DEVELOPMENT OF *GLYPTOGRAPTUS HUDSONI* SP. NOV. FROM SOUTHAMPTON ISLAND, NORTH-WEST TERRITORIES, CANADA

by D. E. JACKSON

ABSTRACT. The development of *Glyptograptus hudsoni* sp. nov. is described based upon specimens isolated from an argillaceous limestone of Late Ordovician age on Southampton Island.

THE material described was obtained from a slab of limestone collected by Dr. S. J. Nelson on Southampton Island in 1966. The horizon was referred to by Nelson (*in* Nelson and Johnson 1966) as the 'Oil Shale Horizon' which he considered to be of latest Ordovician age. Associated with the described material was *Amplexograptus* sp. indet. as well as several pygidia of ?*Pseudogygites*.

The graptoloids were freed from the argillaceous calcilutite using dilute (5%) hydrochloric acid and those specimens which carried clay particles benefited by treatment with hydrofluoric acid. Early growth stages were found to be naturally translucent and were mounted directly in 'Plastimount' on concave glass slides whereas the more advanced growth stages required clearing in Schulze's Solution prior to being studied. All specimens described (UA907–924) are in the possession of the Department of Geology, University of Alberta, Edmonton.

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SYSTEMATIC PALAEONTOLOGY

Order GRAPTOLOIDEA Lapworth 1875
Family DIPLOGRAPTIDAE Lapworth 1873
Genus GLYPTOGRAPTUS Lapworth 1873

Glyptograptus hudsoni sp. nov.

Plate 90, figs. 1–6; text-figs. 1–3

Diagnosis. Rhabdosome small, aseptate, 1·1–1·2 mm wide across th 1^1–th 1^2 and 2·0 mm across th 6^1–th 6^2. Sicula 1·3 mm long, furnished with conspicuous virgella and a pair of apertural spines. Thecae have pronounced glyptograptid profile; th 1^1 carries subapertural spine; apertural margins, with lappets except on th 1^1; there are 7 thecae in 5 mm. Development prosoblastic with th 1^2 rather straight and reclined.

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Holotype. UA 924, text-fig. 1A.

Paratypes. UA 907–923.

Material. More than 200 isolated growth stages and fragmented rhabdosomes are available.

Type locality and horizon. Slab of limestone probably from base of Oil Shale interval of Nelson (in Nelson and Johnson 1966, p. 567); field designation N 64–8A; near East Bay, Southampton Island; collected by Dr. S. J. Nelson in 1966. Uppermost 50 ft of Ordovician at this locality consists of interbedded 'oil shale and limestone' and is considered to be Richmond in age.

Derivation of name. The species is named for the navigator Henry Hudson who entered Hudson Bay in 1610.

Description. Rhabdosome small, not exceeding 5·5 mm in length, widening from 1·1 to 1·2 mm across first pair of thecae to 1·4 to 1·5 mm across fourth pair to 2·0 mm distally. Rhabdosome aseptate, rectangular in cross-section, and slightly depressed axially, usually exhibits prominent virgula. Sicula of diplograptid type, straight, 1·30 mm long and 0·40 mm in diameter across aperture, furnished with a conspicuous virgella 0·35 mm long, and a pair of apertural spines 0·20–0·30 mm long directed obliquely downward and outward. Apex of sicula extends to between 3rd and 4th pairs of thecae (see text-fig. 2C). The free ventral wall of th 1^1 carries a spine about 0·20 mm below aperture. No spines exist on subsequent thecae.

Free ventral walls of proximal thecae have pronounced glyptograptid curvature becoming less marked distally; thecae overlap one-third to one-half. Apertural margins of th 1^1 and th 1^2 straight, whereas subsequent thecae have margins slightly excavated at dorsal edge; margins distinctly lip-like in mature thecae. There are 7 thecae in 5 mm.

Blister-like abnormalities of the cortical tissue are not uncommon among the larger specimens and tend to be localized on the obverse and reverse sides of the proximal end of the rhabdosome (text-fig. 1A). They may have a parasitic origin, on the other hand Urbanek (1958, p. 36) considered similar abnormalities in *Monograptus haupti* Kühne to be a feature of old age.

