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SILURIAN STROMATOPOROIDS FROM CHEESEMANS CREEK, WITH A SURVEY OF SOME STROMATOPOROIDS FROM THE HUME LIMESTONE MEMBER, YASS, NEW SOUTH WALES

By P. K. BIRKHEAD

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SILURIAN STROMATOPOROIDS FROM CHEESEMANS CREEK, WITH A SURVEY OF SOME STROMATOPOROIDS FROM THE HUME LIMESTONE MEMBER, YASS, NEW SOUTH WALES

By P. K. BIRKHEAD*

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ABSTRACT

Twenty-seven species of Silurian stromatoporoids are described from limestones at Cheesemans Creek near Orange and the Hume Limestone Member of the Yass area, New South Wales. Three species are new: *Labechia oligolepida*, *Anostylostroma mirrabookense*, and *Anostylostroma pilaevarium*. On the basis of species-ranges of stromatoporoids, the Wenlock–Ludlow boundary is placed at the base of Limestone E of the Mirrabooka Formation. The Hume Limestone Member correlates with the strata of the Mirrabooka Formation which lie above Limestone E (early to middle Ludlow).

CONTENTS

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INTRODUCTION

The objectives of this study were to describe the stromatoporoids known to occur in the Silurian limestones of the Cheesemans Creek district, especially those from the type section of the Mirrabooka Formation (Sherwin 1971); to make independent age determinations for the strata, if possible, and to compare these with previous age assignments based on other taxa of the total fauna; and to compare those stromatoporoids from the Cheesemans Creek area with some of those from the Hume Limestone Member of the classical Silurian section of the Yass area, New South Wales, in order to check the possibility of a correlation between the Hume Limestone Member and units of the Mirrabooka Formation.

Exhaustive collections were not made, but representative collections were obtained. The work is dominantly systematic. Time considerations rendered an ecological study of the occurrences infeasible.

The stratigraphic nomenclature used for the Cheesemans Creek district is that of Sherwin (1971).

AGE OF THE STROMATOPOROID-BEARING STRATA

Stromatoporoids collected from the study areas are not endemic. They resemble the faunas reported from Silurian rocks of several localities, especially those of Estonia, Gotland, Russia, and North America.

Stratigraphic occurrences of Silurian stromatoporoids examined during the course of this study are tabulated in text-figure 1. The following summary of age determinations is derived from an examination of the faunal range chart (text-figure 2).

Ten species of stromatoporoids were collected from Limestones D and E of the Mirrabooka Formation. Three of these species, *Labechia oligolepida*, *Ecclimadictyon fastigiatum*, and *Stelodictyon iniquum*, are common to both limestones. A plot of the ten species (text-figure 3) reveals maximum overlap in late Wenlock time for the species from Limestone D and the Wenlock–Ludlow boundary for Limestone E. According to the ranges of stromatoporoid species, the Wenlock–Ludlow boundary is drawn at the base of Limestone E. Informally, Limestones D and E may be said to encompass the zone of *Stelodictyon iniquum*. Sherwin (1971, pp. 216–217) suggested that Limestone D "... is probably of late Wenlock age", and that "... the position of this unit [Limestone E] above Limestone D, almost certainly of Upper Wenlock age, suggests an age for Limestone E somewhere near the Wenlock–Ludlow boundary". His determinations were based mainly on identifications of corals and brachiopods in conjunction with position in sequence of stratigraphic features. Ages of Limestones D and E based on stromatoporoid species agree with those indicated by Sherwin (op. cit.).

Limestones F, G, and J of the Mirrabooka Formation; M1 (middle of the Molong Limestone); and Limestone L of the Wallace Shale all occur stratigraphically above Limestones D and E (text-figure 4). None of the species collected from the Hume Limestone Member was found in Limestones D or E. Two of the species from the Hume Limestone Member, *Plumatalinia densa* and *Clathrodictyon delicatulum*, were also found in Limestone M1. One species, *Clathrodictyon delicatulum*, is found in the Hume Limestone Member, Limestone M1, and Limestone J. *Parallelostroma maestermyrense* is found in the Hume Limestone Member and Limestone L. The Hume Limestone Member appears to correlate with those strata above Limestone E of the Mirrabooka Formation, having greater affinity with Limestones M1, J, and L. Key stromatoporoid species of those collected from the Hume Limestone Member are

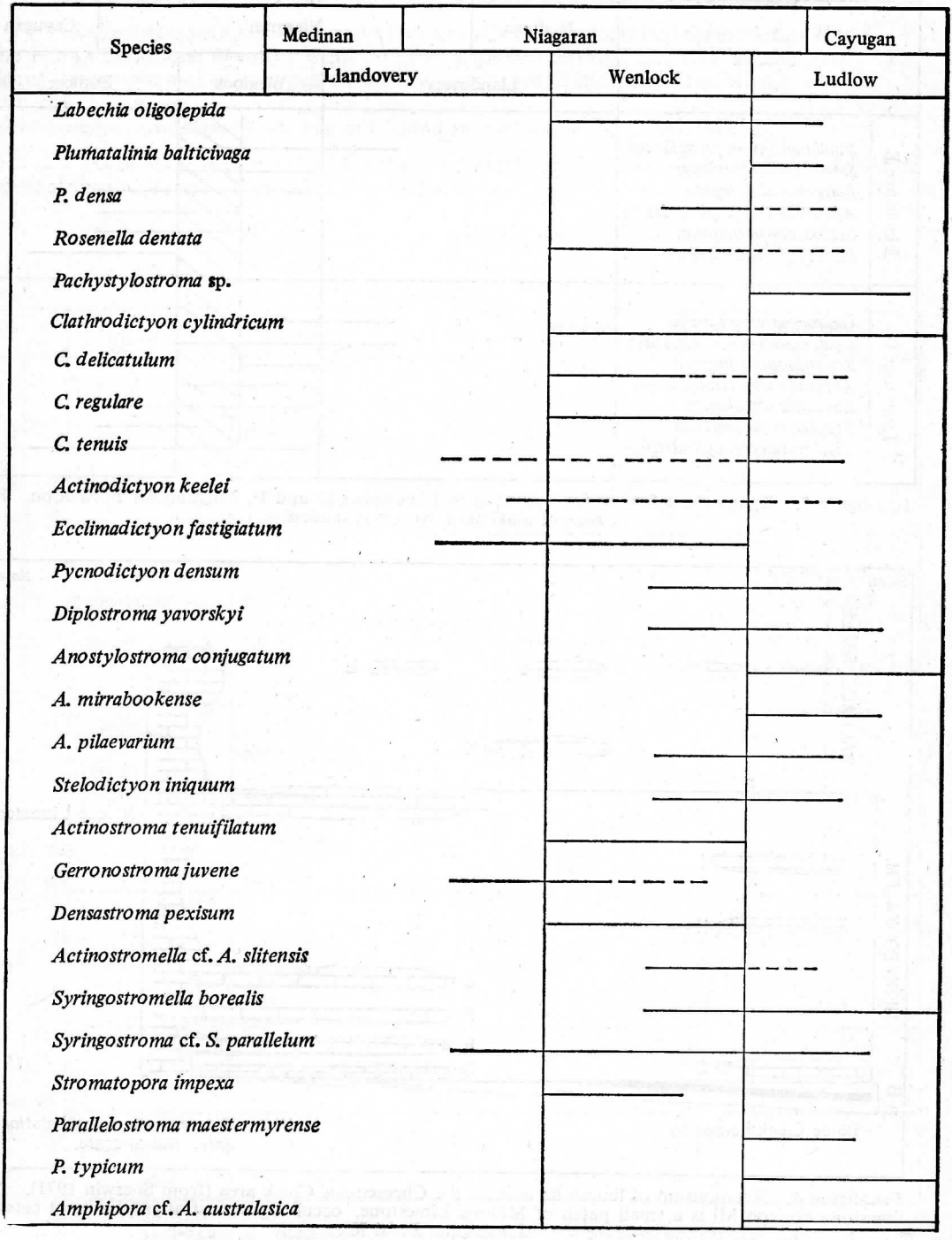
Species	Boree Creek Fm.	Mirrabooka Formation							Molong Ls.	Hume Ls. Mb.
	A	D	E	F	G	H	J	L	M1	
Labechia oligolepida		x	x	x						
Plumatalinia balticivaga										x
P. densa									x	x
Rosenella dentata										x
Pachystylostroma sp.				x			x			
Clathrodictyon cylindricum		x			x					
C. delicatulum							x		x	x
C. regulare						x				
C. tenuis										x
Actinodictyon keelei										x
Ecclimadictyon fastigiatum		x	x	x						
Pycnodictyon densum										x
Diplostroma yavorskyi										x
Anostylostroma conjugatum										x
A. mirrabookense							x			
A. pilaevarium			x							
Stelodictyon iniquum		x	x							
Actinostroma tenuifilatum		x								
Gerronostroma juvene		x								
Densastroma pexisum			x							
Actinostromella cf. *A. slitensis*							x			
Syringostromella borealis				x	x					
Syringostroma cf. *S. parallelum*	x									
Stromatopora impexa		x								
Parallelostroma maestermyrense								x		x
P. typicum					x					
Amphipora cf. *A. australasica*					x		x			

Text-figure 1. Local occurrences of species described in this article

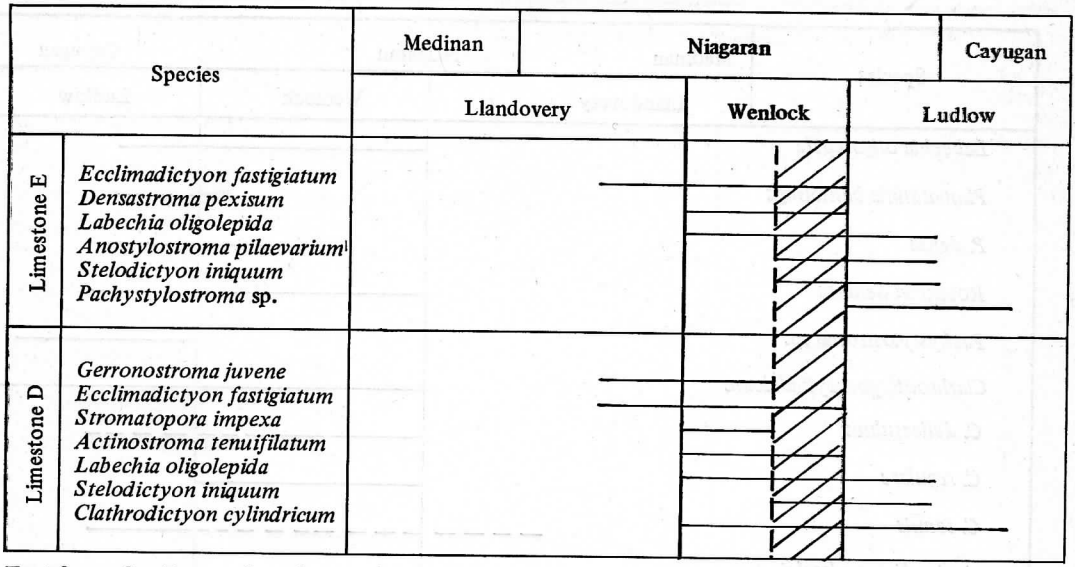
Diplostroma yavorskyi Nestor 1966 and *Anostylostroma conjugatum* (Lesovaya 1970). These species indicate an age of early to middle Ludlow for the Hume Limestone Member. Link and Druce (1972, p. 22) assign a late early Ludlovian to middle Ludlovian age to the basal beds of the Hume Limestone Member and a late middle Ludlovian age to its upper part. Their age assignments are based on conodont assemblage zones. The concurrent range zone of the key stromatoporoid species agrees in age with the conodont determinations.

A specimen of *Clathrodictyon regulare* was collected from Limestone H, which is exposed 1 km south of the Wattle Creek (Mirrabooka) section. *C. regulare* was not found in other units. The age of *C. regulare*, as suggested by its occurrences elsewhere, most nearly corresponds to the ages of the species found in Limestone D. No other species were found in Limestone H.

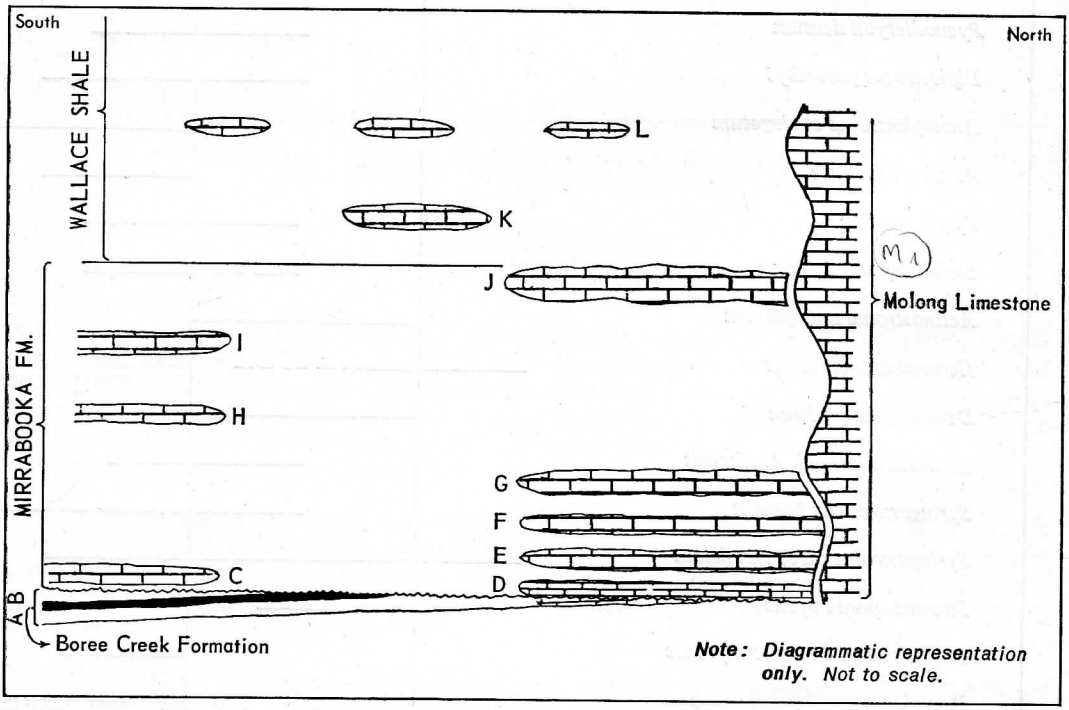
One species, *Syringostroma parallelum*, was collected from Limestone A of the Boree Creek Formation. The latter species has Niagaran affinity (Parks 1909) but is not definitive. Limestones B and C of the Boree Creek Formation are not exposed in the Wattle Creek section and were not visited.



Text-figure 2. Ranges of stromatoporoid species, compiled from relevant literature



Text-figure 3. Range chart for species occurring in Limestones D and E, Mirrabooka Formation. The zone of maximum overlap is shaded



Text-figure 4. Relationship of limestone units in the Cheesemans Creek area (from Sherwin 1971). The limestone horizon Ml is a small patch of Molong Limestone, occurring at a stratigraphic level between Limestones J and K.

Stromatoporoids were not found in Limestone K of the Wallace Shale.

Biozonation with stromatoporoids could not be accomplished for horizons F to L and the Hume Limestone Member from the data gathered during the course of this study. The genus *Amphipora* makes its appearance at the Limestone G horizon of the Mirrabooka Formation and can be used as a local guide fossil for Limestones G and J within the present bounds of knowledge. *Amphipora* sp. was not found in the Hume Limestone Member.

A correlation between the Mirrabooka Formation and comparable sections, based on stromatoporoid faunas, is given in text-figure 5.

