

## GRAPTOLITES OF VICTORIA; NEW SPECIES AND ADDITIONAL RECORDS.

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### Plates XX–XXII.

Nine new species and three new varieties of Graptolites are described below and several species are recorded in Australia for the first time. *Monograptus aplini* T. S. Hall and *Stomatograptus australis* (McCoy) are redescribed. Except where otherwise indicated specimens quoted are in the collections of the Geological Survey of Victoria. All drawings were made with a camera lucida.

Of the new species, *Pterograptus lyricus* is probably the most graceful graptolite known; *Tetragraptus chapmani* and *Cryptograptus circinus* have unusual structural characters; and *Reliograptus pulcherrimus* and *Stomatograptus australis* clearly show the internal clathria.

Several species are common to more than one province. *Diplograptus* (*Glyptograptus*) *euglyphus* occurs in Australia, Europe and America; *D. (G.) euglyphus* var. *sepositus* in Australia and New Zealand; and *Monograptus pandus* in Australia and Europe. The following Australian species here described have closely related European representatives:—*Didymograptus acriculus* in *D. euodus* Lapworth, *Pterograptus lyricus* in *P. elegans* Holm, *Climacograptus subminimus* in *C. minimus* (Carruthers), *Monograptus spiralis* var. *permensus* in *M. spiralis* Geinitz. The Australian species *Glossograptus pilosus* has an American representative in *G. hystrix* Ruedemann, and *Didymograptus mendicus* has a New Zealand representative in *D. bidens* Keble.

The stratigraphical classification adopted is that of Thomas and Keble (14) for the Silurian and Upper Ordovician, and that of Harris and Keble (9) for the Lower Ordovician, as shown in the following table.

PERIOD.	SERIES.	ZONES.
Silurian .. .. .	Melbournian	
	Yeringian	
	Keilorian	
Upper Ordovician .. .. .	Bolindian	
	Eastonian	
	Gisbornian	

# GRAPTOLITES OF VICTORIA.

PERIOD	SERIES	ZONES.
Lower Ordovician .. .. .	Darriwilian .. .. .	{ D1
		{ D2
		{ D3
		{ D4
		{ D5
	Castlemainian .. .. .	{ C1
		{ C2
		{ C3
		{ C4
		{ C5
	Bendigonian .. .. .	{ B1
		{ B2
		{ B3
		{ B4
		{ B5
	Lancefieldian .. .. .	{ L1
		{ L2
		{ L3
		{ L4
		{ L5

Family **DICHOGRAPTIDAE** Lapworth 1873.

Genus **DIDYMOGRAPTUS** McCoy 1851.

*Didymograptus acriculus*, sp. nov.

(Plate XX, Figs. 1a, 1b, and Text fig. 1.)

Branches several centimetres in length; incomplete; less than 0.5 mm. wide at origin but widens rapidly (at 3.5 mm. from sicula 2.0 mm. wide) to 3.5 mm.; diverging from inconspicuous sicula at slightly more than 180° but rapidly becoming horizontal.



Fig. 1. *Didymograptus acriculus*, sp. nov.

a. Distal thecae (No. 23507). b. Proximal thecae (No. 22811).  $\times 4$ .

Thecae, in proximal portion, 10 or 11 in 10 mm.; inclined at 30°; overlapping about half of length. In distal portion, thecae 7 in 10 mm.; inclined at 50°; overlapping two-thirds of length; three times as long as wide; ventral margins doubly curved; apertural margins sigmoidal, at 95° to axis of branch and produced into broad, conspicuous denticles.

*Remarks.*—The sicula is less than 1.0 mm. long and the first theca originates near its aperture. Some branches up to 6 mm. in length have all thecae of the distal type. *D. acriculus* appears to have some thecal characters in common with *D. euodus* Lapw., see Elles and Wood (1), but it differs from Lapworth's species in the absence of proximal curvature of its branches and in its rapidly increasing and greater distal width.

*Associated graptolites.*—*Tetragraptus* cf. *quadribrachiatus* (J. Hall), *Iscograptus forcipiformis* (Rued.), *Didymograptus nodosus* Harris, *Cryptograptus tricornis* var. *schuferi* Lapworth, *Diplograptus* cf. *coelatus* Lapworth, *Glossograptus pilosus* sp. nov., *Lasiograptus* sp., *Cardiograptus crawfordi* Harris, *Phyllograptus nobilis* Harris & Keble, *Trigonograptus* sp., *Brachiograptus clafornis* H and K., *Atograptus woodwardi* Harris, and other, as yet undescribed, species.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1.

*Locality.*—Bendigo East, on south side of Bendigo-Axedale Road, about 30 chains east of the Whitelaw Fault.

*Didymograptus mendicus*, sp. nov.

(Plate XX, fig. 2.)

Branches arising suborally; abruptly curved for first half of thecae 1<sup>1</sup> and 1<sup>2</sup>, then very slightly curved and lying within an angle of 70°. Minimum width near sicula under 0.2 mm.; maximum width distally 1.5 mm.; maximum length over 1 mm.

Sicula less than 1 mm. long and relatively broad. Thecae 12 or 13 in 10 mm.; about as long as broad (except 1<sup>1</sup> and 1<sup>2</sup>); free for three-fourths length; apertural margins undulate, approximately 105° to axis of branch; ventral margins slightly concave, inclined between 40° and 45°; broadly submucronate. Thecae 1<sup>1</sup> and 1<sup>2</sup> twice as long as broad; proximal half from near origin slightly over 0.1 mm. wide with concentrically curved sides; distal half rapidly widening to 1.4 mm. at aperture.

*Remarks.*—The first thecae are about 2.0 mm. long, the succeeding thecae 1.5 mm.; an unusual feature. The curvature giving the polypary its dependent form is confined to the narrow half of the first thecae. Later thecae are characteristically broad and have an unusually small overlap in proportion to their breadth. The angle of the aperture varies considerably with the mode of preservation, and in the right hand branch of the holotype (Pl. XX, fig. 2), appears to be considerably more than 105°. The mode of origin of the first thecae is suggestive of the *Leptograptidae*; we have not yet obtained a specimen showing the reverse aspect, but we suspect that a rudimentary double crossing canal is present.

*D. mendicus* belongs to the *D. bidens* group; *D. bidens*, a New Zealand form recently described by Keble (11), is the

oldest known representative of this characteristic group of dependent *Didymograpti*.

*D. mendicus* differs from *D. bidens* in the more abrupt proximal curvature of its branches ; in its distally wider angle of divergence ; in its greater distal width ; and in its more closely set thecae. It has, however, the characteristic small overlap, the same ratio of thecal length to breadth, and unusually long first thecae. Unquestionably *D. mendicus* is the Australian equivalent of the New Zealand form, *D. bidens*, and it is associated with a similar graptolite fauna.

