Late Ordovician Corals from Allochthonous Clasts in the Devonian Drik-Drik Formation of Northeastern New South Wales, Australia

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New coral material is documented from allochthonous limestones informally termed the 'Trelawney Beds', of the New England Region in northeastern New South Wales, enabling previous identifications to be revised. Taxa newly recognised in the Trelawney fauna include the tabulate corals *Paleofavosites rarispinulatus* Hall, 1975, and *Navoites cargoensis* (Hill, 1957), a lambelasmatid assigned to Coelostylinae gen. et sp. nov., the tryplasmatid *Bowanophyllum*? sp., and two indeterminate species of *Heliolites* and *Propora*. The taxonomic revisions strengthen similarities between the Trelawney fauna and that described from a comparable occurrence of allochthonous limestones informally known as the 'Uralba Beds' of the Manilla-Attunga area to the north, supporting a coral/stromatoporoid Fauna IIIb age (middle Katian) for both faunas. These Late Ordovician corals were likely eroded from the same carbonate shelf before redeposition into Silurian and Devonian sediments, now represented by the Glen Bell Formation and Drik-Drik Formation, respectively.

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KEYWORDS: Katian, Late Ordovician, New England region, rugose corals, tabulate corals

INTRODUCTION

Late Ordovician corals of eastern Australia are best represented and documented in the Lachlan Orogen of central New South Wales (NSW) where a robust local biostratigraphic framework has been established based on more than six decades of systematic studies (Hill, 1957; Webby, 1969, 1971, 1972, 1975, 1977, 1988; Webby and Semeniuk, 1969; McLean and Webby, 1976; Webby et al., 1981; Webby and Kruse, 1984; Percival et al. 2001, 2006; Pickett and Percival, 2001; Webby et al., 2004; Zhen et al., 2017; Wang et al., 2020). In comparison, contemporaneous coral-bearing strata are relatively sparse in the New England Orogen of northeastern NSW, being restricted to allochthonous limestones of middle Katian age (late Eastonian), historically known as the 'Uralba Beds' but now included within the Glen Bell Formation of early Silurian or younger age southeast of Manilla (Brown, 2009; Vickery et al., 2010), and the former 'Trelawney Beds' contained within the Early Devonian Drik-Drik Formation southeast of Tamworth (Fig. 1). Although corals from these rocks have been described in some detail (Etheridge, 1918; Hill, 1942; Hall, 1975; Webby, 1988), these faunas are still in need of modern revision, particularly in terms of updated classification. Furthermore, some of the previously published illustrations are inadequate in showing insufficient detail, often being represented only by a transverse and longitudinal section of a single specimen. In the present paper, we document new coral material obtained from the 'Trelawney Beds', with the aim to complete and update knowledge of the corals of this time interval in the New England region.

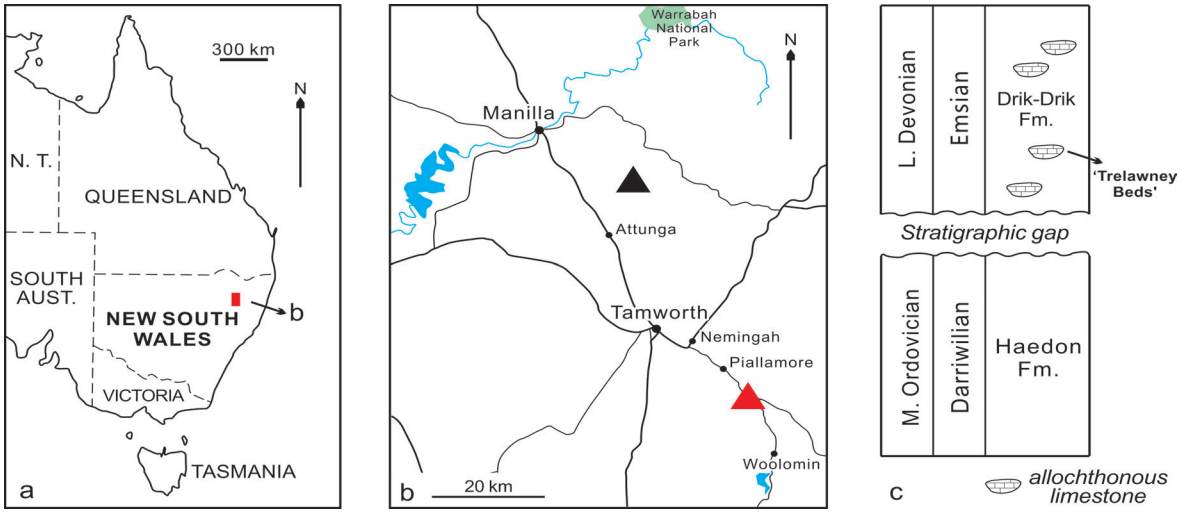

Figure 1. Locality maps and stratigraphy of the study area. a, map of eastern Australia, with position of detailed locality map b indicated by red rectangle; b, map showing the locality of the 'Trelawney Beds' (red triangle) in the New England region of northeastern NSW, with that of the 'Uralba Beds' shown by a black triangle; c, simplified stratigraphic column for the area southeast of Piallamore showing units mentioned in the text and the occurrence of the 'Trelawney Beds'.

STRATIGRAPHY AND MATERIAL

The studied material was collected from limestone blocks, informally named the Trelawney Beds by Philip (1966), that are intermittently and generally very poorly exposed in the Piallamore-Woolomin area approximately 15–25 km southeast of Tamworth in the New England region, northeastern NSW (Fig. 1a, b). All specimens described herein come from a single paddock, in which the limestone blocks (mostly hand-sized clasts) were brought to the surface by ploughing. In the century since corals were first documented from this site (Etheridge, 1918), all of the readily available clasts have been collected, so that the corals described in this paper (and by Hall, 1975; Webby, 1988) almost certainly represent the complete coral diversity.

Benson (1914, 1915, 1918), who in a series of pioneering studies mapped the region south and east of Tamworth, within and immediately adjacent to the major Peel Fault Zone, recognised only Devonian rocks (including several different horizons of fossiliferous limestones) assigned to his Tamworth Series. Due to several errors of interpretation in Benson's mapping noted by Crook (1961, p. 175), the regional stratigraphy of the area required significant revision, resulting in a complex nomenclatural history that further evolved with a series of fossil discoveries (Philip, 1966; Hall, 1975; Cawood, 1976, 1983; Furey-Greig, 2000a, 2003) revealing the presence of older Palaeozoic strata.

Crook (1961) defined the Drik-Drik Formation to replace the 'Nemingha Red Breccia' of Benson (1918), a very distinctive clastic sedimentary unit variably coloured purple-red and bright green, that also included the 'Nemingha Limestone Member' of Benson (1915). The Early Devonian coral fauna described from that limestone by Hill (1942) established the age of the Drik-Drik Formation. Now recognised as localised lenses within the Drik-Drik Formation (and therefore no longer accorded formal status as a stratigraphic member of that formation), the Nemingha limestone is massive-bedded and grey or pink in colour. This limestone is quite different in field appearance compared to the pale grey or light orange coloured clasts and blocks of limestone named the Trelawney Beds by Philip (1966) from which he extracted Late Ordovician conodonts. To explain the presence of this limestone in the area mapped as Devonian Drik-Drik Formation, Philip (1966) invoked an infaulted block hypothesis. Cawood (1976, 1983) further revised the stratigraphy by identifying Cambrian agnostoid trilobitomorphs and Middle Ordovician conodonts and gastropods in separate sedimentary units east of the Drik-Drik Formation. Cawood (1983) interpreted the Trelawney Beds of Philip (1966) to be allochthonous, and noted a previously unrecognised unconformity (representing a substantial stratigraphic gap) separating the Drik-Drik Formation from the underlying Haedon Formation. Conodonts from the latter indicate a Middle Ordovician (Darriwilian) age (Cawood, 1983; Furey-Greig, 2003; Percival et al., 2011) (Fig. 1c).

Furey-Greig (2000a) further constrained the age of the 'Trelawney Beds' by conodonts documented from equivalent limestone blocks along strike in the Woolomin area to the southeast (Fig. 1b), which are representative of the *Taoqupognathus tumidus-Protopanderodus insculptus* Biozone of middle Katian age (Ea3–4) (Zhen et al., 2015; Zhen and Percival, 2017).

It should be noted that both the names 'Trelawney Beds' and 'Uralba Beds' are obsolete terminology (Percival et al. 2011, p. 39) and neither are recognised as formal stratigraphic units in the Geoscience Australia Stratigraphic Names Database. Both names are used in this paper purely in their historical context and as an abbreviated way of referring to allochthonous limestone blocks of Late Ordovician age redeposited in the Drik-Drik Formation and Glen Bell Formation, respectively.

FAUNAL COMPOSITION AND BIOSTRATIGRAPHY

Hall (1975) described rugose corals from the 'Trelawney Beds' including *Palaeophyllum* sp. cf. *P. thomi* (Hall, 1857), *P. trelawneyense* Hall, 1975, *Cyathophylloides sinuata* Hall, 1975, *Cy. juncta* Hall, 1975, *Crenulites australis* Hall, 1975, and *Cr. australis minor* Hall, 1975. *Cyathophylloides sinuata* was later revised by Webby (1988) as *Favistina neminghensis* (Etheridge, 1918), a species documented much earlier from the same horizon (Etheridge, 1918; Hill, 1942). *Palaeophyllum* sp. cf. *P. thomi* and *P. trelawneyense* are synonymised herein with *P. bothroides* Hall, 1975, and *Crenulites australis minor* with *Cr. australis*. We also document a lambelasmatid Coelostylinae gen. et sp. nov., and a tryplasmatid *Bowanophyllum*? sp., the latter representing the earliest known record of this fossil group in eastern Australia.

The accompanying tabulate corals documented by Hall (1975) have now been revised to include *Paleofavosites magnus* Hall, 1975, *Hemiagetolites spinimarginatus* (Hall, 1975), *Navoites circumflexus* (Hall, 1975), *Mongoliolites contiguus* (Hall, 1975), *Plasmoporella inflata* Hill, 1957, and *Reuschia* sp. (Zhen et al., 2017; Wang et al., 2020; this paper). We have also identified the presence of *Paleofavosites rarispinulatus* Hall, 1975, *Navoites cargoensis* (Hill, 1957) and two indeterminate species of *Heliolites* and *Propora* from this stratigraphic level, and all but *N. circumflexus* (of which no further specimens were found to supplement the original description by Hall, 1975) are described herein.

The Trelawney fauna is remarkably similar to that described by Hall (1975) from the 'Uralba Beds' of the Manilla–Attunga area about 60 km to the north-northwest (Fig. 1b), with notable examples at species level including rugosans *Favistina neminghensis*, *Crenulites australis* and *Palaeophyllum bothroides*, and tabulates *Paleofavosites magnus*, *Pa. rarispinulatus*, *Navoites circumflexus,* and *Plasmoporella inflata* (Table 1). Based on criteria originally used by Webby (1972, p. 150) to characterise coral-stromatoporoid (C/S) Fauna IV as being "typified by abundant favositids, *Favistina*-like forms and the first appearance of *Catenipora*", Hall (1975, pp. 77, 78) assigned the Uralba fauna to Fauna IV and regarded the Trelawney assemblage which lacks halysitids as more closely comparable with the older C/S Fauna III. However, *Catenipora* was subsequently confirmed in C/S Fauna III (Webby, 1977) and the apparent absence from the 'Trelawney Beds', according to Hall (1975), of *Plasmoporella inflata* (a diagnostic element of C/S Fauna III as defined by Webby, 1969) has now been resolved by recognition (herein) of *P. bacilliformis* Hall, 1975, as a junior synonym of *P. inflata*. The reason for the complete absence of halysitids in the 'Trelawney Beds' compared with their abundance in the Uralba fauna remains unknown, but otherwise the composition of the two faunas is essentially the same. This is consistent with the fact that conodonts from the two units are indicative of the same biozone (Furey-Greig, 2000a, 2000b). The proximity of the Trelawney and Uralba faunas, their pronounced faunal affinities and their identical age implies that the limestones in which they occur were originally part of the same carbonate shelf or shelves flanking contemporaneous islands. As allochthonous blocks they now reside in stratigraphic units of differing ages due to the complexity of faulting along the Peel Fault Zone.

Late Ordovician coral biostratigraphy in eastern Australia has recently been discussed in detail by Zhen et al. (2017, pp. 146–148) (Table 1). These authors attributed the Trelawney and Uralba faunas from the New England Region to C/S Fauna IIIb (late Eastonian to possibly early Bolindian) characterised by the incoming of agetolitid corals, and the first appearance of the rugosans *Cyathophylloides* and *Crenulites* (Webby in Webby et al., 1981, p. 9; Zhen et al., 2017). Other coral faunas of Fauna IIIb age include those from the Cargo Creek and Canomodine limestones (Hill, 1957; Webby and Semeniuk, 1969; Webby, 1972, 1977, 1988; McLean and Webby, 1976) and allochthonous limestones of

Table 1. Lists of representative coral assemblages from Fauna IIIb and Fauna IV in eastern Australia.

Fauna IIIb	**'Trelawney Beds' (Ea3–4)**	
	Rugose corals: *Favistina neminghensis* (Etheridge, 1918); *Crenulites australis* Hall, 1975; *Cyathophylloides juncta* Hall, 1975; *Palaeophyllum bothroides* Hall, 1975; Coelostylinae gen. et sp. nov.; *Bowanophyllum* ? sp.	Tabulate corals: *Paleofavosites magnus* Hall, 1975; *P. rarispinulatus* Hall, 1975; *Hemiagetolites spinimarginatus* (Hall, 1975); *Heliolites* sp. indet.; *Navoites cargoensis* (Hill, 1957); *Navoites circumflexus* (Hall, 1975); *Mongoliolites contiguus* (Hall, 1975); *Plasmoporella inflata* Hill, 1957; *Propora* sp. indet.; *Reuschia* sp.
	'Uralba Beds' (Ea3–4)	
	Rugose corals: *Favistina neminghensis* (Etheridge, 1918); *Crenulites australis* Hall, 1975; *Palaeophyllum bothroides* Hall, 1975; indeterminate streptelasmatids	Tabulate corals: *Paleofavosites magnus* Hall, 1975; *P. rarispinulatus* Hall, 1975; *P.* sp.; *Hemiagetolites crassus* (Hall, 1975); *H. spinimarginatus* (Hall, 1975); *Catenipora spatiosa* Hall, 1975; *C. flexa* Hall, 1975; *Falsicatenipora stricta* Hall, 1975; *Halysites* sp.; *Quepora* sp.; *Navoites circumflexus* (Hall, 1975); *Plasmoporella inflata* Hill, 1957; *Cyrtophyllum* sp.; *Calapoecia* sp. cf. *C. canadensis* Billings
	Angullong Formation (Bo1–2?)	
	Rugose corals: not recorded	Tabulate corals: *Agetolites angullongensis* Wang in Zhen et al., 2017; *Heliolites orientalis* Yu, 1962; *Hemiagetolites breviseptatus* (Lin, 1960); *H*. sp. cf. *H*. *spinimarginatus* (Hall, 1975); *Navoites* sp. cf. *N. circumflexus* (Hall, 1975); *Plasmoporella bacilliforma* Hall, 1975; *P. marginata* Dixon in Dixon & Jell, 2012; *Quepora* sp. cf. *Q. calamus* Webby & Semeniuk, 1969; *Sarcinula* sp.
Fauna IV	**Malachis Hill Formation (Bo3)**	
	Rugosans: *Cyathophylloides semeniuki* Webby, 1988; *Palaeophyllum macrocaule* Webby, 1972; *Grewingkia* sp.; *Bowanophyllum pilatum* McLean & Webby, 1976; *B. ramosum* Wang et al., 2020; *B* . sp.	Tabulate corals: *Catenipora clausa* Webby, 1977; *Adaverina acritos* Webby, 1977; *Paleofavosites* sp.; *Hemiagetiolites spinimarginatus* (Hall, 1975); *H.* cf. *H. palaeofavositoides* (Lin & Chow, 1977); *H. longiseptatus* Wang et al., 2020; *H.* sp.; *Heliolites waicunensis* Lin & Chow, 1977; *Navoites cargoensis* (Hill, 1957); *Plasmoporella* sp.

the Angullong Formation (Webby, 1977; Zhen et al., 2017) all occurring in central NSW, and the Carriers Well Formation (now interpreted as allochthonous limestones within the Wairuna Formation, Zhen et al., 2015) of northern Queensland (Hill et al., 1969; Dixon and Jell, 2012).

SYSTEMATIC PALAEONTOLOGY

Morphological terminology used in this study largely follows that of Hill (1981), and biometric methods of Young and Elias (1995) are adopted. All figured specimens (including hand specimens

and associated thin sections) are deposited in the palaeontological collection of the Geological Survey of New South Wales, housed at the WB Clarke Geoscience Centre at Londonderry in outer western Sydney. The following abbreviations are used: TS=transverse section; LS=longitudinal section; CoD=corallite diameter; TaD=tabularium diameter; ACD (6+)=average diameter of corallites with 6 or more sides; WT=wall thickness; PoD=pore diameter (corner pores only); Ta5=number of tabulae per 5 mm.

Class ANTHOZOA Ehrenberg, 1834
Subclass RUGOSA Milne-Edwards and Haime, 1850
Order STAURIIDA Verrill, 1865
Family STAURIIDAE Milne-Edwards and Haime, 1850

Genus FAVISTINA Flower, 1961

Type species

Favistella undulata Bassler, 1950, from the Upper Ordovician ("Blackriveran") of Wisconsin, USA.

