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Archaeocyatha of the Amadeus and Georgina Basins

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The Todd River Dolomite (Amadeus Basin) and Mount Baldwin Formation (Georgina Basin) are a part of the Early Cambrian platform cover of the central Australian craton. Marine dolostones of these rock units preserve a limited archaeocyathan-radiocyathan fauna, including *Aldanocyathus greeni* **Kruse sp. nov.,** *Coscinocyathus bilateralis* **(Taylor),** *'Dictyocyathus'*, *Aruntacyathus toddi* **Kruse gen. et sp. nov. (Metacyathidae), and** *Radiocyathus minor* **(Bedford & Bedford).** *?Aruntacyathus rossi* **Kruse sp. nov. and** *Beltanacyathus* **Bedford & Bedford are known traditionally from the Todd River Dolomite. On the basis of the common occurrence of elements of Faunal Assemblage No. 2 (Daily, 1956), the Todd River Dolomite and Mount Baldwin Formation can be correlated with the lower part of the Ajax and Wilkawillina Limestones of South Australia. The central Australian and corresponding South Australian archaeocyathan faunas appear to be coeval with those of the Atdabanian and possibly early Lenian stages of Siberia.**

This paper documents an archaeocyathan fauna common to both the Amadeus and Georgina Basins of central Australia. Kruse is responsible for the description of the fauna and review of Amadeus Basin stratigraphy, and the synthesis, while the contribution on the Georgina Basin is the result of fieldwork by West in support of the Bureau of Mineral Resources' Georgina Basin project.

The Amadeus Basin is an east-west-trending intracratonic trough or aulacogen spanning the central portion of a much larger elongate zone of relative crustal mobility ('Trans-Australia Zone' of Austin & Williams, 1978). The Georgina Basin, presently separated from the Amadeus Basin by the Arunta Block, represents a more stable region of the ancient continental platform. In both basins deposition commenced in mid to late Adelaidean time (Wells & others, 1970; Smith, 1972; Marjoribanks & Black, 1974; Mayne, 1976; Shergold & others, 1976; Burek & others, 1979). Palaeogeographic reconstructions of the Australian craton by Veevers (1976) and Webby (1974, 1978) depict the two basins united as a single marine embayment of variable extent throughout their Cambro-Ordovician depositional phase. Preiss & others (1978) have suggested that there was interconnection between these basins in the Adelaidean also.

In the Amadeus Basin, archaeocyaths are present only in the Todd River Dolomite (Wells & others, 1967) of the Pertaoorrta Group, and in the Georgina Basin, the Mount Baldwin Formation (Smith, 1964) of the Mopunga Group. Both occurrences were first reported by Madigan (1932), and represent elements of a shallow marine fauna developed in Early Cambrian continental platform successions on the Australian craton.

Amadeus Basin

The Todd River Dolomite is an Early Cambrian rock unit cropping out over an extensive area of the northeastern Amadeus Basin, covering portions of the ALICE SPRINGS, RODINGA and HALE RIVER 1:250 000 geological map sheets. The type section is in the Ross River gorge (on the present northeastern margin of the basin), where a maximum thickness of 155 m is preserved (Fig. 1). In the present study the archaeocyathan fauna was sampled both here and on the southern limb of the Ooraminna Anticline, some 60 km to the southwest, where the formation is only 66 m in thickness. Spot samples in the collections of the Bureau of Mineral Resources from several intervening localities were also examined.

The type section, as defined by Wells & others (1967), consists of a basal unit of thin-bedded sandstones, siltstones, and dolostones (83 m), overlain by 72 m of thick-bedded to massive yellow-brown dolostone (Fig. 2). Daily (1972) has recorded a fauna of *Pelagiella, Chancelloria, 'Micromitra' etheridgei* Tate, brachiopods, hyoliths, Problematica, and archaeocyaths, indicative of his Early Cambrian Faunal Assemblage No. 2 (Daily, 1956), from the 'thick-bedded unit'. The archaeocyaths are here identified as *Aldanocyathus greeni* Kruse sp. nov., *Coscinocyathus bilateralis* (Taylor), *'Dictyocyathus'* spp., *Aruntacyathus toddi* Kruse gen. et sp. nov., *?Aruntacyathus rossi* Kruse sp. nov., *Beltanacyathus* Bedford & Bedford and the radiocyathan *Radiocyathus minor* (Bedford & Bedford); they are present only in the lowermost 50 m of the 'thick- bedded unit' (Fig. 3). The upper limit of the range of the archaeocyaths is represented by a prominent band of silicified fossiliferous dolostone crowning the scarp on the western side of the gorge. No fossils have been recovered from the 'thin-bedded unit'.

The Todd River Dolomite is overlain with apparent conformity by the Giles Creek Dolomite (Wells & others, 1967). The rich biota recorded from this unit, of hyoliths (including *Biconulites*), brachiopods, gastropods, trilobites (including *Redlichia amadeana* Öpik 1970), and the alga *Girvanella,* is considered to be Ordian (earliest Middle Cambrian) in age (Gilbert-Tomlinson *in* Wells & others, 1967, 1970).

Conformably underlying the Todd River Dolomite is the Arumbera Sandstone (Prichard & Quinlan, 1962), which in its upper parts (informally termed Arumbera II and III) contains trace fossils considered to be Early Cambrian (Gilbert-Tomlinson *in* Wells & others, 1967, 1970; Glaessner, 1969) (Fig. 4). Daily (1972, 1976a-c) has regarded the Arumbera II and III interval (his Box Hole and Allua Formations respectively) as equivalent to a part of the earliest (Tommotian) stage of the Siberian Early Cambrian (Zhuravleva & others, 1969; Banks, 1970; Alpert, 1977).

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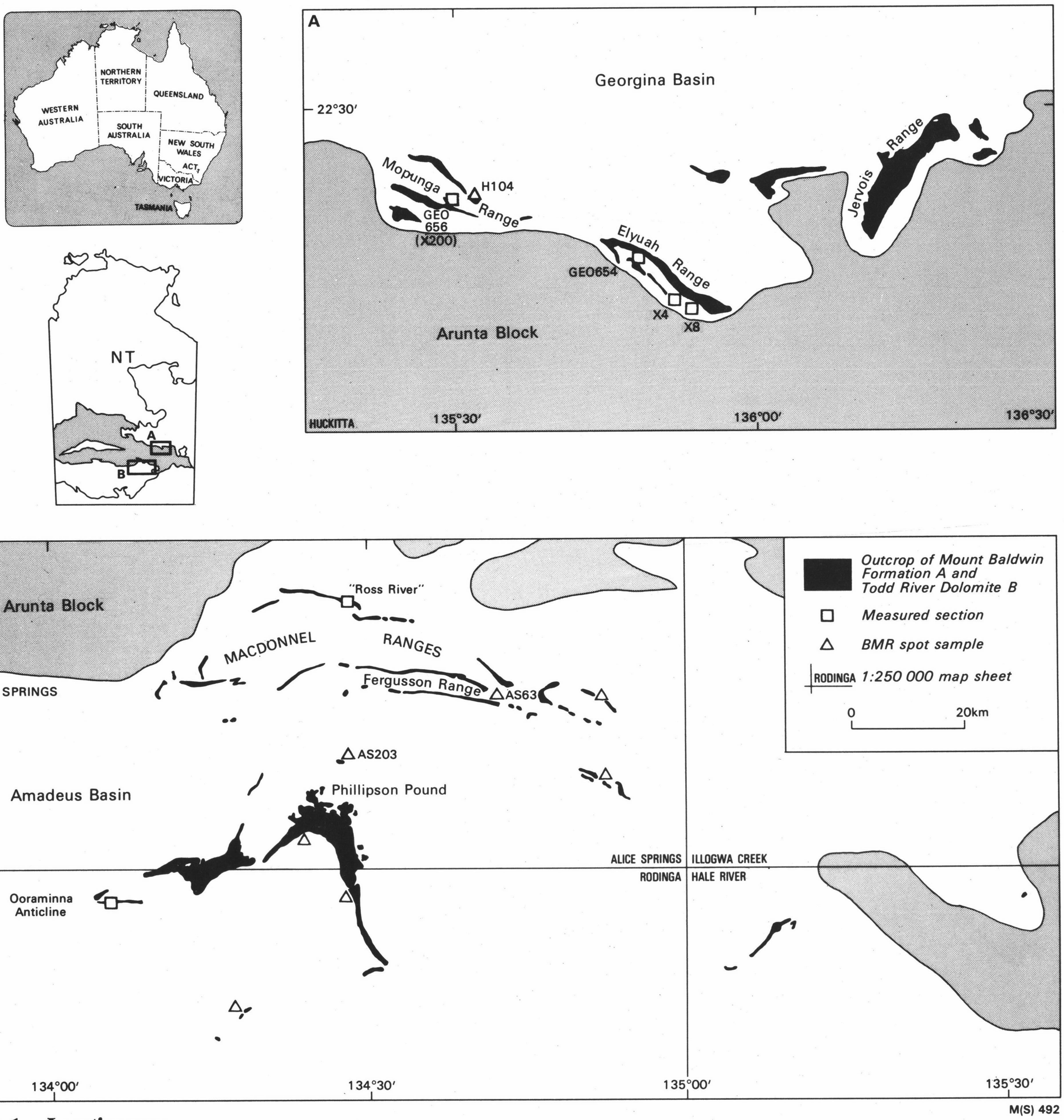

Figure 1. Location map.
Prefixes: AS—BMR spot samples; GEO—measured or remeasured sections of this study; X—section designations of Smith (1964).

In the Ooraminna Anticline section (Fig. 5) the Todd River Dolomite is overlain by the Chandler Limestone, an unfossiliferous sequence of evaporites and grey laminated and contorted limestones tentatively referred to the Early Cambrian by Wells & others (1967, 1970). *Coscinocyathus bilateralis* (Taylor), '*Dictyocyathus*', and *Aruntacyathus toddi* Kruse gen. et sp. nov. have been identified from lenses of pink dolostone in the uppermost 10-12 m of the section (Fig. 6), in association with elements of Faunal Assemblage No. 2 (Daily, 1972). This more restricted archaeocyathan fauna is also encountered in the Todd River Dolomite of intervening areas between Ross River and the Ooraminna Anticline.

Georgina Basin

Exposure of the archaeocyath-bearing Mount Baldwin Formation is confined to the environs of the Mopunga, Elyuah and Jervois Ranges on the HUCKITTA 1:250 000 Sheet. The type section (X4 of Smith, 1964) is in the Elyuah Range, where the formation is of the order of 300 m thick (Fig. 1). (PWW considers the sandstones above the archaeocyathan horizon in the type section (Smith, 1964, fig. 15) to be a faulted repetition of lower beds of the Mount Baldwin Formation.)

Three broad lithological divisions recognised within the formation are: a basal red-purple siltstone shale unit (90-150 m); a resistant red sandstone unit (140-210 m); an uppermost dolostone unit (60-80 m) capped by a single dolostone archaeocyathan horizon of 1-2 m thickness. This horizon, with its fauna of *Aldanocyathus greeni* Kruse sp. nov., *Coscinocyathus bilateralis* (Taylor), '*Dictyocyathus*', *Aruntacyathus toddi* Kruse gen. et sp. nov., and *Radiocyathus minor* (Bedford & Bedford) can be traced discontinuously through the Mopunga and Elyuah Ranges. For the present study, the horizon was sampled at four separate localities, altogether some 50 km apart (Fig. 7).

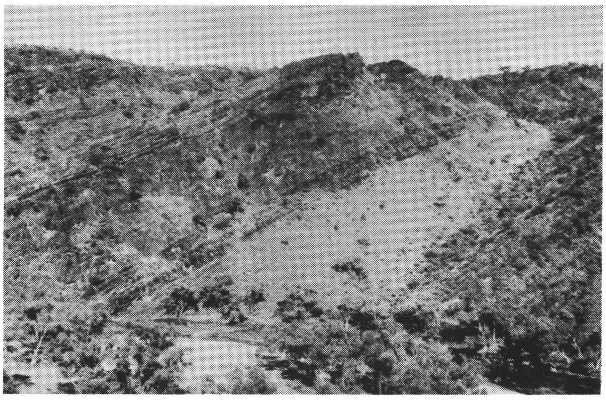

Figure 2. Type section of Todd River Dolomite, western side of Ross River gorge.
Arumbera III ('Allua Formation') at right; vegetated area at centre represents the 'thin-bedded unit' of the Todd River Dolomite; upper part of cliff scarp (above dark stratum) is the 'thick-bedded unit', with Archaeocyatha; Giles Creek Dolomite at left background.

