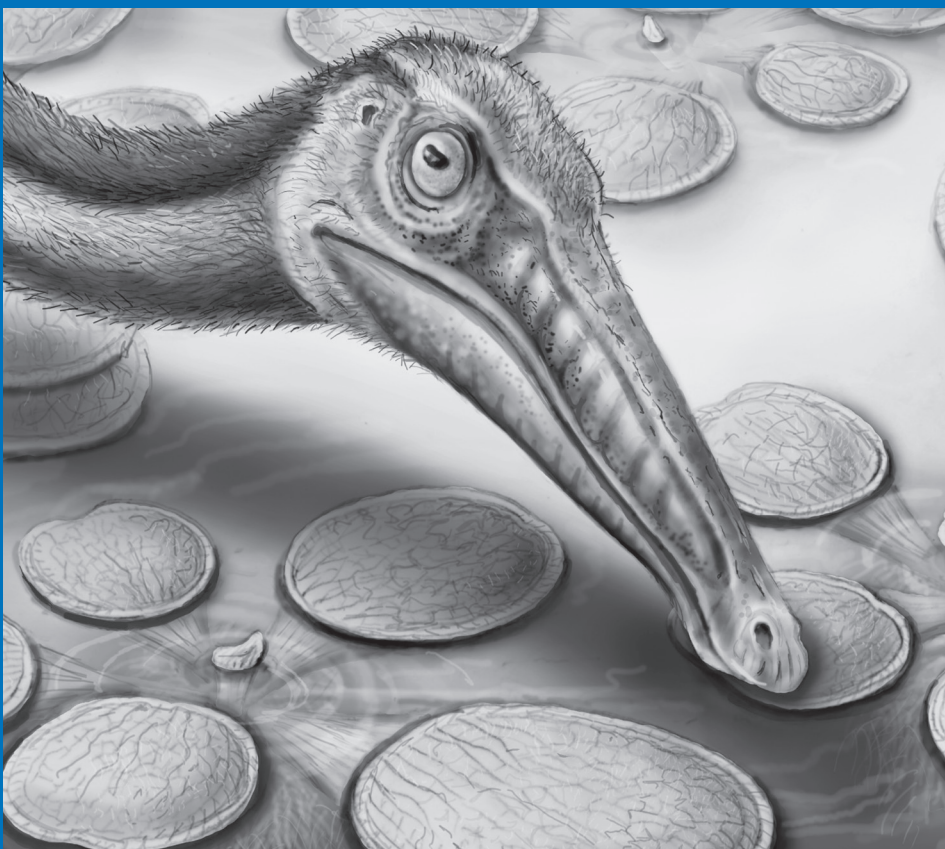


Zitteliana

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Series A/Reihe A
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48/49



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Cover illustration: Cover illustration: The floating plant *Cobbania corrugata* (LESQUEREUX) STOCKEY et al. from the Upper Cretaceous of North America inspected by an *Ornithomimus* dinosaur. The quarry in the Dinosaur Provincial Park, Alberta (Canada), produced numerous complete specimens of this plant and the most complete skeleton of the dinosaur (Reconstruction by Marjorie LEGIN). For details, see BOGNER, J.: The free-floating Aroids (Araceae) – living and fossil, pp. 113–128 in this issue.

Umschlagbild: Umschlagbild: Ein *Ornithomimus* Dinosaurier betrachtet die Schwimmpflanze *Cobbania corrugata* (LESQUEREUX) STOCKEY et al. aus der Oberkreide Nordamerikas. Im Steinbruch des Dinosaur Provincial Park, Alberta (Kanada), wurden mehrere komplette Exemplare dieser Pflanze und ein nahezu vollständiges Skelett des Dinosauriers gefunden (Rekonstruktion Marjorie LEGIN). Für weitere Informationen siehe BOGNER, J.: The free-floating Aroids (Araceae) – living and fossil, S. 113–128 in diesem Heft.

Jurassic corals from the Jaisalmer Basin, western Rajasthan, India

By

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Abstract

The first comprehensive taxonomic description of Jurassic corals from the Jaisalmer Basin, a pericratonic shelf basin on the northwestern slope of the Indian peninsular shield, is based on 75 specimens, which belong to five suborders, seven families, nine genera, and ten species. In Upper Bajocian rocks, all corals belong to the suborder Faviina, in Middle Bathonian rocks 75% of the specimens are members of the Stylinina, whereas corals occurring in the Tithonian all belong to the Caryophylliina.

Key words: Jurassic, scleractinian corals, taxonomy, Jaisalmer Basin, India

Kurzfassung

Die Korallenfauna des Jaisalmer-Beckens, eines perikratonischen Schelfbeckens am Nordwestrand des indischen Schildes, wird zum ersten Mal umfassend beschrieben. Die taxonomische Bearbeitung basiert auf 75 Individuen, die zu fünf Unterordnungen, sieben Familien, neun Gattungen und zehn Arten gehören. Alle Korallen, die im Oberen Bajocium auftreten, gehören der Unterordnung Faviina an, die des Mittel-Bathonium zu 75% der Unterordnung Stylinina, während alle Korallen des Tithonium Vertreter der Caryophylliina sind.

Schlüsselwörter: Jura, Scleractinia, Taxonomie, Jaisalmer-Becken, Indien

1. Introduction

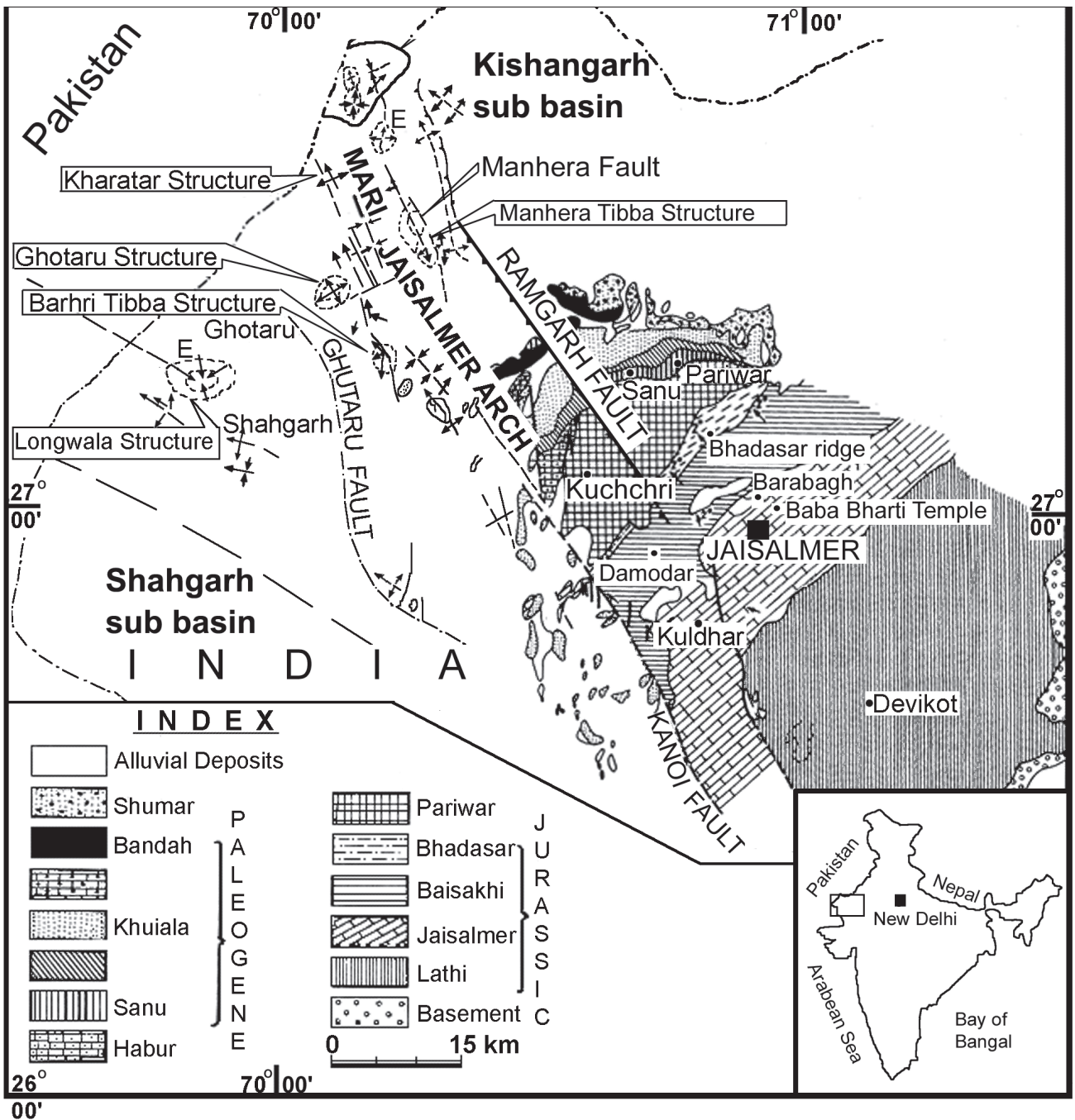
The pericratonic shelf basin of Jaisalmer, situated on the northwestern slope of the Indian peninsular shield (Textfig. 1), is known for both its Jurassic-Cretaceous sediments and rich fossil fauna. Although the succession is barely complete,

several shallowing-upward hemicycles (PANDEY & CHOUDHARY 2007), the occurrence of hardgrounds (FÜRSICH et al. 1992), and the well-preserved fauna have attracted the interest of palaeontologists, sedimentologists, and stratigraphers (OLDHAM 1886; DAS GUPTA 1975; KRISHNA, 1980, 1987; KACHHARA & JODHAWAT 1981; GARG & SINGH 1983; KALIA & CHOWDHURY 1983; KALIA & CHAKRABORTY 1985; MAHENDRA & BANERJI 1989, 1990; PANDEY & FÜRSICH 1994; DAVE & CHATTERJEE 1996, 1986; KHOSLA et al. 2006; PANDEY et al. 2005, 2006a, b, 2007; SINGH 2006). The sediments of the Jaisalmer Basin consist of non-marine sandstones and conglomerates at the base, followed by nearshore, littoral, brackish and marine sandstones, siltstones, clays, and carbonates. Lithostratigraphically, the Jurassic strata have been subdivided into the Lathi, Jaisalmer, Baisakhi, and Bhadasar formations in ascending order. While the Lathi Formation consists of non-marine rocks, the Jaisalmer, Baisakhi, and Bhadasar formations are dominantly composed of marine sediments, which were deposited during the Late Bajocian to Late Tithonian time interval (Tabs 1, 2). The Jaisalmer and Bhadasar formations are coral-bearing, but the corals never formed reefal structures. Instead, corals occur in the Jaisalmer Formation (Upper Bajocian–Oxfordian) as scattered, reworked specimens of both solitary and colonial corals, and in the Bhadasar Formation (Upper Tithonian) they mostly consist of parautochthonous, monospecific solitary corals (Tab. 3).

2. Material

A total of 75 coral specimens were collected during field sessions from 1999 to 2008. These specimens are housed in the Department of Geology, University of Rajasthan, Jaipur 302004, India. Except for *Isastrea bernardiana* (D'ORBIGNY) (PANDEY & FÜRSICH 1994), detailed taxonomic descriptions and identifications of Jurassic corals from the Jaisalmer Basin were not available. Here we describe 75 specimens assigned to

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Textfigure 1: Geological map of parts of northwestern India showing localities and distribution of rock formations in the Jaisalmer Basin (geological map modified after DAS GUPTA 1975).

five suborders, seven families, nine genera, and ten species. In Upper Bajocian rocks, all corals belong to the suborder Faviina, in Middle Bathonian rocks 75% of the specimens are members of the Stylinina, whereas corals occurring in the Tithonian all belong to the Caryophylliina.

Abbreviations of measurements

- cc minimum distance between centers of corallites
- d diameter of corallites
- D diameter of corallum
- Dc density of costae per 2 mm

- Ds density of septa at the periphery (or where septa are almost parallel) per 2 mm
- Dt number of trabeculae at the distal margin of the septa per 2 mm
- H height of corallum
- Ns number of septa
- Wp width of peritheca

3. Taxonomy

Class Anthozoa EHRENBERG, 1834
 Subclass Zoantharia BLAINVILLE, 1830

Table 1: Stratigraphic succession of Jurassic to Quaternary strata exposed in the southeastern part of the Jaisalmer Basin on the raised platform of the Jaisalmer-Mari Arch (modified from DAS GUPTA 1975, SINGH et al. 2005 and PRASAD 2006). Wavy lines denote unconformities.

Event	Lithology	Formation	Age
	Unconsolidated sediments	Shumar Formation	? Subrecent
third marine transgression	clay and limestone	Bandah Formation	Lutetian
	Nummulitic limestone	Khuiala Formation	Upper Paleocene to Ypresian
	regression	glauconitic and silty sandstone	Sanu Formation
second marine transgression	sandy limestone, sandy marl	Habur Formation	Aptian
	continental deposit sandstones	Pariwar Formation	Neocomian
regression	sandstone	Bhadasar Formation	Tithonian
first marine transgression	shales	Baisakhi Formation	Kimmeridgian
	carbonate rocks	Jaisalmer Formation	Bajocian-Oxfordian
	sedimentation starts with continental deposits	Lathi Formation	Lower Jurassic
	Bhuana Formation		Permian-Triassic
	Birmania Formation		Ediacaran-Early Cambrian
	Randha Formation		Early Proterozoic to Early Cambrian
	Basement Rocks - Malani Igneous suite-rhyolite/granite / metamorphic rocks (Phyllite and Schist)		

Table 2: Lithostratigraphic classification of Jurassic strata of the Jaisalmer Basin (after NARAYANAN et al. 1961 (1); DAS GUPTA 1975 (2) and KACHHARA & JODHAWAT 1981 (3)); * members yielding coral specimens.

Formation	Members	Age
Bhadasar Formation	Mokal Member ²	Late Tithonian - ? Early Cretaceous
	Kolar Dungar Mb ^{*2}	
Baisakhi Formation	UNCONFORMITY	Klimmeridgian
	Ludharwa Member ²	
	Rupsi Member ²	
Jaisalmer Formation	Baisakhi Member ²	Callovian to Oxfordian
	UNCONFORMITY	
	Jajiya Member ^{*3}	
	Kuldhar Member ^{*1}	Bajocian to Bathonian
	Badabag Mb ^{*1}	
	Fort Member ^{*1}	
Joyan Member ^{*1}		
Lathi-Formation	Hamira Member ²	Early Jurassic
	Thaiat Member ²	
	Odania Member ²	

Order Scleractinia BOURNE, 1900
Suborder Stylinina ALLOITEAU, 1952

(nom. corr. ex Stylinida ALLOITEAU, 1952)
Family Stylinidae D'ORBIGNY, 1851
Subfamily Stylininae D'ORBIGNY, 1851,
emended RONIEWICZ, 1976

Genus *Heliocoenia* ÉTALLON, 1859

Type species *Heliocoenia variabilis* ÉTALLON, 1859

Remarks: The differentiating morphological characters of *Heliocoenia* ÉTALLON (1859) and *Stylinia* LAMARCK (1816) have created some discussion among Mesozoic coral workers. ÉTALLON (1859: 474) created *Heliocoenia* mainly for a plocoid coral with costae confined to the edge (wall) of calices and granulations along the lateral surface of septa, whereas in the genus *Stylinia* the costae are well developed (KOPY 1881: 73, pl. 15, figs 1-9, pl. 16, fig. 2, pl. 30, figs 1-3, pl. 17, figs 2-3; ALLOITEAU 1952: 608, fig. 53; PANDEY & FÜRŠICH 2003: pl. 2, fig. 3, 6). FROMENTEL (1861) found no difference between the two genera, except for the two opposite septa in *Heliocoenia*, which are joined in the center to the columella and the presence of intercalicular intervals that are granulated. KOPY (1881: 63, pl. 27, figs 4-6, pl. 30, figs 4-5, pl. 129, fig. 4) illustrated, through drawings, that *Heliocoenia* has thinner costae on the upper surface of the intercalicular area, but in the description he mentioned that the area between calices is covered with granules and that these granules are often arranged in a radial

Table 3: Stratigraphic distribution of corals in the Jurassic strata of the Jaisalmer Basin.