Favistina neminghensis (Etheridge, 1918)
Fig. 2a–c

Synonymy

1918 *Columnaria neminghensis* Etheridge, pp. 50, 51, pls 8, 9.
1942 *Favistina neminghensis* (Etheridge); Hill, p. 158, pl. 2, fig. 4a, b.
1975 *Cyathophylloides sinuata* Hall, pp. 81, 82, pl. 2, figs a, b.
1988 *Favistina neminghensis* (Etheridge, 1918); Webby, pp. 146, 149, figs 8.1–8.5.

Material

Two sectioned specimens, MMF47401 and MMF47402, with the latter only represented by a LS.

Description

See Webby (1988, p. 146).

Discussion

The present material completely conforms to the concept of *Favistina neminghensis* (Etheridge, 1918) provided by Webby (1988). Here, we amplify Webby's documentation by illustrating a well-

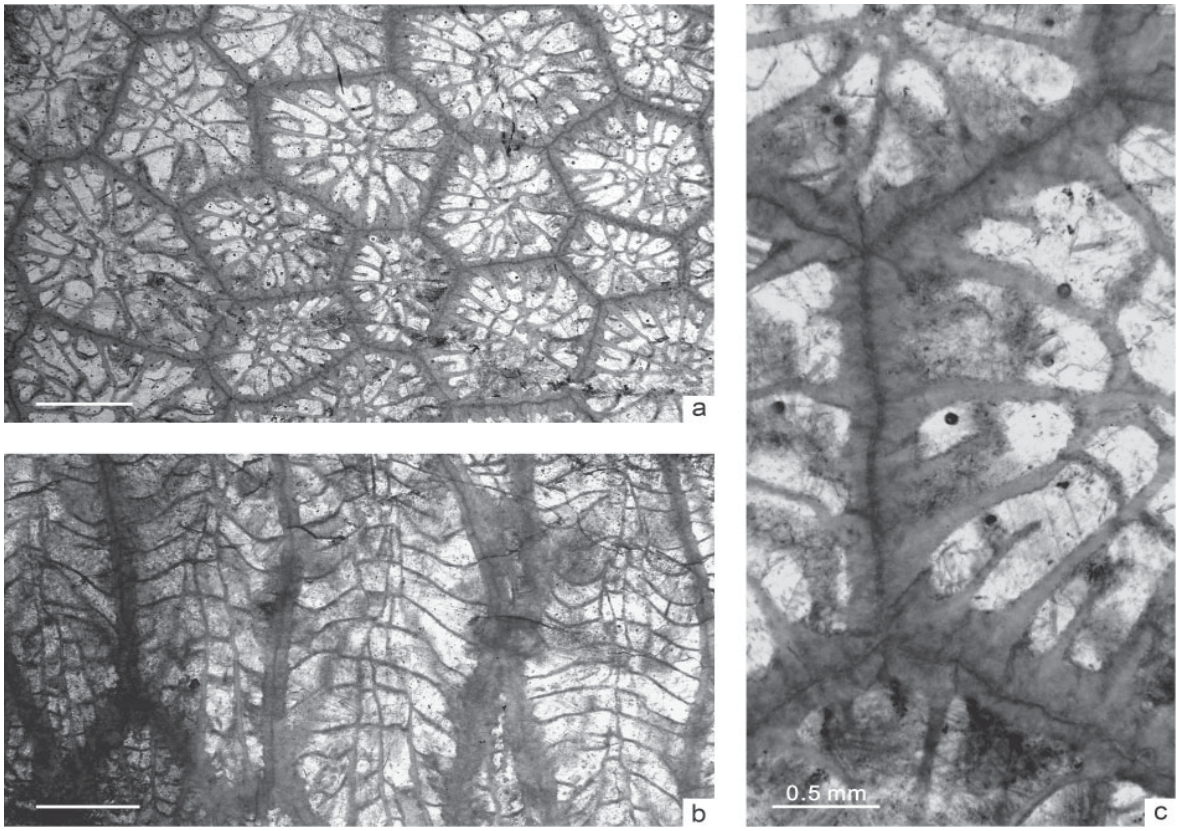

Figure 2. ***Favistina neminghensis*** **(Etheridge, 1918), topotype, MMF47401. a, c, TSs; b, LS. Scale bars=2 mm unless otherwise indicated.**

preserved specimen (MMF47401) to show more details of its morphological features, particularly the microstructure of corallite walls and septa which has not hitherto been figured. As shown in Fig. 2c, corallite walls of this specimen are separated by thin dark lines, with each consisting of thickened peripheral ends of major and minor septa.

Genus CRENULITES Flower, 1961

Type species

Crenulites duncanae Flower, 1961, from the lower Cincinnatian (middle Katian) of Texas, USA.

Crenulites australis Hall, 1975
Figs 3a–f, 4a–h

Synonymy

1975 *Crenulites australis* Hall, pp. 82, 83, pl. 2, figs e, f.
1975 *Crenulites australis minor* Hall, p. 83, pl. 2, figs g, h.
?1976 *Crenulites discreta* Bolton, in Workum et al., p. 168, pl. 1, figs 9, 10.
1979 *Favistina rozmanae* Sytova, pp. 172, 173, pl. 36, fig. 3a, b.

Material

Ten sectioned specimens, MMF46757, MMF46759, MMF46761, MMF46762, MMF46765, MMF46767, MMF47095, MMF47097, MMF47100 and MMF47403.

Description

Four complete (or almost complete) coralla (MMF46757, MMF46759, MMF46765 and MMF46767) were measured. One (MMF46765) is of tabular form, 157 mm wide and 46 mm high; the other three are of high domical to columnar form, with the smallest one (MMF46759) 73 mm wide and 79 mm high, and the largest (MMF46757) 191 mm wide and 166 mm high. Corallites polygonal, ACDs (6+) ranging from 1.26 to 3.12 mm (av. 2.00 mm). Corallite walls straight, or slightly wavy, separated by thin dark lines (Fig. 3b, 3e). WT moderately thick, varying from 0.05 to 0.14 mm (av. 0.08 mm). Major septa amplexoid, typically numbering 8–12 in mature corallites, long, extending almost to the axis. Minor septa consistently short, generally less than 25% of the corallite radius. Tabulae complete; flat to slightly arched, commonly with downturned edges; generally widely spaced, Ta5 3–9, rarely 10–12 (Table 2).

Discussion

Our redescription of *Crenulites australis* is based on 10 topotype specimens, extending the range of morphological variations. Given that this species was originally illustrated only by a transverse and longitudinal section of the holotype in poor quality (Hall, 1975), some well-preserved topotypes are figured herein.

Crenulites australis is distinguished from most other species of the genus by a combination of small-sized corallites and thick corallite walls. The subspecies *C. australis minor* Hall, 1975, from the same level, differs only in having a slightly smaller corallite diameter (1.0–1.5mm), and is best regarded as synonymous with *C. australis*. *Crenulites discreta* Bolton in Workum et al., 1976 recorded from the Upper Ordovician of Akpatok Island, Canada, represents the only form outside Australia showing comparable corallite size (1.5–2.3 mm in diameter) to *C. australis*. The main differences are the slightly thinner corallite walls and more strongly arched tabulae of the Canadian species, which is very likely conspecific with *C. australis*.

Sytova (1979) introduced *Favistina rozmanae* based on material from the Dolbor Formation (middle Katian) of the Tungus Basin, Siberia. This species has amplexoid major septa and is clearly attributable to *Crenulites*. It is regarded herein as a synonym of *C. australis* notably because of similar small-sized corallites (less than 3–3.5 mm in diameter) and septa extending almost to the corallite axis.

Genus CYATHOPHYLLOIDES Dybowski, 1873

Type species

Cyathophylloides kassariensis Dybowski, 1873, from the Llandovery (lower Silurian) of Estonia.

Cyathophylloides juncta Hall, 1975
Fig. 5a–g

Synonymy

Cyathophylloides juncta Hall, 1975, p. 82, text-fig. 6; pl. 2, figs c, d.

Material

Three sectioned specimens, MMF46766, MMF46769 and MMF47404.

Description

Two complete coralla measured, both of low domical form, one (MMF46766) is 116 mm wide and

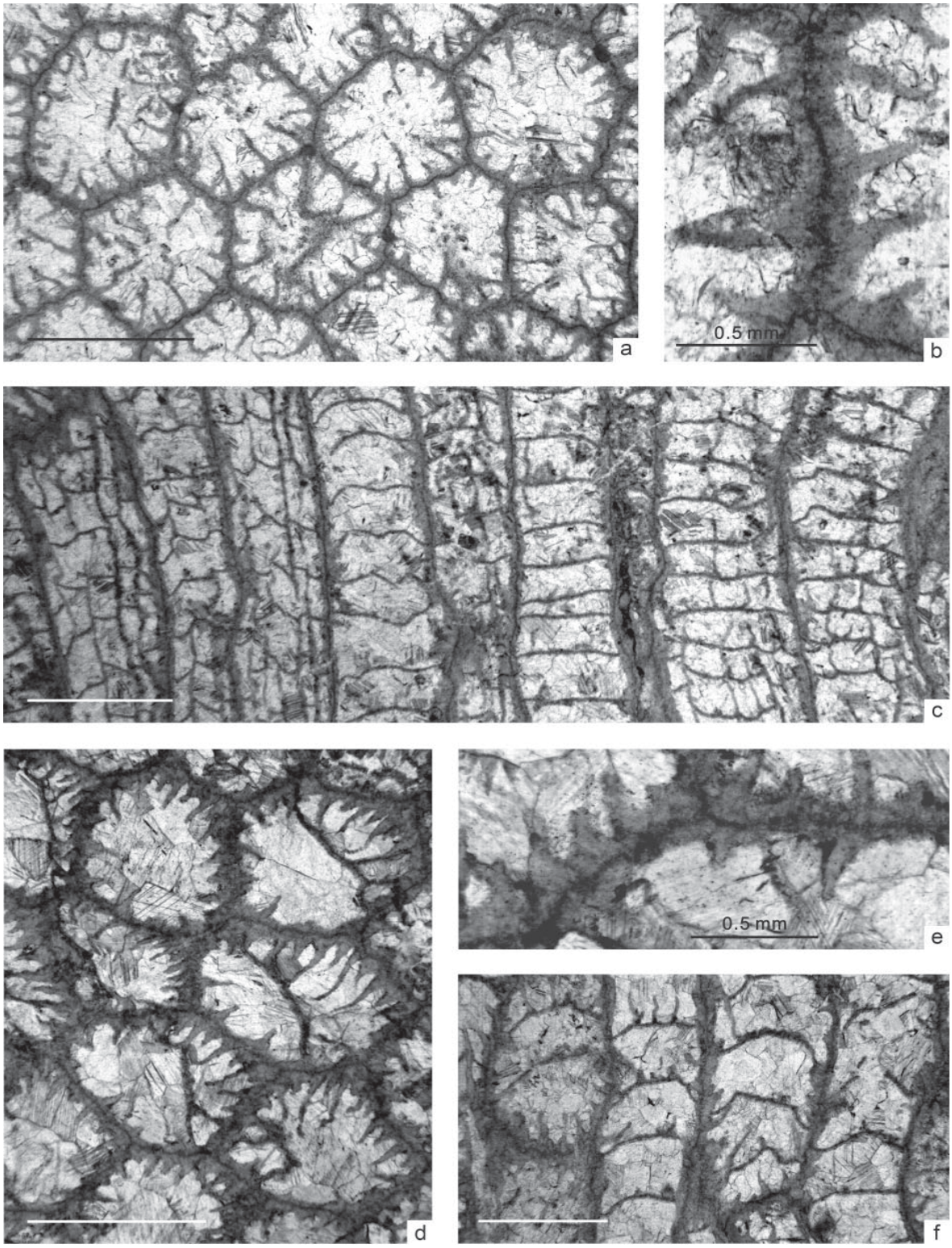

Figure 3. ***Crenulites australis*** **Hall, 1975. a–c, topotype, MMF46765; a, b, TSs; c, LS. d–f, topotype, MMF46762; d, e, TSs; f, LS. Scale bars=2 mm unless otherwise indicated.**

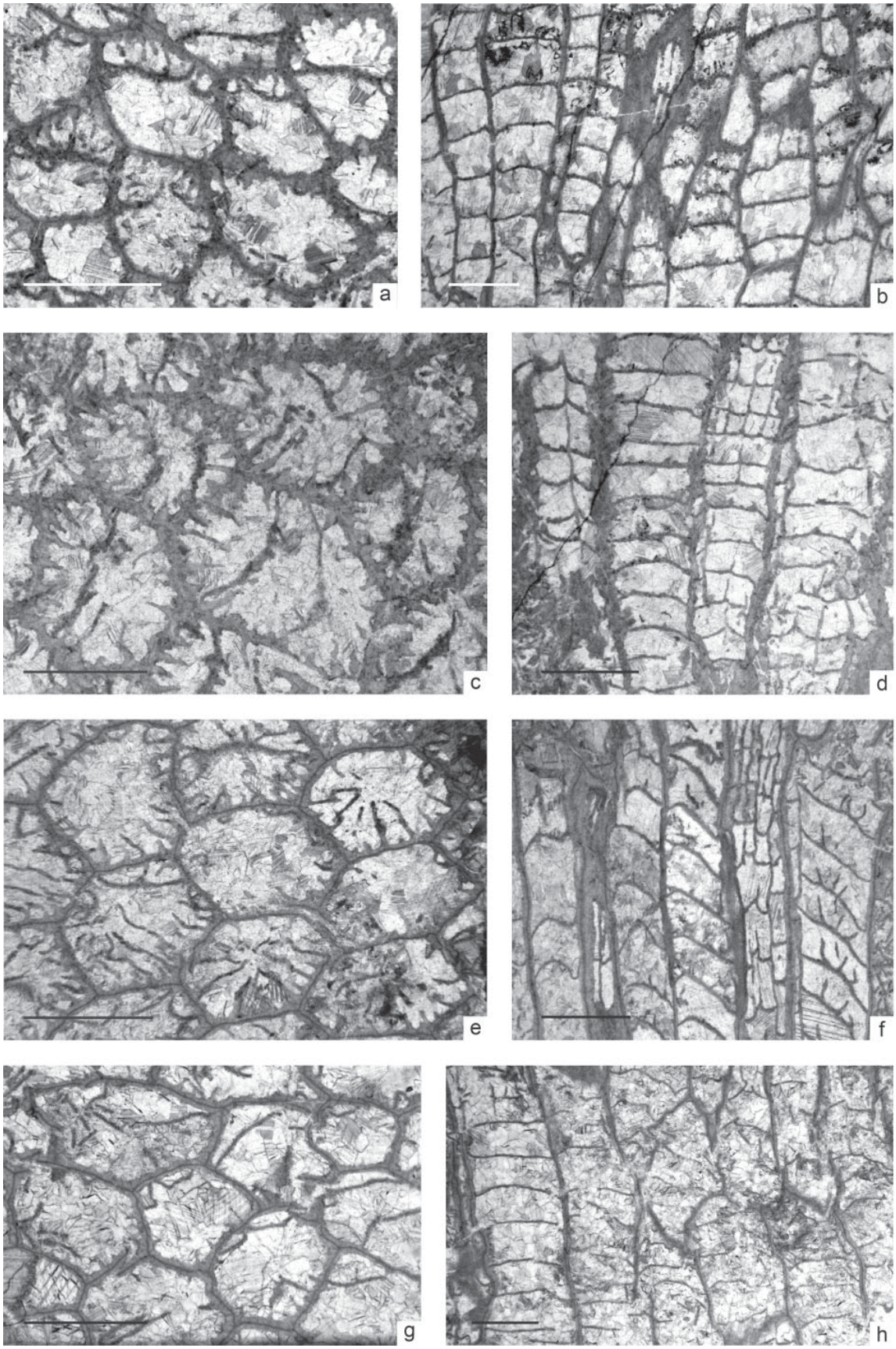

Figure 4. ***Crenulites australis*** **Hall, 1975. a, b, topotype, MMF46757; a, TS; b, LS. c, d, topotype, MMF46761; c, TS; d, LS. e, f, topotype, MMF46767; e, TS; f, LS. g, h, topotype, MMF47100; g, TS; h, LS. Scale bars=2 mm.**

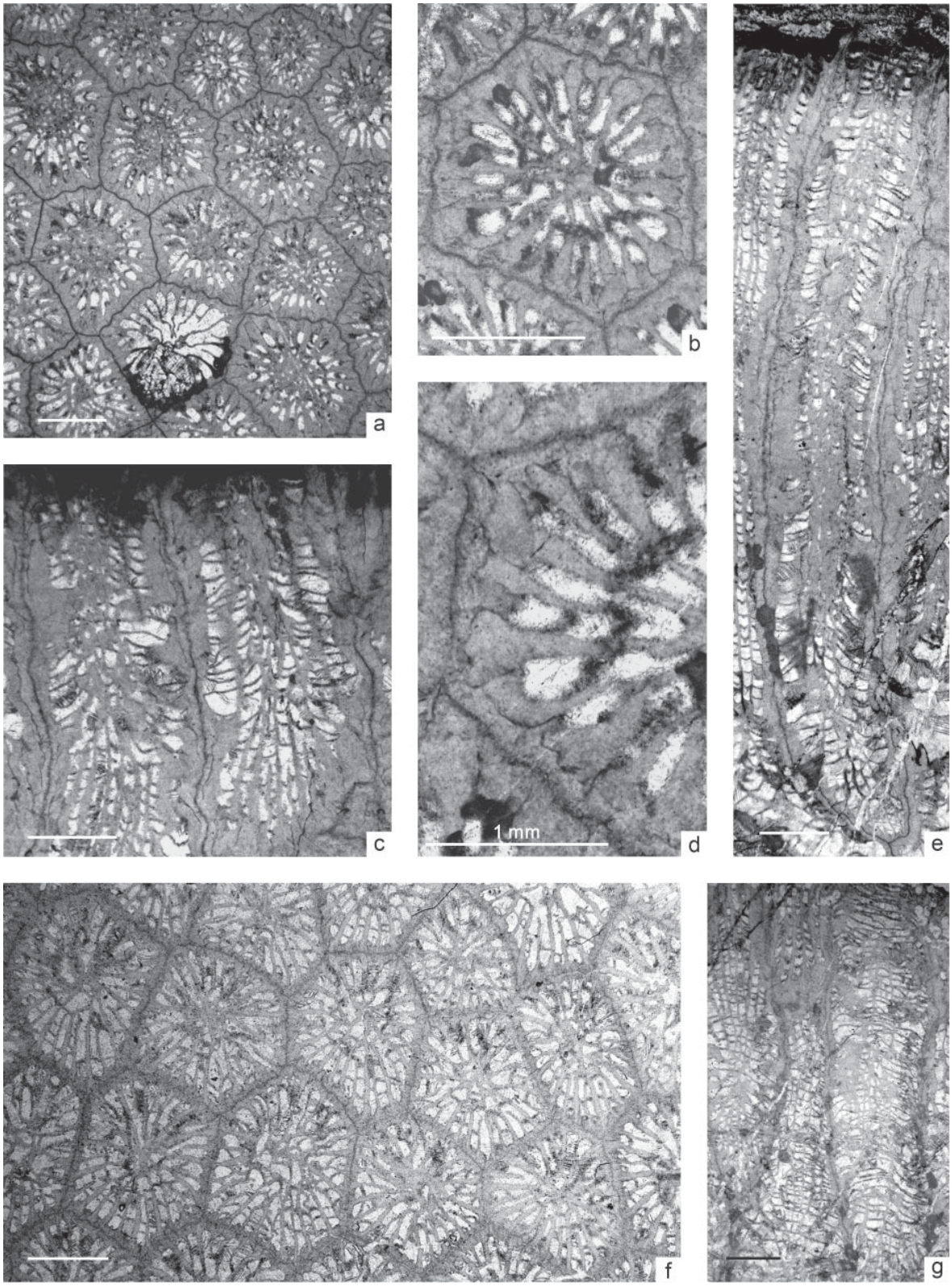

Figure 5. ***Cyathophylloides juncta*** **Hall, 1975. a–e, topotype, MMF46766; a, b, d, TSs; c, e, LSs. f, g, topotype, MMF46769; f, TS; g, LS. Scale bars=2 mm unless otherwise indicated.**

Table 2. Biometric data on cerioid stauriids described in this paper.

