

TREMADOC GRAPTOLITES FROM YUKON TERRITORY, CANADA

by D. E. JACKSON

ABSTRACT. Sixteen species of graptolites of Tremadoc age are described from a continuous succession of the Road River Formation in the Upper Canyon on Peel River. New species described are *Kiaerograptus(?) peelensis* n. sp., *Didymograptus(?) stelcki* n. sp., and *Staurograptus tenuis* n. sp. At this locality the Tremadoc is 136 m thick and contains two zones which have been divided into four subzones as follows: *Adelograptus* Zone; *Adelograptus antiquus* Subzone, *Clonograptus aureus* Subzone; *Staurograptus* Zone; *Anisograptus richardsoni* Subzone, *Staurograptus tenuis* Subzone.

THIS paper was prompted by a letter from Professor O. M. B. Bulman in May 1970 in which he wrote:

There must be a lot of funny things happening between the Lower Tremadoc and the *approximatus* Zone, but nowhere do we seem to have a straightforward stratigraphy and nowhere at all is there a continuous graptolite succession as yet.

Professor Bulman was referring in particular to the difficulties of unravelling the early evolution of graptolites because of the existence of facies changes and unconformities in the European region and structural complications at such classic localities as Lancefield, Australia, and at Levis and Deepkill, in North America. In this paper details are given of the faunal sequence in a gently tilted, stratigraphically continuous succession in the Tremadoc on Peel River in the Southern Richardson Mountains, Yukon Territory.

The existence of this remarkable sequence of graptolitic beds spanning the whole of Ordovician and Silurian time was first documented by Jackson and Lenz (1962) and amplified by Jackson (1966) and more recently by Jackson (*in* Lenz and Pedder 1972). These results were based largely upon collections made by several oil company geologists from the Peel River and elsewhere. Due to access problems and the fact that the complete section could be measured only when the river level was abnormally low it was not until the very dry summer of 1969, when conditions were ideal for examining the rock floor of the Upper Canyon, that the lower 900 feet (274 m) of the Road River Formation was measured, described, and re-collected. This new study enabled me to integrate various oil company collections with considerable confidence. The task was facilitated by the occurrence of easily identifiable marker beds, particularly a thick carbonate breccio-conglomerate in the middle part of the Tremadoc. Most of the graptolites described in this paper have been stratigraphically localized with reference to this marker.

BIOSTRATIGRAPHY

The Tremadoc on Peel River is 447 feet (136 m) thick (see Appendix I) and yielded graptolites from 23 horizons (see Appendix II). Two zones are recognized, namely,

the *Staurograptus* Zone characterized by an anisograptid fauna in which *Dictyonema* is notably absent and the thick *Adelograptus* Zone containing a diversified fauna of adelograptids, clonograptids, didymograptids, and two species of *Dictyonema*. This zonal scheme differs from that introduced by Jackson and Lenz (1962) in that the younger zone has changed its name to conform with the fact that all early identifications of *Bryograptus* from the Yukon are now referred to the genus *Adelograptus*. Another difference is that I now discount the existence of a zone of *Dictyonema* at the base of the graptolitic sequence in Yukon Territory thus removing an apparent anomaly from what in every other sense appears to be a Pacific type fauna.

Within these two zones on Peel River four subzones can be recognized based upon the sequential appearance of the genera *Staurograptus*, *Anisograptus*, *Clonograptus*, and *Adelograptus* (see Table 1). The base of the graptolitic sequence is marked by

TABLE 1. Zonal and Subzonal assemblages of graptolites of Tremadoc age established mainly from the Peel River section.

Adelograptus Zone	}	Subzone of <i>Adelograptus antiquus</i>
		<i>A. antiquus</i> (T. S. Hall)
		<i>A. victoriae</i> (T. S. Hall), <i>A. sp.</i> , <i>A(?) sp.</i>
		<i>Clonograptus aureus</i> Jackson
		<i>Clonograptus</i> spp. A, B, C, D
		<i>Dictyonema cf. macgillivrayi</i> T. S. Hall
		<i>Dictyonema cf. pulchellum</i> T. S. Hall, <i>Didymograptus(?)</i>
		<i>stelcki</i> n. sp., <i>Kiaerograptus(?) peelensis</i> n. sp.
		<i>Kiaerograptus(?) cf. pritchardi</i> (T. S. Hall)
		<i>Tetragraptus decipiens</i> T. S. Hall
		<i>Tetragraptus(?) sp.</i> , <i>Psigraptus arcticus</i> Jackson
<i>P. lenzi</i> Jackson		
Staurograptus Zone	}	Subzone of <i>Clonograptus aureus</i>
		<i>C. aureus</i> Jackson
		<i>Clonograptus sp. indet.</i>
	}	Subzone of <i>Anisograptus richardsoni</i>
		<i>A. richardsoni</i> Bulman
		Subzone of <i>Staurograptus tenuis</i>
		<i>S. tenuis</i> n. sp.

the first appearance of *Staurograptus tenuis* n. sp. The teilzone of this species corresponds to the proposed *S. tenuis* Subzone and it is a little over 2 m thick. Barren beds about 1 m thick separate this subzone from the overlying *Anisograptus richardsoni* Subzone. The *A. richardsoni* Subzone is just over 0.2 m thick and corresponds to the teilzone of *A. richardsoni* Bulman. As Table 1 shows, neither of these subzonal designates is associated with other graptolites. The disappearance of *Anisograptus* 4.6 m above the base of the measured section PW-15J (see Appendix II) marks the top of the *Staurograptus* Zone. The overlying 8.5 m of strata did not yield graptolites primarily because of lack of exposure in the floor of the canyon.

The entry of *Clonograptus* 15 m above the base of PW-13J marks the base of the *Adelograptus* Zone. This zone embraces the upper Tremadoc and is 123 m in thickness and is divided into two subzones: the lower Subzone of *Clonograptus aureus*, estimated to be 20.2 m thick, contains the earliest clonograptids. In addition to

C. aureus Jackson there occurs a small form which is too poorly preserved to be identified. The incoming of adelograptids signifies the base of the subzone of *A. antiquus*. This subzone is 100.8 m thick and carries an abundance of *A. antiquus* (T. S. Hall), *Clonograptus* spp. including holdovers of *C. aureus*, the first true *Tetragraptus*, the two-stiped *Kiaerograptus*(?) cf. *pritchardi* (T. S. Hall) and *Didymograptus*(?) *stelcki* n. sp. as well as siculate species of *Dictyonema* that are compared to *D. macgillivrayi* T. S. Hall and *D. pulchellum* T. S. Hall. Beds of equivalent age near Rock River (lat. 66° 48' N., long. 136° 07' W.) yield the endemic *Psigraptus arcticus* Jackson and *P. lenzi* Jackson. These two species together with *Clonograptus aureus* have been described elsewhere (Jackson 1967 and Jackson 1973 respectively).

CORRELATION

The existence of graptolite faunal provinces (or sub-provinces) even as early as Tremadoc time renders world-wide correlation of published faunas difficult. Tremadoc faunas of the Pacific region are notable for the presence of *Staurograptus*, *Anisograptus*, and *Adelograptus* as well as for the absence of *Bryograptus* and the rarity of *Dictyonema* until mid-Tremadoc time. On the other hand, the Atlantic (= European) Province is characterized by *Dictyonema flabelliforme*, *Clonograptus*, *Adelograptus*, and *Triograptus* as well as the rarity of *Staurograptus*. As we might expect, mingling of these provincial faunas occurs in eastern North America, e.g. Quebec, Newfoundland, New York, and Argentina.

The rich and diversified Matane fauna of Quebec (Bulman 1950) containing several species of *Dictyonema* (not allied to *D. flabelliforme*), *Anisograptus*, *Staurograptus*, and *Triograptus* is considered correlative with the *Staurograptus* Zone of Peel River. Two isolated outcrops near Lauzon (Osborne and Berry 1966) also yield a *Staurograptus* fauna. All these faunas are thought to be younger than the *Dictyonema flabelliforme* Zone of the European province and therefore younger than the *D. flabelliforme*-bearing strata in the Halifax Shale, Nova Scotia and St. James Group, New Brunswick. The association of *Staurograptus dichotomus* and *Dictyonema flabelliforme* in the Cow Head Region, Newfoundland (Kindle and Whittington 1958), and Schaghticoke Shale of New York (Berry 1962) may mean that these sections straddle the two lowermost Tremadoc zones.

Zone 1 of the Marathon Basin, Texas (Berry 1960) is correlated with the *Anisograptus richardsoni* Subzone and probably the *Clonograptus aureus* Subzone of Peel River. Importance is attached to the occurrence in Zone 1 of fragments of *Clonograptus* cf. *tenellus* that are very nearly identical to *Clonograptus* sp. indet. in the *C. aureus* Subzone of Yukon. Berry's Zone 2 of Texas carries large clonograptids, *Adelograptus*, *Didymograptus*, and *Tetragraptus* such as I have found in the *A. antiquus* Subzone.

Studies on South American graptolites by Turner (1960) indicate two distinct ages of Tremadoc fauna. The Salta locality of Argentina yields several subspecies of *Dictyonema flabelliforme* and represents the basal Tremadoc Zone, whereas the *Anisograptus*-bearing beds of Famatina, La Rioja, Argentina are correlated with the upper part of the *Staurograptus* Zone.

The relative age of the lower Lancefield (La 1) Zone in Victoria, Australia is very uncertain. The zone is restricted to a single locality where the stratigraphy is not clear

and is characterized by endemic species of siculate *Dictyonema* in association with *Staurograptus diffissus*. Later in this paper I hint at the possibility that *Staurograptus diffissus* may be erroneous. If this is the case, the age of La 1 fauna is a wide-open question. On the other hand, the La 2 fauna in both Australia and New Zealand can be confidently correlated with the *A. antiquus* Subzone of Yukon on the basis of mutually common species such as *Adelograptus antiquus*, *A. victoriae*, *Dictyonema macgillivrayi*, *D. pulchellum*, and *K.(?) pritchardi*.

Sections in Taimyr, U.S.S.R. that have been described by Obut and Sobolevskaya (1962) contain faunas of mixed provincial affinity at species level. Beds 2 and 6 with *Dictyonema sociale*, *Anisograptus richardsoni*, and *Triograptus canadensis* are considered equivalent to the *Staurograptus* Zone. Higher up, Beds 8 and 9 yielding numerous species of large clonograptids together with *Didymograptus* and *Tetra-graptus* are the equivalents of the *A. antiquus* Subzone.

