MONOGRAPTIDS FROM THE UPPER SILURIAN AND LOWER DEVONIAN OF YUKON TERRITORY, CANADA

by D. E. JACKSON *and* A. C. LENZ

ABSTRACT. Monograptids recorded and described from Arctic Canada for the first time comprise *Monograptus* cf. *cornutus* (Urbanek), *M.* cf. *balticus* Teller and *M. helicoides* sp. nov. from probable late Ludlovian; *M. bouceki* Přibyl and *Saetograptus pilosus* sp. nov. from mid-Přidolian; *M. uniformis angustidens* Přibyl and *M. uniformis parangustidens* subsp. nov. from the latest Přidolian *angustidens* Zone; *M. aequabilis aequabilis* (Přibyl) and *M.* cf. *hercynicus subhercynicus* Willefert from the lower Lochkovian *uniformis* Zone; and *M. aequabilis notoaequabilis* Jaeger and *M.* cf. *craigensis* Jaeger from the Pragian. In addition, the existence in Yukon Territory of *M. uniformis uniformis* Přibyl is confirmed. The number of species and subspecies known from the Přidolian and Lower Devonian strata in Yukon Territory is herein increased to eleven and nine respectively. The question of the youngest known species of *Monograptus* is also discussed.

EXISTING knowledge of post-Ludlow graptolite biostratigraphy in Yukon Territory has unfolded in three stages. A beginning was made when we published an account of *Monograptus yukonensis* and stated it was the youngest *Monograptus* known in North America (Jackson and Lenz 1963). Dating the new species was, however, problematical because it was without graptolitic association and lay several hundreds of feet above the *M. nilssoni* Zone. Very shortly afterwards it became widely recognized throughout Yukon Territory and was shown to range through hundreds of feet of strata. The next significant development was the discovery of upper Budnanian and Lower Přidolian graptolites on Porcupine River (Jackson and Lenz 1969); more recently we have been able to fill in many of the gaps in the zonal sequence above the Lower Přidolian. Thus Lenz and Jackson (1971) documented the existence of the uppermost Přidolian zone of *M. transgrediens*, the Lochkovian zones of *M. uniformis* and *M. hercynicus*, and the basal Pragian *M. thomasi* Zone directly below *M. yukonensis*. To these zones are now added the *M. bouceki* and *M. uniformis angustidens* Zones.

During the last few years, proof that species of *Monograptus* range upwards across the Siluro-Devonian boundary well into the Lower Devonian is considered to be one of the more significant contributions to biostratigraphy of this decade. Because agreement on the boundary problem is in sight and there appears to be widespread acceptance of a workable graptolite zonation within the Lower Devonian, it is natural that the tailing of the Monograptid Fauna should become a focal point of interest. At the present time there are no fewer than twelve species of *Monograptus* known from post-Přidolian strata in various parts of the world, but whereas the successional array of the Lochkovian species has a sound basis in observed stratigraphic occurrences, there is no general agreement on the relative ages of the Pragian species because most of them appear to have a restricted geographic distribution (see Table 1).

At the present time it seems possible to assign these Pragian species to three lineages, namely, the monospecific lineages of *M. atopus*, and *M. aequabilis*, and the large and variable *M. yukonensis* lineage. The taxonomic status of some of these species in Table 1

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is problematical due to poor preservation and to the extremely narrow range of variation in morphology upon which the speciation is based. Even more important, knowledge of the stratigraphic ages of some of the species has dramatically changed since their original description so that at this moment we have three contenders for the youngest known *Monograptus*. They are *M. atopus*, *M. yukonensis* and *M. pacificus*. This state

TABLE 1. Geographic distribution of Pragian species of *Monograptus* arranged in order of publication.

Date	*Species and author*	*Occurrence*
1963	*M. yukonensis* Jackson and Lenz	Canada, U.S.A., Czechoslovakia
1964	*M. belketaiefensis* Planchon	Algeria
1965	*M. anguerensis* Legrand	Algeria
1966	*M. atopus* Bouček	Czechoslovakia
1969	*M. aequabilis notoaequabilis* Jaeger and Stein	Thailand, Australia, Russia, Czechoslovakia, U.S.A., Canada
	M. yukonensis fangensis Jaeger and Stein	Canada, Thailand
1970	*M. craigensis* Jaeger	Alaska, U.S.A.
	M. pacificus Jaeger	Alaska, U.S.A.
1971	*M. telleri* Lenz and Jackson	Canada

of affairs stems from methods of dating as well as the circumstances of occurrence so let us digress one moment to examine both factors. The various methods used in dating these monograptids are:

1. With reference to associated monograptids whose ranges elsewhere are known, e.g. *M. telleri* (see Lenz and Jackson 1971) and *M. thomasi* (see Jaeger 1967).
2. With reference to associated or contiguous shelly faunas, conodonts or plants, e.g. *M. yukonensis* (see Lenz 1967).
3. By stage of evolution achieved by monograptid in question, e.g. *M. pacificus* (see Churkin *et al.*, 1970).

Concerning the relative ages of *M. pacificus* and *M. yukonensis*, we do not share the view expressed by Churkin, Jaeger and Eberlein (1970) that in Alaska *M. pacificus* post-dates and forms a mappable zone above *M. yukonensis*. If it is assumed that the two forms are distinct species, we believe that the existence of a *M. pacificus*-bearing horizon above another horizon containing *M. yukonensis* at a single locality carries little significance. Furthermore, there is little to be gained from using a presumed evolutionary stage of development until such time that a definitive phylogenetic scheme has been formulated which is firmly based upon stratigraphic succession. As far as the ages of the three contenders for the last monograptid is concerned, we simply believe it is an open question. It seems probable to us that *M. pacificus* becomes extinct before *M. yukonensis* because in Alaska both are associated with *M. aequabilis notoaequabilis* whereas in Yukon we find *notoaequabilis* associated with *M. craigensis* but not with *M. yukonensis* sensu-stricto at the type locality.

All specimens with GSC designation have been deposited with the Geological Survey of Canada, Ottawa.

SYSTEMATIC DESCRIPTIONS

Suborder MONOGRAPTINA Lapworth 1880
Family MONOGRAPTIDAE Lapworth 1873
Genus MONOGRAPTUS Geinitz 1852

Monograptus aequabilis aequabilis (Přibyl 1941)

Text-fig. 1 A, C, K, L

1941 *Pristiograptus aequabilis* Přibyl, p. 8, pl. 1, figs. 6–8.
1959 *Monograptus aequabilis* (Přibyl 1941); Jaeger, pp. 102–105, pl. 1, fig. 8, pl. 4, fig. 3, pl. 5, figs. 1–5, text-fig. 17a, b.
1967 *Monograptus aequabilis* (Přibyl 1941); Boucot, Cumming and Jaeger, p. 10, pl. 3, figs. 5–9.
1970 *Monograptus aequabilis aequabilis* (Přibyl 1941); Churkin, Jaeger and Eberlein, fig. 9B, I.

Material. A dozen specimens compressed on black mudstone from three stratigraphic levels in the Road River Formation on Hart River. They include figured specimens: GSC 30083 and 30084 at 494 feet, GSC 30085 at 490 feet, and GSC 30087 from 500 feet stratigraphically above base of measured section. All material collected by D. E. Jackson and A. C. Lenz in 1969.

