LOWER DEVONIAN LAND PLANTS FROM GRAPTOLITIC SHALE IN SOUTH-EASTERN ALASKA

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ABSTRACT. The discovery of vascular plants (*Drepanophycus* sp. and *Hostimella* spp.) in graptolitic shale from Noyes Island, south-eastern Alaska is the first record of such an association in North America and the oldest confirmed occurrence of land plants in the western hemisphere. *Monograptus* aff. *thomasi* associated with the plants on Noyes Island occurs in Australia with the famous *Baragwanathia* flora that has long been considered Silurian, but now is regarded to be no older than early Devonian, about the same age as the earliest undoubted vascular plants in Europe. Corals that occur in limestone interbedded with the Alaskan plant and graptolite-bearing shale further indicate an early Devonian age.

The plant and graptolite shale of Noyes Island is part of a section composed predominantly of conglomerate, sandstone, and coral limestone breccia, suggesting high-energy shallow marine sedimentation that was interrupted by brief periods of accumulation of graptolitic mud that also preserved fragments of land plants that lived on nearby uplifts.

FOR many years the earliest record of vascular land-plants was known with certainty only from the Old Red Sandstone of early Devonian age in England. A few records from older strata had been open to doubt either because the age of the beds was not proven or because the plant remains were obscure. Then from Australia Lang and Cookson (1935) described the remarkably well-preserved *Baragwanathia* flora from graptolite-bearing shale in Victoria. The graptolites associated with these plants, often preserved on the same slab of rock, were considered as definitely Silurian (and not younger than lower Ludlow); thus the associated plants were considered the most ancient record of vascular plants anywhere in the world.

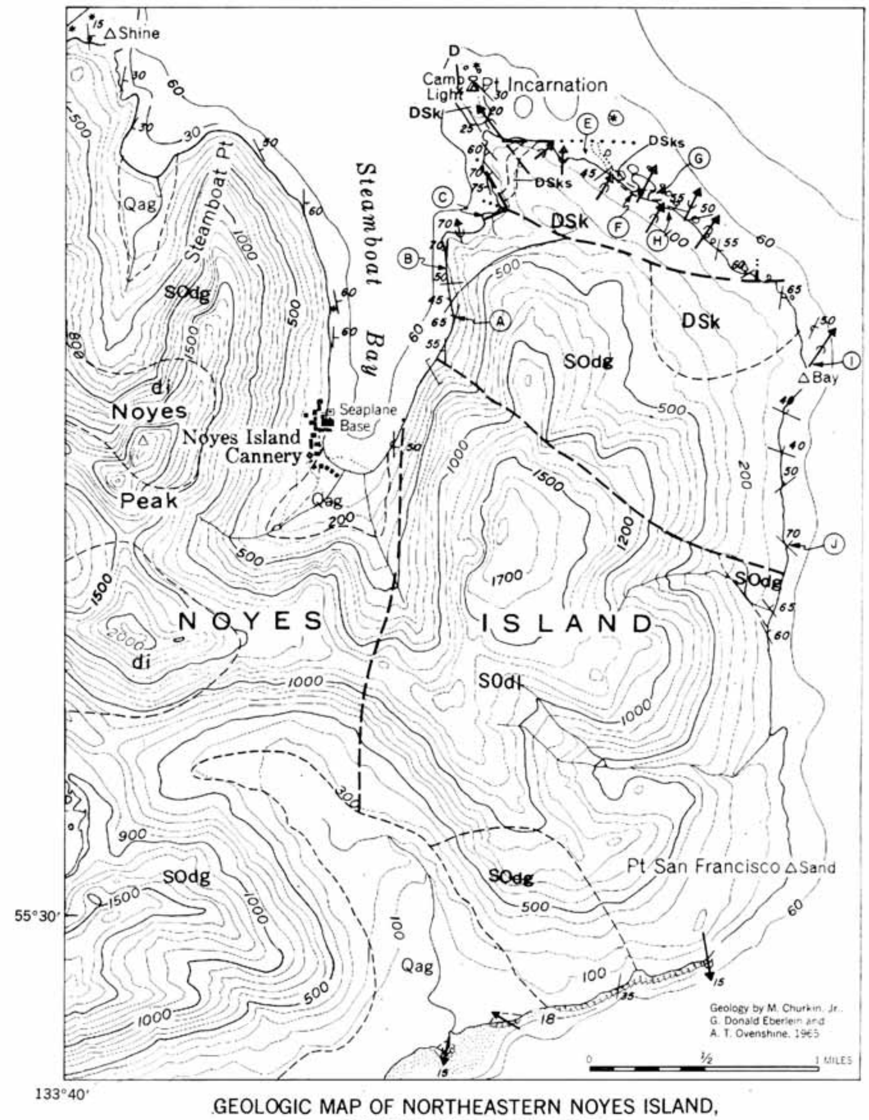
Recently, however, re-examinations of the Australian graptolites (Jaeger 1966, 1967; Berry 1965), long regarded as conspecific with those from the British lower Ludlow, indicate that they correlate with the considerably younger, Lower Devonian, graptolite succession established by Jaeger (1959, 1962) in Europe. The *Baragwanathia* flora accordingly is now considered post-Ludlow and approximately the same age as the earliest undoubted vascular plants in Europe.

The presence of land plants in earliest Devonian or possibly latest Silurian graptolitic shale although very rare has been observed from widely separated regions: Bohemia (Obrhel 1962); Germany (Zimmermann 1953, Roselt 1962); Russia (Obut 1957); Australia (Lang and Cookson 1935).