	ACD (6+)	WT	Ta5
Favistina neminghensis **(Etheridge, 1918)**			
Minimum	2.69	0.13	7
Maximum	4.49	0.24	9
Mean	3.63	0.16	8
Measurements	18	21	4
No. of specimens studied	1	1	1
Crenulites australis **Hall, 1975**			
Minimum	1.26	0.05	3
Maximum	3.12	0.14	12
Range of colony means	1.77–2.55	0.07–0.10	3.75–8.95
Mean	2.00	0.08	6.33
Measurements	128	138	101
No. of specimens studied	10	10	10
Cyathophylloides juncta **Hall, 1975**			
Minimum	2.30	0.16	13
Maximum	4.17	0.40	21
Range of colony means	2.89–3.68	0.20–0.25	15–16.4
Mean	3.29	0.22	15.7
Measurements	45	40	12
No. of specimens studied	2	2	2

39 mm high, the other (MMF46769) 89 mm wide and 37 mm high. Corallites polygonal, ACDs (6+) ranging from 2.30 to 4.14 mm (av. 3.29 mm). Corallite walls slightly wavy, separated by thin dark lines (Fig. 5b, d). Corallite wall thick, WT varying from 0.16 to 0.40 mm (av. 0.22 mm). Major septa generally numbering 11–13 in mature corallites, strongly to moderately dilated, long, usually extending to the axis where their inner ends are twisted and fused to form an aggregated axial structure (Fig. 5a, b, e, f). Minor septa moderately dilated; typically extending to 50% the length of the majors. Tabulae complete, slightly to moderately arched, closely spaced, Ta5=13–21 (av. 15.7) (Fig. 5c, e, g) (Table 2).

Discussion

Our specimens are almost identical to the holotype of *Cyathophylloides juncta* Hall, 1975 from the same stratigraphic level, differing only in having a slightly wider range of corallite sizes and stronger septa.

Cyathophylloides juncta is distinguished from the only other Australian species, *C. semeniuki* Webby, 1988, from the top of the Malachis Hill Formation of central NSW, by having less consistently developed minor septa and much more closely spaced tabulae, as noted by Webby (1988, p. 151). It further differs from *C. semeniuki* in developing much thicker septa.

Genus PALAEOPHYLLUM Billings, 1858

Type species

Palaeophyllum rugosum Billings, 1858, from the middle Katian (Edenian) of Quebec, Canada.

Palaeophyllum bothroides Hall, 1975
Figs 6a–g, 7a–j, 8a–e

Synonymy

1975 *Palaeophyllum bothroides* Hall, p. 79, pl. 1, figs f–j.
1975 *Palaeophyllum* sp. cf. *P. rugosum* Billings; Hall, pp. 78, 79, pl. 1, figs a–e.
1975 *Palaeophyllum* sp. cf. *P. thomi* (Hall, 1857); Hall, p. 80, pl. 1, figs k–n.
1975 *Palaeophyllum trelawneyense* Hall, pp. 80, 81, pl. 1, figs o–q.
?1976 *Palaeophyllum arrectum* McLean and Webby, p. 237, pl. 27, figs 8, 9, pl. 28, figs. 1, 2, text-fig. 3C.

Material

Nine sectioned specimens, MMF46774, MMF46778, MMF46780A-1, MMF47099, MMF47102, MMF47107, MMF47108, MMF47109, and MMF47412.

Description

Coralla fasciculate, with lateral increase mode (Figs 6a, b; 7j). Their original growth form and size are unknown due to the fragmentary nature of available topotypic material. Corallites cylindrical to subcylindrical, with adult diameters of 3.48–6.56 mm (av. 5.31 mm). Marginarium a distinct peripheral stereozone, composed of peripheral septal ends and thick lamellar sclerenchyme; commonly thick, with a maximum thickness up to 34% of corallite radius. Septa slightly to moderately dilated, and tapering axially. Major septa 14–22 in number, long, extending nearly to the axis, without forming an axial structure. Minor septa absent, or rarely developed; when present, probably acanthine (Fig. 8c–e), with spines completely confined within the peripheral

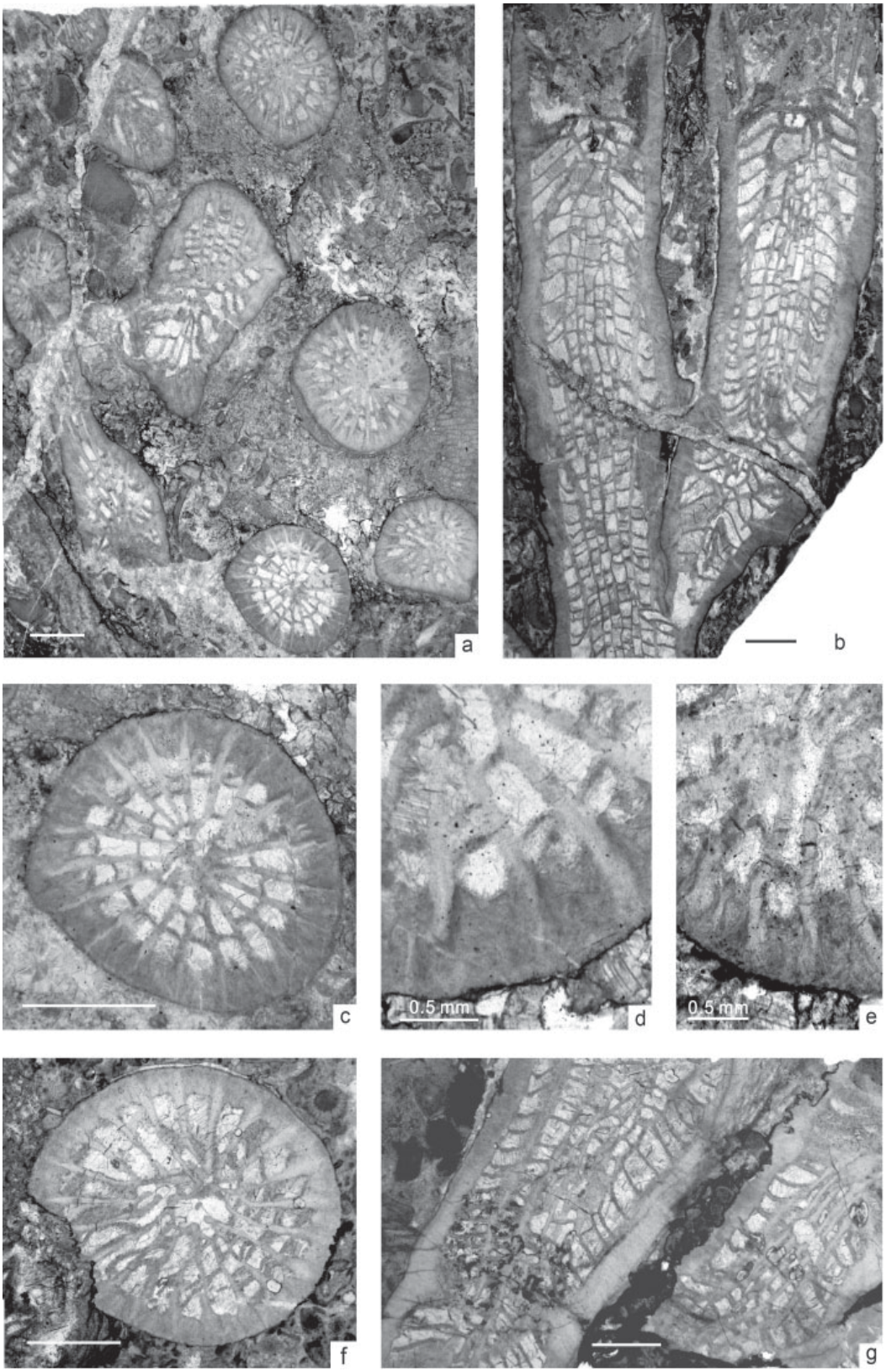

Figure 6. ***Palaeophyllum bothroides*** **Hall, 1975. a–e, topotype, MMF47099. a, c–e, TSs; b, LS. f, g, topotype, MMF47412. f, TS; g, LS. Scale bars=2 mm unless otherwise indicated.**

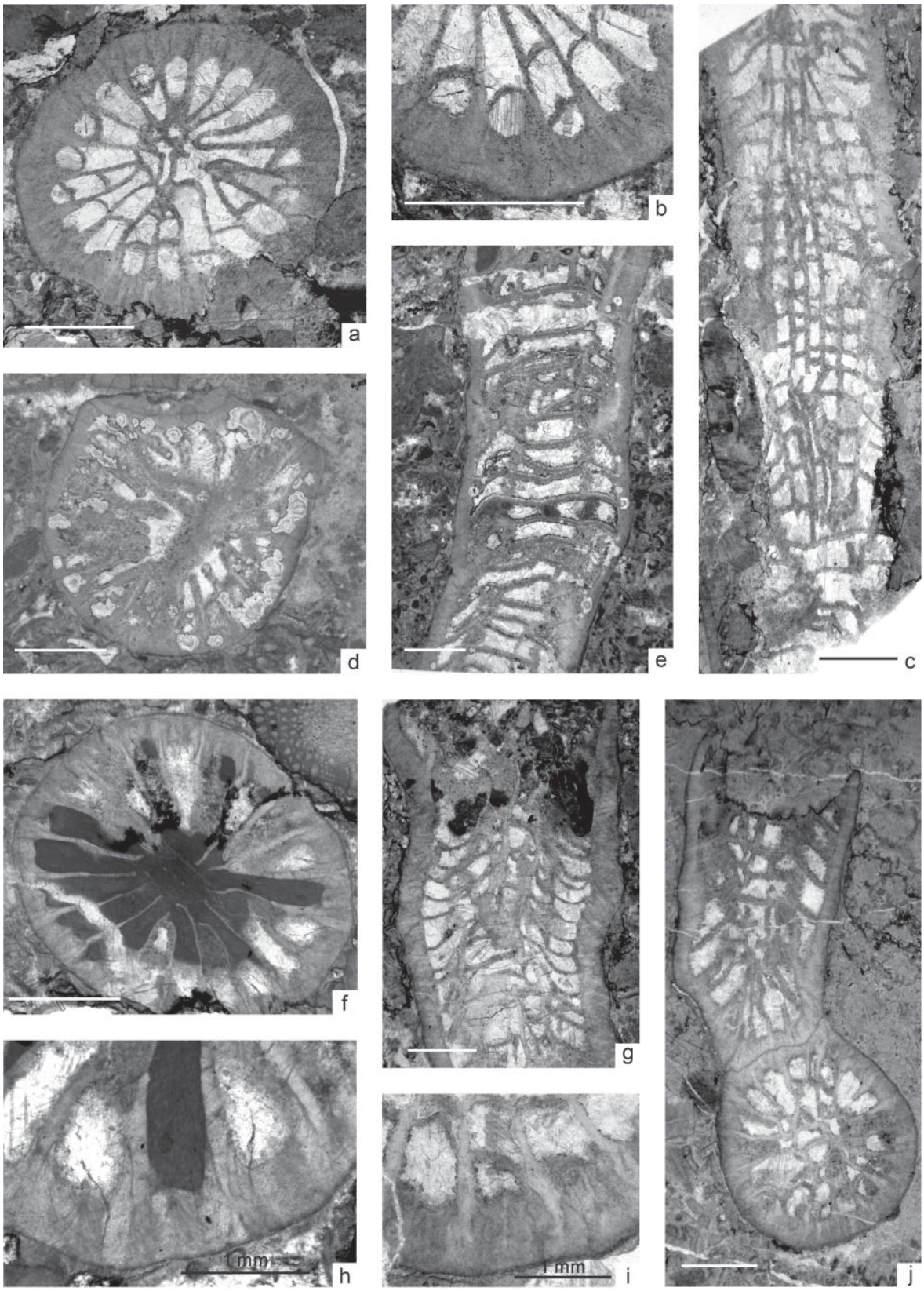

Figure 7. ***Palaeophyllum bothroides*** **Hall, 1975. a–c, topotype, MMF47107. a, b, TSs; c, LS. d, e, topotype, MMF47108. d, TS; e, LS. f–h, topotype, MMF47102. f, h, TSs; g, LS. i, j, topotype, MMF46774. i, TS; j, LS and TS. Scale bars=2 mm unless otherwise indicated.**

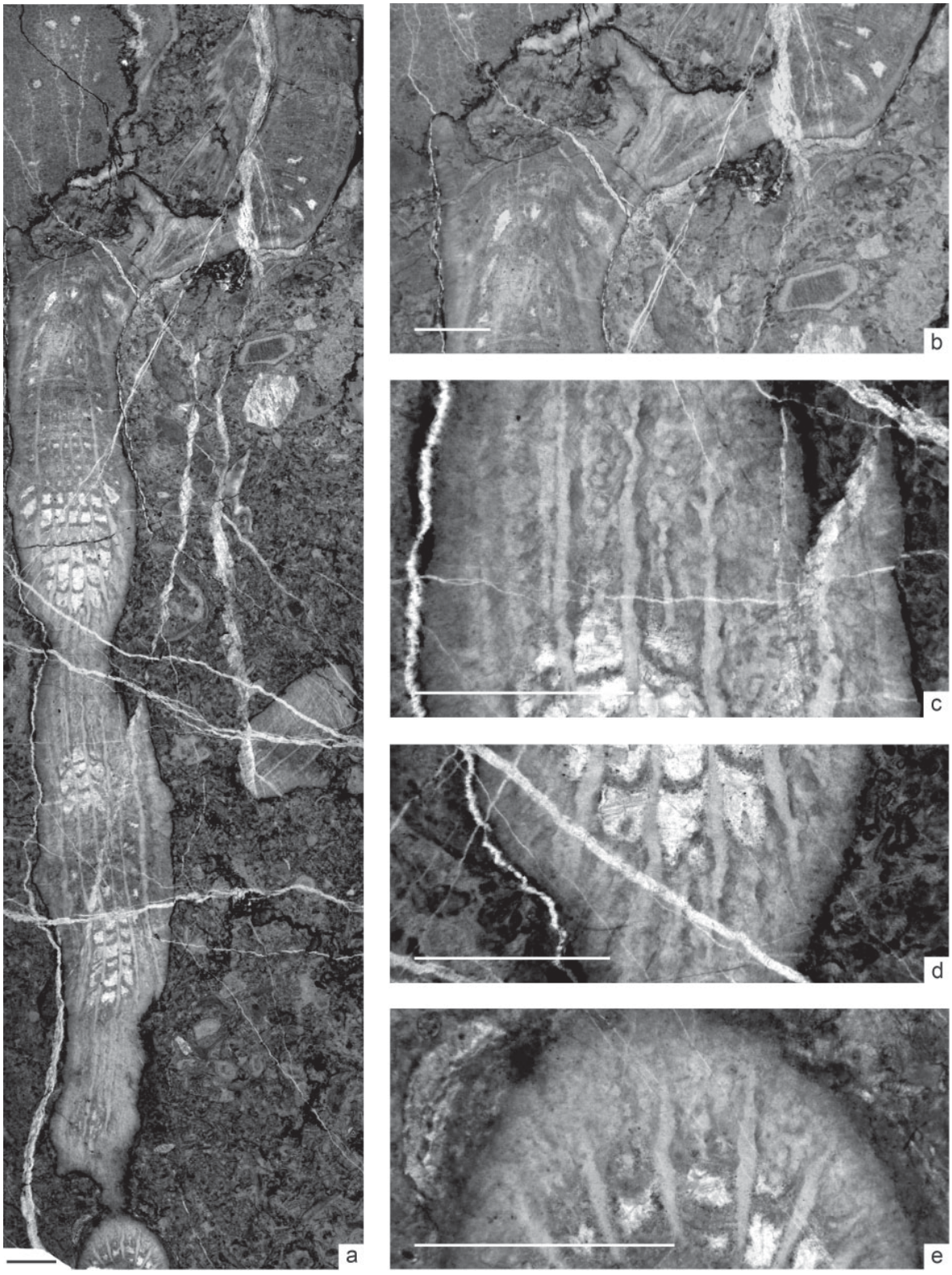

Figure 8. ***Palaeophyllum bothroides*** **Hall, 1975, topotype, MMF47780A-1. a, TS (left bottom) and LS; b–d, enlargements of LS in a; e, an enlargement of the TS in a. Scale bars=2 mm.**

stereozone (Figs 6d, e; 7b, h, i; 8c–e). Septa radially arranged, lacking a recognisable cardinal septum. Septal microstructure apparently fibrous (Figs 6d, e; 7b, i). Tabulae complete, slightly to moderately arched, with broad, subhorizontal central platform or shallow depression, and downturned margins; moderately spaced, Ta5 commonly 6–8, rarely 9–11.