*Associated graptolites*.—*Didymograptus protobifidus* Elles, *Tetragraptus quadribrachiatus* (J. Hall), *T. similis* (J. Hall), *Phyllograptus* spp., etc.

*Horizon*.—Lower Ordovician, Castlemaine Series, Zone C5 or C4.

*Locality*.—Connell's Mine, east bank of Werribee River, 12 miles south of Daylesford.

### Genus TETRAGRAPTUS Salter 1863.

#### *Tetragraptus chapmani*, sp. nov.

(Plate XX, figs. 3a, 3b)

The obverse view is the only one so far seen. Sicula 1.2 mm. long, 0.7 mm. wide. Theca 1<sup>1</sup> originates suborally, apparently a little below aperture of sicula ; theca 1<sup>2</sup> crosses a little above 1<sup>1</sup> and lies slightly downwards across sicular aperture. Funicle apparently straight ; consists of three pairs of thecae (1<sup>1</sup>, 1<sup>2</sup>, 2<sup>1</sup>, 2<sup>2</sup>, 3<sup>1</sup> and 3<sup>2</sup>) ; 7.7 mm. long. Thecae 3<sup>1</sup> and 3<sup>2</sup> bifurcate and give rise to four slender branches of second order uniformly under 0.5 mm. wide. Secondary branches long (in one case 96 mm.), sinuous, irregular in direction. Thecae 9 to 11 in 10 mm. ; between two and three times as long as wide ; overlap one-fourth or less of length ; ventral margins inclined between 20° and 25°, apertural margins at 70° to axis of branch ; both slightly concave.

*Remarks*.—The thecae appear to be simple tubes, not unlike those of some *Bryograpti*, but more specialised. Their apertures come into view in rotation as if the thecae were arranged spirally ; this is perhaps due to torsion of the branches. Specimens seldom have more than one theca at a time laterally compressed, and this makes the study of thecal structure difficult, even in specimens in partial relief.

The angle between each pair of branches of the second order at the end of the funicle varies considerably and is of no specific importance.

We regard *T. chapmani* as one of the most important and characteristic of Victorian graptolites ; in fact we are not aware of any other member of the Dichograptidae with such peculiar



structural details. We anticipate that better specimens will throw light on both structure and functions of graptolites; we have, therefore, named this unusual form after Mr. F. Chapman whose researches have so greatly advanced Australian palaeontology.

*Associated graptolites.* *Clonograptus tenellus* Linnarsson, *Bryograptus* sp., *Didymograptus aurcus* T. S. Hall, *D. latens* T. S. Hall, *D. latus* T. S. Hall, *Tetragraptus fruticosus* (J. Hall) (4 br.), *T. quadribrachiatus* (J. Hall), *T. approximatus* Nicholson, *T. decipiens* T. S. Hall, *T. acclinans* Keble, *Loganograptus logani* J. Hall.

*Horizon.*—Lower Ordovician, Bendigo and Lancefield Series, Zones B5 and L2.

*Localities.*—Holotype, gully near junction of Kangaroo Creek and Lerderderg River, 2 miles below Blackwood (left bank); paratype, Antimony Mine, Lerderderg River, 1 mile below Blackwood (right bank).

*Tetragraptus decipiens* T. S. Hall var. *bipatens* nov.

*Tetragraptus decipiens*, T. S. Hall, Proc. Roy. Soc. Vict., xi (n.s.), 2, 1899, p. 168, pl. xvii, xviii.

(Text figs. 2, 3.)

Sicula 1.4 mm. long, 0.6 mm. wide. Theca 1<sup>1</sup> originates within apertural third of sicula and grows downwards at approximately 110° to sicular axis; theca 1<sup>2</sup> turns in opposite direction and forms with 1<sup>1</sup> a funicle enclosing an angle of 140°. Thecae 1<sup>1</sup> and 1<sup>2</sup> bifurcate, giving rise to branches of second order, 13 mm. or more in length, normally straight, but usually flexed by compression. Secondary branches widen rapidly to 0.8 mm. and maintain that width throughout.



Fig. 2. *Tetragraptus decipiens* T. S. Hall var. *bipatens* nov. a. Sicula and theca 1 (No. 25094). b. (?) serrated or irregular apertural margins on branch of second order (No. 25058). c. Proximal portion of branch of second order showing peculiar arrangement of thecae (holotype No. 25094).  $\times 4$ .

Thecae, long tapering tubes a little more than three times as long as wide; divergent; overlapping one-fourth of length; 8 in 10 mm.; ventral margins straight, inclined to axis of branch at 20°. Thecal apertures of holotype either acutely dentiform, sigmoidal, concave or straight, according to mode of compression.

*Remarks.*—In some specimens the sicula has a short inconspicuous nema. The variable aspect of the polypary (text figs. 3a–3g), due to mode of compression, is suggestive in regard to other quadribrachiate *Tetragrapti*. The funicle may appear angular or straight, and branches of the second order straight or flexed. The funicle normally encloses an angle of 140° (text figs. 3a, 3b). Assuming that the whole polypary was

suspended by a nema, the secondary branches continue on the same slope as the funicle; in other words they were not horizontal as is generally assumed for *T. quadribrachiatum*, see J. Hall (6, Pl. 5).

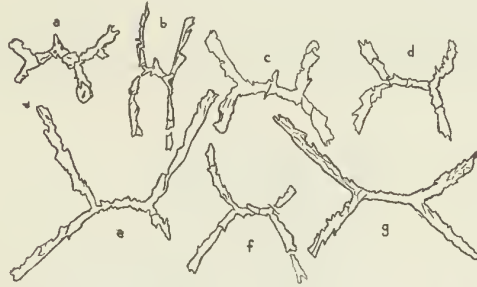


Fig. 3. *Tetragraptus decipiens* T. S. Hall var. *bipatens* nov.; polyparies subvertically compressed. *a.* Obverse view; sicula and funicle turned over, branches of second order flexed and contorted (No. 25097). *b.* Reverse view (No. 25016). *c.* Sicula turned over, funicle partly turned over and elongated, lower branches flexed (No. 25041). *d.* (No. 25087); *e.* (No. 25055); *f.* (No. 25058); *g.* almost vertically compressed (No. 25061); sicula apparently compressed against funicle.  $\times 2$ .

The angle contained by pairs of secondary branches is between  $100^{\circ}$  and  $105^{\circ}$ .