Dimensions of figured specimens in mm

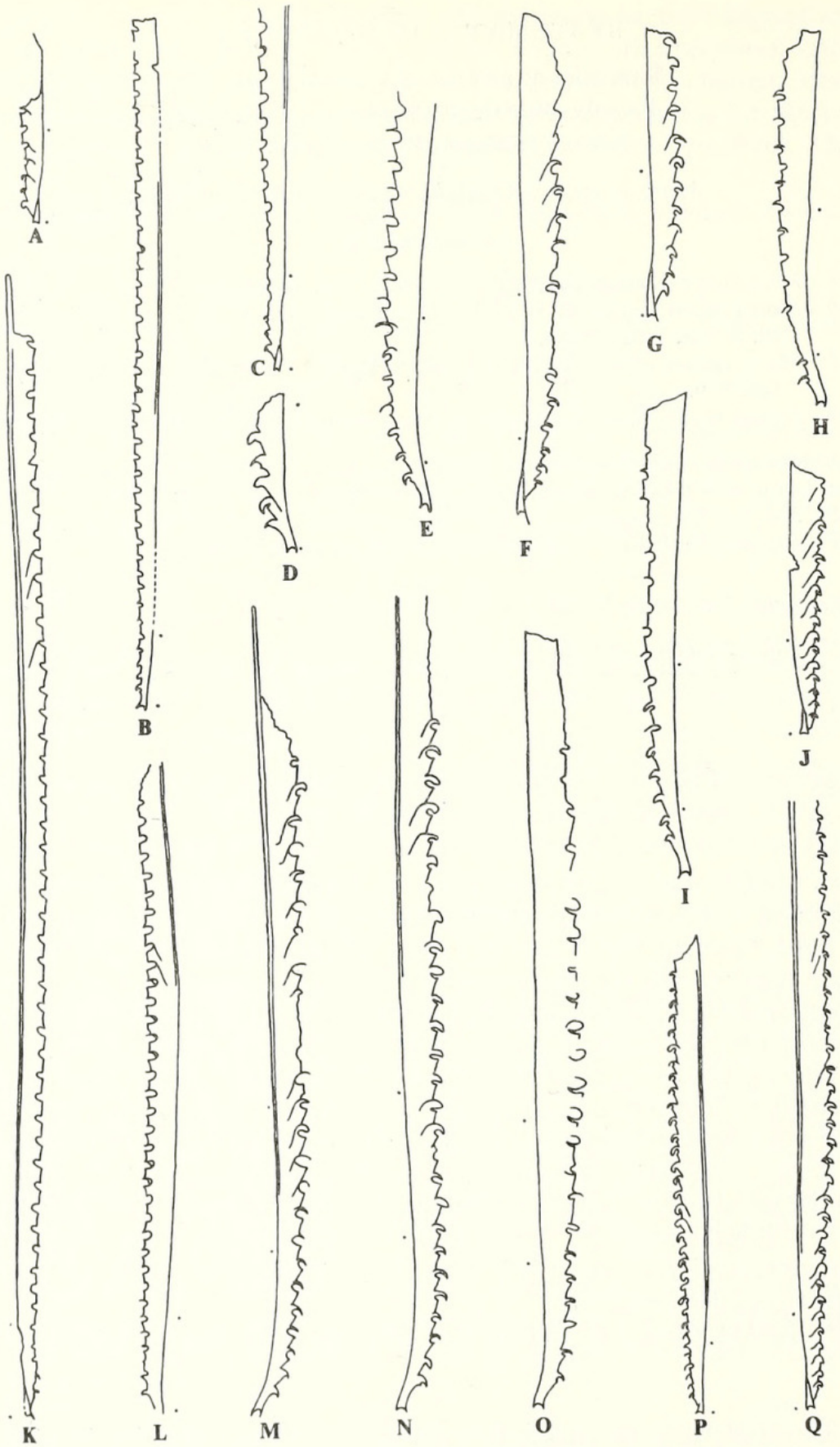
GSC No.	*Length*	*Rhabdosome width*				*Thecae in*	
		th^{1}	th^{5}	th^{10}	*max.*	*1st 10 mm*	*2nd 10 mm*
30083	55	0·8 (0·5)	0·9 (0·7)	1·2 (0·85)	1·4 th^{19} (1·0)	10	8
30084	8	0·95 (0·56)	1·0 (0·85)	—	—	—	—
30085	+35	1·0 (0·7)	1·1 (0·85)	1·5 (1·1)	1·8 th^{14} (1·2)	11	10½
30087	55	0·95 (0·5)	?1·1 (0·7)	1·2 (1·0)	1·7 th^{27}	10	8

Description. Largest rhabdosome is 55 mm long exclusive of virgula and is 0·9–1·0 mm across the hood of th^{1} widening to 0·9–1·1 mm across th^{5} and attaining a maximum width of 1·7–1·8 mm in first 2 cm, narrowing slightly distally. Dorsal edge of rhabdosome is straight except for slight ventral incurvature at proximal end. Sicula is 1·5–1·7 mm long, straight, apex extends distally to a level between apertures of th1 and 2, sicula aperture furnished with fine virgellar spine and short dorsal tongue.

Thecae biform. Thecae 1, 2 and occasionally 3 of *uncinatus* type possess down-curved supra-apertural hoods; more distal thecae have climacograptid profile and hoods are replaced by supra-apertural selvages about 0·2 mm long, the free ventral wall above the selvage is concave and slightly inclined. Inter-thecal septa are straight, inclined at 30 degrees to dorsal edge. Apertural excavations are approximately normal to interthecal septa and not at right angles to dorsal edge of rhabdosome. At the proximal end the length of the excavations occupy $\frac{1}{4}$–$\frac{1}{3}$ stipe width, increasing distally to $\frac{1}{3}$ where they are 0·5 mm long and 0·4 mm high.

There are 10–11½ thecae in first 10 mm reducing to 8–10½ in second 10 mm and beyond.

Remarks. The Hart River specimens fall within the limits of variation in width quoted by Jaeger (1959, p. 105) for the European material and these similarities can be extended



TEXT-FIG. 1. (See opposite.)

to include the length of the sicula and biform nature of thecae. The Yukon specimens have 8 to $10\frac{1}{2}$ thecae in 10 mm distally whereas Jaeger's measured specimens never exceeded $9\frac{3}{4}$ in 10 mm.

Occurrence and Distribution. According to Jaeger (1959), *Monograptus aequabilis aequabilis* is confined to the upper part of the *M. uniformis* Zone in Thüringia but Churkin, Jaeger and Eberlein 1970, p. 195, reported that this species ranged throughout the Lochkovian in the Carnic Alps. Willefert (1962) has also described *M. aequabilis* (Přibyl) var. nov. from the Lochkovian of North Africa. In Yukon Territory, this subspecies is known from the Hart River section at four stratigraphic levels through the basal ten feet of the *M. uniformis* Zone, where it is associated with *M. uniformis uniformis*. On Peel River, it has been collected in the Upper Canyon (65° 52′ N, 135° 45′ 40″ W) 235 feet above *M. transgrediens praecipuus*.

Monograptus aequabilis notoaequabilis Jaeger and Stein 1969

Text-fig. 1 B

1966 *Monograptus aequabilis* (Přibyl 1941); Jaeger, pp. 398–403, pl. 41.
1969 *Monograptus aequabilis notoaequabilis* Jaeger and Stein, pp. 182–184, text-fig. 1E–F, pl. 15, fig. A, B.
1970 *Monograptus aequabilis notoaequabilis* Jaeger and Stein; Churkin, Jaeger and Eberlein, pp. 194–195, fig. 9 C, J.
1970 *Monograptus aequabilis notoaequabilis* Jaeger *sic*; Koren and Enokyan, pl. IX, figs. 1–4.

Material. Two well preserved, and several poorly preserved specimens as films in uncleaved shale. Figured specimen GSC 30086 from uppermost part of Road River Formation, Tetlit Creek; 66° 44′ N, 135° 46′ W, Yukon Territory; field designation DJ-66-8F; collected by M. C. Pick, Chevron Standard Ltd., 1966.