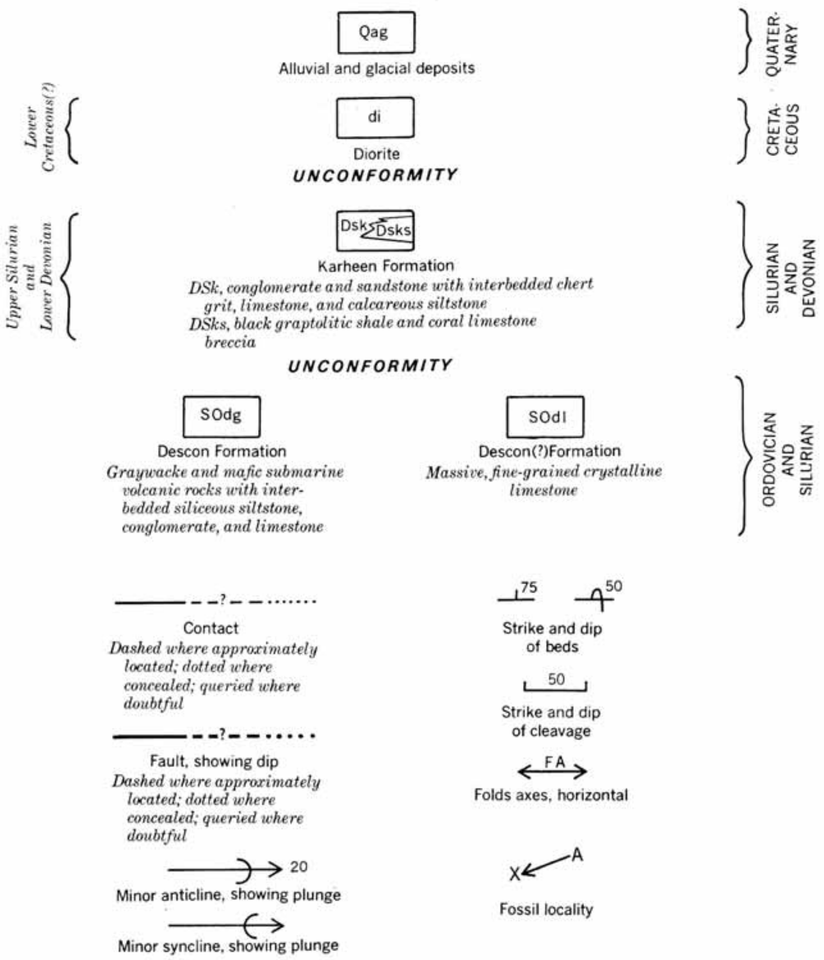
The discovery of vascular plants in graptolitic shale from south-eastern Alaska described in this paper is the first record of such an association from North America and the oldest confirmed occurrence of land plants in this hemisphere. In addition, the close association of corals with the plant and graptolite-bearing shale further defines the age of the plants in terms of a marine shelly fauna.

Acknowledgements. This study is the result of finding plants in graptolite shale in 1965 by M. Churkin, Jr., G. D. Eberlein, and A. T. Ovenshine while mapping parts of the Craig quadrangle in south-eastern

[Palaeontology, Vol. 12, Part 4, 1969, pp. 559–73, pls. 100–1.]



TEXT-FIG. 1. Geologic map of north-eastern Noyes Island, south-eastern Alaska. Explanatory symbols on opposite page.



TEXT-FIG. 1 (*continued*). Explanation of symbols. Contours are in feet above and below sea level.

Alaska for the U.S. Geological Survey. We are indebted to Hermann Jaeger (Institut für Paläontologie und Museum der Humboldt Universität, Berlin) for his identification of *Monograptus* aff. *thomasi*; to A. M. Obut (Institute of Geology and Geophysics, Novosibirsk) for discussion of graptolite-plant occurrences in the U.S.S.R.; to I. I. Chudinova, V. N. Dubatolov, A. B. Ivanovskii, K. A. Ermakova, A. G. Kravtsov, F. E. Yanet, and other Soviet palaeontologists for their identifications and comments on the Alaskan tabulate corals while Churkin visited the Soviet Union on the exchange programme of the United States and Soviet Academies of Science. Claire Carter helped prepare the graptolite descriptions. Publication authorized by the Director, U.S. Geological Survey.

STRATIGRAPHY

The beds containing the plant-graptolite assemblage described here crop out along the north-east shore of Noyes Island, a small island in the Alexander Archipelago of south-eastern Alaska (text-fig. 1). The predominantly greywacke and mafic volcanic rocks with interbedded siltstone, shale, conglomerate, and limestone constitute one of the most westerly exposures of the Palaeozoic Cordilleran geosyncline in North America.

The stratigraphic details in the Noyes Island area are complicated by rapid lateral gradation from one lithology into another, especially among the volcanic rock types, and by tight folding and high-angle faulting (text-fig. 1).

The oldest rocks in the immediate area, the Descon Formation (Eberlein and Churkin, in press), consist mainly of greywacke and siltstone, with minor interbeds of basaltic tuff and limestone, bedded chert with graptolitic shale partings, and chert-rich pebble conglomerate. The only fossils found in the formation are graptolites indicating a range from upper Arenigian (Early Ordovician) at locality A, into upper Caradocian (Middle Ordovician) at locality I, and finally into the lower Llandoverian zone of *Akidograptus acuminatus* (earliest Silurian) at locality J (see text-fig. 1 for fossil locations, and text-fig. 2 for stratigraphic positions of key graptolite faunules).