Whether the funicle is straight or angular when compressed, or the branch straight or flexed, depends on how the polypary came to rest; this was usually on the distal ends of the branches, and it then became fixed with the aperture of its sicula opening downwards. The funicle and sicula would thus be compressed last, either vertically or slightly subvertically; vertical compression would elongate the funicle and press the sicula against it (text figs. 3*d*–3*g*), but subvertical compression would cause funicle and sicula to bend over and display a lateral aspect (text figs. 3*a*, 3*b*). In one example (text fig. 3*c*) the sicula has been turned over and the funicle is elongated. The following are measurements of the funicle under different modes of compression:—

Incidence of pressure	Vertical	Slightly Subvertical	Subvertical	Subvertical
Shape of funicle	straight	slightly angular	slightly angular	angular
Position of sicula	elongated, compressed against funicle	elongated, compressed against funicle	elongated, turned over	not elongated, turned over
Length in mm.	2.3 (Fig. 3 <i>d</i> ) 2.5 ( „ 3 <i>f</i> ) 3.0 ( „ 3 <i>g</i> )	2.5 (Fig. 3 <i>g</i> )	3.2 (Fig. 3 <i>c</i> )	2.1 (Fig. 3 <i>a</i> ) 1.7 ( „ 3 <i>b</i> )

Elongation of the funicle is accompanied by slight flexing of the branches (text figs. 3c-3g); subvertical compression and turning over of the sicula and funicle, by strong flexing and distortion (text figs. 3a, 3b).

If the polypary came to rest on the apex of the sicula and the distal ends of two branches, all four branches would be compressed on one side of the funicle; this has been observed in *T. decipiens*.

*T. decipiens* var. *bipatens* differs from *T. decipiens*, see T. S. Hall (7), in the following respects:—

	<i>T. decipiens</i> var. <i>bipatens</i> .	<i>T. decipiens</i> .
Branches of second order.	Widen rapidly to 0.8 mm. and maintain that width throughout	Widen from 0.6 mm. rapidly to 1.5 mm.
Thecae—		
Number in 10 mm. ..	8 or 10	9 or 11
Length to width .. ..	3 : 1	4 : 6
Angle of inclination ..	20°	27°
Overlap .. .. .	$\frac{1}{4}$	$\frac{1}{2}$

*Associated graptolites*.—*Clonograptus* cf. *rigidus* J. Hall, *Bryograptus* spp., *Tetragraptus approximatus* Nicholson, *T. acclinans* Keble, *T. decipiens* T. S. Hall, *T. fruticosus* (J. Hall), *Didymograptus aureus* T. S. Hall, *D. latens* T. S. Hall, *D. latus* T. S. Hall, *Loganograptus logani* J. Hall, etc.

*Horizon*.—Lower Ordovician, Bendigo Series, Zone B5; probably also Lancefield Series, Zone L1.

*Locality*.—Antimony Mine, Lerderderg River, one mile downstream from Blackwood.

## Genus PTEROGRAPTUS Holm 1881.

### *Pterograptus lyricus*, sp. nov.

(Plate XX, fig. 4 and text fig. 4.)

Polypary consisting of (a) two outer monopodial branches widening from 0.2 mm. near sicula to 0.5 mm. in distal portion, approximately straight for at least 1.2 cm. and lying within an angle of 65°, then curving gracefully for rest of length (3.5 cm.), first away from, then towards, axis of polypary, the curve increasing at distal extremity until ultimately trending at right angles to axis; (b) forty or more inner branches of like dimensions arising from consecutive monopodial thecae, forming at point of origin an acute angle with branch of first order, those arising near sicula being slightly curved, curvature increasing with remoteness of branch, the most distal curving gracefully upwards and inwards and converging like outer branches towards axis of polypary. Sicula 0.5 mm. long. Thecae long, narrow, simple tubes; in proximal portion 10 or 11 in 10 mm.; about four times as long as wide, over-

lapping one-half to two-thirds of length; inclined at about  $25^{\circ}$ ; apertural margins straight, normal to axis of branch; in distal portion, about 8 in 10 mm., in contact for a small fraction of length, apertural margins introverted.

*Remarks.*—At first sight the inner branches seem to be given off in pairs, suggesting Ruedemann's genus *Syndyograptus* (see Ruedemann, 13), but closer inspection shows that they arise serially.

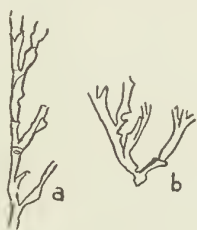


Fig. 4. *Pterograptus lyricus*, sp. nov. Polyparies bilaterally compressed. *a.* Proximal portion showing inner branches arising serially (No. 13755 Nat. Mus.). *b.* Proximal portion (No. 13756 Nat. Mus.).  $\times 4$ . Paratypes, Turner's Quarry, 5 miles W. of Hastings.

*Associated graptolites.*—*Tetragraptus* cf. *quadribrachiatus* (J. Hall), *Iso-graptus ovatus* (T. S. Hall), *Cryptograptus tricornis* (Carruthers), *Glossograptus hincksi* (Hopkinson), *Climacograptus riddellensis* Harris, *Diplograptus* (*Glyptograptus*) *euglyphus* (Lapworth).

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1 (uppermost beds).

*Localities.*—Holotype and paratypes, Turner's Quarry, Allot. 27B, Parish of Bittern, 5 miles west of Hastings (Mornington Peninsula); Sandy's Creek, near confluence with Merrijig Creek, Tabberabbera (Gippsland); Howqua River, above Eight Mile Creek.

## Family **DIPLOGRAPTIDAE** Lapworth 1873.

### Genus **CLIMACOGRAPTUS** J. Hall 1865.

#### *Climacograptus uncinatus*, sp. nov.

(Plate XX, figs. 5a–5c.)

Polypary widening from pointed proximal end to 2.5 mm. in 3 mm. and maintaining that width. Sicula obscure. Thecae 12 to 14 in 10 mm. Two fairly stout curved spines, about 2.0 mm. long, arise about 2.0 mm. from proximal end.

*Remarks.*—The only polyparies found exhibit scalariform or subscalariform aspects, probably because the curved spines in the proximal portion function as septal spines which prevent the polypary coming to rest except with the thecal apertures at right angles to the bedding. A subscalariform specimen



indicates that the thecae are approximately 2.0 mm. long and overlap about one-half their length.

*Associated graptolites.*—*Rctiograptus pulcherrimus*, sp. nov., *Climacograptus missilis* Keble & Harris, *C. tubuliferus* Lapworth, *D. carnei* T. S. Hall, *Leptograptus eastonensis* Keble & Harris, *L. flaccidus* J. Hall.

*Horizon.*—Upper Ordovician, Bolinda Series.

*Locality.*—About 10 chains west of Jordan River where it crosses the Yarra Track, between Matlock and The Oaks.

*Climacograptus subminimus*, sp. nov.

(Plate XX, figs. 6a, 6b.)

Polypary 15 mm. long, widening rapidly to maximum width of about 1 mm. Virgella conspicuous. Virgula relatively stout; 6 mm. or more in length. Thecae 10 or 11 in 10 mm.; long, overlapping from one-half to two-thirds of length; free outer edges straight and vertical; apertural margins horizontal, lying within sub-elliptical excavations occupying one-third width of polypary and one-third of ventral margin. Septum incomplete.