The dolostones of the overlying Arthur Creek Beds (Smith, 1964) in the Mopunga and Elyuah Ranges are sparsely fossiliferous, with only localised occurrences of hyoliths and possibly Ordian trilobites and brachiopods (Casey & Gilbert-Tomlinson, 1956; Smith, 1964). However, equivalent shales, limestones, and sandstones of the Arthur Creek Beds in the Jervois Range have yielded abundant faunas of trilobites, brachiopods and sponge spicules, spanning much of the Middle Cambrian (Smith, 1964, 1972; Gatehouse, 1968; Shergold, 1969; Öpik, 1970).

At present the archaeocyathan horizon, located in a continuous sequence of dolostones, constitutes the boundary between the Mount Baldwin Formation and Arthur Creek Beds in the Mopunga and Elyuah Ranges. Revision of the stratigraphy is necessary in order to bring the nomenclature into conformity with current stratigraphic practice.

Two algal occurrences were recorded from dolostones of the Mount Baldwin Formation below the archaeocyathan horizon in the Mopunga Range by Smith (1964). The stratigraphically higher of these contains the columnar stromatolite *Georginia howchini* Walter (1972) of 'early Cambrian or Vendian age' (Fig. 7). An abundant and diverse trace fossil fauna is also known from sandstones in the middle part of the Mount Baldwin Formation in the northeastern Jervois Range. These traces are of similar aspect to those from Arumbera II and III of the Amadeus Basin (M. R. Walter, pers. comm., 1978).

Systematic palaeontology

Specimens bearing the prefix SUP are deposited in the collection of the Department of Geology and Geophysics, University of Sydney; those bearing the prefixes CPC or F are deposited in the collection of the Bureau of Mineral Resources, Canberra.

The following abbreviations are used in the accompanying tables: *holotype. *Cup*: ø, cup diameter; w, intervallum width; loc, ratio of sides of interseptal loculi in transverse section; SC, Septal Coefficient = number of septa/cup diameter; GPC, General Porosity Coefficient = porosity coefficient for inner wall/porosity coefficient for outer wall. *Walls, septa and tabulae*: n, number of vertical pore rows (per intersept for walls; across intervallum for septa); ø, pore diameter; l, lintels (horizontal distance between adjacent rims of neighbouring pores); ø/l, Porosity Coefficient; t, wall-septum-tabula thickness; r, number of radial pore rows per intersept; p, number of pores per radial row.

Phylum ARCHAEOCYATHA Bornemann, 1884

Class REGULARES Vologdin, 1937

Family AJACICYATHIDAE Bedford & Bedford, 1939

Genus **ALDANOCYATHUS** Voronin *in* Debrenne & Voronin, 1971

Type species: Ajacicyathus sunnaginicus Zhuravleva, 1960; OD Voronin *in* Debrenne & Voronin, 1971.

Diagnosis: Outer and inner walls with simple pores, septa completely porous.

Remarks: Aldanocyathus is a cosmopolitan genus ranging throughout the Tommotian, Atdabanian, and Lenian stages (*sensu* Rozanov, 1973; Rozanov & Debrenne, 1974) of Siberia. The genus is distinguished

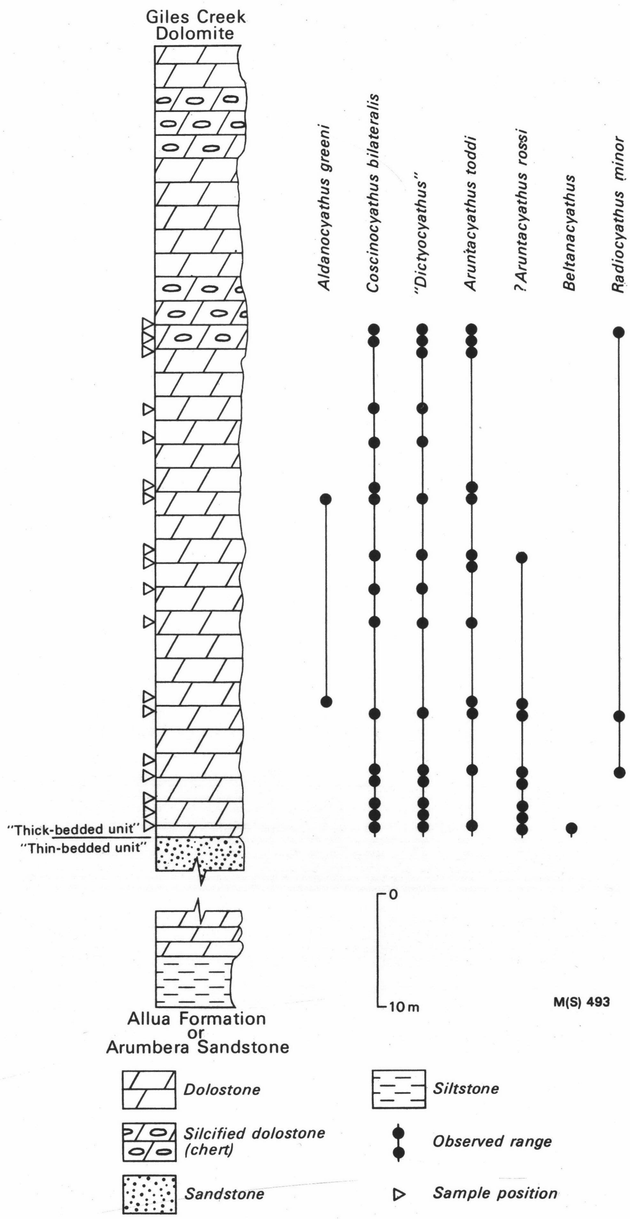

Figure 3. Stratigraphic column of type section of Todd River Dolomite, Ross River.

from *Ajacicyathus* Bedford & Bedford (1939) by the completely porous nature of the septa and by the absence of true stirrup pores.

True stirrup pores are formed by the union of a wall pore with an adjacent septal pore, such that the septal pore constitutes a hemispherical indentation in the septal margin. In genera showing this feature, true stirrup pores are consistently present along the entire length of each septal margin, on either the inner wall, outer wall, or both walls. By contrast, false stirrup pores represent the occasional or sporadic amalgamation of a septal pore with a wall pore. There is no consistent pattern of occurrence. Resultant indentations of the septal margin may be a variety of shapes, as determined by the shape of the component septal pore.

ALDANOCYATHUS GREENI Kruse sp. nov.
Fig. 8A-F

Name: After Mr Gil Green, co-manager of Ross River tourist camp.

Material: 10 specimens: holotype CPC18354, paratypes SUP86201-86203, CPC18684, additional material F24097-24098, 24120-24122. Ross River, Phillipson Pound (AS203), Mopunga Range (GEO656), Elyuah Range (GEO654).

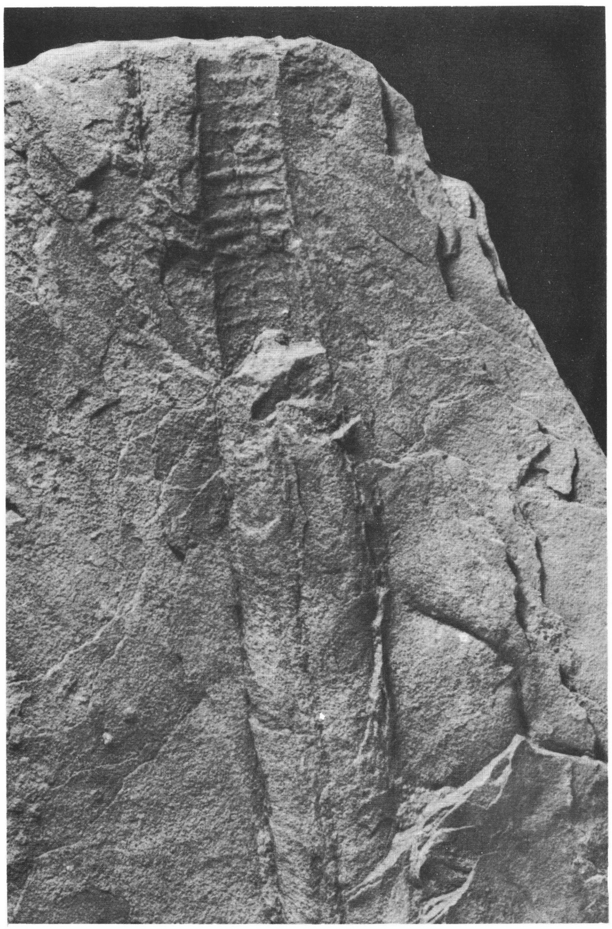

Figure 4. Plagiogmus from Arumbera III ('Allua Formation'), Ross River.
The upper surface (lower half of photo) is comparable to specimens figured by Glaessner (1969, fig. 9C) as 'molluscan trails'. These forms must now be included in *Plagiogmus*. Glaessner's reconstruction of *Plagiogmus* (p. 387, fig. 8) requires modification to allow for a median longitudinal groove on the upper surface.

Diagnosis: Septa with 6-8 pore rows, pores in centre of intervallum being somewhat larger. False stirrup pores present on both walls.

Description: Cup conical, diameter up to 11.1 mm, with intervallum 1.8 mm in width. Outer wall with 2-3 rows of simple rounded pores per intersept (diameter 0.10

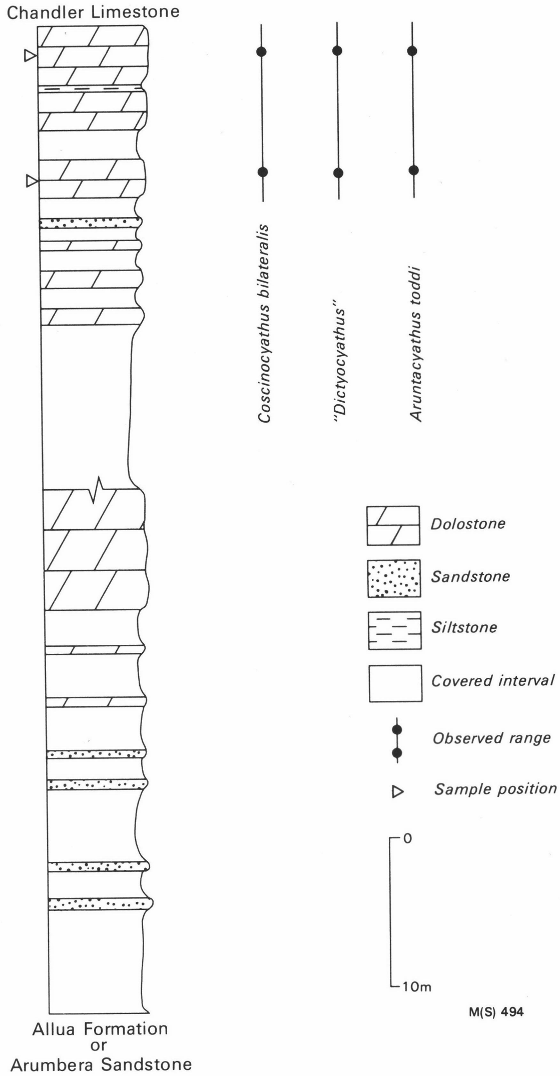

Figure 5. Stratigraphic column of section of Todd River Dolomite, southern limb of Ooraminna Anticline.

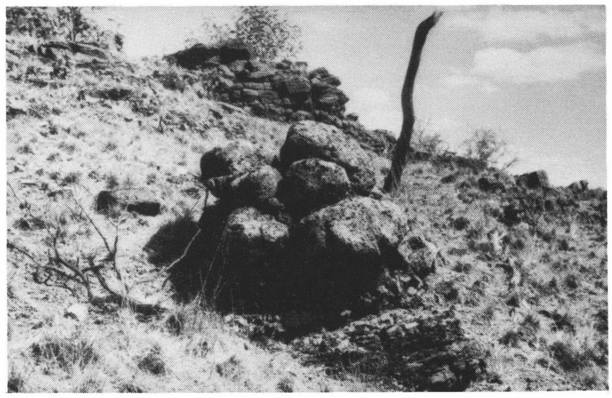

Figure 6. Archaeocyath-bearing dolostone lens in uppermost Todd River Dolomite, southern limb of Ooraminna Anticline.
Lens about 1 metre in size.

mm, lintels 0.09 mm, wall thickness 0.1 mm), and rare false stirrup pores. Inner wall with 2-3 rows of simple, rounded pores per intersept (diameter 0.11 mm, lintels 0.07 mm, wall thickness 0.1 mm); false stirrup pores common. Septa with 6-8 rows of rounded to elliptical or ovoid pores (diameter 0.12 mm, lintels 0.11 mm). Septal pores in centre of intervallum may be larger and more elongate (up to 0.18 mm diameter) than those nearer the walls. False stirrup pores are formed where a septal pore row converges with either wall; this takes place more commonly at the inner wall (Fig. 8C). Septal coefficient 6.3-7.4. Ratio of sides of interseptal loculi 1/3.8-1/5.0.