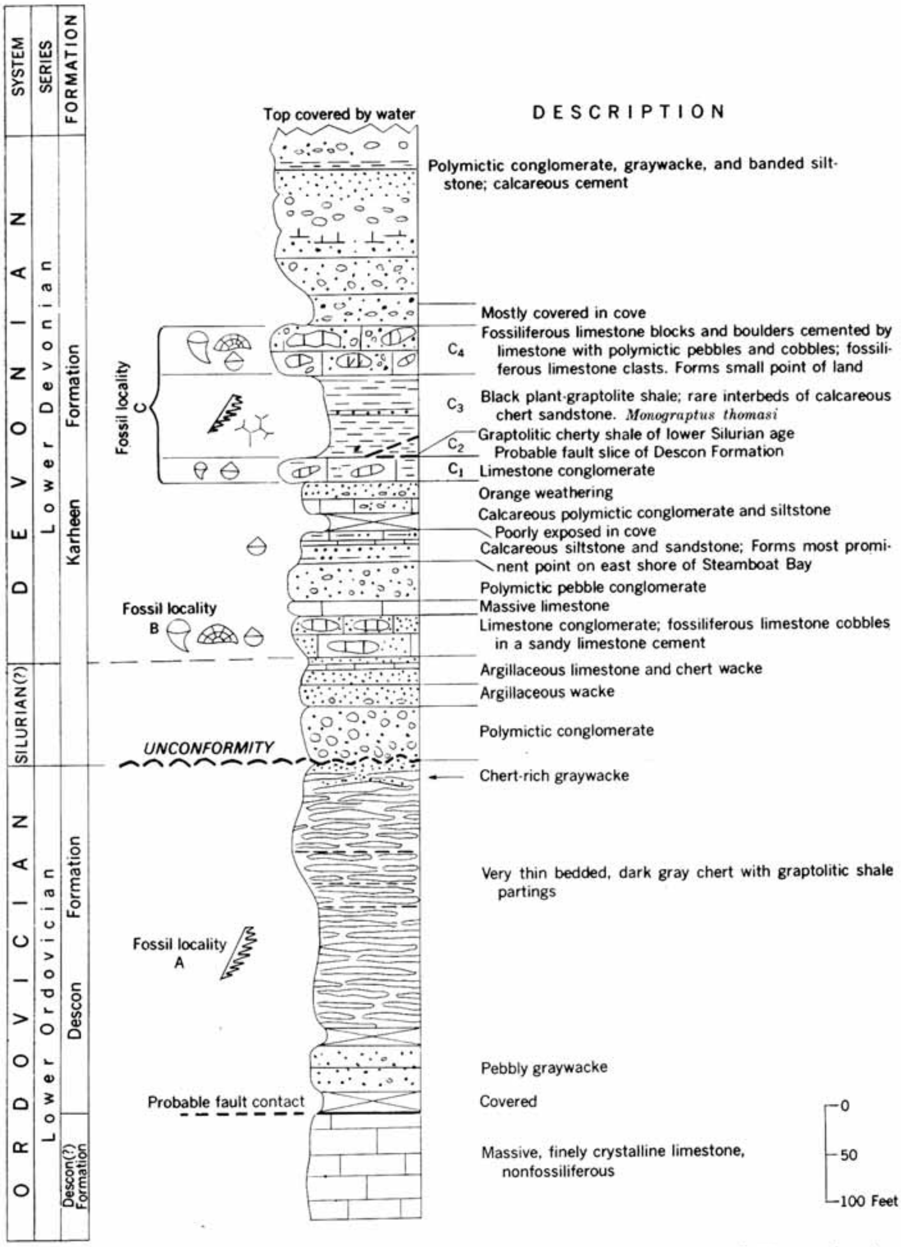
Overlying the Descon Formation with apparent unconformity is the Karheen Formation (Eberlein and Churkin, in press). Conglomerate, sandstone, siltstone, and shale are the dominant lithologies of the Karheen also, but the formation generally is not as indurated as the Descon, has conspicuous amounts of carbonate cement, and contains far more limestone interbeds than the underlying Descon Formation. Interbedded with fossiliferous limestone and calcareous siltstone is a thin black graptolitic shale unit (text-fig. 1). At two localities (C and F), plants were found on the same shale bedding planes with graptolites.

The best plant-graptolite locality is on a small point on the east shore of Steamboat Bay (locality C_3), where a wave-cut bench exposes about 75 ft. of nearly vertical black shale that is underlain by limestone and limestone conglomerate and apparently overlain by the coral-limestone breccia that forms the seaward edge of the point. Widely divergent orientations of cleavage and fractures within the shale imply that it is internally folded and faulted. In fact, what appears to be the basal part of the shale fossil locality C_2 surprisingly yields a Lower Silurian graptolite fauna far older than the plant and graptolite-bearing upper part of the shale unit of early Devonian age. Thus, either a similar black shale that contains much older graptolitic material has been faulted into the base of the unit or the shale represents a condensed section about 75 ft. thick that ranges in age from early Silurian into early Devonian.