Development of rhabdosome

Prosicula. The prosicula is a flask-shaped body comprising the nema, the narrow hollow neck (nema prosicula) and the parallel-sided distal part (Pl. 90, figs. 1–6). The prosicula is 450–570 μm long exclusive of nema and has a maximum diameter of 170–220 μm in mid-length. Prior to budding of the first theca, the nema is merely 100 μm long and is probably a hollow structure. It is not uncommon to find the prosicula lacking a nema which usually breaks off immediately above the ends of the longitudinal fibres. In no instance could the author observe the longitudinal fibres extending proximally to form or to reinforce the nema. Instead, these fibres appear to terminate in the neck as shown in text-fig. 1G (cf. Barrass 1954, fig. 12).

The prosicula is constructed of a brown transparent sheath of structureless periderm which is thinnest just below the neck and thickest at the distal extremity. In about one-fifth of the specimens this sheath contains the spiral line or schraubenlinie (see Pl. 90, fig. 1) having approximately twelve rotations in either a right-handed or left-handed sense and individual spirals more widely spaced just below the neck.

Longitudinal fibres are always visible in early growth stages and consist of four or five long primary fibres which are formed contemporaneously with the secretion of the sheath, and several shorter secondary fibres which are deposited between the primaries somewhat later. Prosiculae are seen with as few as four and as many as thirteen fibres. Those prosiculae with only four to eight fibres show no metasicular growth and are immature with respect to development of these strengthening fibres since measurements suggest that each sicula had the full complement of fibres present by the time metasicular growth began. The longitudinal fibres all terminate just a little above the aperture of the prosicula but, whereas the primary fibres extend proximally almost to the top of the nema prosiculae (text-fig. 1G), secondary fibres fade out at various levels prior to reaching the neck (cf. Cox 1933, figs. 1–5; Barrass 1954, fig. 12).

A dark brown line at the base of the neck (see Pl. 90, fig. 2) is seen in several early growth stages and may constitute an apical diaphragm (= membrane of Kraft 1926). No further light can be shed on whether or not this feature is a transverse partition.

Length and width measurements of 49 prosiculae indicate that the prosicular sheath has no growth stages thus supporting the idea that it was secreted fully grown as suggested by Kozłowski (1966).

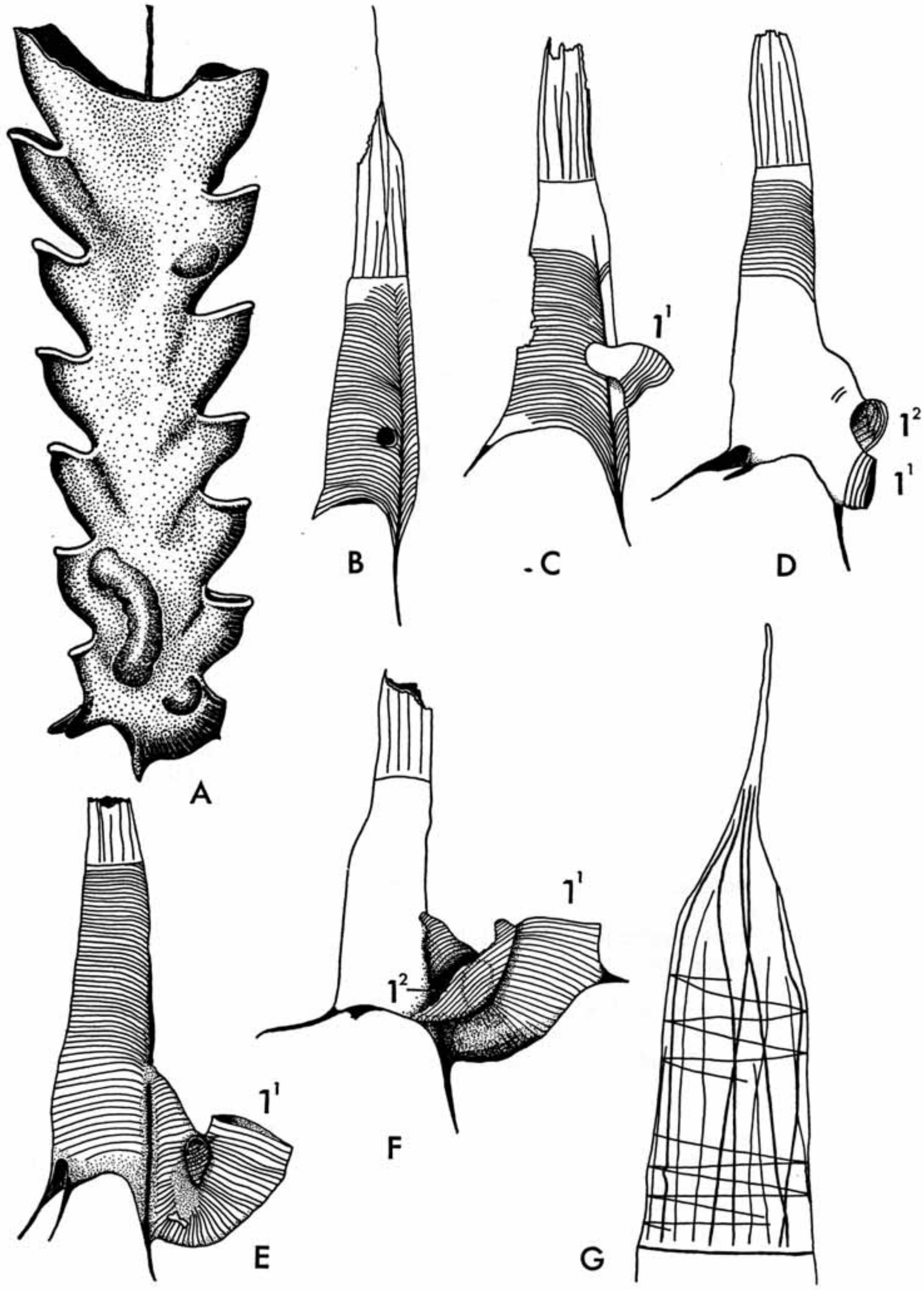
Metasicula. The metasicula is subcylindrical about 0·80 mm long, widening from 0·20 mm diameter proximally to 0·40 mm distally. There are 60–70 fuselli in the mature metasicula and these bands are about 0·01 mm wide at the distal end. The metasicular aperture is adorned by a stiff virgellar spine 0·40–0·45 mm long and a pair of apertural spines 0·25–0·30 mm long which are directed downward and outward.