Taxa	Members yielding corals (see Tab. 2)	Age	Specimen numbers (no. of specimens)
<i>Heliocoenia stellata</i> Roniewicz, 1966	Badabag Member	Middle Bathonian	RUC2007I 102 (1)
<i>Stylina</i> cf. <i>girodi</i> ÉTALLON, 1859	Badabag Member Fort Member	Middle Bathonian Middle Bathonian	RUC2007I 106, 111, 236-237, 239 (5)
<i>Cryptocoenia hexaphyllia</i> (D'ORBIGNY, 1850)	Fort Member	Middle Bathonian	RUC2007I 103-105, 107-109, 112-117 (12)
<i>Isastrea bernardiana</i> (D'ORBIGNY, 1850)	Joyan Member	Upper Bajocian	RUC2007I 241 (1)
<i>Isastrea helianthoides</i> (GOLDFUSS, 1826)	Jajiya Member	Oxfordian	RUC2008I 1 (1)
<i>Trochocyathus laminus</i> (QUENSTEDT, 1858)	Kolar Dungar Member	Upper Tithonian	RUC2007I 1-100, 125-244 (50)
<i>Craterastraea crateriformis</i> (GREGORY, 1900)	Badabag Member	Middle Bathonian	RUC2007I 238 (1)
<i>Collignonastraea meandra</i> (D'ORBIGNY, 1850)	Badabag Member	Middle Bathonian	RUC2007I 101, RUC2008I 2 (2)
<i>Trochoplegma</i> sp.	Fort Member	Middle Bathonian	RUC2007I 110 (1)
<i>Periseris</i> cf. <i>elegantula</i> (D'ORBIGNY, 1850)	Badabag Member	Middle Bathonian	RUC2007I 240 (1)

fashion. ALLOITEAU (1958), too, distinguished the two genera and mentioned that *Heliocoenia* shows costo-septa, an elongated columella, one or two S1 septa elongated in the same direction as the columella, a granulose peritheca, a very thick septotheca, and additional costae, which have either no corresponding septa or only rudimentary septa. Thus, ALLOITEAU (1958) was the first to have mentioned the existence of true costae in *Heliocoenia*. However, later on ALLOITEAU (1952: 608) changed his view and mentioned the presence of a peritheca without "lamelles" (costae). RONIEWICZ (1976: 59) mentioned that the trabeculae in the peritheca were trabecular in origin. These trabeculae are isolated and sub-vertically oriented as opposed to the inclined orientation of trabeculae of costo-septa. BEAUVAIS (1994: 874, fig. 2b) also illustrated dissociated trabeculae of costae. The present authors (DKP & FTF) studied several specimens of *Heliocoenia variabilis* ÉTALLON from east-central Iran (PANDEY & FÜRSICH 2003: 22, pl. 5, figs 1-5) and other species of *Heliocoenia* from Iran and Tunisia (PANDEY & FÜRSICH 2003: 24, pl. 3, fig. 5; PANDEY & FÜRSICH 2005: 9, pl. 2, figs 2-3; PANDEY et al. 2007, 14, pl. 4, fig. 5) and always found that the peritheca in these specimens was devoid of costae. On the basis of the above mentioned

observation we are of the opinion that there are no true costae in *Heliocoenia*. There are several characters, which might be significant for differentiating *Heliocoenia* ÉTALLON, 1859 from *Stylina* LAMARCK, 1816:

- (1) Absence or poorly developed costae in *Heliocoenia* but well developed sub-confluent to confluent costae in *Stylina*.
- (2) Upper surface of peritheca in *Heliocoenia* is granulose but only costate in *Stylina*.
- (3) There is an elongated columella in *Heliocoenia*, but in *Stylina* the columella is sub-circular to irregular in outline.
- (4) Septa arranged commonly in bilateral symmetry due to elongation of one or two primary septa in *Heliocoenia*, which is not the case in *Stylina*.

Heliocoenia stellata RONIEWICZ, 1966

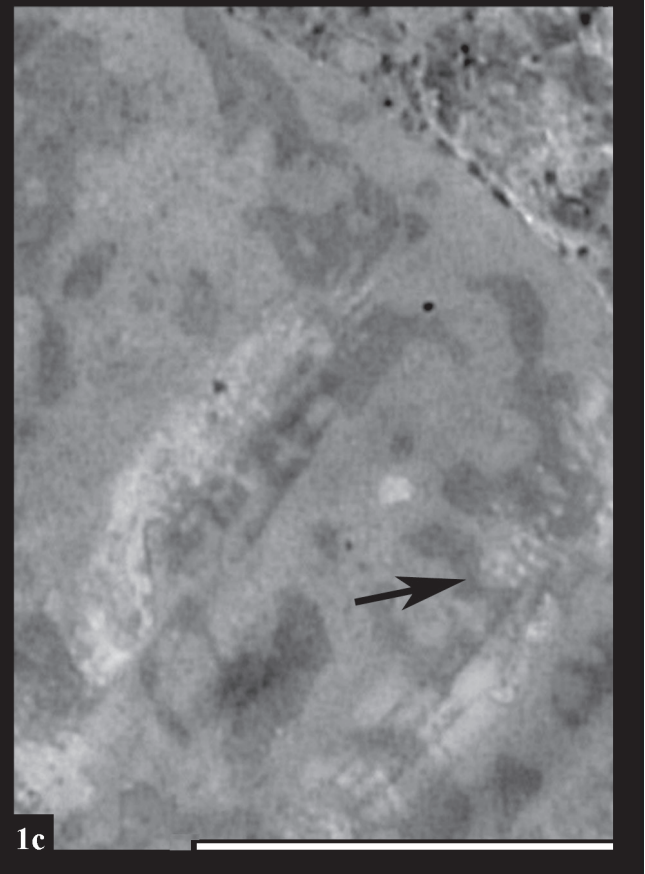
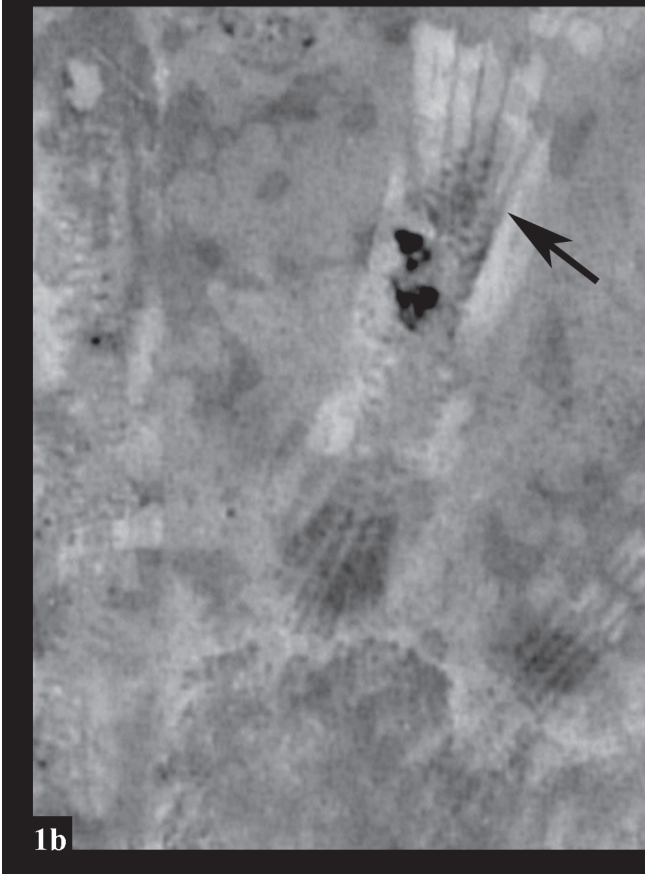
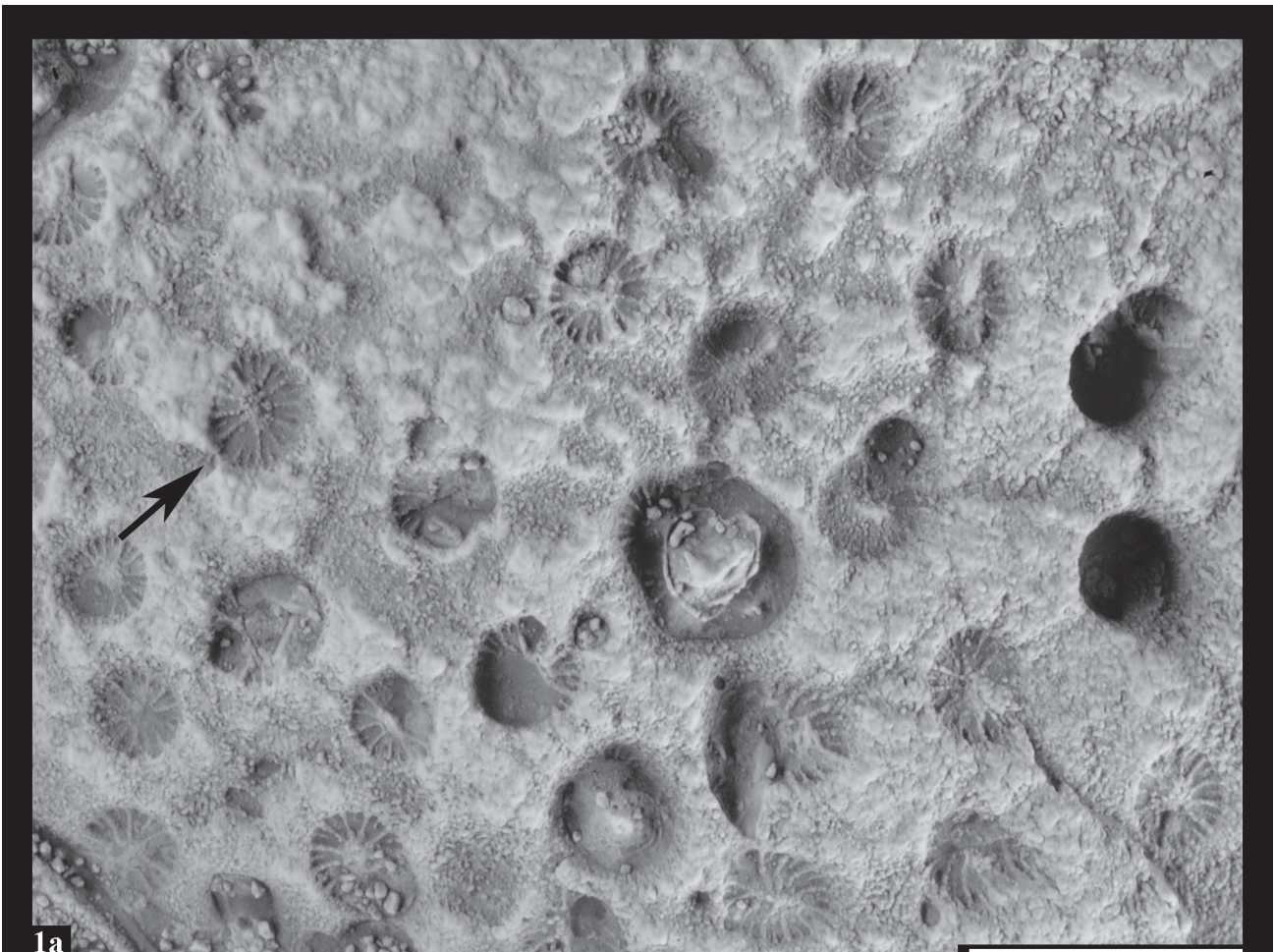
Pl. 1, Fig. 1a-c, Textfig. 2

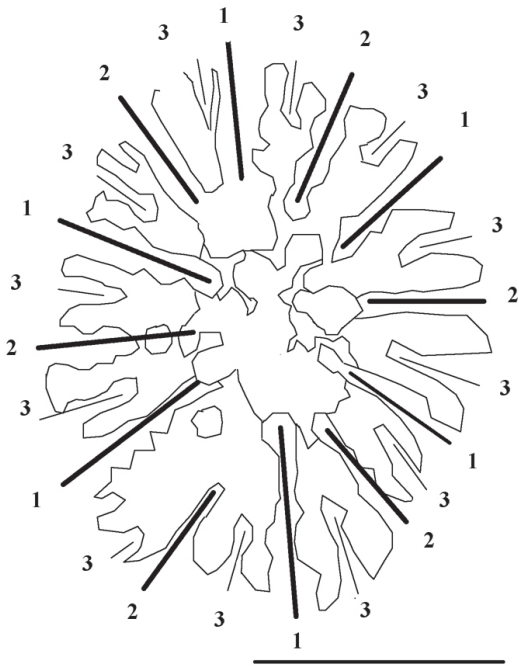
1966 *Heliocoenia stellata* sp. nov. – RONIEWICZ: 204, pl. 11, fig. 4a-b, textfig. 9A.

1994 *Heliocoenia stellata* RONIEWICZ – BEAUVAIS: 886.

Plate 1:

Heliocoenia stellata RONIEWICZ, 1966 from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer. Scale bar 5mm; RUC2007I 102. **a:** Close up view of part of the upper surface showing a bilateral symmetry along a thick primary septum joined with the columella. The arrow indicates the corallite on which Textfig. 2 is based. Note that not all corallites are seen in transverse-section, but some of them are oblique to the upper surface. **b, c:** Polished longitudinal section showing the inner edges of septa with auriculae and spaces between auriculae (arrowed). Note endothecal tabular dissepiments.





Textfigure 2: *Heliocoenia stellata* RONIEWICZ, 1966. Figure drawn from Pl. 1, Fig. 1a showing three complete cycles and the irregular outline of the columella. Specimen RUC2007I 102 from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer. Scale bar: 1.25 mm.

Material: One specimen from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer (RUC2007I 102).

Dimensions (in mm): see Tab. 4.