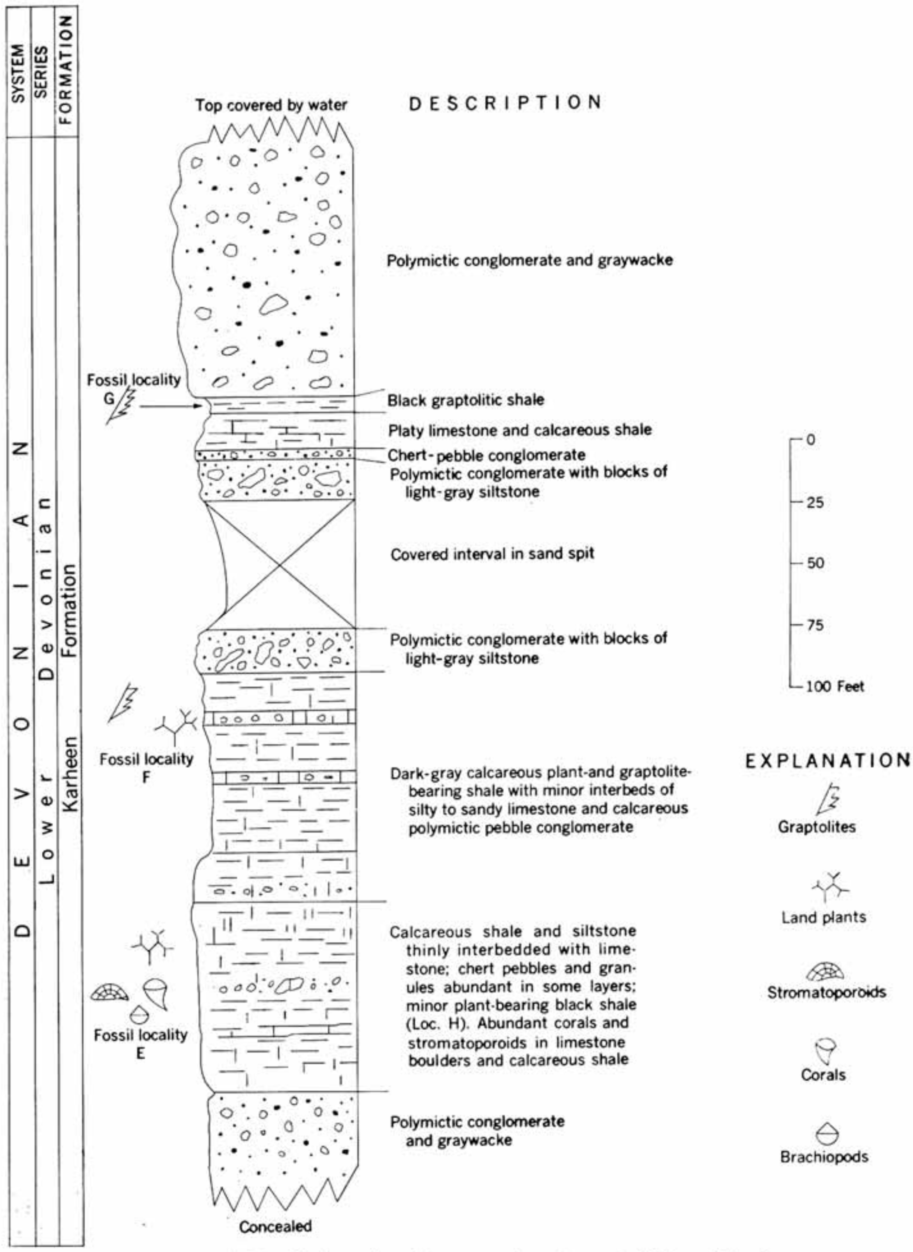
The other plant-graptolite locality (text-figs. 1 and 3; locality F) is about 0·70 miles east of locality C at the head of a rocky cove 0·85 miles south-east of Point Incarnation. Plant remains are also present in shale at locality H (text-fig. 1).

GENERAL DESCRIPTION OF THE PLANTS AND FAUNAS

The Lower Devonian graptolites and plants are frequently encountered on the same slabs of shale providing the shale splits parallel to the bedding. Where cleavage has developed at angles to the bedding, no trace of these fossils is visible on fracture surfaces.



TEXT-FIG. 2. Detailed stratigraphy on eastern shore of Steamboat Bay, Noyes Island. For explanation of symbols see text-fig. 3. For *M. thomasi* read *M.* aff. *thomasi*.



TEXT-FIG. 3. Detailed stratigraphy on north-east coast of Noyes Island.

Both the plants and graptolites are preserved as flattened silvery films with only a trace of original relief present in a few specimens. Although nearly 100 individual plant specimens were collected, most are fragmentary. Three types of plant structures are preserved: stout axes possessing widely spaced lateral appendages; dichotomously branched slender stems that have evenly paired branchlets; dichotomously branched stems small, but robust.

More than 100 graptolites in association with plant fossils were collected at localities C and F. Because of the fragmentary preservation, and in many cases intense deformation of the graptolites, a first impression suggested several species of *Monograptus* characterized by rapidly widening unbranched stipes having hooked thecae on one side and a straight smooth margin on the other side. Fossils identified from these collections from north-eastern Noyes Island, south-eastern Alaska, are listed below:

Locality C_3. From a black shale section about 75 ft. thick in the Karheen Formation. Exposed in a wave-cut bench just back from limestone breccia that forms the seaward edge of a small point on the east side of Steamboat Bay. U.S. Geological Survey field localities 65ACn1181, 66ACn1101B.

Plants: *Drepanophycus* sp. (rare), *Hostimella* sp. A (common), *Hostimella* sp. B (rare).

Graptolite: *Monograptus* aff. *M. thomasi* Jaeger (frequent).