Discussion

Hall (1975) described four *Palaeophyllum* species from the middle Katian of the New England Orogen in northeastern NSW, namely *P.* sp. cf. *P. rugosum* Billings, *P. bothroides*, *P.* sp. cf. *P. thomi* (Hall), and *P. trelawneyense*, the first three occurring in the 'Uralba Beds' southeast of Manilla, and the latter two restricted to the 'Trelawney Beds' of southeast of Tamworth. All these forms are characterised by a wide peripheral stereozone and rarely developed minor septa, and are clearly conspecific with our material. Hall's species are said to differ chiefly in corallite size, septal number and tabular spacing, all, however, being better regarded as intraspecific variation, as demonstrated in the topotypes described herein. Thus all four species are attributable to *P. bothroides*, which has page priority.

Palaeophyllum rugosum, the type species of the genus, and *P. thomi* are regarded by Hall (1975) as comparable with *P. bothroides.* Both show well-developed minor septa (Hill, 1959, 1961), and are therefore clearly separable from the latter. Further*, P. rugosum* is distinguished by having a partly cerioid corallum and a narrower peripheral stereozone, and *P. thomi* by the better development of incomplete tabulae.

Among *Palaeophyllum* species documented from elsewhere in eastern Australia, *P. arrectum* McLean and Webby, 1976, from the upper part of the Canomodine Limestone (middle Katian) of Canomodine, central NSW, is the only other form with poorly developed minor septa as in *P. bothroides*. As the former differs only in having a consistently narrower peripheral stereozone, the two species are probably synonymous.

Congeneric forms with similar minor septal development are also known from North America and North China, including *P. guyuanense* Lin in Cao and Lin, 1982 from the Beiguoshan Formation (middle Katian) of Guyuan, Ningxia, *P. gracile* Flower, 1961 from the Second Value Formation (middle Katian) of Texas*,* and specimens identified as *P. thomi* by Flower (1961) from the Aleman Formation (upper Katian) of Texas*. P. guyuanense* has much shorter major septa (normally less than 60% of corallite radius), and more flattened tabulae. *P. gracile* is distinguished by having a consistently narrower peripheral stereozone and much smaller corallite size (mostly 3.0, rarely 3.5 mm in diameter).

The specimens described by Flower (1961) as *P. thomi* have poorly developed minor septa, and probably represent a distinct species, since the holotype of *P. thomi,* according to Hill's (1959) restudy, evidently shows well-developed minor septa. Compared with *P. bothroides*, Flower's form has comparable corallite size (diameter 4–5, rarely 6, mm), but can be distinguished by having a consistently narrower peripheral stereozone and better developed incomplete tabulae.

Suborder MONACANTHINA Neuman, 1984
Family LAMBELASMATIDAE Weyer, 1973
Subfamily COELOSTYLINAE Weyer, 1973

Coelostylinae gen. et sp. nov.
Figs 9a–f, 10a–h, 11a–e

Material

Six sectioned specimens, consisting of two morphological groups: Group 1, MMF47105B (LS only) and MMF47110 (A and B-2, two TSs); Group 2, MMF46755 (TS only), MMF47096 (two TSs), MMF47105A (LS only) and MMF47110B-3 (LS only). Another specimen, MMF47110B-1 (TS only; Fig. 12a–d), is tentatively assigned to Group 2.

Description

Group 1. Original external form and size unknown, largely inferred from thin sections. Coralla solitary, trochoid, with an observed maximum diameter and height of 23.44 and 16.08 mm, respectively. Calicular boss present, moderately arched (Fig. 9a, d). Marginarium a distinct peripheral stereozone, consisting of laterally contiguous, strongly dilated major and minor septa, with width 25–38% of corallum radius (Fig. 9a, b). Septa wedge-shaped, with carinae developed on each side probably due to lateral expansions of trabeculae (Fig. 9c). Major septa numbering 35 at 17.97 mm corallum diameter in specimen MMF47110A and B-2, extending to the corallum centre, forming an axial region with many septal lobes and lamellae (Fig. 9a). Minor septa generally projecting slightly beyond the peripheral stereozone. Septa probably of monacanthine type, upwardly directed longitudinally (Fig. 9c, e, f). Tabulae thin, strongly arched, closely spaced, with intervals ranging from 0.52 to 0.78 mm (Fig. 9d).

Group 2. External form and size again largely based on thin sections. Coralla solitary, trochoid, with an observed maximum diameter and height of

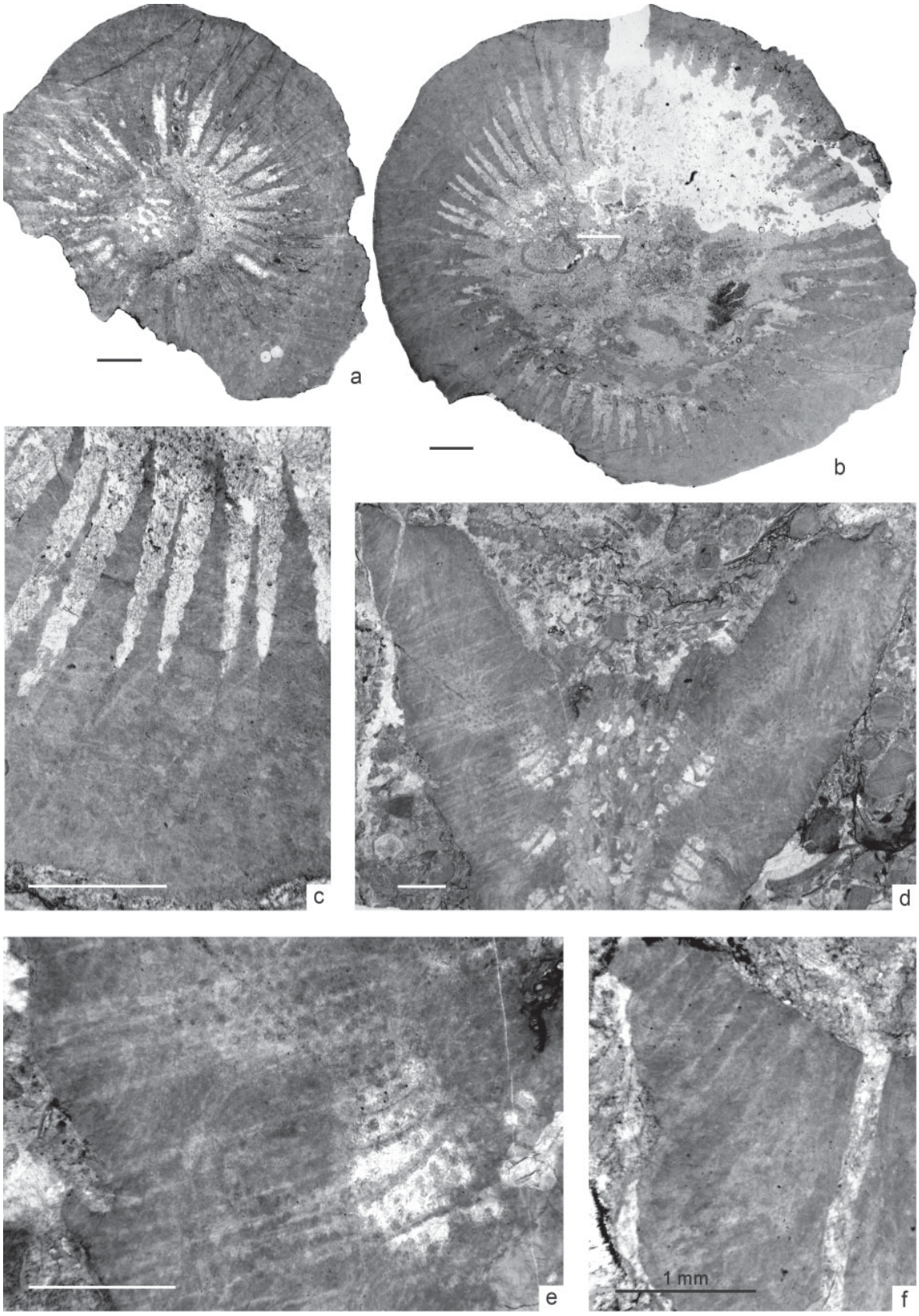

Figure 9. Coelostylinae gen. et sp. nov. (Group 1). a–c, MMF47110 (A and B-2), two TSs and an enlarged portion. d–f, MMF47105B, LS and two enlarged portions. Scale bars = 2 mm except for f.

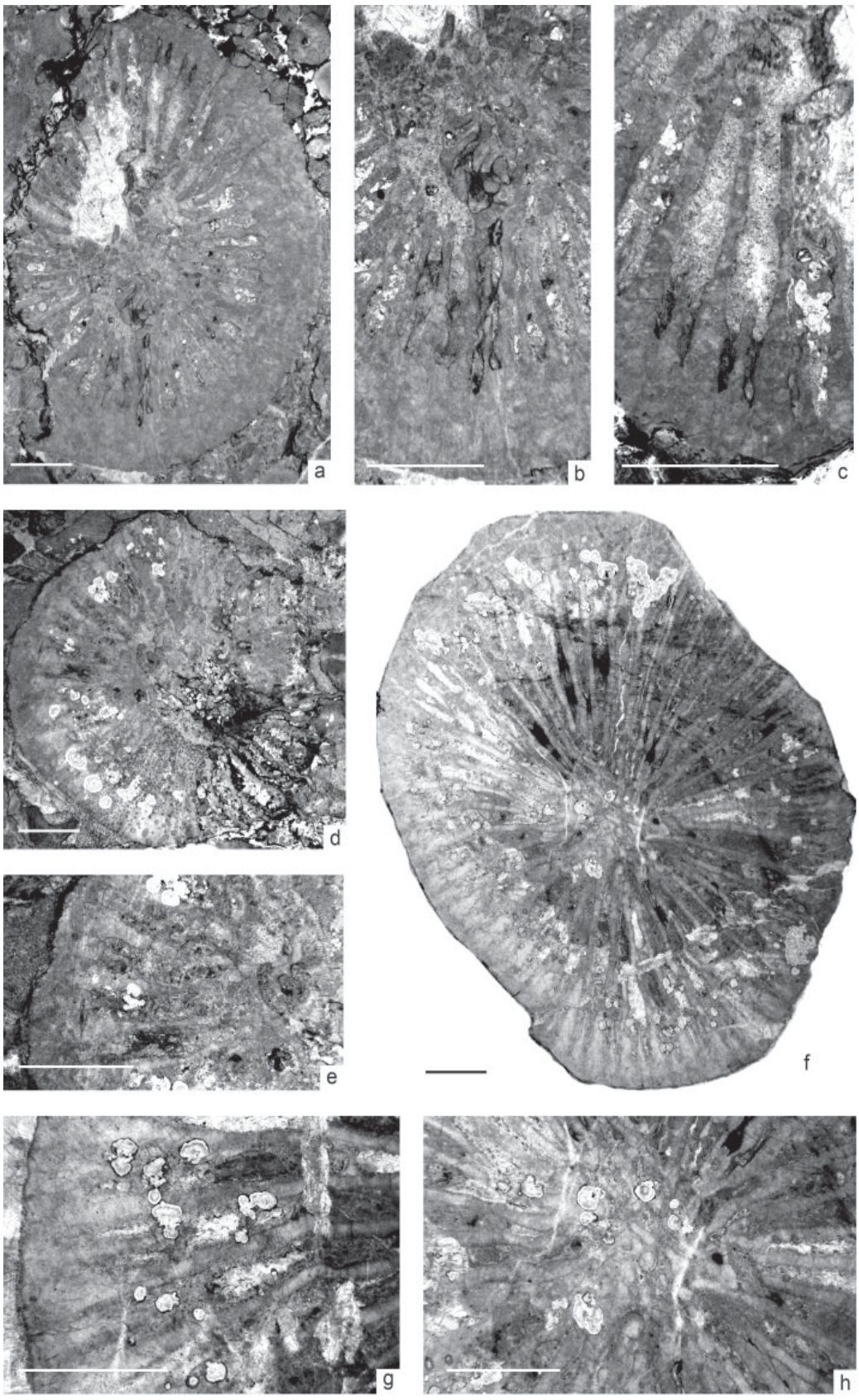

Figure 10. Coelostylinae gen. et sp. nov. (Group 2). a–c, MMF46755, TS and two enlargements. d–f, MMF47096, TS d and enlargement e, and TS f with enlargements g and h. Scale bars=2 mm.

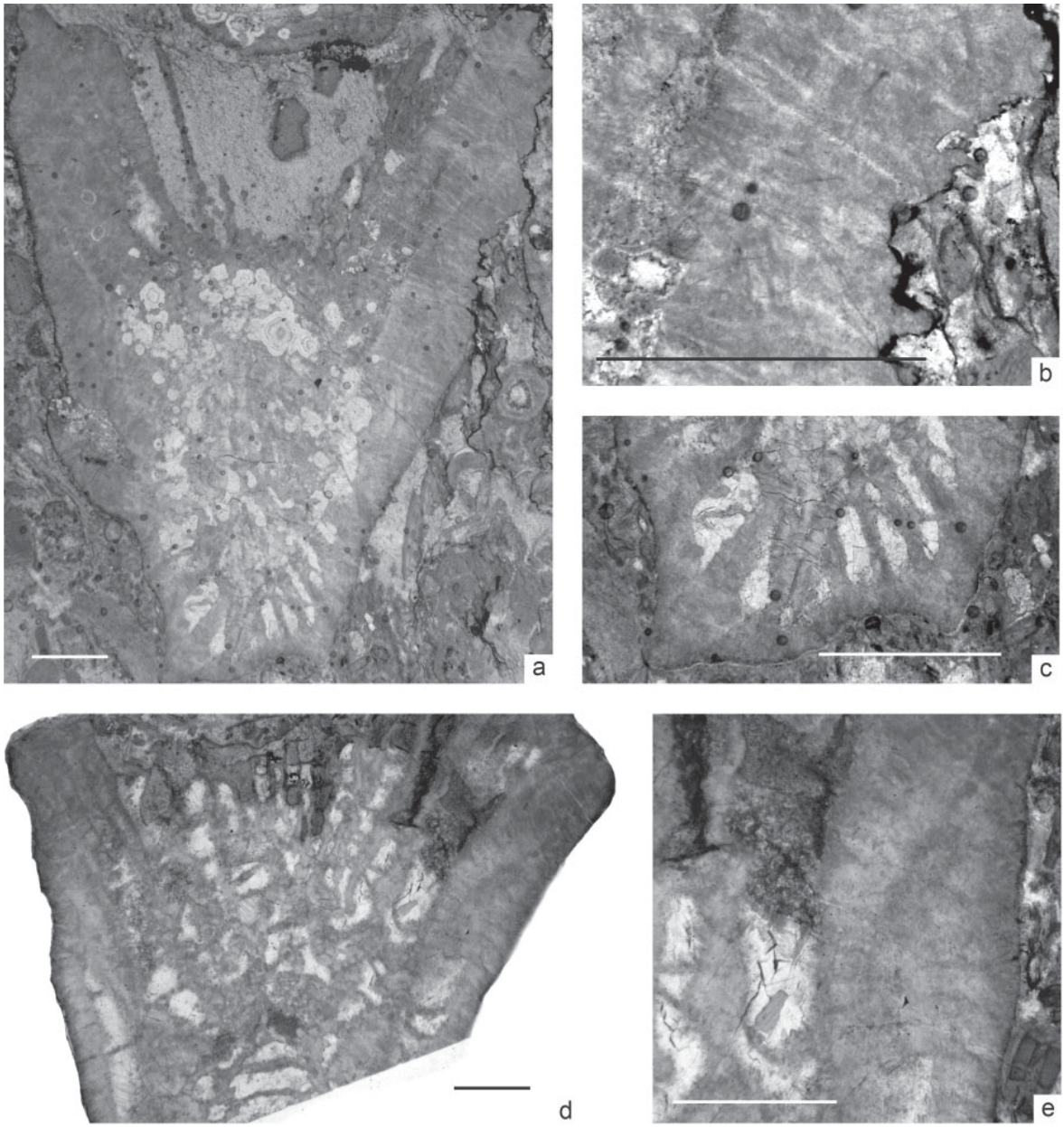

Figure 11. Coelostylinae gen. et sp. nov. (Group 2). a–c, MMF47110B-3, LS and two enlarged portions. d, e, MMF47105A, LS and an enlarged portion. Scale bars=2 mm.