Finally, correlation of the Yukon Tremadoc with north-western Europe is best attempted in terms of the *Dictyonema* Shale (2e) and the overlying Ceratopyge Shale (3a α) of Scandinavia. The *Staurograptus* Zone of Yukon is equated with the upper *Dictyonema* Shale of Scania and lower *Ceratopyge* Shale (3a α) of the Oslo region. The *Clonograptus aureus* Subzone of the *Adelograptus* Zone is considered to be equivalent to the Shineton Shales, England and the shale at Flagabro, Scania. The remaining part of the *Adelograptus* Zone in Yukon would, therefore, find approximate equivalence in the upper part of the *Ceratopyge* Shale and Limestone of Norway and Sweden but beds of this age may not be represented in Britain.

SYSTEMATIC DESCRIPTIONS

The taxonomic categories used in this paper follow those of Bulman (1970) with the exception that I would widen the diagnosis of the genus *Clonograptus* to accommodate *Ternograptus*.

It should be noted that descriptions of the proximal-end development of some pauciramous species employs a graptoloid thecal notation. Such a procedure is convenient and appropriate until it can be shown that these species have a dendroid stipe structure.

All specimens prefixed UA have been deposited with the Department of Geology, University of Alberta, Edmonton, Canada. Other prefixes GSC and SM signify Geological Survey of Canada and Sedgwick Museum respectively.

Class GRAPTOLITHINA Bronn, 1849
Order DENDROIDEA Nicholson, 1872
Family DENDROGRAPTIDAE Roemer *in* Frech, 1897
Genus DICTYONEMA Hall, 1851

Dictyonema cf. *macgillivrayi* T. S. Hall, 1851

Text-fig. 1K, L

cf. 1932 *Dictyonema macgillivrayi* T. S. Hall; Harris and Keble, pl. 3, fig. 4.

Material. Several fragmented or immature rhabdosomes; all are compressed.

Figured material. UA hypotype 1210, Road River Formation 26 m (85 ft) above the breccio-conglomerate marker in Upper Canyon on Peel River, field designation PR 1-61-7-280F; collected by J. Craig and B. Patsch, Imperial Oil Co. Ltd., 1961.

Stratigraphic range. Subzone of *A. antiquus* associated with *A. antiquus* and *D.?* *stelcki* n. sp.

Description. Rhabdosome extremely robust and large, probably extensiform. Largest fragment is 10.5 cm long; zones of branching occur 6–9 mm, 22–26 mm, and 32–43 mm from position of sicula; regularity of branching decreasing distally. Stipes are 1–2 mm wide in dorsal view, not seen in profile. Width of proximal dissepiments is similar to the stipes but distal dissepiments on some fragments are only 0.8 mm wide. Spacing between individual dissepiments increases from 2–8 mm proximally to 13–14 mm distally. Details of thecae are not seen but the figured specimen (text-fig. 1K) indicates there are 9–10 autothecae in 10 mm.

Remarks. The lack of knowledge about the thecae leads me to make only a comparison with *Dictyonema macgillivrayi* Hall, 1897 *sensu* Harris and Keble 1932 who gave the first reasonably good illustration of the species. The robust stipes and widely spaced dissepiments render the species distinct from *D. pulchellum* T. S. Hall, from the upper Lancefieldian (La 2) in Australia.

Dictyonema cf. *pulchellum* T. S. Hall, 1899

Plate 5, fig. 9

cf. 1899 *Dictyonema pulchellum* T. S. Hall, p. 174, pl. 18, figs. 28–30.

Material. Two specimens preserved as silvery films on shale.

Figured material. UA hypotype 1230 Road River Formation, 12 m (40 ft) below breccio-conglomerate marker Upper Canyon, Peel River; field designation 68-PLR-1-F-56-760 ft collected by D. Darrah, British American Oil Co., 1968.

Stratigraphic range. Subzone of *A. antiquus* associated with *A. antiquus*, *A. victoriae*, *Clonograptus* cf. *aureus*, and *D.?* *stelcki* n. sp.

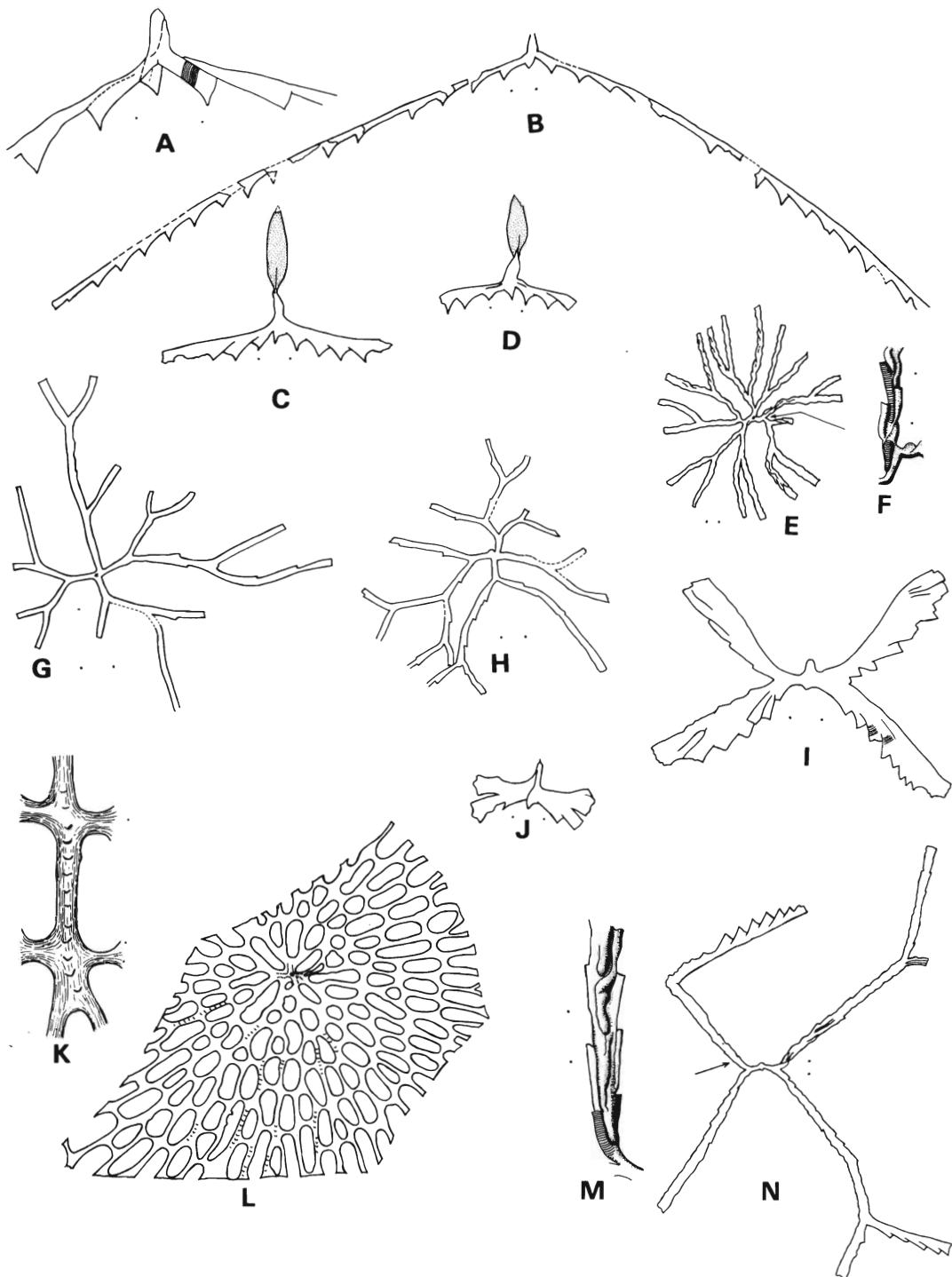
Description. Rhabdosome broadly conical, 10.5 cm long and possibly as wide distally, sicula and details of proximal end not preserved. Stipes are uniformly 1.5 mm wide in dorsal view and interspaces are about the same, distally there are 4 stipes present in a 1-cm transect. Dissepiments are 0.7–1.0 mm in width present at the rate of 5 in 20 mm, aligned both at right angles and obliquely to stipes. Autothecae are present at the rate of 8 per cm.

Remarks. Apart from the much greater size of the rhabdosome of the Yukon form, the thecal spacing and width and spacing of the stipes are comparable to *D. pulchellum* from the La 2 in Australia.

Family ANISOGRAPTIDAE Bulman, 1950
Genus ANISOGRAPTUS Ruedemann, 1937
Anisograptus richardsoni Bulman, 1941

Text-fig. 1E, F

- 1941 *Anisograptus richardsoni* Bulman, pp. 109–110, text-fig. 2a, b; pl. 11, fig. 6.
1947 *Anisograptus richardsoni* Bulman; Ruedemann, pp. 292–293, pl. 47, fig. 10.
1950 *Anisograptus richardsoni* Bulman; Bulman, pp. 85–87, text-fig. 7a–h; pl. 6, figs. 8–12.
1962 *Anisograptus richardsoni* Bulman; Obut and Sobolevskaya, p. 75, pl. 11, fig. 1.
1962 *Anisograptus* cf. *A. richardsoni* Bulman; Jackson and Lenz, pp. 37, 44.



TEXT-FIG. 1. A, B, *Didymograptus(?) stelcki* n. sp.; A, UA paratype 1213, $\times 10$; B, UA holotype 1212, $\times 4$; C, D, *Kiaerograptus(?) peelensis* n. sp. UA 1214, 1215 respectively, $\times 4.5$; E, F, *Anisograptus richardsoni* Bulman; E, UA 1200, $\times 2$; F, enlargement of second-order stipe, $\times 7.5$; G, H, *Staurograptus tenuis* n. sp.; G, UA 1223, $\times 5$; H, UA 1222, $\times 4$; I, J, *Clonograptus(?)* sp. early growth stages, UA 1224, 1225 respectively, $\times 4.5$; K, L, *Dictyonema* cf. *macgillivrayi* T. S. Hall; L, UA 1210, $\times 0.6$; K is an enlargement of a portion of UA 1210, $\times 18$; M, N, *Clonograptus* sp. B; N, UA 1206, $\times 2$; M is an enlargement of a second-order stipe on UA 1206, $\times 7$.

Material. Ten specimens in partial relief.

Figured material. UA hypotype 1200, 220 feet stratigraphically below breccio-conglomerate marker in Upper Canyon, Peel River; field designation HS-32-58 at 948 m (3110 ft) below top of formation; collected by H. J. Stewart, Pan American Petroleum Corporation, 1958.