The development of the metasicula begins with the accretion of several superposed partial fuselli which form the virgella (see Pl. 90, figs. 2, 3, 4). These partial fuselli are joined along a zigzag line and laterally overstep foregoing fuselli to pinch out on the rim of the aperture of the prosicula. After several such fuselli have been formed on either side of the zigzag line subsequent fuselli encircle the rim of the prosicula and meet in a zigzag line on the dorsal side. The virgella continues to elongate and is transformed into a spine after fifteen to twenty complete fuselli have been deposited (see Pl. 90, fig. 6). At a distance of approximately ten fuselli above the metasicular aperture, growth is retarded on the dorsal side of the sicula and a notch forms between a pair of denticles that later develop into the apertural spines (see text-figs. 1D, E).

Theca 1^1. Growth of the metasicula ceases with the appearance of paired apertural spines opposite the virgella and the next important development is the formation of the foramen of the initial bud. The resorption foramen is circular or oval, and about 80 μm in diameter; it is positioned on the reverse side of the virgella two-thirds of the way down the metasicula (see text-fig. 1B).

Initially the bud takes the form of a split tube ankylosed to the sicula growing downward along the virgella (see text-fig. 1C) becoming tube-like as it turns out from the sicular aperture (text-fig. 1D). A little below the sicular aperture, direction of growth of

TEXT-FIG. 1A–G. *Glyptograptus hudsoni* sp. nov. A, reverse view of holotype UA 924, with epicortical blister-like abnormalities, magnification ×22. B–F, reverse views of early growth stages; B, sicula with foramen in metasicula UA 909, ×47; C, sicula with initial bud of th 1^1, UA 910, ×47; D, development of th 1^2 low down on th 1^1, UA 911, ×47; E, further growth of th 1^1, UA 912, ×47; F, early development of th 1^2 and th 2^1 by diagonal build up of fuselli at base of U-shaped bend in th 1^1, UA 913, ×45; G, prosicula of UA 908 with primary fibres terminating in nema prosicula, ×137.


1¹
1²
1¹
A
B
C
D
1¹
1²
1¹
E
F
G

th 1^1 is outward then upward to form a U-shaped bend (text-fig. 1E); when mature, the aperture of th 1^1 is about level with the initial bud. Approximately 0·20 mm below the aperture, the free ventral wall carries a spine 0·20–0·30 mm long. This spine has a hollow base and is full grown upon completion of growth of th 1^1.