*Remarks.*—In some specimens there is a suggestion of a rudimentary basal spine. *C. subminimus* seems intermediate between *C. minimus* Carruthers and *C. brevis* Elles and Wood; from *C. minimus* it is distinguished by its lesser width, and from *C. brevis* by its greater thecal overlap. This graptolite is referred to *Climacograptus* with some hesitation, but its inclusion in the genus is supported by comparing it with figures of related species; see Elles and Wood, 2, p. 193, fig. 125b.

*Associated graptolites.*—The same as with *Didymograptus acriculus*.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1.

*Locality.*—Bendigo East, on south side of Bendigo-Axedale Road, about 30 chains east of Whitelaw Fault, and at other outcrops of the same belt of strata in this locality.

Genus DIPLOGRAPTUS McCoy 1850.

Subgenus GLYPTOGRAPTUS Lapworth 1880.

*Diplograptus (Glyptograptus) euglyphus* Lapworth.

*Diplograptus (Glyptograptus) euglyphus*, Lapworth, Ann. Mag. Nat. Hist. [5], v, 1877, p. 166, pl. iv.

(Plate XXI, fig. 1.)

In some of the Upper Darriwil beds a *Diplograptus* occurs which is intermediate between *D. (G.) euglyphus* and *D. (G.) teretiusculus* (Hisinger), see Elles and Wood (3). The maximum

length observed is 3.0 cm.; it widens from about 1.0 mm. in the proximal portion to 2.0 mm. within 4.5 mm. and has, therefore, a robustness suggestive of *D. (G.) teretiusculus*. The virgella is fine and short, like that of the American forms of *D. (G.) euglyphus* described by Ruedemann (13). No basal spines have been detected. The thecae are sacculate above and impressed below, 2.5 mm. long, overlap about one-half, and have undulate apertural margins. Thecae 11 to 12 in 10 mm. in proximal part, and 9 to 10 in 10 mm. in distal part of polypary. Until we have examined a wider range of material we prefer to regard this form as *D. (G.) euglyphus*.

*Associated graptolites*.—Graptolites associated with this form are typical of the Gisborne Series (Upper Ordovician) or of Zone D1, Darriwil Series (Lower Ordovician).

*Horizon*.—Lower Ordovician, Darriwil Series, Zone D1; and Upper Ordovician, Gisborne Series.

*Localities*.—One Mile Creek, Enoch's Point, Goulburn River; Howqua River above Eight Mile Creek; Geological Survey Locality, Ba67, Quarter Sheet 6 S.E., at the junction of Riddell's and Jackson's Creeks, near Gisborne; Bendigo East, on the Bendigo-Axedale Road, about 30 chains east of the Whitelaw Fault; Turner's Quarry, Allot. 27B, Parish of Bittern, Mornington Peninsula.

*Diplograptus (Glyptograptus) euglyphus* Lapworth

var. *sepositus* nov.

(Plate XXI, figs. 2a-2c.)

Polypary 21 mm. in length; widening from 0.7 near sicula to about 1.8 mm. in 6 mm. and then of uniform width to distal extremity. Sicula about 0.6 mm. long; furnished with short, fine virgella and curved spine. Thecae 8 to 10 in 10 mm., similar to those of *D. (G.) euglyphus*.

*Remarks*.—All our specimens have a subscalariform aspect but vary considerably in appearance with slight variation in the angle of compression. Some modes of preservation suggest introversion in the apertural region. In some polyparies the first thecae have grown to an abnormal size. The development of the first thecae is obscure, but Th. 1<sup>1</sup> seems to originate near the aperture of the sicula and turns quickly, growing outwards; it is furnished with a small apertural spine. Th. 1<sup>2</sup> grows outwards and upwards.

*D. (G.) euglyphus* var. *sepositus* has much in common with the form described by Elles and Wood (3) as *D. teretiusculus* var. *euglyphus* and that relegated by Ruedemann (13) to *D. euglyphus*, more with the latter than with the former. It

differs from Elles and Wood's form in having thecae more closely set, in its smaller maximum width and wider proximal portion; from Ruedemann's form in having a smaller angle of the thecae and a persistent basal spine. Though Ruedemann does not illustrate the proximal thecae and no definite conclusion can be based on his figure, the differences between his form and ours appear to be of varietal importance only.

*Associated graptolites.*—As with *D. (G.) euglyphus*.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1; Upper Ordovician, Gisbornian Series.

*Localities.*—The same as those of *D. (G.) euglyphus*.

### Subgenus AMPLEXOGRAPTUS Elles and Wood 1907.

*Diplograptus (Amplexograptus) cf. perexcavatus* Lapworth.

*Diplograptus perexcavatus*, Lapworth, Cat. West. Scott. Foss., II, 1876, p. 6, pl. ii.

*Diplograptus (Amplexograptus) perexcavatus*, Elles and Wood, Mon. Brit. Grapt., pt. vi, p. 267, Pl. Soc., lxi, 1907, pl. xxxi.

(Plate XXI, fig. 3.)

A few specimens of *D. (A.) cf. perexcavatus* have been collected at Bendigo East and Sunbury. All are distorted or fragmentary, particularly in the proximal portion, and all specific criteria cannot be checked. The largest fragment is 11.0 mm. long and has a maximum breadth of 2.0 mm. at the distal extremity. Thecae from 12 to 14 in 10 mm., preserved in both scalariform and subscalariform aspects. In scalariform (*Climacograptus*) aspect, the excavations are deep, occupying one-half the breadth of the polypary; in subscalariform aspect, the ventral margins of thecae have a double curvature, but less pronounced than that of some British forms.

*Associated graptolites.*—*Diplograptus coelatus* Lapworth.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1; Upper Ordovician, Gisbornian Series.

*Localities.*—Small washout east of Sunbury-Gisborne Road, about 2 miles N.W. of Sunbury; Bendigo East.

### Genus TRIGONOGRAPTUS Nicholson 1869.

*Trigonograptus* sp.

(Plate XXI, figs. 4a, 4b.)

Polypary about 2 cm. long, at proximal end approximately 1 mm. wide, widening to 3.1 mm. in 1 cm. and then narrowing to a pointed distal extremity.

Thecae 11 to 13 in 10 mm., slightly curved, inclined at  $40^{\circ}$  to  $50^{\circ}$ ; in contact throughout; apertural margins forming a more or less broken line representing margin of compressed polypary. Test somewhat attenuate.

*Remarks.*—The median suture is indistinct but is apparently wider than that of *T. wilkinsoni* T. S. Hall or *T. ensiformis* J. Hall (see T. S. Hall, 8, and J. Hall, 6, pl. 14). Its spindle-shaped polypary and the absence of subparallel margins may be merely characteristic of a stage of development. Until better specimens are available, we have contented ourselves by referring it to its genus.