Locality F. From about a 75-ft.-thick section of dark-grey slightly calcareous shale containing some thin interbeds of laminated silty to sandy limestone and calcareous polymictic pebble conglomerate, Karheen Formation. About 0·70 mile east of locality C at the head of a rocky cove 0·85 mile south-east of Point Incarnation. U.S. Geological Survey field localities 65ACn1221 and 66ACn1121.

Plant: *Hostimella* sp. A (common).

Graptolite: *Monograptus* aff. *M. thomasi* Jaeger (common).

Locality G. From 3-ft.-thick black shale containing thin beds of chert sandstone. Underlain by black platy limestone and calcareous shale with chert grit layers and overlain by polymictic pebble conglomerate, all within the Karheen Formation. In small bluff on north-east side of small cove across sandspit from locality F. U.S. Geological Survey field locality 65ACn1192.

Graptolite: *Monograptus* aff. *M. thomasi* Jaeger (rare).

In addition to graptolites, the fossil plants in Alaska are associated with shelly faunas consisting mainly of corals, stromatoporoids and brachiopods. (Fossil localities B, C_1, C_4, E, and H.) The best collections, mainly tabulate corals, were made from argillaceous limestone at localities B, E, H, directly below the plant-graptolite shale, and from a limestone boulder conglomerate and breccia, locality C_4, directly above the plant-graptolite shale (Table 1).

AGE AND CORRELATION

The graptolites associated with the plants from Noyes Island can be recognized by their distinctively hooked thecae as belonging to the *Monograptus hercynicus* group. Until recent years, monograptids were considered restricted in their age range to the Silurian, but the most recent work on the Silurian–Devonian boundary using graptolites

(Jaeger 1962, Bouček *et al.* 1966) has shown that where monograptids of the *M. hercynicus* type have been found in close association with the shelly fossils (upon which the stages of the Silurian and Devonian are based), the shelly fossils have been interpreted to be of post-Ludlow (post-Silurian) age. The graptolites associated with the plants in localities C_2 and F compare most closely with *M. thomasi* Jaeger, one of the youngest graptolites in Australia that is associated with the famous *Baragwanathia* flora (Jaeger 1966, 1967).

TABLE 1

Coral faunas closely associated with plant and graptolite-bearing shale from Noyes Island, south-eastern Alaska. Field locality numbers: Loc. B, 65ACn1172, 65ACn1162; Loc. C_1, 66ACn1101D; Loc. E, 65ACn1182, 65ACn1281; Loc. H, 65ACn1311; Loc. C_4, 65ACn1181.

Species	Localities				
	B	C_1	E	H	C_4
Striatopora minuscula Tchud.	×				
Syringopora sp.			×	×	
Favosites sp.			×	×	
Pachyfavosites sp. transitional to *Favosites* sp.				×	
Thamnopora sp.	×				
Disphyllum sp.	?	?			×
Tryplasma		×			
Tryplasma altaica (Dybowski)			×	×	
Pseudomicroplasma sp.			×		
Thamnoporoid coral					×

According to Jaeger the typical form of *Monograptus thomasi* closely resembles *M. praehercynicus*, but differs chiefly from *praehercynicus* in its thin, 'stalk like' habit of the proximal part and in the tendency towards isolation of the first 3–5 thecae. *M. thomasi* in Australia occurs with *Baragwanathia* in the most widespread development of plant-graptolite beds, i.e. the Wilson's Creek Shale and its equivalents. *M. aequabilis* (subsp.) reported first to be stratigraphically below *M. thomasi* (Jaeger 1966) was later found to be above *M. thomasi* (Jaeger 1967). *M. aequabilis* (subsp.) is also recognized by Jaeger from the uppermost Pragian (Early Emsian) beds with *M. atopus* Bouček and *M.* sp. cf. *M. yukonensis* Jackson and Lenz in Bohemia (Bouček 1967). In the Tanjil Formation overlying the Wilson Creek Shale with *M. thomasi* occur the tentaculitids *Nowakia* cf. *N. acuaria* and *Styliolina* sp. also indicating a Pragian age (Bouček 1967). This suggests to Jaeger (1967) that the zone of *M. thomasi* in Australia associated with the *Baragwanathia* flora could also be early Pragian in age (Siegenian). The earliest adequately dated occurrence of vascular land-plants in Australia and, by analogy, in south-eastern Alaska is early Devonian, at about Siegenian time. This occurrence in Alaska constitutes the earliest evidence of a land flora in the Western Hemisphere. It parallels other occurrences, for example, in Britain (Croft and Lang 1942) and Belgium (Stockmans 1940) and Germany (Kräusel and Weyland 1930) but is younger than the material reported by Lang (1937) from Wales (Gedinnian) and by Obrhel (1962) from Czechoslovakia (uppermost Silurian).

The corals associated with the graptolite-plant shale are mostly long-ranging genera of Silurian through Devonian and, in some cases, younger age. The presence of *Tryplasma* *altaica*, a very widespread and easily recognizable large solitary coral restricted to the Lower Devonian of Asiatic U.S.S.R., suggests an early Devonian age in agreement with *M. thomasi*. In addition, the presence of *Striatopora minuscula*, a tabulate coral found only in the lowest Devonian of the Kuzbas, U.S.S.R., strengthens the early Devonian age assignment. A more detailed correlation of the Alaskan corals must await the results of studies in progress of corals from other parts of Alaska and western North America where the first Lower Devonian faunas have just been recognized (Churkin and Brabb 1968, Lenz 1968).