Stratigraphic range. Confined to a 0.2-m interval in the upper part of the *Staurograptus* Zone.

Description. Rhabdosome tri-radiate, horizontal and rigid, attains a diameter of slightly less than 20 mm (commonly 10 mm) with dichotomous branching at irregularly increasing intervals to fourth-order resulting in as many as seventeen terminal branches.

Three short first-order stipes diverge at about 120°, average 0.7 mm long and 0.3 mm wide in dorsal view; second-order stipes are usually longer with an average length of 1.2 mm and a dorsal width of 0.5 mm; most, but not all, second-order stipes produce third-order stipes which vary considerably in length but average 2.4 mm long; fourth-order stipes are up to 6 mm long. Even in these long terminal branches, the rigidity is such that the thecae are not seen in profile thus the spacing of the autothecae is not known; bithecae are visible.

Branching frequency (in mm) of Yukon material

UA types	1st-order		2nd-order		3rd-order	
	Mean	Range	Mean	Range	Mean	Range
1200	0.7 ^{[3]†}	0.7-0.8	0.8 ^[5]	0.5-1.0	2.4 ^[6]	1.5-3.0
1201	0.7 ^[3]	0.5-0.8	1.7 ^[6]	1.0-2.2	2.2 ^[3]	2.0-2.5
1202*	0.7 ^[2]	0.5-0.8	1.2 ^[4]	0.6-1.5	2.6 ^[2]	2.5-2.7
1203*	0.7 ^[3]	0.6-0.8	1.4 ^[4]	0.7-1.8	—	—

* Position of sicula uncertain. † Number of measurements.

Branching frequency (in mm) of Matane material illustrated by Bulman (1941, 1950)

Specimen	1st-order		2nd-order		3rd-order	
	Mean	Range	Mean	Range	Mean	Range
GSC No. 9862	0.9 ^[3]	0.9-1.0	1.2 ^[6]	1.0-1.8	—	—
GSC No. 9863	1.0 ^[3]	0.9-1.2	1.2 ^[6]	1.0-1.8	2.9 ^[7]	2.0-4.0
GSC No. 9864	0.7 ^[3]	0.5-0.8	0.8 ^[6]	0.7-1.0	2.0 ^[9]	1.3-3.0
GSC No. 9865	0.9 ^[3]	0.7-0.9	1.3 ^[6]	0.8-1.8	2.9 ^[11]	1.0-5.0
Holotype SM A10043	1.0 ^[3]	0	2.0	1.0-3.3	—	—

Remarks. Material of *Anisograptus richardsoni* Bulman from Yukon Territory compares closely with the type specimens from the *Dictyonema* Shales of Matane, Quebec. However, Yukon specimens do not attain the diameter of the larger Matane specimens although comparable growth stages appear very similar with respect to capacity and spacing of zones of dichotomy.

Genus ADELOGRAPTUS Bulman, 1941
Adelograptus antiquus (T. S. Hall, 1898)

Text-fig. 2F, G, H

- 1898 *Leptograptus antiquus* T. S. Hall, p. 166, pl. 17, figs. 5, 6.
 1935 *Bryograptus* (?) *antiquus* T. S. Hall; Benson and Keble, pp. 266-267.
 1935 *Bryograptus* (?) *antiquus* var. *inusitatus* Benson and Keble, pp. 267-268, pl. 30, figs. 17, 18.
 1960 *Bryograptus antiquus*, Thomas, pl. 11, fig. 8.

Material. More than twenty specimens preserved as silvery films on black shale.

Figured material. UA hypotypes 1201 and 1202, from shales 9.5 m (31 ft) above conglomerate marker in Upper Canyon on Peel River, field designation PW-13J-31 feet, collected by D. E. Jackson 1969. UA hypotype 1203 from 11.6 m (38 ft) above conglomerate marker in same section. All three specimens are compressed and fragmented rhabdosomes.

Stratigraphic range. The species ranges through 100 m of section on Peel River where it is the index species for the *Adelograptus antiquus* Subzone.

Description. Rhabdosome extensiform or pendent, flexuous, 25 mm across the largest specimen and probably twice this size when complete; second-order stipes produced by dichotomous division of main stipes at $th7^2$ or 8^2 in UA 1202 and $th9^1$ in UA 1201.

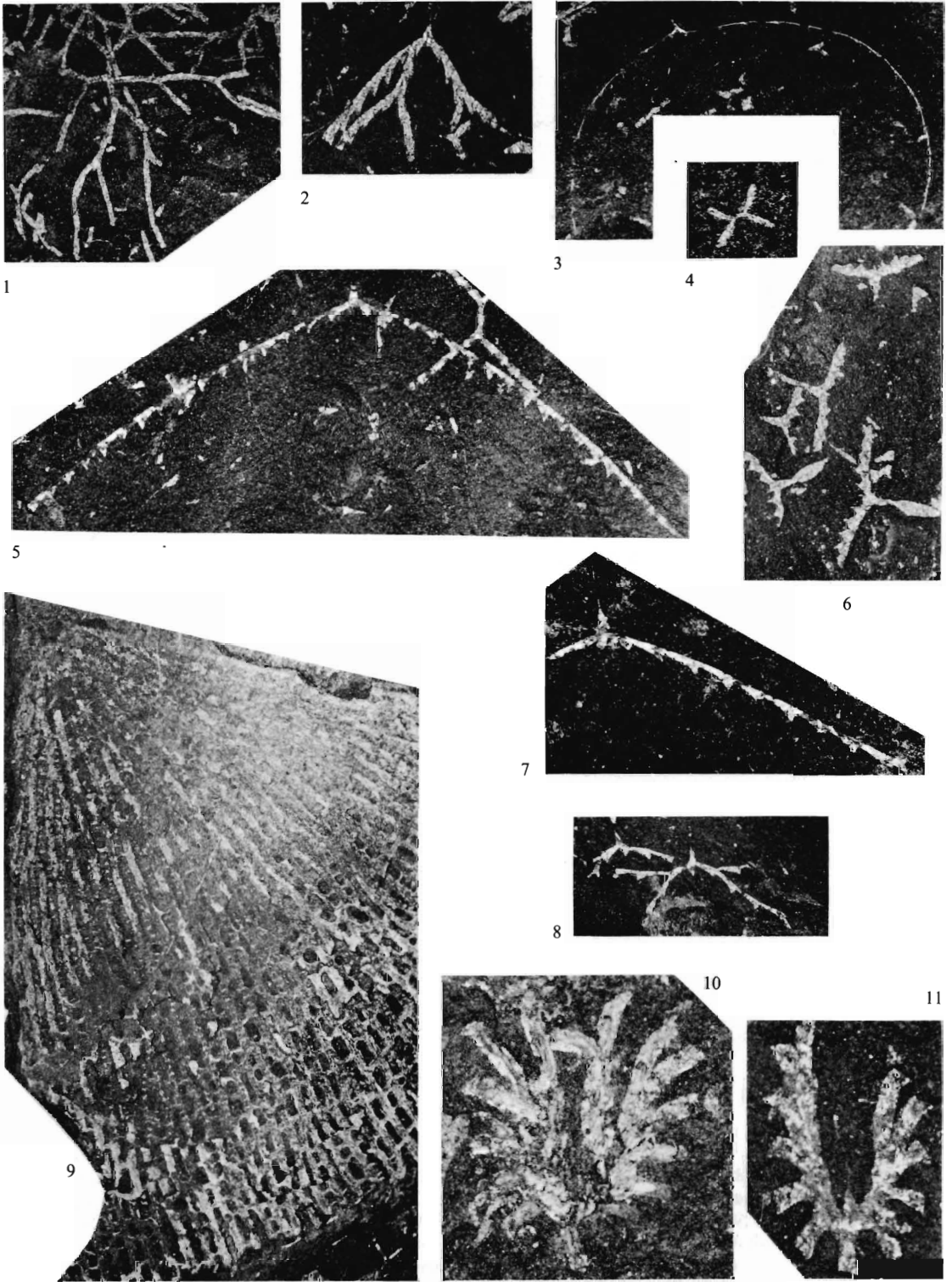
Sicula 1.0–1.1 mm long and 0.3 mm wide at aperture, curved away from $th1^1$, a long thread-like nema present in UA 1203. Theca 1^1 originates near apex of sicula, and grows downwards for a distance of 0.5 mm then diverges from the sicula at right-angles, free ventral wall is 0.8 mm long. Origin of $th1^2$ obscure, proximal part of theca ankylosed to sicula wall as far as the sicular aperture. Main stipes are at least 10 mm long, and diverge at about 180° ; second-order stipes are up to 10 mm long and diverge from main stipe at 80° .

Thecae rather uniform throughout rhabdosome, free ventral wall 1.1–1.9 mm long, minimum profile width is 0.1 mm at origin of $th1$, maximum profile width of 0.3–0.4 mm measured across thecal apertures on main stipe, free ventral wall near thecal aperture inclined at 10° – 30° , overlap probably less than one-quarter, 4 thecae in 5 mm on first-order stipe, $4\frac{1}{2}$ in 5 mm on second-order stipe. No bithecae seen.