		Estonia	Gotland	Podolia	East Slope, Central Urals	Baffin Island	Mirrabooka Formation
Cayugan	Ludlow		Sundre Beds Hamra Beds Burgsvik	Skaly			
Niagaran	Wenlock	Kaugatuma K_3 Paadla K_2 Kaarma K_1	Eke Beds Hemse Beds Klinteberg	Malinovtsy Konovskie	Is Suite		Limestone J Limestone G Limestone F Limestone E
		Jaagarahu J_2	Mulde Beds Halla Beds Slite Beds Tofta Beds Hogklint	Ust'ye			Limestone D
		Jaani J_1	Visby Beds	Muksha		Fauna IVa (Lower Cape Crauford)	
	Llandovery					Fauna III (Baillarge)	
Medinan		(Nestor) 1964-1966	(Mori) 1968–1970	(Bol'shakova) 1973	(Bogoyavlenskaya) 1969b	(Petryk) 1967	

Text-figure 5. Suggested correlations of local and overseas successions

SYSTEMATIC PALAEONTOLOGY

The terminology of Galloway and St Jean (1957) is used generally throughout the systematic descriptions, with some modifications from Stearn (1966), Mori (1968), Zukalova (1971), and Kazmierczack (1971) incorporated for clarity. Classification is also basically that used by Galloway and St Jean (1957), with some additions by Nestor (1964, 1966), Bogoyavlenskaya (1969b), and Mori (1968, 1970). Specimen numbers are those of the Geological and Mining Museum, Geological Survey of New South Wales.

Phylum COELENTERATA
Class HYDROZOA Owen 1843
Order STROMATOPOROIDEA Nicholson and Murie 1878
Family LABECHIIDAE Nicholson 1878
Genus LABECHIA Milne-Edwards and Haime 1851

Type species: Labechia conferta (Lonsdale).

Labechia oligolepida sp. nov.

Plate 1, figures 1–2

Holotype: MMF 19099 from Limestone D of the Mirrabooka Formation, Wattle Creek section, Mirrabooka Station.

Other material: MMF 19221 from Limestone E of the Mirrabooka Formation; MMF 19202 from Limestone F of the Mirrabooka Formation.

Comparable species: Labechia lepida Mori 1970 from the Hemse Beds of early Ludlow age, Gotland; *Labechia venusta* Yavorsky 1955 of Wenlock age.

Derivation of name: "oligolepida" = less elegant, which refers to the species' lack of astrorhizae and less complex structure when compared with *Labechia lepida* Mori.

Exterior: A fragment of a specimen associated with crinoid debris was laminar, 20 mm in height with indeterminable length and breadth. Laminae are discernible on weathered surfaces. Astrorhizae, mamelons, and papillae are absent.

Vertical section: Pillar and laminar tissue is compact. Laminae are formed from cyst plates. Cyst plates have tripartite structure with a clear median layer, are convex upward, thin, averaging 0.05 mm in thickness. Eight to eleven laminae occur in 2 mm, averaging ten. Pillars are conspicuous, preferentially infiltrated with sediment over much of section, and average 0.1 mm in diameter with little variance. Pillars average 5.0 mm in length but may extend for the thickness of the coenosteum. Latilaminae and astrorhizae are absent.

Tangential section: Pillars are conspicuous, small, 0.1 to 0.15 mm in diameter, averaging 0.1 mm, and are spaced 0.3 mm apart. There is an average of twelve pillars in 1 mm^2. Pillars are connected by cyst plate tissue which forms a continuous network over the section. Astrorhizal structures are absent.

Remarks: Labechia oligolepida closely resembles *Labechia lepida* Mori 1970 but lacks the astrorhizae which are conspicuous in the latter species. The specimens are also comparable with *Labechia venusta* Yavorsky 1955 but have smaller pillars than *L. venusta.* Pillars of *L. oligolepida* are conspicuously smaller than those of *L. conferta* (Lonsdale 1839), even when compared with the range of pillar diameters attributed to that species by Mori (1970, p. 79), and cyst plates are more closely spaced in the vertical direction in *L. oligolepida.*

Genus PLUMATALINIA Nestor 1960

Type species: Plumatalinia ferax Nestor

Plumatalinia balticivaga Mori 1970

Plate 1, figures 5–6

1970 *Plumatalinia balticivaga* n. sp.; Mori, p. 84, pl. 2, figures 1–2.

Hypotype: MMF 19287 from the Hume Limestone Member, Derringullen Creek.

Other occurrences: The Klinteberg Beds of early Ludlow age, Gotland.

Exterior: The coenosteum is massive, laminar. A partial specimen measures 40 mm height, 130 mm length, 70 mm width. Papillae are visible on weathered tangential surfaces. Faint traces of astrorhizae are apparent when the coenosteum is viewed with a hand lens. Weathered vertical surfaces show no structural detail to the unaided eye. A slight trace of lamination can be seen with the aid of a hand lens. No latilaminae or mamelons are present.

Vertical section: Tissue of skeletal structures is compact. Strong vertical columns are developed, averaging 0.25 mm in width and reaching 35 mm in length. The columns are not regularly placed. Laminae (cyst plates) connect the columns, curving upward into them. Cyst plates are 0.02 mm thick, about twenty-four plates occurring in 2 mm. Pillars are formed of downturned cyst plates and are equal in thickness to the cyst plates. Galleries are oval, elongate in horizontal direction. They measure 0.1 mm in height and 0.15 mm in length. Segments of astrorhizal canals, reaching 0.7 mm in length and 0.12 mm in height occur frequently over the section area.

Tangential section: Columns have a finely reticulate structure. They average 0.25 mm in diameter, seven occurring in 1 mm^2. Segments of astrorhizal canals, averaging 0.1 mm in width, are profusely scattered over the section area. The canals bifurcate, radiate from a central tube of the same diameter as the width of the canals. The central part of astrorhizae is rarely visible in tangential section. Pillars are small, circular, and average 0.05 mm in diameter. All pillars are connected by cyst plate tissue to form a network of tissue between columns and astrorhizal structures.

Remarks: The study specimen differs from the holotype description of Mori (1970) in having smaller, less conspicuous astrorhizae and more widely spaced laminae. The coenosteum from the Hume Limestone Member grew in association with *Syringopora* sp. Corallites seem to substitute for the columns in the structure of the coenosteum; where corallites developed, columns diminished in frequency.

Plumatalinia densa Mori 1968

Plate 1, figures 3–4

1968 *Plumatalinia densa* n. sp.; Mori, p. 48, pl. 15, fig. 1; pl. 16, figs 1–2.

Hypotypes: MMF 19335, 19337 from the Hume Limestone Member, Limestone Creek.

Other material: MMF 19250 from Limestone M1 of Mirrabooka Station; MMF 19280, 19281, 19282, 19285, 19288, 19295, 19296 from the Hume Limestone Member, Derringullen Creek; MMF 19336, 19338, 19339, 19342 from the Hume Limestone Member, Limestone Creek; MMF 19430 from the Hume Limestone Member, Hattons Corner.

Other occurrences: The Slite Beds of late Wenlock age, Gotland.

Exterior: The coenosteum is massive, conical to hemispherical in form. One specimen measures 120 mm in basal diameter, 60 mm in height. The surface is profusely papillate, and latilaminae are visible on broken, weathered, vertical surfaces. One specimen (MMF 19337) has a wrinkled basal epitheca. No astrorhizal structures were observed.

Vertical section: Microstructure of the tissue is compact. The most conspicuous feature of vertical sections made from well-preserved coenostea is the long vertical columns which are composed of reticulate tissue. The columns vary from 0.2 mm to 0.3 mm in width, averaging 0.25 mm. Length of the columns is variable. One column measured 9.0 mm in length. The columns are closely spaced, five occurring in 2 mm. Laminae are thin, averaging 0.02 mm in thickness, and turn upward into the columns. They extend in cyst-like fashion from one column to the next and are closely spaced, averaging thirty to thirty-two in 2 mm. Small pillars of the same thickness as the laminae occur in areas of the section between columns. Gallery spaces are small, averaging 0.08 mm in height where measurable. Many galleries have a concave-upward form because the laminae curve upward into adjacent columns. Astrorhizae are absent.

Tangential section: Tangential sections of well-preserved coenostea show closely spaced columns composed of reticulate tissue. The columns average 0.3 mm in diameter with ten to twelve occurring in an area of 1 mm^2. A few of the columns are connected by horizontal rods. Gallery spaces anastomose around the columns. Clear rings of calcite encircle some of the columns. Astrorhizae were not observed. Eighty-five per cent of the area of tangential sections is tissue.

Remarks: Plumatalinia densa Mori differs from *P. balticivaga* Mori in that *P. densa* lacks astrorhizae. Gross skeletal structures resemble those of the genus *Syringostroma*, but the absence of continuous microlaminae and the presence of compact tissue in *P. densa* instead of maculate (cellular) tissue preclude assignment of the study specimens to the genus *Syringostroma*. The specimens resemble species of *Pseudolabechia*, but the horizontal elements of the structure are not composed of "delicate processes" instead of cyst plates.

Genus ROSENELLA Nicholson 1886

Type species: Rosenella macrocystis Nicholson

Rosenella dentata (Rosen 1867)

Plate 1, figures 7–8

1867 *Stromatopora dentata* n.; Rosen, p. 75, pl. 10, figs 1–3.

1886 *Rosenella* (*Stromatopora*) *dentata* Rosen; Nicholson, p. 84.

1962 *Rosenella dentata* (Rosen); Nestor, p. 6, pl. 1, figs 1–4.

1964 *Rosenella dentata* (Rosen), Nestor, p. 37, text-fig. 11; pl. 12, figs 1–2.

Hypotype: MMF 19278 from the Hume Limestone Member, Derringullen Creek.

Other occurrences: Jaani (J_1) Stage of early–middle Wenlock age, Estonia.

Exterior: The coenosteum is laminar. A fragment of a specimen measures 10 mm in height with length and width dimension greater than 45 mm. Weathered tangential surfaces show sporadic occurrences of low, dome-like mamelons. Papillae are observable with the aid of a hand lens. Astrorhizae are absent.

Vertical section: Tissue of the structural elements is compact. Vesicles adjoin one another in imbricating fashion. Vesicle walls are thin, averaging 0.05 mm in thickness. Dimensions of the vesicles are variable, ranging from 0.5 to 1.0 mm in length and 0.1 to 1.5 mm in height. Vesicles diminish in size toward the exterior of the coenosteum. The large vesicles have mamelon structure but mamelon columns are not present. Conical denticles profusely cover the surfaces of the vesicles. Most denticles do not extend for the entire height of the vesicles, but intermittently spaced larger denticles extend through one to three vesicles. Small denticles average 0.08 mm in basal diameter and large denticles average 0.2 mm.

Tangential section: Tangential sections show an arcuate pattern of cut edges of vesicle walls (cyst plates). The space between plates is occupied by cut denticles which produce a dotted appearance. Denticles average 0.07 mm in diameter and are most closely spaced near the plate tissue where up to forty per square millimetre occur. Astrorhizae are absent.

Remarks: The species differs from species of *Pachystylostroma* Nestor in not having primary plates packed closely together to form thick plates, and the denticles are not continuations of pillar-like structures. The studied specimen does not have the alternation of layers of vesicles with small denticles with layers having large pillars which Yavorsky (1967) described for the genus *Rosenellinella.*

Genus PACHYSTYLOSTROMA Nestor 1964

Type species: Stromatopora ungerni Rosen

Pachystylostroma sp. Nestor 1966

Plate 2, figures 1–2

1966 *Pachystylostroma* sp.; Nestor, p. 7, pl. 1, figs 1–4.

Hypotypes: MMF 19156 from Limestone J of the Mirrabooka Formation, Wattle Creek section; MMF 19229 from Limestone E of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19217, 19219, 19223, 19233 from Limestone E of the Mirrabooka Formation, Wattle Creek section; MMF 19160 from Limestone J of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Paadla (K_2) Stage, Kaugatuma (K_3) Stage of Ludlow age, Estonia.

Exterior: Coenostea are massive, having columnar to irregular laminar form. One specimen measures 90 mm in height with a basal diameter of 70 mm. Weathered surfaces are covered with papillae. Traces of laminae are visible on vertical surfaces. Bands of thick vesicle plates are separated by sediment in coenostea of irregular laminar form. The bands average 1.0 mm in thickness and have the appearance of latilaminae. Laminations conform to bedding planes. Mamelons and astrorhizae were not observed.

Vertical section: The tissue of skeletal structures is altered. Gallery spaces are filled in by migration of specks from tissue of structural elements. Both pillars and plates of vesicles are amalgamated. Thick plates average 0.2 mm in thickness where measurable. Vesicles are elongate in horizontal direction with some reaching 0.8 mm in length. They are approximately 0.1 mm in height. Denticles are observable only over small areas of the sections because of the "filled-in" vesicles. Denticles are closely spaced, and many extend through the height of the vesicles. They average 0.15 mm in basal diameter. The longer pillars extend through three or four vesicles. No columnar structures were observed.

Tangential section: Bands of thick plate tissue and gallery (vesicle) spaces alternate on tangential sections. The tissue of structures is compact. Pillars are round, appearing as dots in section. Some pillars are darker in shade than the tissue of plates. Pillar diameters vary from 0.1 to 0.2 mm. Some pillars are connected by vesicle plate tissue, forming an arcuate pattern over the section area. Galleries anastomose around the circular pillars. Astrorhizal structures are absent.

Remarks: Structural detail is better defined in tangential sections than in vertical ones. Coenostea of the irregular laminar type closely resemble those described by Nestor (1966, pl. 1, fig. 1), and tangential sections are comparable to his species. The Mirrabooka specimens were placed in the genus *Pachystylostroma* because of the long pillars which occur in the skeleton and the presence of thick vesicular plates as well as thin ones.

Family CLATHRODICTYIDAE Kühn 1939

Genus CLATHRODICTYON Nicholson and Murie 1878

Type species: Clathrodictyon vesiculosum Nicholson and Murie.

Clathrodictyon cylindricum Yavorsky 1955

Plate 2, figures 3–4

1955 *Clathrodictyon cylindricum* sp. nov.; Yavorsky, p. 49, pl. 18, figs 1–5.

1961 *Clathrodictyon cylindricum* Yavorsky; Yavorsky, p. 25, pl. 12, figs 5–6.

Hypotype: MMF 15781 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19209 from Limestone G of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Late Silurian rocks of Siberia.

Comparable species: Clathrodictyon kudriavzevi Riabinin 1951 from the Jaani (J_1) and Jaagarahu (J_2) Stages of Wenlock age, Estonia, and the Tofta Beds of middle–late Wenlock age, Gotland.

Exterior: Coenostea are small with irregular form. A specimen measures 55 mm in length, 40 mm in width, and 20 mm in height. The surface is covered with "knobby" protrusions, but mamelons with a symmetrical shape are not present. Mamillae occur sporadically on well preserved surfaces. Small pits at centres of rings of laminae can be observed with the aid of a hand lens on some weathered surfaces. Latilaminae and definite astrorhizae are not present.

Vertical section: Tissue of the skeletal elements is altered, dense, composed of fine specks. Gallery spaces are filled with specks of tissue which have migrated from laminae and pillars. Laminae are formed of cysts arranged in rows. Laminae vary from 0.02 to 0.1 mm in thickness, averaging 0.05 mm. About ten laminae occur in the space of 2 mm. Pillars are formed from downturned edges of cyst plates. Pillar and laminar tissue is amalgamate. Gallery spaces are subdued by tissue alterations. The galleries are small, oval shaped to elongate, averaging 0.08 mm in height and from 0.1 to 0.25 mm in length. Neither astrorhizal structures nor columnal structures are apparent in vertical section.

Tangential section: The most conspicuous feature of tangential sections is the arrangement of tissue whorls around vague astrorhizal structures. The whorls of tissue occupy positions of protrusions on the exterior of the coenosteum. Astrorhizal structures within the whorls are composed of short canal segments, 0.1 mm in width, which extend from a central tube of 0.12 mm diameter. Whorls are spaced 4 to 5 mm apart (centre to centre). Pillars are round, some elongate. Pillars average 0.08 mm diameter. Galleries are mostly circular in form with diameter of 0.05 to 0.1 mm. Tissue occupies 85 per cent of the section area.