Description. The figured specimen is 50 mm long, rhabdosome straight, widening from 0·8 mm across hood of th^1 (0·5 mm immediately above hood), to 1·3 mm at th^{10} and a maximum of 1·7 at th^{20} diminishing to 1·5 mm at distal end.

Thecae biform, th^{1-3} provided with down-curved apertural hoods. Subsequent thecae have climacograptid profile and hoods are replaced by selvages at point of geniculation. Apertural excavations horizontal, 0·5 mm long and 0·3 mm high in mature part of rhabdosome. Free ventral wall concave, inclined so that maximum width of thecae is at apertural lip. There are $9\frac{1}{2}$ thecae in first 10 mm; $8\frac{1}{2}$ in second 10 mm, and 41 in 50 mm.

TEXT-FIG. 1. A, K, L. *Monograptus aequabilis aequabilis* (Přibyl). A, K. GSC 30084 and 30083, 494 feet in Hart River section. ×2½. L. GSC 30085 at 490 feet in Hart River section. ×2½. B. *M. aequabilis notoaequabilis* Jaeger and Stein. GSC 30086 80 feet below top of Road River Formation in Tetlit Creek. ×2. C. *M. aequabilis aequabilis* Přibyl. GSC 30087, 500 feet in Hart River section. ×2½. D–I. *M. uniformis parangustidens* subsp. nov. D–F, H, I. Paratypes GSC 30088–30090, 30092–30093, 430 feet; and G, Paratype GSC 30091, 445 feet, Hart River section. ×4. J, Q. *M. uniformis angustidens* Přibyl. GSC 30094 and 30095, 995 feet in tributary of Peel River. ×2½. P. *M. uniformis uniformis* (Přibyl). GSC 30096, 509 feet in Hart River. ×2. M–O. *M. uniformis parangustidens* subsp. nov. N. Holotype GSC 30098, 430 feet. ×4; M, O. Paratypes GSC 30097 and 30099, 445 feet and 430 feet, respectively, Hart River section. ×4. Note: two dots represent 5 mm.

TABLE 2. Stratigraphic distribution of graptolite species from Road River Formation of Hart River section located at river level on west bank of Hart River, Ogilvie Mountains, latitude 65° 34′ N, longitude 136° 55′ W. Section 75% exposed; measured by authors June, 1969. X—positive occurrence; ?—possible occurrence at that interval.

GRAPTOLITE SPECIES	DISTANCE IN FEET ABOVE BASE OF SECTION																																																	
	0-05	1	2	4	8	10	13-14	15-17	26	30	32	35	38-40	45	48-50	55	60	65-68	75-80	85	90	100	115	120	123	127	205	210	215	220	234	235	236	245	260	280	320	327	340	345	370	405	410	430	445	485	490	494	500	509
Monograptus nilssoni (Lapworth)	X	X	X	X			X	X																																										
M. dubius (Suess)	X	X	X				X											X	?		X						X																							
M. bohemicus (Barrande)	X	X	X	X	X	X	X	X				X			X	X	X	X																																
M. bohemicus tenuis (Bouček)										?			?	X	X			X																																
M. fumescens Wood		X		X	X																																													
M. colonus compactus Wood			X																																															
M. roemeri (Barrande)					X	X	X																																											
M. uncinatus Tullberg								X	X	X																																								
M. leintwardinensis primus Bouček											X																																							
M. helicoides n.sp.														X																																				
M. cf. *egregius* Urbanek														X																																				
M. aff. *roemeri* (Barrande)																X	X			X																														
M. cf. *cornutus* Urbanek																	X																																	
M. cf. *leintwardinensis* Hopkinson																			X																															
M. cf. *balticus* Teller																				X																														
M. cf. *haupti* Kühne																				X																														
M. paraformosus Jackson and Lenz																						X		X	X	X			X																					
M. aff. *kosoviensis* Bouček																						X	X	X	X			X																						
M. cf. *angustidens* Přibyl																											X	X			X								X											
M. cf. *lebanensis* Teller																													X																					
M. chelmiensis (Teller)																												?	?	?	?	X	X	X	X	X	X	X	X	X	X									
M. norfordi Lenz and Jackson																																					X	X												
M. transgrediens praecipuus (Přibyl)																																									?	X	X							
M. uniformis parangustidens n.ssp.																																												X	X					
M. cf. *hercynicus* var. *subhercynicus* Willefert																																														X				
M. aequabilis (Přibyl)																																														X	X	X	X	
M. uniformis uniformis Přibyl																																																X	X	
? *Barrandeograptus operculatus* Münch																					X																													
Linograptus posthumus tenuis Jaeger																X						X							X	X						X	X			X	X									

TABLE 2. Stratigraphic distribution of graptolite species from Road River Formation of Hart River section located at river level on west bank of Hart River, Ogilvie Mountains, latitude 65° 34′ N, longitude 136° 55′ W. Section 75% exposed; measured by authors June, 1969. X—positive occurrence; ?—possible occurrence at that interval.

GRAPTOLITE SPECIES	DISTANCE IN FEET ABOVE BASE OF SECTION																																																	
	0-0.5	1	2	4	8	10	13-14	15-17	26	30	32	35	38-40	45	48-50	55	60	65-68	75-80	85	90	100	115	120	123	127	205	210	215	220	234	235	236	245	260	280	320	327	340	345	370	405	410	430	445	485	490	494	500	509
Monograptus nilssoni (Lapworth)	X	X	X	X			X	X																																										
M. dubius (Suess)	X	X	X				X											X	?		X						X																							
M. bohemicus (Barrande)	X	X	X	X	X	X	X	X				X			X	X	X	X																																
M. bohemicus tenuis (Bouček)										?			?	X	X			X																																
M. tumescens Wood		X		X	X																																													
M. colonus compactus Wood			X																																															
M. roemeri (Barrande)					X	X	X																																											
M. uncinatus Tullberg								X	X	X																																								
M. leintwardinensis primus Bouček											X																																							
M. helicoides n. sp.														X																																				
M. cf. *egregius* Urbanek														X																																				
M. aff. *roemeri* (Barrande)																X	X			X																														
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M. cf. *haupti* Kühne																				X																														
M. paraformosus Jackson and Lenz																						X		X	X	X			X																					
M. aff. *kosoviensis* Bouček																						X	X	X	X			X																						
M. cf. *angustidens* Přibyl																											X	X			X								X											
M. cf. *lebanensis* Teller																													X																					
M. chelmiensis (Teller)																												?	?	?	?	X	X	X	X	X	X	X	X	X	X									
M. norfordi Lenz and Jackson																																					X	X												
M. transgrediens praecipuus (Přibyl)																																									?	X	X							
M. uniformis parangustidens n. ssp.																																												X	X					
M. cf. *hercynicus* var. *subhercynicus* Willefert																																														X				
M. aequabilis (Přibyl)																																														X	X	X	X	
M. uniformis uniformis Přibyl																																																X	X	
? *Barrandeograptus operculatus* Münch																					X																													
Linograptus posthumus tenuis Jaeger																X						X							X	X						X	X			X	X									

The sicula is 2·2 mm long and 0·5 mm wide at aperture, apex lies at level of aperture of th^2. Sicular aperture is furnished with virgella and prominent dorsal tongue.

Remarks. Dimensions of rhabdosome, thecae and sicula agree with measurements given by Jaeger *et al.*, except that the Yukon specimen is the longest specimen on record.