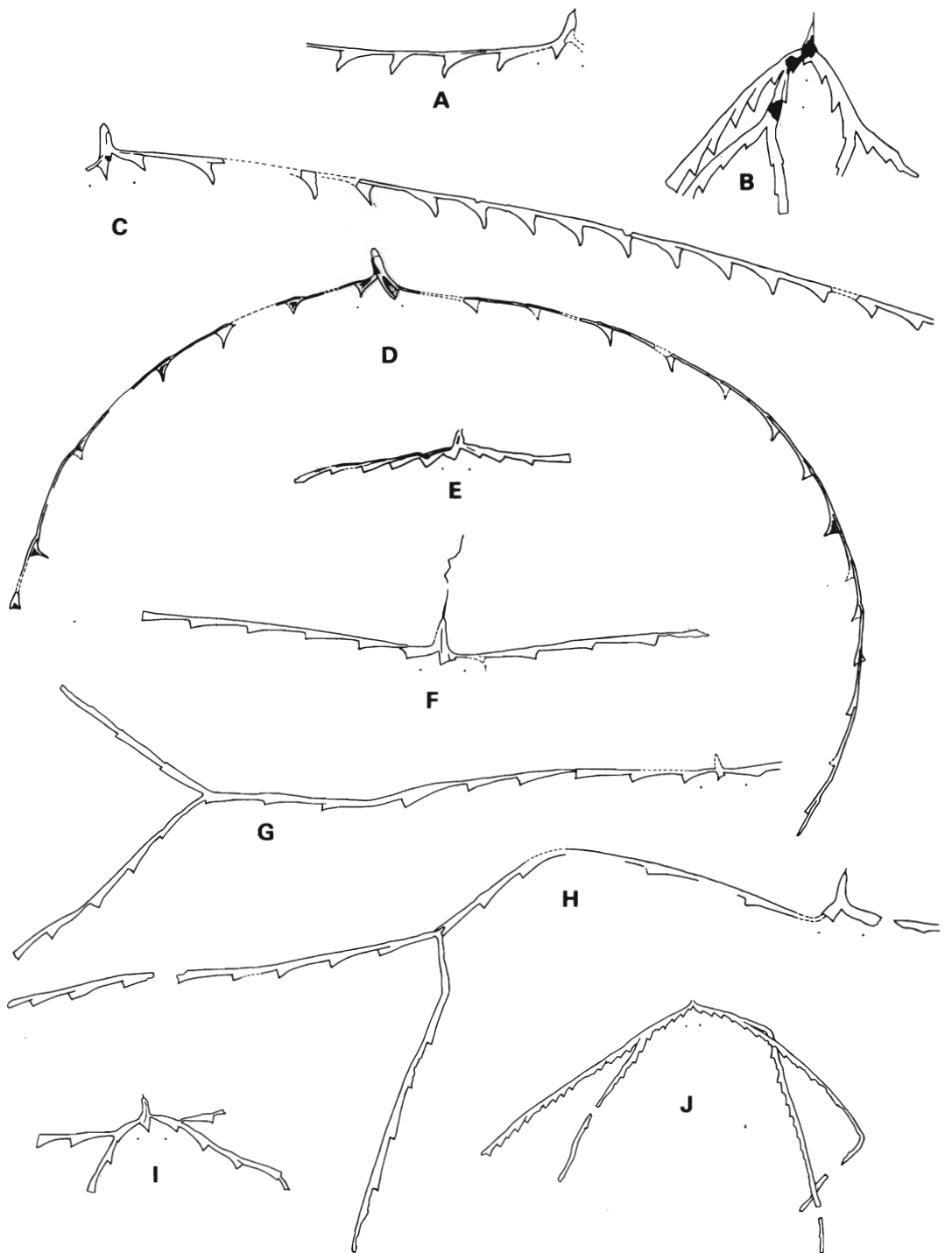
Remarks. This form is one of the commonest graptolites in the Upper Tremadoc and is confidently assigned to *A. antiquus* on the basis of comparison of sicula, width of stipes and thecal details and the existence of terminal second-order stipes. The origin of the second-order stipes between $th7$ and $th9$ in the Yukon specimens is much closer to the sicula than in the Australian materials where branching is delayed until $th20$ – $th25$. Benson and Keble's (1935, p. 267) reference to the initial pair of thecae being relatively much shorter than later thecae stems from a misinterpretation of the proximal-end development having mistaken the curved metasicula for $th1^1$.

EXPLANATION OF PLATE 5

- Fig. 1. *Staurograptus tenuis* n. sp., UA 1223 (paratype), Upper Canyon, Peel River, $\times 3.5$.
 Fig. 2. *Adelograptus victoriae* (T. S. Hall), UA 1229, Upper Canyon, Peel River, $\times 3$.
 Fig. 3. *Kiaerograptus*(?) cf. *pritchardi* (T. S. Hall), UA 1219, Upper Canyon, Peel River, $\times 3$.
 Fig. 4. *Tetragraptus decipiens* T. S. Hall, UA 1228, Upper Canyon, Peel River, $\times 1$.
 Figs. 5, 7. *Didymograptus*(?) *stelcki* n. sp. 5, UA holotype 1212 Upper Canyon, Peel River, $\times 3$. 7, UA paratype 1211, same locality, $\times 4.2$.
 Fig. 6. *Kiaerograptus*(?) *peelensis* n. sp. In descending order UA 1215, 1216, 1217, 1218, and 1214 (holotype). Upper Canyon, Peel River, $\times 2.7$.
 Fig. 8. *Tetragraptus*(?) sp. In descending order UA 1226 and 1227 Upper Canyon, Peel River, $\times 3$.
 Fig. 9. *Dictyonema* cf. *pulchellum* T. S. Hall, UA 1230, Upper Canyon, Peel River, $\times 1$.
 Fig. 10. *Psigraptus arcticus* Jackson, GSC 21248 (holotype), tributary of Rock River, $\times 7$, described elsewhere (Jackson 1967).
 Fig. 11. *Psigraptus lenzi* Jackson, GSC 21253, Rock River, $\times 7$, described elsewhere (Jackson 1967).



JACKSON, Tremadoc graptolites



TEXT-FIG. 2. A, C, D, *Kiaerograptus(?)* cf. *pritchardi* (T. S. Hall); A, stipe based on theca 1², UA 1220, $\times 7$; C, stipe based on theca 1¹ same specimen, $\times 7$; D, UA 1219 (pyritized), $\times 7$; B, *Adelograptus victoriae* (T. S. Hall), UA 1229, $\times 4$; E, *Adelograptus(?)* sp. UA 1221, $\times 4$; F-H, *Adelograptus antiquus* (T. S. Hall); F, proximal end with no second-order branches, UA 1203, $\times 7$; G, UA 1201, $\times 7$; H, UA 1202, $\times 7$; I, *Tetragraptus(?)* sp. UA 1226, $\times 4$; J, *Adelograptus* sp. UA 1209, $\times 2$.

Adelograptus victoriae (T. S. Hall, 1899)

Plate 5, fig. 2; text-fig. 2b

- 1899 *Bryograptus victoriae* T. S. Hall, p. 165, pl. 17, figs. 1, 2.
 ?1899 *Bryograptus clarki* T. S. Hall, pp. 165-166, pl. 17, figs. 3, 4.
 1932 *Bryograptus victoriae* T. S. Hall; Harris and Keble, pl. 4, fig. 2.
 1935 *Bryograptus victoriae* T. S. Hall; Benson and Keble, p. 270.
 1941 *Adelograptus victoriae* (T. S. Hall); Bulman, p. 115.
 1960 *Bryograptus victoriae*, Thomas, p. 23, pl. 1, fig. 6.
 1966 *Adelograptus victoriae* (T. S. Hall); Berry, pp. 421-422, pl. 44, fig. 1.

Material. Three specimens preserved as carbon films on black shale.

Figured material. UA hypotype 1229 from shales 15 m (50 ft) above limestone breccia in south bank of Upper Canyon of Peel River; field designation 68-PLR-1 F57, collected by D. Darrah and L. Sanche, British American Oil Co. Ltd., 1968.

Stratigraphic range. Upper part of *A. antiquus* Subzone associated with *A. antiquus*, *Clonograptus* cf. *aureus* and *Dictyonema* cf. *pulchellum*.

Description. Rhabdosome 8 mm long, declined to pendent, comprising five terminal stipes produced by dichotomous branching up to third-order. Sricula conical, 1.4 mm long, tilted slightly towards th¹ and furnished with short nema. Two main stipes initially diverge at about 100° decreasing to 80° after two autothecae have been produced on each of the first-order stipes, dichotomous branching occurs near apertures of first and third autothecae on each first-order stipe respectively.

Thecae have a profile width of 0.6-0.8 mm across apertures, free ventral wall concave, inclined at 15°-30°, apertural margins straight, normal to axis of stipe. There are 4½ thecae in 5 mm; bithecae not seen.

Remarks. The shape of the rhabdosome and disposition of branchings according to Hall's (1899) illustrations seems to be highly variable. For this reason I agree with Bulman (1941, p. 115) that *Bryograptus clarki* T. S. Hall is probably a junior synonym of *A. victoriae* (cf. Berry 1966, p. 420).

Adelograptus sp.

Text-fig. 2j

- 1962 *Adelograptus lapworthi* Ruedemann; Jackson and Lenz, p. 37.

Material. Two specimens preserved as pyritized films on black shale.

Figured material. UA hypotype 1209, Road River Formation, 14 m (46 ft) above conglomerate marker in Upper Canyon on Peel River; collected by W. Murray, Texaco Exploration Company, 1958.

Stratigraphic range. This adelograptid occurs in the *A. antiquus* Subzone where it is associated with *A. victoriae* and *Clonograptus* sp. A.

Description. Rhabdosome declined, composed of three to four lax branches. Two primary stipes enclose angles of 110°-150°, second-order branches are given off within first seven thecae. Sricula estimated to be about 1.0 mm long, axis inclined towards aperture of th¹. Stipes are 0.5 mm wide across first autothecal aperture and attain a maximum width of 0.8 mm about 20 mm from sricula. Thecal tubes are straight, overlap one-third to one-half, free ventral margin inclined 15°-20°. There are 5-7 thecae in first 5 mm and 11 per cm distally.

Remarks. This form has a superficial resemblance to *A. lapworthi* but can be distinguished on account of having wider stipes and more proximal origin of the second-order stipes. Furthermore, *A. lapworthi* is an Arenig species at Deepkill, New York.

Adelograptus(?) sp.

Text-fig. 2E

Material. One partially pyritized specimen.

Figured material. UA hypotype 1221, Road River Formation, 30.5 m (100 ft) below the breccio-conglomerate marker in the Upper Canyon of Peel River; field designation PR1-61-7 lot 267-269; collected by J. Craig and B. Patsch, Imperial Oil Co. Ltd., 1961.

Stratigraphic range. Confined to the *Adelograptus* Zone.

Description. Rhabdosome small, sub-ensiform, consisting of two short stipes which diverge from sicula at 165° . Stipes are 0.2 mm wide at origin, 0.4 mm across aperture of $th1^2$ thereafter decreasing slightly. Sicula greater than 1.3 mm long, curved so that axis of metasicula is nearly parallel to free ventral wall of $th1^2$. Theca 1^1 buds from upper one-third of sicula, is adpressed to sicular wall as far as the mid-length where it turns sharply at 90° . Origin of $th1^2$ not seen.

Thecal tubes straight, expanding gradually towards apertures, free ventral wall straight, or slightly leptograptoid, inclined 10° , overlap $\frac{1}{2}$, apertural margin straight and normal to axis to theca, $4\frac{1}{2}$ thecae in 5 mm. No bithecae seen.

Remarks. The specimen resembles the ensiform graptolite *Didymograptus? priscus* Mu from the *Clonograptus tenellus* Zone of Chekiang. However, the existence of didymograptids at such a stratigraphical level would not be expected on evolutionary evidence and I prefer to regard the Yukon form as an early growth stage of an adelograptid.