*Associated graptolites.*—The typical assemblage of Zone D1, Darriwil Series; see *Didymograptus acriculus*, p. 167.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1.

*Locality.*—Bendigo East, on south side of Bendigo-Axedale Road, about 30 chains east of Whitelaw Fault, and at other local outcrops of the same strata.

## Genus GLOSSOGRAPTUS Emmons 1855.

*Glossograptus pilosus*, sp. nov.

(Plate XXI, figs. 5a–5d.)

Polypary oval, fusiform or subcircular; 3.6 mm. long, about 2.0 mm. broad. Sicular about 1.0 mm. long. Thecae from 22 to 27 in 10 mm.; overlap three-fourths of length; ventral margin straight; apertures everted; from sicular to distal extremity facing downwards, outwards, and upwards; furnished with robust, arcuate, blunted spines. Virgula stout, about 1.5 mm. long.

*Remarks.*—*G. pilosus* differs from *G. hystrix* Rued. (see Ruedemann, 12) in general shape, relative shortness, more closely set thecae, and its arcuate spines. The distal thecae may grow to abnormal size and produce unusually long spines. The sicular has sometimes an extremely fine virgella. The septal spines are robust though seldom visible. The apertural spines often widen into a dilation, suggesting affinities to the genus *Lasiograptus*.

*Associated graptolites.*—Those found with *Didymograptus acriculus*.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1.

*Locality.*—Bendigo East, on south side of Bendigo-Axedale Road, about 30 chains east of Whitelaw Fault; and occasionally in other local outcrops of the same strata, as in Sect. xxix, Parish of Huntley.

## Genus CRYPTOGRAPTUS Lapworth 1880.

*Cryptograptus circinus*, sp. nov.

(Plate XXI, figs. 6a–6e, and text fig. 5.)

Polypary widening rapidly to approximately 3.0 mm., attaining 18 mm. in length. Sicular obscure; minute virgella. Thecae 13 to 15 in 10 mm.;



tubular; apertures open obliquely downwards and outwards; overlap one-half of length; submucronate.



Fig. 5. *Cryptograptus circinus*, sp. nov. Proximal end (No. 22913, syntype).  $\times 3$ .

*Remarks.*—*C. circinus* differs from *C. tricornis* Carruthers in its greater width, in its less widely spaced thecae, and in thecal characters (see Elles and Wood 4). Thecae opening obliquely downwards and outwards indicate retroversion; it is, however, difficult to trace the walls of the thecae into the body of the polypary. Some specimens show torsion (Pl. XXI, fig. 3d); the aspects of the polypary are not as varied as in *C. tricornis*, bilateral aspect being common and suggesting that the cross section of the polypary is not so concavo-convex as it is in *C. tricornis*.

*Associated graptolites.*—As with *Didymograptus acriculus*.

*Horizon.*—Lower Ordovician, Darriwil Series, Zone D1.

*Locality.*—Common at Bendigo East in outcrops of strata of the Darriwil Series.

## Genus RETIOGRAPTUS J. Hall 1865.

*Retiograptus pulcherrimus*, sp. nov.

(Plate XXII, figs. 1 and text fig. 6.)

Polypary 12 cm. or more in length, widening proximally to 2.0 mm. in the first few centimetres and maintaining that width throughout. Sicula furnished with spines. Polypary consists of a series of superimposed rhombic areas



Fig. 6. *Retiograptus pulcherrimus*, sp. nov. Portion of polypary, reproduced from photograph, showing consecutive pairs of rhombs and alternating thecae. (No. 26700 [1], holotype).  $\times 5$ .

outlined by strands. Subvertical sides of consecutive pairs of rhombs from an outer and inner angle; thecae project from the outer angles, successive thecae being on opposite sides of the polypary, and separated by rhombic interspaces. Apertures subangular, each with a short blunt spine. Longitudinally throughout the polypary are two septal strands, one zigzag (obverse aspect), and the other straight (reverse aspect).

*Associated graptolites*.—*C. uncinatus*, sp. nov., *C. missilis* Keble & Harris, *C. tubuliferus* Lapworth, *Diplograptus carnei* T. S. Hall, *Leptograptus eastonensis* Keble & Harris, *L. flaccidus* J. Hall, etc.

*Horizon*.—Upper Ordovician, Bolinda Series.

*Locality*.—About 10 chains West of Jordan River where it runs under Yarra Track between Matlock and The Oaks.

### Family **MONOGRAPTIDAE** Lapworth 1873.

#### Genus **MONOGRAPTUS** Geinitz 1852.

*Monograptus aplini* T. S. Hall, emended Keble and Harris.

*M. aplini* T. S. Hall, Vict. Grap., Pt. IV, Proc. Roy. Soc. Vict., Vol. XXVII (n.s.) Pt. 1, p. 114, 1914, pl. xvii, fig. 17.

(Plate XXII, figs. 2*a*–2*i*, and text fig. 7.)

T. S. Hall's original description (8) is as follows: "Very minute, curved toward the ventral side. The most complete specimens form an open U-shaped figure. Thecae 18 to 20 in 10 mm.; apparently coiled in a rounded mass, and opening laterally. Sicular about 1 mm. long and narrow." He adds that "*M. aplini* is closely allied to *M. exiguus* Nicholson, and *M. nodifer* Tornquist, but its minute size separates it from them." Hall's type is from Keilor, Victoria. The type, as figured by him, does not show the characteristic form of the polypary. On this account, and influenced by the words "very minute" in Hall's diagnosis, we failed at first to identify our specimens with *M. aplini*. We have refigured the type specimen (Pl. XXII, fig. 2*a*), together with another specimen from the same slab (Pl. XXII, fig. 2*h*.)

Although *M. aplini* resembles *M. exiguus* Nicholson and *M. nodifer* Tornquist (see Elles and Wood, 5) in general appearance, we are convinced after examining hundreds of specimens that the thecae of *M. aplini* are curved tubes opening, as Hall observes, laterally, the apparent coils being due to compression of the apertural margins. Specimens from Enoch's Point are usually more robust than those from Keilor and have more widely spaced thecae (about 14 in 10 mm.).

*Associated graptolites.*—*M. pandus* Lapworth (Pl. XXII, figs. 3a, 3b), *M. spiralis* Geinitz var. *permensus* nov., *M. scanius* Tullberg (Pl. XXII, fig. 4), *M. cf. dubius* Suess, *M. turriculatus* Barrande, *Stomatograptus australis* (McCoy).

*Horizon.*—Silurian, Keilor Series, near top.

*Localities.*—Keilor; Enoch's Point, a few chains north of where the abandoned Darlingford-Enoch's Point Road crosses Knowles Creek.