Table 4: Dimensions (in mm) of *Heliocoenia stellata* RONIEWICZ, 1966

specimen	D	H	d	c-c	Ns
RUC2007I 102	37	24	1.7–2.6	3	21–28 (6+6+12+S ₄)

Description: Corallum massive, discoidal, plocoid. Calices distinct, shallow to moderately deep, circular to oval in outline. Septa compact with spinules on the lateral surface, arranged in three to four hexamerous cycles (Textfig. 2), occasionally anastomosing, swollen or auriculate at the inner margins. The septal pattern shows bilateral symmetry along a primary septum joined to the columella. Columella large, prominent, modified by inner edge of primary septa, irregular in outline. Endothecal tabular dissepiments common. Budding extracalicular. Wall septo-parathecal.

Remarks: The single specimen is bored and poorly preserved. The interior is completely recrystallized. The outer parts of the corallites are recrystallized to the extent that the wall of the corallites cannot be traced. However, there seem to be a few traces of costae on the upper surface of the peritheca. The polished surface shows both longitudinal and transverse sections through the corallites. The peritheca is poorly preserved. The morphological features, such as inner edge of septa, columella and endothecal tabular dissepiments as well as the dimensions match *Heliocoenia stellata* RONIEWICZ, 1966. *Heliocoenia variabilis* ÉTALLON (BEAUVAIS 1994, pl. 1, figs 1–8, pl. 2, figs 1–8; PANDEY & FÜRSICH 2003: 22, pl. 5, figs 1–5) is another comparable form with respect to number of septa, but the septal cyclicality in the present specimen is exclusively hexamerous in comparison to the hexa- to decamerous symmetry of *Heliocoenia variabilis*. In longitudinal section (Plate 1, Fig. 1c), the inner edges of septa seem to be porous. These are not true pores, but spaces between auriculae (GILL 1977). The features at the inner edges of septa closely correspond to those illustrated for the genus for example by THURMANN & ÉTALLON (1864: 375, pl. 52, fig. 13), RONIEWICZ (1966: pl. 10, fig. 2a, 1976, pl. 9, figs 1b, 2c), ERRENST (1990: 182, pl. 7, fig. 2g), BEAUVAIS (1994: pl. 2, fig. 8), and STOLARSKI & RONIEWICZ (2001: fig. 2.4).

Stratigraphic distribution: Middle Bathonian.

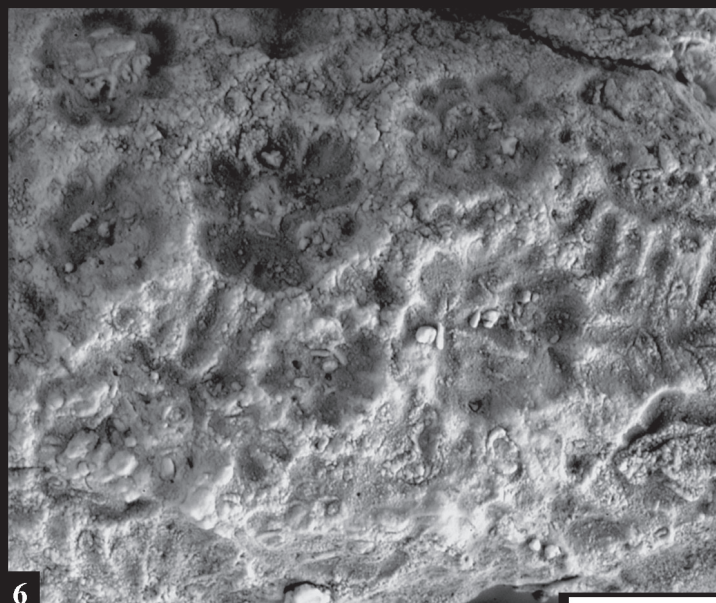
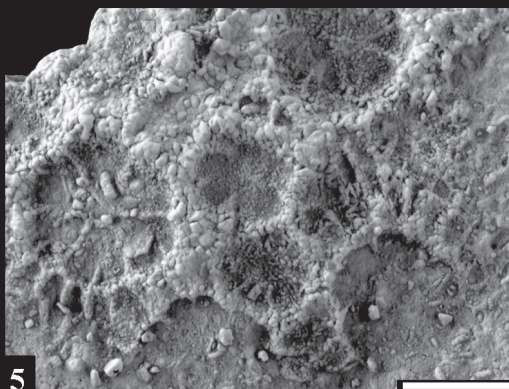
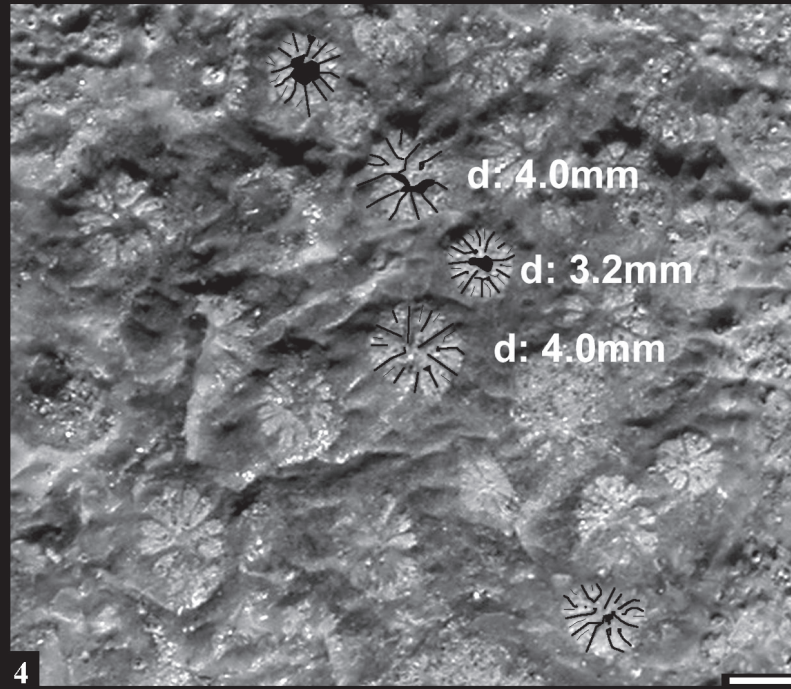
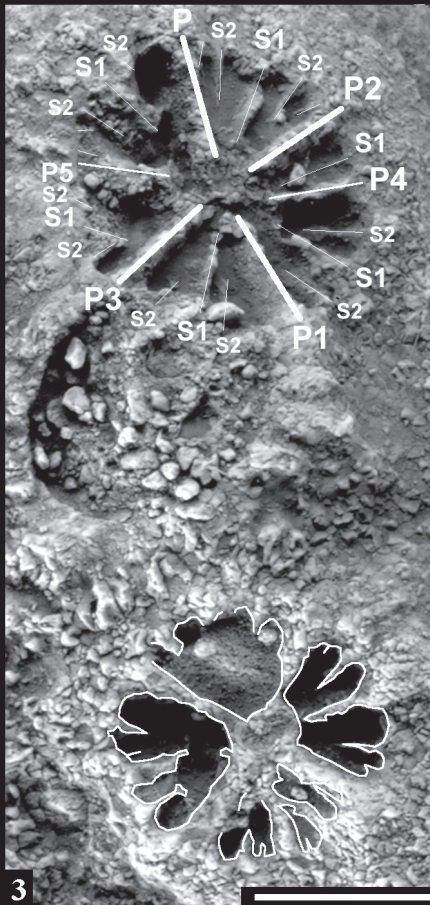
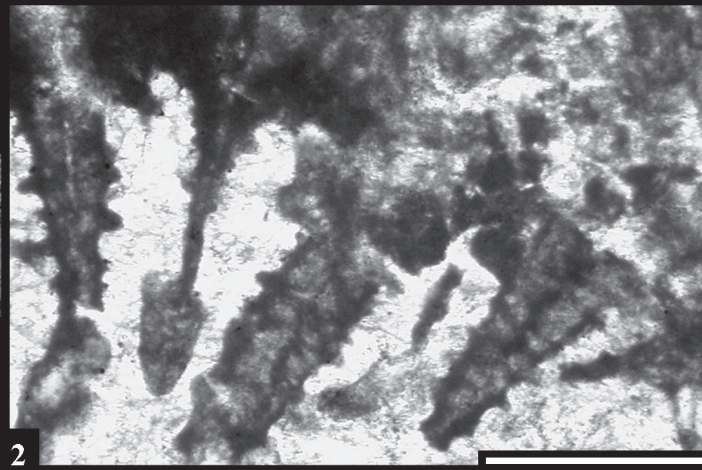
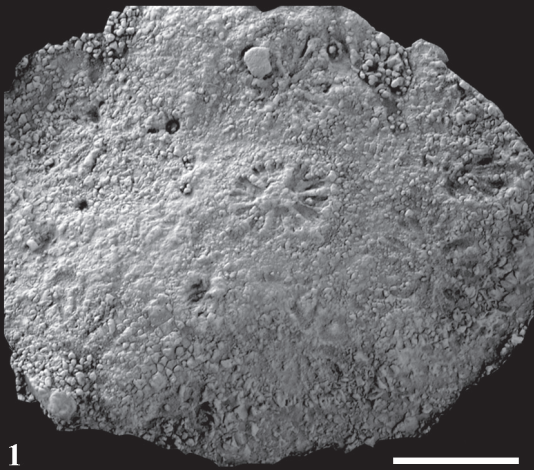
Genus *Stylina* LAMARCK, 1816

Type species *Stylina echinulata* LAMARCK, 1816

Plate 2:

Figs 1–4: *Stylina* cf. *girodi* ÉTALLON, 1859. **1:** Upper surface view showing the plocoid colony and irregular outline of the columella. Scale bar: 5 mm; RUC2007I 236, from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer. **2:** Magnified view of transverse-section showing granulose lateral surface of septa and swollen or auriculate inner edge of septa. Note the microstructure showing a zigzag mid-septal line, each calcification center giving off a lateral branch slightly oblique to the right angle of the mid-septal line. Scale bar: 0.5 mm; RUC2007I 106, from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 5 km northeast of Jaisalmer. **3:** Close up view of upper surface showing different cycles of septa. Note four primary septa of which two each oppose each other to form an angle of 70°–80° (i.e. P-P2 and P1-P3). They are thicker than the remaining two primary septa which form an obtuse angle (i.e. P4-P5). The secondary septa are also not symmetrically arranged so that not even a bilateral symmetry exists. Scale bar: 2.5 mm; RUC2007I 237, from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer. **4:** Close up view taken on the outcrop showing part of the plocoid colony and varying outlines of the columella. Scale bar: 2.5 mm; rudstone bed of the Jajiya Member (Oxfordian) of the Jaisalmer Formation, 6 km south of Damodar village located about 18 km west of Jaisalmer.

Figs 5–6: *Cryptoecoenia hexaphyllia* D'ORBIGNY, 1850 from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 3 km northeast of Jaisalmer. Scale bar: 2.5 mm. **5:** Close up view of upper surface showing hexamerally arranged septa and septo-costae of adjacent corallites nearly touching each other; RUC2007I 103. **6:** Close up view of upper surface showing septo-costae and thick coenosteum; RUC2007I 104.



Stylina cf. *girodi* ÉTALLON, 1859

Pl. 2, Figs 1–4, Textfig. 3

- cf. 1859 *Stylina girodi* sp. nov. – ÉTALLON: 64.
 cf. 1864 *Stylina girodi* ÉTALLON – THURMANN & ÉTALLON: 368, pl. 51, fig. 10.
 cf. 2003 *Stylina girodi* ÉTALLON – PANDEY & FÜRSICH: 19, pl. 4, fig. 2 [cum syn.].

Material: Six specimens; 4 specimens from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer (RUC2007I 111, 236–237, 239), 1 specimen from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 3 km northeast of Jaisalmer (RUC2007I 106) and 1 specimen from a rudstone unit of the Jaiya Member (Oxfordian) of the Jaisalmer Formation, exposed 6 km south of Damodar village located about 18 km west of Jaisalmer (no sample, only a field photograph available; Pl. 2, Fig. 4).

Dimensions (in mm): see Tab. 5.

Table 5: Dimensions (in mm) of *Stylina* cf. *girodi* ÉTALLON, 1859

specimen	D	H	d	cc	Ns
RUC2007I 106	36.0	22	3.0–4.0	3.5–4.3	24
RUC2007I 111	32.0	21.3	4.0–4.3	4–6.3	21
RUC2007I 236	22.0	–	2.5–3.4	3.5–6.0	24
RUC2007I 237	39.5	22	5.0–5.2	5.5–6.0	24
RUC2007I 239	34.0	18	4.0–4.5	5.0	24
specimen from Jaiya Mb. (Pl. 2, Fig. 4)	33.0	35.0	3.2–4.0	3.0–5.0	24

Description: Colony plocoid. Corallites moderately large in diameter, sub-circular in cross-section, slightly raised above the upper surface of the colony. Septa compact, arranged hexamerally in three cycles, distal margin denticulate with up to 6–7 denticles. Septa of first two cycles complete, those of third cycle incomplete. Septa of first ring thick and long, occasionally joined at the center, those of higher cycles thinner and shorter. Inner edge of septa swollen or auriculate. Septal calcification centers closely set, forming almost a zigzag mid septal line. Each calcification center giving off a lateral branch slightly oblique to the right angle of the mid-septal line. Lateral surfaces of septa granulated or spinose (Pl. 2, Fig. 2). Dissepiments present along wall. Coenosteum varying in thickness from 0.0–3.5 mm, consisting of costae. Costae thinner than septa. Columella irregular in cross-section, stylinid-type. Wall septo-parathecal.

Remarks: The specimen from the Jaiya Member could not be collected and is represented by a field photograph only. All colonies are recrystallized, nodular, bored, and abraded on the upper surface, but microarchitecture and septal microstructure are moderately well preserved. Septal calcification centers are not completely separated. This is in contrast to separated septal

calcification centers as illustrated for the Stylinina by STOLARSKI & RONIEWICZ (2001: fig. 9.2). The lateral branches, slightly oblique with respect to the right angle of the mid-septal line, and close setting of the calcification centers possibly produce the zigzag mid-septal line. The number of costae is unknown. Exothecal dissepiments could not be seen. At their distal ends the septa never seem to show a hexamerall arrangement. For example, in one of the specimens (RUC2007I 237; see Pl. 2, Fig. 3) four primary septa, of which two each are situated at opposite poles, form an angle of 70–80° (i.e. P, P2 and P1, P3), are thicker than the remaining two primary septa lying within the obtuse angle (i.e. P4 and P5). The secondary septa are also not arranged symmetrically thus not exhibiting even bilateral symmetry. However, in the transverse thin-section the corallites show perfect hexamerall symmetry and equal distribution of septa in six systems (specimen RUC2007I 106; Textfig. 3).