14.34 and 17.27 mm in the specimen MMF47110B-3. Calicular boss not observed (Fig. 10a, f, 11a, d). Marginarium a distinct peripheral stereozone, consisting of laterally contiguous, moderately dilated major and minor septa, with width 9–31% of corallum radius (Fig. 10a, d, f). Septa tapering, with carinae developed on each side probably due to lateral expansions of trabeculae (Fig. 10b, c, e, g). Major septa numbering 39 at 13.64 mm corallum diameter, and 39 at 17.59 mm, in specimens MMF46755 (TS only) and MMF47096, respectively; long, with inner ends extending to the corallum centre, and forming an axial region with septal lobes and lamellae (Fig. 10a, b, d, f, h). Minor septa generally projecting well beyond the peripheral stereozone, with maximum length 30% of corallum radius (Fig. 10f). Septa probably of monacanthine type, upwardly directed longitudinally (Figs 10c, e, g, 11b, c, e). Tabulae thin, slightly arched in early stages, and moderately arched in late stages, closely spaced, at intervals averaging 0.83 mm (Fig. 11a, d).

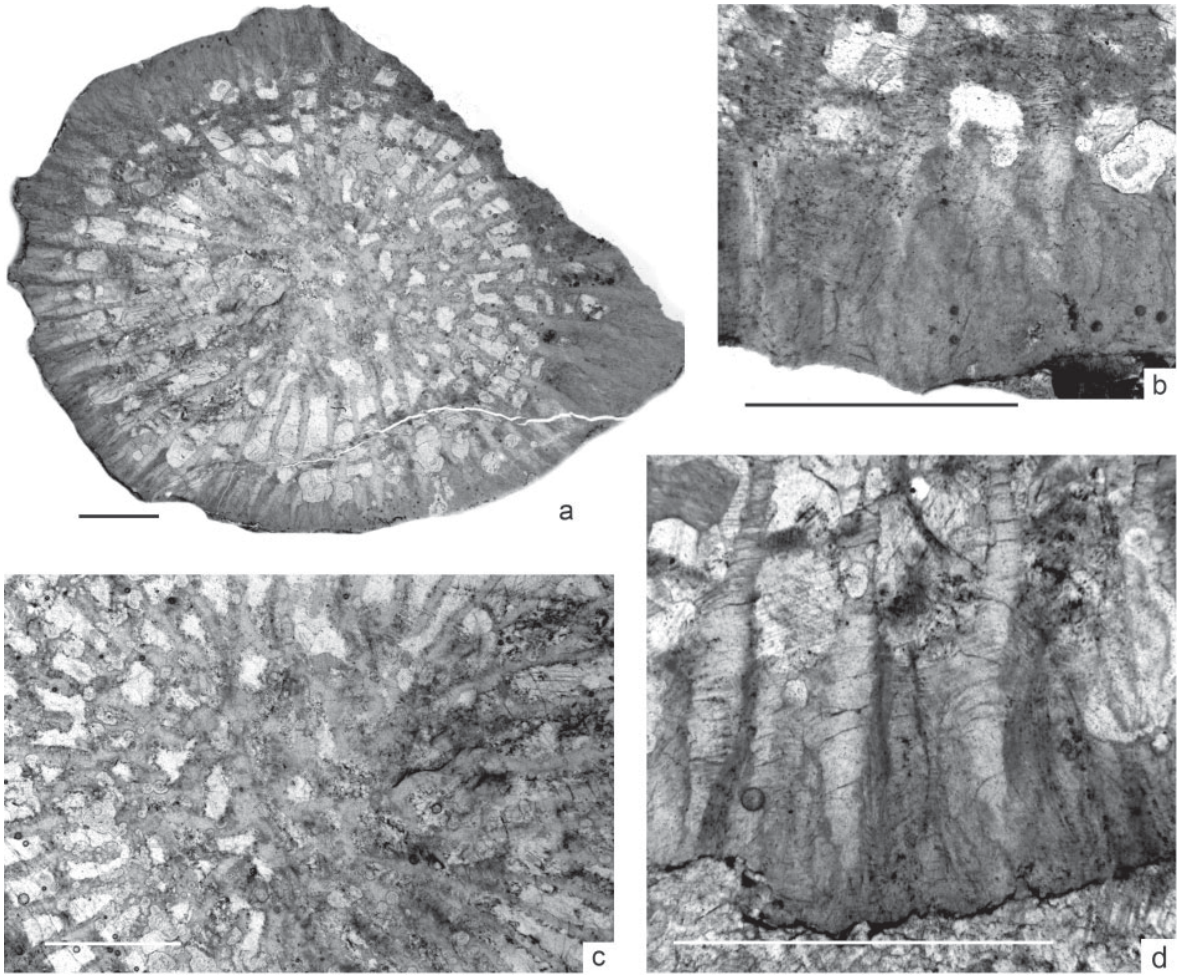

Figure 12. Coelostylinae gen. et sp. nov. (Group 2?). a–d, MMF47110B-1, TS and three enlarged portions. Scale bars=2 mm.

Discussion

Both morphological groups show radially arranged septa of monacanthine type, justifying their placement within the Coelostylinae, but they are clearly separable from other members of that subfamily by the development of numerous, moderately to strongly arched tabulae. They can be further distinguished from *Estonielasma* Weyer, 1973 by the absence of amplexoid septa, and from *Hillophyllum* Webby, 1971 by commonly larger coralla and much longer septa with inner ends forming an axial structure of lobes and lamellae. These specimens probably represent a new genus, but the available material is too poorly preserved to properly erect one.

Group 1 chiefly differs from Group 2 in having more dilated septa and a normally wider septothecal marginarium, as well as more strongly arched tabulae. The two may therefore be reasonably regarded as separate species, but we cannot preclude the possibility that they are synonymous.

A further specimen (MMF47110B-1 with a TS; Fig. 12a–d) is similar to other specimens of Group 2, but is only tentatively assigned there as its septal microstructure is uncertain due to recrystallisation.

Order CYSTIPHYLLIDA Nicholson in Nicholson and Lydekker, 1889
Family TRYPLASMATIDAE Etheridge, 1907

Genus BOWANOPHYLLUM McLean and Webby, 1976

Type species

Bowanophyllum pilatum McLean and Webby, 1976, from the top of the Malachis Hill Formation (upper Katian), Bowan Park area, central-western NSW.

Discussion

Bowanophyllum was recently discussed by Wang et al. (2020, p. 360), and their view is followed herein.

Bowanophyllum? sp.
Figs 13a–f, 14a–e

Material

Three sectioned specimens, MMF47106, MMF47104-1 (with only a TS) and MMF47104-2 (with only a LS).

Description

The original external form and dimensions of the material examined are unknown, with details of the morphology largely inferred from thin sections. Coralla solitary, cylindrical. Three measured specimens (MMF47106, MMF47104-1 and MMF47104-2) 8.72, 11.22 and 6.17 mm in diameter, respectively; the observed maximum height of the former is 17.75 mm, and that of the latter 10.83 mm. Marginarium a distinct peripheral stereozone, consisting of septa and associated stereome, wide, accounting for 38–50% of corallum radius (Figs 13a, d; 14a, c). Septa numbering 27–46, consisting of numerous spines largely coated by well-developed lamellar stereome; radially arranged, without marked differentiation into major and minor; generally projecting slightly beyond the peripheral stereozone. Septal spines of holacanthine type, horizontally or subhorizontally directed longitudinally (Figs 13b, c, e, f; 14b, d, e). Tabulae complete, flat or slightly wavy, widely spaced, with intervals ranging from 1.37 to 3.10 mm (Figs 13d; 14c).

Discussion

This species displays holacanthine septa that lack a marked differentiation into major and minor, a feature typical of *Bowanophyllum*. However, it differs from representatives of that genus in having almost horizontally directed septal spines and a much narrower peripheral stereozone, hence possibly representing an undescribed genus and species. Since its early growth stages are unknown due to rarity and incompleteness of our material, an open nomenclature is used herein.

Bowanophyllum was previously known only from C/S Fauna IV of latest Katian age, in the Malachis Hill Formation of the Bowan Park area near Orange, in central western NSW. The occurrence of *Bowanophyllum*? sp. in the fauna from the 'Trelawney Beds' is significant in potentially representing the first appearance of this distinctive form both in time and in an area outside the Lachlan Orogen.

Subclass TABULATA Milne-Edwards and Haime, 1850
Order FAVOSITIDA Wedekind, 1937
Family FAVOSITIDAE Dana, 1846

Genus PALEOFAVOSITES Twenhofel, 1914

Type species

Favosites aspera d'Orbigny, 1850, from the Aymestry Limestone (Ludlow) of Leinthall Earls, Welsh Borderland, U.K. (Powell and Scrutton, 1978, p. 313).

Paleofavosites magnus Hall, 1975
Figs 15a–e, 16a–e

Synonymy

1975 *Palaeofavosites magnus* Hall, p. 87, pl. 4, figs c, d.
1975 *Palaeofavosites* sp., Hall, p. 88, pl. 4, figs k, l.

Material

Six sectioned specimens, MMF46760 and MMF46768, MMF47093, MMF47094, MMF47101 and MMF47103.

Description

Two specimens are complete and of low domical form, one (MMF46760) measuring 120 mm wide and 101 mm high, and the other (MMF46768) 132 mm wide and 118 mm high. Corallites polygonal, ACDs (6+) ranging from 2.83 to 4.80 mm (av. 3.45 mm). Septa extremely weakly developed, or absent (Figs 15a, d; 16a, d). Corallite walls straight, or slightly wavy, moderately thick (av. 0.11 mm), separated by thin dark lines (Figs 15b; 16b). Corner pores well developed, commonly connecting two corallites (Figs 15a, b, d; 16a, b, d), with a mean diameter of 0.19 mm. Tabulae complete, subhorizontal, or moderately wavy, moderately to widely spaced, Ta5=3–9 (Figs 15c, e; 16c, e) (Table 3).

Discussion

The present specimens display somewhat larger average corallites than does the type material of *Paleofavosites magnus*, with corallites of the latter averaging 2.0–3.0 mm, but reaching a maximum of 4.6 mm. The variation is regarded as intraspecific.

Paleofavosites sp. documented by Hall (1975) from the 'Uralba Beds' of the Manilla–Attunga area appears to differ from *P. magnus* only in having

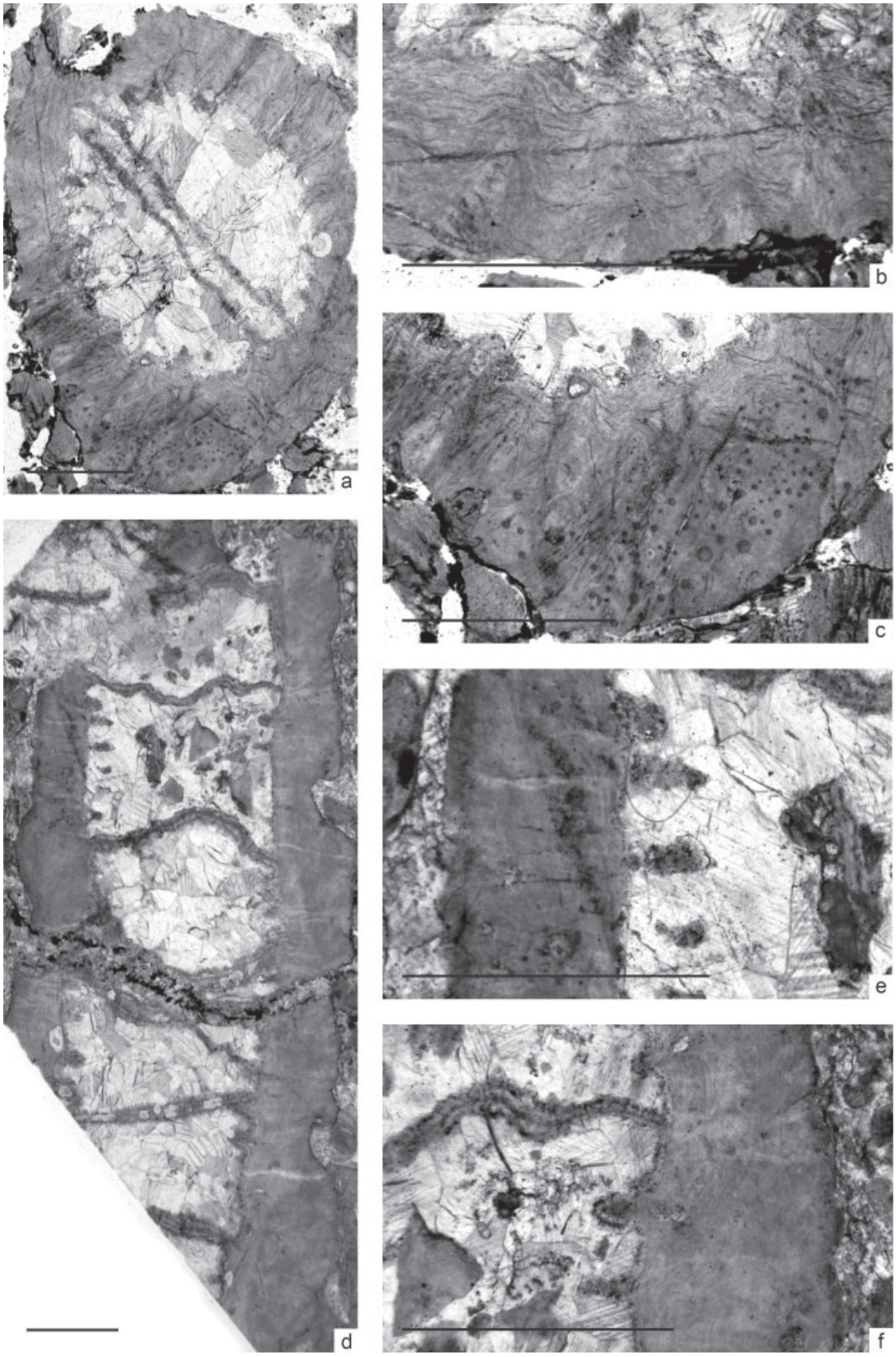

Figure 13. *Bowanophyllum*? sp. MMF47106. a–c, TSs; d–f, LSs. Scale bars=2 mm.

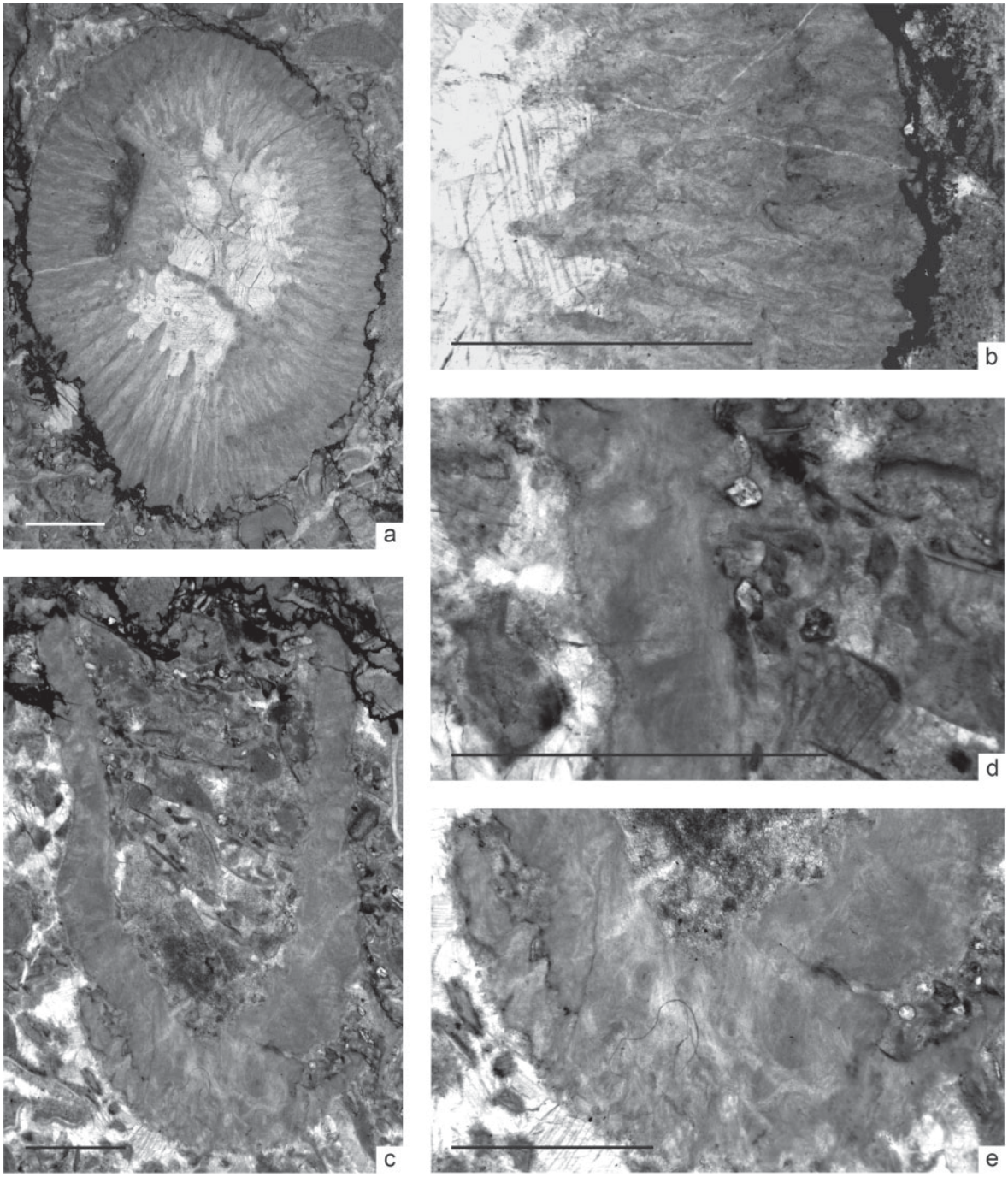

Figure 14. ***Bowanophyllum*****? sp. a, b, MMF47104-1, TSs. c–e, MMF47104-2, LSs. Scale bars=2 mm.**

thicker walls and crenulate tabulae; these differences are insufficient to distinguish the two forms.