Genus CLONOGRAPTUS Nicholson, 1873

Clonograptus sp. A

Text-fig. 4

Material. Two specimens in partial relief.

Figured material. UA hypotype 1207, from 14 m (46 ft) above the breccio-conglomerate marker in the Upper Canyon of Peel River; collected by Dr. J. Murray, Texaco Oil Co., 1958.

Stratigraphic range. Confined to the *A. antiquus* Subzone.

Description. Rhabdosome ensiform, at least 15 cm across with dichotomous branching to fifth-order. First-order stipes form a funicle 3 mm long, second-order stipes are 20 mm long, third-order stipes are 20–26 mm, and fourth-order stipes divide at 27–33 mm. Fourth-order stipes have a profile width of 2 mm across thecal apertures.

Thecae consist of straight or slightly sinusoidal tubes inclined at 25° , overlapping two-thirds, with concave apertural margins. Thecal rate on terminal stipes is eight per cm. Bithecae and stolothecae not seen.

Remarks. Open nomenclature is used for species of *Clonograptus* because of the

difficulties encountered in identification. These difficulties arise partly from poor preservation and from lack of sufficient numbers of specimens to evaluate the significance of differences in data on branching frequency.

Clonograptus sp. A is the largest and most robust clonograptid found in northern Canada. It is easily distinguished from *C. aureus* and *C. spp.* B, C, and D on account of the dispersed zones of branching and greater width of stipe (see Table 2).

TABLE 2. Dimensions of Tremadoc clonograptids from Yukon Territory.

Species	Lengths (mm) of stipes* by orders					Profile† width	Thecae per cm	Inclination of free ventral wall
	1st	2nd	3rd	4th	5th			
<i>Clonograptus</i> sp. A	1.2	20	20-26	27-33	—	1.8	8	25°
„ B	3.0	12-15	20-30	20-30	—	1.0	10	20°
„ C	0.8-1.2	0.6-1.7	0.8-3.3	1.1-4.6	2.0-6.5	0.3-0.4	9	20°
„ D	0.8-1.8	1.5-2.8	2.2-7.0	3.3-17.8	6.5-26.0	0.9	10-11	25°-30°
<i>C. aureus</i> Jackson	1.2-1.5	2.0-3.0	3.0-5.5	3.0-5.5	—	0.6-0.8	11	20°-30°

* Length of undivided terminal stipes not included.

† Maximum width measured across thecal apertures.

Clonograptus sp. B

Text-fig. 1M, N

Material. Three partially pyritized specimens from a single bedding plane.

Figured material. UA hypotype 1206, Road River Formation, collected 8.2 m (27 ft) above breccio-conglomerate marker in Upper Canyon of Peel River, field designation PW-13J-219 feet, collected by D. E. Jackson, 1969.

Stratigraphic range. *A. antiquus* Subzone associated with *A. antiquus* and *Clonograptus aureus*.

Description. Rhabdosome extensiform, fragmented, one-half of UA 1206 measures 13 cms across; branchings to seventh-order produce twenty-four terminal stipes. First-order stipes form a funicle 6.0 mm long; second-order stipes are 12.5 and 15.0 mm long and subsequent orders appear to be of similar lengths within the range 20.0-30.0 mm. Distal stipes are 1.0 mm wide in profile, thecae are of dendroid type with straight autothecae inclined at 20° and present at the rate of five in 5 mm. Bithecae occasionally seen where stipes are pyritized.

Remarks. This species also has dispersed zones of branching but can be distinguished from *Clonograptus* sp. A on the basis of the very wide funicle and the narrower width of its stipes.

Clonograptus sp. C

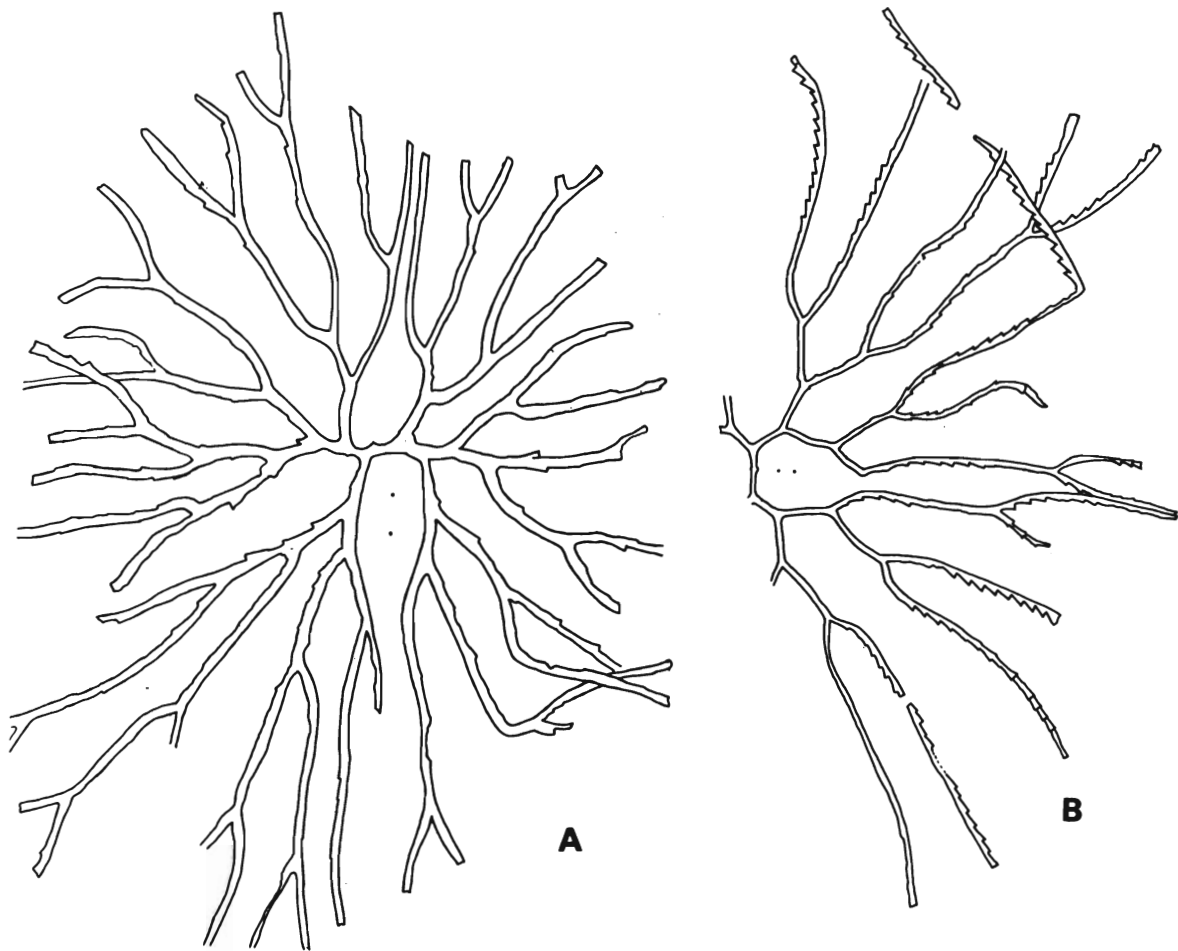
Text-fig. 3A

1962 *Clonograptus*, sp. Jackson and Lenz, p. 36.

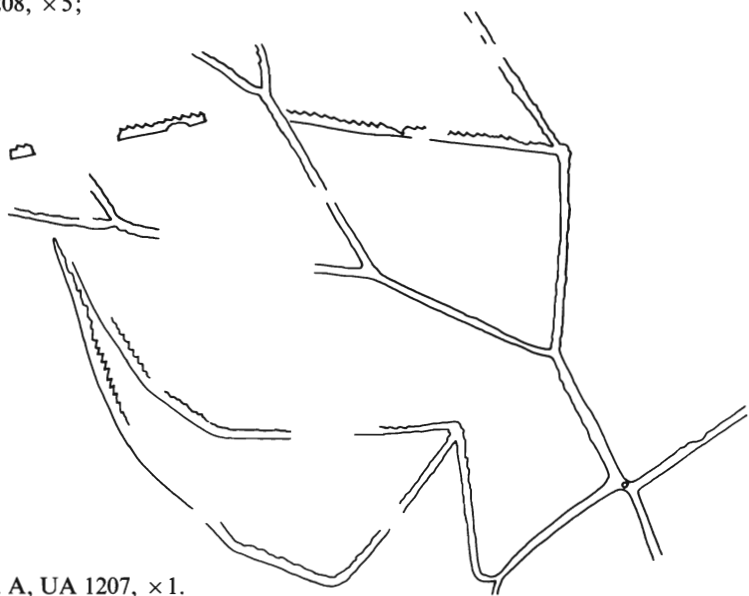
Material. Fifteen specimens preserved as carbonaceous films on shale.

Figured Material. UA hypotype 1208 Road River Formation, unit 1b of Jackson and Lenz (1962, p. 36), Tetlit Creek (lat. 66° 44' N.; long. 135° 46'-48' W.); field designation FA-8-59 at 20 feet, collected by D. E. Jackson, 1959.

Stratigraphic range. On Tetlit Creek, the species occurs without association in the upper part of unit 1b of Jackson and Lenz (1962, p. 36) which is assigned to the *Adelograptus* Zone.



TEXT-FIG. 3. A, *Clonograptus* sp. C, UA 1208, $\times 5$;
 B, *Clonograptus* sp. D, UA 1209, $\times 2$.



TEXT-FIG. 4. *Clonograptus* sp. A, UA 1207, $\times 1$.

Description. Rhabdosome horizontal, bilaterally symmetrical, with a maximum observed diameter of 3.5 cm and branchings to seventh-order producing as many as forty-four terminal stipes. First-order branches form a funicle 0.8–1.2 mm long, second-order branches characteristically comprise two pairs of branches of unequal length. If the points of origin of the third-order branches are joined they outline a parallelogram and the broad symmetry of this figure is maintained through successive branchings. The range in the lengths of successive orders of stipes is: second-order 0.6–1.7 mm, third-order 0.8–3.3 mm, fourth-order 1.1–4.6 mm, and fifth-order 2.0–6.5 mm. The angles enclosed by dichotomous branchings decreases from 90° at origins of second-order stipes to 50° or less in most distal branchings.

Stipes are occasionally seen in profile to be 0.3–0.4 mm wide across thecal apertures. Thecae are straight narrow tubes, inclined at 20°, spaced at the rate of 4½ in 5 mm. Bithecae have not been observed.