Remarks: The tissue of the Mirrabooka specimens is altered so that galleries are not as well defined as those of the holotype figured by Yavorsky (1955). The "whorls" of tissue as seen in tangential section are more closely spaced than those of the type, and astrorhizal features are not so readily discernible in the Australian specimens. The study specimens resemble *Clathrodictyon kudriavzevi* Riabinin 1951, but do not have the more regular development of laminae and definite astrorhizae of the latter species.

Clathrodictyon delicatulum Nestor 1964

Plate 2, figures 5–6

1964 *Clathrodictyon delicatulum* sp. nov.; Nestor, p. 60, pl. 18, fig. 4; pl. 21, fig. 6.
1968 *Clathrodictyon delicatulum* Nestor; Mori, p. 51, pl. 5, figs 1–2; pl. 15, fig. 3.
1970 *Pycnodictyon delicatulum* (Nestor); Mori, p. 103.

Hypotype: MMF 19249 from Limestone M1, Molong Formation, of Mirrabooka Station.

Other material: MMF 19184, 19187 from Limestone J of the Mirrabooka Formation, Wattle Creek section; MMF 19284, 19297 from the Hume Limestone Member, Derringullen Creek; MMF 19428 from the Hume Limestone Member, Hattons Corner.

Other occurrences: Jaani (J_1) Stage of early–middle Wenlock age, Estonia, and the Visby Beds of early–middle Wenlock age, Gotland.

Exterior: Coenostea are thickly laminate or columnar in form. A typical laminar specimen measures 150 mm in length, 100 mm in width, and 50 mm in height. The surface is generally smooth. Latilaminae and regular laminae are sometimes etched on weathered vertical surfaces. Mamelons and astrorhizae are not present on coenosteal surfaces. Surfaces appear "grainy" when they are examined with a hand lens. Some coenostea contain commensal *Syringopora* sp. which protrude from the surface and give a false impression of mamillae or papillae.

Vertical section: The tissue is compact, composed of fine, dark specks. Cysts are arranged in more or less horizontal rows, but laminae are not continuous. Laminae are thin, averaging 0.015 mm in thickness with approximately twenty-five to thirty laminae in 2 mm. Pillars have the same thickness as the laminae, being formed from downturned edges of cyst plates. Galleries (cysts) are small, oval to subrectangular in shape. Galleries average 0.1 mm in height and are slightly longer than their height on average but reach a length of 0.3 mm. The longer galleries may be parts of astrorhizal structures, but definite astrorhizae or columnal structures were not observed.

Tangential section: Pillar and laminar tissue form a connected network over the section. Some pillars appear as small dots of tissue. Gallery spaces have a circular or vermicular form. In some parts of the section, segments of elongate canal-like structures which are 0.1 mm wide are present. These segments may be part of a rudimentary astrorhizal network. Most of the section area is tissue.

Remarks: The study specimens differ from *C. delicatulum* as described by Nestor (1964) and Mori (1968) in having greater spacing between skeletal elements and in having poorly defined astrorhizal features. Mori (1970) placed *C. delicatulum* in the genus *Pycnodictyon*. The assignment of the species to *Clathrodictyon* is retained in this study because of the coarser structures of the Australian specimens. Figures of tangential sections of the holotype were not published by Nestor (1964).

Clathrodictyon regulare (Rosen 1867)

Plate 2, figures 7–8

1867 *Stromatopora regularis* n.; Rosen, p. 74, pl. 9, figs 1–4.

1962 *Clathrodictyon regulare* (Rosen 1867); Nestor, p. 13, pl. 4, figs 1–4.

1964 *Clathrodictyon regulare* (Rosen 1867); Nestor, p. 57, pl. 20, figs 1–2; pl. 22, fig. 5.

Hypotype: MMF 19243 from Limestone H of the Mirrabooka Formation, Mirrabooka Station.

Other occurrences: Jaani (J_1) Stage of early-middle Wenlock age, Estonia.

Comparable species: Clathrodictyon simplex (Nestor); Mori 1968 from the Visby, Hogklint, and Slite Beds of early–middle–late Wenlock age, Gotland.

Exterior: The coenosteum is laminar. A partial specimen measures 60 mm in length, 30 mm in height. Partly silicified laminae stand out on weathered vertical surfaces. Freshly broken tangential surfaces appear papillate and pitted when viewed with a hand lens. Astrorhizae, latilaminae, and mamelons were not observed.

Vertical section: Tissue of the skeletal network is basically compact, but is finely fibrous in well-preserved areas of the section. Laminae are continuous over part of the section, discontinuous over other parts. Laminae are thin averaging 0.02 mm in thickness with eighteen laminae occurring in 2 mm. Laminae do not have a median dark or light line. Pillars are mostly confined between laminae. Pillars have the same thickness as the laminae. The tissue of pillars and laminae is confluent. Galleries are suboval to rectangular in outline, averaging 0.1 mm in height and 0.2 to 0.5 mm in length. No astrorhizal, columnar, or pseudozooidal structures are present in vertical section.

Tangential section: Pillars between laminar bands of tissue are round. They average 0.08 mm in diameter and are spaced 0.1 mm apart. A few pillars are connected with cyst plate tissue. Pillars are more closely spaced in and near bands of laminar tissue. Galleries anastomose about the pillars. No astrorhizal structures are present. Tissue occupies 50 per cent of the section.

Remarks: The species is close to *Simplexodictyon simplex* Nestor but lacks the median line of the laminae, has pillars and laminae composed of confluent, compact tissue, and laminae are spaced more closely together than those of *S. simplex*. If pillars were separate from the laminae, this species would have the attributes of species of the genus *Anostylostroma* Parks.

Clathrodictyon tenuis Bol'shakova 1973

Plate 3, figures 1–2

1973 *Clathrodictyon tenuis* sp. nov.; Bol'shakova, p. 60, pl. 5, figs 1a–1b.

Hypotype: MMF 19431 from the Hume Limestone Member, Hattons Corner.

Other material: MMF 19429 from the Hume Limestone Member, Hattons Corner.

Other occurrences: Malinovtsy Stage (Konovskie) of early Ludlow age, Podolia.

Comparable species: Clathrodictyon miniapse Petryk 1967 from the Baillarge Formation, Faunal Assemblage III of Niagaran age, Baffin Island.

Exterior: Coenostea are hemispherical in form with a concave base. A specimen measures 30 mm in height and 70 mm in basal diameter. Laminae are etched into weathered vertical surfaces. Tangential surfaces appear smooth to the unaided eye, but under a hand lens surfaces are pitted and segments of small astrorhizal canals are profusely displayed. Latilaminae are indistinct and no mamelons were observed.

Vertical section: Tissue is compact, composed of specks, appearing finely maculate (finely cellular) in some well-preserved parts of the skeleton. Laminae are composed of cyst plates arranged in regular fashion. Cyst plates are 0.025 mm thick. About twenty-five laminae occur in 2 mm. Closely spaced laminae regularly alternate with more widely spaced laminae in the ratio of three closely spaced laminae to one widely spaced lamina. The widely spaced laminae represent concordant layers of astrorhizae. Galleries are oval in shape. Small galleries (cysts) average 0.05 mm in height, 0.1 mm in length. Some galleries have a highly arched appearance. Larger gallery spaces represent transects of astrorhizal canals. Small monticules formed from upturns of laminae occur sporadically over the area of the vertical section. Monticules are 0.4 mm high and 0.9 mm across the base. Pillars are formed from downward inflected cyst plates and are of the same thickness as the cyst plates. No columnar structures were observed.

Tangential section: Bands of laminar tissue alternating with gallery spaces form concentric rings over the area of the tangential section. Astrorhizae are prominent, being composed of long, continuously bifurcating canals which radiate from a central tube. The canals are 0.15 mm wide, and the central tubes average 0.2 mm in diameter. The overall diameter of an astrorhiza is 5.5 mm. Pillars appear as small dots which are 0.02 to 0.03 mm in diameter. Many pillars are connected by cyst plate tissue. Galleries are meandroid in shape and anastomose about the pillars. Tissue occupies 50 per cent of the section area.

Remarks: The Hume species is close to *Clathrodictyon miniapse* Petryk, but astrorhizae are larger and better defined than those described for the latter species. Mamelons are not present on the coenosteum of the study specimens. The species resembles species of *Intexodictyon* Yavorsky, but vertical structure consists of widely spaced laminae alternating with closely spaced laminae, not interwoven pillar tissue developing secondary laminae.

Genus ACTINODICTYON Parks 1909

Type species: Actinodictyon canadense Parks.

Actinodictyon keelei Parks 1909

Plate 3, figures 3–4

1909 *Actinodictyon keelei* n. sp.; Parks, p. 35, pl. 19, figs 5–6.

Hypotype: MMF 19286 from the Hume Limestone Member, Derringullen Creek.

Other occurrences: Niagaran Series of North America.

Comparable species: Actinodictyon crispatum Petryk 1967 from Faunal Assemblage IV of Niagaran age, Baffin Island; *Actinodictyon quebecense* Stearn and Hubert 1966; Mori 1970 from the Hemse Beds of Ludlow age, Gotland.

Exterior: The coenosteum is small with laminar form. A partial specimen measures 15 mm in height, 40 mm in length, and 30 mm in width. Surface features were not observed because the study specimen was entirely embedded in the rock matrix. No indications of astrorhizae, mamelons, or latilaminae are present.

Vertical section: Tissue of the structural elements is compact. Laminae are composed of cyst plates with the cysts being regularly arranged. Laminae reach a thickness of 0.1 mm but average 0.02 mm. Sixteen to eighteen laminae occur in 2 mm. Gallery spaces are cysts arranged end to end. Some galleries adjoin one another in imbricating fashion. Galleries average 0.12 mm in height and 0.4 mm in length. Pillars are of two types, regular ones formed from downward inflexions of cyst plates and "stout" pillars which extend through as many as seven laminae. Laminae (cyst plates) are inflected both downward and upward where they intersect stout pillars. Stout pillars average 0.04 mm in width and regular pillars 0.02 mm width. No columnar structures are present in vertical section.

Tangential section: Laminar (cyst plate) tissue occupies about 60 per cent of the section. Laminar tissue alternates with bands of gallery spaces over some areas, attesting to regular development of laminae and cysts in the coenosteum. Pillars appear as darker dots in the laminar tissue and gallery spaces. Diameters of pillars vary from 0.03 to 0.15 mm. No astrorhizae were observed, but vermicular gallery spaces sometimes resemble segments of astrorhizal canals.

Remarks: Parks' (1909) description of *Actinodictyon keelei* in which he stated "laminae are more distinct than in other *Actinodictyons*" aptly characterizes the Hume species. *A. keelei* resembles *A. crispatum* Petryk 1967, but laminae are more regular than those of the latter species, and astrorhizae are a more definite character of *A. crispatum*. Laminae of *A. keelei* are not highly undulose and are more closely spaced than those of *A. quebecense* Stearn and Hubert.

Genus ECCLIMADICTYON Nestor 1964

Type species: Clathrodictyon fastigiatum Nicholson.

Ecclimadictyon fastigiatum (Nicholson 1886)

Plate 3, figures 5–6

1886 *Clathrodictyon fastigiatum* n. sp.; Nicholson, p. 79; p. 43, figs 3a–3b; p. 78, figs 12a–12b.

1964 *Ecclimadictyon fastigiatum* (Nicholson 1886b); Nestor, p. 70, pl. 26, figs 3–5; pl. 28, figs 7–8.

Hypotype: MMF 15772 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19215, 19225, 19228 from Limestone E of the Mirrabooka Formation, Wattle Creek section; MMF 19201 from Limestone F of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Jaani (J_1) Stage of early–middle Wenlock age, Estonia; Slite Beds of late Wenlock age, Gotland; Guelph Formation of late (?) Wenlock age, North America; Baillarge Formation of Niagaran age, Baffin Island.

Exterior: Coenostea are small with subhemispherical to thick laminar form. The largest specimen collected measures 130 mm in length, 90 mm in width, and 40 mm in height. Papillae and "zig zag" laminae can be detected with the aid of a hand lens on well-preserved surfaces. Latilaminae, mamelons, and astrorhizae are absent.

Vertical section: Tissue is compact. Laminae are not continuous, diverging in horizontal direction. They follow a "zig zag" course across vertical sections. Laminae average 0.08 mm in thickness, nine or ten occurring in 2 mm. Pillars are formed from downturned laminae and have the same thickness as the laminae. Galleries have an irregular to quadrangular shape, averaging 0.19 mm in height and 0.4 mm in length, but some reach a length of 1.0 mm. Circular galleries averaging 0.15 mm in diameter occur sporadically over vertical sections. They may be part of an astrorhizal canal complex, but astrorhizal structures are not definite. Approximately 40 per cent of the section is tissue.

Tangential section: Pillars are round and elongate in form. Many are connected with laminar tissue to form a meandroid network. Round pillars average 0.1 mm in diameter. Complete rings of tissue from 0.1 to 0.4 mm in inside diameter occur sporadically over the section area. Vague indications of astrorhizae which consist of elongate arrangements of pillars and laminar tissue are associated with the rings of tissue. Galleries are meandroid in shape and anastomose around the pillars.

Remarks: The Mirrabooka specimens conform to previous descriptions of *Ecclimadictyon fastigiatum*, differing only in having the vague astrorhizal structures. Presence of *E. fastigiatum* in Limestones E and F of the Mirrabooka Formation is one of the later reported occurrences of the species.

Genus PYCNODICTYON Mori 1970

Type species: Pycnodictyon densum Mori.

Pycnodictyon densum Mori 1970

Plate 3, figures 7–8

1970 *Pycnodictyon densum*, n. sp.; Mori, p. 104, pl. 7, figs 1–6; pl. 8, figs 1–2; pl. 30, fig. 4.

Hypotype: MMF 19293 from the Hume Limestone Member, Derringullen Creek.

Other material: MMF 19289 from the Hume Limestone Member, Derringullen Creek; MMF 19427 from the Hume Limestone Member, Hattons Corner.

Other occurrences: Mulde and Hemse Beds of late Wenlock–early Ludlow age, Gotland.

Exterior: Coenostea are irregularly laminar to hemispherical in form. A typical specimen measures 20 mm in height, 80 mm in length, and 60 mm in width. The coenostea are latilaminate. Latilaminae average 2 mm in thickness. Freshly broken tangential surfaces are "knobby", but mamelons are not present. Papillae can be observed on surfaces with the aid of a hand lens as can faint indications of segments of astrorhizal canals. Complete astrorhizae were not observed.

Vertical section: The tissue of cyst plates is compact, composed of specks. Tissue appears "micromaculate" (microcellular) under 40× magnification. Laminae are not regular and are poorly defined. Cyst plates are 0.015 mm thick with thirty-two to forty cyst plates (laminae) occurring in 1 mm. Pillars are formed from downward inflected cyst plates and are of the same thickness as the laminae. Galleries (cysts) are oval in shape, some are elongate in horizontal direction, average 0.025 mm in height and 0.05 mm in length. Latilaminae are marked by darker lines of sediment. Latilaminae average 2.5 mm in thickness. No columnar or astrorhizal structures are present in vertical section.

Tangential section: Tangential sections are mostly tissue. Pillars are small dots which average 0.015 mm in diameter. Many pillars are connected by cyst plate tissue to form a tissue network over the section. Some rings of tissue represent transected cysts. The rings average 0.025 mm in inside diameter. Gallery spaces are difficult to define but are meandroid in form and anastomose about the round pillars. Astrorhizae are absent.

Remarks: The description of the specimens from the Hume Limestone Member generally agrees well with that of the holotype. The presence of latilaminae in the Australian species is at variance with the type, and cyst plates are spaced closer together on the average.

Genus DIPLOSTROMA Nestor 1966

Type species: Clathrodictyon pseudobilaminatum Khalfina.

Diplostroma yavorskyi Nestor 1966

Plate 4, figures 1–2

1966 *Diplostroma yavorskyi* sp. nov.; Nestor, p. 29, pl. 9, fig. 4; pl. 10, figs 4–5.

1968 *Diplostroma yavorskyi* Nestor; Mori, p. 71, pl. 2, figs 5–6; pl. 24, figs 5–6.