The plocoid colony, corallites slightly raised above the upper surface (seen only in specimen RUC2007I 111), the moderately large diameter of corallites, presence of auricles or a swollen inner edge of septa, the nature of the columella, and the dimensions match *Stylina tenax* Koby (1881: 78, pl. 16, figs 1–2; PANDEY & FÜRSICH 2003: 18, pl. 3, fig. 3; Textfig. 3) and *Stylina girodi* ÉTALLON (Koby 1881). As in the present specimen the corallites protrude less strongly above the upper

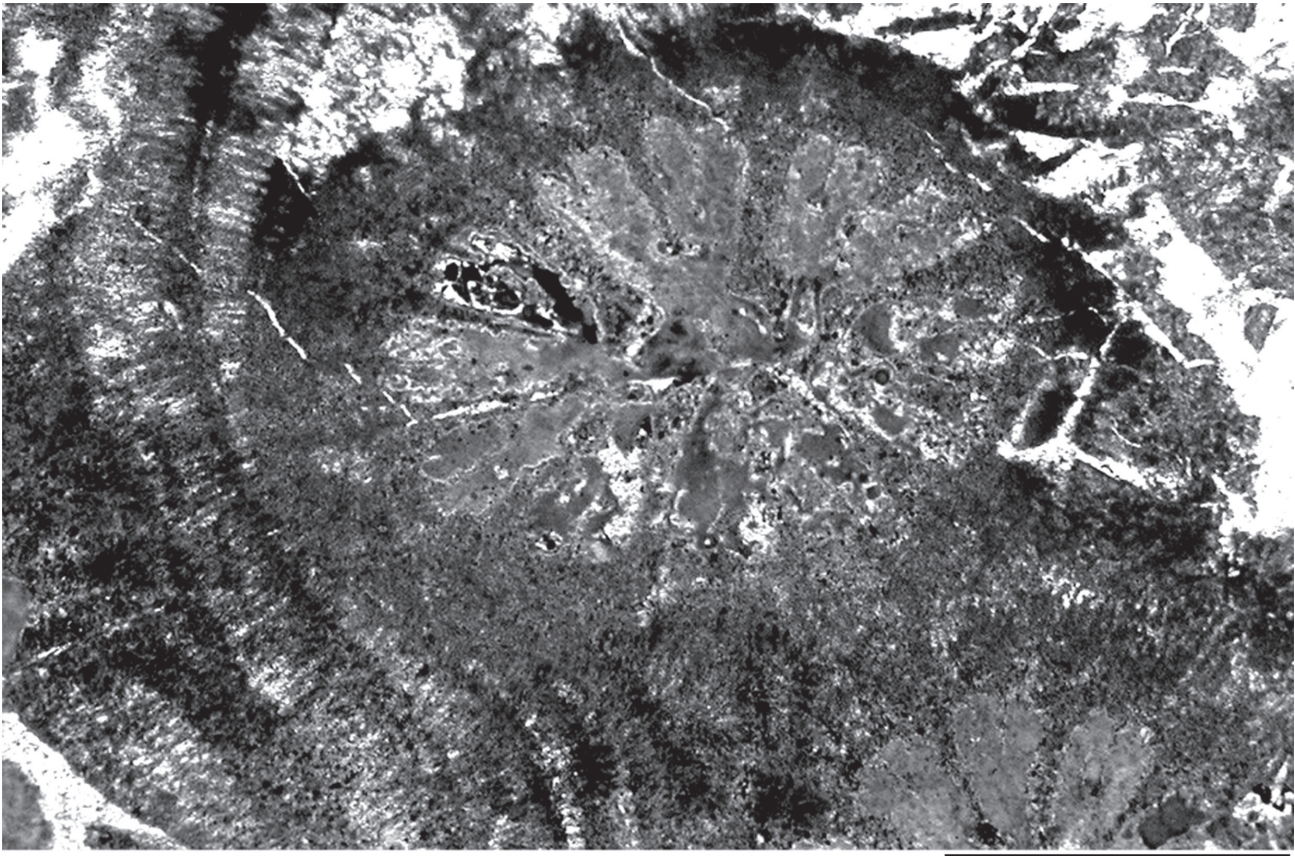
surface of the corallum, the specimen more closely corresponds to *Stylina girodi* than to *Stylina tenax*. The number of costae in *Stylina girodi*, however, is consistently twice the number of septa (Tab. 4; PANDEY & FÜRSICH 2003: 20). In the present specimens the number of costae could not be determined due to the poor preservation, but certainly seems to be larger than the number of septa. Therefore, the specimens are recorded as *Stylina* cf. *girodi*. The character of costae in *Heliocoenia variabilis* shown by BEAUVAIS (1994: pl. 1, figs 3–5) matches that of specimen RUC2007I 106 (Textfig. 3), but the diameter of corallites in *Heliocoenia variabilis* is small (ranging from 1.5–2.5 mm) and the outline of the columella is elongated in the direction of longest S1 septa.

Stratigraphic distribution: Middle Bathonian–Oxfordian.

Family Cyathophoridae VAUGHAN & WELLS, 1943

Genus *Cryptocoenia* D'ORBIGNY, 1849

Type species *Astrea alveolata* GOLDFUSS, 1826 from the Upper Jurassic of Heidenheim, Germany



Textfigure 3: *Stylina* cf. *girodi* ÉTALLON, 1859. Transverse thin-section showing hexameral symmetry. Note septa arranged in three cycles and traces of thinner costae. Specimen RUC2007I 106 from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 5 km northeast of Jaisalmer. Scale bar 2 mm.

Remarks: A discussion of the generic status of *Pseudocoenia* D'ORBIGNY, 1850 is here not out of place, because it has a very intricate relationship with several nominal species of *Cryptocoenia* D'ORBIGNY, 1849. D'ORBIGNY (1850: 33) established *Pseudocoenia* for plocoid corals such as *Cryptocoenia* D'ORBIGNY (1849: 7) but with octameral septal cycles. Subsequently, several species were assigned to *Pseudocoenia* based not only on characters of *Cryptocoenia* with octameral septal cycles (D'ORBIGNY 1850: 34; TURNŠEK 1997: 167) but also on hexamerally arranged septa, which are longer, and on a peritheca that is narrower than in *Cryptocoenia* (RONIEWICZ 1976: 48). That is to say the symmetry of septa was not regarded as a diagnostic feature at the generic level (KOBY 1881: 86; RONIEWICZ 1976: 51, pl. 6, figs 1–2; TURNŠEK 1972: 162; 1997: 168; PANDEY & FÜRSICH 2003: 26).

WÉRY (1954) revised the type species of *Cryptocoenia* D'ORBIGNY and mentioned that septa are arranged both in hexa- or octameral cycles. He also found the material very poorly preserved and similar to *Cyathophora* MICHELIN, 1843 (BEAUVAIS 1964: 123; RONIEWICZ 1976: 48; LÖSER 1998: 31; PANDEY & FÜRSICH 2003: 30). BARON-SZABO (2002: 184) also re-examined the type material of *Cryptocoenia* D'ORBIGNY and also pointed out that the septa are arranged in varying systems. Thus the main basis of separating *Pseudocoenia* D'ORBIGNY, 1850, i.e. with septal development in eight cycles, from *Cryptocoenia* with septal development in six cycles cannot be upheld. BARON-SZABO (2002: 184) is of the opinion that specimens

assigned to *Pseudocoenia* most likely belong to *Cryptocoenia*.

LÖSER (2007: 79), in turn, studied the type material of the type species of the genus *Pseudocoenia* D'ORBIGNY and reinstated again the generic status of *Pseudocoenia* with the type species *Pseudocoenia bernardina* D'ORBIGNY.

The length of septa, whether long or short, and the width of the peritheca cannot be criteria to separate genera as we know that these vary within in a single colony, based on several factors including environmental parameters. The arrangement of septa in cycles of six or eight in the same species or even in the same colony has been observed quite commonly in stylininids, including the specimens described in the present work (RONIEWICZ 1966: 201, 1976: 59; BEAUVAIS 1994: 876; PANDEY & FÜRSICH 2003: 24). We suspect that this is also an epigenetic character.

Cryptocoenia hexaphyllia D'ORBIGNY, 1850

Pl. 2, Figs 5–6, Pl. 3, Figs 1–3

- | | |
|------|---|
| 1850 | <i>Cryptocoenia hexaphyllia</i> sp. nov. – D'ORBIGNY: 33. |
| 1964 | <i>Cryptocoenia hexaphyllia</i> D'ORBIGNY – BEAUVAIS: 126, pl. 6, fig. 7. |
| 1976 | <i>Pseudocoenia hexaphyllia</i> D'ORBIGNY – RONIEWICZ: 50, pl. 4, fig. 3. |
| 1990 | <i>Pseudocoenia hexaphyllia</i> D'ORBIGNY – ERRENST: 169, pl. 3, figs 4a, b [cum syn.]. |
| 2003 | <i>Pseudocoenia hexaphyllia</i> D'ORBIGNY – PANDEY & FÜRSICH: 26, pl. 3, figs 2, 4. |

Material: Twelve specimens from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 3 km northeast of Jaisalmer (RUC2007I 103–105, 107–109, 112–117).

Dimensions (in mm): see Tab. 6.

Table 6: Dimensions (in mm) of *Cryptocoenia hexaphyllia* D'ORBIGNY, 1850.

specimen	D	H	d	cc	Ns	Wp
RUC2007I 103			3.6–4.2	3	24	2
RUC2007I 104			3–3.6	3–4	12	2
RUC2007I 105			4	4	8–12	1.5
RUC2007I 108	12.5	7	3–4	3		
RUC2007I 109	15.5		4	4–4.5	6+4	1.2–2.2
RUC2007I 112	18		2–3.5	3–4	12+4	0–2
RUC2007I 113	ca 19		3–4	2.2–3	12	1.4
RUC2007I 116	32		3.5	4.3	8–15	1

Description: Corallum small in size, flat to discoidal, plocoid. Calices small, moderately deep, circular in outline, separated by coenosteum. Coenosteum consisting of costae. Costo-septa bicuneiform, compact, thick, hexamerally arranged in two to three cycles. Costo-septa of adjacent corallites nearly touching each other. Wall septo-parathecal. Columella absent.

Remarks: All specimens are poorly preserved. However, the large diameter of calices, hexamerall septal arrangements, bicuneiform costo-septa, character of coenosteum and costae, absence of auricles at the inner edge of septa and absence of a columella, all refer the present material to *Cryptocoenia* D'ORBIGNY. The different species of the genus have been differentiated on the basis of diameter of corallites, number of septa and number of costae. The costae can be equal to or double the number of septa. The diameter of the corallites (3.0–4.2 mm), number of septa and costae (maximum 24) in the present specimens fit *Cryptocoenia hexaphyllia*. *C. wegeneri* PANDEY & FÜRSICH (1993: 10, pl. 5, figs 4, 6, 9, textfig. 8) from the Jumara Dome in the neighbouring Kachchh Basin exhibits larger corallite diameters (4.5–6.0 mm).

Stratigraphic distribution: Middle Bathonian.

Suborder Faviina VAUGHAN & WELLS, 1943
(nom. corr. ex Faviida VAUGHAN & WELLS, 1943;
after WELLS 1956)

Family Isastreidae ALLOITEAU, 1952

Genus *Isastrea* MILNE-EDWARDS & HAIME, 1851

Type species *Astrea helianthoides* GOLDFUSS, 1826

Isastrea bernardiana (D'ORBIGNY, 1850)

Pl. 4, Fig. 2a–b

1850 *Prionastrea bernardiana* sp. nov. – D'ORBIGNY: 293.

1988 *Isastrea bernardiana* (D'ORBIGNY) – LATHUILIÈRE: 287, pls 1–4, pl. 5, figs 1–3, pl. 6, figs 1–3 [cum syn.].

1989 *Isastrea bernardiana* (D'ORBIGNY) – LATHUILIÈRE: 887, pl. 2, fig. 2.

1994 *Isastrea bernardiana* (D'ORBIGNY) – PANDEY & FÜRSICH: 78, fig. 2.

1996 *Isastrea bernardiana* (D'ORBIGNY) – LATHUILIÈRE: pl. 73, figs 11–12.

2000a *Isastrea bernardiana* (D'ORBIGNY) – LATHUILIÈRE: 61, figs 6.5–6.8 [cum syn.].

2003 *Isastrea bernardiana* (D'ORBIGNY) – PANDEY & FÜRSICH: 53, pl. 12, figs 1–2.

2006 *Isastrea bernardiana* (D'ORBIGNY) – PANDEY & FÜRSICH: 54, pl. 2, fig. 3–5, pl. 3, figs 1–4.

Material: One specimen from the Rudstone, the uppermost unit of the Joyan Member (Upper Bajocian) of the Jaisalmer Formation, exposed 2 km southeast of Jaisalmer on the Jaisalmer-Kuri road (RUC2007I 241).

Dimensions (in mm): see Tab. 7.

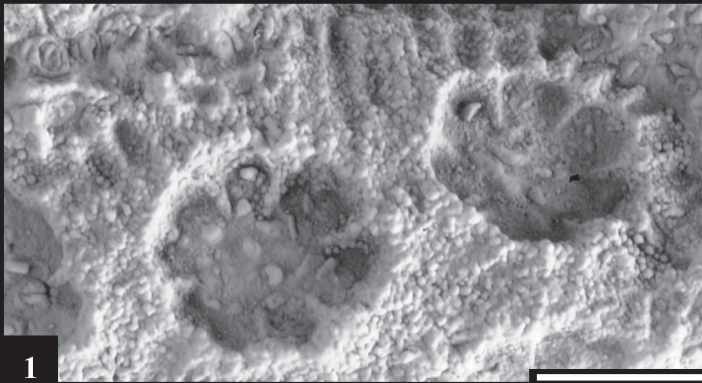
Table 7: Dimensions (in mm) of *Isastrea bernardiana* (D'ORBIGNY, 1850).

specimen	D	H	d	c-c	Ns
RUC2007I 241	200	80	5–7	5–7	24

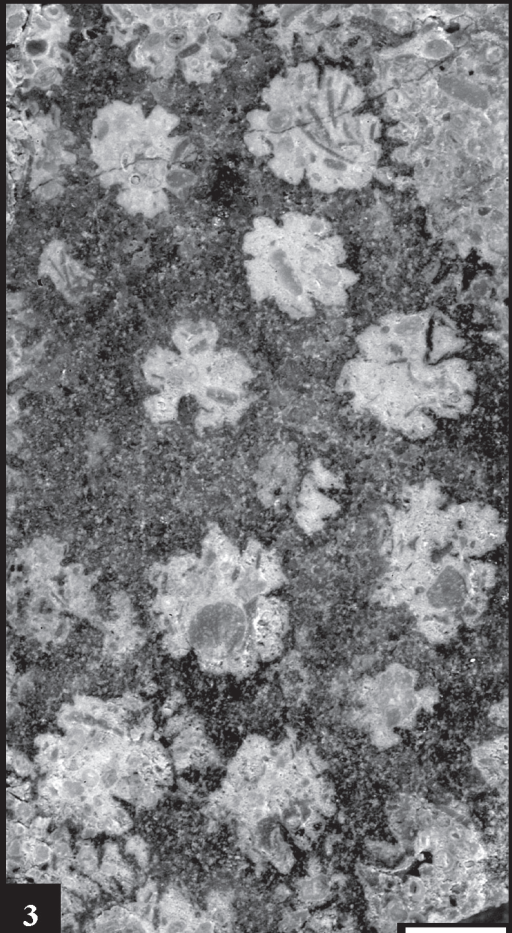
Description: Corallum large, massive, cerioid. Corallites moderately large, pentagonal to subrounded in transverse-section. Septa compact, moderately thick, of *Montlivaltia*-type, non-anastomosing, arranged in three distinct cycles, septa of the first two cycles nearly reaching the center, those of the third cycle shorter. Lateral margin covered with spinules. Septa of adjacent corallites confluent to non-confluent, and in a few cases

Plate 3:

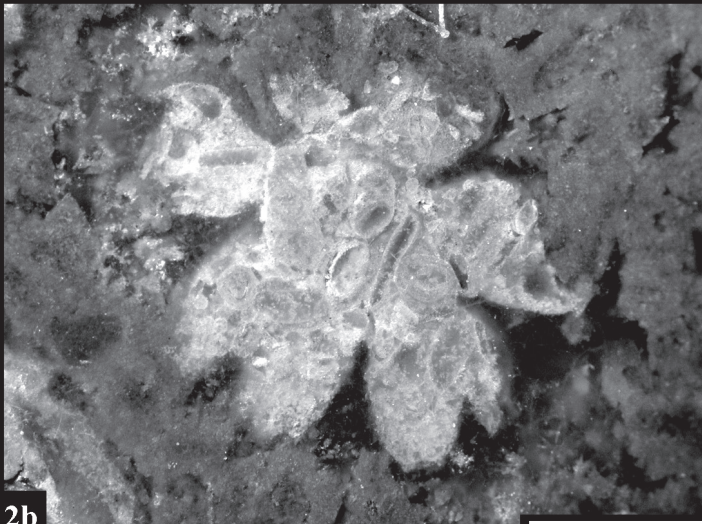
Figs 1–3: *Cryptocoenia hexaphyllia* D'ORBIGNY, 1850 from the Fort Member of the Jaisalmer Formation (Middle Bathonian) at Baba Bharti Temple, 3 km northeast of Jaisalmer. 1: Close up view of upper surface; RUC2007I 109, Scale bar: 2.5 mm. 2: RUC2007I 112. 2a: Close up view of upper surface. Scale bar: 2.5 mm, 2b: magnified view of a single corallite showing inner edges of septa. Scale bar: 1.25 mm. 3: Close up view of polished surface showing septo-parathecal wall and absence of a columella; RUC2007I 117, Scale bar: 2.5 mm.