Paleofavosites rarispinulatus Hall, 1975
Fig. 17a–j

Synonymy

1975 *Palaeofavosites rarispinulatus* Hall, p. 88, pl. 4, figs i, j.

Material

Four sectioned specimens, MMF46753, MMF46754, MMF46756 and MMF47091.

Description

Two complete specimens measured, both of high domical form, one (MMF46754) measuring 111 mm in width and 81 mm in height, the other

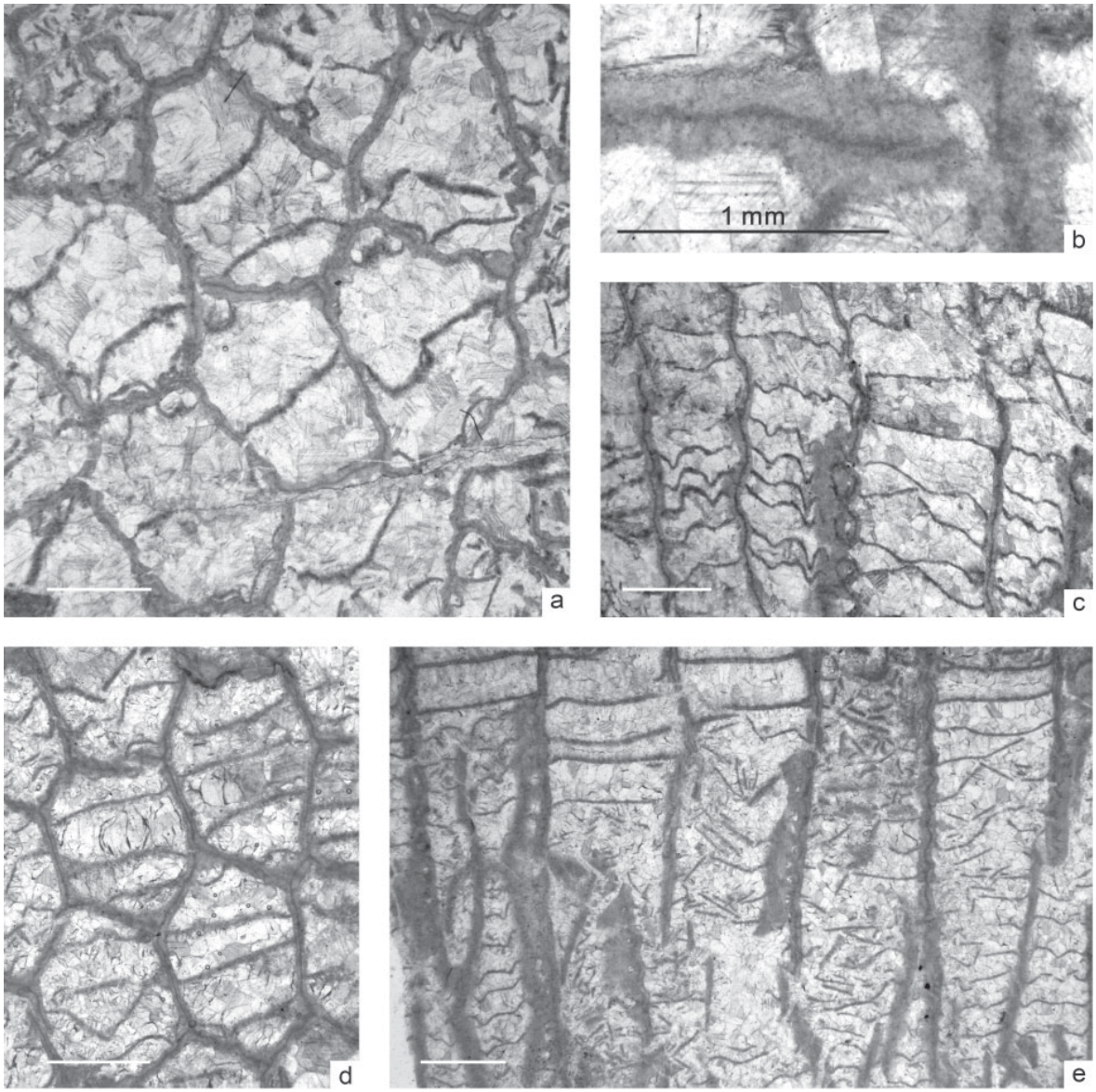

Figure 15. ***Paleofavosites magnus*** **Hall, 1975. a–c, MMF46768. a, b, TSs; c, LS; d, e, MMF47093, d, TS; e, LS. Scale bars=2 mm unless otherwise noted.**

(MMF46756) 136 mm in width and 89 mm in height. Corallites polygonal, ACDs (6+) ranging from 1.44 to 3.18 mm (av. 2.52 mm). Septal ridges present, rather short (Fig. 17b, d, g). Corallite walls moderately thick, ranging from 0.06 to 0.13 mm (av. 0.09 mm), separated by thin dark lines (Fig. 17b, g). Corner pores well developed, commonly connecting 2, or rarely 3 (Fig. 17e, f), corallites, with a mean diameter of 0.19 mm. Tabulae complete, subhorizontal, or moderately wavy, widely spaced, Ta5=4–9 (Fig. 17c, h, j) (Table 3).

Discussion

Paleofavosites rarispinulatus is chiefly distinguished from the other species of the genus described from the 'Trelawney Beds', *P. magnus*, by having much smaller corallites. The presence of septal spines in *P. rarispinulatus* was regarded by Hall (1975) as diagnostic, but this feature appears to be of low taxonomic value since it is also observed in *P. magnus*.

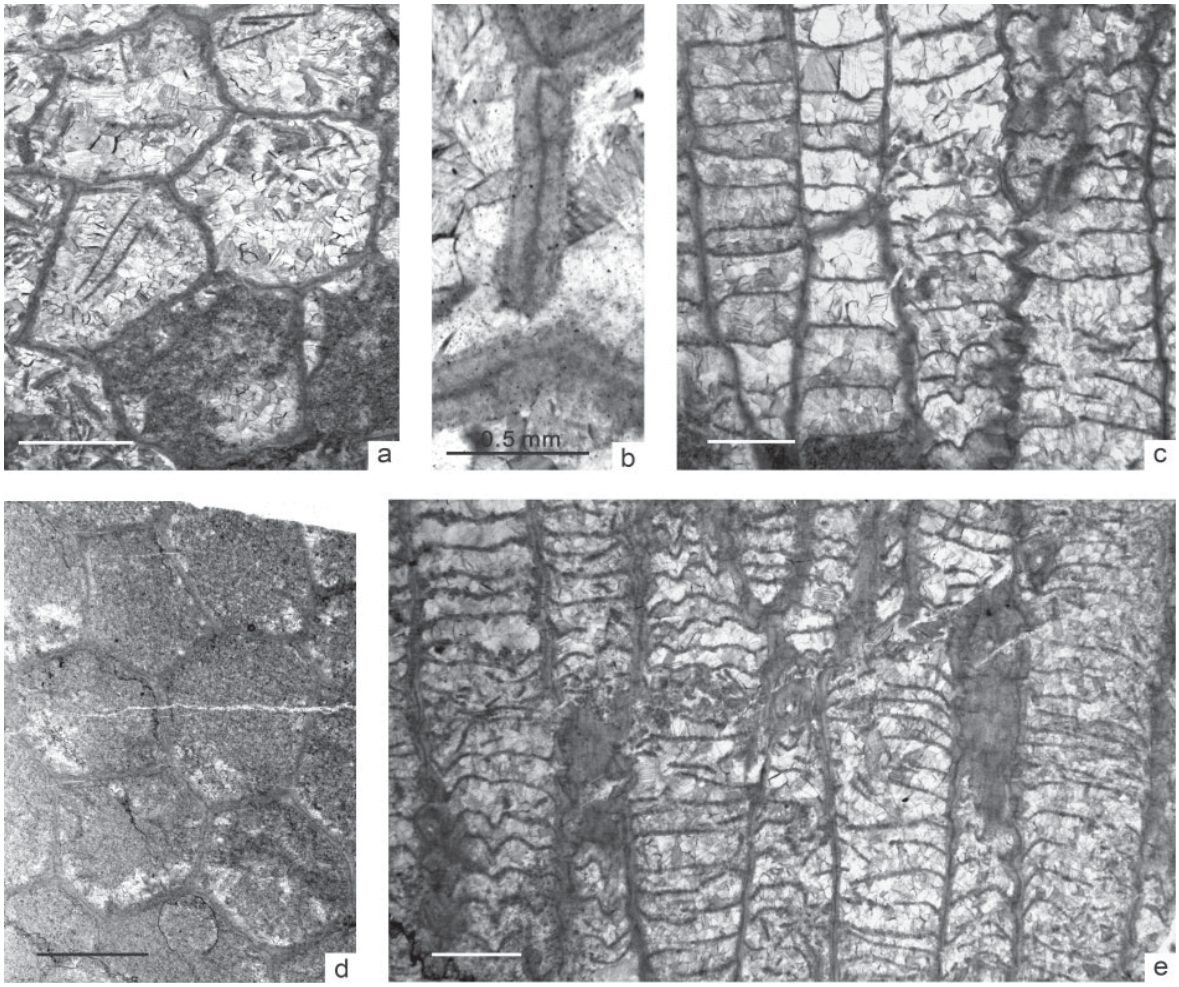

Figure 16. ***Paleofavosites magnus*** **Hall, 1975. a–c, MMF47101. a, b, TSs; c, LS; d, e, MMF47103, d, TS; e, LS. Scale bars=2 mm unless otherwise noted.**

Family AGETOLITIDAE Kim, 1962

Genus HEMIAGETOLITES Leleshus, 1963

Type species

Hemiagetolites sugranicus Leleshus, 1963, from the upper Katian of Zeravshan Range, Tajikistan.

Hemiagetolites spinimarginatus (Hall, 1975)
Fig. 18a–i

Synonymy

1975 *Palaeofavosites spinimarginatus* Hall, p. 87, pl. 4, figs g, h, text-fig. 11a, b.
2017 *Hemiagetolites* sp. cf. *H. spinimarginatus* (Hall, 1975); Zhen et al., p. 162, fig. 8A–D.
2020 *Hemiagetolites spinimarginatus* (Hall, 1975); Wang et al., pp. 364, 365, fig. 7A–E.

Material

Four sectioned specimens, MMF46758, MMF46770, MMF47092 and MMF47098.

Description

One complete specimen (MMF46758) measured, of tabular form, 65 mm wide and 16 mm high. Corallites polygonal, ACDs (6+) ranging from 2.08 to 2.98 mm (av. 2.56 mm). Corallite walls commonly slightly wavy, separated by thin dark lines (Fig. 18b, c, g), WT varying from 0.08 to 0.15 mm (av. 0.11 mm). Septa well developed, extremely short, represented by numerous spines with wide bases forming narrow continuous plates (Fig. 18d, h, i). Corner pores moderately developed, with PoDs ranging from 0.12 to 0.16 mm (av. 0.14 mm) (Fig. 18a, f), commonly connecting 2, or rarely 3 (Fig. 18g) corallites. Mid-wall pores rarely observed (Fig. 18a, b). Tabulae

Table 3. Biometric data on favositids and an agetolitid described in this paper.

	ACD (6+)	WT	PoD	Ta5
Paleofavosites magnus **Hall, 1975**				
Minimum	2.83	0.08	0.16	3
Maximum	4.80	0.18	0.24	9
Range of colony means	3.03–3.80	0.10–0.12	0.18–0.22	4–7.80
Mean	3.45	0.11	0.19	5.85
Measurements	66	59	12	41
No. of specimens studied	6	6	5	5
Paleofavosites rarispinulatus **Hall, 1975**				
Minimum	1.44	0.06	0.13	4
Maximum	3.18	0.13	0.24	9
Range of colony means	2.18–2.81	0.08–0.11	0.18–0.21	5.26–7.17
Mean	2.52	0.09	0.19	6.18
Measurements	74	51	17	51
No. of specimens studied	4	4	3	4
Hemiagetolites spinimarginatus **(Hall, 1975)**				
Minimum	2.08	0.08	0.12	6
Maximum	2.98	0.15	0.16	12
Range of colony means	2.37–2.68	0.09–0.13	0.12–0.15	7.60–8.75
Mean	2.56	0.11	0.14	8.48
Measurements	59	56	7	60
No. of specimens studied	4	4	3	4

complete, flat, or slightly wavy, moderately spaced, Ta5 mostly 8–9 (Fig. 18d, h, i) (Table 3).

Discussion

These specimens strongly resemble those of *Paleofavosites spinimarginatus* described from the same rock unit of northeastern NSW, notably in the septal nature and the mid-wall pore development, with at least one mid-wall pore present in the original illustration of this species (Hall, 1975, fig. 11A). The main difference lies in the slightly smaller corallites (1.7–2.2 mm in diameter) of Hall's specimens, but this probably represents intraspecific variation as demonstrated by an overlap in the corallite size. This species was transferred to *Hemiagetolites* by Zhen et al. (2017) based on the presence of septal plates, and this reassignment is followed herein.

The specimen described by Zhen et al. (2017) as *Hemiagetolites* sp. cf. *H. spinimarginatus* (Hall, 1975) from the Angullong Formation of the Cliefden Caves area in central NSW was stated to differ from *H. spinimarginatus* in having sparse mid-wall pores, thinner walls and fewer tabulae. With the revised concept of *H. spinimarginatus* as discussed above, it seems reasonable to regard this Angullong form as synonymous with it. *Hemiagetolites spinimarginatus* is also documented by Wang et al. (2020) from the uppermost Malachis Hill Formation (latest Katian) of the Bowan Park area, central NSW.

Order HELIOLITIDA Frech, 1897
Family HELIOLITIDAE Lindström, 1876

Genus HELIOLITES Dana, 1846

Type species

Astraea porosa Goldfuss, 1826, from the Middle Devonian of Eifel District, Germany.

Heliolites sp. indet.
Fig. 19a, b

Material

One sectioned specimen MMF47405 (with only one TS).

Description

The shape and size of this corallum is unknown. Corallites circular in TS, TaDs=1.23–1.30 mm (av. 1.27 mm). Corallite walls slightly faceted, WT=0.03–0.09 mm (av. 0.06 mm). Septa 12 in number, short, extending less than one-quarter of the corallite radius (Fig. 19b). Corallites generally separated by 2–6 rows of tubules, with corallite centres 2.18–3.08 mm apart (av. 2.55 mm), or occasionally in contact (Fig. 19a). Intercorallite spaces filled with coenenchyme of prismatic or sometimes elongate tubules. Tubules surrounding each corallite commonly number 14–17, and are generally similar in size and shape (Fig. 19a, b). Diameter of tubules 0.16–0.43 mm (av. 0.27 mm), with walls 0.03–0.07 mm thick (av. 0.04 mm). Features of tabulae and diaphragms unknown.