*Monograptus spiralis* (Geinitz) var. *permensus* nov.

*Graptolithus spiralis*, Geinitz, Neues Jahrb. f. Min., 1842, p. 700, pl. x.

*Monograptus spiralis* B. *subconicus*, Törnquist, Siljansor. Grapt., ii, 1892, p. 35, pl. iii.

*M. spiralis*, Elles and Wood, Mon. Brit. Grapt., ix, Pal. Soc., lxvi, 1912, p. 475, text figs. 331 a, b, c, pl. xlviii.

Polypary robust, widening from slender proximal portion persistently through its length; coiled into loose spiral. Thecae on convex margin, 12 to 14 in 10 mm.; of uniform type; subtriangular; scarcely overlapping; with barbed retroverted apertural region, slightly smaller and more triangular at proximal than at distal end.

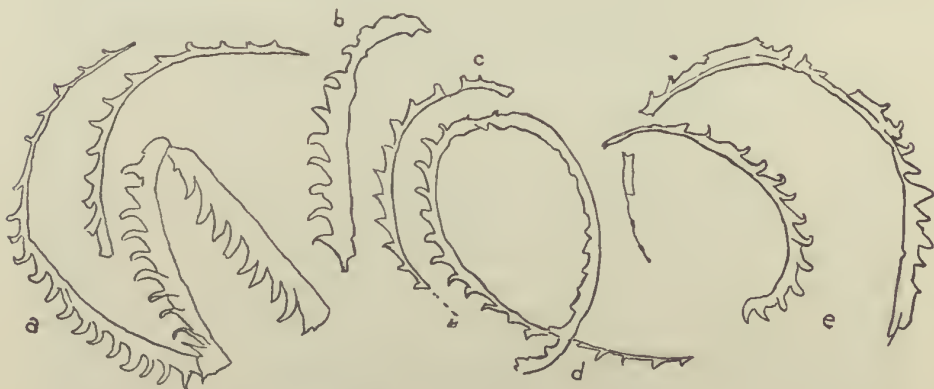


Fig. 7. *Monograptus spiralis* Geinitz var. *permensus* nov. a. Triangular and partly retroverted thecae (No. 29306). b. Distorted polypary with usual form of thecae (No. 29243). c. Triangular thecae (No. 29295). d. Typical spiral shape of polypary (No. 29253). e. Spirals (No. 29255).  $\times 4$ .

*Remarks.*—The polypary forms an irregular spiral, never well displayed and seldom complete. Torsion probably accounts for the scalariform aspect and even for the appearance of thecae on the inner margin of some specimens. The varietal form differs from the parent species in the spacing of thecae, typical *M. spiralis* having 8 or 9 in 10 mm., its variety *permensus* 12 to 14 in 10 mm. (see Elles and Wood 5).

*Associated graptolites and Horizon.*—The same as for *M. aplini*.

*Locality.*—Enoch's Point, a few chains north of where the abandoned Darlingford-Enoch's Point Road crosses Knowles Creek.

*Monograptus* cf. *scanius* Tullberg.

*Monograptus scanius*, Tullberg, Skånes Grapt., ii, 1883, p. 26, pl. ii.

(Plate XXII, fig. 3.)

A form comparable with *M. scanius* Tullberg (see Elles and Wood 5) occurs at Knowles Creek, Enoch's Point, at somewhat lower horizon than it does in Britain. Until more specimens are available we consider that a figure will be sufficient description.

*Associated graptolites, Horizon, and Locality.*—The same as for *M. spiralis* var. *permensus*.

*Monograptus pandus* (Lapworth).

*Monograptus lobiferus* var. *pandus*, Lapworth, Proc. Belfast Nat. Field Club, 1877, p. 129, pl. vi.

*Monograptus pandus*, Elles and Wood, Mon. Brit. Grapt., ix, Pal. Soc., 1912, p. 421, text fig. 283, pl. xlii.

(Plate XXII, figs. 4a, 4b.)

This species is now recorded for the first time in Victoria; it agrees with Lapworth's description and figures in all essentials; see Elles and Wood (4). This graptolite is not uncommon at Knowles Creek, Enoch's Point.

*Associated graptolites, Horizon, and Locality.*—The same as for *M. spiralis* var. *permensus*.

Family **RETIOLITIDAE** Lapworth 1873.

Genus **STOMATOGRAPTUS** Tullberg 1890.

*Stomatograptus australis* (McCoy).

(Plate XXII, figs. 5a–5d.)

*Retiolites australis* McCoy, Prod. Pal. Vict., Dec. II, p. 36, Pl. XX, 1875.

*Emended description.*—Polypary sword-shaped, robust, apparently concavo-convex in section; 20 mm. or more in length; widening steadily upwards from rounded base to 5 mm. or more. Thecae distinct; about 14 in 10 mm.; in contact for greater part of length; outer walls finely reticulate. Well-developed clathria with sub-regular and polygonal meshes, larger meshes being sometimes visible along medial axis. Nearly straight thecal walls inclined from 40° to 60° in forms having straight medial strand; more curved and at a greater angle when arising from zigzagged strand. Thecal apertures D-shaped; curved margin free, straight side attached to wall of next theca.

*Remarks.*—This graptolite conforms to Holm's amplified definition of the genus *Stomatograptus* (10) in its large medial



meshes and in its apertures. Ruedemann (13) records large medial meshes in *Retiolites*, but the apertures in the form here discussed determine its generic position. McCoy's holotype from Locality Ba 56 and 57, Quarter Sheet 1 NW, north-west of Keilor, is very indistinct and imperfect; better specimens have since been obtained, both from the type locality and from Enoch's Point, some of which we have made plesiotypes.

*Associated graptolites, Horizon, and Locality.*—The same as for *Monograptus aplini*.