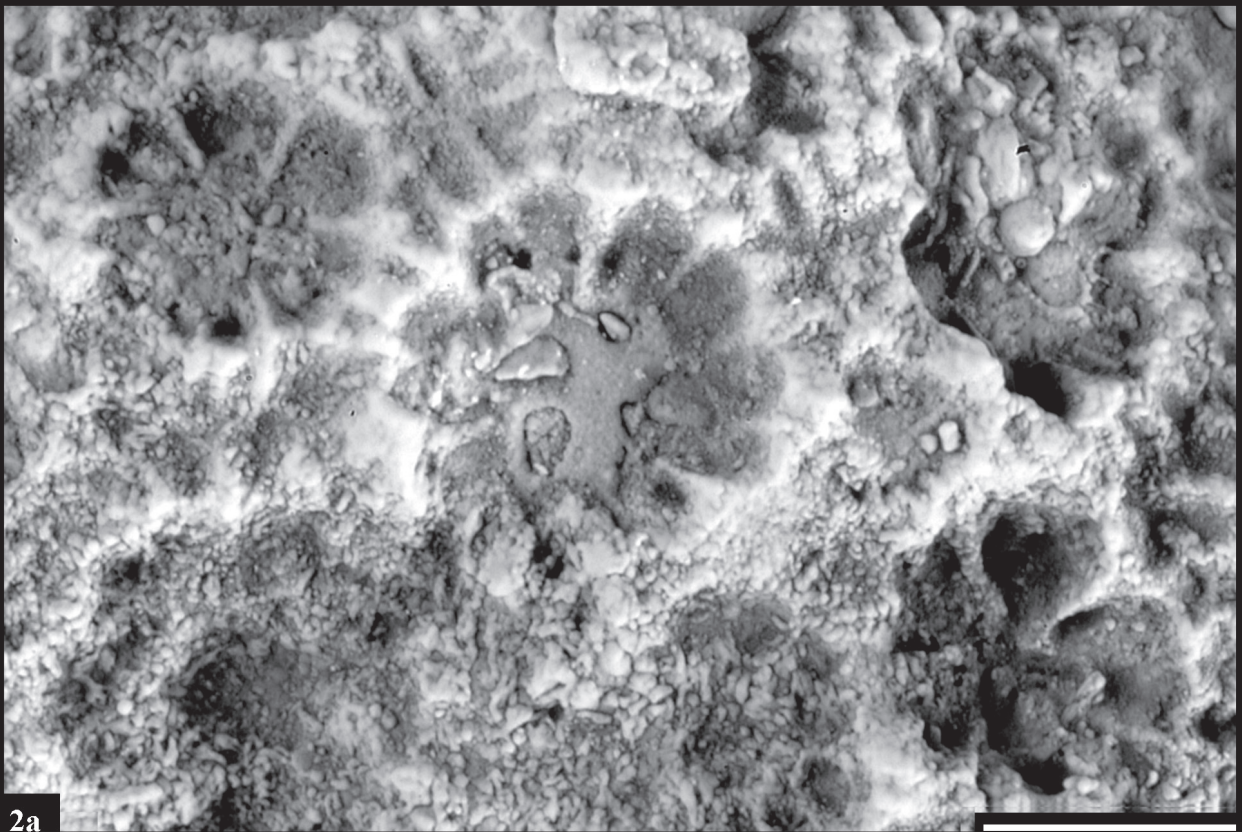
1



3



2b



2a

alternating with the septo-parathecal wall. Endothecal dissepiments common, forming a discontinuous ring near the center.

Remarks: The diagnostic features of *Isastrea* and the range of variation of morphological features within the species have been well documented and explained by RONIEWICZ (1982: figs 6–8), LATHUILLÈRE (1988: pl. 1, fig. 1, pl. 6, figs 1–6, 2000a: figs 6.6, 6.8) and PANDEY & FÜRSICH (2006: 53). The microstructure is not preserved and the trabecular density is not known. The present specimen is a small part of a large, bored, poorly preserved colony. The morphological features could be seen only on the polished surface and in transverse thin-section. They match well with those of *Isastrea bernardiana* (D'ORBIGNY) described and illustrated by earlier workers (e.g., LATHUILLÈRE 2000a; PANDEY & FÜRSICH 2006)

Stratigraphic distribution: Upper Bajocian.

Isastrea helianthoides (GOLDFUSS, 1826)

Pl. 4, Fig. 1

- 1826 *Astrea helianthoides* sp. nov. – GOLDFUSS: 65, pl. 22, fig. 4a (non 4b).
 1843 *Astrea helianthoides* GOLDFUSS – MICHELIN: 105, pl. 24, fig. 3.
 1850 *Prionastraea helianthoides* GOLDFUSS – MILNE-EDWARDS & HAIME: 135.
 1857 *Isastrea helianthoides* GOLDFUSS – MILNE-EDWARDS & HAIME: 538.
 1991 *Isastrea helianthoides* (GOLDFUSS) – ERRENST: 193, pl. 11, fig. 2 [cum syn.].
 1997 *Isastrea helianthoides* (GOLDFUSS) – TURNŠEK: 107, pl. 107, figs A–E.
 2002 *Isastrea helianthoides* (GOLDFUSS) – BARON-SZABO: 36, pl. 20, figs 1, 3 (holotype refigured).
 2003 *Isastrea helianthoides* (GOLDFUSS) – PANDEY & FÜRSICH: 54, pl. 14, figs 4–5.

Material: One specimen from the Jajiya Member (Oxfordian) of the Jaisalmer Formation exposed 2 km north of Kuldhar Ruins village, 16 km southeast of Jaisalmer (RUC2008I 1).

Dimensions (in mm): see Tab.8.

Table 8: Dimensions (in mm) of *Isastrea helianthoides* (GOLDFUSS, 1826).

specimen	D	H	d	c-c	Ns
RUC2008I 1	64	18	4.5–6	4.4–5	31–40

Description: Corallum small, discoidal, massive, cerioid. Corallites moderately large, pentagonal to subrounded in transverse section. Budding intracalcinal. Septa compact, moderately thick, of *Montlivaltia*-type, non-anastomosing, arranged in four distinct cycles, septa of the first two cycles nearly reaching the center, those of the third and fourth cycle shorter. Lateral margin covered with granules and spinules. Septa of adjacent corallites mostly non-confluent and alternating. Wall septo-parathecal. Endothecal dissepiments common, dense along the wall.

Remarks: The morphological characters of the specimen fall also within the range of variation of *Isastrea bernardiana* (D'ORBIGNY, 1850) described above, but the distribution pattern of dissepiments in the two species in question differs. In *Isastrea bernardiana* the dissepiments are uniformly distributed and also form a discontinuous ring more or less in the middle of the corallites, whereas in the present material (*as in I. helianthoides*) the dissepiments are densely packed near the wall of the corallites.

It is interesting to note that *Isastrea bernardiana* (D'ORBIGNY, 1850) is mostly confined to the Bajocian or older sediments (PANDEY & FÜRSICH 1994), whereas *Isastrea helianthoides* is mostly known from younger sediments, e.g. Oxfordian and Kimmeridgian (TURNŠEK 1997). The trabecular density may also be useful in differentiating the species (ERRENST 1990: 194–195; PANDEY & FÜRSICH 2006: 54), but unfortunately trabeculae are not preserved in the present specimen.

Stratigraphic distribution: Oxfordian.

Suborder Caryophylliina VAUGHAN & WELLS, 1943

Remarks: The present collection includes a large number of specimens. Externally these are moderately to well preserved, but internally the microstructure is not well preserved. However, traces of the centers of calcification, which are not confined to the mid-septal zone but are distributed rather irregularly (Pl. 5, Fig. 10, Textfig. 4), suggest their assignment to the suborder Rhipidogyrina RONIEWICZ (1976: 79; STOLARSKI & RONIEWICZ 2001: 1099) rather than to this suborder. However, due to the poor preservation of the microstructure the traditional classification is followed here.

Family Caryophylliidae GRAY, 1847

Subfamily Caryophylliinae GRAY, 1847

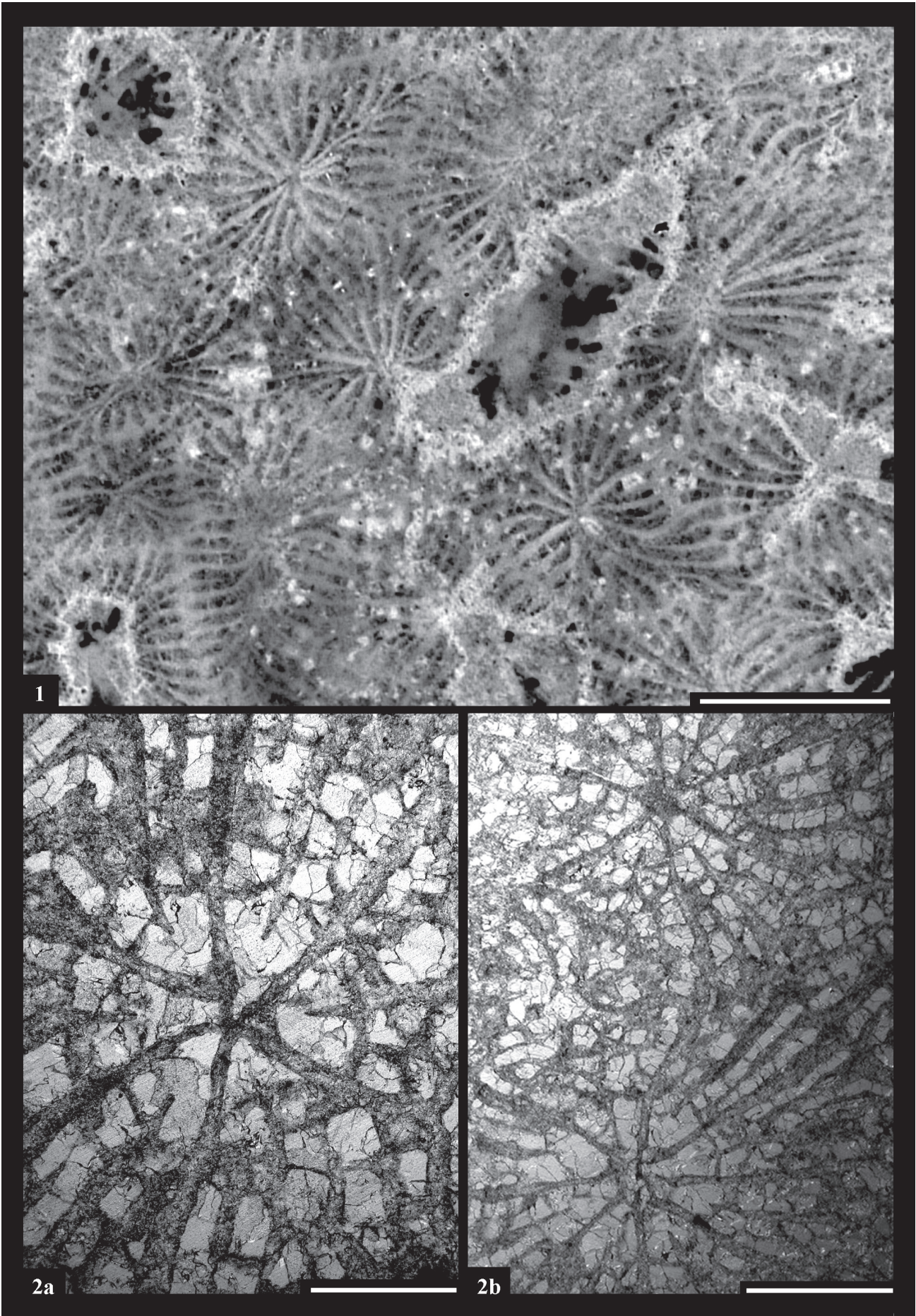
Genus *Trochocyathus* MILNE EDWARDS & HAIME, 1848

Type species *Turbinolia mitrata* GOLDFUSS, 1826 from the Upper Cretaceous of Germany

Plate 4:

Fig. 1: *Isastrea helianthoides* (GOLDFUSS, 1826) from the Jajiya Member (Oxfordian) of the Jaisalmer Formation 2 km north of Kuldhar Ruins village, 16 km southeast of Jaisalmer showing close-up view of a polished transverse section. Note densely packed dissepiments near the wall of the corallites; RUC2008I 1. Scale bar: 5mm.

Fig. 2: *Isastrea bernardiana* (D'ORBIGNY, 1850) from the uppermost rudstone unit of the Joyan Member (Upper Bajocian) of the Jaisalmer Formation, 2 km southeast of Jaisalmer on the Jaisalmer-Kuri road, showing close-up views of a transverse thin-section. Note compact septa, endothecal dissepiments forming a ring near the center and the septo-parathecal wall; RUC2007I 241. a: Scale bar: 1.25 mm, b: scale bar: 2.5 mm.