Discussion

The assignment of the single specimen to *Heliolites* is based on its presence of conspicuously tubular coenenchyme with commonly more than 12 tubules (14–17) around each corallite. However, a specific identification appears to be impossible

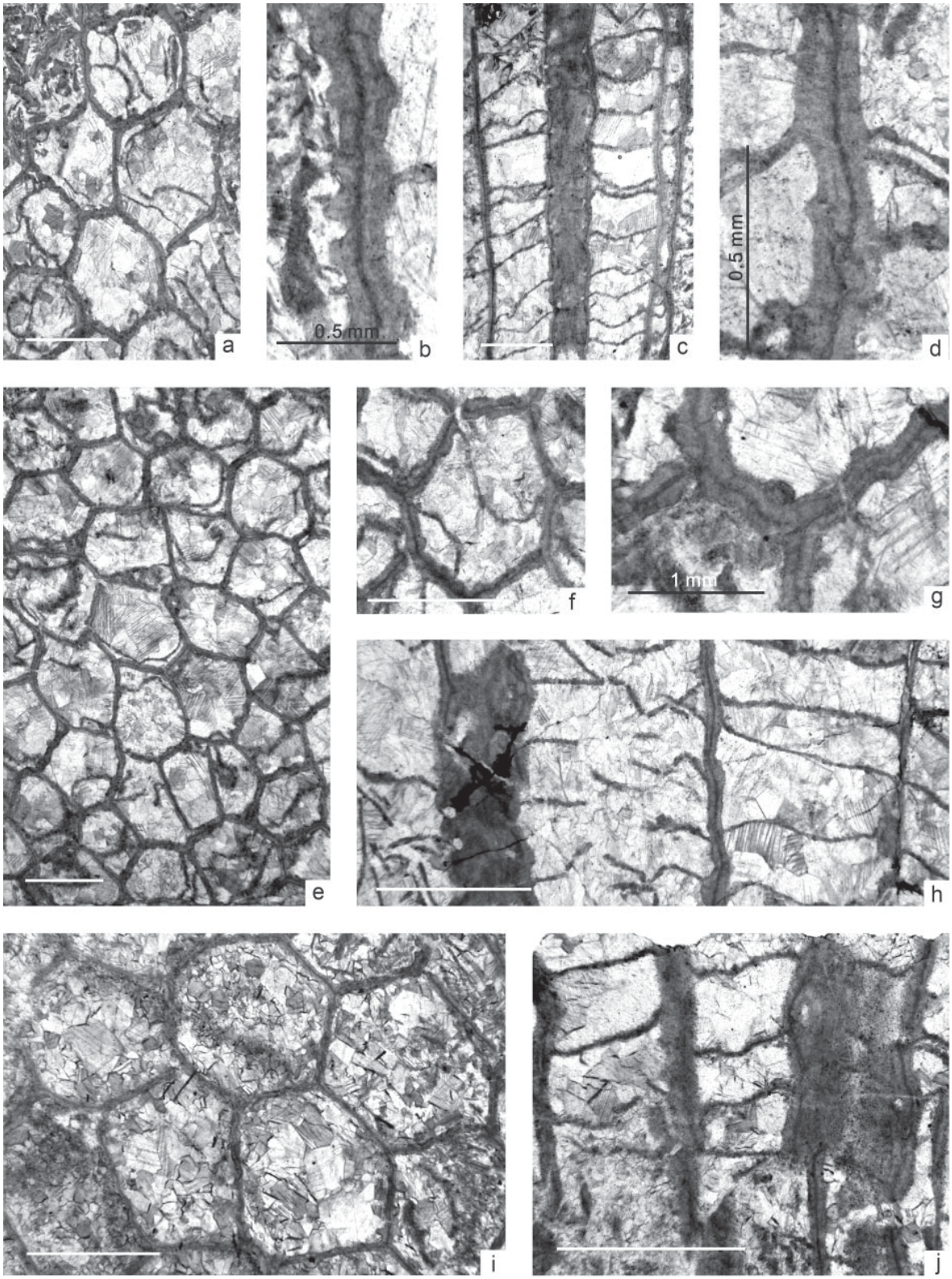

Figure 17. ***Paleofavosites rarispinulatus*** **Hall, 1975. a–d, MMF46753; a, b, TSs; c, d, LSs. e–h, MMF46756; e–g, TSs; h, LS. i, j, MMF47091, i, TS; j, LS. Scale bars=2 mm unless otherwise noted.**

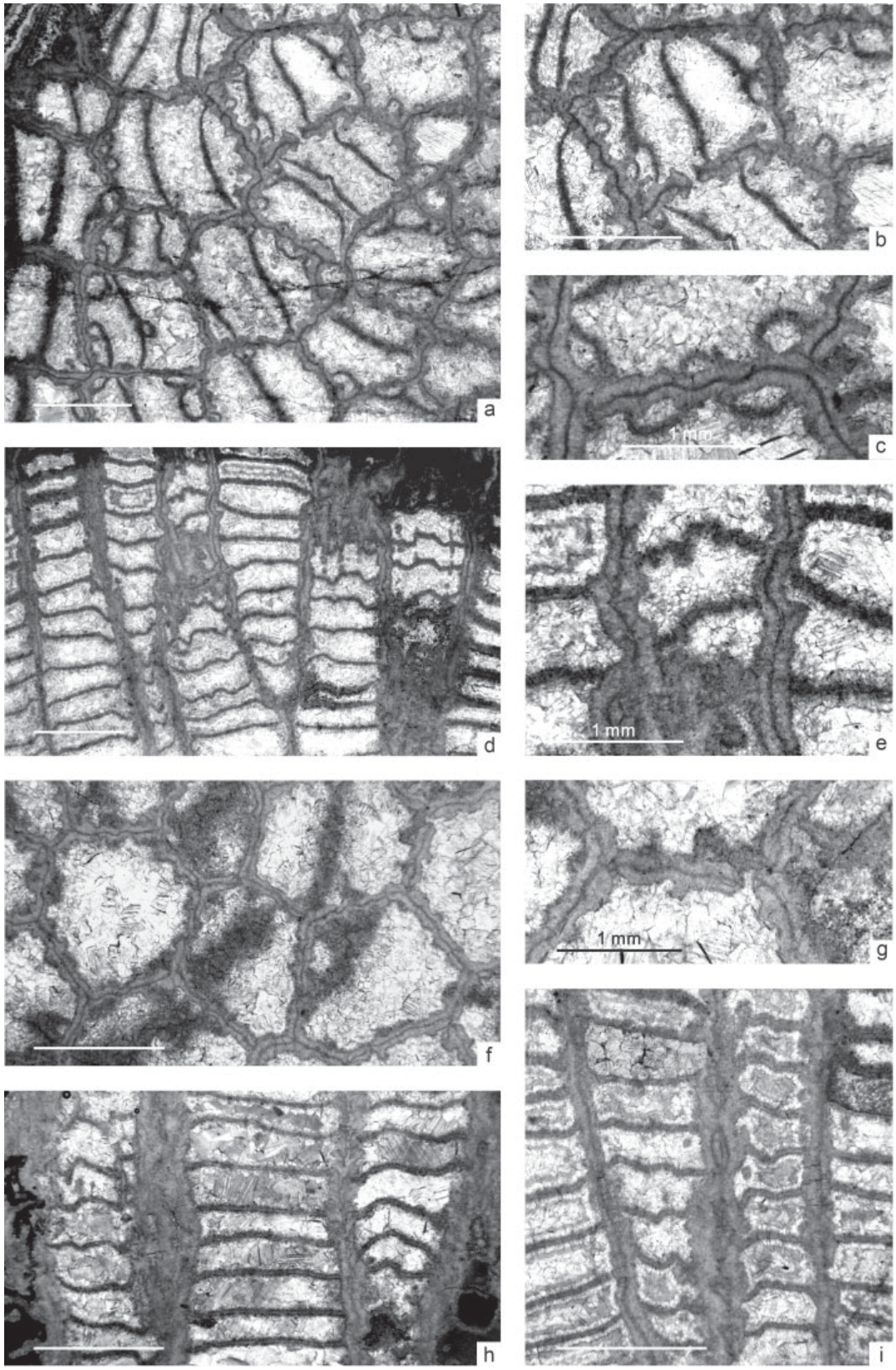

Figure 18. ***Hemiagetolites spinimarginatus*** **(Hall, 1975). a–e, MMF46758; a–c, TSs; d, e, LSs. f–i, MMF47098; f, g, TSs; h, i, LSs. Scale bars=2 mm unless otherwise noted.**

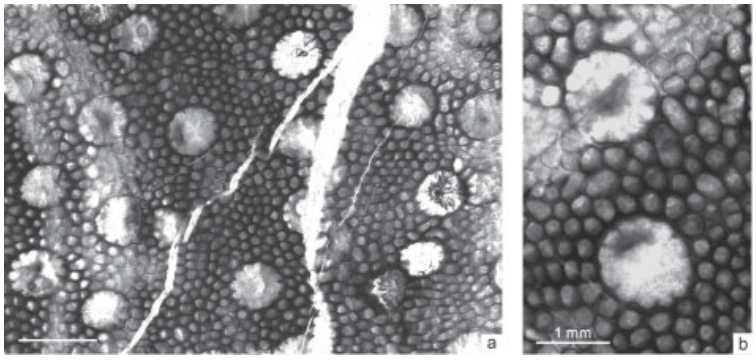

Figure 19. *Heliolites* sp. indet. a–b, MMF47405, TSs. Scale bars = 2 mm unless otherwise noted.

without information on its vertical skeletal elements due to the lack of longitudinal sections.

Family PSEUDOPLASMOPORIDAE Bondarenko, 1963

Genus NAVOITES Leleshus and Ospanova, 1979

Type species

Navoites simmetricus Leleshus and Ospanova, 1979, from the Katian of the Zeravshan-Gissarskiy mountains, Tajikistan.

Discussion

The concept of *Navoites* was recently discussed by Wang et al. (2020), and their view is followed in this study.

Navoites cargoensis (Hill, 1957)
Fig. 20a–d

Synonymy

See Wang et al. (2020, pp. 373, 374)

Material

A single sectioned specimen MMF47406; specimen MMF46780A-2 questionably assigned to this species is also figured (Fig. 20e–g) and discussed below.

Description

Corallum presumedly of globular or nodular shape; small, with a width of more than 18.45 mm (Fig. 20a). Corallites circular in transverse section, TaDs=0.63–0.85 mm (av. 0.76 mm). Corallite walls smooth or slightly faceted, WT=0.04–0.05 mm (av. 0.05 mm). Septa absent or weakly developed (Fig. 20b, c). Tabulae complete, flat, concave or slightly convex, irregularly spaced, 0.15–0.89 mm (av. 0.56 mm) apart (Fig. 20d). Corallite centres 1.06–1.58 mm apart (av. 1.37 mm), commonly separated by 3–5 rows of tubules. Intercorallite spaces filled with coenenchyme of prismatic tubules, generally with 5 or 6 sides (Fig. 20b). Tubules surrounding each corallite 12 in number, generally similar in size and shape (Fig. 20b, c). Tubules 0.17–0.24 mm in diameter (av. 0.21 mm), with walls 0.036–0.042 mm thick (av. 0.04 mm). Diaphragms complete, generally flat, 0.15–0.32 mm (av. 0.22 mm) apart (Fig. 20d).

Discussion

One of the two available specimens (MMF47406) is essentially identical to the holotype of *Navoites cargoensis* (Hill, 1957) documented from the Cargo Creek Limestone (middle Katian) of central NSW, and is clearly conspecific. The other specimen (MMF46780A-2) appears to conform to the concept of *N. cargoensis* based on its single transverse section (Fig. 20e–g), but it differs in having smaller corallite size (TaDs 0.56–0.64 mm, averaging 0.60 mm); for this reason, its assignment to this species is tentative. A detailed discussion of *N. cargoensis* can be found in Wang et al. (2020).

The only other representative of *Navoites* known in eastern Australia is *N. circumflexus* (Hall, 1975) originally described as *Plasmopora circumflexa* by Hall (1975, p. 86, pl. IIIk, l), from the 'Uralba Beds' and 'Trelawney Beds' of the New England Region. This species has 12 aureolar tubules that are not obviously different in size and shape from other coenenchymal tubules, and is therefore attributed to *Navoites*. As noted by Wang et al. (2020), *N. circumflexus* is distinguished from *N. cargoensis* by having better developed septa and larger corallite size (TaDs=0.8–1.2 mm). No further specimens of *N. circumflexus* were identified in our study of the 'Trelawney Beds' fauna. Zhen et al. (2017) tentatively assigned a specimen from the Angullong Formation of central NSW to this species.

Family SIBIRIOLITIDAE Lin in Lin and Chow, 1977

Genus MONGOLIOLITES Bondarenko and Minzhin, 1977

Type species

Mongoliolites paradoxides Bondarenko and Minzhin, 1977, from the Katian (lower Ashgill) of the Khanay Range, central Mongolia.

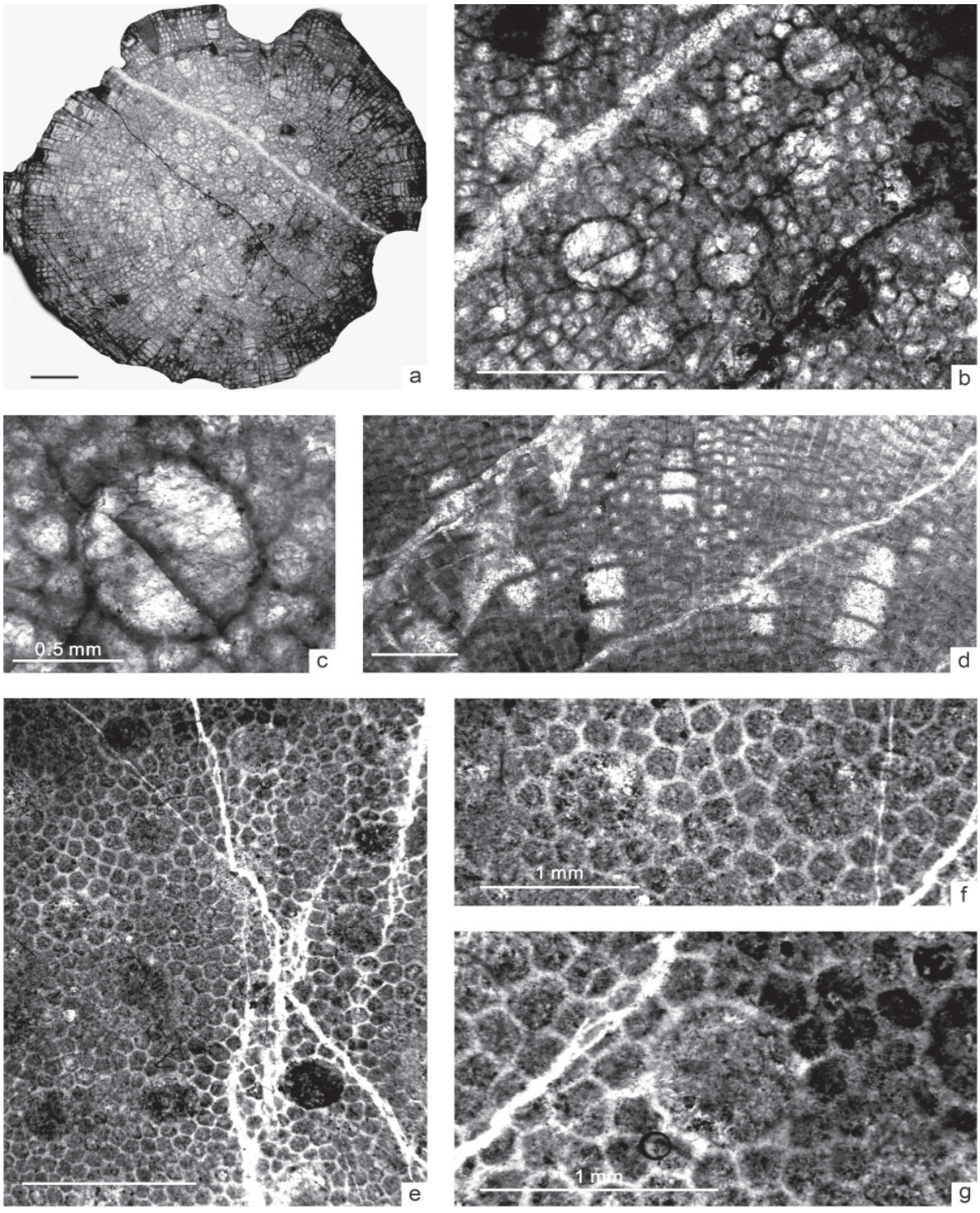

Figure 20. a–d, *Navoites cargoensis* (Hill, 1957), MMF47406; a–c, TSs; d, LS. e–g, *Navoites cargoensis*? (Hill, 1957), MMF46780A-2, TSs. Scale bars=2 mm unless otherwise noted.

Discussion

Morphologically similar genera include *Sibiriolites* Sokolov, 1955, *Protoheliolites* Bondarenko, 1977, and *Schmidtilites* Bondarenko, 1977, all having weak development of coenenchyme. *Sibiriolites* is typified by the zonal or peripheral development of thick longitudinal trabeculae, a feature being absent in *Mongoliolites*. *Protoheliolites* and *Schmidtilites* were recently considered by Liang et al. (2013) as synonymous, and both are separable from *Mongoliolites* in lacking the trabecular wall structure and having well-developed septal spines.

Mongoliolites was referred to the Sibiriolitidae Lin in Lin and Chow, 1977 (Bondarenko, 1977, White and Yang, 2004) or alternatively to the Taeniolitidae Lin and Chow, 1977 (Bondarenko, 1992). Hill (1981) placed this genus tentatively in Sibiriolitidae, noting the possibility of its inclusion in the Proheliolitidae. Following White and Yang (2004), we regard *Mongoliolites* as a sibiriolitid in view of its typical trabecular wall structure.

Mongoliolites contiguus (Hall, 1975)
Fig. 21a–g

Synonymy

Plasmoporella contigua Hall, 1975, p. 85, text-fig. 10; pl. 3, figs i, j.

Material

Three specimens, MMF46763, MMF46764 and MMF47407.

Description

Two complete specimens measured, one (MMF46763) being of high domical form 130 mm in width and 98 mm in height; the other (MMF46764) of low domical form, 117 mm in width and 42 mm in height. Corallites prismatic to subcircular in TS, TaDs=1.30–1.67 mm (av. 1.53 mm). Corallite walls consisting of thickened trabeculae (Fig. 21b, d, f), WT=0.09–0.14 mm (av. 0.11 mm). Septa laminate, extending slightly beyond the corallite wall (Fig. 21b, d, e). The number of septa difficult to be counted. Tabulae complete, flat or slightly arched, or sometimes incomplete (Fig. 21c, d), Ta5=6–14. Corallites mostly in contact, with rare coenenchyme developing at wall junctions (Fig. 21a, e). Dissepiments generally complete, flat or slightly arched, or incomplete, 13–20 per 5 mm.

Discussion

Our specimens are essentially identical to, and hence conspecific with, the type material of *Plasmoporella contiguus* Hall, 1975. This species is transferred herein to *Mongoliolites* Bondarenko and Minzhin, 1977 based on its sporadic coenenchyme and complete corallite walls.

Mongoliolites contiguus shows comparable TaDs to the type species, *M. paradoxides* Bondarenko and Minzhin, 1977, with TaDs of the latter 1.0–1.5 mm. However, *M. paradoxides* develops complete rings of coenenchyme around corallites in late growth stages, which is not observed in *M. contiguus*. The occasional presence of incomplete tabulae in *M. contiguus* may serve as a further feature to distinguish the two forms.

Mongoliolites? *giganteus* White and Yang, 2004, documented from the Stile End Formation (Katian) of the Lake District in the UK, was provisionally assigned to *Mongoliolites* by White and Yang (2004) largely due to uncertainty concerning the trabecular nature of its corallite walls. It is readily distinguishable from other species of *Mongoliolites* by its significantly larger corallite size (3.0–3.8 mm in diameter).