### DESCRIPTION OF PLATES.

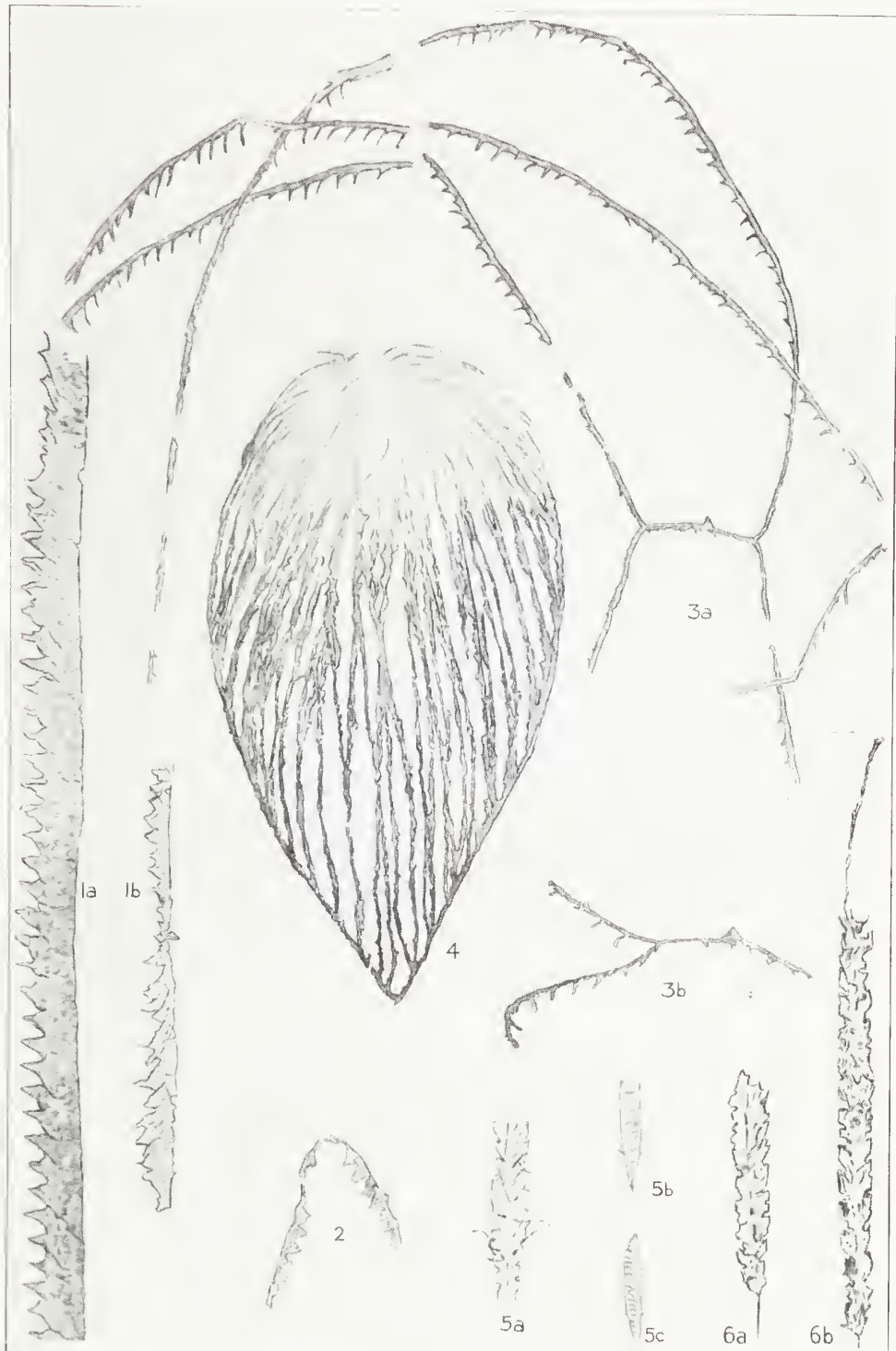
Except where otherwise mentioned, drawings were made with a camera lucida, and specimens are from the Geological Survey Collection.

#### Plate XX.

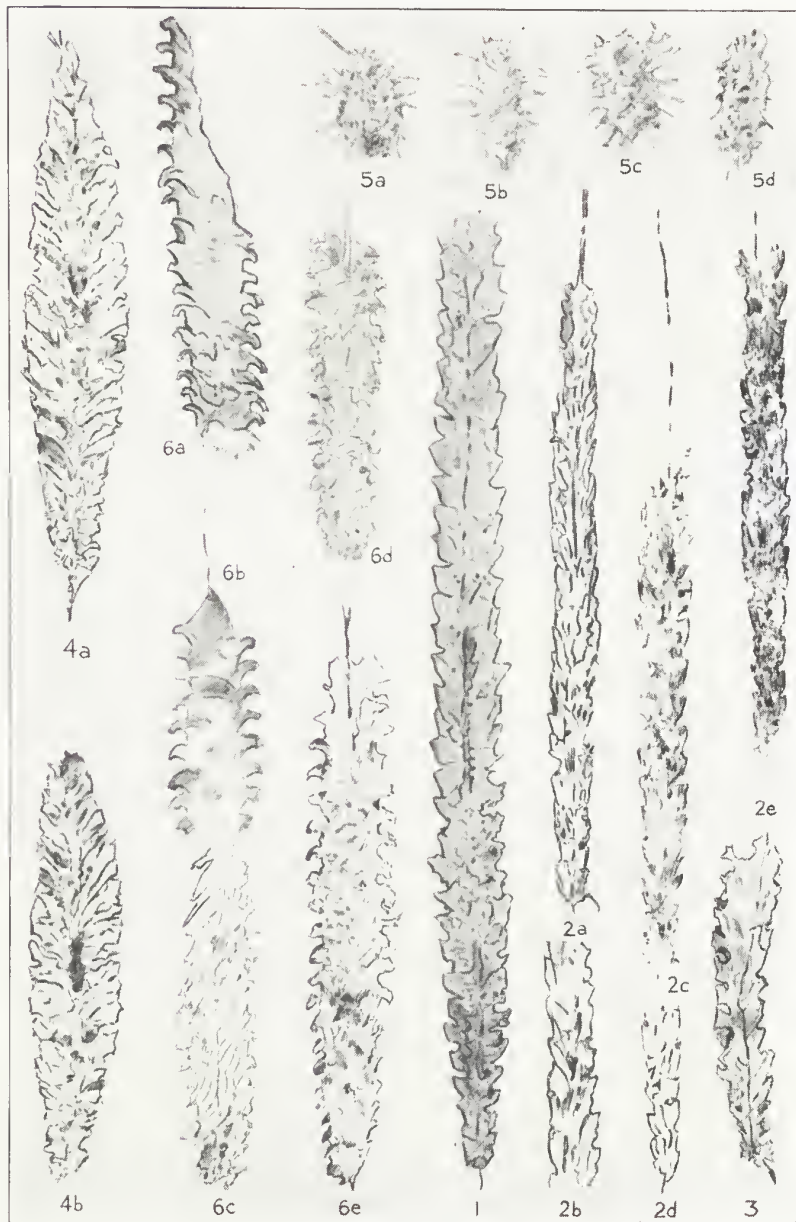
- Fig. 1. *Didymograptus acriculus*, sp. nov. *a.* Distal thecae No. 22811; syntype. *b.* Proximal region; sicula and branches compressed at different angles; No. 23507, syntype. Bendigo East.  $\times 4$ .
- Fig. 2. *Didymograptus mendicus*, sp. nov. No. 24747; holotype. Bendigo East.  $\times 4$ .
- Fig. 3. *Tetragraptus chapmani*, sp. nov. *a.* No. 24985; holotype. *b.* No. 25080; paratype. Blackwood.  $\times 4$ .
- Fig. 4. *Pterograptus lyricus*, sp. nov. No. 12297; holotype. Allot. 27B, Parish of Hastings.  $\times 4$ .
- Fig. 5. *Climacograptus uncinatus*, sp. nov. *a.* Subscalariform aspect; No. 26686; syntype. *b.* and *c.* Scalariform aspect, Spec. 26757; syntype. Yarra Track. *a.*  $\times 6$ ; *b.* *c.*  $\times 4$ .
- Fig. 6. *Climacograptus subminimus*, sp. nov. *a.* No. 22985; syntype. *b.* Proximal portion; No. 22985; syntype. Bendigo East.  $\times 4$ .