1970 *Diplostroma yavorskyi* Nestor; Mori, p. 101, pl. 6, figs 3–6; pl. 25, fig. 1.

Hypotype: MMF 19340 from the Hume Limestone Member, Limestone Creek.

Other occurrences: Paadla (K_2) Stage of early–middle Ludlow age, Estonia; Slite and Hemse Beds of late Wenlock–early Ludlow age, Gotland.

Exterior: The coenosteum is massive, hemispherical in form with a convex base. The study specimen measures 60 mm in height and 130 mm in basal diameter. Laminae are distinctly etched into weathered surfaces. Latilaminae are discontinuous, not well developed. Mamelons and astrorhizae are absent.

Vertical section: The tissue of laminae and pillars is compact. Laminae are of tripartite nature, having a clearly defined median layer of clear calcite. The upper layer of the laminae is thicker than the lower layer and is sometimes composed of two microlaminae. Laminae are 0.1 to 0.28 mm thick, averaging 0.18 mm. Six laminae occur in 2 mm. Pillars are short and spool shaped. Some pillars expand at their top portions, approaching a Y-shape. A few pillars are superposed but distinctly separated by the laminae. Pillars average 0.12 mm in width, with three to six occurring in 2 mm. Galleries are subrectangular in outline. They average 0.2 mm in height and vary from 0.13 to 2.0 mm in length, averaging 0.7 mm. Dissepiments occur in some galleries but are not extensively developed. Astrorhizal and columnal structures are absent.

Tangential section: Wide bands of laminar tissue alternate with bands of gallery spaces to form contours over tangential sections. Pillars are mostly round but some are elongate. Pillars average 0.18 mm in diameter. Dissepiments connect some pillars. Galleries anastomose about the round pillars. Astrorhizae are absent. Tissue occupies 50 per cent of the section.

Remarks: Syringopora sp. is associated with the Hume Limestone Member specimen and may have been commensal with *Diplostroma yavorskyi.*

Genus ANOSTYLOSTROMA Parks 1936

Type species: Anostylostroma hamiltonense Parks.

The genus *Anostylostroma* is previously repoıted from the Early Devonian of Australia by Mallet (1970). During the course of this study it was found necessary to compare Silurian species of *Anostylostroma* with species of other genera, because most Silurian species of *Anostylostroma* have been assigned to other genera.

The following extract is a part of Parks' (1936) description of *Anostylostroma* gen. nov. (p. 44). The genus was formulated to accept his species *Anostylostroma hamiltonense* and variety.

"... stout pillars that break up, particularly near their summits into small secondary pillars or reticulated tissue. The pillar-substance tends to spread on the laminae and thereby thicken them. The pillars, also, in some cases assume a superimposed position and thus present a false *Actinostroma*-like structure in vertical section. Vertical sections are very characteristic in that they show a row of small vacuities across the expanded heads of the pillars and along the thickened laminae. Tangential sections show irregularly shaped pillars in the interlaminar spaces, but in the laminae a coarsely reticulate tissue."

The above characters were adhered to in defining *Anostylostroma* species collected during the course of this investigation.

Anostylostroma conjugatum (Lesovaya 1970)

Plate 4, figures 3–4

1970 *Schistodictyon conjugatum* Lesovaya n. sp.; Lesovaya, p. 193, pl. 5, figs 1a–1b.

Hypotype: MMF 19291 from the Hume Limestone Member, Derringullen Creek.

Other material: MMF 19279, 19283, 19290, 19292 from the Hume Limestone Member, Derringullen Creek; MMF 19341 from the Hume Limestone Member, Limestone Creek.

Other occurrences: Isfara horizon of Ludlow age, Turkestan Range.

Exterior: Coenostea are massive, with low domal to thick laminar form. A typical specimen measures 160 mm in length, 110 mm in width, and 50 mm in height. The surface is smooth. Small pits and papillae can be detected with the aid of a hand lens. No astrorhizal structures or latilaminae are present on weathered or freshly broken surfaces.

Vertical section: The tissue of laminae and pillars is coarsely fibrous. Laminae are continuous, 0.02 to 0.12 mm thick, averaging 0.05 mm. Nine or ten laminae occur in 2 mm. Galleries are circular, oval, subrectangular in outline, averaging 0.2 mm in height and varying up to 1.1 mm in length. Dissepiments occur infrequently in galleries. Pillars are strong, dominantly Y-shaped, short, some superposed. Pillars subdivide into multiple strands, spreading into the bottom of the next succeeding lamina. Many pillars are funnel shaped and have hollow tops. The basal solid part of pillars averages 0.1 mm in thickness, ranging up to 0.2 mm in thickness. Five pillars occur in 2 mm. Upper strands of pillars join those of adjacent pillars, forming a continuous network of tissue at the bottom of many laminae. Astrorhizae and columnar structures are absent from vertical sections.

Tangential section: Tissue of laminae and pillars appears finely perforate because of spaces between coarse fibres. In some areas of the section a falsely maculate (melanospheric, cellular) aspect of tissue is produced by the transversely cut fibres. Pillars are round, forming rings of tissue where tops of funnel-shaped pillars are transected, and are meandroid. Interconnected strands of pillars form erratic rings and networks of tissue near the bands of laminar tissue. Dissepiments connect some pillars. Galleries anastomose (meander) about pillars. Astrorhizae are absent. Tissue occupies 50 per cent of tangential sections.

Remarks: Tissue type of the study material could be described as compact, maculate, melanospheric, granular, finely or coarsely fibrous, dependent on state of preservation and orientation of thin section cuts through the coenostea. The best preserved skeletal tissue is coarsely fibrous and is the basic tissue type (sensu Kazmierczak 1971, p. 39). The specimens studied vary slightly from the description of the holotype in having a few straight, non-divergent pillars, and some pillars are superposed. Also, the basic tissue type is fibrous, not compact as reported for the holotype. The attributes of the genus *Anostylostroma* Parks are displayed in the gross skeletal morphology of the Hume specimens. Thus, the species is assigned to that genus in the present study.

Anostylostroma mirrabookense sp. nov.

Plate 4, figures 5–6

Holotype: MMF 19164 from Limestone J of the Mirrabooka Formation, Wattle Creek section, Mirrabooka Station.

Comparable species: Simplexodictyon convictum (Yavorsky) from the Paadla (K_2) Stage of early–middle Ludlow age, Estonia; from the Klinteberg and Hemse Beds of early Ludlow age, Gotland.

Derivation of name: "mirrabookense" = reference to the occurrence of the species in the Mirrabooka Formation at the type section.

Exterior: The coenosteum is small, laminar in form. The partial specimen measures 30 mm in height, 40 mm in length, and 30 mm in width. The surface contains scattered mamillae and shallow depressions, best observed with a hand lens. Astrorhizae, latilaminae, and mamelons are absent.

Vertical section: The tissue of laminae and pillars is compact, finely fibrous in the better preserved areas of the section. Pillars are separate from the laminae. Most pillars are short, averaging 0.05 mm in width. Some pillars are superposed, and a few are Y-shaped. Laminae are continuous, overlapping one another horizontally in areas where they gently undulate into mamillar columns. Laminae average 0.05 mm in thickness with fourteen to sixteen occurring in 2 mm. Galleries are rectangular in shape, averaging 0.12 mm in height and 0.4 mm in length. Mamillar columns are formed by laminae undulating gently upward. The axial region of some columns is occupied by a central tube which is approximately 0.1 mm in diameter. Columns are not spaced systematically. Dissepiments occur infrequently in galleries.

Tangential section: Laminar tissue forms contours over the area of the section. Pillars are round, averaging 0.07 mm in diameter, and are spaced 0.1 mm apart. A few pillars are connected by dissepiments. Rings of laminar tissue mark the positions of the mamillar columns. Smaller rings of tissue near the laminae are tops of Y-shaped pillars which are cut by the section. Small, rudimentary astrorhizae occupy centres of columns. The astrorhizae are delineated by aligned rows of pillars which define short canals radiating from a small central tube. The average diameter of astrorhizae is 1.0 mm. They are not systematically positioned. About 60 per cent of the section area is gallery space.

Remarks: The specimen studied resembles *Simplexodictyon convictum* (Yavorsky), Nestor (1966), which was reassigned to the genus *Clathrodictyon* by Mori (1970). It differs from that species in having rudimentary astrorhizae on mamillar columns, and it does not have the median line of the laminae reported for the genus *Simplexodictyon. Clathrodictyon convictum*

Yavorsky (Ripper 1937), from the Buchan District, Victoria, differs from the Mirrabooka specimen in having more widely spaced laminae, lacking the small astrorhizae on mamillar columns, and having pillars derived from downward inflexions of laminae. The fibrosity of tissue, Y-shaped pillars, short and superposed pillars, along with separate development of pillars and laminae are the basis for the assignment of the species to *Anostylostroma.*

Anostylostroma pilaevarium sp. nov.

Plate 4, figures 7–8

Holotype: MMF 19226 from Limestone E of the Mirrabooka Formation, Wattle Creek section, Mirrabooka Station.

Comparable species: Clathrodictyon striatellum (d'Orbigny) from the Halla and Klinteberg Beds of late Wenlock–early Ludlow age, Gotland.

Derivation of name: "pilaevarium" = changeable pillars, a reference to the variety and different arrangements of pillars in the skeletal network.

Exterior: The coenosteum is small. The partial specimen is laminar, measuring 25 mm in height, 40 mm in length, and 30 mm in width. Laminae are etched into weathered surfaces, but latilaminae are absent. Mamillae less than 1.0 mm in diameter can be detected on the tangential surface with the aid of a hand lens. They are not regularly placed. Astrorhizae and mamelons were not observed.

Vertical section: The tissue of structural elements is compact with some fibrosity developed as a result of alignment of specks. Laminae are continuous. The thickness of laminae is variable, averaging 0.05 mm. Eight to ten laminae occur in 2 mm. A few laminae contain a median dark or light line. The pillars are short, separate from the laminae but some pillar tissue is confluent with the bottom tissue of laminae. Many pillars are Y-shaped, some have hollow tops, many branch at tops and numerous pillars are superposed through two or three laminae. Pillars entangle between laminae in a few places over the section. Galleries are mostly rectangular in shape, but some are oval. Galleries average 0.18 mm in height with some reaching 0.3 mm; they average 0.3 mm in length with some reaching 1.0 mm. Laminae turn gently up into low mamillae. Mamillae are located sporadically over the section and are not frequent. Dissepiments occur in some galleries, especially those in regions of entangled pillars. No definitive astrorhizal structures were observed.

Tangential section: Laminar tissue forms contours over tangential sections. Pillars are round, vermicular shaped, and elongate between laminae. Pillars average 0.1 mm in diameter or width. Branching tops of pillars form a meshwork of tissue near some laminae. Galleries anastomose around the pillars. Some alignments of pillars suggest astrorhizae may be present, but definite astrorhizal features are absent. Tissue occupies 50 per cent of tangential sections.

Remarks: The median line of a few of the laminae is characteristic of species of *Stictostroma* Parks and *Simplexodictyon* Bogoyavlenskaya. The entangelment of pillars between some of the laminae resembles the structure of *Intexodictyon* Yavorsky. The Y-shaped pillars and pillars with cavities at their tops resemble those described for *Clathrodictyon striatellum* (d'Orbigny) as described by Mori (1970). However, the total characters of the study specimen most nearly conform to characters of *Anostylostroma* Parks.

Genus STELODICTYON Bogoyavlenskaya 1969

Type species: Stelodictyon iniquum Bogoyavlenskaya.

Stelodictyon iniquum Bogoyavlenskaya 1969

Plate 5, figures 1–4

1969 *Stelodictyon iniquum* Bogoyavlenskaya sp. nov.; Bogoyavlenskaya, p. 17, pl. 3, figs 1a–1b.

Hypotype: MMF 19088 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19089, 19092 from Limestone D of the Mirrabooka Formation, Wattle Creek section; MMF 19224 from Limestone E of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Is Suite of late Wenlock–early Ludlow age, Urals.

Exterior: The coenostea are thickly laminar. One complete specimen measures 40 mm in height, 80 mm in width, and 170 mm in length. Latilaminae are prominent on weathered vertical surfaces. Each latilamina is approximately 5 mm thick. The weathered surface is mamillate. Mamillae are 1.0 to 2.00 mm in diameter. They are spaced as close as 2 mm apart, but spacing is not regular. Mamillae are connected by a network of low ridges over part of coenosteal surfaces. Astrorhizae are not readily discernible on weathered surfaces.

Vertical section: Tissue is generally compact, but appears finely fibrous because of alignment of specks in a few of the pillars and laminae. Laminae are thin, averaging 0.05 mm in thickness with nine or ten occurring in 2 mm. Laminae are continuous, but broken intermittently by foramina. Laminae turn abruptly upward into mamillar columns. Pillars are of the same thickness as the laminae. Pillars are both short and long. The long pillars extend through three or four laminae. Mamillar columns are prominent features of vertical sections. Pillars and laminae become thicker within the columns. Some columns extend for the entire height of the vertical section. Columns are spaced 5 mm apart (axis to axis), converging toward the base of the coenosteum. Galleries are rectangular to irregular in shape, averaging 0.3 mm in length and 0.18 mm in height in areas of the section which display a regular reticulation of pillars and laminae. Astrorhizal tubes are elongate in the vertical direction within the mamillar columns and have a "braided" appearance in some columns. The tubes reach a length of 1.5 mm and average 0.2 mm in diameter. Dissepiments occur in astrorhizal tubes and some galleries but are not profusely developed.

Tangential section: Laminar tissue forms concentric rings around the locations of mamillar columns, on which are located the astrorhizae. Astrorhizae consist of multiple axial tubes with short, radiating canals. The steepness of the sides of the columns accounts for the apparent shortness of the astrorhizal canals. Astrorhizae are spaced 4 to 6 mm apart, centre to centre. Pillars appear as small dots, averaging 0.05 mm in diameter, but some are as small as 0.025 mm in diameter. Pillars are connected in places by radial processes within laminar tissue and form an irregular network with laminar tissue where the section is oblique. Cross sections of astrorhizal tubes resemble ring pillars, but true ring pillars are not present. Galleries anastomose around the pillars. Tissue occupies 40 per cent of the tangential section.

Remarks: Stelodictyon iniquum is similar to some species of *Actinodictyon* such as *A. quebecense* Stearn and Hubert 1966, but mamillar columns are strongly developed in the Mirrabooka specimens, while horizontal elements of the skeleton are not undulose as are those of *A. quebecense*. The species is also close to some species of *Actinostroma* such as *A. tenuipalum* Yavorsky 1961, but has more complex development of astrorhizal columns and does not have the definitive hexactinellid network or radial processes connecting pillars.

Family ACTINOSTROMATIDAE Nicholson 1886

Genus ACTINOSTROMA Nicholson 1886

Type species: *Actinostroma clathratum* Nicholson.

Actinostroma tenuifilatum Parks 1908

Plate 5, figures 5–6

1908 *Actinostroma tenuifilatum* n. sp.; Parks, p. 10, pl. 9, figs 1–3.

Hypotype: MMF 15770 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Niagaran Series of North America.

Comparable species: *Actinostroma altum* Ripper from the late Siegenian Lilydale Limestone of Victoria.

Exterior: The coenosteum is massive with elongate, irregular form. It measures 150 mm in length, 70 mm in height, and 60 mm in width. Traces of laminae are etched onto weathered surfaces. Mamillae of 0.1 mm diameter occur sporadically over the surface of the coenosteum. No astrorhizae, mamelons, or latilaminae were observed in hand specimen.

Vertical section: The tissue of laminae and pillars is dense, composed of fine specks. Laminae are thin, regular, averaging 0.05 mm in thickness with nine or ten occurring in 2 mm. Laminae are composed of a network of horizontal processes which connect pillars at concordant levels. Foramina occur as spaces between the horizontal processes. Pillars are both short and long with the long pillars being in greater abundance. Eight to ten pillars occur in 2 mm. Long pillars reach a length of 1.1 mm, extending through up to six laminae. Pillars attain a spool shape because of the development of the horizontal processes at laminar levels. Laminae and pillars form a regular network over the section. Galleries have a rectangular outline. Dimensions of the galleries are variable, averaging 0.2 mm in height, and 0.3 mm in length, but some galleries reach a length of 1.5 mm. Rarely, laminae turn upward to form low, dome-like mamelons, but not over three laminae are affected in this manner.