Remarks: A. grandiporus (Taylor, 1910) from the Ajax Limestone of the Ajax Mine, South Australia shows comparable variation in septal porosity, but lacks the false stirrup pores of *A. greeni*. As well, septa are more widely spaced in *A. grandiporus*. No other Australian species of *Aldanocyathus* is known.

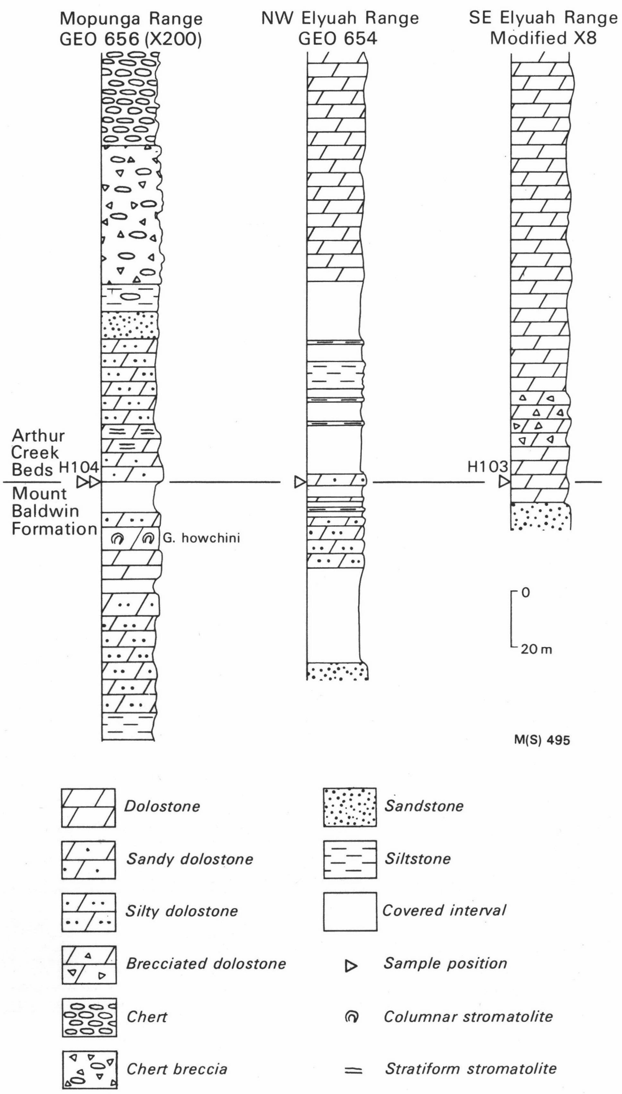

Figure 7. Stratigraphic columns of upper (dolostone) portion of Mount Baldwin Formation and lower portion of Arthur Creek Beds.
Sections measured or remeasured in this study are prefixed GEO; X and H refer to sections and localities respectively of Smith (1964). Archaeocyathan horizon is used as a datum and is not necessarily considered to be isochronous.

	* *CPC 18354*	*SUP 86203*	*SUP 86201*	*CPC 18684*	*SUP 86202*
ϕ	7.6	11.1	10.9	9.7	8.2
w	1.3	1.7	1.5	1.8	1.6
loc	1/4.2	1/3.8	1/4.1	1/4.6	1/5.0
SC	7.4	6.6	6.3	6.6	7.4
GPC	1.4	1.1	1.8	1.0	1.6
Outer wall:					
n	2(3)	2–3	2(3)	2–3	~2
ϕ	0.09	0.11	0.10	0.10	0.12
l	0.10	0.07	0.09	0.08	0.10
ϕ/l	0.9	1.6	1.1	1.3	1.2
t	0.1	0.1	0.1	0.1	0.1
Inner wall:					
n	2	2–3	2(3)	2–3	2
ϕ	0.12	0.09	0.10	0.10	0.13
l	0.09	0.05	0.05	0.08	0.07
ϕ/l	1.3	1.8	2.0	1.3	1.9
t	0.1	0.1	0.1	0.1	0.1
Septa:					
n	6	7	6–8	6–8	~6
ϕ	0.12	0.14	0.10	0.12	0.10
l	0.09	0.10	0.12	0.09	0.13
ϕ/l	1.3	1.4	0.8	1.3	0.8
t	0.07	0.07	0.07	0.07	0.09

Family Coscinocyathidae Taylor, 1910

Genus **COSCINOCYATHUS** Bornemann, 1884

Type species: Coscinocyathus dianthus Bornemann, 1884; ICZN plenary powers; ICZN, 1974; Debrenne, 1970a.

Diagnosis: Outer and inner walls with simple pores, septa and tabulae completely porous.

Remarks: Coscinocyathus is a common genus of the upper Tommotian, Atdabanian, and Lenian stages (*sensu* Rozanov, 1973; Rozanov & Debrenne, 1974) of Siberia.

COSCINOCYATHUS BILATERALIS (Taylor)

Figs. 8G-J, 9A-B

v*1910 *Coscinoptycha bilateralis* Taylor, p. 142, pl. 2, fig. 6, pl. 6, fig. 32, pl. 11, figs. 61-63, text-fig. 6.

1937 *Coscinocyathus fultus* Gordon; Ting, pl. 11, fig. 1.

1960 *Coscinoptycta bilateralis* (Taylor); Debrenne & Debrenne, p. 699, pl. 19, figs. 10-13, pl. 20, fig. 6.

non1964 *Coscinoptycta bilateralis* (Taylor); Hill, p. 614, fig. 2(14-18).

1979 'Coscinoptycta' bilateralis Taylor; Walter & others, p. 308.

Lectotype chosen herein: South Australian Museum T1550 Z-23, Early Cambrian, Ajax Limestone, Ajax Mine area, South Australia.

Material: 124 specimens: SUP86204-86288; CPC18355; F24097-24103, 24123-24153. Ross River, Fergusson Range (AS63), Phillipson Pound (AS203), Ooraminna Anticline, Mopunga Range (GEO656), Elyuah Range (GEO654, X8).

Diagnosis: Intervallum narrow, rarely exceeding 1.1 mm in width. Septa with 3-5 widely spaced pore rows. Tabulae widely spaced.

Description: Cup conical until early maturity, becoming irregular in very large cups (Fig. 9A); cup diameter up to 12.9 mm, with intervallum width constant at 0.8-1.1 mm. Outer wall with 2-4 rows of simple, rounded pores per intersept (diameter 0.13 mm, lintels 0.09 mm, wall thickness 0.1 mm). Inner wall with 2-3 rows of simple, rounded pores per intersept (diameter 0.13 mm, lintels 0.08 mm, wall thickness 0.1 mm). Septa with 3-5

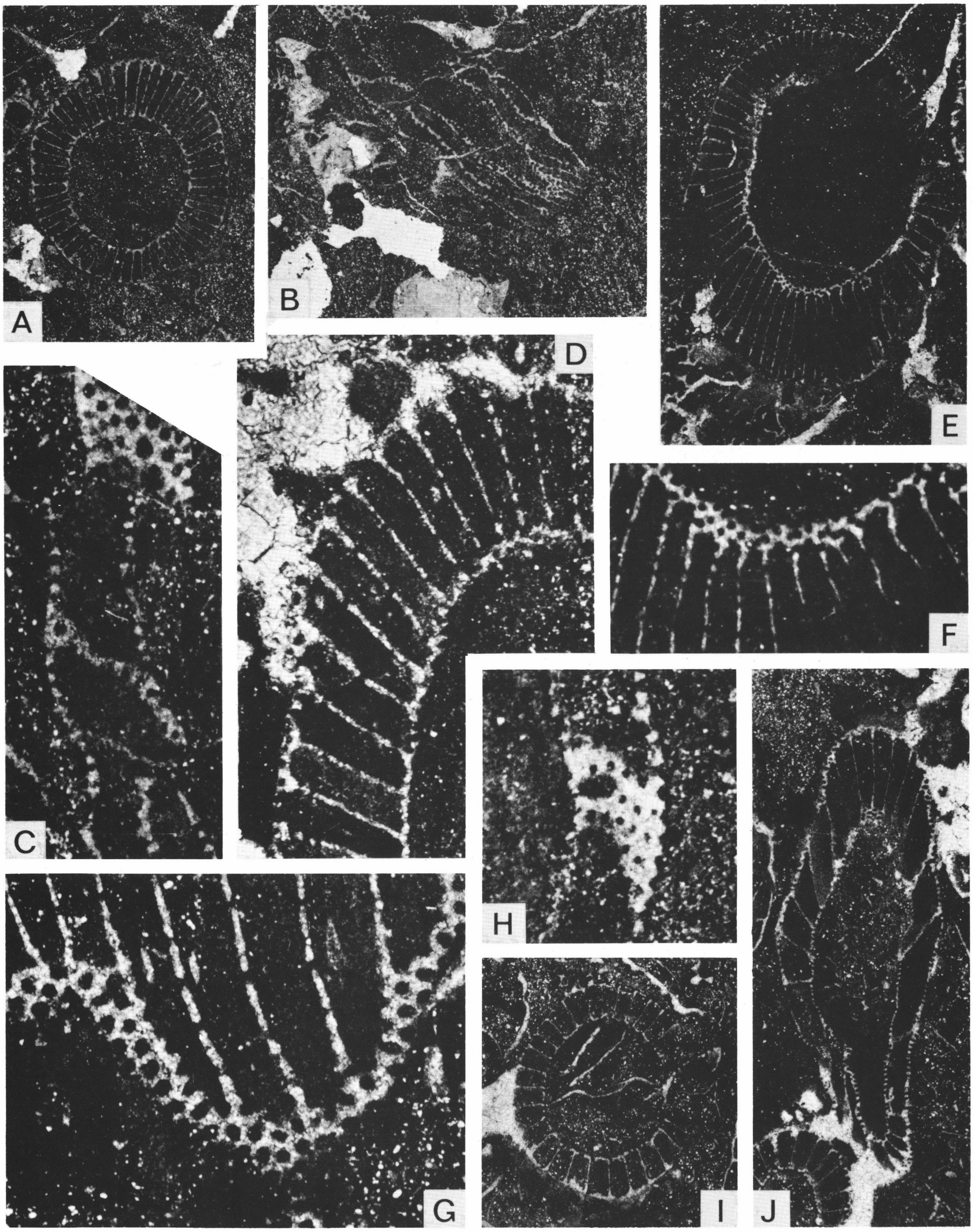

Figure 8. Aldanocyathus greeni Kruse sp. nov.
A-C. Holotype CPC 18354. A. Transverse section X4. B. Longitudinal section X4. C. Detail of longitudinal section showing septal porosity X12. D. Paratype SUP 86203, detail of transverse section showing false stirrup pores on outer wall X12. E-F Paratype SUP 86201. E. Transverse section X4. F. Detail of transverse section showing false stirrup pores on inner wall X12.
Coscinocyathus bilateralis (Taylor).
G. Specimen SUP 86225, detail of longitudinal section showing outer wall X12. H. Specimen CPC 18355, detail of longitudinal section showing septal porosity X12. I-J. Specimen SUP 86220. I. Transverse section X4. J. Longitudinal section X4.