Remarks. This form resembles *Clonograptus tenellus* Linnarsson in the shape and spacing of the thecae but is considered specifically distinct on account of the proximally concentrated zones of branching. The latter characteristic also distinguishes it from *C. kingi* Benson and Keble, *C. aureus*, as well as other clonograptids described in this paper.

Clonograptus sp. D

Text-fig. 3B

1962 *Clonograptus* cf. *C. flexilis* (J. Hall), Jackson and Lenz, p. 37.

Material. Nine specimens with various degrees of relief.

Figured material. UA 1209, Road River Formation, 42.7 m (140 ft) above breccio-conglomerate marker in Upper Canyon of Peel River; field designation HS-32 at 2729 feet, collected by H. J. Stewart, Pan American Petroleum Corporation, 1958.

Stratigraphic range. Apparently confined to the *Adelograptus* Zone.

Description. Rhabdosome bilaterally symmetrical, horizontal, rather rigid, up to 6 cm across. Dichotomous branching to the seventh-order is seen but more commonly to fourth- or fifth-order. Zones of dichotomy appear rather constant for the first four orders, but higher orders are far from regular. The frequency of branching decreases distally as the distance between the zones of branching roughly doubles as the following measurements (based upon nine specimens) show.

1st-order*		2nd-order		3rd-order		4th-order		5th-order	
Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1.1	0.8–1.8	2.0	1.5–2.8	3.6†	2.2–7.0	6.5	3.3–17.8	15.0	6.5–26.0

* Where sicula is not seen, the lengths of the stipes were estimated by halving the length of the funicle.

† Fragmented and undivided stipes are not included.

Stipes have a lateral width of 0.2–0.4 mm and in profile view are 0.9 mm across thecal aperture. Free ventral walls of thecae are inclined 25°–30°, apertural margins straight, normal to axis of stipe. Thecae overlap one-half and are present at the rate of 10–11 per cm.

Remarks. *Clonograptus* sp. D resembles *C. flexilis* J. Hall in branching capacity and

spacing of dichotomies but it has stipes that are only half as wide in profile view. A further difference is that *C. flexilis* is an Arenig species at its type locality at Levis. Measurements of branches of four specimens of *C. flexilis* illustrated by J. Hall (1865).

1st-order		2nd-order		3rd-order		4th-order		5th-order	
Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1.0	1.0-1.3	2.3	1.5-3.0	4.1	2.5-6.0	8.5	4.0-15.0	9.4	3.0-14.0

Clonograptus sp. D and *C. aureus* have similar branching characteristics up to third-order after which branchings become much less frequent in *C. sp. D*. The stipe width and thecal profiles of these two species are so similar that I would be inclined to consider them as chronospecies if it could be proved that *C. sp. D* is also without bithecae.

Clonograptus sp. D differs from *C. sp. C* in having more widely dispersed zones of branching beyond third-order (see Table 2). The species is similar to *C. rigidus* and *C. rigidus* var. *tenellus sensu* T. S. Hall, 1899, however, Hall's identifications are most certainly incorrect.

Genus KIAEROGRAPTUS Spjeldnaes, 1963

Kiaerograptus(?) peelensis n. sp.

Plate 5, fig. 6; text-fig. 1c, d

Material. Twenty compressed specimens mostly preserved with float sac or vane.

Figured material. UA holotype 1214 and paratypes 1215 to 1218, Upper Canyon of Peel River, field designation 68-PLR-1 F65 at 1125 feet, collected by L. Sanche and D. Darrah, British American Oil Ltd., 1968.

Stratigraphic range. Probably confined to the *Adelograptus antiquus* Subzone.

Diagnosis. Sicula 2.5 mm long; stipes diverge at about 170° and have a maximum profile width of 0.5-0.7 mm; free ventral wall of thecae inclined at 30°-50°, seven thecae in 5 mm.

Description. Rhabdosome small, sub-ensiform, not seen to exceed 7.5 mm in length, comprising two stipes with slight dorsal curvature diverging at about 170°. Stipes are 0.25-0.40 mm at origin, widening to 0.5-0.7 mm across th¹ and 1² and of uniform width to distal extremity. Sicula 2.5 mm long inclusive of virgellar spine, axis slightly inclined towards aperture of th¹, apex and nema invested in an elliptical vane or float sac up to 2.5 mm long and 0.6 mm wide.

Thecae are apparently of dichograptid type, overlap about one-half, free ventral wall concave, inclined 30° increasing to 50° near apertural margin, apertural margins concave and mucronate; individual apertures are 0.75 mm apart (7 thecae in 5 mm); stolothecae and bithecae not seen.

Remarks. This new species resembles some forms of *Kiaerograptus kiaeri* (Monsen 1925, e.g. pl. 4, figs. 7 and 8) except that the stipes are only half as wide and the sicula is of graptoloid type. The species is distinct from *Didymograptus novus* Berry, 1960 which has straight ensiform stipes and thecae inclined at only 30°. The possibility that *K.(?) peelensis* n. sp. is an early growth stage of an adelograptid seems improbable because twenty specimens of about the same size can be seen on various laminae through a 1-cm slab of shale.

Kiaerograptus (?) cf. *pritchardi* (T. S. Hall, 1899)

Plate 5, fig. 3; text-fig. 2A, C, D

cf. 1899 *Didymograptus pritchardi* T. S. Hall, p. 167, pl. 17, figs. 7, 9; pl. 19, figs. 8, 10.*Material.* Seven specimens preserved as films on shale and one pyritized specimen.*Figured material.* UA hypotype 1219 (in partial relief) from Road River Formation 23.2 m (76 ft) above breccio-conglomerate marker in Upper Canyon of Peel River; field designation UPC-2-76 ft. UA hypotype 1220 from same locality. All specimens collected by W. Murray, Texaco Exploration Co., 1958.*Stratigraphic range.* The species ranges throughout most of the upper part of the *A. antiquus* Subzone.*Description.* Rhabdosome declined to pendent, comprising two extremely narrow flexuous stipes up to 50 mm long; evidence of bitheca is confined to sicular region. Sicular cylindrical, 1.1–1.2 mm long inclusive of virgella and 0.3 mm wide in semi-relief; curved away from $th1^1$. In UA 1219, $th1^1$ originates on the virgellar side close to apex of sicular directly below a faint constriction in the sicular wall which probably marks the junction of prosicular and metasicular. After growing downwards for about 0.5 mm, $th1^1$ diverges at right-angles to the sicular. Theca 2^1 appears to originate not from $th1^1$ but from the crossing canal of $th1^2$ which also produces $th2^2$. A short sicular bitheca may exist between $th1^1$ and $th1^2$.Stipes have a minimum width of 0.04–0.08 mm at bases of $th1^1$ and 1^2 and quickly attain a maximum width (across thecal aperture) of 0.5–0.7 mm and tend to narrow in more distal thecae. Proximal half of free ventral wall is parallel to stipe axis whereas distal half is strongly concave as inclination increases aperturally to 50°–70°. Thecal tubes average 1.3 mm long, inter-theal septa are 0.3–0.4 mm long, overlap is one-quarter to one-fifth. Weakly developed undulations are visible along the dorsal margin of the stipe. Apertural margins of thecae are concave to sigmoidal and normal to axis of the stipe; thecae are present at the rate of 9–10 per cm.*Remarks.* The taxonomic assignment of this form is problematical at both generic and specific levels. At species level, the best comparison that can be made is with *Didymograptus pritchardi* T. S. Hall, 1899 from beds of equivalent age in Australia. In spite of the fact that the species is in urgent need of adequate illustration and description, the Yukon specimens appear to have similar thecal profile and thecal spacing. However, details of the proximal-end of Hall's species are vague.The generic assignment of two-, three-, and even four-stiped forms to *Didymograptus* is the converse of the problem encountered in classifying immature forms of *Adelograptus*. Unfortunately, the stratigraphic occurrence of these variants at the type locality at Lancefield is uncertain except that Hall (1899, p. 165) stated that the fauna he described came from three distinct bands. At least a dozen specimens are available from the Yukon and all are biramous. Because of this and the presence of a suspected sicular bitheca the species is tentatively assigned to the genus *Kiaerograptus*.

Genus STAUROGRAPTUS Emmons, 1855

Staurograptus tenuis n. sp.

Plate 5, fig. 1; text-fig. 1G, H

1962 *Staurograptus* sp. Jackson and Lenz, p. 36.

Material. Twenty-three specimens representing various growth stages preserved as carbonaceous films on black shale.

Figured material. UA holotype 1222 from 103 feet below breccio-conglomerate marker in Upper Canyon, Peel River; field designation PW-15J-5 feet, collected by D. E. Jackson 1969.

UA paratype 1223 from 100 feet below conglomerate marker; field designation 68-PLR-1 F62, collected by L. Sanche, British American Oil Co., 1968.

Stratigraphic range. In the Upper Canyon on Peel River the species occurs without association in a 2-m-thick layer of shale where it constitutes a subzonal designate. The species was also collected from the base of the graptolitic sequence on Tetlit Creek.

Diagnosis. Rhabdosome small and fragile, composed of up to fifteen terminal stipes, branchings to fourth-order. Stipes 0.3–0.4 mm wide across thecal aperture, free ventral wall of thecae inclined at 10°, estimated 4½–5 thecae in 5 mm.

Description. Rhabdosome small, quadri-radiate, horizontal, up to 11 mm across, composed of between four and fifteen terminal stipes produced by dichotomous and probably lateral branchings to fourth-order. Sicala conical 0.9 mm long. First-order stipes average 1 mm long although the odd stipe may be twice this length (see UA 1222 and 1223); second-order stipes vary in length between 0.8 mm and 3.8 mm and may remain undivided, third-order stipes which terminate in dichotomous division are 20 mm long.

Autothecal tubes seen in profile on second- and higher-order stipes are 0.3–0.4 mm wide across aperture, free ventral wall is 1.0–1.2 mm long, inclined at 10°. Autothecae calculated to be present at the rate of 9–10 per cm. Bithecae and stolothecae probably present.

Remarks. The species differs from *S. dichotomus* Emmons in having stipes that are half as wide in profile, lower inclination of free ventral wall of thecae, and more widely spaced thecae. The new species has a resemblance to *S. diffissus* Harris and Keble (1928) in the form of the rhabdosome. However, it seems probable that *diffissus* is an immature growth stage of *Dictyonema companulatum* Harris and Keble (1928) because the two forms occur on the same bedding planes, they have similar nemae that split into many strands and the holotype of *S. diffissus* appears to have disrupted dissepiments at two places on the rhabdosome. Bulman (1972) has similarly interpreted *Staurograptus*-like forms from the Ardennes as early growth stages of *Dictyonema flabelliforme belgica*.