Theca 1^2. This theca develops from the obverse side of th 1^1 (text-fig. 3 section 18), grows horizontally toward the reverse side through the U-shaped bend of th 1^1 and in so doing bridges the outer side of the initial bud and the inner side of the distal portion of first theca, thus forming a conspicuous fenestrule (text-fig. 1E). Further growth is achieved by deposition of bands along the inner edge of th 1^1 commencing in the U-bend (see text-fig. 1F) and building diagonally upwards to become ankylosed with the wall of the metasicula. Th 1^2 crosses the reverse side of the sicula just above the aperture and becomes tube-like just before it turns upwards at 45° to project slightly beyond the sicula. The apertural margin is slightly thickened and inclined obliquely outward.

Theca 2^1. Theca 2^1 is an outgrowth of the proximal part of th 1^2 (see text-fig. 2C), and is rather erect and straight, the free wall exhibits glyptograptid curvature and the apertural margin has a slight excavation dorsally. Growth of this theca is entirely on the virgellar side of the sicula but in UA 914 can be seen to onlap on to the metasicular wall (see text-fig. 2A).

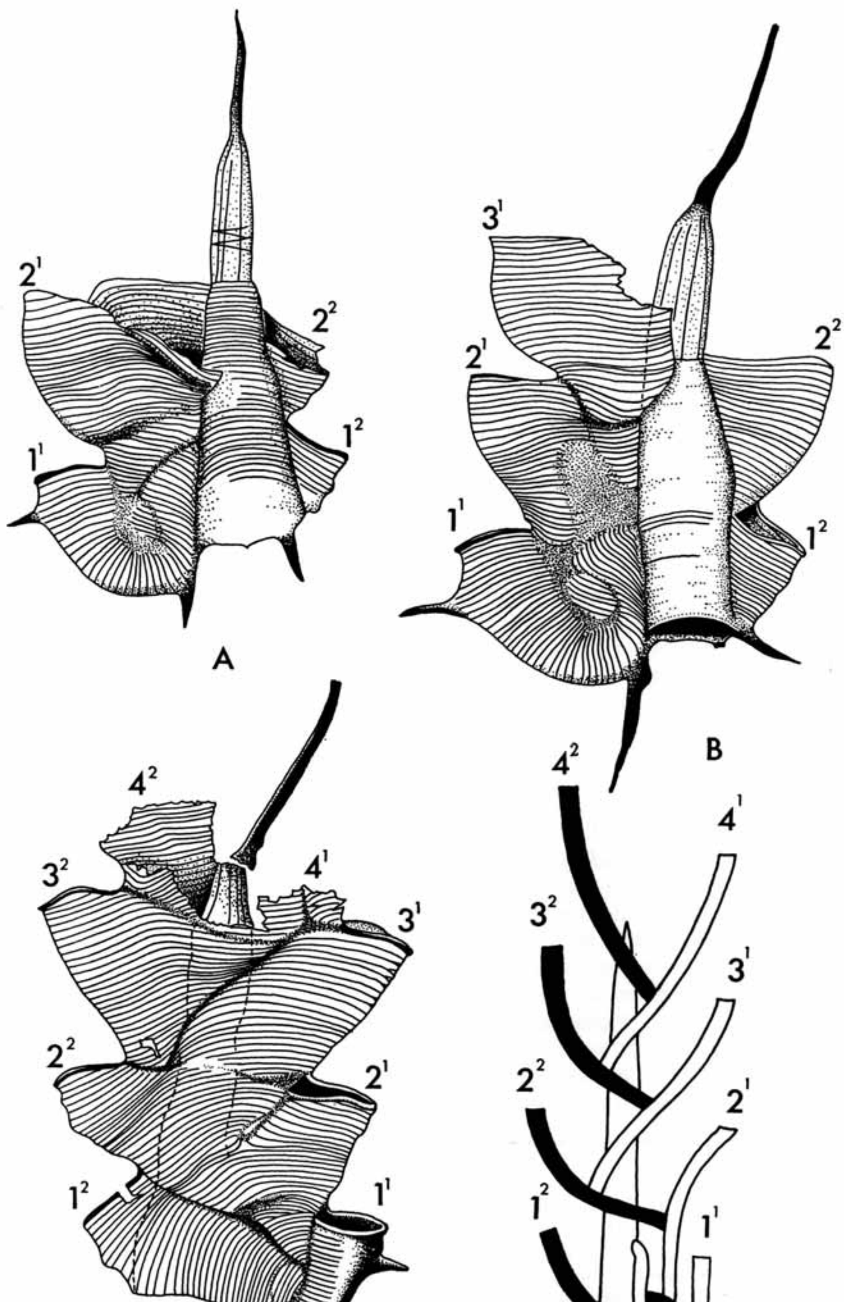
Theca 2^2. After the deposition of a dozen or so fuselli of th 2^1 the bands separate to form two discrete thecal tubes; th 2^2 proceeds to grow diagonally upwards across the reverse side of the sicula (text-fig. 2C) and is approximately half grown when growth of th 2^1 is complete. The free ventral wall exhibits glyptograptid curvature, overlap by th 3^2 is about one-quarter, and the apertural margin is undulatory with a thickened rim and a slight excavation at the dorsal edge.