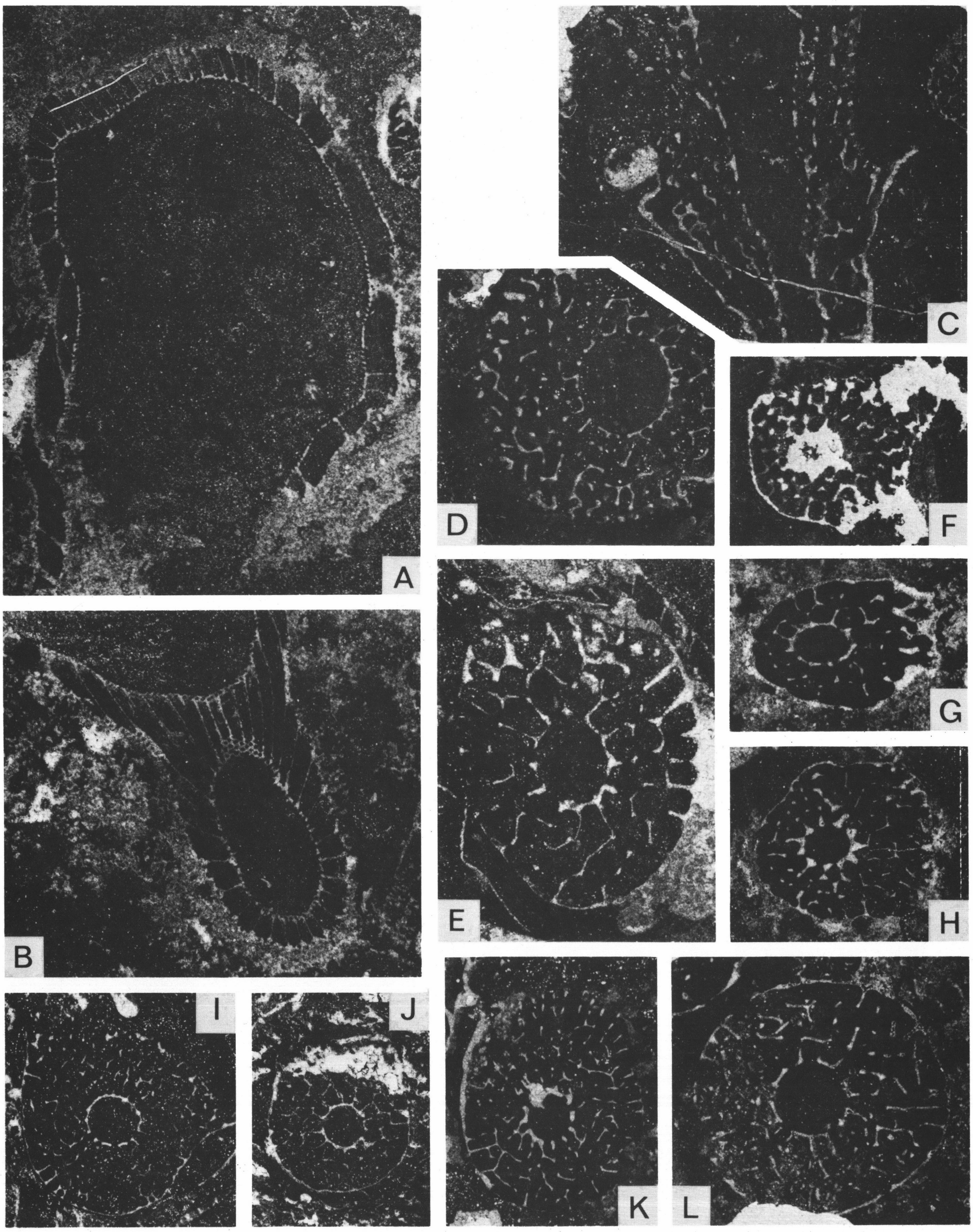

Figure 9. Coscinocyathus bilateralis (Taylor).
A-B. Specimen SUP 86274. A. Transverse section X4. B. Longitudinal section X4.
'Dictyocyathus'.
C-D specimen SUP 86291. C. Longitudinal section X4. D. Transverse section X4. E. Specimen SUP 87156, transverse section X4. F. Specimen SUP 87177, transverse section X4. G. Specimen SUP 87176, transverse section X4. H. Specimen SUP 87152, transverse section X4. I. Specimen SUP 87170, transverse section X4. J. Specimen SUP 87158, transverse section X4. K. Specimen SUP 87180, transverse section X4. L. Specimen SUP 87174, transverse section X4.

widely spaced rows of rounded pores (diameter 0.09 mm, lintels 0.11 mm); pores also form slightly arched horizontal files. Septal coefficient 3.7-6.3. Ratio of sides of interseptal loculi 1/1.4-1/2.2. Tabulae flat, widely and irregularly spaced in mature cups, with 3-5 radial rows of 5-7 pores each per loculus (diameter 0.10 mm, lintels 0.05 mm).

Remarks: Taylor's (1910) original description of *C. bilateralis* was based on fragments of large cups from the Ajax Mine, South Australia. The present collection illustrates the intervening growth stages between these ribbon-like forms and the small conical cups of this species figured by Ting (1937) as *C. fultus* Gordon.

Although *Coscinocyathus* is a genus of widespread occurrence, the two species of Taylor, *C. bilateralis* and *C. australis,* are distinctive in the wide spacing of their septal pore rows and in their remotely spaced tabulae. *C. australis* has a wider intervallum (up to 3.5 mm) than *C. bilateralis.*

	SUP 86274	*CPC 18355*	*SUP 86264*	*SUP 86288*	*SUP 86220*	*SUP 86287*
ϕ	12.9	10.0	8.1	7.9	7.6	7.0
w	1.0	1.1	0.8	1.0	1.1	1.0
loc	1/2.2	1/1.7	1/1.5	1/1.6	1/1.8	1/1.4
SC	3.9	4.0	6.3	3.7	3.9	4.3
GPC	0.8	1.2	1.2	1.1	1.1	0.8
Outer wall:						
n	2	3–4	2–3	3–4	2–4	4
ϕ	0.14	0.11	0.11	0.14	0.15	0.13
l	0.08	0.10	0.08	0.08	0.08	0.09
ϕ/l	1.8	1.1	1.4	1.8	1.9	1.4
t	0.12	0.1	0.1	0.1	0.09	0.11
Inner wall:						
n	2	2–3	2	2–3	2–3	2–3
ϕ	0.12	0.12	0.12	0.16	0.15	0.11
l	0.08	0.09	0.07	0.08	0.07	0.10
ϕ/l	1.5	1.3	1.7	2.0	2.1	1.1
t	0.10	0.1	0.1	0.1	0.10	0.10
Septa:						
n	5	4–5	4–5	4	3–5	4–5
ϕ	0.08	0.09	0.09	0.09	0.09	0.10
l	0.11	0.12	0.10	0.10	0.10	0.12
ϕ/l	0.7	0.8	0.9	0.9	0.9	0.8
t	0.05	0.05	0.06	0.04	0.05	0.04
Tabulae:						
r		4		3–5	3–4	
p	5–6	~6	5–7	~7	~7	~7
ϕ	0.11	0.10		0.11	0.09	0.09
l		0.05		0.06	0.05	0.05
ϕ/l		2.0		1.8	1.8	1.8
t	0.09	0.05	0.1	0.1	0.09	0.04

Class Irregulares Vologdin, 1937

Family Dictyocyathidae Taylor, 1910

Genus 'DICTYOCYATHUS' Bornemann, 1891

Type species: Dictyocyathus tenerrimus Bornemann, 1891; M.

Diagnosis: Both walls 'simple' in mature stages, with one pore per 'intersept'; walls formed largely by elements of the intervallum; intervallum composed of radial, vertical and tangential rods forming an orthogonal framework.

Remarks: Bornemann's conception of the genus *Dictyocyathus* is insufficiently known—the original specimens were poorly figured and described, and the type material is no longer extant. The diagnosis given above corresponds to that in current usage (Debrenne, 1974).

'DICTYOCYATHUS' spp.

Fig. 9C-L

Material: 73 specimens: SUP86215, 86220, 86222, 86254, 86262-86263, 86289-86299, 87150-87180; F24099, 24104-24108, 24138, 24149, 24165, 24180, 24184, 24194-24207. Ross River, Fergusson Range (AS63), Phillipson Pound (AS203), Ooraminna Anticline, Mopunga Range (GEO656), Elyuah Range (GEO654, X8).

Description: Cup narrowly conical, diameter up to 12.5 mm, with intervallum 4.2 mm in width. Outer wall aporose in juvenile stages, becoming 'simple' when cup diameter reaches 6-11 mm. Outer wall is contracted inward at this point (Fig. 9C). Pores of both walls bounded by adjacent rods of the intervallar framework; inner wall pores are well defined, and elliptical in outline (diameter 0.3-0.7 mm, wall thickness 0.1-0.2 mm), and form vertical rows, one per 'intersept'. Intervallum composed of an orthogonal framework of rods (thickness 0.07-0.13 mm) ranging in length from 0.2 to 0.85 mm. Radial and vertical rods may give the appearance of constituting 'pseudosepta', with 'pores' defined by adjacent rods. These 'pores' are subquadrate in outline, arranged in near-vertical rows inclined steeply upward toward the outer wall.

Remarks: The Australian forms assigned to *'Dictyocyathus'*, including *'D.' irregularis* Taylor (1910) and *'D.' quadruplex* Bedford & Bedford (1936), have an aporose outer wall in the juvenile stage. An examination of *'Dictyocyathus'*-like forms in the collection of D. Gravestock (University of Adelaide) has established that such forms are the young stages of irregular archaeocyathan cups.

	SUP 87180		*SUP 87179*	*SUP 87156*	*SUP 87174*	*SUP 87158*
ϕ	12.5	7.4	10.5	9.4	8.7	6.1
w	4.2	2.6	3.9	3.0	2.8	2.2
rod length	0.59	0.45	0.58	0.85	0.61	0.54
rod t	0.10	0.09	0.11	0.11	0.10	0.07
Outer wall:						
ϕ	0.6					
t	0.2	0.05–0.2	0.05–0.1	0.05–0.15	0.1–0.2	0.1
Inner wall:						
ϕ	0.5	0.3	0.3	0.7	0.5	0.4
t	0.2	0.15–0.2	0.1–0.2	0.1	0.1	0.1

Family Metacyathidae Bedford & Bedford, 1934

Genus ARUNTACYATHUS Kruse gen. nov.

Name: After the Arunta aboriginal people.

Type species: A. toddi Kruse sp. nov.

Diagnosis: Outer and inner walls simple, becoming sheathed in very mature stages of ontogeny; rod-like buttresses ('arcs-boutants' of Debrenne, 1974) connect septal margins with both walls; septa completely porous; synapticulae present.

Remarks: Outer wall buttresses are also known in the genus *Spirillicyathus* Bedford & Bedford (1937). The inner wall of *Spirillicyathus* differs from that of *Aruntacyathus* in being simple throughout ontogeny, with one pore, or rarely two pores, per intersept.

ARUNTACYATHUS TODDI Kruse sp. nov.

Figs. 10, 11

1979 new genus of Metacyathidae; Walter & others, p. 308.

Name: After Sir Charles Todd (1826-1910) and the Todd River Dolomite.

Material: 134 specimens: holotype CPC18356; paratypes SUP87202, 87205, 87228, 87233, CPC18357; additional material SUP86279, 87173, 87181-87256, F24099, 24106, 24109-24119, 24124, 24154-24193.

Ross River, Fergusson Range (AS63), Phillipson Pound (AS203), Ooraminna Anticline, Mopunga Range (GEO656), Elyuah Range (GEO654, X8).

Diagnosis: Septal pores large, rounded. Buttresses subtend medium to high angle to wall. Synapticulae occur in clusters.

Description: Cup conical, bifurcating to become 'colonial' in maturity; cup diameter up to 20 mm, with intervallum up to 3.7 mm in width. Outer wall with 2-5 irregular rows of rounded to irregular pores per intersept (diameter 0.18 mm, lintels 0.11 mm, wall thickness 0.2 mm). Rod-like buttresses unite septal margins to the outer wall: in young cups buttresses of adjacent septa mutually intersect the wall at a mid-interseptal position, so delineating a pair of wall pores in each intersept. Additional pores or pore rows appear with maturity. In mature specimens, particularly on the inner wall, there is a tendency for adjacent buttresses to coalesce at a point slightly behind the wall, with a common rod attaching normally to the wall (Fig. 11A). Buttresses subtend moderate to high angle to wall, and are spaced about a half to two millimetres apart longitudinally. In cups of diameter above about 15 mm, the outer wall becomes sheathed; sheath consists of a proliferation of fine lintels forming 2-6 irregularly shaped micropores per framework pore (diameter 0.07-0.15 mm, lintels 0.07 mm). Inner wall with 2-5 irregular rows of rounded to irregular pores per intersept (diameter 0.19 mm, lintels 0.10 mm, wall thickness 0.2 mm). Buttresses of similar arrangement to those on the outer wall unite septal margins with the inner wall. Inner wall becomes sheathed almost simultaneously with the outer wall, with an equivalent arrangement of micropores. Septa straight, with 5-9 near-vertical rows of rounded to ovoid pores (diameter 0.26 mm, lintels 0.20 mm); pore size variable, ranging from 0.2 up to 0.5 mm. There are false stirrup pores at junctions with both walls. Septal coefficient 2.2-3.2. Ratio of sides of interseptal loculi 1/2.4-1/4.0. Synapticulae rare, but when present tend to be clustered (Fig. 10A).