Order GRAPTOLOIDEA Lapworth, 1875
 Suborder DIDYMOGRAPTINA Lapworth, 1880 emend. Bulman, 1970
 Family DICHOGRAPTIDAE Lapworth, 1873
 Genus DIDYMOGRAPTUS M'Coy in Sedgwick and M'Coy, 1851
Didymograptus(?) stelcki n. sp.

Plate 5, figs. 5, 7; text-fig. 1A, B

1962 *Didymograptus* cf. *D. primigenius* Bulman; Jackson and Lenz, pp. 37, 44.

Material. Eleven rhabdosomes and numerous fragments preserved as films on black shale.

Figured material. UA holotype 1212 from Road River Formation, 93.6 m (307 ft) above breccio-conglomerate marker in Upper Canyon of Peel River; field designation 68-PLR-1 F51 at 650 feet; collected by L. Sanche,

British American Oil Co., 1968. UA paratypes 1213, 1221 from shales 21.3 m (70 ft) above conglomerate marker; field designation PR1-61-7 suite 279; collected by J. Craig and B. Patsch, Imperial Oil Co., 1961.

Stratigraphic range. The species ranges through about 70 m of section in the *A. antiquus* Subzone.

Diagnosis. Stipes declined, up to 20 mm long, diverge at 110°–140°, maximum profile width 0.7–0.8 mm; eight thecae per cm, ventral margin concave, inclined 30°–40°, overlapping about one-half.

Description. Rhabdosome declined, composed of two straight or slightly ventrally curved unbranched stipes up to 20 mm long which diverge to enclose angles between 110° and 140°. Sicula cylindrical, 1.3–1.5 mm long and 0.3 mm wide at aperture, apex narrows abruptly and grades into a long nema. Theca 1¹ buds from near top of sicula, grows down the virgellar side as far as the mid-length point of the sicula, then turns abruptly outwards. Theca 1² originates from th1¹ at the point where the latter diverges from the sicula thus the development is of *bifidus* type with th1¹ being dicalycal. In profile, the stipes are 0.2–0.3 mm wide just beyond the thecal apertures and attain a maximum width (across thecal aperture) of 0.7–0.8 mm within 5 thecae from sicula. Dorsal edge of stipe occasionally seen to be slightly sinuous. No evidence of stolotheca or bitheca.

Free ventral walls of thecae concave, proximal part is parallel to dorsal margin of stipe, inclination increasing to 30°–40° at aperture; apertural margin straight, normal to stipe axis. There are 3½–4½ thecae in 5 mm proximally, but on larger specimens 8 thecae per cm is the average rate.

Remarks. This didymograptid is very common in the Upper Tremadoc of Yukon and is easily distinguished from biramous associates such as *Kiaerograptus*(?) cf. *pritchardi* (T. S. Hall) by the more rigid stipes and the less strikingly flared thecal apertures. The species differs from other declined didymograptids, e.g. *D.*(?) *klotschichini* Obut and Sobolevskaya, 1962, *K.*(?) *primigenius* (Bulman, 1950) and *D.*(?) *taylori* T. S. Hall, 1899 in that the free ventral walls of thecae have distinct concave curvature and appreciably fewer thecae per cm.

Genus TETRAGRAPTUS Salter, 1863
Tetragraptus decipiens T. S. Hall, 1899

Plate 5, fig. 4

- 1895 *Tetragraptus quadribrachiatum* J. Hall; Pritchard, p. 30.
1899 *Tetragraptus decipiens* T. S. Hall, pp. 168–169, pl. 17, figs. 13–15; pl. 18, figs. ?16, 17–19.
1915 *Tetragraptus decipiens* T. S. Hall; T. S. Hall, p. 410, pl. 8, fig. 7.
1920 *Tetragraptus decipiens* T. S. Hall; Keble, pp. 199–201, text-fig. 64; pl. 34, fig. 1A–E.
1960 *Tetragraptus decipiens* Hall; Berry, p. 54, pl. 5, fig. 4.
?1962 *Tetragraptus* cf. *decipiens* T. S. Hall; Lee and Chen, p. 21, pl. 11, figs. 15, 16.
1963 *Tetragraptus* n. sp. Ross and Berry, p. 80, pl. 3, fig. 8.
1969 *Tetragraptus decipiens* T. S. Hall; Bulman and Cooper, pp. 215–216, pl. 1, figs. 1, 2, 4; text-figs. 3, 4.

Material. Two specimens preserved as golden pyritic films.

Figured material. UA 1228, from Road River Formation, north bank of Lower Canyon on Peel River; lat. 65° 56' 40" N.; long 134° 51' 30" W.; collected by D. E. Jackson, 1969.

Stratigraphic range. Upper part of *Adelograptus antiquus* Subzone, perhaps ranging up into *T. approximatus* Zone as it does in Australia.

Description. Rhabdosome small, horizontal, up to 9 mm across. Sicula in UA 1226 is 1.5 mm long, parallel-sided, tapering abruptly at apex, with short nema. Theca 1¹ buds high up on the sicula, and together with th1² diverge at 155°–180° to form a funicle 2.0–2.5 mm long; first-order stipes divide above the apertures of th1¹ and 1² to form four second-order stipes which enclose angles between 90° and 100°. These terminal stipes are up to 8 mm long and widen from 0.8 mm across first thecal aperture to a maximum width of 1.5 mm after 6 thecae.

Distal thecae on second-order stipes are curved tubes, free ventral wall inclined at 30° just beyond aperture of preceding theca, and 50°–60° near apertural margin, overlap two-thirds to three-quarters, apertural margin concave and forms an acute angle with axis of thecae. Thecae are spaced at the rate of 6 thecae in 5 mm.

Remarks. This material agrees in all essential characters with Hall's 1899 illustration, with Keble's 1920 description, and with Bulman and Cooper (1969). The inclination of the thecae as quoted by the early workers seems too low, for Keble's drawing shows that the free ventral wall is inclined at 50° near apertures of some thecae.

Four-stiped graptolites in the lower part of the *Adelograptus antiquus* Subzone that look like *T. decipiens* actually represent early growth stages of a clonograptid such as *Clonograptus* sp. A. Similarly, many such records of this species may turn out to be erroneous.

Tetragraptus(?) sp.

Plate 5, fig. 8; text-fig. 21

Material. Six compressed specimens.

Figured material. UA 1226 and 1227 Road River Formation 18.3 m (60 ft) above breccio-conglomerate marker in south bank of Upper Canyon of Peel River; field designation PR1-61-7 lot 279; collected by J. Craig and B. Patsch, Imperial Oil Co., 1961.

Stratigraphic range. Confined to the *A. antiquus* Subzone.

Description. Rhabdosome up to 10 mm across, declined, with four second-order terminal stipes. Sicula 1.1–1.4 mm long, axis curved, aperture tilted towards aperture of th1², prosicula furnished with a long fine nema. Theca 1¹ diverges at right angles from sicula at about mid-length whereas th1² diverges from sicular aperture. The two thecae enclose angles of between 130°–150° and form a funicle 2.5 mm long. Dichotomous branching above the apertures of th1¹ and 1² produce second-order stipes up to 5 mm long. Width of stipes across thecal apertures ranges between 0.4–0.6 mm.

Free ventral wall of thecae concave in more distal half, inclined as much as 40°; there are 3¾–4 thecae in 5 mm.

Remarks. The possibility that this form is an early growth stage of a clonograptid cannot be excluded.

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REFERENCES

- BENSON, W. N. and KEBLE, R. A. 1935. The Geology of the Regions Adjacent to Preservation and Chalky Inlets, Fiordland, New Zealand. Part IV. Stratigraphy and Palaeontology of the fossiliferous Ordovician Rocks. *Trans. R. Soc. N.Z.* **65**, 244-294.
- BERRY, W. B. N. 1960. Graptolite Faunas of the Marathon Region, West Texas. *Univ. Tex. Publs.* **6005**, 179 pp.
- 1962. Stratigraphy, Zonation, and age of Schaghticoke, Deepkill, and Normanskill Shales Eastern New York. *Bull. geol. Soc. Am.* **73**, 695-718.
- 1966. A discussion of some Victorian Ordovician Graptolites. *Proc. R. Soc. Vict.* **79**, 415-448.
- BRONN, H. G. 1849. *Index Palaeontologicus B. Enumerator*. Stuttgart. 980 pp.
- BULMAN, O. M. B. 1941. Some dichograptids of the Tremadocian and Lower Ordovician. *Ann. Mag. nat. Hist.* (11), **7**, 100-121.
- 1950. Graptolites from the *Dictyonema* Shales of Quebec. *Q. Jl geol. Soc. Lond.* **106**, 63-99.
- 1970. *Graptolithina with sections on Enteropneusta and Pterobranchia*. In TEICHERT, C. (ed.). *Treatise on Invertebrate Paleontology V.* (2nd edn.) Geological Society of America and Kansas University Press.
- 1972. A new *Dictyonema* fauna from the Salmien of the Stavelot Massif. *Bull. Soc. belge Géol. Paléont. Hydrol.* **79**, 213-224.
- and COOPER, R. A. 1969. On the supposed occurrence of *Triograptus* in New Zealand. *Trans. R. Soc. N.Z.* **6**, 213-218.
- EMMONS, E. 1855. *American Geology*. Volume 1, part 2. Albany (N.Y.).
- HALL, J. 1851. New genera of fossil corals. *Am. J. Sci.* (2), **11**, 398-401.
- 1865. Figures and descriptions of Canadian Organic Remains. Decade II, Graptolites of the Quebec Group. *Geol. Surv. Can.* 151 pp.
- HALL, T. S. 1898. Victorian Graptolites. Part 2. The Graptolites of the Lancefield Beds. *Proc. R. Soc. Vict.* **4**, 164-178.
- 1899. The graptolite-bearing rocks of Victoria, Australia. *Geol. Mag.* **6**, 438-451.
- 1914. Victorian graptolites. Part 4. Some new or little known species. *Proc. R. Soc. Vict.* **27**, 104-118.
- HARRIS, W. J. and KEBLE, R. A. 1928. The *Staurograptus* Bed of Victoria. *Ibid.* (N.S.) **40**, 91-95.
- — 1932. Victorian Graptolite Zones with correlation and descriptions of species. *Ibid.* **44**, 25-48.
- JACKSON, D. E. 1966. Graptolitic facies of the Canadian Cordillera and Arctic Archipelago: A review. *Bull. Can. Petrol. Geol.* **14**, 469-485.
- 1967. *Psigraptus*, a new Graptolite Genus from the Tremadocian of Yukon, Canada. *Geol. Mag.* **104**, 317-321.
- 1973. On the mode of branching in a new species of *Clonograptus*. *Palaeontology*, **16**, 707-711.
- and LENZ, A. C. 1962. Zonation of Ordovician and Silurian Graptolites of Northern Yukon, Canada. *Bull. Am. Ass. Petrol. Geol.* **46**, 30-45.
- KEBLE, R. A. 1920. Some Subzonal forms of the Lower Bendigo and Upper Lancefield Zones. *Rec. geol. Surv. Vict.* **4**, 194-202.
- KINDLE, C. H. and WHITTINGTON, H. B. 1958. Stratigraphy of the Cow Head Region, Western Newfoundland. *Bull. geol. Soc. Am.* **69**, 315-342.
- LAPWORTH, C. 1873. Notes on the British graptolites and their allies. 1. On an improved classification of the Rhabdophora. *Geol. Mag.* **10**, 500-504, 555-560.
- 1875. In HOPKINSON, J. and LAPWORTH, C. The graptolites of the Arenig and Llandeilo rocks of St. Davids. *Q. Jl geol. Soc. Lond.* **31**, 631-672.
- 1880. On the geological distribution of the Rhabdophora. Part 3, Results and Part 4, Conclusions. *Ann. Mag. nat. Hist.* (5), **6**, 16-29.
- LEE, C. K. and CHEN, X. 1962. Cambrian and Ordovician graptolites from Sandu, S. Guezhou (Kueichou). *Acta. palaeont. sin.* **10**, 12-27. [In Chinese.]

