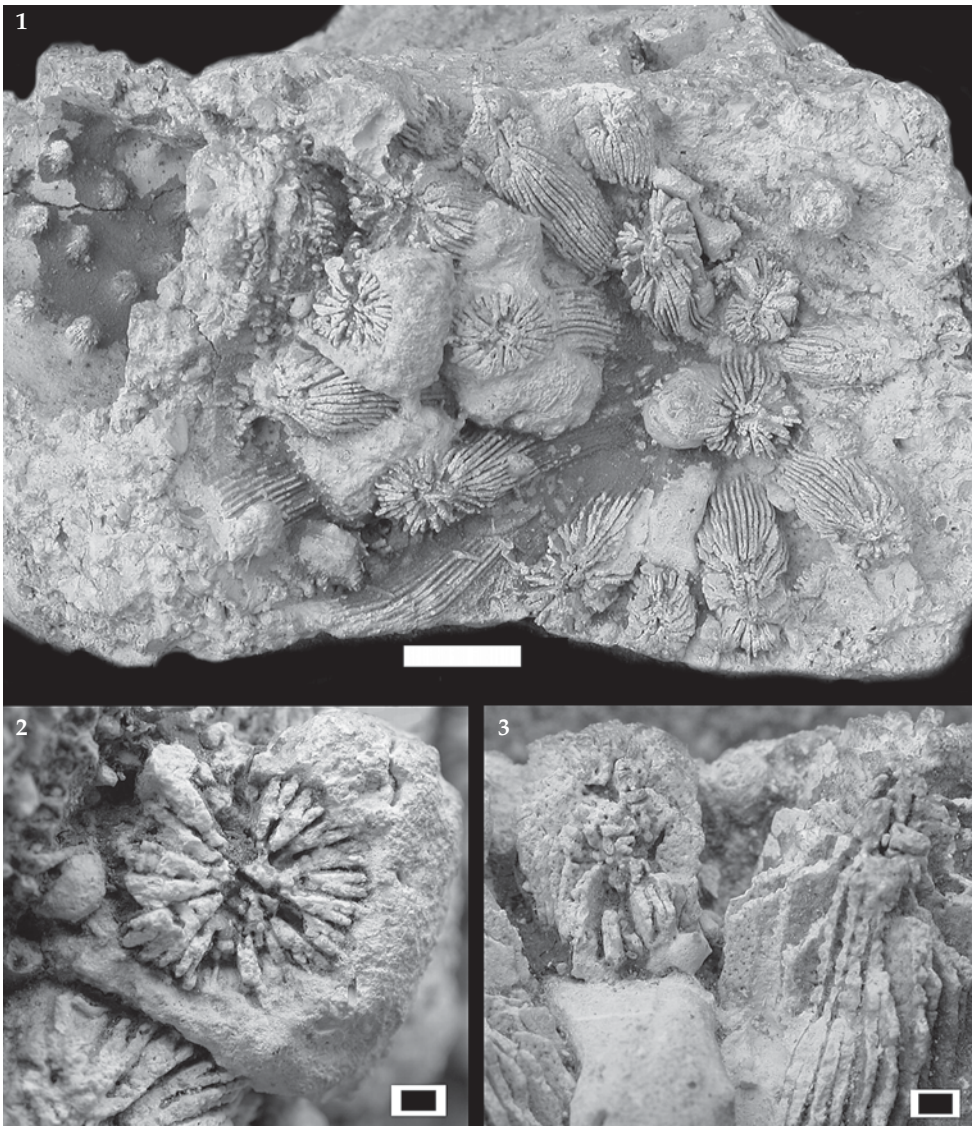

1
2
3

Plate 4

DGP 1398, 1399. *Placocoenia macrophthalma* (Goldfuss, 1926).

Fig. 1. DGP 1398, proximal view of mould of upper surface of a colony (scale bar represents 10 mm).
Fig. 2. DGP 1399, thin section under polarized light (scale bar represents 5 mm).
Fig. 3. DGP 1399, detail showing calcite crystals (scale bar represents 50 μm).
Fig. 4. DGP 1399, detail of first and second order septa. Blue arrows point to ghost remains of dRAFs. Yellow arrow points to the ghost remains of a granule on the septum (scale bar represents 200 μm).