Remarks: Buttresses are present in all observed stages of ontogeny (from cup diameter about 8 mm). Younger ontogenetic stages were not identified due to poor preservation.

	**CPC 18356*	*SUP 87228*	*SUP 87233*	*SUP 87205*	*SUP 87202*	*CPC 18357*
ϕ	15	20	19.4	13.8	12.5	9.6
w	2.0	3.3	2.7	3.1	3.7	2.4
loc	1/2.9	1/3.3	1/4.0	1/2.8	1/4.0	1/2.4
SC	3.0	2.2	3.2	2.2	2.2	2.3
GPC	1.1	1.3	0.9	1.2	0.9	1.3
Outer wall:						
n	2–4	3–5	3–4	3–4	3–4	2–4
ϕ	0.19	0.17	0.21	0.19	0.19	0.14
l	0.09	0.11	0.09	0.13	0.12	0.11
ϕ/l	2.1	1.5	2.3	1.5	1.6	1.3
t	0.2	0.2	0.2	0.2	0.2	0.2
Inner wall:						
n	3–5	3–4	2–4	2–3	2–3	2–3
ϕ	0.17	0.18	0.18	0.20	0.18	0.20
l	0.07	0.09	0.09	0.11	0.13	0.12
ϕ/l	2.4	2.0	2.0	1.8	1.4	1.7
t	0.2	0.2	0.1	0.2	0.2	0.2
Septa:						
n	6–7	6–8	7–9	~7	~8	5–6
ϕ	0.25	0.29	0.21	0.30	0.29	0.24
l	0.17	0.23	0.19	0.23	0.17	0.20
ϕ/l	1.5	1.3	1.1	1.3	1.7	1.2
t	0.09	0.11	0.08	0.10	0.10	0.11

?ARUNTACYATHUS ROSSI Kruse sp. nov.

Figs. 12, 13A-B

Name: After Mr John Ross (1817-1903) and Ross River.

Material: 54 specimens: holotype SUP87257, paratypes SUP87281, 87289, 87299, 88151, 88153, additional material SUP86221, 86292, 87189, 87258-87298, 88150-88157. Ross River.

Diagnosis: Septal pores large, rounded to elliptical, ovoid or irregular. Buttresses subtend low angle to wall. Synapticulae spaced evenly across intervallum.

Description: Cup conical, diameter up to 16.6 mm, with intervallum 3.1 mm in width. Outer wall with 2-4 irregular rows of rounded to irregular pores per intersept (diameter 0.15 mm, lintels 0.12 mm, wall thickness 0.1 mm). Rod-like buttresses unite septal margins with the outer wall: in young cups buttresses of adjacent septa mutually intersect the wall at a mid-interseptal position, so delineating a pair of wall pores in each intersept. Additional pores or pore rows appear with maturity. Buttresses subtend low angle to wall. Inner wall with 2-4 irregular rows of rounded to irregular pores per intersept (diameter 0.15 mm, lintels 0.11 mm, wall thickness 0.1 mm). Buttresses of similar arrangement to those on the outer wall unite septal margins with the inner wall. Septa straight or wavy, closely spaced, with 5-8 rows (?) of rounded to elliptical, ovoid or irregular pores per intersept (diameter 0.30 mm, lintels 0.15 mm); pore size variable, ranging from 0.2 up to 0.5 mm. There are false stirrup pores at junctions with both walls. Septal coefficient 2.9-5.5. Ratio of sides of interseptal loculi 1/3.5-1/5.3. Synapticulae abundant throughout ontogeny, and generally spaced evenly across intervallum.

Remarks: The species is only doubtfully included in the genus *Aruntacyathus*, as very mature specimens, in which a sheath might be expected to be present, are not available for study. The type species *A. toddi* can be distinguished from *?A. rossi* by the rounded shape of septal pores, the more prominent development of buttresses, and the occurrence of synapticulae in clusters.

	**SUP 87257*	*SUP 87281*	*SUP 88153*	*SUP 87289*	*SUP 88151*	*SUP 87299*
ϕ	13.1	16.6	11.3	10.8	10.4	8.9
w	2.5	3.1	2.8	2.5	2.4	2.8
loc	1/3.6	1/4.8	1/3.6	1/3.5	1/4.1	1/5.3
SC	3.4	4.2	2.9	3.3	5.5	3.9
GPC	1.4	1.2	0.9	1.2	1.3	0.9–1.2
Outer wall:						
n	2–3	2–3	2–3	2–3	2–3	2
ϕ	0.15	0.17	0.15	0.14	0.12	0.14
l	0.11	0.13	0.11	0.13	0.11	0.1
ϕ/l	1.4	1.3	1.4	1.1	1.1	1.0–1.4
t	0.1	0.1	0.1	0.1	0.1	0.10
Inner wall:						
n	2	2–3	2–3	2–3	2–3	2
ϕ	0.17	0.18	0.12	0.15	0.11	0.16
l	0.09	0.11	0.10	0.12	0.08	0.13
ϕ/l	1.9	1.6	1.2	1.3	1.4	1.2
t	0.10	0.1	0.1	0.1	0.1	0.1
Septa:						
n	~6	5–8	5–6	6–7	5–6	5–7
ϕ	0.29	0.29	0.34	0.28	0.28	0.31
l	0.15	0.15	0.15	0.12	0.14	0.18
ϕ/l	1.9	1.9	2.3	2.3	2.0	1.7
t	0.07	0.10	0.10	0.09	0.08	0.10

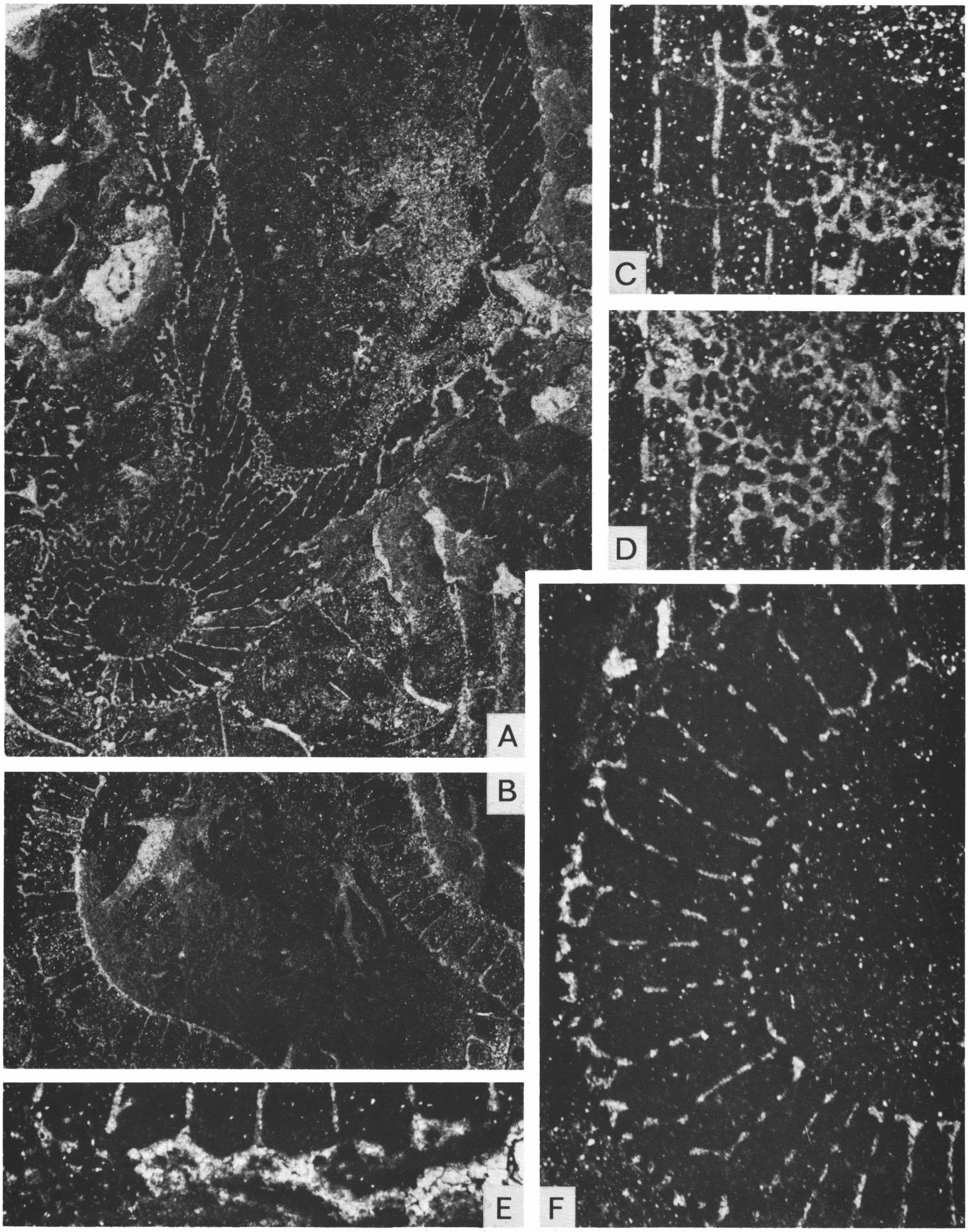

Figure 10. Aruntacyathus toddi Kruse gen. et sp. nov.
A-C. Holotype CPC 18356. A. Longitudinal section showing cluster of synapticulae at lower left X4. B. Transverse section showing bifurcating habit X4. C. Detail of inner wall in longitudinal section showing microporous sheath X12. D-E. Paratype SUP 87233. D. Detail of inner wall in longitudinal section showing microporous sheath X12. E. Detail of outer wall in transverse section showing buttresses X12. F. Specimen SUP 87244, detail of transverse section showing outer and inner wall buttresses X12.