ENVIRONMENTAL SIGNIFICANCE OF THE PLANT-GRAPTOLITE ASSOCIATION

The plant-graptolite shale on Noyes Island is from the lower part of a widely distributed, mainly conglomerate, sandstone and siltstone unit (Karheen Formation) that in its southern area of exposure on Noyes Island rests with a marked unconformity on a greywacke sequence of varying age (Eberlein and Churkin, in press). Some of the more richly fossiliferous limestone and limestone conglomerate of the Karheen Formation probably represent reefs, shell bank deposits or their fragmented equivalents. The plant-graptolite shale interbedded with these coarser-grained rocks reflects, as do numerous thinner beds of siltstone, short periods of deposition under relatively lower energy conditions. The presence of land plants in these, as in similar graptolitic shales, is used as evidence of near-shore sedimentation (Miroshnikov 1956, Obut 1957). However, studies of modern ocean bottoms many miles from shore have shown land-plant fragments of the size present in the much older graptolitic shales. For example, woody fragments from sugar cane processing in the Hawaiian Islands literally cover the ocean bottom at depths up to 12,000 ft. and up to 20 miles from shore (J. G. Moore—personal communication 1968).

In Australia, the *Baragwanathia* flora with graptolites is in a thick succession of siltstone, blocky mudstone, or shale that has numerous interbeds of conglomerate and sandstone (Schleiger 1964). The coarser sediments have well-developed graded bedding and are interpreted by Schleiger as products of turbidity currents induced by slumping of coarse sediment into probably deep standing water accumulating the graptolite-plant mud. The stratigraphic section at Noyes Island, Alaska, differs from the Australian association of plants and graptolites by being mostly conglomerate and sandstone with only occasional siltstone and shale interbeds. The Alaskan section, by its predominantly coarse detritus including large blocks of coral head limestone (probably in part slump blocks), limey cement, and limestone interbeds suggests rapid high-energy sedimentation near the sediment source in shallow marine waters rich in carbonate constituents. Therefore the source of the land-dwelling plants was probably from the nearby uplifts within the geosyncline instead of from some distant continental area to the east.

The remarkable occurrence of the same or very similar species of *Monograptus* at both ends of the Pacific in beds of about the same age supports the universally accepted hypothesis of a drifting mode of life for graptolites, exclusive of dendroid types (Bulman 1957, 1964). It also indicates that the north and south Pacific areas were interconnected perhaps in the form of an ancestral Pacific Ocean basin during early Devonian time.

DESCRIPTION OF THE GRAPTOLITES

Monograptus aff. *M. thomasi* Jaeger

Plate 100, figs. 1–4

1965 *Monograptus* sp. (of the *M. hercynicus* type) forms A and B, Berry, pp. 9–13, figs. 1*a*, *b*; pl. 1–2.

1966 *Monograptus thomasi* Jaeger, pp. 403–11, text-figs. 1*a–c*, *o*, pl. 41, figs. 3–5, pl. 42, figs. 2–7, pl. 43.

Material. About 70 compressed specimens, at least half of which are fragmentary. All are preserved as silvery or whitish films on black slate, and show various degrees of deformation (stretching).

Description. According to Jaeger (1966, p. 404), the rhabdosome of *M. thomasi* is 'medium-sized, straight, with stretched proximal portion and slightly reclined proximal extremity. Thecae of *uncinatus* type, with hoods decreasing in size from proximal to distal end; first few thecae with tendency towards isolation. Sicula with relatively long (0·3 mm.), strongly incurved dorsal tongue. Dimensions for flattened, but tectonically undeformed adult rhabdosomes: Length: 20–50 mm., commonly 20–30 mm. Width: 1 mm. at theca 1 across its hood, $\frac{1}{2}$ mm. just above the hood of theca 1; maximum width attained at theca 10 ± 2: 1·8–2·0 mm. (1·3–1·6 mm. without hoods); number of thecae in 1 cm.; 9–10, practically constant throughout the rhabdosome'.

Discussion. Although the Alaskan specimens have been tectonically deformed, they closely resemble the Australian species *M. thomasi*. Some of the less-deformed specimens (Pl. 100, figs. 2–4) exhibit the distinct stalk-like thinning in the proximal part of the rhabdosome (0·6–0·7 mm. wide at theca 1) which is a characteristic feature of the species. The initial thecae show the characteristic tendency towards isolation, most pronounced in theca 1.

The features which distinguish *M. thomasi* from species such as *M. praehercynicus* and *M. hercynicus* which it otherwise resembles are (1) the thin, stalk-like habit of the proximal portion of the rhabdosome, (2) the tendency towards isolation of the first 3–5 thecae, and especially the strong projection of theca 1, (3) the constant number of thecae in 1 cm. throughout the rhabdosome, and (4) the relatively long, ventrally bent dorsal

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EXPLANATION OF PLATE 100

Graptolites and closely associated corals, Noyes Island, south-eastern Alaska.

Figs. 1–3. *Thamnopora* sp., ×2. 1, Transverse view, loc. B; USNM 162070. 2, Longitudinal view, loc. B; USNM 162071. 3, Longitudinal and transverse views, loc. E; USNM 162072.

Fig. 4. *Pseudomicroplasma* sp., transverse and longitudinal views, ×2, loc. E; USNM 162073.

Fig. 5. *Disphyllum* sp., transverse view, ×2, loc. C_4; USNM 162074.

Fig. 6. *Tryplasma altaica* (Dybowski), transverse view, ×2, loc. E; USNM 162075.