Occurrence. These Yukon specimens occur 60 feet above *M.* cf. *craigensis* Jaeger *et al.*, in the uppermost part of the Road River Formation on Tetlit Creek where the graptolitic shales are overlain by shales with Siegenian conodonts. Apart from the Canadian occurrence, it is known to occur in Bohemia (Bouček 1966), Australia (Jaeger in Churkin *et al.* 1970), Thailand (Jaeger, Stein and Wolfart 1969) and Alaska (Churkin *et al.* 1970) and in all instances it is confined to the Pragian Stage.

Monograptus cf. *balticus* Teller 1966

Text-fig. 2 I, J, K

cf. 1966 *Monograptus balticus* Teller, p. 556, pl. 1, figs. 6–11, text-fig. 4a–b.

Material. Thirty-two specimens, mostly comprising the proximal ends from the Road River Formation on Hart River, 85 feet above the base of the section. They include illustrated specimens GSC 30115 to 30117. All material collected by D. E. Jackson and A. C. Lenz 1969.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*				*Thecae in 5 mm*		*Sicula length*
		th^1	th^5	th^{10}	*max.*	*prox.*	*distal*	
30115	16	0·7 (0·4)	1·05 (0·75)	1·2	1·25	5½	5¼	1·6
30116	19	0·7 (0·4)	1·0 (0·65)	1·3	1·3	5½	5	1·6
30117	14	0·8 (0·4)	1·05 (0·7)	1·3	1·5	5½	5¼	1·5

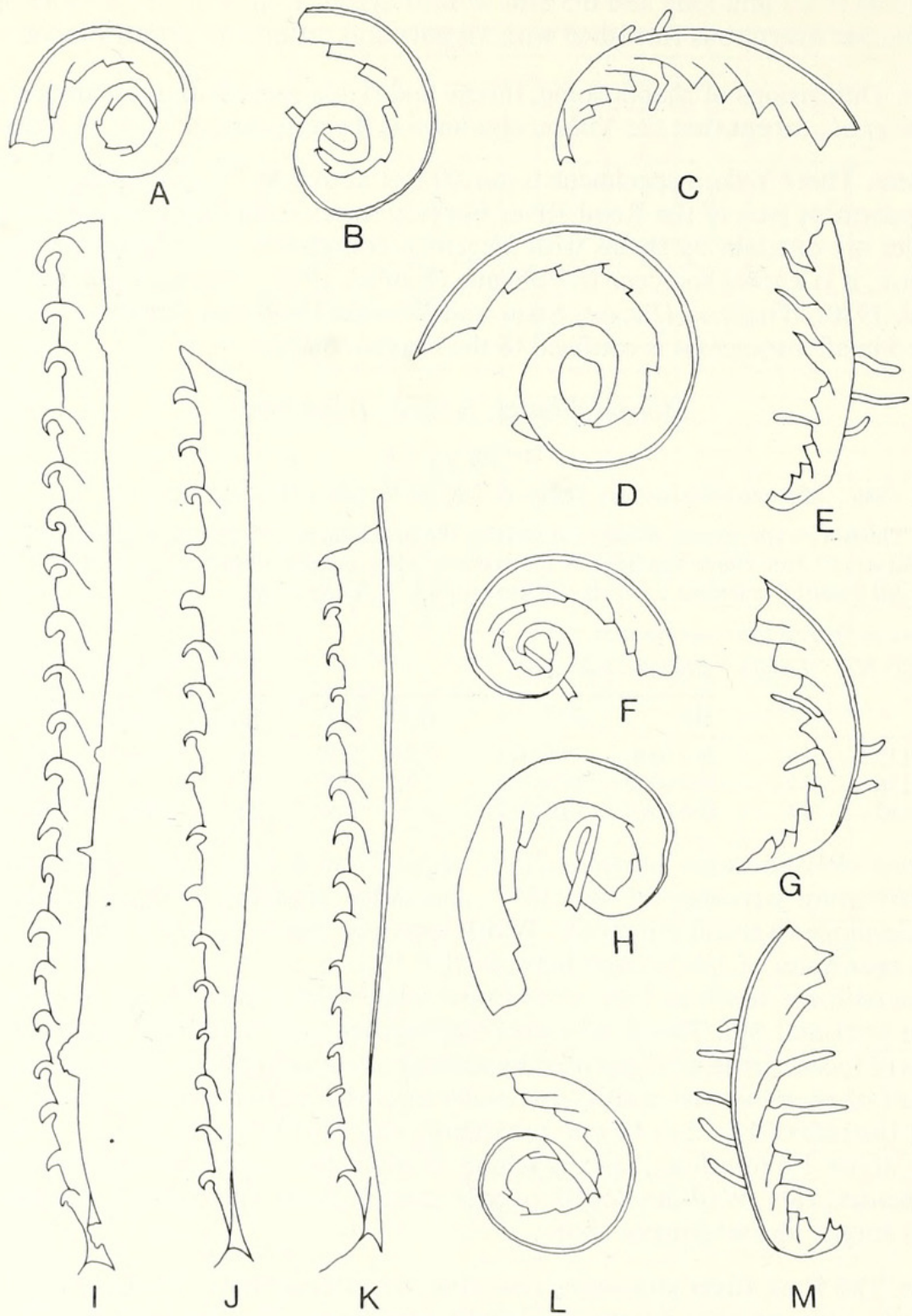
Description. Rhabdosome medium-sized, up to 37 mm long, with moderately weak dorsal curvature between th^1 and th$^{6-7}$, thereafter straight, or occasionally having weakly developed ventral curvature. Width increases gradually from about 0·7 mm at th^1, to a maximum of 1·3–1·4 mm between th$^{12-14}$.

Thecae uniform, hooded. Free ventral wall subparallel to dorsal edge of rhabdosome except at proximal end. Thecal apertures unthickened, approximately at right angles to long axis of thecae, generally obscured by strongly recurved hoods. Thecal hoods occupy about half of rhabdosomal width proximally and about quarter width distally. Thecae occur at the rate of 11–12 in 10 mm proximally and 9½–11 distally.