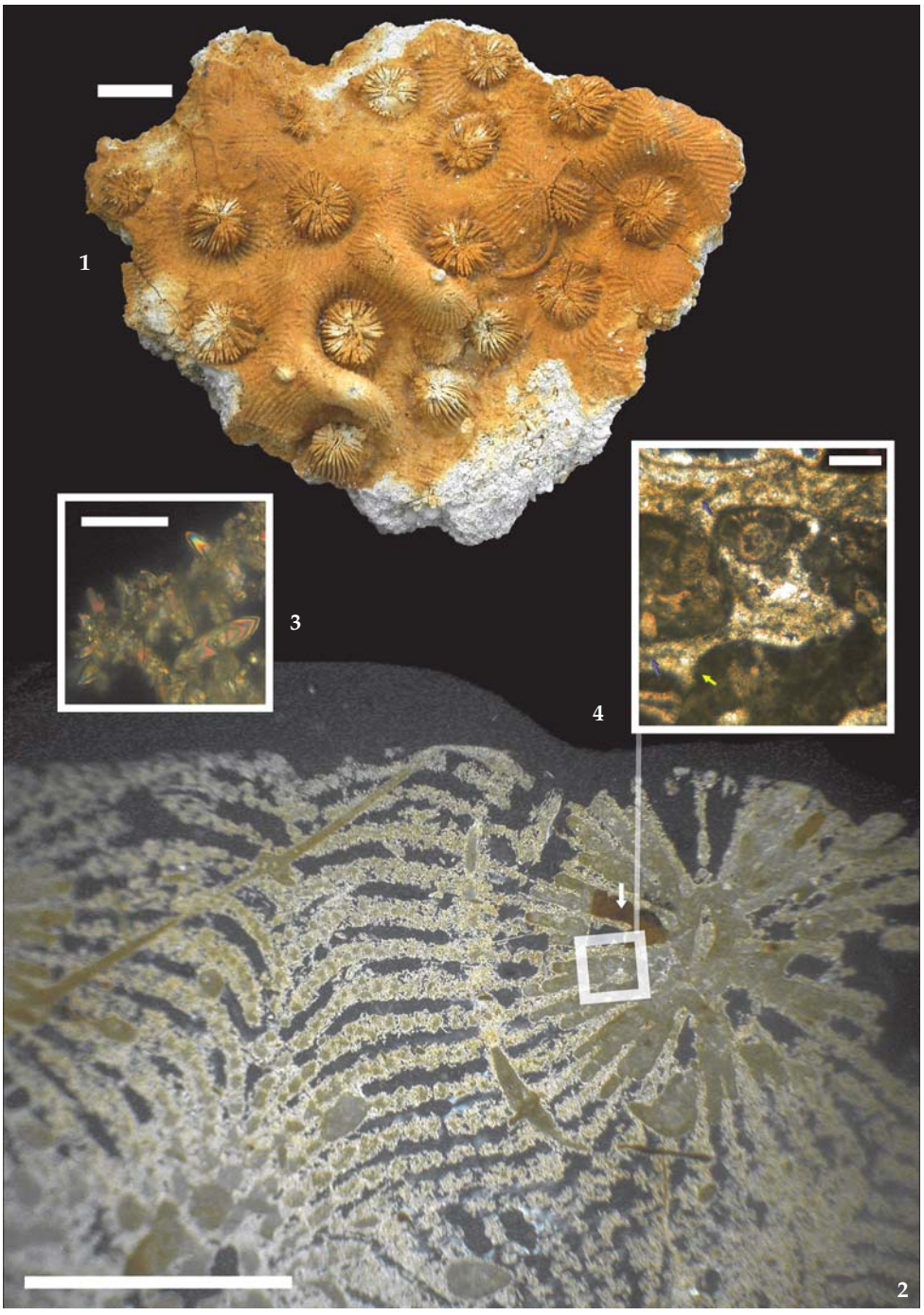

1
2
3
4

Plate 5

Placosmilia? *robusta* (Umbgrove, 1925).

Fig. 1. RGM 29036. Lectotype.
Fig. 2a, b. NHMM MK 4208b.
Fig. 3. NHMM MK 4168c, detail from lateral view of steinkern of the space between septa and dissepiments (marked with arrow).
Fig. 4. NHMM MK 4168c.
Fig. 5a, b. RGM 76766, steinkern.