Tangential section: Intersections of laminae with the plane of the tangential section form contours of denser structures over the area of the section. Pillars in the laminae are connected by horizontal processes, forming a hexactinellid network. Pillars between laminae appear as dots of tissue, averaging 0.05 mm in diameter. Pillars are spaced 1.0 mm apart. Many pillars are connected by processes in the space between the laminae. Galleries anastomose around the pillars. Astrorhizae are absent.

Remarks: The Mirrabooka specimen differs from *Actinostroma altum* Ripper in having a more regular framework of pillars and laminae. Measurements of pillars and laminar spacing and thicknesses conform to Parks' species.

Genus GERRONOSTROMA Yavorsky 1931

Type species: *Gerronostroma elegans* Yavorsky.

Gerronostroma juvene Petryk 1967

Plate 5, figures 7–8

1967 (?) *Gerronostroma juvene* n. sp.; Petryk, p. 23, pl. 3, figs 1–4.

Hypotype: MMF 19098 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Baillarge Formation, Faunal Assemblage III, of Niagaran age, Baffin Island.

Comparable species: Simplexodictyon simplex Nestor from the Jaani (J_1) and Jaagarahu (J_2) Stages of Wenlock age, Estonia.

Exterior: The coenosteum is massive, bulbous in form. It measures 40 mm in height, 80 mm in length, and 60 mm in width. Some areas of the surface are papillate, otherwise the surface of the coenosteum is smooth. No astrorhizae or latilaminae were observed.

Vertical section: Tissue of laminae and pillars is compact although alignment of specks imparts a transverse fibrosity to some pillars. Laminae are regular, ranging in thickness from 0.04 to 0.11 mm with an average of 0.08 mm. Eight to ten laminae occur in 2 mm. Pillars are strong, spool shaped, and short but frequently superposed through as many as eight laminae. A few pillars diverge at their top to form a Y shape. Pillars and laminae form a reticulate network pattern. Galleries are large and rectangular in shape, varying in length from 0.15 to 1.5 mm and in height from 0.1 to 0.3 mm. Sporadic, small astrorhizal tubes which extend through three laminae are present. The tubes average 0.2 mm in diameter. Canals of 0.1 mm in width extend from the central tubes for short distances. Dissepiments are rare in vertical section. About 40 per cent of the section area is tissue.

Tangential section: Laminar tissue forms contours around raised portions of the coenosteum cut by the section. Pillars are dominantly round, averaging 0.11 mm in diameter. Some pillars have a quadrangular cross section. A few pillars are joined by dissepiments. Rings of tissue which occur occasionally near the laminar bands of tissue indicate hollow tops for the Y-shaped pillars. No definite astrorhizae were observed in tangential section.

Remarks: The Mirrabooka specimen is similar to *Simplexodictyon simplex* Nestor, but the median suture of the laminae is not present, and superposition of pillars is frequent in the study specimen. Laminae are not so thick and are spaced farther apart than those described for *S. simplex*. As noted by Petryk (1967, p. 25), this species can be compared to species of *Actinostroma*, but radial processes do not connect pillars, and pillars are superposed, not long. The specimen does not have the overall fibrous tissue or regular development of pillars or "top-branching" pillars characteristic of species of *Anostylostroma*. Astrorhizae are not so pronounced as in (?) *Gerronostroma juvene* Petryk, but the specimen otherwise closely resembles the Baffin Island species.

Genus DENSASTROMA Flügel 1959

Type species: Stromatopora astroites Rosen.

Densastroma pexisum (Yavorsky 1929)

Plate 6, figures 1–2

1929 *Actinostroma pexisum* sp. nov.; Yavorsky, p. 82, pl. 6, figs 1–2.

1966 *Densastroma pexisum* (Yavorsky); Nestor, p. 37, pl. 13, fig. 1; pl. 14, figs 1–2.

1968 *Densastroma pexisum* (Yavorsky); Mori, p. 72, pl. 11, figs 1–7; pl. 12, figs 1–2; pl. 13, figs 1–2.

Hypotype: MMF 19221 from Limestone E of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Jaani (J_1) and Jaagarahu (J_2) Stages of Wenlock age, Estonia; Visby, Hogklint, and Slite Beds of Wenlock age, Gotland.

Exterior: The coenostea are massive, dome-shaped in form. An incomplete specimen measured in the field was 400 mm in basal diameter and 250 mm in height. Latilaminae are etched on to weathered vertical surfaces. The latilaminae are 1 to 3 mm thick with an average of six latilaminae occurring in 10 mm. Mamillae occur sporadically over the weathered surfaces. No astrorhizae were observed.

Vertical section: The tissue of the structural elements is compact, minutely speckled. Laminae are thin, averaging 0.01 mm in thickness. Twenty laminae occur in 1 mm. Thicker laminae, averaging 0.1 mm, mark the boundaries of the latilaminae. Pillars are not so prominent as the laminae. They are equal in thickness to the laminae, are short, and formed confluently with the laminae. Rarely, the laminae turn gently upward over mamillae, but mamillar columns are not developed. Galleries are small, oval to rectangular in shape, averaging 0.025 mm in height with variable length. Astrorhizal structures are absent.

Tangential section: Most of the section area is covered with confluent pillar and laminar tissue. Pillars are darker dots in a lighter groundmass. Pillars average 0.025 mm in diameter and are spaced 0.03 mm apart with some abutting one another. Horizontal processes connect pillars, but a definite "hexactinellid" network is not developed. Astrorhizae are absent. Gallery spaces anastomose around the pillars. Galleries are subdued because of the denseness of pillar and laminar structure in the skeleton.

Remarks: The Mirrabooka specimens differ from *Densastroma podolicum* (Yavorsky 1929) in that astrorhizae are not present in their skeletal make-up. There are fewer laminae per millimetre in the Australian specimens than are described for the holotype of *D. pexisum* (Yavorsky), otherwise the study material conforms to the latter species.

Genus ACTINOSTROMELLA Boehnke 1915

Type species: Actinostromella tubulata Boehnke.

Actinostromella cf. *A. slitensis* Mori 1968

Plate 6, figures 3–4

1968 *Actinostromella slitensis* n. sp.; Mori, p. 76, pl. 13, figs 5–6; pl. 14, figs. 3–4.

Hypotypes: MMF 19168, 19183 from Limestone J of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19162, 19163, 19165, 19169–19182, 19186, 19188 from Limestone J of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Slite Beds of late Wenlock age, Gotland.

Exterior: The coenostea are of irregular massive form, approaching the bell shape, conical shape, and columnar shapes of Mori (1968, p. 11). One of larger specimens measures 130 mm in height, 200 mm in length, and 50 mm in width. Laminae are etched on to weathered surfaces. Vertical astrorhizal tubes can be seen on some surfaces. Latilaminae are observable on some coenostea. The overall appearance of the coenostea is smooth, with no mamelons, papillae, or mamillae present.

Vertical section: The tissue of structures is altered, dense, compact. Laminar and pillar tissue is amalgamated. Pillars are long, dominant in vertical section, and separated from one another by pseudozooidal tubes. The pillars average 0.15 mm in width. Pseudozooidal tubes are formed from superposition of galleries. Galleries are small, averaging 0.1 mm in width and 0.12 mm in height, but are superposed over a height of 0.6 mm. Laminae are thin, averaging 0.02 mm in thickness where distinguishable. Laminae form tabular structures across pseudozooidal tubes. Astrorhizal tubes and canals are difficult to distinguish from pseudozooidal tubes. Latilaminae are vaguely distinguishable in vertical section but are not systematically developed.

Tangential section: Astrorhizal networks are conspicuous in some tangential sections. Astrorhizae are composed of five or six branching canals which radiate from a central tube 0.2 mm in diameter. The canals average 0.12 mm in width and interconnect with adjacent astrorhizae. Astrorhizae average 0.5 mm in overall diameter. Pillars are round in form, from 0.05 to 0.15 mm in diameter, and are connected by horizontal processes to form a mesh. Galleries are circular, vermicular, and meandroid in form. Most of the section is composed of tissue, due in part to alteration.

Remarks: Mori (1968) described two species of *Actinostromella*, *A. slitensis* n. sp., and *A.* sp. He stated (p. 78) that *A.* sp. "differs from *A. slitensis* only by having astrorhizae." The astrorhizae of the Mirrabooka specimens probably occur at concordant levels in coenostea. Thus, some tangential sections show astrorhizae while others do not. Measurements of the study specimens conform to those Mori reported for *A. slitensis*, a difference being the presence of astrorhizae in the Australian species.

Genus SYRINGOSTROMELLA Nestor 1966

Type species: Stromatopora borealis Nicholson.

Syringostromella borealis (Nicholson 1891)

Plate 6, figures 5–6

1891 *Stromatopora borealis* Nich.; Nicholson, p. 315, pl. 9, figs 7–8.

1966 *Syringostromella borealis* (Nicholson); Nestor, p. 48, pl. 17, figs 3–4; pl. 18, figs 1–5.

1970 *Syringostromella borealis* (Nicholson); Mori, p. 128, pl. 15, figs 1–6; pl. 21, fig. 2; pl. 25, figs 5–6.

Hypotype: MMF 19106 from Limestone G of the Mirrabooka Formation, Wattle Creek section.

Other material: MMF 19203 from Limestone F of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Wenlock and Ludlow Series, Estonia; Klinteberg, Hemse, and Sundre Beds of Ludlow age, Gotland.

Exterior: A fragment of a specimen is laminar. The dimensions are 25 mm in height, 60 mm in length, and 50 mm in width. Indications of strong vertical elements of the skeletal structure are discernible on weathered surfaces. Latilaminae are not present. Segments of astrorhizal canals can be seen on freshly cut tangential surfaces. Mamelons are absent.

Vertical section: The tissue of skeletal elements is altered. The limestone matrix has been recrystallized. Vertical elements of the skeleton dominate the horizontal elements. Pillars are long and strong, averaging 0.25 mm in width. Laminar structures consist of thick extensions of tissue between the pillars. Laminar and pillar tissue is amalgamated. Thin horizontal processes connect some pillars. The processes are 0.02 mm in thickness, appearing as dissepiments which divide gallery spaces between pillars and forming pseudozooidal tubes. Gallery spaces appear as long, irregular tubes with approximately the same dimensions as the pillars. No columnal structures are present.

Tangential section: The tissue of structures as seen in tangential section is maculate (melanospheric state of Stearn 1966). Pillars are round and vermicular in form. Some pillars are connected to form a meandroid network over the section area. Galleries are ring shaped,

vermicular, elongate, and irregular in form. Indistinct astrorhizal structures consist of longer gallery spaces which radiate erratically from a central tube which is 0.2 mm in diameter. Gallery spaces comprise 50 per cent of tangential sections.

Remarks: The Mirrabooka specimens are close to *S. borealis* as described by Nestor (1966) except for the less distinct astrorhizae. Preservation is of such a state that details of vertical sections are subdued, whereas tangential sections have better preserved detail.

Family STROMATOPORIDAE Winchell 1867

Genus SYRINGOSTROMA Nicholson 1875

Type species: Syringostroma densum Nicholson.

Syringostroma cf. *S. parallelum* Parks 1908

Plate 6, figures 7–8

1908 *Syringostroma parallelum* n. sp.; Parks, p. 54, pl. 10, figs 3–4.

Hypotype: MMF 19147 from Limestone A of the Boree Creek Formation, Wattle Creek section.

Other material: MMF 19146 from Limestone A of the Boree Creek Formation, Wattle Creek section; MMF 19150, 19153 from Limestone A, Boree Creek Formation, exposure 1.6 km south of Wattle Creek.

Other occurrences: Niagaran Series of Drummond Island, North America.

Exterior: The coenosteum is irregularly laminar (Mori 1968, p. 12). A specimen is 15 mm thick, thinning to a "feather" edge, and has a length of 130 mm. Papillae are present on weathered surfaces, representing projections of large pillars. No astrorhizae or mamelons were observed on coenosteal surfaces.

Vertical section: The tissue of the skeletal structures is finely maculate (cellular) as seen in the better preserved areas, but tissue is generally badly altered. Pillars are strong, long, extend through many laminae, average 0.2 mm in thickness and are spaced 0.5 mm apart. Some pillars show a microstructure of minute vertical rods such as are characteristic of the genus *Parallelopora*. Laminae vary from 0.03 to 0.2 mm in thickness. There is an average of twelve laminae in 2 mm. Galleries are rectangular in shape, averaging 0.05 mm in height and 0.25 mm in length. A row of larger galleries, averaging 0.15 mm in height occurs intermittently in the section. The larger gallery spaces possibly result from tissue alteration. No columnal or astrorhizal structures are present.

Tangential section: The greater part of tangential sections is covered with tissue. Galleries anastomose around the large pillars. Pillars are round with "rough" edges. Pillars average 0.2 mm in diameter where definitely measureable. In the better preserved areas of the sections pillars have a microreticulate structure, representing cut ends of "rods". Astrorhizae are absent.

Remarks: The study specimens differ from the type described by Parks in having wider spacing of pillars, and they do not have well marked astrorhizae. The astrorhizae of Parks' specimens were due to arrangement of pillars in radial fashion. Poor preservation of the Boree Creek specimens gave poor tangential sections, and definite arrangements of pillars were not observed. Parks' measurements of laminae spacing coincide with those of the Boree Creek specimens when one considers Parks' statement that the intervening space showed evidence of about six more laminae but that they were broken down. Otherwise, laminae of the Australian specimens are more closely spaced.

Genus STROMATOPORA Goldfuss 1826

Type species: Stromatopora concentrica Goldfuss.

Stromatopora impexa Nestor 1966

Plate 7, figures 1–2

1966 *Stromatopora impexa*, sp. nov.; Nestor, p. 44, pl. 16, figs 1–4.

1968 *Stromatopora impexa* Nestor; Mori, p. 83, pl. 15, fig. 4; pl. 19, figs 1–4; pl. 20, figs 3–4.

Hypotypes: MMF 19095, 19101 from Limestone D of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Jaani (J_1) Stage of early–middle Wenlock age, Estonia; Visby, Hogklint Beds of Wenlock age, Gotland.

Exterior: The coenostea are massive. An incomplete specimen measures 50 mm in height, 100 mm in length, and 60 mm in width. The surface appears smooth to the unaided eye with traces of laminae etched out on weathered surfaces. Papillae and pits can be detected with the aid of a hand lens. Astrorhizae, mamelons, and latilaminae are not present on the surfaces of the coenostea examined.

Vertical section: The tissue is maculate (cellular). Laminar and pillar tissue is amalgamated. Laminae are both regularly and irregularly developed. Laminae are defined by rows of galleries and vary in thickness from 0.05 to 0.2 mm, averaging 0.1 mm. Six to ten laminae occur in 2 mm. Galleries are circular to subrectangular and irregular in outline. They average 0.1 mm in height with a length which varies from 0.1 to 0.6 mm. Some galleries are superposed to form pseudozooidal tubes, but pseudozooidal tubes are not extensively developed. Pillars are irregular, of equal thickness to the laminae and their height is equal to the gallery height. No mamelon structures were observed in vertical sections. Astrorhizal tubes were not observed. Circular galleries and the lengthy gallery spaces probably represent astrorhizal canals. Tissue occupies 50 per cent of the section area.

Tangential section: Laminar tissue occupies most of the tangential section area. Pillars are round, vermicular, to irregular (meandroid) in shape. Galleries are circular to irregular in shape or anastomose around the pillars. Segments of astrorhizal canals which average 0.1 mm in width and 1.0 mm in length are prominent over parts of tangential sections. The canals diverge. Complete astrorhizae were not observed in tangential section.

Remarks: The two specimens studied differ from the type description in having thinner laminae and less definable astrorhizae.