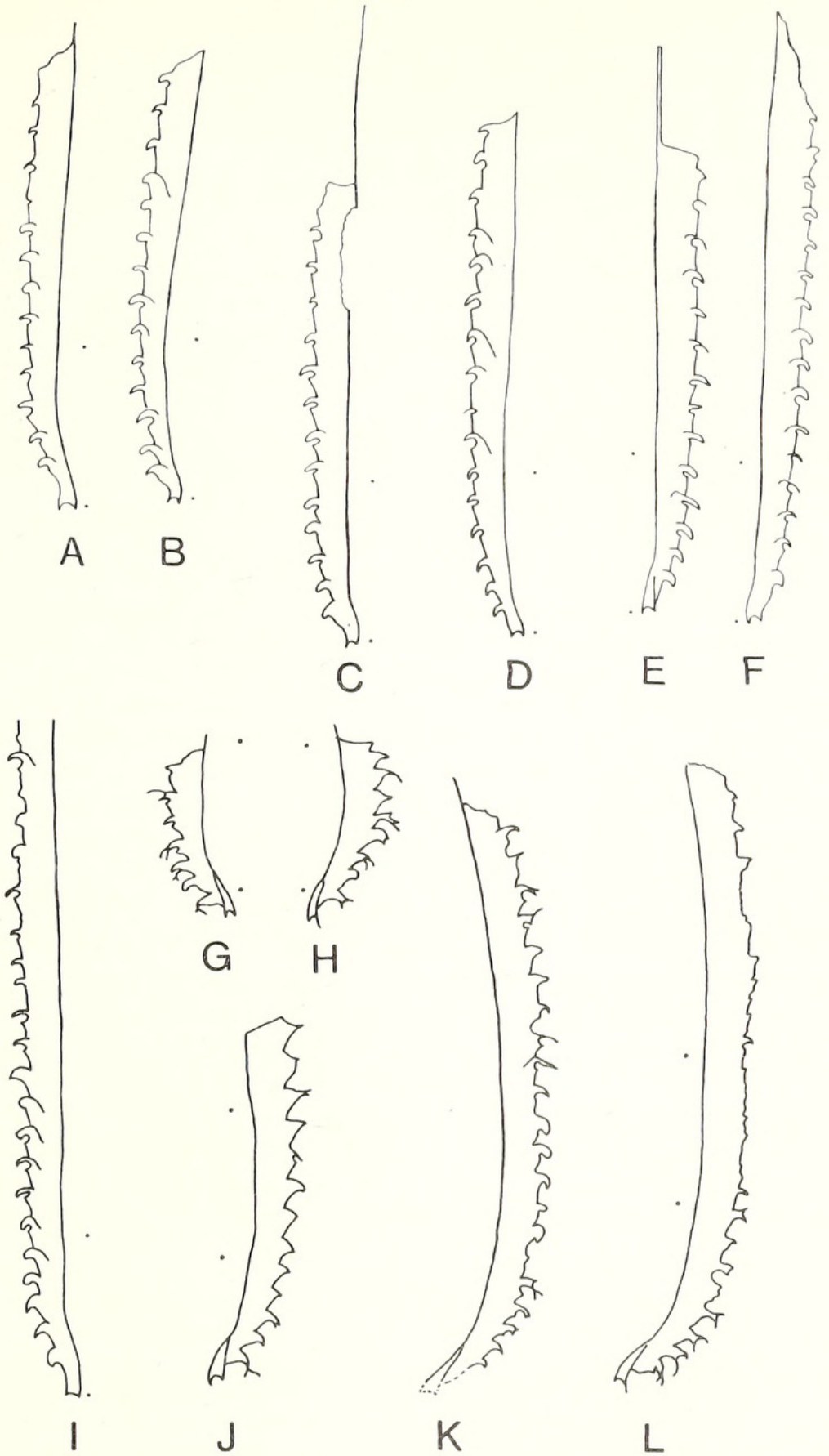
Sicula about 1·6 mm long, apex reaching to about level of top of th^1, aperture tilted toward ventral side. Well-developed virgella extends ventro-proximally and may reach 1 mm in length; dorsal tongue short.

Remarks. The Hart River specimens resemble *M. balticus* from Poland in the shape of the rhabdosome, number of thecae, length and shape of sicula and prominence of virgella. Our material differs in the lack of incurved thecal apertures and undulating interthecal septum shown in Teller (1966, pl. 1, figs. 8 and 9, and text-fig. 4), but more closely resemble Teller's figures 6 (holotype), 10 and 11 of the same plate.

Occurrence. Monograptus cf. *balticus* lies 20 feet above the highest occurrence of *M. bohemicus bohemicus* and 15 feet below *M. paraformosus*. It is associated on the same



TEXT-FIG. 2. A, B, D, F, H, L. *Monograptus helicoides* nov. sp. F, Holotype GSC 30122; Paratypes A, B, D, GSC 30123, 30124, 30127; H, L, GSC 30125 and 30126, 45 feet on Hart River. C, E, G, M. *Monograptus* cf. *cornutus* (Urbanek). C, GSC 30119; E, GSC 30121; G, GSC 30118; M, GSC 30120, 60 feet on Hart River. I, J, K. *Monograptus* cf. *balticus* Teller. I, GSC 30116; J, GSC 30115; K, GSC 30117, 85 feet on Hart River. All figures ×6.



TEXT-FIG. 3. A–F, I. *Monograptus bouceki* Přibyl. A–F, GSC 30100–30105 respectively; I, GSC 30106, 550 to 555 feet in tributary of Peel River. G, H, J–L. *Saetograptus pilosus* sp. nov. K, Holotype GSC 30110 and Paratypes G, H, GSC 30109 and 30112; J and L, GSC 30113 and 30111. All figures ×4.

bedding plane with *M.* aff. *roemeri* and *M.* cf. *haupti*. Its age is tentatively considered to be late Ludlovian as in Poland, but may range downward into the middle Ludlovian.

Monograptus bouceki Přibyl 1940

Text-fig. 3 A–F, I

1940 *Monograptus* (*Pomatograptus*) *bouceki* Přibyl, pl. 1, figs. 7–8, text-fig. 1, no. 4.
1942 *Monograptus bouceki* Přibyl, p. 6, pl. 1, figs. 1–3.
1964 *Monograptus bouceki* Přibyl; Teller, pp. 56–57, pl. II, fig. 13, pl. V, fig. 5, pl. VI, figs. 1–3, pl. VIII, figs. 12, 13, pl. XV, figs. 4, 5, text-fig. 13a–d.

Material. Seven adult or near adult specimens preserved as films in black shale are available, namely, GSC 30100 to 30106, Road River Formation on unnamed tributary of Peel River, latitude 65° 53′ 45″ N, longitude 135° 55′ 25″ W, field designation PW–2L at 550–555 feet; collected by A. C. Lenz and D. E. Jackson 1969.

Description. Rhabdosome small, not seen to exceed 20 mm. Dorsal margin with dorsal curvature between apertures of th^1 and th^{3-4}, and straight distally. Width across the apertural hood of th^1 is 0·75 to 1·0 mm (average 0·9 mm), across th^5 it is 1·0–1·2 mm and at th^{10} only 1·3–1·5 mm. A maximum width of about 1·5 mm is attained between th^{8-11}.

Thecae uniform, free ventral wall inclined up to 30° toward dorsal edge of rhabdosome proximally, becoming subparallel distally. Thecal apertures at proximal end are obscured by down-curved apertural hoods which distally become slightly smaller exposing apertural margin. There are $4\frac{1}{2}$ to 6 thecae in first 5 mm and 11 in first 10 mm.

Sicula 2 mm long, apex reaching midway between apertures of th^1 and th^2, axis curved so that aperture deflected ventrally. Aperture carries prominent virgella and dorsal tongue.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*				*Thecae in*	
		th^1	th^5	th^{10}	*max.*	*1st 5 mm*	*1st 10 mm*
30100	14	0·9	1·0	1·3	1·3 th^{10}	$5\frac{3}{4}$	11
30101	+20	0·9	1·2	1·3	1·5 th^{11}	$5\frac{1}{2}$	11
30102	14	0·9	1·2	1·5	1·5 th^8	5	$10\frac{1}{2}$
30103	17·5	0·9	1·2	1·5	1·5 th^{10}	$4\frac{1}{2}$	10
30104	14	0·9	1·1	1·4	1·4 th^8	5	$10\frac{1}{2}$
30105	15	1·0	1·2	1·4	1·5 th^9	$5\frac{1}{2}$	10
30106	14	0·75	1·2	1·4	1·5 th^{11}	6	$10\frac{1}{2}$

Remarks. This material is identical with that described by Teller (1964) and differs from Přibyl's original description only in the slightly greater length of the sicula. Rhabdosomes of the Yukon specimens have a distinct dorsal curvature as mentioned by Přibyl and illustrated by well-preserved material from Australia (Jaeger 1967, pl. 14, fig. a).

Occurrence. The species occurs on a single bedding plane associated with *Saetograptus pilosus* sp. nov. and fragments of *Linograptus* 20 feet above *M.* ex gr. *M. transgrediens* and 350 feet below the *yukonensis* Zone. We consider tentatively that this occurrence

signifies the existence of the *M. bouceki* Zone in Yukon Territory and represents the first recognition of the zone on this continent.