Figs. 7–11. *Monograptus* aff. *M. thomasi* Jaeger; Noyes Island, south-eastern Alaska. 7, 8, and 11, Wide rhabdosomes with proximal stalk-like portion largely obliterated by tectonic compression along length of rhabdosome, loc. C_3; these deformed specimens cannot effectively be separated from *M. praehercynicus* Jaeger. 7 and 8, ×3; USNM 162382. 11, ×5; USNM 162386. 9, 10, Specimens that show stalk-like proximal part not appreciably tectonically modified, ×3; lineation formed by intersection of cleavage and bedding subparallel to length of rhabdosomes. 9, Loc. C_3; USNM 162387. 10, Loc. F; USNM 162380.

Fig. 12. Type specimen of *Monograptus thomasi* Jaeger from 19 Mile Quarry, Yarra track, Australia; ×3.

CHURKIN et al., Lower Devonian corals and graptolites tongue of the sicula (Jaeger 1966, p. 407). In the more deformed Alaskan specimens, where the lineation or direction of stretching is nearly at right angles to the length of the rhabdosome, i.e. Pl. 100, fig. 1, the thin stalk-like shape of the proximal part is deformed into a much broader form resembling *M. praehercynicus*. In these cases the thecal count/unit length also increases (14 thecae/cm. in USNM 162382) as in the Australian deformed specimens. Some of these specimens with wide proximal ends in Australia are considered by Jaeger (1967) as new subspecies of *M. thomasi* and are found in beds below typical *M. thomasi* (see also Addendum on p. 573).

DESCRIPTION OF THE PLANTS

Plant material is contained in small collections of black shale from fossil localities C_3, F, and G. Fragmentary axes are fairly abundant in these collections, but the collection from locality C_3 contains the richest concentration of plant material, as well as most of the larger specimens. The plants are preserved as thin, lustrous black films on the otherwise dull black matrix, so that angles of oblique lighting are critical in observation or photography. With one or two exceptions, the plant fragments show no relief whatsoever. No cuticular material or evidence of fructifications is preserved, and only one specimen (*Drepanophycus* sp.) shows evidence of emergences. Only one tiny fragment of a xylem strand showing tracheidal wall ornamentation was found (locality C_3), but this is sufficient to establish without doubt that the material represents an assemblage of vascular land plants.

With the exception of the single specimen of *Drepanophycus*, the plants are small, naked axial fragments ranging from less than 1·0 mm. to 7·0 mm. in width and up to 5 cm. in length. Morphologically, most of the specimens are small parallel-sided fragments. However, a few of the specimens show varying degrees of branching or other characters that permit provisional recognition of the following entities in the assemblage.

Genus DREPANOPHYCUS Goeppert 1852

Drepanophycus sp.

Plate 101, fig. 8

Material. One broken axial fragment forms the basis for the identification; both counterparts of the upper half of the specimen were found.

Description. The specimen is a stout, unbranched axial fragment, measuring 6·5 cm. in length and 1 cm. in width. A faint longitudinal ridge presents the suggestion of a compressed, median vascular system, best seen in the lower half of the specimen. Also present on the surface of the axis are four approximately circular, shallow depressions or punctations that suggest points of attachment of spinose emergences. The best defined of these is seen at about the middle of the upper half of the specimen as shown in Plate 101, fig. 8; it measures approximately 2·5 mm. in diameter.

The most definitive feature of this specimen lies in the presence of parts of several stout leaf-like emergences. The two best examples of these are shown in the upper half of Plate 101, fig. 8; the emergence on the right side of the specimen is about 8 mm. long and 5 mm. broad at its base; its decurrent attitude is clearly shown in the photograph. A somewhat smaller emergence is shown on the left side and somewhat lower on the specimen. No evidence of vascularization is observable in the emergences.

Discussion. Although nothing is known of the branching pattern or reproductive parts of the plant represented by this specimen, the very stout proportions of the lateral projections are distinctly more suggestive of the vascularized leaves of *Drepanophycus* than of the slender spines of *Psilophyton*. The few characteristics of the leaves or emergences that are preserved relate the specimen more closely to *D. spinaeformis* Goeppert than to *D. spinosus* (Kreji) Kräusel and Weyland, *D. gaspianus* (Dawson) Kräusel and Weyland, or *D. colophyllus* Grierson and Banks.

Genus HOSTIMELLA Barrande 1882

Discussion. The generic designation *Hostimella* is applied to naked, dichotomously divided, sterile, psilophyte-like plant axes, several excellent examples of which are present in the Noyes Island collections; they are represented from both locality C and locality F. Because of differences in degree of tapering in successive ramifications of the axes, it is possible that two distinct taxa may be present.

Hostimella sp. A

Plate 101, figs. 1, 2, 3, 7, 9, 10, 11

Description. This form of *Hostimella* is characterized by repeated, equal dichotomies of the slender axis, the successive divisions being not substantially more slender than their parent axial segments. Two excellent examples are illustrated in Plate 101, figs. 1 and 10.

The largest specimen (Pl. 101, fig. 10) is 6·5 cm. long and no more than 2·0 mm. wide. Two successive dichotomies are indicated, although the left terminal segment of the right initial segment apparently was broken away when the matrix was split, leaving only 3 terminal segments. The angles formed by the dichotomies are about 30° in both instances. Another similar, though less complete, specimen with one dichotomy is shown in Plate 101, fig. 9; a yet smaller, Y-shaped fragment with a somewhat broader angle of dichotomy is shown in fig. 3.