Theca 3^1 and later thecae. The initial development of th 3^1 is entirely on the reverse side of the sicula, as it is for all earlier thecae, and arises through the budding of th 2^2 to form a crossing canal. As the theca elongates the obverse wall progressively onlaps the sicula (see text-fig. 2B) and this finally results in the apex of the sicula being completely enveloped by th 3^2 and 4^1. The free ventral walls of th 3^1 and subsequent thecae have a glyptograptid profile and the apertural margins are concave to slightly undulating, with thickened rims.

The development of subsequent thecae is by alternate budding as in all aseptate diplograptids (see text-fig. 2D).

Virgula. The virgula is a hollow rod of 30 μm diameter which extends from the apex of the sicula to beyond the distal extremity of the rhabdosome. Beyond th 3^2 it lies in the common canal and is without supporting structures.

TEXT-FIG. 2A–D, early growth stages of *Glyptograptus hudsoni* sp. nov. A, B. Obverse views of UA 914 and UA 915, magnifications ×47 and ×44 respectively. C. Reverse view of UA 916, magnification ×42. All three specimens have been rendered transparent by chemical treatment. D. Schematized illustration of development of two thecal series in *Glyptograptus hudsoni* sp. nov. as deduced from UA 916.


2^1
2^2
1^1
1^2
A
3^1
2^1
2^2
1^1
1^2
B
4^2
3^2
4^1
3^1
2^2
2^1
1^2
1^1
C
4^2
4^1
3^2
3^1
2^2
2^1
1^2
1^1
D

C 8216 K k

Discussion. Bulman (1963) has indicated that early Ordovician diplograpti of the *Glyptograptus austrodentatus* group have a proximal-end development which exhibit atavistic characteristics, namely, a strong downward component of th 1^2, th 2^2 and occasionally th 2^1. For this type of development Bulman (1963, p. 671) proposed the term streptoblastic. From it is derived the prosoblastic type characterized by the tendency to straighten out th 1^2 as exemplified by the *G. dentatus* group which appears to be ancestral to most of the later Ordovician glyptograptids, orthograptids, and climacograptids. This trend in proximal-end development has a tendency to be accompanied by a deferment in the development of the dicalycal theca resulting ultimately in an aseptate rhabdosome. The late Ordovician diplograptids *Amplexograptus inuiti* (Cox) and *G. hudsoni* n. sp. represent end members of these two separately operating trends.

By comparison with the development details that have been worked out for other diplograptids some specific differences and similarities are noted. The appearance of the virgella during the earliest developmental stages of the metasicula of *Glyptograptus hudsoni* n. sp. finds a parallel in *Amplexograptus inuiti* (Cox 1933), *A. elongatus* and *A. prominens* Barrass 1954. In contrast to this is the delayed formation of the virgella in *A.* cf. *maxwelli* Decker (*in* Walker 1953) and *Climacograptus* aff. *scalaris* (Hisinger) in Barrass 1954.