Monograptus cf. *cornutus* (Urbanek) 1970

Text-fig. 2 C, E, G, M

cf. 1970 *Bohemograptus cornutus* Urbanek, p. 310, pl. 20, fig. D, pls. XXV–XXVIII.

Material. Fourteen specimens compressed in black mudstone from the Road River Formation of Hart River, at 60 feet above the base of the measured section. Figured specimens are GSC 30118 to 30121. All material collected by D. E. Jackson and A. C. Lenz 1969.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*			*Thecae in 1st 5 mm*	*Sicula length*
		th^1	th^5	*maximum at distal end*		
30118	8	0·65	1·25	1·25	$6\frac{1}{2}$	—
30119	8	0·65	1·25	1·45	7	1·45
30120	8	0·8	1·1	1·4	7	+1·0
30121	7	0·55	1·1	1·0	7	—

Description. Rhabdosome short, up to 8 mm long with strong ventral curvature proximally, weakening distally. Width increases gradually from about 0·7 mm exclusive of lappets at th^1 to a maximum of 1·45 mm at distal end.

Thecae simple, inclined about 30–40° to axis of rhabdosome, overlapping one-half to two-thirds, and about three times longer than wide. Apertural margins of thecae modified by paired lappet-like appendages which exceed 1·5 mm in length. Specimens not well enough preserved to determine whether apertural lips are thickened by peridermal tissue, such as illustrated by Urbanek (1970, pl. XXV, fig. A_1).

Sicula conical, ventrally curved, maximum length 1·45 mm and width 0·4 mm. Apex of sicula about level with top of th^1.

Remarks. This species is distinguished from all other species of bohemograptids, including the closely related *M. praecornutus* (Urbanek), by the long, thecal lappets. The Yukon specimens appear to differ from the Polish material in the apparent lack of lappets in the first two or three thecae, and in having a shorter sicula (1·45 mm vs. 1·61–2·14 mm). In the latter feature, the Yukon material overlaps the sicula measurement of *M. praecornutus* (Urbanek).

Occurrence. The species is known from a single bedding plane where it is associated with *Monograptus bohemicus bohemicus*, *M. bohemicus tenuis*, *Monograptus* aff. *roemeri* and ?*Linograptus* sp. indet. (see Table 2). In Poland *M. cornutus* occurs within the *cornutus* Zone of Late Ludlovian age (Teller 1969, p. 457).

Monograptus cf. *craigensis* Jaeger 1970

Text-fig. 4 F, G, M

cf. 1970 *Monograptus craigensis* Jaeger *in* Churkin, Jaeger and Eberlein, pp. 198–202, figs. 6, 7B, C, 8B, C, 9A, F, K.

Material. Three immature compressed specimens are available comprising figured specimens GSC 30107–30109, Road River Formation, Tetlit Creek, latitude 66° 44′ N, longitude 135° 46′ W, field designation DJ-66-2F; collected by M. C. Pick, Chevron Standard Ltd., 1966.

Description. Largest rhabdosome 20 mm long, dorsal margin is dorsally curved reversing to ventral curvature beyond th[4]; rhabdosome widens gradually to about th[15]. Width increases from 0·8 mm across hood of th[1] (0·4 mm immediately above hood) to 1·2–1·4 mm across hood of th[5], and 1·5–1·8 mm at th[10]. The maximum observed width of 2·5 mm is at th[17] (1·7 mm immediately above apertural hood).

Thecae are of *M. yukonensis* form provided with apertural hoods which increase in size slightly towards distal end. Subapertural free ventral wall of thecae is concave and inclined at 30° to 40° to axis of rhabdosome. There are 6 thecae in first and second 5 mm reducing to 5 per 5 mm thereafter. The distance between the aperture of th[1] and the base of sicula is 1·5 to 1·6 mm.

Length of sicula is unknown, sicular aperture does not apparently possess large expanded virgella.

Remarks. This material resembles *M. craigensis* in the degree of recurvature of the proximal end, the gradual widening of the rhabdosome to the same maximum width, and in having the same thecal spacing over the first 10 mm. A minor difference involves the thecal hoods which enlarge slightly rather than diminish distally.

The lappet-shaped expansion of the virgella which Jaeger (in Churkin *et al.* 1970) considers characteristic of adult representatives of the species was not observed on our immature specimens.

Occurrence. This form from Tetlit Creek occurs 75 feet below *M. aequabilis notoaequabilis* thus providing a striking parallel to the range of the two species at the type locality at Port St. Nicholas, Prince of Wales Island, Alaska.

Monograptus helicoides sp. nov.

Text-fig. 2 A, B, D, F, H, L

Material. Twenty-six moderately well-preserved specimens compressed on black mudstone, are available.

Holotype. GSC 30122 (text-fig. 2 F).

Paratypes. GSC 30123–30127.

Type locality and horizon. Road River Formation, 45 feet above base of measured section on Hart River; collected by D. E. Jackson and A. C. Lenz 1969.

Derivation of name. Helix, Greek for screw.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*			*No. of thecae in 5 mm*	*Sicula length*
		th[1]	th[5]	*max.*		
30122	12	0·3	1·0	1·0	7?	1·4?
30123	+12	0·4	0·8	0·9	7?	—
30124	+12	0·3	0·8	1·0	7	1·4
30125	15	0·3	0·8	1·1	6	1·6
30126	+10	0·45	0·9	0·9	—	1·6
30127	19	0·3	0·8	1·0	7	1·6

Description. Rhabdosome small, maximum length 19 mm, coiled in one and one-half spirals. From the fact that the sicular region may be hidden by, or partially conceals succeeding portions of rhabdosome, it is probable that the spiral was helicoid rather than planispiral. Rhabdosome widens gradually and uniformly from 0·3–0·4 mm across th^1 to a maximum of about 1·1 mm.

Thecae simple, inclined 15–20° to the dorsal edge of the rhabdosome, overlapping about one-half, and 4–5 times longer than wide. Apertures approximately at right angles to axis of thecae. Thecae are spaced at the rate of 7 in 5 mm.

Sicula generally straight about 1·6 mm in length and 0·3 mm wide at aperture. Apex of sicula apparently lies just below level of aperture of th^1.

Remarks. The combination of simple, *Monograptus bohemicus* type thecae, and the tight spiral of the rhabdosome distinguishes this species from all known monograptid species of Ludlovian age. Indeed it is the only monograptid in the Upper Silurian which has a coiled stipe.

Occurrence. This species occurs on a single bedding plane in association with *Monograptus bohemicus tenuis* and *Monograptus* cf. *egregius* Urbanek. It lies 15 feet stratigraphically below *Monograptus* cf. *cornutus* and 15 feet above *M. leintwardinensis primus* suggesting a middle or late Ludlovian age (see Table 2).

Monograptus cf. *hercynicus subhercynicus* Willefert 1963

Text-fig. 4 A, B, D

cf. 1963 *Monograptus hercynicus subhercynicus* Willefert, p. 75, pl. II, figs. 16, 18, 23, text-figs. 4a–d, 5a–e.