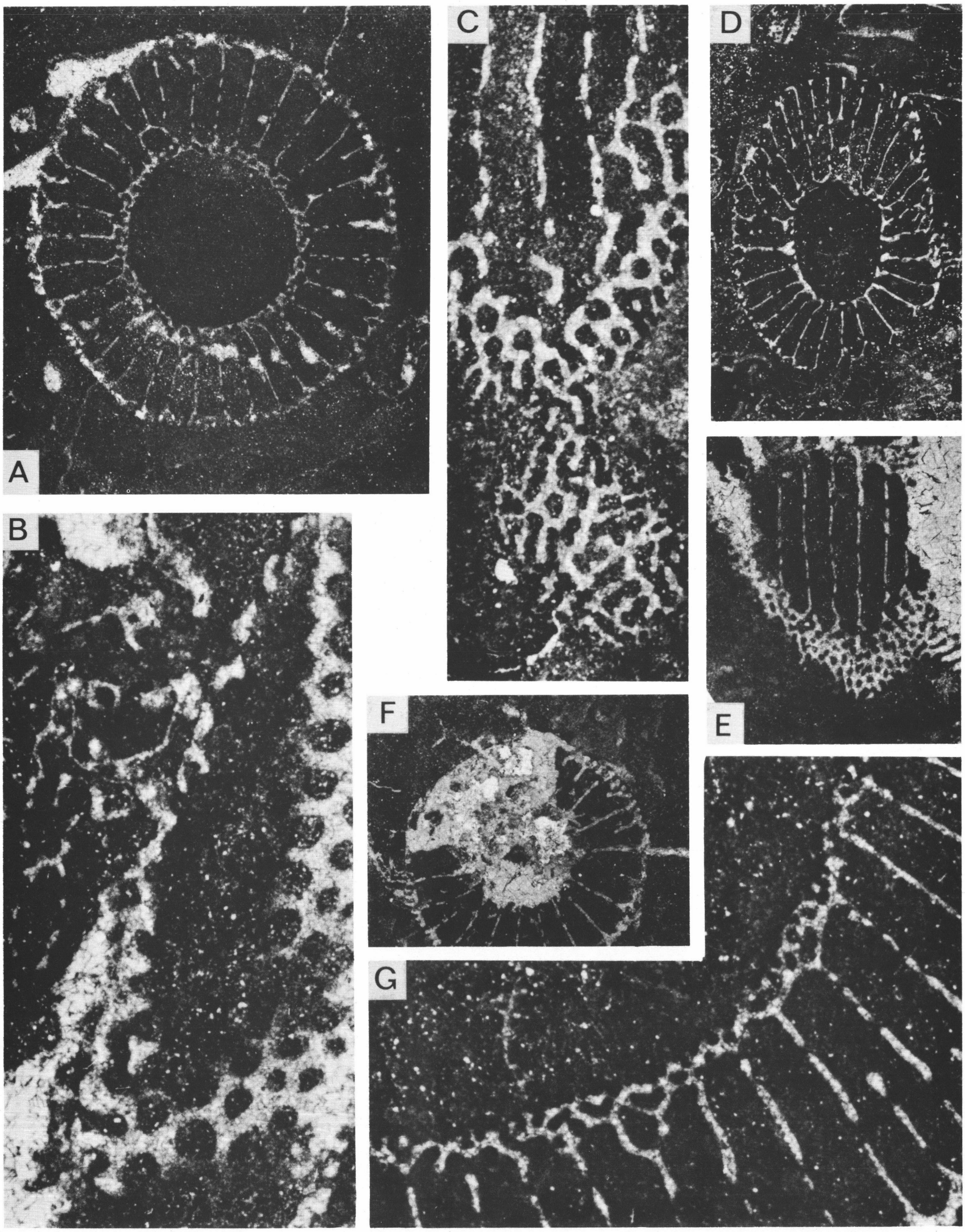

Figure 11. Aruntacyathus toddi Kruse gen. et sp. nov.
A. Paratype SUP 87205, transverse section X4. B. Specimen SUP 87225, detail of longitudinal section showing septal porosity X12. C. Holotype CPC 18356, detail of outer wall in longitudinal section showing microporous sheath X12. D. Specimen SUP 87237, transverse section X4. E. Specimen SUP 87227, longitudinal section showing outer wall prior to formation of microporous sheath X4. F. Paratype CPC 18357, transverse section X4. G. Specimen SUP 87244, detail of inner wall in transverse section showing buttresses X12.

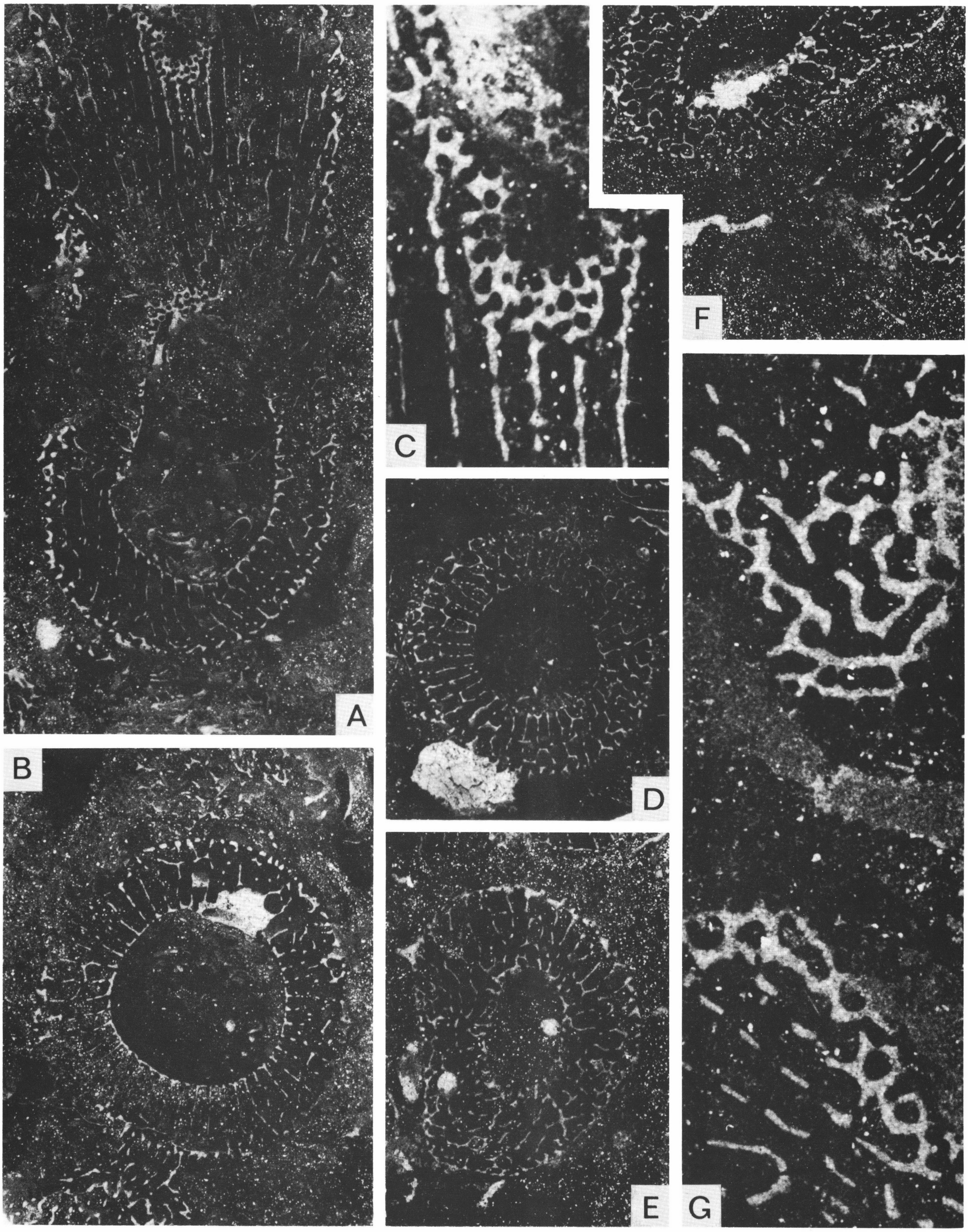

Figure 12. ?Aruntacyathus rossi Kruse sp. nov.
A-C. Holotype SUP 87257. A. Longitudinal section X4. B. Transverse section X4. C. Detail of inner wall in longitudinal section X12. D. Specimen SUP 87287, transverse section X4. E-F. Paratype SUP 87299. E. Oblique transverse section X4. F. Longitudinal section X4. G. Holotype SUP 87257, detail of outer wall in longitudinal section X12.

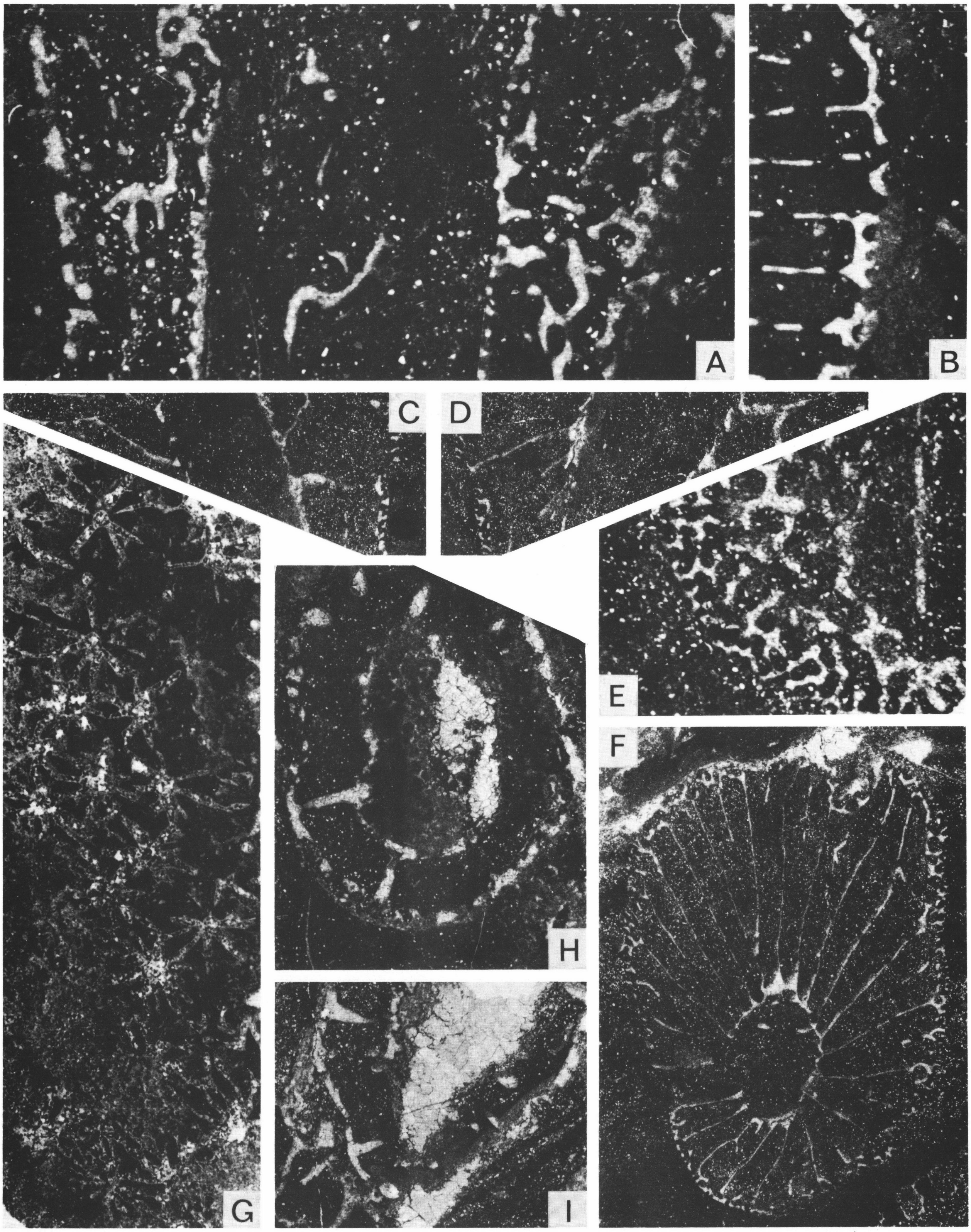

Figure 13. ?Aruntacyathus rossi Kruse sp. nov.

A. Paratype SUP 87289, detail of longitudinal section showing septal porosity X12. B. Holotype SUP 87257, detail of outer wall in transverse section showing buttresses X12.

Beltanacyathus sp.

C-F. Specimen SUP 88158. C. Longitudinal section showing septal porosity X4. D. Longitudinal section showing inner wall pore tubes X4. E. Detail of outer wall in longitudinal section showing microporous sheath X12. F. Transverse section X4.

Radiocyathus minor (Bedford & Bedford).

G. Specimen CPC 18685, detail of outer wall in longitudinal section showing asters X12. H-I. Specimen SUP 88159. H. Transverse section X4. I. Longitudinal section X4.

Family BELTANACYATHIDAE Debrenne, 1970b

Genus **BELTANACYATHUS** Bedford & Bedford, 1936

Type species: Archaeocyathus wirrialpensis Taylor, 1910; SD Debrenne, 1974.

Diagnosis: Outer wall of pore canals protected by a microporous sheath; inner wall with one pore tube per intersept, opening upward into central cavity; intervallum with two types of septa: straight, radial, porous septa linking both walls, and short, incomplete 'quarter-septa' arising from the outer wall.

Remarks: B. ionicus Bedford & Bedford (1936) was originally proposed as type species of *Beltanacyathus*. Debrenne (1974) designated *A. wirrialpensis* as type when *ionicus* was found to be a junior synonym of that species.

BELTANACYATHUS sp.
Fig. 13C-F

Material: 1 specimen: SUP88158. Ross River.

Diagnosis: Septa with large, remotely spaced pores. Inner wall pore tubes steeply inclined upward into central cavity.

Description: Cup conical, diameter 11.9 mm, with intervallum 3.4 mm in width. Outer wall with 2-4 rows of rounded to elliptical pore canals per intersept (diameter 0.40 mm, lintels 0.14 mm, wall thickness 0.3 mm); pore canals angled slightly upward and outward. There are occasional false stirrup pore canals. Pore canals protected by a flat microporous sheath, consisting of 3-5 rounded to irregular micropores (diameter 0.14 mm, lintels 0.07 mm). Inner wall with 1 pore tube per intersept (diameter 0.55 mm, lintels 0.09 mm, wall thickness 0.04 mm), angled steeply upward into central cavity. Septa with 6-7 rows of rounded pores (diameter 0.24 mm, lintels 0.30 mm, septal thickness 0.09 mm). Septal coefficient 1.6. Ratio of sides of interseptal loculi 1/3-1/4. 'Quarter-septa', with a single row of pores close to the outer wall, are common.