Trochocyathus laminus (QUENSTEDT, 1858)
Pl. 5, Figs 1–10, Textfig. 4

- 1858 *Turbinolia lamina* sp. nov. – QUENSTEDT: 793, pl. 98, figs 7–8.
1876 *Trochocyathus mancus* sp. nov. – MILASCHEWITSCH in BECKER & MILASCHEWITSCH: 183, pl. 43, fig. 3, 3a.
1881 *Turbinolia lamina* QUENSTEDT – QUENSTEDT: 716, pl. 171, figs 7–13.
1954 *Trochocyathus laminus* QUENSTEDT – GEYER 1954: 188, pl. 15, figs 9a, b.
1991 *Trochocyathus laminus* QUENSTEDT – LAUXMANN: 141, pl. 6, fig. 2 [cum syn.].

Material: Fifty specimens from the Kolar Dungar Member of the Bhadasar Formation (Upper Tithonian) at Bhadasar ridge, 24 km north of Jaisalmer at the Jaisalmer–Ramgarh Road (RUC2007I 1–50).

Dimensions (in mm): see Tab. 9.

Description: Corallum solitary, cupolate turbinate, trochoid with very small attachment area. Costo-septa slightly exert, thick, compact, hexamerally arranged in four cycles. Septa of first two cycles thick, long and occasionally merged with a conspicuously papillose to spongy columella. Septa of third to fourth cycles remarkably shorter, their distal margin convexo-concave with maximum convexity near the periphery and concavity before reaching the columella. Lateral surfaces of septa ornamented with moderately large granules along the trabeculae, trabeculae arranged in a single fan (RUC2007I 18). Distal margin of costo-septa acutely rounded with denticles corresponding to trabeculae. Pali present opposite to inner edge of septa, anastomosing with septa. Dissepiments present along the periphery. Costae corresponding to septa, numbering 48, distinct, occasionally covered with epitheca, occasionally fading proximally. Wall septothecal.

Remarks: The specimens are poorly preserved and except in a few the septal ornamentation is covered with matrix. The attachment area mostly consists of the mould of a granule or a small pebble. The poor state of preservation and the dense, conspicuously papillose columella do not allow a clear demarcation of pali or paliform lobes in front of septa of the first three cycles, but as observed in a few specimens, their presence cannot be ruled out. In general, the morphological features of the present specimens, such as calice outline, position of septa, presence of pali and papillose columella resemble those of *Trochocyathus* MILNE EDWARDS & HAIME (1848: 300–301). However, in *Trochocyathus* the pali or paliform lobes are distinct, which is not the case in the present specimens. With respect to the indistinct nature or the absence of pali, *Bathycyathus* MILNE EDWARDS & HAIME and *Ceratotrochus* MILNE EDWARDS & HAIME, respectively, are comparable genera (WELLS 1956: F423–F424). The former genus has also been recorded from the Jurassic of Crimea (BARON-SZABO 2002: 157–158),

Table 9: Dimensions (in mm) of *Trochocyathus laminus* (QUENSTEDT, 1858).

specimen	D	d	H	Ns (Ns joining columella)
RUC2007I 1	12.9	10	4.4	32 (12)
RUC2007I 2	13	11	9	30 (11)
RUC2007I 3	14	13	7.5	36 (15)
RUC2007I 4	13	12	9	44 (11)
RUC2007I 5	11	10	8	36 (12)
RUC2007I 6	11	10	7	32 (12)
RUC2007I 7	14	13.1	9	31 (11)
RUC2007I 8	13.4	12	8.5	36 (12)
RUC2007I 9	13.5	13	9.4	30 (12)
RUC2007I 10	15	14	7	34 (12)
RUC2007I 11	12.2	12	11	34 (11)
RUC2007I 12	11	10.2	7.2	28 (12)
RUC2007I 13	12.2	11.5	8	36 (12)
RUC2007I 14	11.4	11	12	44 (12)
RUC2007I 15	8	7.5	8.4	42 (12)
RUC2007I 16	14.1	13.4	11.1	44 (12)
RUC2007I 17	12.1	11.2	10	46 (10)
RUC2007I 18			8	28 (11)
RUC2007I 19	14	13.2	8	42 (12)
RUC2007I 20	14	13.1	11.1	48 (12)
RUC2007I 21	14.2	12.4	8.3	42 (9)
RUC2007I 22	11	10	6.6	38 (10)
RUC2007I 23	14.1	12	11.4	38 (8)
RUC2007I 24	12.5	10.1	11	44 (10)
RUC2007I 25	11	10	7.2	34 (12)
RUC2007I 26	13.2	12.5	8	46 (12)
RUC2007I 27	13.5	12.3	8.2	42 (8)
RUC2007I 28	11	10.5	7.5	42 (12)
RUC2007I 29	14	12.3	11	42 (12)
RUC2007I 30	14	13	9.2	40 (8)
RUC2007I 31	13.4	12	10.2	46 (12)
RUC2007I 32	16.5	14.2	13.5	40 (10)
RUC2007I 33	12.2	11	10.1	38 (11)
RUC2007I 34	13.5	13.5	12	46 (10)
RUC2007I 35	16	16	14	40 (8)

Textfigure 4: *Trochocyathus laminus* (QUENSTEDT, 1858). Specimens from the Kolar Dungar Member of the Bhadasar Formation (Upper Tithonian) at Bhadasar ridge, 24 km north of Jaisalmer on the Jaisalmer – Ramgarh Road. Scale bar: 5 mm. a: Transverse polished section showing skeletal elements. Note that the matrix has been removed from the spaces between the septa. RUC2007I 37. b: Transverse thin-section showing skeletal microstructure. The very small dark dots, which are spread within the wall and septa, represent centers of calcification. RUC2007I 36.



but differs in having a very deep fossula (MILNE EDWARDS & HAIME, 1850: xiii). The latter genus so far has not been recorded from strata older than Cretaceous (WELLS 1956: F424, BARON-SZABO 2002: 163).

Trochocyathus magnevillianus (MICHELIN) (1840: 8, pl. 2, figs 2a, b; MILNE EDWARDS & HAIME 1851: 126, pl. 26, figs 1, 1a, 1b) from the Inferior Oolite of England differs by its distinct pali. The number of septa in *T. magnevillianus* ranges from 48–60 (KOBY 1880: 12, pl. 3, figs 8–11), i.e. higher than in the present specimens. *Trochocyathus cruciana* ÉTALLON (1864: 357, pl. 50, fig. 1) also differs by its greater number of septa (60). *Trochocyathus corallinus* KOBY (1880: 13, pl. 3, figs 12, 12a) is a comparable species with respect to the number of septa, but the illustrations are too poor to judge the nature of pali and columella. *Trochocyathus laminus* (QUENSTEDT, 1858: 793, pl. 98, figs 7–8 [= *Trochocyathus mancus* MILASCHWITSCH in BECKER & MILASCHWITSCH 1875: 183, pl. 43, figs 3, 3a]; GEYER 1954: 188, pl. 15, figs 9a, b) has a similar number of septa but again the nature of pali and columella is not known. *Trochocyathus? primus* MILNE EDWARDS & HAIME (1851: 145, pl. 30, fig. 8), represents a juvenile form and thus has very few septa and costae. *Trochocyathus florealis* (QUENSTEDT, 1852: 657; 1881: 593, pl. 164, figs 78–84; FROMENTEL & FERRY 1865: 19, pl. 17, fig. 1) has four complete septal cycles (=48 septa) of non-anastomosing septa that are uniform in thickness and distribution. *Microsmilia delemontana* (THURMANN), which COUFFON (1919: 20, pl. 1, fig. 13) and FROMENTEL & FERRY (1865: 25, pl. 5, fig. 3) considered to be *Trochocyathus*, is very similar with respect to the general shape of the corallum, number of septa, and presence of pali (KOBY 1888: 417, pl. 112, figs 16–21). However, BEAUVAIS (1964: 205, textfig. 44) re-examined KOBY'S material and observed granules on the lateral surfaces and along the distal margin of septa. The granules are arranged along trabeculae, which show diverging lines. The granules in the present specimens also are arranged along trabeculae but these do not show diverging lines. Moreover, any comparison of species belonging to *Trochocyathus* and *Microsmilia* should be done with great care, because apparently they may look similar with respect to arrangement and number of septa and pali, but in the latter genus there are pores in the wall, regularly arranged between two adjacent septa (KOBY 1888: 415, pl. 112, fig. 14; WELLS 1956: 433, fig. 337, 5f). The assignment of species of THURMANN (1851), such as *Microsmilia delemontana* or *Microsmilia erguelensis* (see also FROMENTEL & FERRY 1865: 27, pl. 5, fig. 4) to *Trochocyathus* needs reinvestigation.

In the present specimens the number of septa, fossular cavities left by shortening of the septa of the third and fourth cycle, conspicuous nature of columella, indistinct nature of pali match well *Trochocyathus laminus* (QUENSTEDT) described by LAUXMANN (1991). The fossular cavities left by shortening of the septa of the third and fourth cycle, conspicuous nature of the columella, and indistinct nature of pali differentiate them from all other Jurassic species of *Trochocyathus* mentioned above and also all Cretaceous species of *Trochocyathus* described by earlier workers (e.g., MILNE EDWARDS & HAIME 1850: 63–67; DUNCAN 1869–1870: 32–34; ALLOITEAU 1952: 647, pl. 1, figs 6a, b; ALLOITEAU 1958: 122–129; BARON-SZABO 2002: 158, pl. 118, figs 1–11).

Stratigraphic distribution: Upper Tithonian.

Suborder Fungiina VERRILL, 1865
(nom. corr. ex Fungiida DUNCAN, 1885)
Family Agariciidae GRAY, 1847

Genus *Craterastraea* BEAUVAIS, 1978

Type species *Thamnastraea crateriformis* GREGORY, 1900

Remarks: PANDEY & FÜRSICH (2003: 79) emended the diagnosis of the genus *Craterastraea* BEAUVAIS. The genus is known from the Middle Bathonian of the Kachchh Basin (PANDEY & FÜRSICH 1993: 27), Callovian of northwestern Jordan (PANDEY et al. 2000: 10), Lower Callovian and Lower Kimmeridgian rocks of the Tabas-Kerman area of east-central Iran (PANDEY & FÜRSICH 2003: 79), Callovian of southern Tunisia (PANDEY & FÜRSICH 2005: 21) and from the Lower Cretaceous of the Koppch Dag, northeastern Iran (PANDEY et al. 2007: 44).

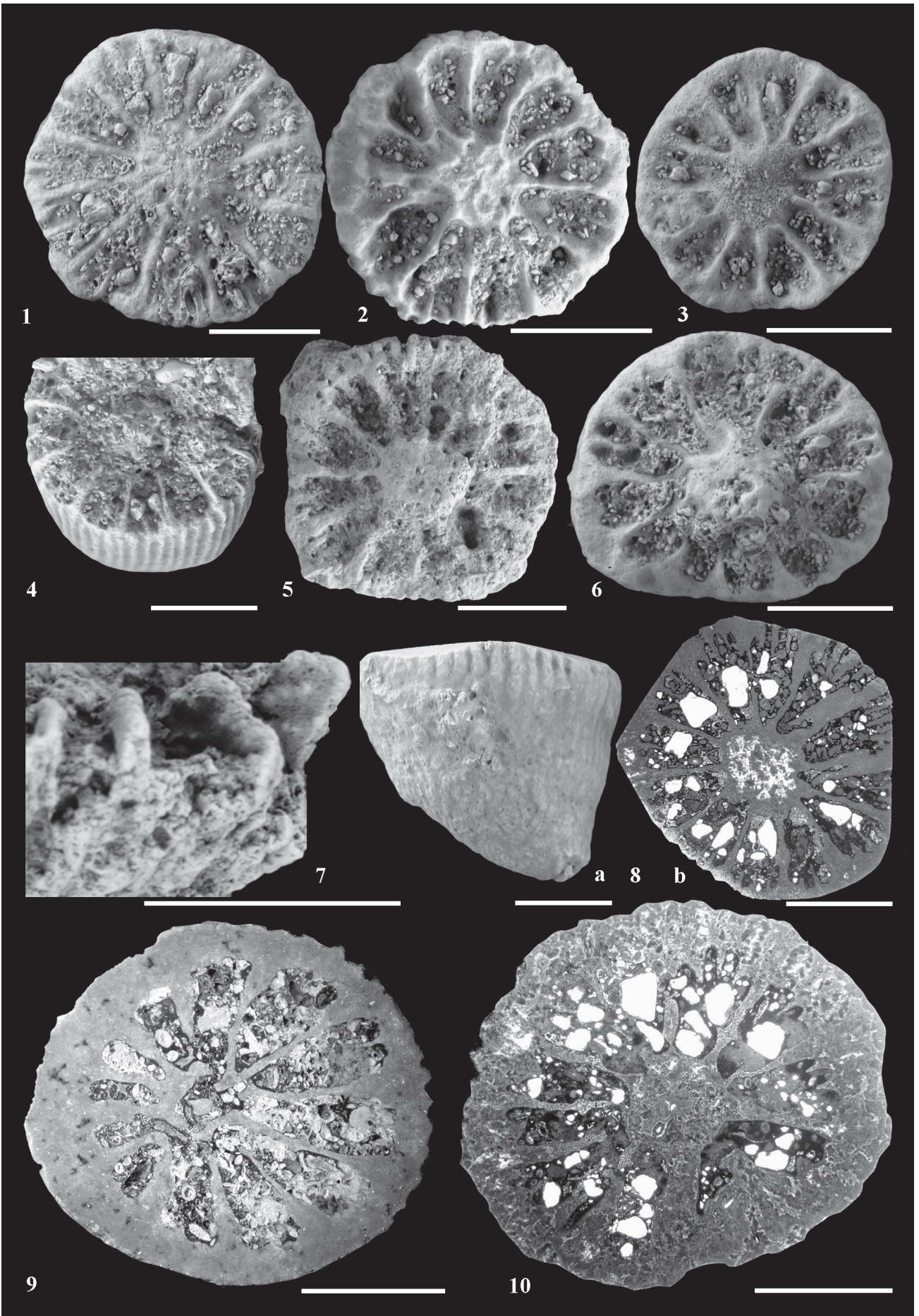
Craterastraea crateriformis (GREGORY, 1900)

Pl. 6, Fig. 1a–d

- 1900 *Thamnasteria crateriformis* sp. nov. – GREGORY: 135, pl. 17, figs 4–5, 7.
1978 *Craterastraea crateriformis* (GREGORY) – BEAUVAIS: 56, pl. 4, fig. 1.
1993 *Craterastraea crateriformis* (GREGORY) – PANDEY & FÜRSICH: 27, pl. 6, fig. 12, pl. 7, figs 10, 12, 15, textfig. 18.
2000 *Craterastraea* cf. *crateriformis* (GREGORY) – PANDEY et al.: 10, pl. 2, fig. 1.