Family PLASMOPORELLIDAE Kovalevsky, 1964

Genus PLASMOPORELLA Kiaer, 1899

Type species

Plasmoporella convexotabulata forma *typica* Kiaer, 1899, from the Upper Ordovician of Norway.

Plasmoporella inflata Hill, 1957
Fig. 22a–e

Synonymy

1957 *Plasmoporella inflata* Hill, p. 104, pl. 4, figs 26a, b, 28a, b.
1975 *Plasmoporella inflata* Hill; Hall, p. 84, pl. 3, figs c, d.
1975 *Plasmoporella* sp. cf. *P. inflata* Hill; Hall, p. 84, pl. 3, figs e, f.
1975 *Plasmoporella bacilliformis* Hall, p. 85, pl. 3, figs g, h, text-fig. 9A, B.
?1977 *Plasmoporella shiyanshanensis* Lin and Chow, p. 185, pl. 55, figs 2a, b, 3a, b.
?1980 *Plasmoporella subkasakhstanica* Lin and Chow, p. 37, pl. 4, fig. 5a, b.
2012 *Plasmoporella bacilliforma* Hall; Dixon and Jell, pp. 87, 88, pl. 3, figs 12A, B, 13A, B.
2017 *Plasmoporella bacilliforma* Hall; Zhen et al., p. 164, fig. 11A–D.

Material

Five specimens, MMF46775, MMF46776, MMF47408, MMF47409 and MMF47410.

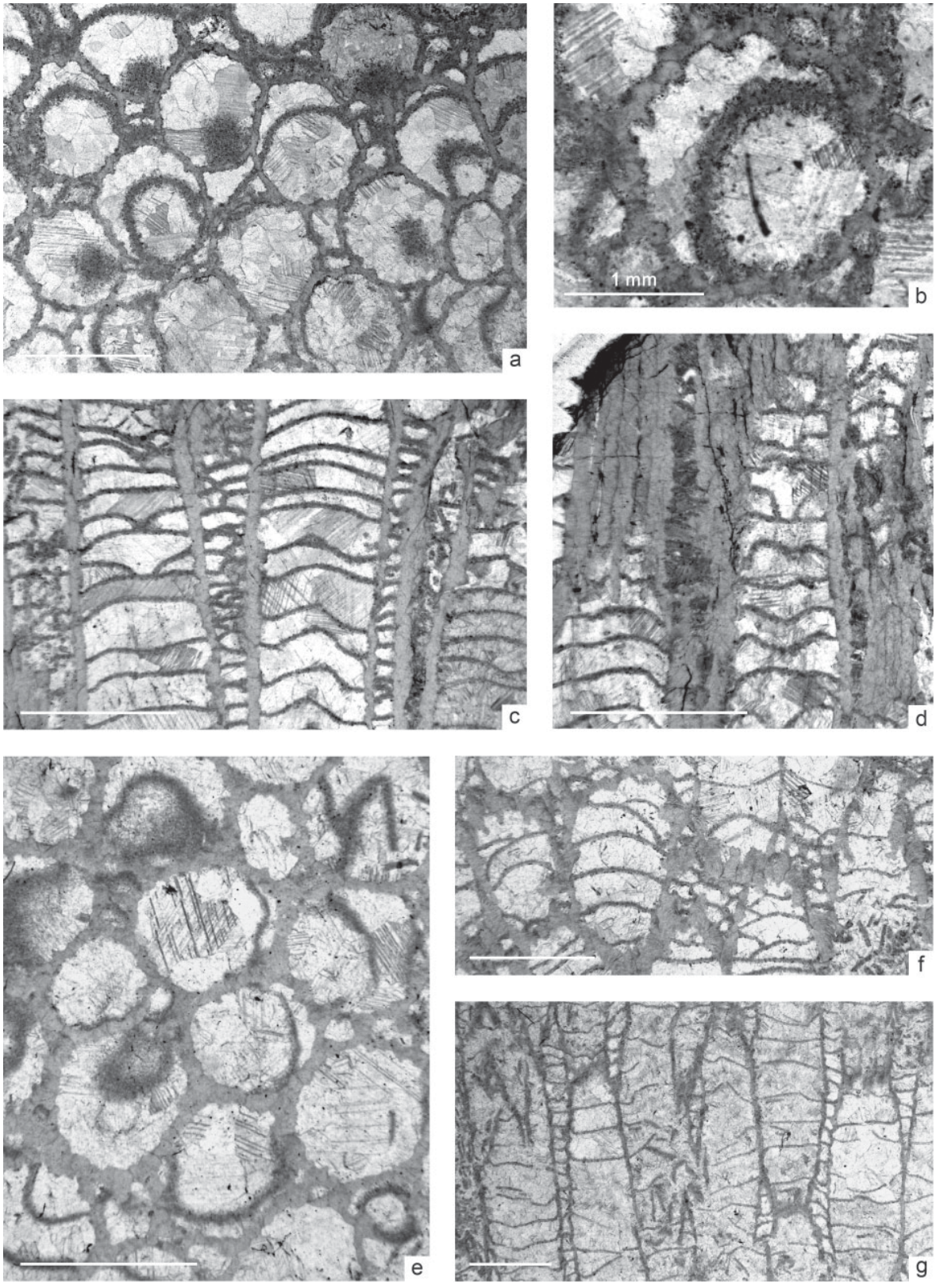

Figure 21. ***Mongoliolites contiguus*** **(Hall, 1975). a–d, MMF46763; a, b, TSs; c, d, LSs. e–g, MMF46764; e, f, TSs with f slightly oblique; g, LS. Scale bars=2 mm unless otherwise noted.**

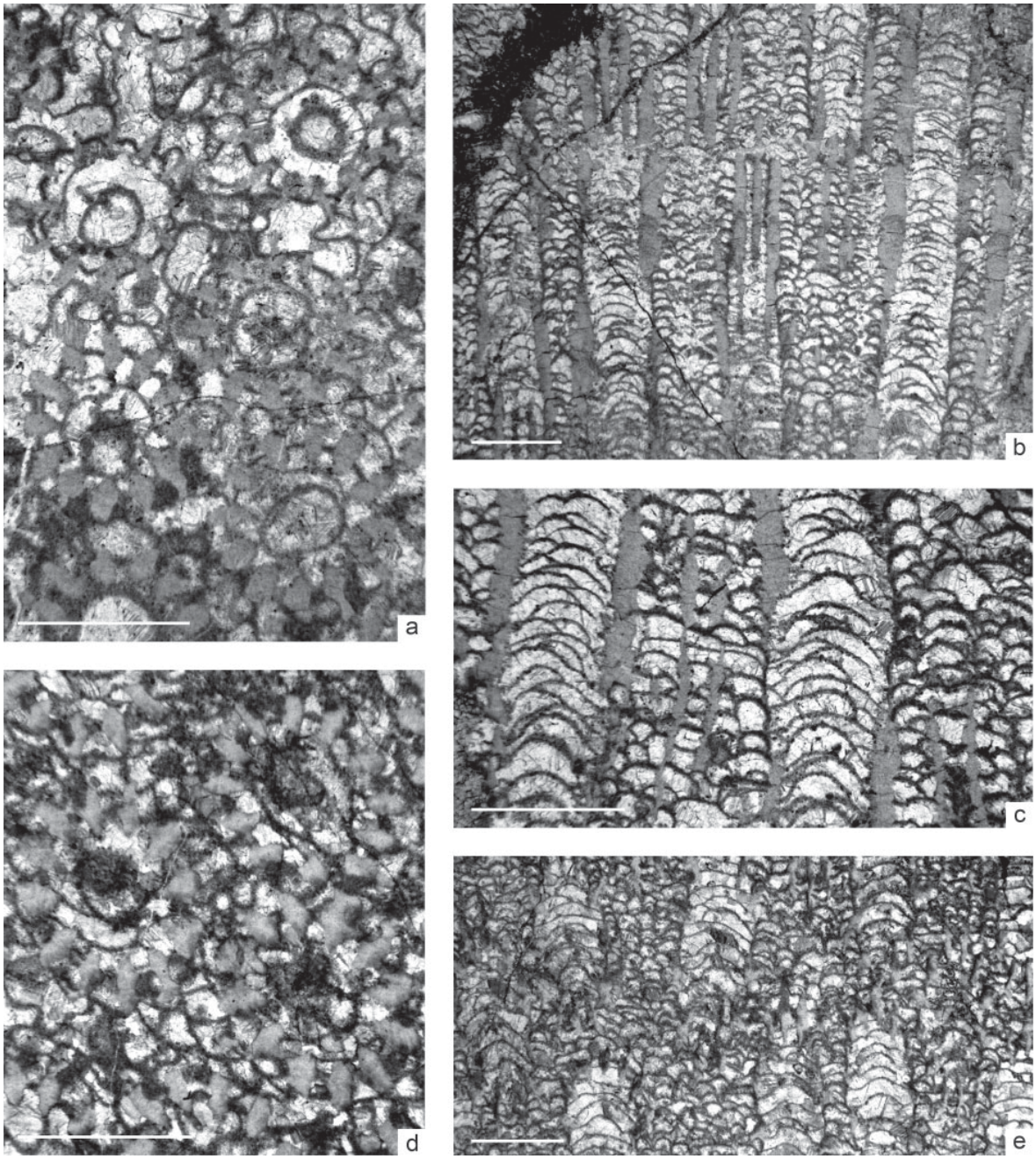

Figure 22. ***Plasmoporella inflata*** **Hill, 1957. a–c, MMF46775; a, TS; b, c, LSs. d, e, MMF46776; d, TS; e, LS. Scale bars=2 mm.**

Description

Only two complete coralla measured, both of low domical form, one (MMF46775) is 88 mm wide and 49 mm high, the other (MMF46776) 88 mm wide and 45 mm high. Corallites outlined in transverse section by 12 well developed septal laminae, with walls of tabularia in interseptal positions defined by edges of coenenchymal dissepiments (Fig. 22a, d). TaDs varying from 1.50 to 1.86 mm (av. 1.74 mm). Septa generally blade-like in transverse section, elongate radially, decreasing both inwardly in tabularia and outwardly in coenenchyme. Septa continuous vertically, forming laminae, extending no more than 41% of the TaD both into tabularia and coenenchyme (Fig. 22a, d), with maximum widths highly variable, ranging from 0.13 to 0.34 mm in transverse section (Fig. 22a). Tabulae moderately to strongly convex, complete or incomplete, closely spaced, Ta5=16–

25. Corallite centres 2.08–2.84 mm (av. 2.43 mm) apart. Coenenchyme consisting of commonly convex dissepiments, with rod-like vertical trabeculae observed (Fig. 22b, c, e). Dissepiments mostly 0.40–0.54 mm wide, rarely slightly broader in more central areas of coenenchyme, with width of 0.69–0.95 mm (Fig. 22b), or occasionally running through entire coenenchymal spaces between adjacent corallites (Fig. 22c). Dissepiments 20–24 per 5 mm.

Discussion

These specimens from the 'Trelawney Beds' show closest resemblance to the holotype of *Plasmoporella bacilliforma* Hall, 1975 documented from the same horizon, except they show better development of incomplete tabulae and have a wider range of septal thickness. Such differences are best regarded as normal intraspecific variations. Dixon and Jell (2012, p. 88), based on their study of specimens from the middle Katian 'Carriers Well Formation' of north Queensland, revised the diagnosis of this species to include "the infrequent occurrence of short, rod-like vertical trabeculae in coenenchyme", and this feature is also observed in our material (Fig. 22b, c). This species is also known from the Angullong Formation of central NSW (Zhen et al., 2017).

Plasmoporella inflata Hill, 1957, which was first documented from the Cargo Creek Limestone of central NSW, has a comparable corallite size to *P. bacilliforma* (1.5–2 mm in TaD, the higher figure being more common). According to Hall (1975, p. 85), *P. bacilliforma* was said to differ from *P. inflata* only in having thinner and shorter septal trabeculae, and less arched tabulae. However, these differences are considered here as intraspecific variation, as shown by our material. Thus, *P. bacilliforma* is regarded as a junior synonym of *P. inflata*.

Two Chinese forms, *Plasmoporella shiyanshanensis* Lin and Chow, 1977, and *P. subkasakhstanica* Lin and Chow, 1980, were regarded by Dixon and Jell (2012) as somewhat comparable to *P. bacilliforma*, and they are likely conspecific with, *P. inflata*.

Plasmoporella sp., described recently by Wang et al. (2020) from the Malachis Hill Formation (latest Katian) of central NSW, shows great resemblance to *P. inflata*. It differs chiefly in having slightly larger TaDs (1.80 to 2.13 mm, av. 1.96 mm), better developed broad dissepiments in the coenenchyme, and somewhat bifurcated septal bases, the latter feature not being mentioned in that paper.

Family PROPORIDAE Sokolov, 1949

Genus PROPORA Milne-Edwards and Haime, 1849

Type species

Porites tubulata Lonsdale, 1839, from the Woolhope Limestone (Wenlock, Silurian) of the Welsh Borderlands, UK.

Propora sp. indet.
Fig. 23a–d

Synonymy

?1957 *Propora* sp., Hill, p. 103, pl. 4, fig. 29a, b.

Material

A single sectioned specimen MMF47411 (with only one TS).

Description

The shape and size of this corallum are unknown. Corallites circular in TS (Fig. 23a), TaDs=0.93–1.04 mm (av. 0.97 mm). Corallite walls slightly faceted, of variable thickness ranging from 0.03 to 0.09 mm (av. 0.05 mm). Septa 12 in number, typically extending outward into coenenchyme, with a maximum thickness of 0.09 mm (Fig. 23a, b, d). Features of tabulae unknown. Corallites widely separated, with corallite centres 1.59–2.17 mm apart (av. 1.79 mm). Intercorallite spaces filled with dissepimental coenenchyme (Fig. 23c).

Discussion

The single specimen shows remarkable similarities to those described by Hill (1957) as *Propora* sp. from the Canomodine Limestone (middle Katian) of central NSW, particularly in corallite size (TaDs of the latter averaging 1 mm) and the outward extension of "septa", and they are probably conspecific. However, limited material prevents a reliable identification at species level.

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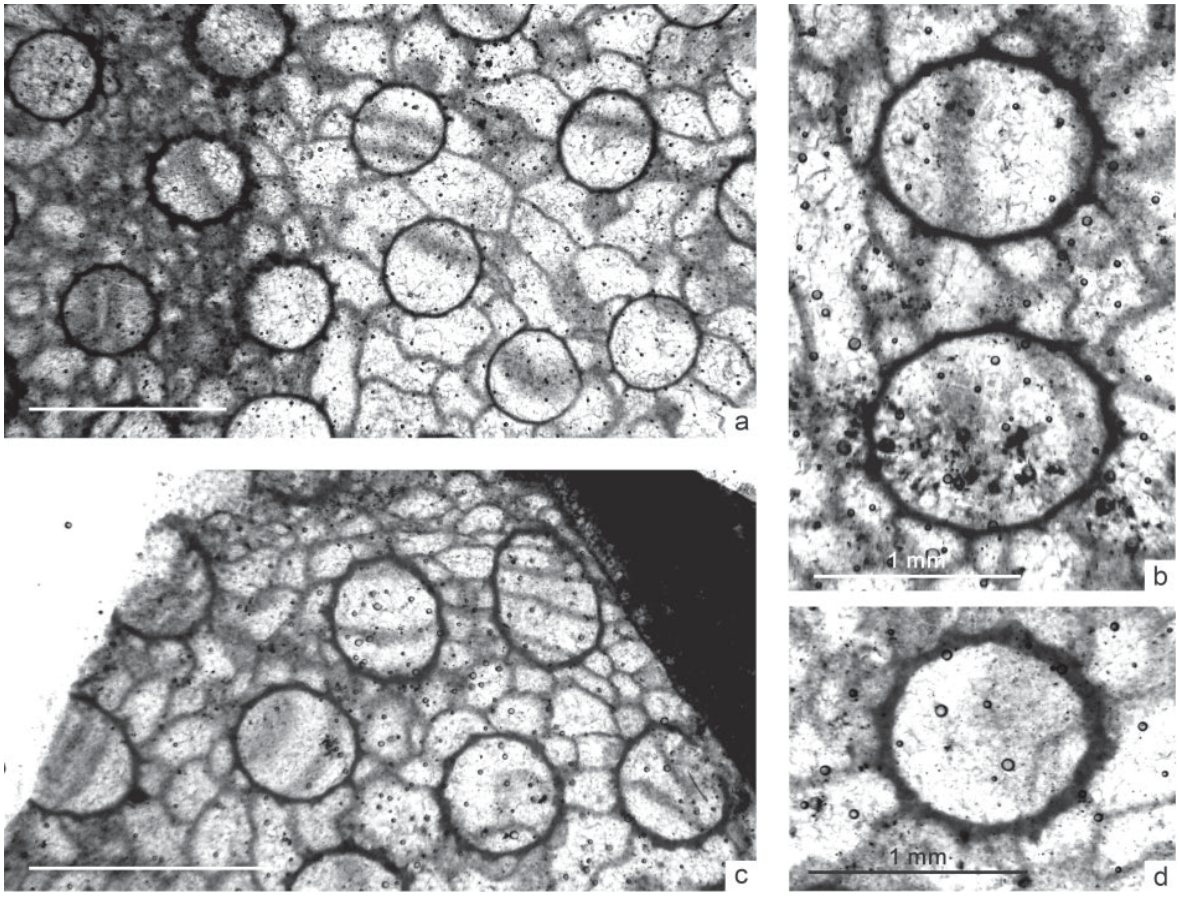

Figure 23. *Propora* sp. indet. a–d, MMF47411, TSs. Scale bars=2 mm unless otherwise noted.

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