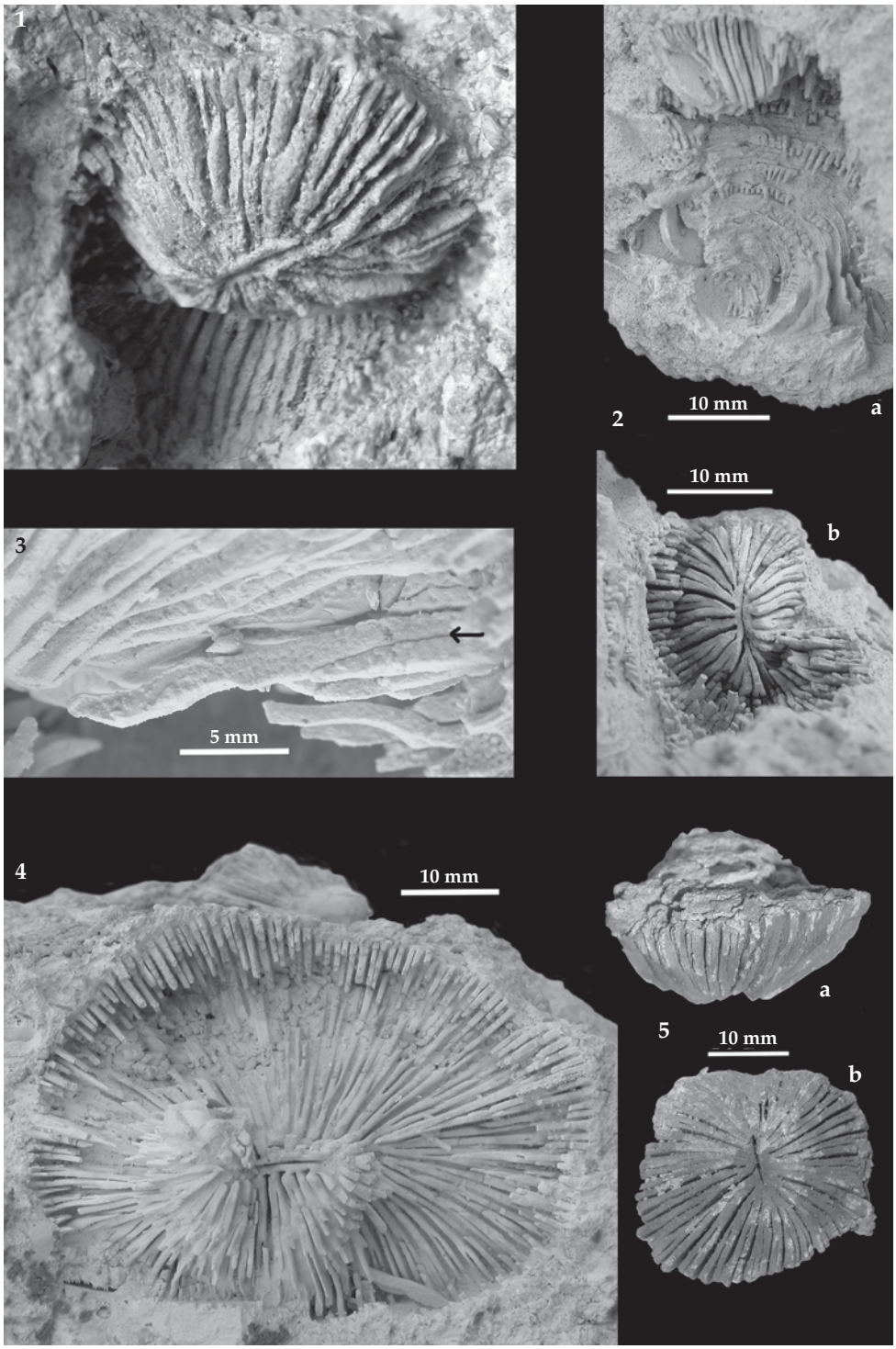
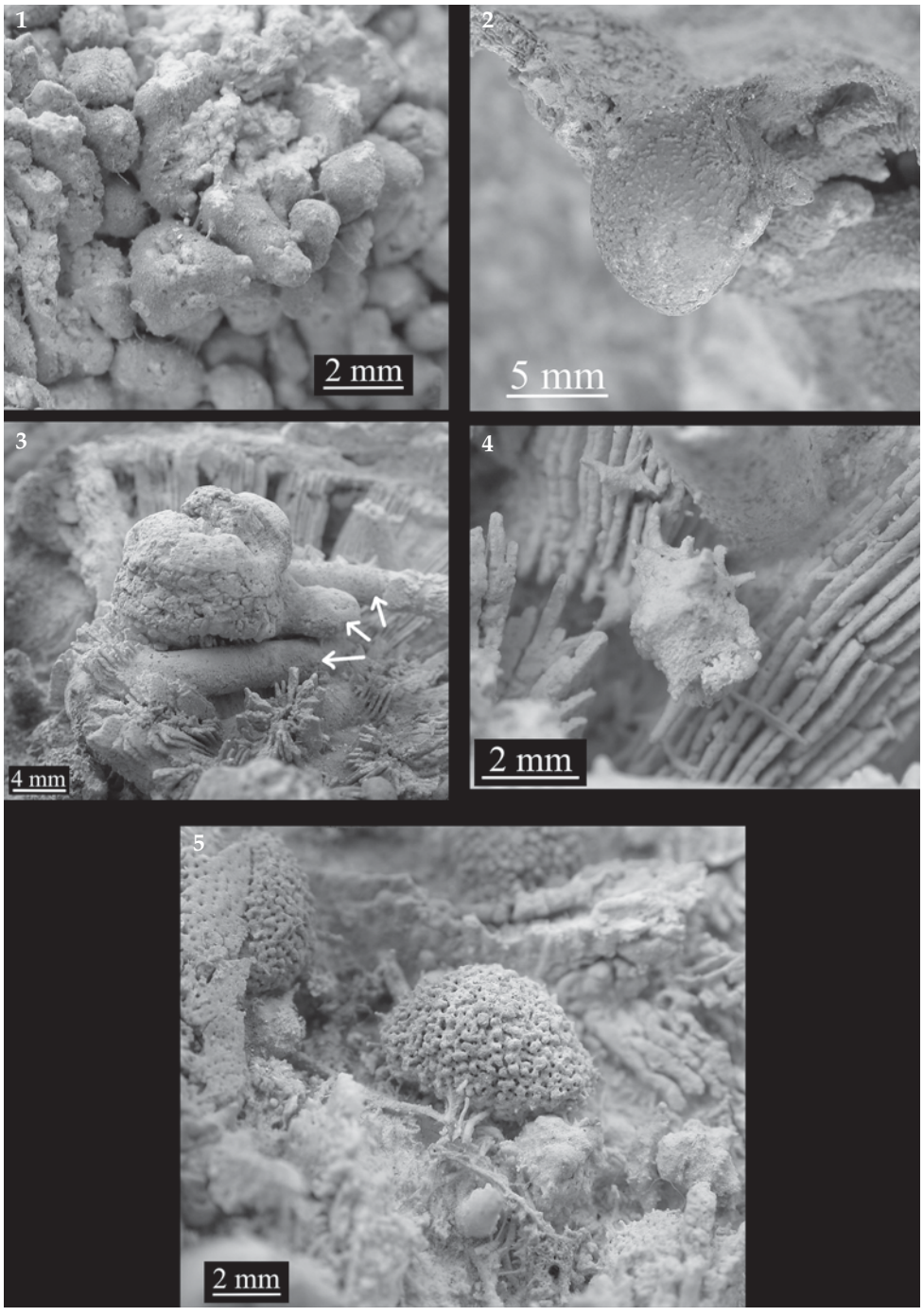

1
2
10 mm
a
10 mm
b
3
5 mm
4
10 mm
a
5
10 mm
b

Plate 6

NHMM K 552, ichnofossils.

Fig. 1. *Entobia* cf. *ovula* Bromley & d'Alessandro, 1984. Chambers, intercameral canals and some apophyses (well-exposed on top-left). On the left are moulds of interseptal space of the *Placocoenia umbgrovei* holotype.
Fig. 2. *Gastrochaenolites* cf. *lapidicus* Kelly & Bromley, 1984 in an indeterminable coral colony.
Fig. 3. Borings, 3 mm in thickness, probably from a polychaete worm and a large chamber of *Uniglobites glomerata* enclosing a corallite steinkern.
Fig. 4. Chamber of *Uniglobites glomerata* in a younger stage than in Plate 6, fig. 3.
Fig. 5. Chambers of *Entobia* sp. 1 with exploratory threads in front of them.


1
2 mm
2
5 mm
3
4 mm
4
2 mm
5
2 mm