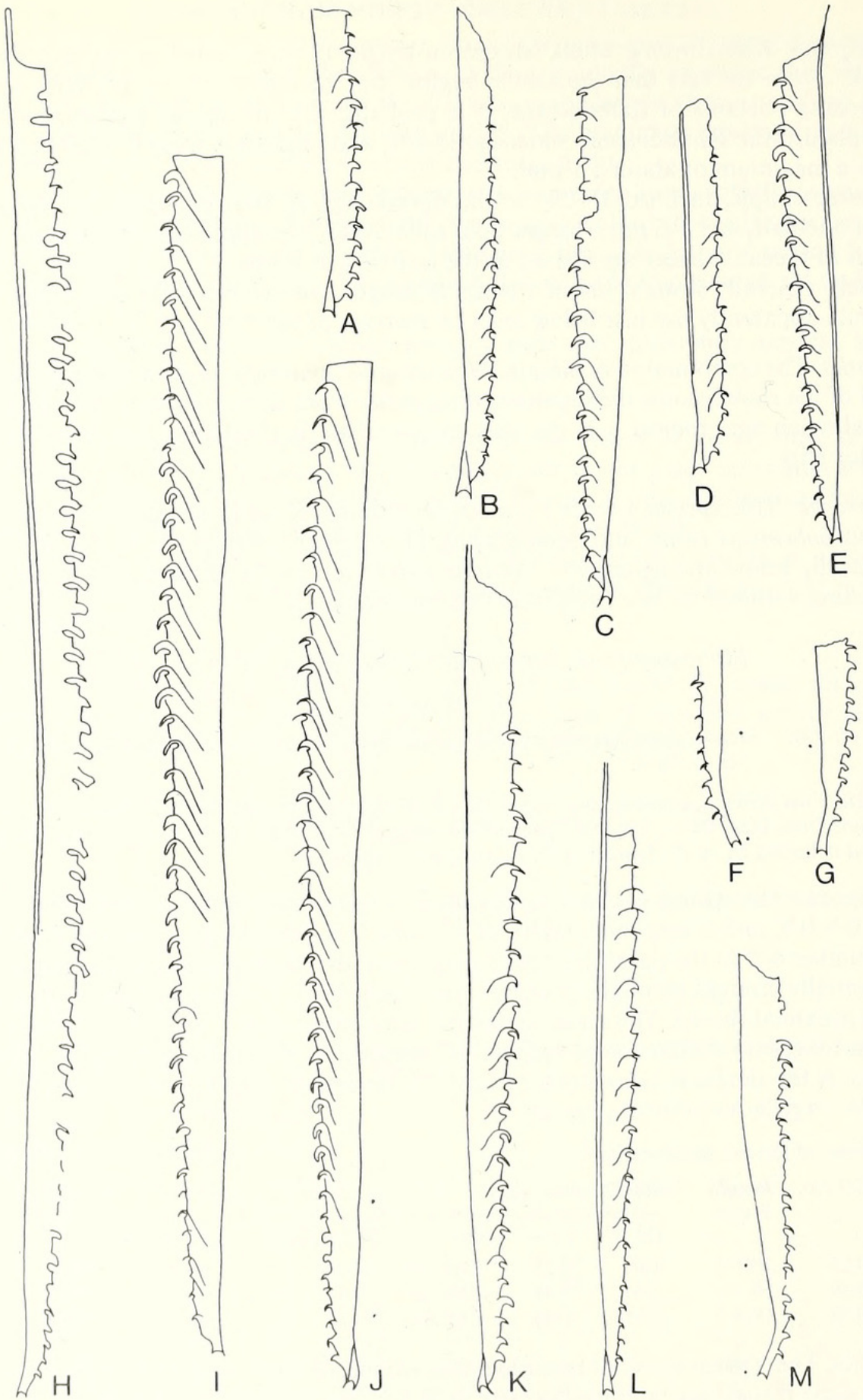
Material. Two dozen specimens, only seven of which show reasonable details, compressed on black mudstone from Hart River. Figured specimens consist of GSC 30128 to 30130 from Hart River. All material collected by A. C. Lenz and D. E. Jackson in 1969.

Description. The species is characterized by a length greater than 10 mm, width across th^1 is 0·8–0·9, and a maximum width of 1·9 mm. The thecae are of the *hercynicus* type and number 6–7 in the proximal 5 mm, and 5–6 in the distal portions. The rhabdosome is essentially straight throughout except for a very weak dorsal curvature in the region of the proximal thecae. The most distinctive characteristic, and one which distinguishes it from otherwise similar forms such as *M. hercynicus*, *M. angustidens* and *M. praehercynicus*, is the sicula. It is triangular to slightly flaring, up to 2 mm long, and possesses straight virgella and dorsal process.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*			*No. of thecae*		*Sicula length*
		th^1	th^5	*max.*	*1st 5 mm*	*2nd 5 mm*	
30128	20	1·0	1·23	1·85 th^{10}	6·5	5·6	1·8
30129	16	1·0	1·54	1·85 th^8	6	5·5	1·9
30130	18·5	1·15	1·46	1·85 th^{11}	7	6·0	1·4

Remarks. The Yukon material resembles this subspecies in possessing a straight rhabdosome, same thecal rate, and particularly in the shape and length of the sicula.



TEXT-FIG. 4. (See opposite.)

Occurrence. This species was collected 485 feet above the base of the Road River Formation on Hart River and is considered to lie within the Gedinnian *M. uniformis* Zone (see Table 2).

Monograptus uniformis angustidens Přibyl 1940

Text-figs. 1 J, Q, 4 C, E, K, L

1940 *Monograptus angustidens* Přibyl, p. 70, text-fig. I, 1, 2, pl. 1, figs. 3, 4.
1964 *Monograptus angustidens* Přibyl; Teller, p. 60, pl. 2, fig. 11, pl. 8, figs. 1–3, pl. 9, figs. 13–15, pl. 13, fig. 5, text-fig. 15a, b.

Material. Several dozen specimens preserved as carbonaceous films on black shale, collected from two bedding planes 990 feet and 995 feet above the base of the section on an unnamed tributary of Peel River, latitude 65° 53′ 45″ N, longitude 135° 55′ 25″ W, field designation PW-8J, at 990 feet and 995 feet. Figured specimens comprise GSC 30094 and 30095, and GSC 30131–30134, collected by D. E. Jackson and A. C. Lenz 1969.

Description. Rhabdosome up to 36 mm long, straight except for very weak ventral curvature between th^3 and th^{7-9}. Width of rhabdosome increases fairly rapidly from 0·8–1·1 mm across th^1 to 1·25–1·3 mm across th^5, and attains maximum width of up to 2·4 mm beyond th^{15}. Sicula normally 1·7 mm long, curved ventrally, and possessing a distinct ventrally directed dorsal process. Apex of sicula lies at level of aperture of th^2.

Thecae provided with down-curved apertural hoods which increase in size proximally, then maintain constant size, or decrease slightly, distally. Thecae overlap such that a transverse section across the rhabdosome would cut through only two tubes. There are 6 to 7 thecae in 5 mm proximally, and 9–11 in 10 mm distally.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*				*Thecae in*	
		th^1	th^5	th^{10}	*max.*	*1st 5 mm*	*distally in 5 mm*
30094	13	0·9	1·3	1·75	2·15 th^{17}	$6\frac{3}{4}$	$5\frac{3}{4}$
30095	42	0·9	1·17	1·6	2·16 th^{18}	$6\frac{1}{2}$	$4\frac{3}{4}$
30131	31	1·1	1·3	1·7	2·4 th^{26}	6	$4\frac{1}{2}$
30132	29	0·8	1·25	1·8	2·25 th^{14}	$6\frac{1}{2}$	$5\frac{1}{4}$
30133	22	0·75	1·1	1·5	1·8 th^{17}	6	5
30134	20	0·8	1·25	1·65	2·25 th^{20}	6	$5\frac{1}{2}$

Remarks. Because of the inadequate nature of Přibyl's (1940) original description, comparison with the type specimens is difficult. However, our material is very similar in every respect to the material described by Teller (1964). In addition, measurements of additional Bohemian material made by Jaeger (privately circulated at the Second International Symposium on the Silurian–Devonian Boundary, Leningrad, 1968) conform closely to our material.