Genus PARALLELOSTROMA Nestor 1966

Type species: Stromatopora typica Rosen.

Parallelostroma maestermyrense Mori 1970

Plate 7, figures 3–4

1970 *Parallelostroma maestermyrense* n. sp.; Mori, p. 134, pl. 16, figs 1–4; pl. 24, figs 5–6.

Hypotype: MMF 19294 from the Hume Limestone Member, Derringullen Creek.

Other material: MMF 19246 from Limestone L of the Wallace Shale, Wattle Creek section.

Other occurrences: The Hemse Beds of early Ludlow age, Gotland.

Exterior: The coenostea are massive with irregular hemispherical form. One specimen measures 80 mm in height and 100 mm in basal diameter. The surface is smooth. Traces of laminae can be observed on weathered surfaces. Latilaminae are not well developed. Astrorhizae and mamelons are absent.

Vertical section: Laminae are composed of layers of vesicles (multilayered type tissue of Mori 1970, p. 69). The laminae composed of vesicles are separated from one another by wide interlaminar gallery spaces. Laminae vary from 0.1 to 0.5 mm thickness, averaging 0.25 mm. Five to eight laminae occur in 2 mm. The walls of the vesicles are composed of compact tissue and are 0.01 mm in thickness. The rows of large galleries average 0.1 mm in height, with the length of the galleries extending up to 1.0 mm. Pillars are formed from confluent laminar tissue. Pillars vary in spacing and thickness. Rarely, laminae turn gently upward into small mamillar-like structures which are about 1.0 mm in diameter. Pseudozooidal tubes are absent. Astrorhizal structures are indefinite. If present, astrorhizae occupy gallery spaces between laminae.

Tangential section: Laminar tissue appears maculate (cellular). Laminae form rings of tissue which contour the surface of the sections. Galleries average 0.1 mm in diameter. They may be transects of astrorhizal tubes. Segments of astrorhizal canals are distinct. The canals average 0.12 mm in width, bifurcate, and join with one another to form network. No complete astrorhiza is visible. Incomplete astrorhizae measure 4.0 mm in diameter, with centres about 6.0 mm apart. Central portions of astrorhizae were not observed. Tissue occupies 60 per cent of tangential sections.

Remarks: Each individual lamina with the multilayer type B tissue (Mori 1970) closely resembles the general structure of *Pycnodictyon* Mori 1970. The study specimens have more distinct astrorhizae as seen in tangential section than those described for the holotype.

Parallelostroma typicum (Rosen 1867)

Plate 7, figures 5–6

1867 *Stromatopora typica* n.; Rosen, p. 58, pl. 1, figs 1–3; pl. 2, fig. 1.

1966 *Parallelostroma typicum* (Rosen); Nestor, p. 54; pl. 19, figs 1–4; pl. 20, figs 1–3.

1970 *Parallelostroma typicum* (Rosen); Mori, p. 136, pl. 17, figs 1–6; pl. 18, figs 1–4; pl. 24, fig. 3; pl. 26, fig. 2; pl. 28, figs 1–3.

Hypotype: MMF 19207 from Limestone G of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Paadla (K_2) and Kaugatuma (K_3) Stages of early–middle Ludlow age, Estonia; Cosmopolitan in the beds of Ludlow age, Gotland.

Exterior: The coenosteum is conical. The specimen measures 60 mm in height and has a basal diameter of 60 mm. Laminae are etched into the weathered surfaces. Latilaminae are present but not distinct. No mamelons, papillae, or astrorhizae were observed on the surface of the coenosteum.

Vertical section: The tissue of laminae and pillars is maculate (cellular), partially altered to melanospheric (Stearn 1966) and compact. Microreticulation of maculae is seen only in less altered parts of the section. Laminae are strong, averaging 0.15 mm in thickness. Eight to ten laminae occur in 2 mm. Pillars are confluent with and of equal thickness to the laminae. Galleries are circular to rectangular in form. Circular galleries average 0.1 mm in diameter.

The rectangular galleries average 0.1 mm in height and vary in length up to 0.6 mm. The circular galleries and the lengthy rectangular ones are most probably sections of the astrorhizal network. Pseudozooidal and astrorhizal tubes are rare. No columnal structures are present. Laminar structures are dominant over vertical structures in vertical section.

Tangential section: Tissue of the melanospheric type occupies the better preserved parts of the section. Laminar bands of tissue form contours over the section area. Pillars are round, elongate, some connected. Galleries are vermicular shaped or anastomose around the pillars. Some foramina appear as circular spaces through the laminae. Astrorhizae are delineated by pillar alignment. They are composed of branching canals 0.1 mm wide which radiate from a small central tube of 0.1 mm in diameter. Astrorhizae are small, 2.5 mm in overall diameter and approximately 5 mm from centre to centre. Tissue occupies 50 per cent of the section area.

Remarks: Astrorhizae are vague in vertical sections but are more distinct in tangential section. They occur in the interlaminar spaces at concordant levels. The study specimen most nearly resembles those specimens from the Sundre Beds (Mori 1970, pl. 17). The laminae are not so thick as those of *Parallelostroma minosi* Nestor 1966.

Family IDIOSTROMATIDAE Nicholson 1886

Genus AMPHIPORA Schulz 1883

Type species (monotypy): *Caunopora ramosa* Phillips.

Amphipora cf. *A. australasica* Etheridge 1917

Plate 7, figures 7–8

1971 *A. australasica* Etheridge, p. 241, pl. 44; pl. 45, fig. 1.

1971 *Amphipora australasica* Etheridge; Fletcher, p. 17.

Hypotype: MMF 19166 from Limestone J of the Mirrabooka Formation, Wattle Creek section; MMF 19209 from Limestone G of the Mirrabooka Formation, Wattle Creek section.

Other occurrences: Glen Bower "Series" of Ludlow (?) age, Taemas, New South Wales.

Exterior: Individual coenostea are visible on weathered surfaces of rock. The coenostea are ramose. They are scattered profusely through the rock matrix with long axes generally parallel to the bedding planes but with no preferred orientation. Axial tubes of coenostea are observable on weathered surfaces without the aid of a hand lens. Coenostea average 25 mm in length and 2 mm in diameter. Coenostea rarely branch. They protrude slightly from the less resistant ground mass of rock. No surface features are observable with the unaided eye.

Axial section: The tissue is poorly preserved, but a slight fibrosity is maintained along the borders of axial tubes. Axial tubes average 0.4 mm in diameter which is one-quarter to one-fifth the diameter of the coenostea. Marginal vesicles are formed on the outer periphery of the coenostea. The vesicles are elongated in the axial direction and average 0.1 mm in height. The outside perimeters of coenostea are covered with a sheath of dense tissue, as is the lining of the axial tubes. The sheaths are approximately 0.08 mm thick. The space between the marginal vesicles and the axial tube is filled with dense tissue and has a small amount of gallery spaces. Dissepiments or tabulae were not observed in the axial tubes or vesicles. The black median line, characteristic of species of *Amphipora*, is not apparent in tissue of the skeletal structures.

Cross section: Cross sections show a peripheral zone of marginal vesicles separated from the axial canal by a dense layer of tangled pillar and laminar tissue. Marginal vesicles are suboval to subrectangular in outline and average 0.12 mm in height and 0.25 mm in length. Pillar and laminar tissue of the dense layer is so closely spaced that galleries are not defined.

Tangential section: Marginal vesicles are elongate in the axial direction of the coenostea. The length of the vesicles averages 0.8 mm and width averages 0.18 mm. Pillars anastomose about vesicular spaces, averaging 0.2 mm in width. Vesicles apparently open to the exterior of the coenosteum through pores in the sheaths.

Remarks: The state of preservation of the tissue determines detail of descriptions of these specimens of *Amphipora.* The dark median line in tissue of skeletal structures, characteristically reported in many descriptions of *Amphipora* species, is missing in the Mirrabooka specimens. Forms with more "open" network of structural elements occur sporadically with those of "closed" network construction.

The axial canal: Branch-diameter ratio of 1:4 – 1:5 most nearly conforms to that of *A. rudis* Lecompte as reported by Zukalova (1971). Examination of cross sections of the holotype shows the peripheral zone of large vesicles separated from the axial canal by a zone of tangled pillar and laminar tissue which defines smaller galleries. As noted by Etheridge (1917), axial sections of the holotype were imperfect, but elongated marginal vesicles are visible and clearly separable from the inner zone of tangled pillars and laminae. The tissue of the holotype is in a better state of preservation than that of the Mirrabooka specimens, with the dark median line in skeletal structures commonly preserved. The external dimensions conform to those reported by Etheridge (1917) for *A. australasica.* The presently studied species is probably conspecific with the latter, the difference in quality of illustrated detail being due to the state of preservation of tissue shown by specimens from the different localities.

COLLECTING LOCALITIES

Wattle Creek section on Mirrabooka Station: Type section of the Mirrabooka Formation—Sherwin (1971, section 4 of text-figure 15, between pages 234 and 235). GR 18338947, Bathurst 1:250 000.

Hume Limestone Member: Derringullen Creek; exposure 1.6 km upstream from the Hume Highway bridge over Derringullen Creek. GR 18687025, Goulburn 1:250 000. Hume Limestone Member of Silverdale Formation.

Limestone Creek: 4 km north of the junction of the Hume Highway and the Boorowa road, on west bank of creek. GR 18537062, Goulburn 1:250 000. Hume Limestone Member of Silverdale Formation.

Hattons Corner: Yass River, 2.4 km west of Yass. GR 18816959, Goulburn 1:250 000. Hume Limestone Member of Silverdale Formation.

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EXPLANATION OF PLATES

All figures ×10

PLATE 1

Figure 1. *Labechia oligolepida* sp. nov. Tangential section; pillars connected with cyst-plate tissue. Holotype, slide No. MMF 19099T. Limestone D, Mirrabooka Formation.

Figure 2. *Labechia oligolepida* sp. nov. Vertical section; darker pillars infiltrated with sediment. Holotype, slide No. MMF 19099V. Limestone D, Mirrabooka Formation.

Figure 3. *Plumatalinia densa* Mori 1968. Tangential section; reticulate tissue of columns discernible. Hypotype, slide No. MMF 19335T. Hume Limestone Member, Silverdale Formation.

Figure 4. *Plumatalinia densa* Mori 1968. Vertical section; vertical columns apparent. Hypotype, slide No. MMF 19337V. Hume Limestone Member, Silverdale Formation.

Figure 5. *Plumatalinia balticivaga* Mori 1970. Tangential section; large, clear, circular areas of calcite are *Syringopora* sp. Hypotype, slide No. MMF 19287T. Hume Limestone Member, Silverdale Formation.

Figure 6. *Plumatalinia balticivaga* Mori 1970. Vertical section; larger gallery spaces are segments of astrorhizal canals. Hypotype, slide No. MMF 19287V. Hume Limestone Member, Silverdale Formation.

Figure 7. *Rosenella dentata* (Rosen 1867). Tangential section; transects of denticles produce dot pattern. Hypotype, slide No. MMF 19278T. Hume Limestone Member, Silverdale Formation.

Figure 8. *Rosenella dentata* (Rosen 1867). Vertical section; small and large vesicles shown. Hypotype, slide No. MMF 19278V. Hume Limestone Member, Silverdale Formation.

PLATE 2

Figure 1. *Pachystylostroma* sp. Nestor 1966. Tangential section; arcuate pattern of cyst plates connecting pillars shown. Hypotype, slide No. MMF 19156T. Limestone J, Mirrabooka Formation.

Figure 2. *Pachystylostroma* sp. Nestor 1966. Vertical section; amalgamation of the tissue of pillars and plates of vesicles is apparent. Hypotype, slide No. MMF 19229V. Limestone E, Mirrabooka Formation.

Figure 3. *Clathrodictyon cylindricum* Yavorsky 1955. Tangential section; typical display of whorl of tissue observable. Hypotype, slide No. MMF 15781T. Limestone D, Mirrabooka Formation.

Figure 4. *Clathrodictyon cylindricum* Yavorsky 1955. Vertical section; migration of specks into gallery spaces has obscured detail. Hypotype, slide No. MMF 15781V. Limestone D, Mirrabooka Formation.

Figure 5. *Clathrodictyon delicatulum* Nestor 1964. Tangential section; rudimentary astrorhizal structure shows in lower right corner. Hypotype, slide No. MMF 19249T. Limestone J, Mirrabooka Formation.

Figure 6. *Clathrodictyon delicatulum* Nestor 1964. Vertical section; cysts arranged in rows, but laminae not continuous. Hypotype, slide No. MMF 19249V. Limestone J, Mirrabooka Formation.

Figure 7. *Clathrodictyon regulare* (Rosen 1867). Tangential section; regular disposition of pillars illustrated. Hypotype, slide No. MMF 19243T. Limestone H, Mirrabooka Formation.

Figure 8. *Clathrodictyon regulare* (Rosen 1867). Vertical section; overall regularity of skeletal network obvious. Hypotype, slide No. MMF 19243V. Limestone H, Mirrabooka Formation.

PLATE 3

Figure 1. *Clathrodictyon tenuis* Bol'shakova 1973. Tangential section; a prominent astrorhiza and connected pillars are shown. Hypotype, slide No. MMF 19431T. Hume Limestone Member, Silverdale Formation.

Figure 2. *Clathrodictyon tenuis* Bol'shakova 1973. Vertical section; closely spaced laminae are separated by widely spaced laminae. Hypotype, slide No. MMF 19431V. Hume Limestone Member, Silverdale Formation.

Figure 3. *Actinodictyon keelei* Parks 1909. Tangential section; bands of laminar tissue alternate with bands of gallery spaces. Hypotype, slide No. MMF 19286T. Hume Limestone Member, Silverdale Formation.

Figure 4. *Actinodictyon keelei* Parks 1909. Vertical section; regular and stout pillars displayed. Hypotype, slide No. MMF 19286V. Hume Limestone Member, Silverdale Formation.

Figure 5. *Ecclimadictyon fastigiatum* (Nicholson 1886). Tangential section; meandroid network of pillar and laminar tissue shown. Hypotype, slide No. MMF 15772T. Limestone D, Mirrabooka Formation.

Figure 6. *Ecclimadictyon fastigiatum* (Nicholson 1886). Vertical section; zig-zag laminae developed. Hypotype, slide No. MMF 15772V. Limestone D, Mirrabooka Formation.

Figure 7. *Pycnodictyon densum* Mori 1970. Tangential section; most of section is tissue, pillars appear as small dots. Hypotype, slide No. MMF 19293T. Hume Limestone Member, Silverdale Formation.

Figure 8. *Pycnodictyon densum* Mori 1970. Vertical section; latilaminae marked by darker lines of sediment. Hypotype, slide No. MMF 19293V. Hume Limestone Member, Silverdale Formation.

Plate 4

Figure 1. *Diplostroma yavorskyi* Nestor 1966. Tangential section; large circular rings of tissue are *Syringopora* sp. Hypotype, slide No. MMF 19340T. Hume Limestone Member, Silverdale Formation.

Figure 2. *Diplostroma yavorskyi* Nestor 1966. Vertical section; microlaminae of laminae can be seen over section. Hypotype, slide No. MMF 19340V. Hume Limestone Member, Silverdale Formation.

Figure 3. *Anostylostroma conjugatum* (Lesovaya 1970). Tangential section; interconnected network of pillar tissue shows near laminar bands. Hypotype, slide No. MMF 19291T. Hume Limestone Member, Silverdale Formation.

Figure 4. *Anostylostroma conjugatum* (Lesovaya 1970). Vertical section; fibrosity of tissue shown, pillars thick, Y shaped. Hypotype, slide No. MMF 19291V. Hume Limestone Member, Silverdale Formation.

Figure 5. *Anostylostroma mirrabookense* sp. nov. Tangential section; bands of laminar tissue contour section area. Holotype, slide No. MMF 19164T. Limestone J, Mirrabooka Formation.

Figure 6. *Anostylostroma mirrabookense* sp. nov. Vertical section; laminae gently undulate into mamillar columns. Holotype, slide No. MMF 19164V. Limestone J, Mirrabooka Formation.