The most complete specimen on hand is shown in Plate 101, fig. 1. Parts of four successive dichotomies are shown, which, if complete, would have resulted in 16 terminal ramifications or branchlets. The dichotomies involve much broader angles than the specimens shown in figs. 9 and 10; here they reach angles of 90° or more and display an

EXPLANATION OF PLATE 101

Plants from graptolitic shale, Noyes Island, south-eastern Alaska.

Figs. 1–3, 7, 9–11. *Hostimella* sp. A. 1, Most complete specimen showing four successive dichotomous divisions, ×2, loc. F; USNM 43045. 2–3, Small fragments showing different angles of divergence of the dichotomies, ×2, loc. C_3; USNM 43046 and 43047. 7, Smallest branched specimen showing ultimate division of the branching system, ×2, loc. C_3; USNM 43048. 9–10, Long segments of once and twice dichotomously branched axes; fig. 10 illustrates the largest specimen of the species, ×2, loc. F; USNM 43049 and 43050. 11, Scalariform and helical tracheids preserved by pyrite in axis (comparable in diameter to the basal portion of axis in fig. 10), ×270, loc. C_3; USNM 43051.

Figs. 4–6, *Hostimella* sp. B; axes stout and ultimate divisions seemingly foreshortened as compared with *H.* sp. A (in figs. 1–2 especially), ×2, loc. C_3; USNM 43052, 43053, and 43054.

Fig. 8. *Drepanophycus* sp.; arrows in the illustration indicate base of emergence in face view and emergence in side view, ×2, loc. C_3; USNM 43044.

CHURKIN et al., Lower Devonian land plants essentially uniform, symmetrical pattern of division. Smaller specimens with similarly wide angles of dichotomy are shown in figs. 2 and 7. Fig. 7 represents the smallest branching specimen available; its base is only 1·0 mm. broad, and one of its ultimate divisions, seen at the upper left, is a small process only 1·5 mm. long.

It should be noted that regardless of the angles of dichotomy involved, in all the specimens included under this category of *Hostimella*, there is a generally slight, gradual diminution in the width of the axis above each point of dichotomy.

A few tracheids have been found preserved as pseudomorphs by iron pyrite in an unbranched fragment of an axis comparable in size to the basal portion of *H.* sp. A illustrated in Plate 101, fig. 10. The best-preserved tracheid is illustrated in fig. 11. It has simple scalariform secondary thickenings. In the lower left of fig. 11 is a partially preserved tracheid with helical secondary thickenings. No information could be gained with regard to the actual outline of the xylem strand nor of the sequence of its maturation or development.

Hostimella sp. B

Plate 101, figs. 4, 5, 6

Description. Three specimens of this form of *Hostimella* are present, all from locality C. These each represent one more or less complete set of branch tips involving the three ultimate orders of ramification, or the branchlets produced by the last two successive dichotomies. The best specimen (Pl. 101, fig. 5) is 13 mm. long and clearly shows two of the ultimate axial divisions at the left; these are each slightly less than 1·5 mm. long, while the penultimate division from which they were produced is about 3·5 mm. long. The outstanding morphological feature common to these three specimens, and by which they seem to be readily distinguishable from material of *H.* sp. A, is their stubby appearance. This is a function of a relatively abrupt decrease in width of axial divisions of successive orders, in contrast to a much more gradual size decrease in *H.* sp. A. As shown in Plate 101, figs. 4–6, the basal widths of the specimens of *H.* sp. B are 2·5 to 3·0 mm.; this is substantially more robust than corresponding parts of the specimens of *H.* sp. A. Furthermore, the penultimate divisions of *H.* sp. B are much more slender in proportion to their parent axial segments than in *H.* sp. A. These differences are well brought out by a comparison of fig. 6 (B) with fig. 7 (A); in fig. 6 the penultimate division is not more than one quarter the width of the parent division, whereas in fig. 7, this proportion is more of the order of 1:2. In *H.* sp. B the penultimate divisions are also relatively much shorter than in *H.* sp. A. As the aggregate effect of these seemingly disproportionate dimensions of successive parts, the over-all appearance of *Hostimella* sp. B is considerably more robust than that of *H.* sp. A.

SIGNIFICANCE OF THE ALASKAN PLANTS IN THE EVOLUTION OF LAND PLANTS

It is recognized that the phenotypic differences between the two species of *Hostimella* described in the foregoing paragraphs may eventually prove not to be of sufficient magnitude to segregate the two on even a tentative taxonomic basis. It may, however, be of more than coincidental significance that *Hostimella* sp. B is restricted to locality C, while *H.* sp. A appears at both localities C and F. Although the localities are less than a mile apart geographically, it is possible that two slightly different plant communities are represented at the two localities and there may be some genetic basis for the morphological differences described here. These same differences are observed in plants being studied from the Emsian of Gaspé Bay, Canada, and results so far show that truly different plants are represented by such morphological characteristics.

A comparison of these few plants with those from other Lower Devonian floras could have merit only in pointing up the broad morphological simplicity of earliest Devonian land parts. The Alaskan plants are definitely the earliest record of land plants for the Western Hemisphere, and yet we probably are not in possession of the earliest land plants as such. The Devonian Period saw the rapid diversification of plants that had become adapted to the rigours of growth on land, although those adaptations probably occurred during Silurian time.

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Typescript received 1 November 1968

ADDENDUM

Further study of these and other monograptids from Alaska has shown that the Noyes Island graptolites, although very similar to *M. thomasi*, are a distinct new species (H. Jaeger 1969, pers. commun.).