- LENZ, A. C. and PEDDER, A. E. H. 1972. Excursion A-14: Lower and Middle Palaeozoic Sediments and Palaeontology of Royal Creek and Peel River, Yukon and Powell Creek, N.W.T. *24th Int. Geol. Congr. Montreal*. 43 pp.
- MCCOY, F. 1851. In SEDGWICK, A. and MCCOY, F. 1851-1855. *A synopsis of the British Palaeozoic fossils in the geological museum of the University of Cambridge*. xcvi+661 pp., 25 pls. London and Cambridge.
- MONSEN, A. 1925. Über eine neue Ordovicische Graptolithen fauna. *Norsk geol. Tidsskr.* **8**, 147-187.
- NICHOLSON, H. A. 1872. *Monograph of British Graptolites*. Edinburgh and London.
- 1873. On some fossils from the Quebec Group of Point Levis, Quebec. *Ann. Mag. nat. Hist.* (4), **11**, 133-143.
- OBUT, A. M. and SOBOLEVSKAYA, R. F. 1962. Early Ordovician Graptolites from Taimyr. *Trudy nauchno-issled. Inst. Geol. Arkt.* **127**, 65-85. [In Russian.]
- OSBORNE, F. F. and BERRY, W. B. N. 1966. Tremadoc rocks at Levis and Lauzon. *Naturaliste can.* **93**, 133-143.
- PRITCHARD, G. B. 1895. Notes on some Lancefield Graptolites. *Proc. R. Soc. Vict.* **7**, 27-30.
- ROEMER, F. 1897. In FRECH, F. *Lethaia Geonostica I. Leth. Pal.* **1** (3). Leipzig.
- ROSS, R. J. and BERRY, W. B. N. 1963. Ordovician graptolites of the Basin Ranges in California, Nevada, Utah and Idaho. *Bull. U.S. geol. Surv.* **1134**, 177 pp., 13 pls.
- RUEDEMANN, R. 1937. A new North American graptolite faunule. *Am. J. Sci.* **33**, 59-62.
- 1947. Graptolites of North America. *Mem. geol. Soc. Am.* **19**, x+652 pp., 92 pls.
- SALTER, J. W. 1863. Notes on the Skiddaw Slate fossils. *Q. Jl geol. Soc. Lond.* **19**, 135-140.
- SPJELDNAES, N. 1963. Some Upper Tremadocian graptolites from Norway. *Palaeontology*, **6**, 121-131.
- THOMAS, D. E. 1960. The Zonal Distribution of Australian Graptolites. *J. Proc. R. Soc. N.S.W.* **94**, 58 pp., 15 pls.
- TURNER, J. C. M. 1960. Faunas Graptolíticas de America del Sur. *Revta Asoc. geol. argent.* **14**, 5-180, 9 pls.

DENNIS E. JACKSON

Department of Earth Sciences
The Open University
Milton Keynes
England

APPENDIX 1

PEEL RIVER UPPER CANYON, YUKON TERRITORY

The measured section crops out along the floor of the canyon on the south side of the river and begins 0.8 km (0.5 mile) downstream from the Gate at the east end of the Gorge. The section was measured stratigraphically upwards in two parts with field designations PW-15J and PW-13J. No gap exists between these two parts. Latitude 65° 52' 30" N.; longitude 135° 35' 30" to 40' W.

PW-15J section begins 182.9 m (200 yd) east of a stream which cascades over a cliff-forming conglomerate in the south bank of the Peel River. The section was measured by D. E. Jackson and S. Ballantyne, 22 June 1969.

ROAD RIVER FORMATION

Unit	Description	Footage (metres) above base
1	Shale, black, calcareous, fissile; interbedded with limestone black, argillaceous, pyritic, thinly bedded, medium crystalline, weathers pale grey. Beds strike N. 40° W., dip SW. 26°. Covered	0-23 (0-7.0) 23-40 (7.0-12.2)
2	Chert, black, pyritic in 3 in (7.6 cm) beds; interbedded with shale and limestone as above.	40-42 (12.2-12.8)
3	Shale and limestone as above. Covered	42-67 (12.8-20.4) 67-72 (20.4-21.9)

Road River Formation (*cont.*):

Unit	Description	Footage (metres) above base
4	Limestone, black argillaceous pyritic as beds 2 in (5.1 cm) thick yield <i>Cariocaris</i> . Covered	72-73 (21.9-22.3) 73-77 (22.3-23.5)
5	Shale, black calcareous, pyritic Covered Base of PW-13J lies at 85 ft (25.9 m)	77-80 (23.5-24.4) 80-85 (24.4-25.9)

Section PW-13J commences at the top of PW-15J 79 ft (24.1 m) below the massive conglomerate marker. Structure is essentially homoclinal, beds strike N. 38° W. to N. 50° W. and dip south-westwards 10°-28°. The section was measured by D. E. Jackson and H. Boehm, 20 June 1969.

Unit	Description	Footage (metres) above base
1	Shale, black, calcareous, fissile, devoid of cleavage; interbeds of limestone, dark grey to black, very fine grained in 1-6 in (2.54-15.2 cm) beds; occasional bed of conglomerate up to 18 in (45.7 cm) thick; proportions 70:25:5 respectively.	0-23 (0-7.0)
2	Conglomerate, dark-grey limestone, pyritic, with sub-rounded clasts of limestone and dolomite, clasts appear size-graded upwards, matrix of cherty limestone; forms prominent ledge.	23-25 (7.0-7.6)
3	Shale and limestone as between 0-23 ft (0-7.0 m)	25-79 (7.6-24.1)
4	Conglomerate, medium-grey limestone, weathers light grey, sub-rounded clasts of limestone, dolomite, chert and shale, crudely size-graded upwards; massive weathering, forms prominent ledge to river.	79-92 (24.1-28.0)
5	Shale, black, calcareous, fissile, interbedded with limestone, black, argillaceous calcilitite.	99-225 (31.0-68.6)
6	Conglomerate, medium-grey limestone; probably same unit as seen between 79-92 ft (24.1-28.0 m) repeated by fault which crosses section at 225 ft (68.6 m).	225-255 (68.6-77.7)
7	Shale, black, calcareous, fissile, interbedded with limestone, black, argillaceous, in beds 1-6 in (2.54-15.2 cm) thick, weathers pale grey to buff. Beds strike N. 38° W. dip south-westwards 25°.	255-388 (77.7-118.3)

APPENDIX II
FAUNAL LIST

Feet above base of PW-13J	Cumulative height above base of PW-15J (in metres)	<i>Adelograptus antiquus</i> Subzone (100·8 m)
362	136·2	<i>A. antiquus</i> , <i>Clonograptus</i> sp. D
350	132·6	<i>A. antiquus</i> , <i>Clonograptus</i> sp. indet., <i>Dictyonema</i> cf. <i>pulchellum</i> , <i>Kiaerograptus</i> (?) cf. <i>pritchardi</i>
340	129·5	<i>A. antiquus</i> , <i>A. victoriae</i> , <i>Clonograptus</i> cf. <i>aureus</i> , <i>Dictyonema</i> cf. <i>pulchellum</i>
327	125·6	<i>A. antiquus</i> , <i>Clonograptus</i> sp. indet., Tetragraptid(?)
320	123·4	<i>Dictyonema</i> cf. <i>macgillivrayi</i>
223	93·8	<i>Clonograptus</i> sp. indet.
219	92·6	<i>A. antiquus</i> , <i>C. aureus</i> , <i>Clonograptus</i> sp. B
185	82·3	<i>C. aureus</i> , <i>Dictyonema</i> cf. <i>pulchellum</i>
165	76·2	<i>Clonograptus</i> sp. indet.
154	72·8	<i>A. antiquus</i> , <i>Didymograptus</i> (?) <i>stelcki</i> n. sp., Tetragraptid?
79	49·9	<i>Clonograptus</i> sp. A?
45	39·6	<i>Clonograptus</i> sp. undet. (of <i>tenellus</i> type)
38	37·5	<i>A. antiquus</i> , <i>Clonograptus</i> sp. indet.
31	35·4	<i>A. antiquus</i> , <i>Adelograptus</i> sp.
		<i>Clonograptus aureus</i> Subzone (20·2 m)
30	35·1	<i>Clonograptus</i> sp. indet.
25	33·5	<i>C. aureus</i>
20	32·0	<i>Clonograptus</i> sp. indet.
0	25·9	
Feet above base of PW-15J		
57	17·4	<i>Clonograptus</i> sp. indet.
55	16·8	<i>Clonograptus</i> sp. indet.
49	14·9	<i>Clonograptus</i> sp. indet.
		<i>Anisograptus richardsoni</i> Subzone (0·2 m)
15	4·6	<i>A. richardsoni</i>
		<i>Staurograptus tenuis</i> Subzone (2·1 m)
12	3·6	<i>S. tenuis</i> n. sp.
5	1·5	<i>S. tenuis</i> n. sp.
3	0·9	graptolitic fragments