Figure 7. *Anostylostroma pilaevarium* sp. nov. Tangential section; most of area of figure composed of thick laminar tissue, pillars round. Holotype, slide No. MMF 19226T. Limestone E, Mirrabooka Formation.

Figure 8. *Anostylostroma pilaevarium* sp. nov. Vertical section; Y-shaped and regular pillars shown, some superposed. Holotype, slide No. MMF 19226V. Limestone E, Mirrabooka Formation.

Plate 5

Figure 1. *Stelodictyon iniquum* Bogoyavlenskaya 1969. Tangential section; section oriented across mamillar column. Hypotype, slide No. MMF 19088T. Limestone D, Mirrabooka Formation.

Figure 2. *Stelodictyon iniquum* Bogoyavlenskaya 1969. Vertical section; section oriented through mamillar column. Hypotype, slide No. MMF 19088V. Limestone D, Mirrabooka Formation.

Figure 3. *Stelodictyon iniquum* Bogoyavlenskaya 1969. Tangential section; some pillars connected in laminar tissue. Hypotype, slide No. MMF 19088T. Limestone D, Mirrabooka Formation.

Figure 4. *Stelodictyon iniquum* Bogoyavlenskaya 1969. Vertical section; section oriented between mamillar columns. Hypotype, slide No. MMF 19088V. Limestone D, Mirrabooka Formation.

Figure 5. *Actinostroma tenuifilatum* Parks, 1908. Tangential section; typical development of hexactinellid network of radial processes connecting pillars shown near laminae. Hypotype, slide No. MMF 15770T. Limestone D, Mirrabooka Formation.

Figure 6. *Actinostroma tenuifilatum* Parks 1908. Vertical section; long pillars dominant over short ones. Hypotype, slide No. MMF 15770V. Limestone D, Mirrabooka Formation.

Figure 7. *Gerronostroma juvene* Petryk 1967. Tangential section; about half of section is laminar tissue, pillars dominantly round. Hypotype, slide No. MMF 19098T. Limestone D, Mirrabooka Formation.

Figure 8. *Gerronostroma juvene* Petryk 1967. Vertical section; pillars short but some superposed through several laminae. Hypotype, slide No. MMF 19098V. Limestone D, Mirrabooka Formation.

PLATE 6

Figure 1. *Densastroma pexisum* (Yavorsky 1929). Tangential section; pillars are small dots between rings of laminar tissue. Hypotype, slide No. MMF 19221T. Limestone E, Mirrabooka Formation.

Figure 2. *Densastroma pexisum* (Yavorsky 1929). Vertical section; Minuteness of skeletal network of pillars and laminae demonstrated. Hypotype, slide No. MMF 19221V. Limestone E, Mirrabooka Formation.

Figure 3. *Actinostromella* cf. *A. slitensis* Mori 1968. Tangential section; section oriented through two astrorhizae. Hypotype, slide No. MMF 19168T. Limestone J, Mirrabooka Formation.

Figure 4. *Actinostromella* cf. *A. slitensis* Mori 1968. Vertical section; traces of pseudozooidal tubes can be seen through altered tissue. Hypotype, slide No. MMF 19183V. Limestone J, Mirrabooka Formation.

Figure 5. *Syringostromella borealis* (Nicholson 1891). Tangential section; meandroid network of pillars and galleries are typical. Hypotype, slide No. MMF 19106T. Limestone G, Mirrabooka Formation.

Figure 6. *Syringostromella borealis* (Nicholson 1891). Vertical section; strong, long pillars are vaguely seen in the altered tissue. Hypotype, slide No. MMF 19106V. Limestone G, Mirrabooka Formation.

Figure 7. *Syringostroma* cf. *S. parallelum* Parks 1908. Tangential section; rough-edged pillars are seen outside and within laminar tissue. Hypotype, slide No. MMF 19147T. Limestone A, Boree Creek Formation.

Figure 8. *Syringostroma* cf. *S. parallelum* Parks 1908. Vertical section; strong pillars and laminae seen through badly altered tissue. Hypotype, slide No. MMF 19147V. Limestone A, Boree Creek Formation.

PLATE 7

Figure 1. *Stromatopora impexa* Nestor 1966. Tangential section; longer gallery spaces are segments of astrorhizal canals. Hypotype, slide No. MMF 19101T. Limestone D, Mirrabooka Formation.

Figure 2. *Stromatopora impexa* Nestor 1966. Vertical section; amalgamation of pillar and laminar tissue is shown. Hypotype, slide No. MMF 19095V. Limestone D, Mirrabooka Formation.

Figure 3. *Parallelostroma maestermyrense* Mori 1970. Tangential section; segments of astrorhizae occupy central portion of figure. Hypotype, slide No. MMF 19294T. Hume Limestone Member, Silverdale Formation.

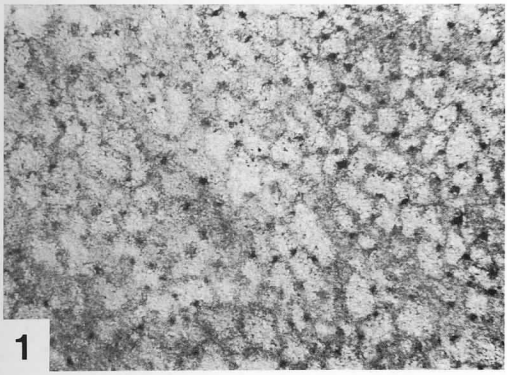
Figure 4. *Parallelostroma maestermyrense* Mori 1970. Vertical section; multilayered type tissue is distinguishable in laminae. Holotype, slide No. MMF 19294V. Hume Limestone Member, Silverdale Formation.

Figure 5. *Parallelostroma typicum* (Rosen 1867). Tangential section; incomplete astrorhiza occupies right central part of figure. Hypotype, slide No. MMF 19207T. Limestone G, Mirrabooka Formation.

Figure 6. *Parallelostroma typicum* (Rosen 1867). Vertical section; strongly developed laminae visible. Hypotype, slide No. MMF 19207V. Limestone G, Mirrabooka Formation.

Figure 7. *Amphipora* cf. *A. australasica* Etheridge 1917. Cross section; marginal vesicles, dense tissue layer, and axial canal shown. Hypotype, slide No. MMF 19166. Limestone J, Mirrabooka Formation.

Figure 8. *Amphipora* cf. *A. australasica* Etheridge 1917. Axial section; axial canal separated from marginal vesicles by dense tissue layers. Hypotype, slide No. MMF 19166. Limestone J, Mirrabooka Formation.



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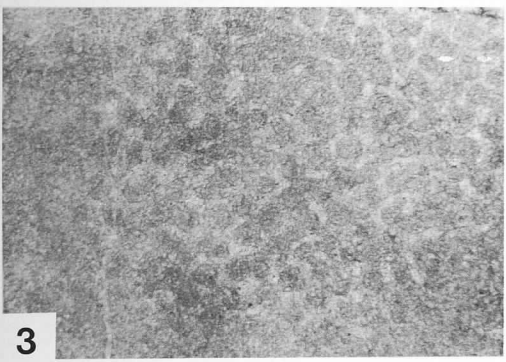

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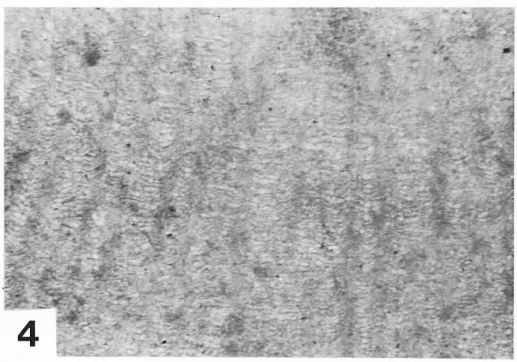

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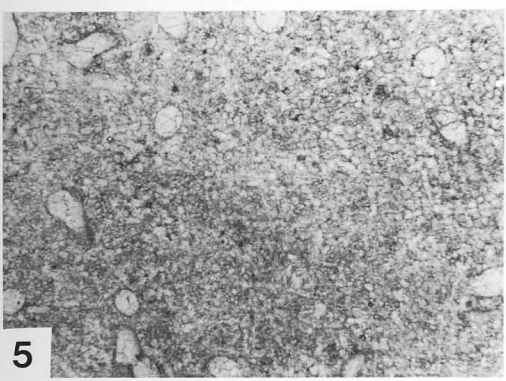

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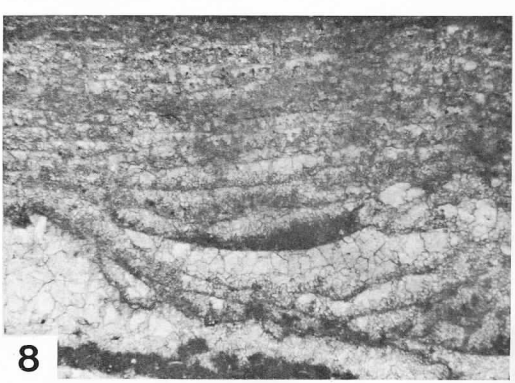

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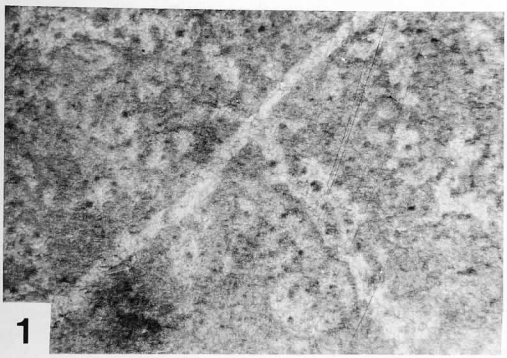

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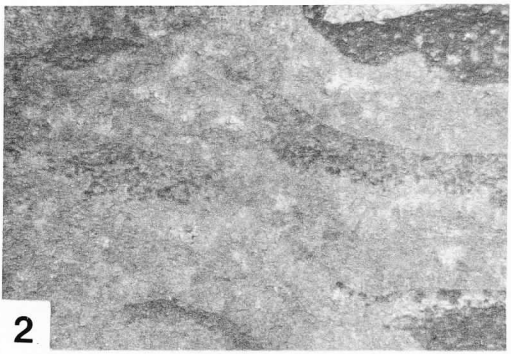

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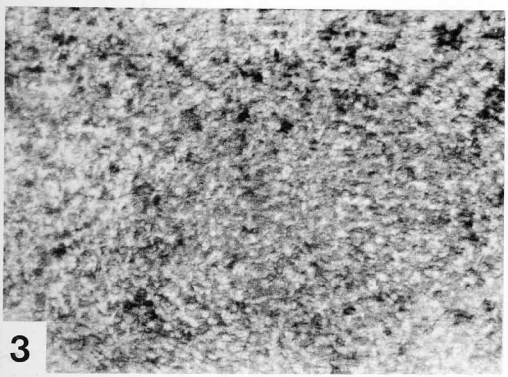

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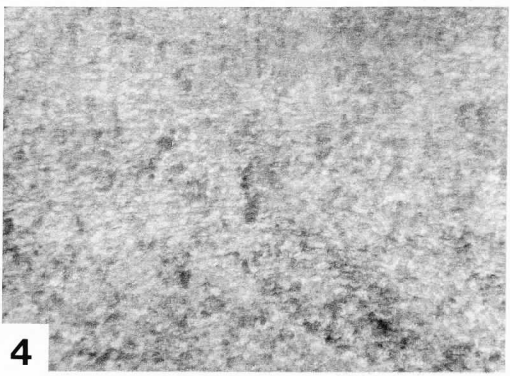

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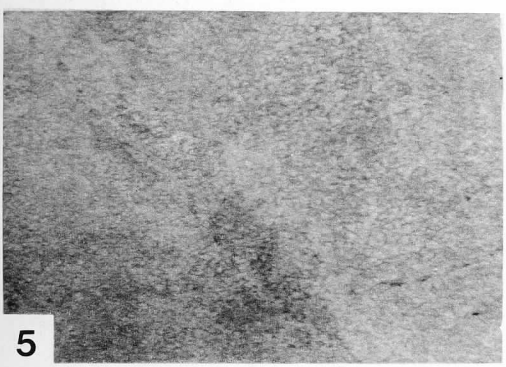

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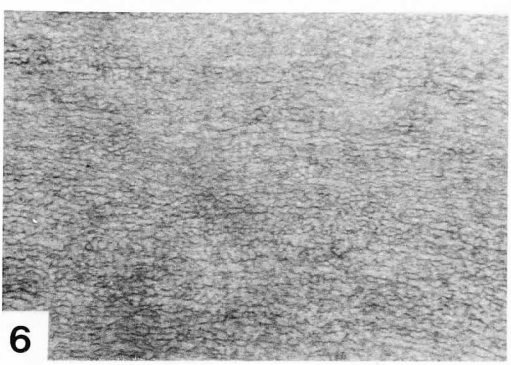

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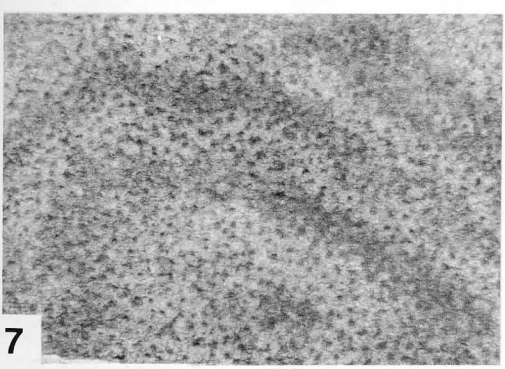

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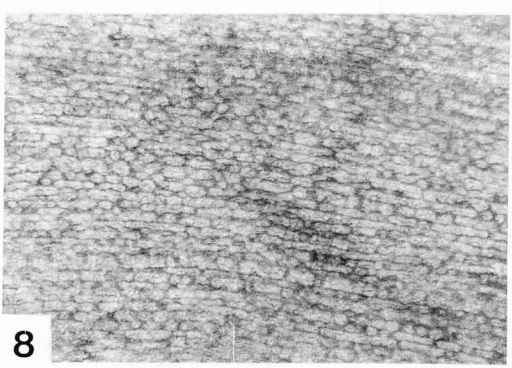

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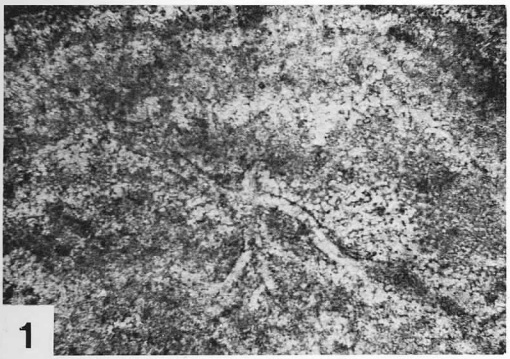

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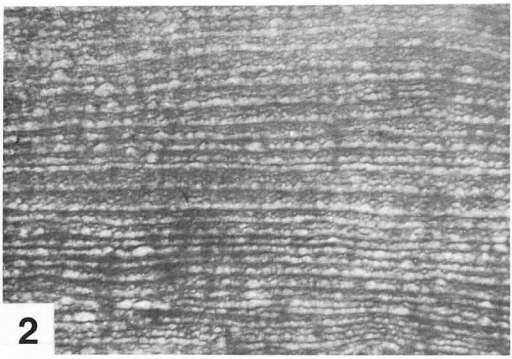

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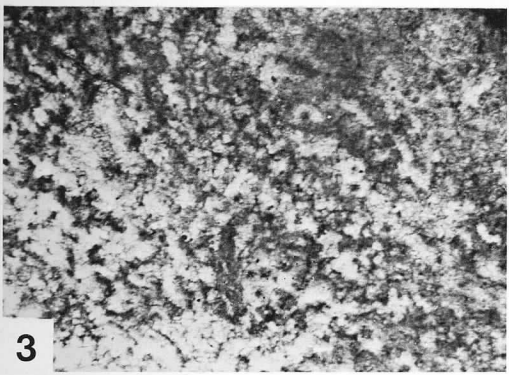