Outer wall ϕ/l 2.9, inner wall ϕ/l 6.1, GPC 2.1.

Remarks: The type species *B. wirrialpensis* (Taylor, 1910) and its possible synonym *B. ionicus* Bedford & Bedford (1936; Debrenne, 1974) are known also from the Faunal Assemblage No. 2 interval in the Ajax Limestone of the Ajax Mine area, South Australia. *B. wirrialpensis* is known additionally from that interval in the nearby Mount Scott Range. Other, undescribed forms of *Beltanacyathus* are present within Faunal Assemblage No. 1 levels of the Wilkawillina Limestone at Wilkawillina Gorge, South Australia (D. Gravestock, pers. comm. 1979).

Phylum INCERTAE SEDIS

Class RADIOCYATHA Debrenne, Termier & Termier, 1970

Family RADIOCYATHIDAE Okulitch, 1955

Genus **RADIOCYATHUS** Okulitch, 1937

Type species: Heterocyathus minor Bedford & Bedford, 1934; OD.

Diagnosis: Two-walled conical cups in which asters form a continuous framework; each aster of one wall connects to a corresponding aster of the other wall via an intervallar rod.

Remarks: The genus name is the first proposed substitute for the preoccupied name *Heterocyathus* Bedford & Bedford (1934) *non* Edwards & Haime (1848). In proposing the substitute name *Radiocyathus*, Okulitch (1937) did not cite the type species *R. minor* (Bedford & Bedford). Consequently this entry does not appear in the synonymy list.

RADIOCYATHUS MINOR (Bedford & Bedford)
Fig. 13G-I

*1934 *Heterocyathus minor* Bedford & Bedford, p. 7, pl. 6, fig. 32.
.1934 *Heterocyathus major* Bedford & Bedford, p. 7, pl. 6, fig. 34.
v?1936 *Dictyocyathus macdonnelli* Bedford & Bedford, p. 14, pl. 12, fig. 61.
.1936 *Heterocyathus tertius* Bedford & Bedford, p. 22, pl. 21, fig. 90, pl. 22, fig. 91.
1936 *Heterocyathus minor* Bedford & Bedford; Bedford & Bedford, p. 22, pl. 22, fig. 92.
1955 *Radiocyathus minor* (Bedford & Bedford); Okulitch, p. E18, fig. 13,2.
?1964 *?Alphacyathus macdonnelli* (Bedford & Bedford); Zhuravleva & others, p. 91, text-fig. 55.
1965 *Radiocyathus minor* (Bedford & Bedford); Hill, p. 141, pl. 12, fig. 4.
1970 *Radiocyathus minor* (Bedford & Bedford); Debrenne, Termier & Termier, p. 121, pl. 4, figs. 1-3, pl. 5, fig. 1, pl. 6, figs. 1-2.
.1970 *Radiocyathus major* (Bedford & Bedford); Debrenne, Termier & Termier, p. 121, pl. 4, fig. 4.
.1970 *Radiocyathus tertius* (Bedford & Bedford); Debrenne, Termier & Termier, p. 122, pl. 4, figs. 5-6.
1972 *Radiocyathus minor* (Bedford & Bedford); Hill, p. E141.
?1974 *'Dictyocyathus' macdonnelli* Bedford & Bedford; Debrenne, p. 196, fig. 4.
1974b *Radiocyathus minor* (Bedford & Bedford); Zhuravleva, p. 58.
1979 *Radiocyathus minor* (Bedford & Bedford); Nitecki & Debrenne, p. 8, pl. 1, figs. 1-2, pl. 2, figs. 1-3, pl. 3, fig. 6.
1979 *Radiocyathus minor* (Bedford & Bedford); Walter & others, p. 308.

Material: 10 specimens: SUP88159-88166; CPC18685; F24208. Ross River, Mopunga Range (GEO656).

Diagnosis: Outer wall asters anastomosing on the inner surface, and interfingering on the outer surface of the wall; asters spaced 1-4 mm apart.

Description: Cup conical, diameter up to 33 mm, with intervallum 6.5 mm in width. Outer wall 0.3-0.6 mm in thickness, constructed of asters having 9-12 thickened rays (thickness 0.1-0.4 mm) on the inner surface and 12-21 thinner rays (thickness 0.1-0.3 mm) on the outer surface. Rays on the inner surface anastomose with those of neighbouring asters, forming angled junctions. Those on the outer surface do not anastomose, but interfinger with rays of adjoining asters. Asters spaced 1.1-3.3 mm apart. Inner wall 0.2-0.3 mm in thickness, not well preserved. Asters have 9-11 rays (thickness 0.1-0.2 mm) and are spaced 0.6-1.2 mm apart. Intervallum traversed by circularly cross-sectioned rods (thickness 0.2-0.7 mm) which link each outer wall aster with a corresponding aster on the inner wall.

Remarks: R. minor was originally described from the Ajax Limestone, Ajax Mine, South Australia (Bedford & Bedford, 1934). Nitecki & Debrenne (1979) have figured silicified specimens from the Todd River Dolomite at Ross River.

	CPC 18685	*SUP 88166*	*SUP 88163*	*SUP 88160*	*SUP 88165*	*SUP 88159*
ϕ	33	16.3	15.1	13	11.5	10.5
w	6.5	2.7	2.6	2.6	1.3	2.3
rod t	0.3	0.2	0.4	0.5	0.3	0.4
Outer wall:						
d	3.3	3.0	1.1	2.9	1.4	1.5
n	9–12/15–18	9–12/13–21	~9	12–15	9–10	
rt	0.2–0.4/0.1	0.1/0.2–0.3	0.1	0.3	0.1	
t	0.3	0.4	0.3	0.4	0.6	0.3
Inner wall:						
d	1.2			0.8	0.9	0.6
n	9–11			9		
rt	0.2			0.1		
t	0.2		0.2	0.2		0.3

d = distance between centres of asters
n = number of rays per aster (inner surface/outer surface)
rt = ray thickness (inner surface/outer surface)
rod t = rod thickness

Synthesis

A single archaeocyathan assemblage can be recognised within the Amadeus and Georgina Basins. Although of limited diversity, the assemblage provides a basis for regional and intercontinental correlation.

Regional correlations

Within the Amadeus and Georgina Basins, the discrete archaeocyathan assemblage described here is everywhere associated with Faunal Assemblage No. 2 of Daily (1956, 1972, 1974). The composite fauna provides an approximate correlation datum for the Early Cambrian of the central Australian region, linking the Todd River Dolomite of the Amadeus Basin with the Mount Baldwin Formation of the Georgina Basin. The archaeocyathan assemblage has recently been reported also from the Red Heart Dolomite on the HAY RIVER 1:250 000 map sheet (Walter & others, 1979).

Coscinocyathus bilateralis (Taylor), *Beltanacyathus* Bedford & Bedford and *Radiocyathus minor* (Bedford & Bedford) were originally described from the Ajax Mine area (Ajax Limestone) of the Flinders Ranges, South Australia. In the much more complete archaeocyathan succession of this region, in the Ajax and Wilkawillina Limestones, Faunal Assemblage No. 2 is commonly separated from younger Early Cambrian assemblages (Nos. 3-9) by a widespread disconformity (Daily, 1976b). The classic Ajax Mine locality (Ajax Limestone), from which Taylor (1910) and Bedford & Bedford (1934-1939) described many forms of Archaeocyatha, is an area of complex structure, but it appears that the majority of the described forms are from the interval stratigraphically above the disconformity (Daily, 1972). The remainder, particularly those from the nearby Paint Mine locality (Bedford & Bedford, 1937), and including *Beltanacyathus wirrialpensis* (Taylor), are from rocks bearing the Faunal Assemblage No. 2.

Although the full stratigraphic ranges of *Coscinocyathus bilateralis* and *Radiocyathus minor* are not yet established, a correlation of the Todd River Dolomite and Mount Baldwin Formation with at least the lower levels of the Ajax and Wilkawillina Limestones seems clear.

Intercontinental correlation

The best documented Early Cambrian successions are those of the Siberian region, at present divided into four stages named, from oldest to youngest, the Tommotian, Atdabanian, Lenian, and Elankian by Rozanov (1973) and Rozanov & Debrenne (1974). The Elankian and later part of the Lenian stages appear to be Middle Cambrian in the Australian sense (Öpik, 1976).

Of the central Australian archaeocyathan genera, only *Aldanocyathus* and *Coscinocyathus* are not endemic to the Australian region, and these are long-ranging forms of the Tommotian, Atdabanian, and Lenian stages. At present, a sounder basis for intercontinental correlation is to compare the more diverse faunas of the equivalent strata in the South Australian succession with those of Siberia.

The Ajax and Wilkawillina Limestones of South Australia are generally considered to represent part or all of the Atdabanian and early Lenian stages, with the archaeocyathan collections of Taylor (1910) and the Bedfords (1934-1939) being equivalent to the latest Atdabanian and earliest Lenian (Walter, 1967; Debrenne, 1969; Debrenne & others, 1971; Hill, 1972; Rozanov, 1973; Rozanov & Debrenne, 1974 Daily, 1976a; Debrenne & Rozanov *fide* Kirschvink, 1978). These conclusions are broadly based on the respective ranges of genera and higher taxonomic categories common to the two regions.

Thus Daily (1972, 1976a), on the evidence of his Faunal Assemblage No. 2, has considered the fossiliferous interval of the Todd River Dolomite to be Atdabanian. Certainly the archaeocyathan fauna exhibits no distinctively Lenian features, although *Coscinocyathus bilateralis* (Taylor) and *Radiocyathus minor* (Bedford & Bedford) may range into Lenian equivalent strata in the Flinders Ranges succession. An Atdabanian, possibly also early Lenian age, is suggested here for the archaeocyathan fauna of the Todd River Dolomite and Mount Baldwin Formation.

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References

ALPERT, S. P., 1977—Trace fossils and the basal Cambrian boundary; *in* CRIMES, T. P., & HARPER, J. C. (Editors), TRACE FOSSILS 2, 1-8. *Geological Journal Special Issue*, **9**.

AUSTIN, P. M., & WILLIAMS, G. E., 1978—Tectonic development of late Precambrian to Mesozoic Australia through plate motions possibly influenced by the Earth's rotation. *Journal of the Geological Society of Australia*, **25**, 1-21.

BANKS, N. L., 1970—Trace fossils from the late Precambrian and Lower Cambrian of Finnmark, Norway; *in* CRIMES, T. P., & HARPER, J. C. (Editors), TRACE FOSSILS, 19-34. *Geological Journal Special Issue*, **3**.

BEDFORD, R. & BEDFORD, J., 1936—Further notes on Cyathospongia (Archaeocyathi) and other organisms from the Lower Cambrian of Beltana, South Australia. *Memoirs of the Kyancutta Museum*, **3**, 21-26.

BEDFORD, R., & BEDFORD, J., 1937—Further notes on Archaeos (Pleospongia) from the Lower Cambrian of South Australia. *Memoirs of the Kyancutta Museum*, **4**, 27-38.

BEDFORD, R., & BEDFORD, J., 1939—Development and classification of Archaeos (Pleospongia). *Memoirs of the Kyancutta Museum*, **6**, 67-82.

BEDFORD, R., & BEDFORD, W. R., 1934—New species of Archaeocyathinae and other organisms from the Lower Cambrian of Beltana, South Australia. *Memoirs of the Kyancutta Museum*, **1**, 1-7.

BEDFORD, R., & BEDFORD, W. R., 1936—Further notes on Archaeocyathi (Cyathospongia) and other organisms from the Lower Cambrian of Beltana, South Australia. *Memoirs of the Kyancutta Museum*, **2**, 9-20.

BORNEMANN, J. G., 1884—Bericht über die Fortsetzung seiner Untersuchungen cambrischer Archaeocyathus—Formen und verwandter Organismen von der Insel Sardinien. *Deutsche Geologische Gesellschaft, Zeitschrift*, **36**, 702-6.

BORNEMANN, J. G., 1891—Zweite Abt. Nachschrift, iii. Archaeocyathinae. *Nova Acta Academiae Caesareae Leopoldino—Carolinae Germanicae naturae curiosorum*, **56**, 495-500.

BUREK, P. J., WALTER, M. R., & WELLS, A. T., 1979—Magnetostratigraphic tests of lithostratigraphic correlations between latest Proterozoic sequences in the Ngalia, Georgina and Amadeus Basins, central Australia. *BMR Journal of Australian Geology & Geophysics*, **4**, 47-55.