Plate 5:

Figs 1–10: *Trochocyathus laminus* (QUENSTEDT, 1858) from the Kolar Dungar Member of the Bhadasar Formation (Upper Tithonian) at Bhadasar ridge 24 km north of Jaisalmer at the Jaisalmer – Ramgarh Road. Scale bar: 5 mm. **1:** Upper view showing four septal cycles. Note incomplete fourth cycle; RUC2007I 9. **2:** Upper view showing irregular outline of the columella. Note pali, which are not very distinct, against septa of the first three cycles; RUC2007I 5. **3:** Upper view showing thick inner part of pali joining septa with thin outer part. It seems that the septa of the first two cycles are joined to the columella; RUC2007I 6. **4:** Oblique view showing costae along the distal part of the corallum; RUC2007I 17. **5:** Upper view showing septoparathecal wall and spongy columella; RUC2007I 13. **6:** Upper view showing papillose columella; RUC2007I 2. **7:** Magnified side view of the distal part of corallum showing septal ornamentation. Note that the granules are arranged in lines which are not parallel to the distal edge of septa; RUC2007I 18. **8:** RUC2007I 43, a: Side view showing costae along distal end diminishing towards proximal end. Note the very small attachment area, b: transverse thin-section showing septa, pali, and papillose columella. **9:** Polished transverse section showing anastomosing septa. Note the nature of columella; RUC2007I 37. **10:** Transverse thin-section showing septa of the first two cycles mostly joined to the pali; RUC2007I 36.



- 2003 *Craterastraea crateriformis* (GREGORY) – PANDEY & FÜRSICH: 79, pl. 23, figs 1, 3–5.
- 2005 *Craterastraea crateriformis* (GREGORY) – PANDEY & FÜRSICH: 21, pl. 6, figs 4–6.
- 2007 *Craterastraea crateriformis* (GREGORY) – PANDEY et al.: 44, pl. 12, fig. 2.

Material: One specimen from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer (RUC2007I 238).

Dimensions (in mm): see Tab. 10.

Table 10: Dimensions (in mm) of *Craterastraea crateriformis* (GREGORY, 1900).

specimen	D	H	d	c-c	Ns
RUC2007I 238	88	42.5	1.0–2.0	1.3–3.0	15–22

Description: Corallum with large diameter, colonial, massive, nodular, plocothamnasterioid. Calices small, slightly depressed, subcircular in outline. Costo-septa few in number, confluent. Septa subcompact, occasionally anastomosing, less dense in the center than along the periphery of the calices, arranged in at least three cycles. Ten to 13 septa reaching the center, occasionally joined to the columella, other septa increasingly shorter. Lateral surfaces of septa ornamented with spinules. Dissepiments common, sub-tabular to vesicular, dense towards the periphery of the corallites. Synapticulae present. Columella papillose to spongy, occasionally protruding and of a small diameter.

Remarks: The single specimen is bored and abraded. However, the internal microarchitecture is well preserved. It seems that the septal microstructure consists of separated calcification centers. Lateral branching leading to spinules could be observed. The morphological characters of the present specimen match well those of *Craterastraea crateriformis* (GREGORY).

Stratigraphic distribution: Middle Bathonian.

Genus *Collignonastraea* ALLOTEAU, 1958

Type species *Comoseris jumarensis* var. *radiata* GREGORY, 1900

Table 11: Dimensions (in mm) of *Collignonastraea meandra* (D'ORBIGNY, 1850).

specimen	D	H	d	Ns	Ds	Dc	Dt
RUC2007I 101	50.5	22.0		16		8/2 mm	8/2 mm
RUC2008I 2	11.3	4	3–3.9	25–27	6/2 mm	–	–

Plate 6:

Fig. 1: *Craterastraea crateriformis* (GREGORY, 1900) from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer; RUC2007I 238. **a:** Upper surface view of part of colony. Note only two cycles of septa reach the centers of corallites producing the crater-like appearance of corallites. Scale bar: 5 mm. **b:** Oblique thin-section. Scale bar: 2.5 mm. **c:** Transverse section showing position of septae. Scale bar: 1.25 mm. **d:** Magnified view of oblique section showing dissepiments and septal ornamentation. Scale bar: 1.25 mm.

Remarks: PANDEY & FÜRSICH (2003: 84; 2006: 66) noticed the plasticity of the external morphological features of *Collignonastraea* in response to micro-environmental factors and also summarized the diagnostic morphological features of *Collignonastraea* and *Microphyllia* D'ORBIGNY (1849).

Collignonastraea meandra (D'ORBIGNY, 1850)
Pl. 7, Figs 1–2

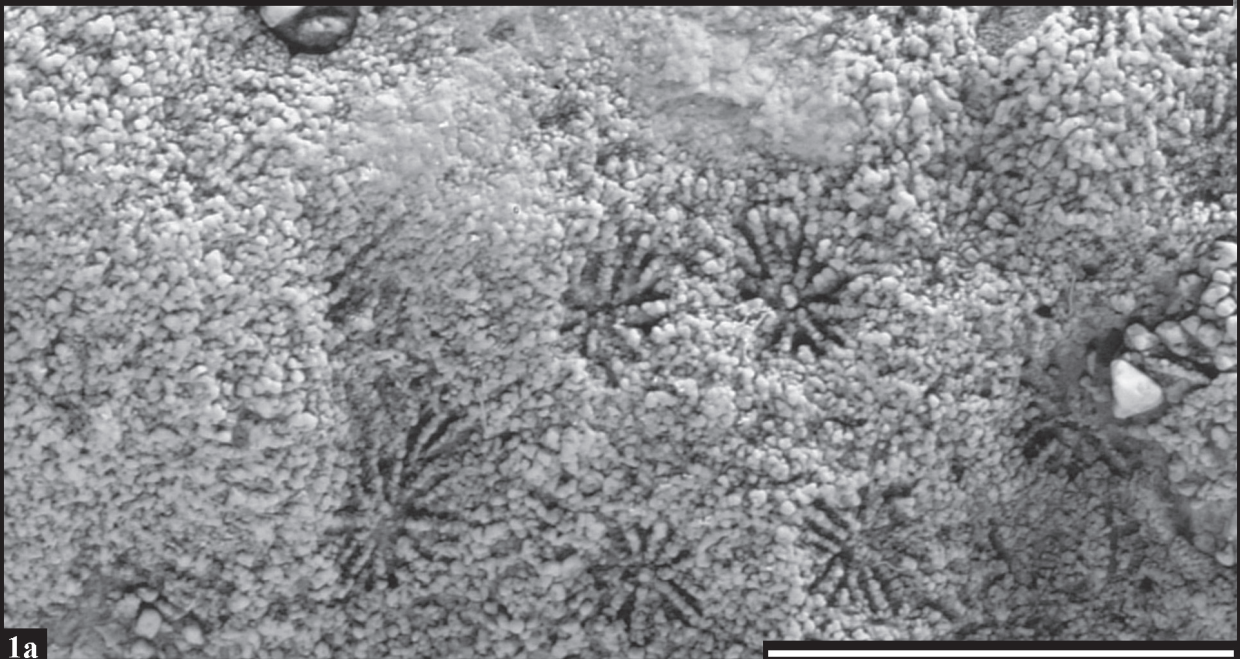
- 1850 *Oulophyllia meandra* sp. nov. – D'ORBIGNY: 293, pl. 1.
- 2006 *Collignonastraea meandra* D'ORBIGNY – PANDEY & FÜRSICH: 68, pl. 6, figs 2–5 (cum syn.)

Material: Two specimens, one from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer (RUC2007I 101) the other one from the Jajiya Member (Oxfordian) of the Jaisalmer Formation exposed 2 km north of Kuldhara Ruins village, 16 km southwest of Jaisalmer (RUC2008I 2).

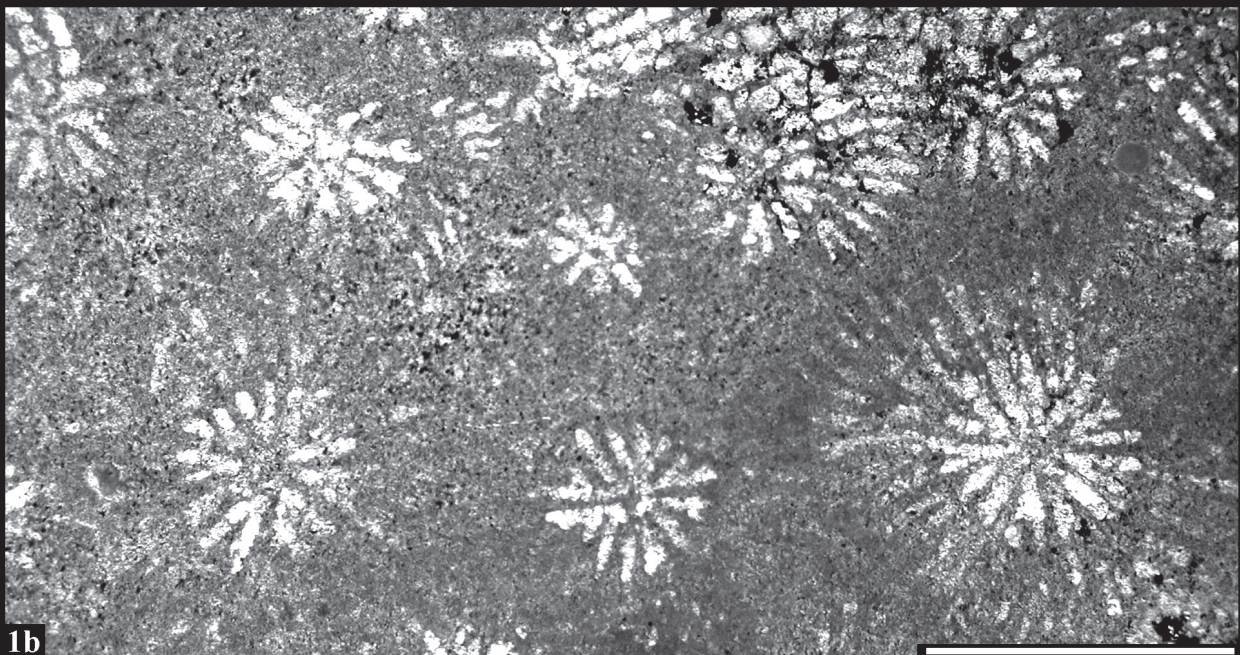
Dimensions (in mm): see Tab. 11.

Description: Corallum discoidal to hemispherical, colonial. Calicular series poorly to well developed. Budding intracalicular. Upper surface convex, sub-circular in plan view. Lower surface sub-pedunculate to slightly convex with a large, flat attachment area. Calices distinct, collines tectiform, radial, short, and low. Septa sub-compact, moderately thick, commonly anastomosing, pores rare. Septa of first and second cycle reaching the center, those of the third and fourth cycle increasingly shorter and thinner. Denticles along distal margins of septa obtusely rounded. Lateral septal surfaces covered with spinules and granules, occasionally with pennulae-like structures (Pl. 7, Fig. 1b). Vesicular dissepiments common, gently to steeply inclined, occasionally forming hammock-like structure. Columella small in cross-section, parietal, papillose to spongy. Wall along collines septothecal (see lower part of Pl. 7, Fig. 1b).

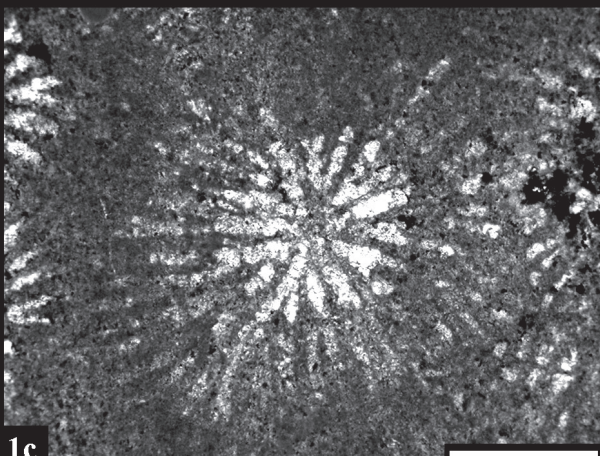
Remarks: Of the two specimens the larger one is poorly preserved externally. Collines could be observed only at the periphery of the corallum. However, the internal microarchitecture is well preserved. The septal microarchitecture resembles pennular structures. However, in close view it can



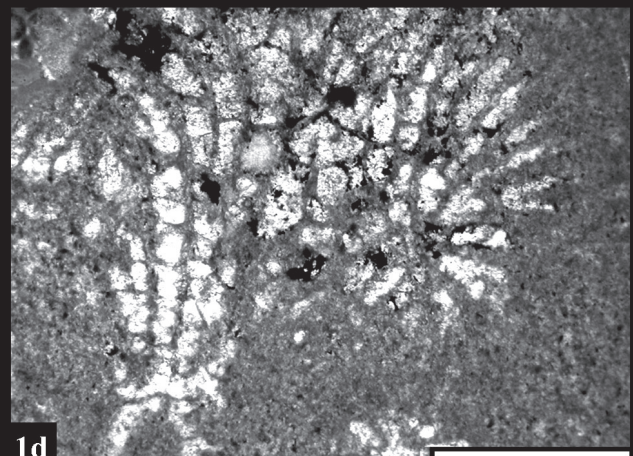
1a



1b



1c



1d

be seen that the upper surfaces of these structures are not concave but rather mostly slant downward. In some cases the edge is obtusely rounded, and similar to the microarchitecture of *Epistreptophyllum* (PANDEY & LATHUILLIÈRE 1997: 573, figs 10.4, 11). None of these structures are bilaterally symmetrical but rather occasionally fused. There is no regularity. Functionally, these structures do not fit pennular structures. In many cases, wherever there is something like a pennular edge, this is because it carries an extension for a dissepiment. In longitudinal section (Pl. 7, Fig. 1b) it looks like alternating mi-pennulae. The morphological characters agree well with the present species.

The second specimen is a juvenile but is externally better preserved. However, the wall along the collines is not very clear. It appears to consist of dissepiments.

Stratigraphic distribution: Middle Bathonian – Oxfordian.

Suborder Microsolenina MORYCOWA &
RONIEWICZ, 1995

Family Microsolenidae KOBAY, 1890

Genus *Trochoplegma* GREGORY, 1900

Type species *Trochoplegma tenuilamellosa* GREGORY, 1900

Trochoplegma sp.
Pl. 7, Fig. 3

Material: One specimen from the Fort Member of the Jaisalmer Formation at Baba Bharti Temple, 3 km north Jaisalmer (RUC2007I 110).

Dimensions (in mm): see Tab. 12.

Table 12: Dimensions (in mm) of *Trochoplegma* sp.

specimen	D	Ns	ds
RUC2007I 110	13	> 90	12 per 2 mm

Remarks: The solitary corallum with crowded, more or less flexuous, anastomosing, fenestrate, pennular septa and an oval calicular fossa match *Trochoplegma tenuilamellosa* described by GREGORY (1900: 180, pl. 23, figs 3–10, pl. IIA, fig. 8) and other workers from Middle Bathonian sediments of the Kachchh Basin (BEAUVAIS 1978: 61; PANDEY & FÜRSICH 1993:

29, pl. 8, figs 11–16) and from Toarcian to Lower Callovian sediments of east-central Iran (FLÜGEL 1966: 67, pl. 17, figs 3–4; PANDEY & FÜRSICH 2003: 112, pl. 29, figs 4–5). However, the single, poorly preserved specimen from the Jaisalmer Basin does not merit identification at the species level.

Stratigraphic distribution: Middle Bathonian.