#### Plate XXI.

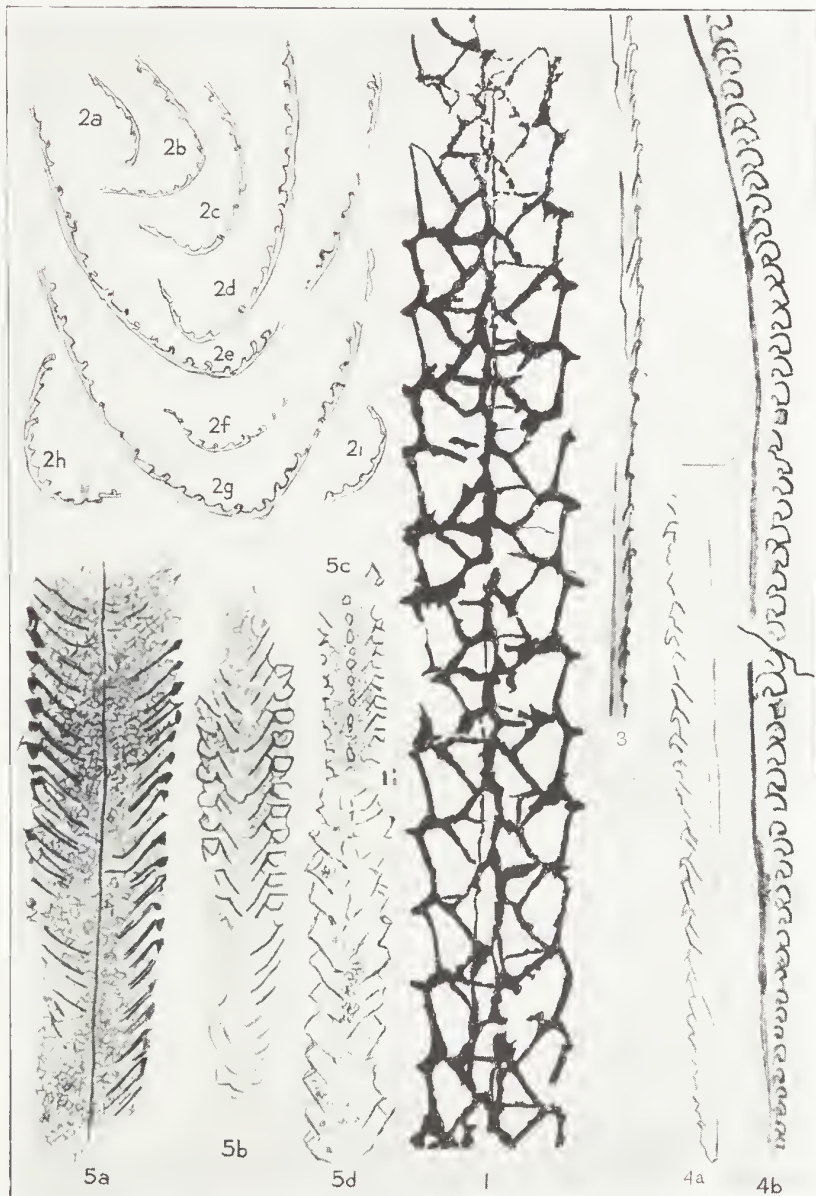
- Fig. 1. *Diplograptus* (*Glyptograptus*) *euglyphus* (Lapworth). No. 24738. Bendigo East; plesiotype.  $\times 4$ .
- Fig. 2. *Diplograptus* (*Glyptograptus*) *euglyphus* (Lapw.) var. *sepositus* nov. *a.* No. 22427; syntype. *b.* Distal thecae; No. 22902; syntype. *c.* No. 22385; syntype. *d.* Proximal end; No. 22909. *e.* No. 22385; syntype. Bendigo East.  $\times 4$ .
- Fig. 3. *Diplograptus* (*Amplexograptus*) cf. *perexcavatus* (Lapworth). Distorted polypary; No. 23776, plesiotype. Bendigo East.  $\times 4$ .
- Fig. 4. *Trigonograptus* sp. *a.* No. 22980. *b.* Common mode of preservation; No. 22865. Bendigo East.  $\times 4$ .
- Fig. 5. *Glossograptus pilosus*, sp. nov. *a.* No. 23779; syntype. *b.* No. 22913; syntype. *c.* No. 23779. *d.* No. 23914. Bendigo East.  $\times 4$ .
- Fig. 6. *Cryptograptus circinus*, sp. nov. *a.* Proximal portion; spec. KD., W. J. Harris Coll. *b.* Distal portion of same specimen. *c.* Polypary showing torsion; No. 22887. *d.* No. 24722; syntype. *e.* No. 22913; syntype. Bendigo East.  $\times 4$ .



Graptolites



Graptolites



Graptolites



Plate XXII.

- Fig. 1. *Retiograptus pulcherrimus*, sp. nov. Distal portion (from a photograph); No. 26700; holotype. Yarra Track.  $\times 7$ .
- Fig. 2. *Monograptus aplini* T. S. Hall (emend. Keble & Harris). *a*. Holotype refigured; Nat. Museum Coll. *b*. Spec. K, Harris Coll. *c*. No. 29267. *d*. No. 29274. *e*. No. 29274. *f*. Spec. K, Harris Coll. *g*. No. 29274. *h*. Specimen on slab with holotype. *i*. No. 29297. *e*. and *h*. from Keilor, the rest from Enoch's Point. (*b-h*, plesiotypes).  $\times 4$ .
- Fig. 3. *Monograptus* cf. *scanius* Tullberg. No. 29252. Enoch's Point.  $\times 4$ .
- Fig. 4. *Monograptus pandus* (Lapworth). *a*. Polypary showing thecal apertures turned away; No. 29245. *b*. Common aspect; No. 29277. Enoch's Point. (*a*, *b*, pleotypes).  $\times 4$ .
- Fig. 5. *Stomatograptus australis* (McCoy). *a*. No. 29292; plesiotype. *b*. No. 29293; plesiotype. *c*. No. 29297; plesiotype. *d*. McCoy's holotype; Nat. Museum Coll. Holotype from Keilor, the rest from Enoch's Point.  $\times 4$ .

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