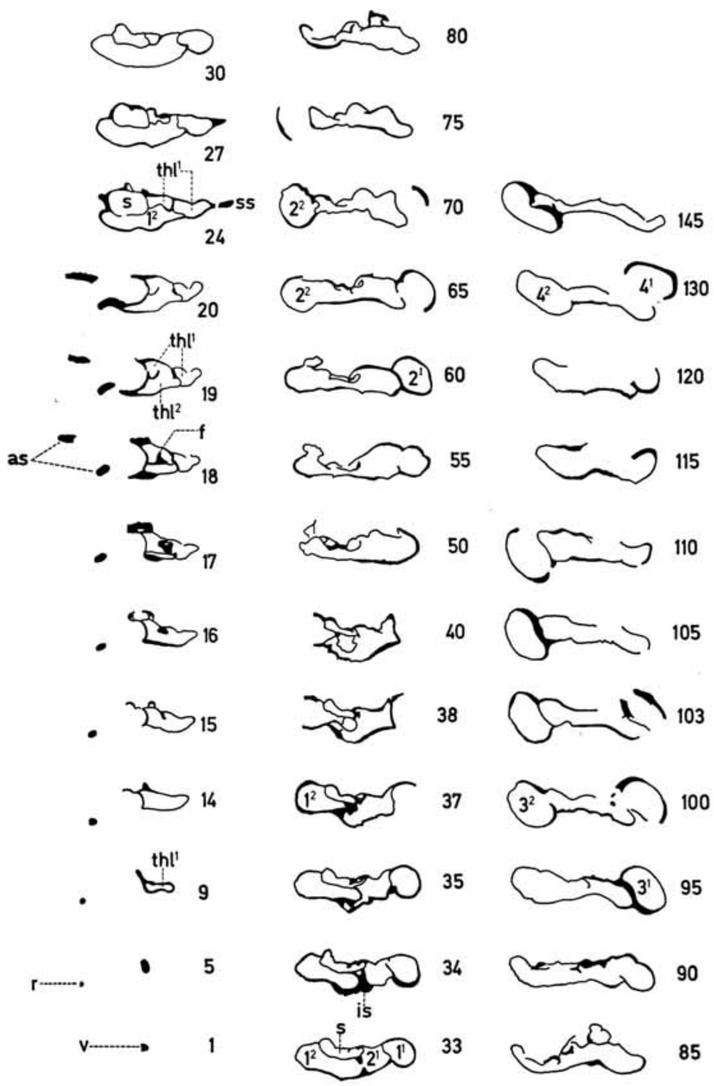
The manner in which th 1^2 grows horizontally through the crook in the U-shaped bend of th 1^1 and the erect nature of th 2^1 (see text-fig. 2D) can be likened to the development of *Amplexograptus inuiti* and is quite different from that of *Orthograptus gracilis* (Roemer) in Kraft (1926) where the initial growth of th 1^2 has a downward component thus producing an X-shaped arrangement of fuselli.

Comparison. The presence of four proximal sicular and thecal spines together with the lack of a median septum renders *Glyptograptus hudsoni* sp. nov. distinct from other European glyptograptids. A closely allied species probably exists in *G. lorrainensis* (Ruedemann) from late Middle to early Upper Ordovician of eastern North America. Using Riva's (1969, fig. 6*d–f*) concept of the species as a basis for comparison in preference to Ruedemann's (1947) inadequate illustrations, we see that *G. lorrainensis* is slightly narrower and the thecal apertures are horizontal whereas they are slightly introverted in *G. hudsoni* n. sp.

Perhaps even more closely allied to, if not conspecific with, *G. hudsoni* is a new species of *Glyptograptus* figured by Riva (1969, fig. 6*l*) from the English Head Formation, Anticosti Island. This glyptograptid has the same width, thecal spacing, and the slightly introverted thecal apertures seen in *G. hudsoni* sp. nov. Only the lack of a subapertural spine on th 1^1 makes the comparison *a priori* less than perfect. This comparison appears especially satisfactory from a stratigraphical viewpoint because Riva (1969, table 1)

EXPLANATION OF PLATE 90

Figs. 1–6. Siculae of *Glyptograptus hudsoni* sp. nov. 1, prosicula with longitudinal fibres and spiral line, no metasicular growth, UA 917, magnification ×133. 2, dark line in neck of prosicula may be apical diaphragm, metasicula damaged, UA 918, magnification ×141. 3, metasicular growth commences with local build-up of partial fusellar bands to form virgella, UA 919, magnification ×143. 4, 5, 6, further growth stages of metasiculae, respectively UA 920, magnification ×141; UA 921, magnification ×143; UA 922, magnification ×146.