Family Latomeandridae ALLOITEAU, 1952

Genus *Periseris* FERRY, 1870

Type species *Agaricia elegantula* D'ORBIGNY, 1850

Periseris cf. *elegantula* (D'ORBIGNY, 1850)
Pl. 8, Fig. 1a–b

cf. 1850 *Agaricia elegantula* sp. nov. – D'ORBIGNY: I, 293.

cf. 1990 *Periseris elegantula* (D'ORBIGNY 1850) – LATHUILLIÈRE: 38, pl. 1, figs 1–2, pl. 2, figs 1–4, pl. 3, figs 1–6, pl. 4, figs 1–7, pl. 5, figs 1–6 [cum syn.].

cf. 1993 *Periseris elegantula* (D'ORBIGNY 1850) – PANDEY & FÜRSICH: 37, pl. 11, fig. 2, textfig. 22.

cf. 1993 *Periseris* cf. *renevieri* (KOBAY) – PANDEY & FÜRSICH: 37, pl. 6, fig. 14, textfig. 23.

cf. 2000b *Periseris elegantula* (D'ORBIGNY 1850) – LATHUILLIÈRE: 157, figs 13.1–13.2.

cf. 2003 *Periseris elegantula* (D'ORBIGNY 1850) – PANDEY & FÜRSICH: 94, pl. 28, figs 1–6.

Material: One specimen from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer (RUC2007I 240).

Dimensions (in mm): see Tab. 13.

Table 13: Dimensions (in mm) of *Periseris* cf. *elegantula* (D'ORBIGNY, 1850).

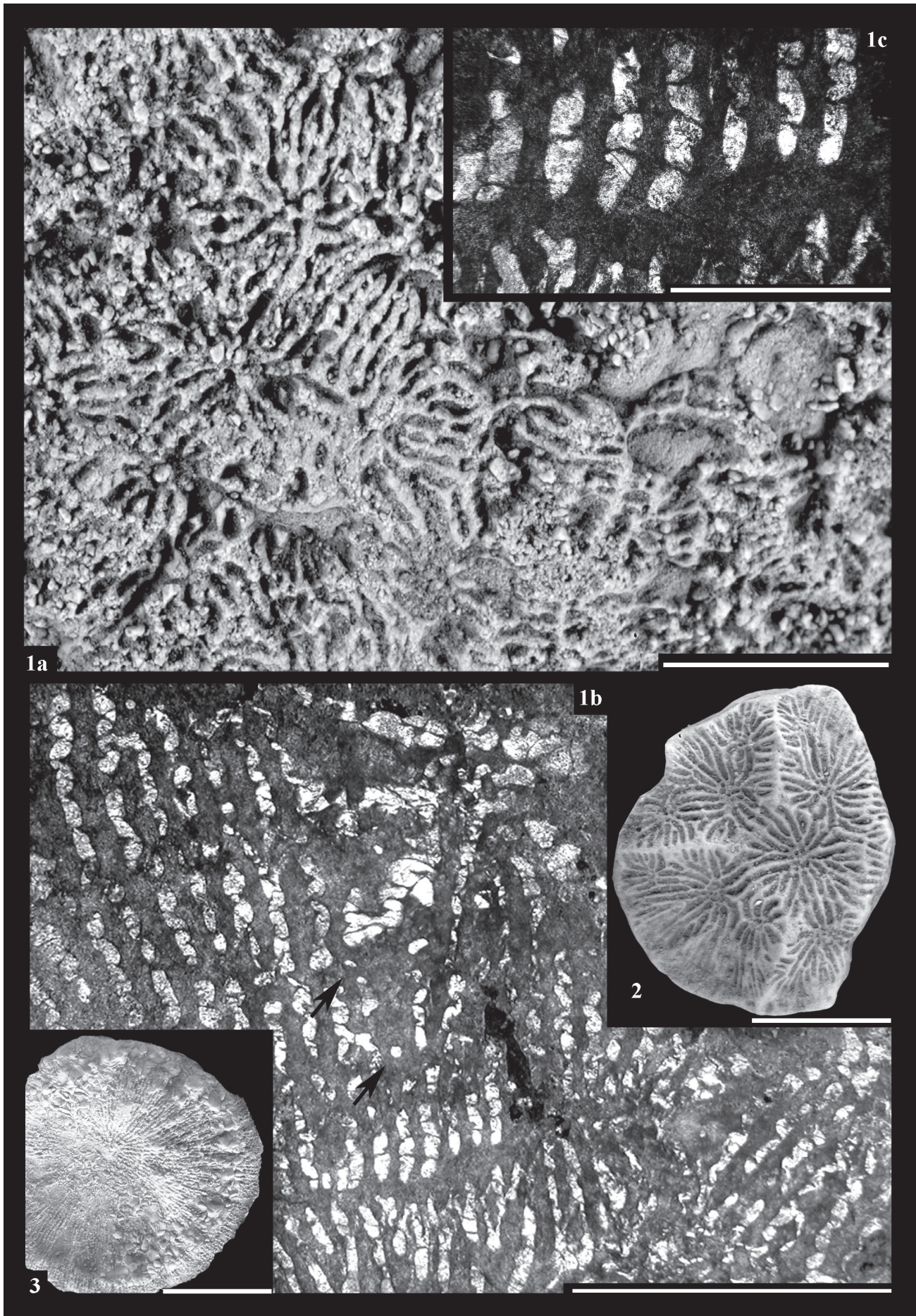
specimen	c-c	Ns	Ds
RUC2007I 240	3.5	ca 20	5–7 per 2 mm

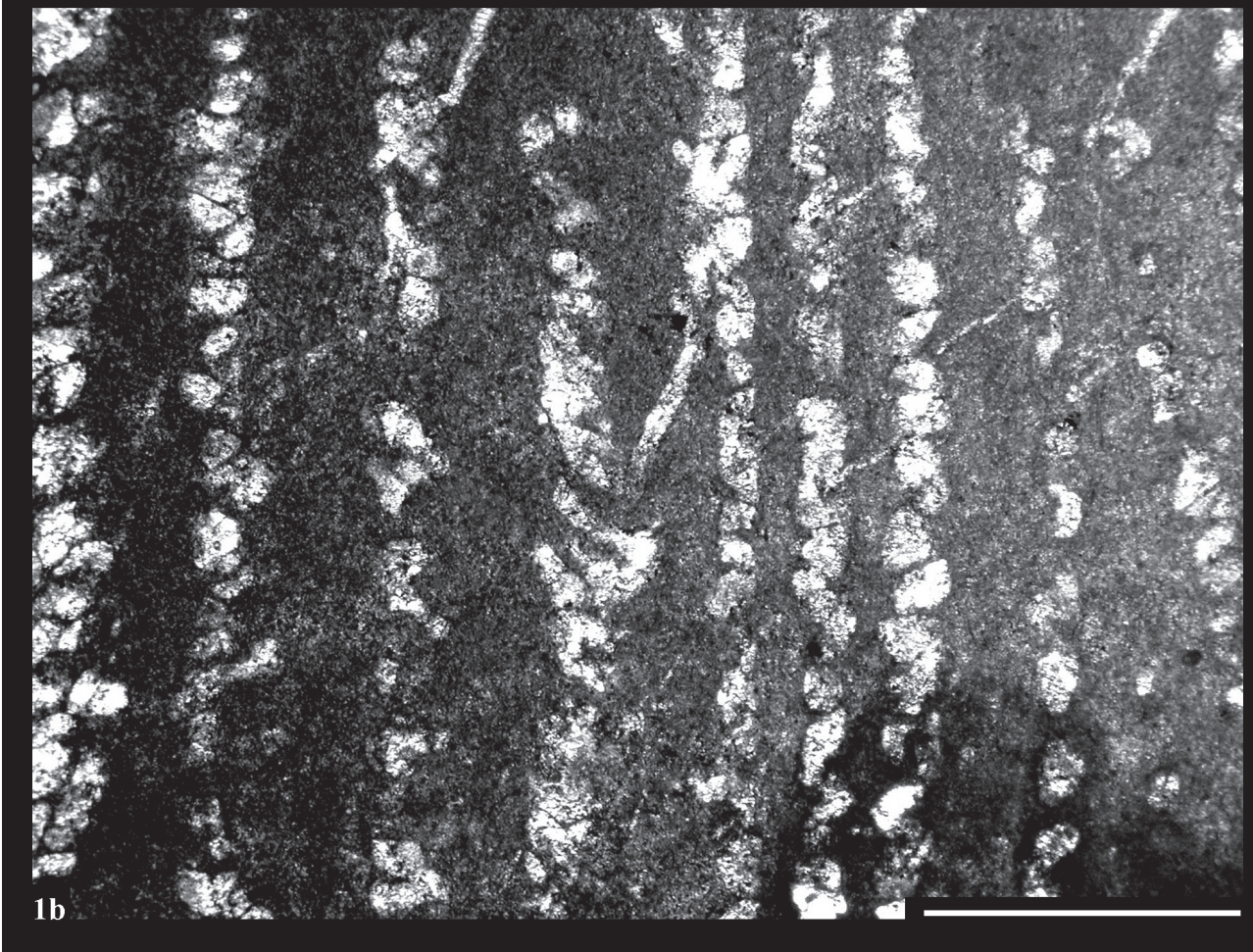
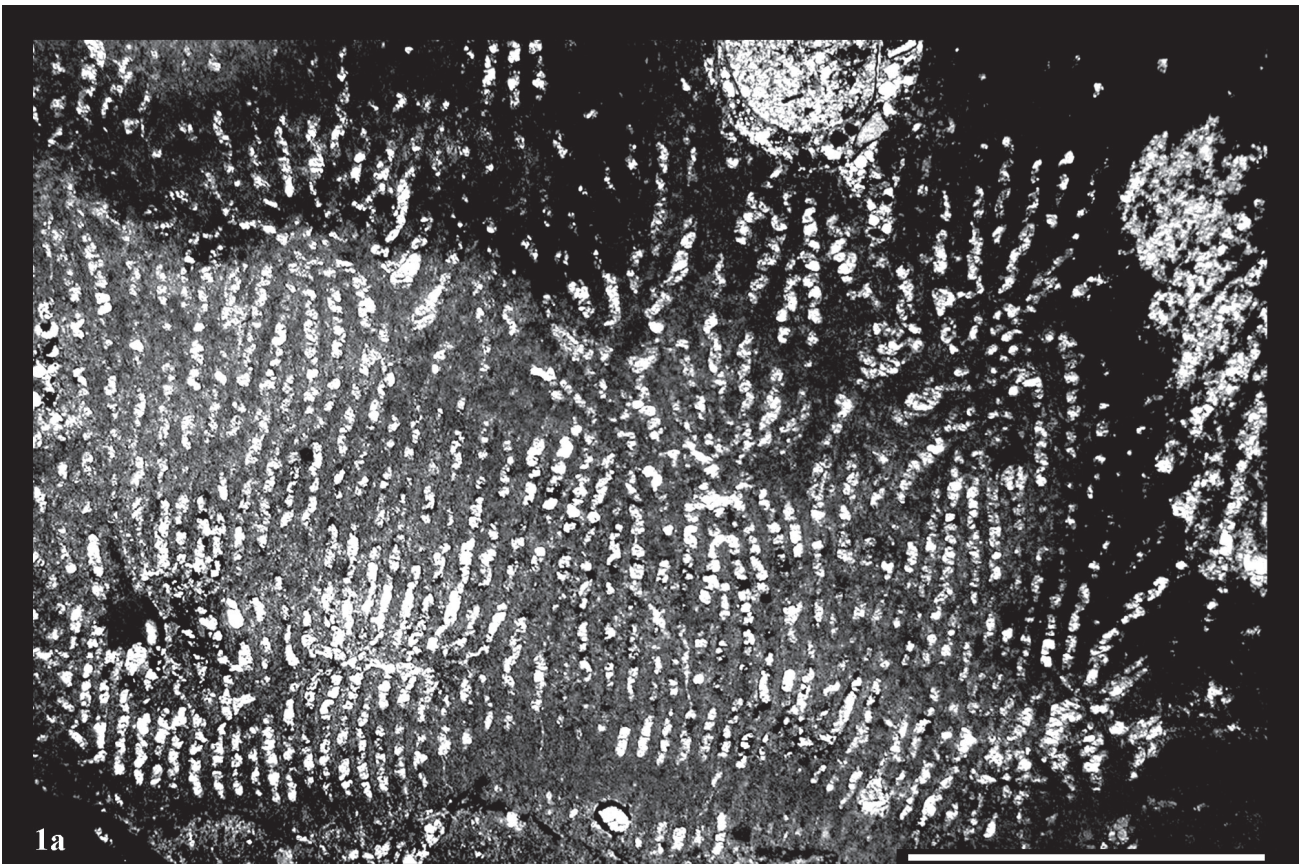
Description and remarks: The colony is very poorly preserved. On the external surface a few corallite centers and parallel arranged septa can be observed. Up to 20 septa are present. The longitudinal thin-section shows that the colony

Plate 7:

Figs 1–2: *Collignonastraea meandra* (D'ORBIGNY, 1850). 1: RUC2007I 101, from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer. 1a: Close up view of part of the upper surface showing tectiform, short, low, and radial collines. Note parallel arrangement of septa between two corallites of the same series. Scale bar: 5 mm. 1b: Longitudinal thin-section showing septal ornamentation. Note pores (arrowed), dissepiments, septotheca along the collines (seen in the lower part of the photograph) and pennulae-like structures. Scale bar: 5 mm. c: Magnified view of (b) showing septal ornamentation. Note the septothecal wall. Scale bar: 1.25 mm. 2: Upper view showing tectiform, radial collines and anastomosing septa. Jajiya Member (Oxfordian) of the Jaisalmer Formation, 2 km north of ruins of Kuldhara village, 16 km southwest of Jaisalmer; RUC2008I 2.

Fig. 3: *Trochoplegma* sp. from the Fort Member of the Jaisalmer Formation at Baba Bharti Temple, 3 km north Jaisalmer, RUC2007I 110. Scale bar: 5 mm. Upper view showing crowded septa.





is thamnasterioid. The septa are sub-compact with a few pores, anastomosing, and laterally covered with spinules. Vescicular dissepiments and synapticalae are common. The trabeculae show pennular structures, but are not well preserved; in places they resemble more strongly those found in *Thamnasteria* (LATHUILIÈRE 1990: fig. 3). The thamnasterioid colony and the septal microarchitecture of the present specimen resemble *Periseris elegantula* (D'ORBIGNY). However, as information about the corallite diameter, arrangement of corallite centers, and precise range of number of septa is lacking the specific identification has been done only with qualification.

Stratigraphic distribution: Middle Bathonian.

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Plate 8 (pg. 34):

Fig. 1: *Periseris cf. elegantula* (D'ORBIGNY, 1850) from a conglomerate bed of the Badabag Member (Middle Bathonian) of the Jaisalmer Formation, exposed opposite to Barabagh cenotaph, 6 km north of Jaisalmer; RUC2007I 240. **a:** Oblique thin-section showing thamnasterioid structure with a few pores. Note continuous thick dark band, where section cuts through dissepiments. Scale bar: 5 mm. **b:** Magnified part of a longitudinal section showing common dissepiments and synapticalae. Scale bar: 1.25 mm.

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