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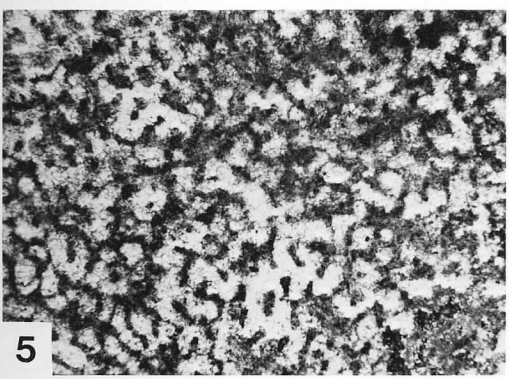

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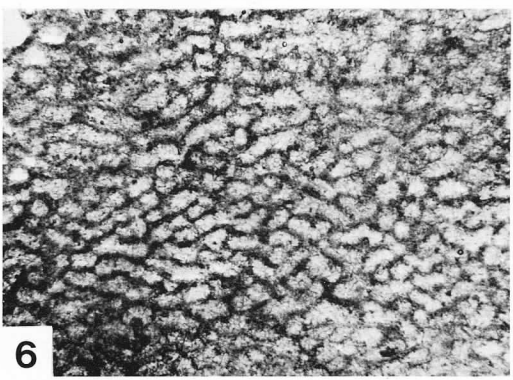

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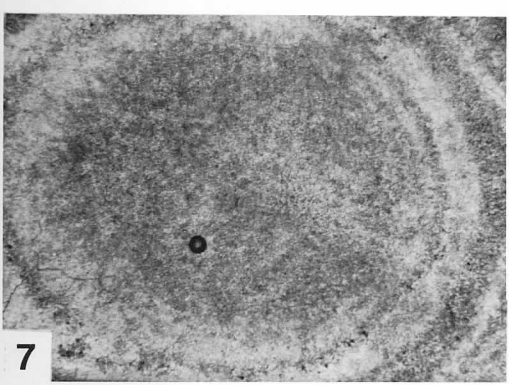

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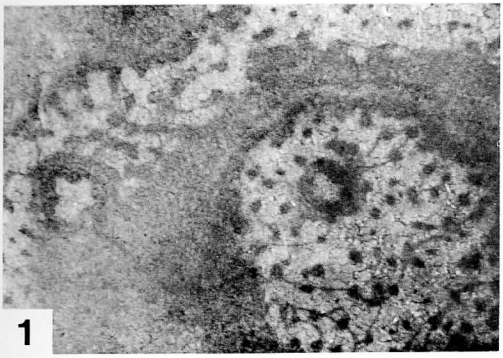

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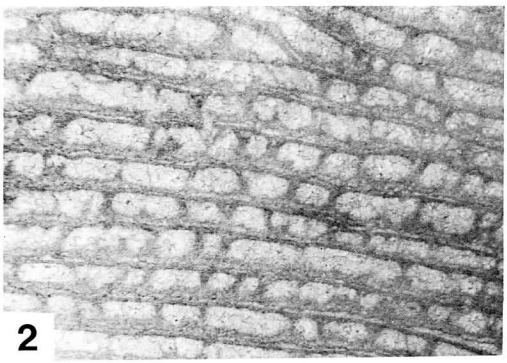

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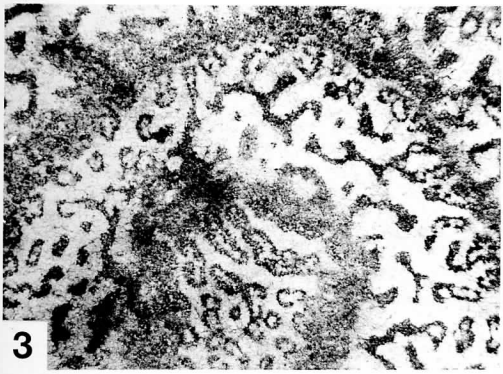

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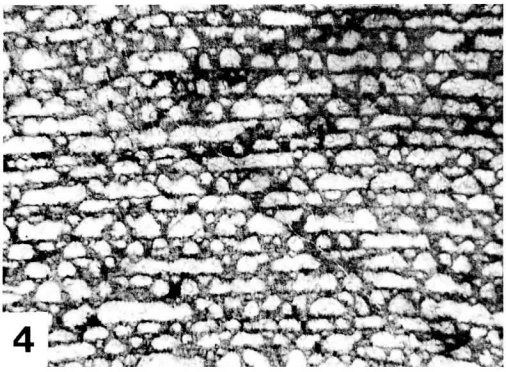

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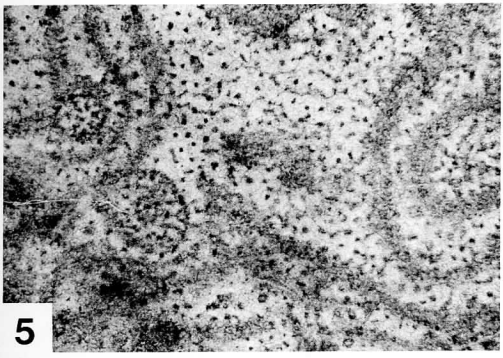

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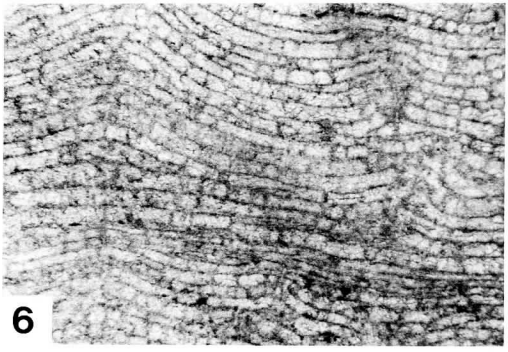

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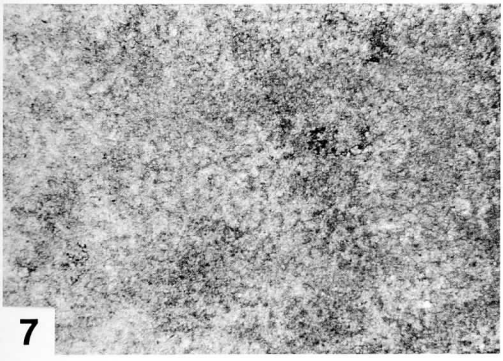

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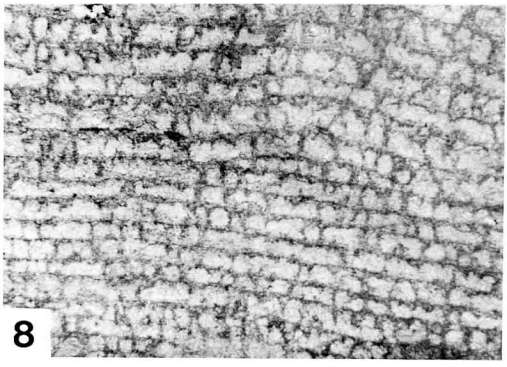

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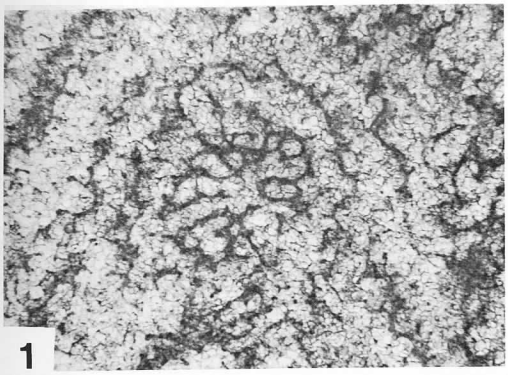

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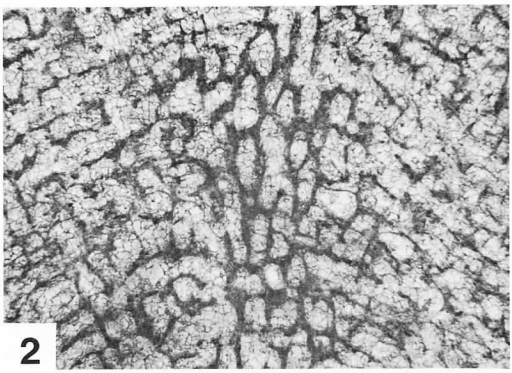

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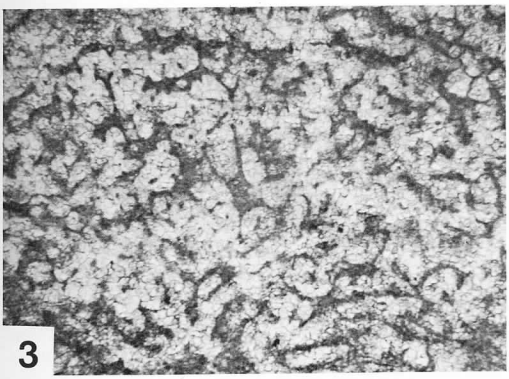

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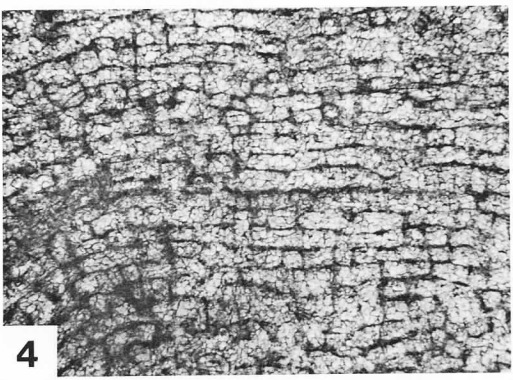

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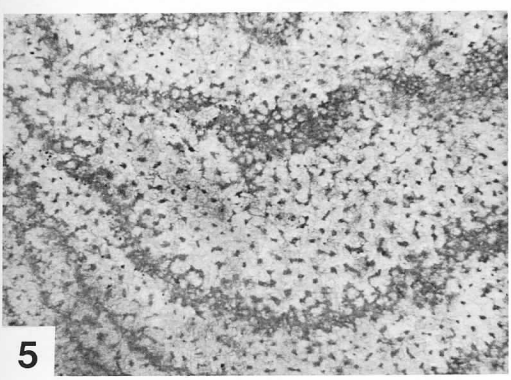

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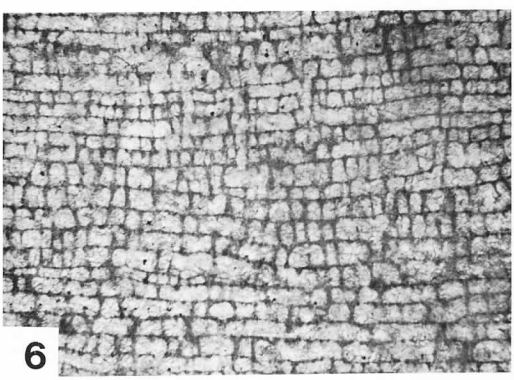

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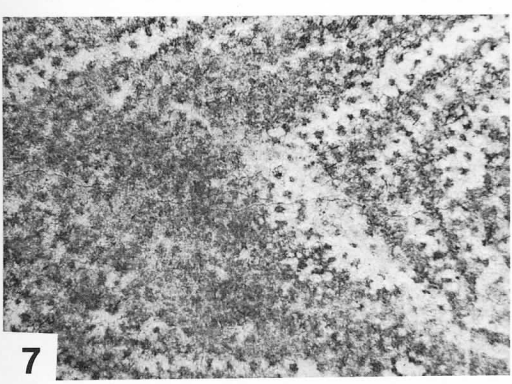

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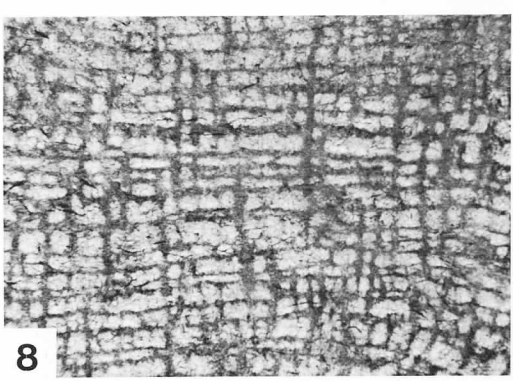

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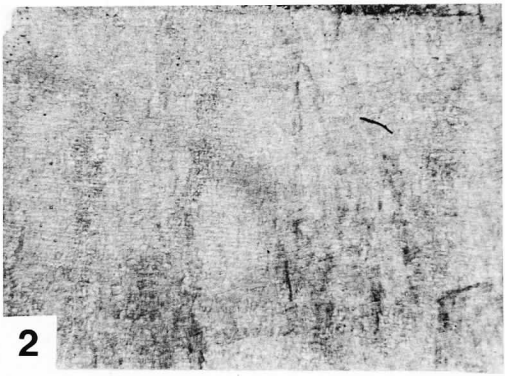

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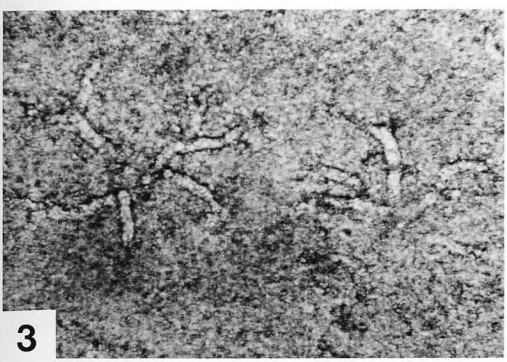

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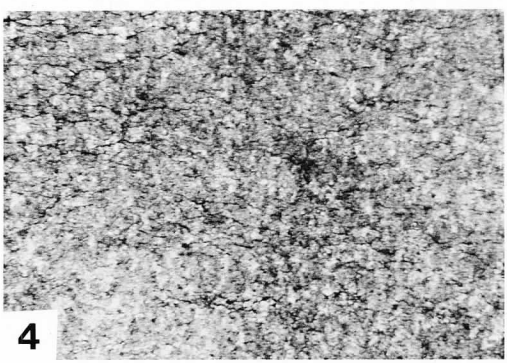

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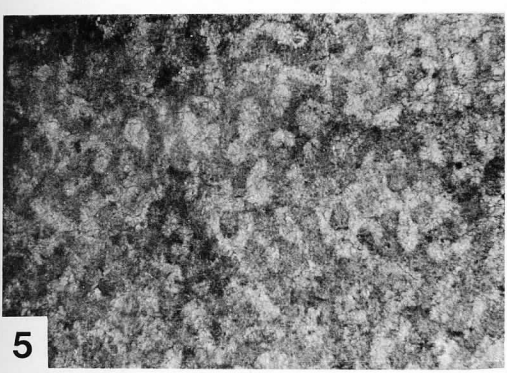

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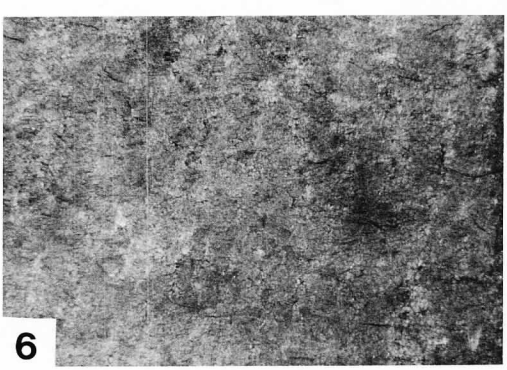

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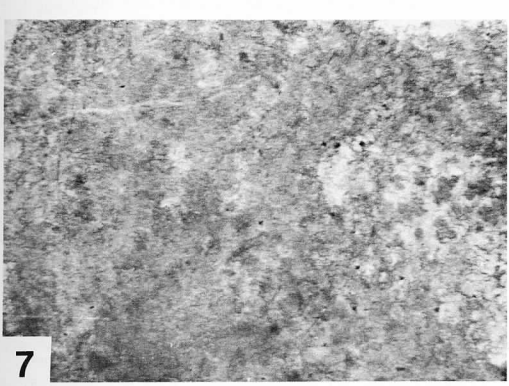

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