CASEY, J. N., & GILBERT-TOMLINSON, J., 1956—Cambrian geology of the Huckitta-Marqua region, Northern Territory. *XX International Geological Congress*, **2**, 55-74.

DAILY, B., 1956—The Cambrian in South Australia. *XX International Geological Congress*, **2**, 91-147.

DAILY, B., 1972—The base of the Cambrian and the first Cambrian faunas. *Centre for Precambrian Research, University of Adelaide, Special Paper*, **1**, 13-41.

DAILY, B., 1974—The Precambrian-Cambrian boundary in Australia. Specialist Group in Biostratigraphy and Palaeontology, "Precision in Correlation". Hobart, (Abstract).

DAILY, B., 1976a—Novye dannye ob osnovanii kembriya v yuzhnoy avstralii (New data on the base of the Cambrian in South Australia). *Izvestiya Akademiya Nauk SSSR, Seriya Geologicheskaya*, **3**, 45-52.

DAILY, B., 1976b—The Cambrian of the Flinders Ranges; *in* THOMSON, B. P., DAILY, B., COATS, R. P., & FORBES, B. G., Late Precambrian and Cambrian geology of the Adelaide 'Geosyncline' and Stuart Shelf, South Australia, 15-19. *XXV International Geological Congress, Excursion Guide* **33A**.

DAILY, B., 1976c—The base of the Cambrian in Australia. *XXV International Geological Congress, Abstracts*, **3**, 857.

DEBRENNE, F., 1969—Lower Cambrian Archaeocyatha from the Ajax Mine, Beltana, South Australia. *Bulletin of the British Museum of Natural History* (Geology), **17**, 295-376.

DEBRENNE, F., 1970a—*Coscinocyathus* Bornemann, 1884 (Archaeocyatha): proposed designation of a type-species under the plenary powers. Z.N. (S.) 1924. *Bulletin of Zoological Nomenclature*, **27**, 207-8.

DEBRENNE, F., 1970b—A revision of Australian genera of Archaeocyatha. *Transactions of the Royal Society of South Australia*, **94**, 21-49.

DEBRENNE, F., 1974—Les archéocyathes irréguliers d'Ajax Mine (Cambrien inférieur, Australie du Sud). *Bulletin du Muséum National d'Histoire Naturelle*, **195**, *Sciences de la Terre*, **33**, 185-258.

DEBRENNE, F., & DEBRENNE, M., 1960—Révision de la collection T. H. Ting d'Archaeocyatha conservée au Musée de Marburg (Allemagne). *Bulletin de la Société Géologique de France*, **2**, 695-706.

DEBRENNE, F., & VORONIN, Yu. I., 1971—Znacheniye poristosti peregorodok dlya klassifikatsii ayatsitsiatid (The significance of septal porosity for classification of ajacicyathids). *Paleontologicheskiy Zhurnal*, **3** ,301-6.

DEBRENNE, F., TERMIER, H., & TERMIER, G., 1970—Radiocyatha. Une nouvelle classe d'organismes primitifs du Cambrien inférieur. *Bulletin de la Société Géologique de France*, **12**, 120-5.

DEBRENNE, F., TERMIER, H., & TERMIER, G., 1971—Sur le nouveaux représentants de la classe des Radiocyatha. Essai sur l'évolution des Métazoaires primitifs. *Bulletin de la Société Géologique de France*, **13**, 439-44.

GATEHOUSE, C. G., 1968—First record of lithistid sponges in the Cambrian of Australia. *Bureau of Mineral Resources, Australia, Bulletin*, **92**, 57-68.

GLAESSNER, M. F., 1969—Trace fossils from the Precambrian and basal Cambrian. *Lethaia*, **2**, 369-93.

HILL, D., 1964—Archaeocyatha from loose material at Plunket Point at the head of Beardmore Glacier. *Antarctic Geology, SCAR Proceedings 1963*, **XI**. Palaeontology, 609-19.

HILL, D., 1965—Archaeocyatha from Antarctica and a review of the phylum. *Scientific Reports of the Transantartic Expedition*, **10**, Geology **3**.

HILL, D., 1972—Archaeocyatha; *in* TEICHERT, C. (Editor), TREATISE ON INVERTEBRATE PALAEONTOLOGY, Part E, Volume 1. *Geological Society of America & The University of Kansas*.

ICZN (International Commission on Zoological Nomenclature), 1974—Opinion 1007. *Coscinocyathus* Bornemann, 1884 (Archaeocyatha): designation of a type-species under the plenary powers. *Bulletin of Zoological Nomenclature*, **30**, 155-6.

KIRSCHVINK, J. L., 1978—The Precambrian—Cambrian boundary problem: paleomagnetic directions from the Amadeus Basin, central Australia. *Earth and Planetary Science Letters*, **40**, 91-100.

MADIGAN, C. T., 1932—The geology of the eastern MacDonnell Ranges, central Australia. *Transactions of the Royal Society of South Australia*, **56**, 71-117.

MARJORIBANKS, R. W., & BLACK, L. P., 1974—Geology and geochronology of the Arunta Complex, north of Ormiston Gorge, central Australia. *Journal of the Geological Society of Australia*, **21**, 291-9.

MAWSON, D., & MADIGAN, C. T., 1930—Pre-Ordovician rocks of the MacDonnell Ranges (central Australia). *Quarterly Journal of the Geological Society of London*, **86**, 415-29.

MAYNE, S. J., 1976—Australian platform-cover correlation charts—Adelaidean to Recent. *Bureau of Mineral Resources, Australia, Bulletin* **183**.

NITECKI, M. H., & DEBRENNE, F., 1979—The nature of radiocyathids and their relationship to receptaculitids and archaeocyathids. *Geobios*, **12**, 5-27.

NOAKES, L. C., 1956—Upper Proterozoic and Sub-Cambrian rocks in Australia. *XX International Geological Congress*, **2**, 213-38.

OKULITCH, V. J., 1937—Some changes in nomenclature of Archaeocyathi (Cyathospongia). *Journal of Paleontology*, **11**, 251-2.

OKULITCH, V. J., 1955—Archaeocyatha, *in* MOORE, R. C. (Editor), TREATISE ON INVERTEBRATE PALEONTOLOGY, Part E. *Geological Society of America & The University of Kansas*.

ÖPIK, A. A., 1956—Cambrian geology of the Northern Territory. *XX International Geological Congress*, **2**, 25-54.

ÖPIK, A. A., 1970—*Redlichia* of the Ordian (Cambrian) of northern Australia and New South Wales. *Bureau of Mineral Resources, Australia, Bulletin* **114**.

ÖPIK, A. A., 1976—Cymbric Vale fauna of New South Wales and early Cambrian biostratigraphy. *Bureau of Mineral Resources, Australia, Bulletin* **159**.

PREISS, W. V., WALTER, M. R., COATS, R. P., & WELLS, A. T., 1978— Lithological correlations of Adelaidean glaciogenic rocks in parts of the Amadeus, Ngalia and Georgina Basins. *BMR Journal of Australian Geology & Geophysics*, **3**, 43-53.

PRICHARD, C. E., & QUINLAN, T., 1962—The geology of the southern half of the Hermannsburg 1:250 000 sheet. *Bureau of Mineral Resources, Australia, Report* **61**.

ROZANOV, A. Yu., 1973—Zakonomernosti morfologicheskoy evolyutsii arkheotsiat i voprosy yarusnogo raschleneniya nizhnego kembriya (Regularities in the morphological evolution of regular Archaeocyatha and problems of Lower Cambrian stage division). *Akademiya Nauk SSSR*.

ROZANOV, A. Yu., & DEBRENNE, F., 1974—Age of archaeocyathid assemblages. *American Journal of Science*, **274**, 833-48.

SHERGOLD, J. H., 1969—Oryctocephalidae (Trilobita: Middle Cambrian) of Australia. *Bureau of Mineral Resources, Australia, Bulletin* **104**.

SHERGOLD, J. H., DRUCE, E. C., RADKE, B. M., & DRAPER, J. J., 1976—Cambrian and Ordovician stratigraphy of the eastern portion of the Georgina Basin, Queensland, and eastern Northern Territory. *XXV International Geological Congress, Excursion Guide* **4C**.

SMITH, K. G., 1964—Progress report on the geology of the Huckitta 1:250 000 sheet, Northern Territory. *Bureau of Mineral Resources, Australia, Report* **67**.

SMITH, K. G., 1972—Stratigraphy of the Georgina Basin. *Bureau of Mineral Resources, Australia, Bulletin* **111**.

TAYLOR, T. G., 1910—The archaeocyathinae from the Cambrian of South Australia, with an account of the morphology and affinities of the whole class. *Memoirs of the Royal Society of South Australia*, **2**, 55-188.

TING, T. H., 1937—Revision der Archaeocyathinen. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, **78**, abt. *B*, 327-79.

VEEVERS, J. J., 1976—Early Phanerozoic events on and alongside the Australasian-Antarctic platform. *Journal of the Geological Society of Australia*, **23**, 183-206.

VOLOGDIN, A. G., 1937—Arkheotsiaty i rezul'taty kh izucheniya v SSSR (Archaeocyatha and the results of their study in the USSR). *Problemy Paleontologii*, **2-3**, 453-500.

WALTER, M. R., 1967—Archaeocyatha and the biostratigraphy of the Lower Cambrian Hawker Group, South Australia. *Journal of the Geological Society of Australia*, **14**, 139-52.

WALTER, M. R., 1972—Stromatolites and the biostratigraphy of the Australian Precambrian and Cambrian. *Special Papers in Palaeontology*, **11**.

WALTER, M. R., 1976—Late Precambrian to Early Cambrian stratigraphy of the SW Georgina Basin, Australia. *XXV International Geological Congress, Abstracts*, **3**, 859.

WALTER, M. R., SHERGOLD, J. H., MUIR, M. D., & KRUSE, P. D., 1979—Early Cambrian and latest Proterozoic stratigraphy, Desert Syncline, southern Georgina Basin. *Journal of the Geological Society of Australia*, **26**, 305-12.

WEBBY, B. D., 1974—Lower Palaeozoic rocks of the craton of Australia. University of Sydney, unpublished report 1974/3.

WEBBY, B. D., 1978—History of the Ordovician continental platform shelf margin of Australia. *Journal of the Geological Society of Australia*, **25**, 41-63.

WELLS, A. T., 1978—Ngalia Basin; *in* Geological Branch summary of activities 1977. *Bureau of Mineral Resources, Australia, Report* **208**.

WELLS, A. T., FORMAN, D. J., RANFORD, L. C., & COOK, P. J., 1970—Geology of the Amadeus Basin, central Australia. *Bureau of Mineral Resources, Australia, Bulletin* **100**.

WELLS, A. T., RANFORD, L. C., STEWART, A. J., COOK, P. J., & SHAW, R. D., 1967—Geology of the north-eastern part of the Amadeus Basin, Northern Territory. *Bureau of Mineral Resources, Australia, Report* **113**.

ZHURAVLEVA, I. T., 1960—Arkheotsiaty Sibirskoy platformy (Archaeocyatha of the Siberian Platform). *Akademiya Nauk SSSR*.

ZHURAVLEVA, I. T. (Editor), 1974a—Katalog rodov arkheotsiat. Chast' 1 (Catalogue of archaeocyathan genera. Part 1). *Nauka, Novosibirsk*.

ZHURAVLEVA, I. T. (Editor) 1974b—Katalog rodov arkheotsiat. Chast' 2 (Catalogue of archaeocyathan genera. Part 2). *Nauka, Novosibirsk*.

ZHURAVLEVA, I. T., KONYUSHKOV, K. N., & ROZANOV, A. Yu., 1964—Arkheotsiaty Sibiri—dvustennye arkheotsiaty (Archaeocyatha of Siberia—two-walled Archaeocyatha). *Akademiya Nauk SSSR*.

ZHURAVLEVA, I. T., KORSHUNOV, V. I., & ROZANOV, A. Yu., 1969—Atdabanskiy yarus i ego obosnovanie po arkheotsiatam v stratotipicheskom razreze (The Atdaban stage and its significance based on the Archaeocyatha of the stratotypical section); *in* ZHURAVLEVA, I. T. (Editor), BIOSTRATIGRAFIYA I PALEONTOLOGYA NIZHNEGO KEMBRIYA SIBIRI I DAL'NEGO VOSTOKA (BIOSTRATIGRAPHY AND PALAEONTOLOGY OF THE LOWER CAMBRIAN OF SIBERIA AND THE FAR EAST), 5-59. *Akademiya Nauk SSSR*.