TEXT-FIG. 3. Selected microtome thin sections of *Glyptograptus hudsoni* sp. nov., UA 923, magnification $\times 18\frac{1}{3}$, 1 unit = 20 μm. Sections oriented with obverse side of rhabdosome facing upward. as = apertural spines, is = interthecal septum, f = foramen at origin of th 1^2, r = reverse apertural spine, s = sicula, ss = sub-apertural spine, v = virgella.

records his glyptograptid as ranging through the Upper Ordovician zones of *Climacograptus manitoulinensis* and *Dicellograptus complanatus* into his 'zone of *Climacograptus prominens-elongatus*' which he (1969, p. 551) considers to be post-Ashgillian but pre-Llandoverian.

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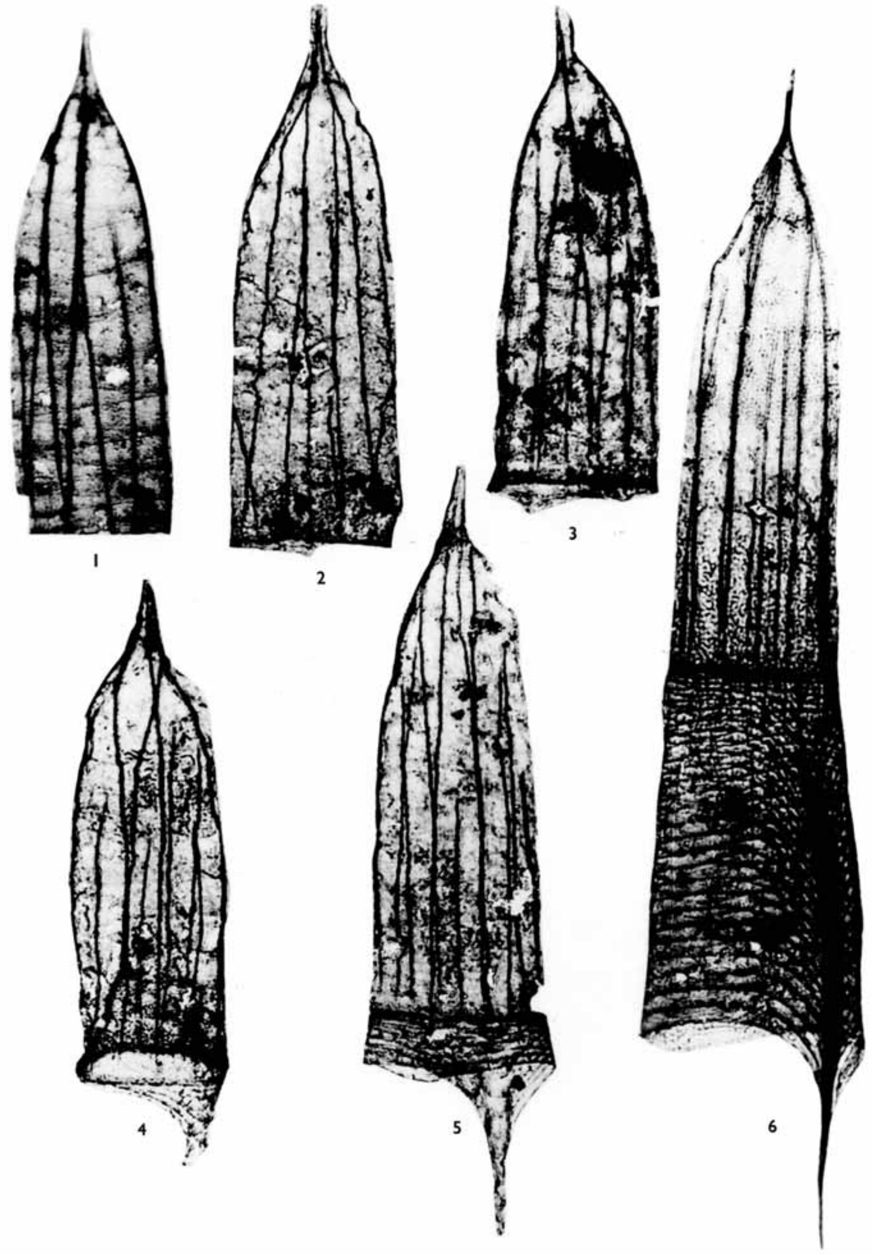

JACKSON, *Glyptograptus*