Specimens from the Peel River area are extremely similar to those from Porcupine

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TEXT-FIG. 4. A, B, D. *Monograptus* cf. *hercynicus subhercynicus* Willefert. A, GSC 30130; B, GSC 301238; D, GSC 30129, 485 feet on Hart River. C, E, K, L. *Monograptus uniformis angustidens* Přibyl. C, GSC 30132; K, GSC 30131, 990 feet on Peel River tributary; E, GSC 30134; L, GSC 30133, 995 feet on Peel River tributary. F, G, M. *Monograptus* cf. *craigensis* Jaeger. F, GSC 30109; G, GSC 30108; M, GSC 30107, 20 feet below top of Road River Formation in Tetlit Creek. H–J. *Monograptus uniformis uniformis* Přibyl. H, GSC 30135; I, GSC 30136; J, GSC 30137, 509 feet in Hart River. All figures × 3.

River described as *M.* aff. *angustidens* by Jackson and Lenz (1969). The major difference between the forms is that the latter are consistently broader. Further collecting and studies will be necessary to determine if this difference is meaningful.

Occurrence. Monograptus uniformis angustidens is, to date, known from an unnamed tributary on the north side of the Peel River, about six miles upstream from the beginning of the Upper Canyon. It lies 45 feet stratigraphically above the highest occurrence of *M. transgrediens praecipuus*, and 15 feet below a form morphologically intermediate between *M. uniformis angustidens* and *M. hercynicus subhercynicus*.

The occurrence of this species undoubtedly represents the latest Přidolian *angustidens* Zone, and as such is the first recognition of the zone in western Canada.

Monograptus uniformis parangustidens subsp. nov.

Text-fig. 1 D–I, M–O

Material. A dozen specimens preserved as pyritized films in black shale and collected from two bedding planes.

Holotype. GSC 30098 (text-fig. 1 N).

Paratypes. GSC 30088–30093, 30097–30099.

Type locality and horizon. Road River Formation on Hart River, 430 feet and 445 feet above base of measured section; collected by D. E. Jackson and A. C. Lenz 1969.

Description. Largest rhabdosome 28 mm exclusive of virgula, straight except for dorsal curvature between th^{1-5} and ventrally deflected sicula. Width of rhabdosome is 0·6–0·8 mm across hood of th^1 increasing to 1·0–1·4 mm across th^5 and has a maximum width of 1·5–1·7 mm beyond th^{10}. Sicula is 1·7 mm long, distinctly curved ventrally with prominent virgellar spine, apex lies at a level slightly below th^2 aperture.

All thecae provided with apertural hoods which sometimes increase in size distally. Proximal thecae slightly isolate with strongly down-curved hoods, distal thecae have climacograptid profile and with hoods above horizontal apertural excavations, and a transverse section across the rhabdosome would cut through only two tubes. Thecal rate is 11–12 in 10 mm.

Dimensions of figured specimens in mm

GSC No.	*Length*	*Rhabdosome width*				*Thecae in*	
		th^1	th^5	th^{10}	*max.*	*1st 5 mm*	*1st 10 mm*
30088	5·7	0·8 (0·4)	1·4 (0·8)	—	—	—	—
30089	14	0·75 (0·45)	1·25 (0·9)	1·4 (1·2)	1·5 th^{14}	6	11
30090	18·0	0·8 (0·5)	1·2 (0·75)	1·5 (1·2)	1·5 th^{16}	6	—
30091	10·5	0·75 (0·6)	1·0 (0·75)	1·0 (0·9)	1·3 th^8	$6\frac{1}{2}$	—
30092	13·5	0·8 (0·4)	+0·8 (0·8)	1·0—	1·5 th^{13}	$5\frac{3}{4}$	12
30093	17·3	0·7 (0·3)	1·0 (0·75)	1·2 (1·0)	1·4 th^{16}	$6\frac{1}{2}$	12
30097	25·8	0·6 (0·3)	1·0 (0·6)	1·2 (1·0)	1·7 th^{24}	$6\frac{1}{2}$	12
30098	28	0·75 (0·4)	1·2 (0·7)	1·25 (0·8)	1·5 th^{18}	$6\frac{1}{2}$	12
30099	23·3	0·9 (0·5)	1·25 (0·9)	1·4 (1·25)	1·75 th^{14}	$5\frac{3}{4}$	11

Remarks. This subspecies is clearly related to the *Monograptus uniformis* group, and particularly to *M. uniformis angustidens* and stratigraphically appears to be a chronospecies of *uniformis*. It differs in its more distinct proximal dorsal curvature, more

gradual increase in width, and in general by being more slender (average 1·5 or 1·6 mm for *parangustidens* vs. greater than 2 mm for *angustidens*). *M. uniformis paragustidens* differs from *M. telleri* Lenz and Jackson in its more pronounced proximal dorsal curvature, and more gradual increase in width.

Occurrence. The specimens were collected 430 feet and 445 feet above the section base, on the Hart River. The lower collection lies 20 feet above the highest occurrence of *M. transgrediens praecipuus*, and the higher occurrence lies 40 feet below *M.* cf. *hercynicus subhercynicus*. Their occurrence almost certainly represents the highest Přidolian *angustidens* Zone.

Monograptus uniformis uniformis Přibyl 1940

Text-figs. 1 P, 4 H–J

1940 *Monograptus* (*Pomatograptus*) *uncinatus uniformis* Přibyl, p. 71, pl. 1, fig. 1.
1959 *Monograptus uniformis* Přibyl; Jaeger, p. 94, pl. 1, fig. 3, pl. 3, figs. 9–10, pl. 4, figs. 4–15, ffs. 16d–h. For complete synonymy up to 1959, see Jaeger 1959, p. 94.
1971 *Monograptus* cf. *uniformis* Přibyl; Lenz and Jackson, p. 16, text-fig. 3C, G.

Material. Three specimens from 494 feet, and nine specimens from 509 feet above the base of the section on Hart River. All compressed on black shales. Figured specimens comprise GSC 30096 and 30135–30137. All material collected by D. E. Jackson and A. C. Lenz 1969.

Discussion. This species was tentatively identified by us (1971) also from the Hart River section, but its fragmentary condition prevented certain identification. Subsequent collecting has yielded complete and better preserved material. Our material resembles that described by Jaeger (1959) by lengths of 50 mm or more, maximum width of up to 3 mm, strongly overlapping thecae, and thecae numbering up to 7 in 5 mm proximally and 5–6 in 5 mm distally.

Occurrence. M. uniformis is associated with *M. aequabilis aequabilis* at 494 feet, and is without association at 509 feet in the Road River Formation of Hart River. These two species characterize the Gedinnian *uniformis* Zone.

Genus SAETOGRAPTUS Přibyl 1943

Saetograptus pilosus n. sp.

Text-fig. 3 G, H, J–L

1947 *Monograptus chimaera* var. *alaskaensis* Ruedemann, p. 475, pl. 85, figs. 17–22.

Material. A dozen specimens preserved as silvery films on black shale are available.

Holotype. GSC 30110, text-fig. 3 H.

Paratypes. GSC 30111–30114.

Type locality and horizon. Road River Formation, on unnamed tributary of Peel River; latitude 65° 53′ 45″ N, longitude 135° 55′ 25″ W, field designation PW–2L at 550–555 feet collected by A. C. Lenz 1969.

Derivation of name. Pilosus, Latin for hairy.

Description. Rhabdosome up to 21 mm long exclusive of virgula, dorsal margin exhibits slight ventral curvature in proximity of sicula and strong dorsal curvature between th^1 and th^5, becoming nearly straight distally. The amount of dorsal curvature varies between