PUBLICACIONES

del

MUSEO DE HISTORIA NATURAL "JAVIER PRADO"

UNIVERSIDAD NACIONAL MAYOR DE SAN MARCOS

Serie C. Geología | Lima, Noviembre 1956 | Nº 5

GRAPTOLITES FROM HUACAR, PERU

by

R. R. H. LEMON and J. S. CRANSWICK

Introduction

The fauna to be described here was collected by Sr. Bernardo Boit of the Museo de Historia Natural "Javier Prado", Lima, Peru, from a locality close to the village of Huacar, five km. south-west of Ambo, Province of Ambo, Department of Huanuco (lat. 10° 7' S. and long. 76° 10' W.).

In 1952 the collection was presented to the Sedgwick Museum, Cambridge, where, in October of the following year, J. S. Cranswick began work on it under the supervision of Professor O. M. B. Bulman. After the death of Mr. Cranswick in 1954 the work was completed by the present writer during the winter of 1955/56. The writer wishes to convey his sincere thanks to Professor Bulman for the opportunity of working on the material and for his supervision and generous help throughout the work. The co-operation and generosity of Sr. Boit is also gratefully acknowledged. (R.R.H.L.).

With the exception of a few very poorly preserved fragments of small, ribbed brachiopods, the fauna is made up exclusively of graptolites. The following is a list of the forms described :

Dictyonema spp.
? *Ptilograptus* sp.
Phyllograptus angustifolius Hall
..... aff. *anna* Hall
Didymograptus stabilis Elles and Wood
..... *pandus* Bulman
..... *protobifidus* Elles
..... *bifidus* (J. Hall)
..... *amboensis* sp. nov.
..... *artus* Elles and Wood
..... *miserabilis* Bulman
..... aff. *cognatus* Harris and Thomas
..... *nitidus* (Hall)
Isograptus caduceus? armatus Ruedemann
Janograptus peruviensis sp. nov.
.... *attenuatus* var. nov.
Dichograptid stipes indet.
Azygograptus fasciculatus (Nicholson)
Cryptograptus tricornis schäferi Lapworth
Glossograptus hincksii (Hopkinson)
Amplexograptus confertus Lapworth
Glyptograptus dentatus (Brongniart)
..... *euglyphus pygmaeus* Ruedemann.

The material was collected from the rubble carried down a small ravine by a temporary torrent, and more than one horizon may be represented. Little can be learned from the lithology, and since every one of the species identified is found, either directly or indirectly, to be associated with every other, the whole assemblage can only be treated as a single faunal unit.

The fossils are preserved as flattened carbonised impressions. Although the preservation is not good the use of wetting agents such as 70% alcohol enables a considerable amount of structural detail to be observed.

The majority of the graptolites occur in a pale grey-weathering, medium-grained rock which, in hand specimen, appears to be an ashy mudstone with rather poorly developed bedding and irregular, brittle fracture. In thin section it is seen to be made up dominantly of sericite, with a pronounced orientation approximately parallel to the bedding, and a second, minor orientation, shown by the smallest flakes, at about 80 degrees to the bedding. Scattered throughout the rock are subangular to subrounded quartz grains of silt grade (typically about 50 to 60 microns in diameter) and small irregular aggregates of hematite; rare, subrounded grains of plagioclase feldspar have also been noted.

Also in the collection are numerous samples of a darker rock, often almost black in colour. Graptolites present in this material are very poorly preserved and, in general, only the gross morphology can be seen. In thin section the general features are seen to be similar to those described above. The sericite flakes tend to be larger and more irregular but the primary and secondary orientation are again present. Scattered quartz grains also occur; pyrite is present in abundance as tiny irregular grains and aggregates, and probably also occurs in a finely divided state in the dark matrix accounting in large part for the dark colour of the rock.

Systematic Descriptions

(Where a species is described by Ruedemann (1947) the references cited by that author are not included in the synonymy here.).

A. DENDROIDEA

The present fauna contains only one fragmentary and poorly preserved specimen of each of the forms described below and it is not possible to attempt specific identifications.

Genus **Dictyonema** Hall

Dictyonema sp.

Fragment of a conical rhabdosome, overall axial length 1.4 cm., maximum width 1.0 cm. Stipes moderately sinuous 0.15 to 0.25 mm. broad, spaced at 18 to 20 in 10 mm. bifurcating at intervals and arranged in a parallel to semi-radiating manner. The dissepiments are extremely delicate, straight, generally normal to the stipes, and are spaced at intervals of 1.5 to 2.0 mm. No details of the thecae are discernible.

Dictyonema sp.

Portion of radial or conical rhabdosome, overall length 1.0 cm., maximum width 1.0 cm. Stipes arranged in sub-parallel to radiating manner, irregularly sinuous, 0.2 to 0.4 mm. thick, 14 to 16 in 10 mm. irregularly bifurcating. Dissepiments thin, few and irregularly scattered (or not preserved). No thecae discernible.

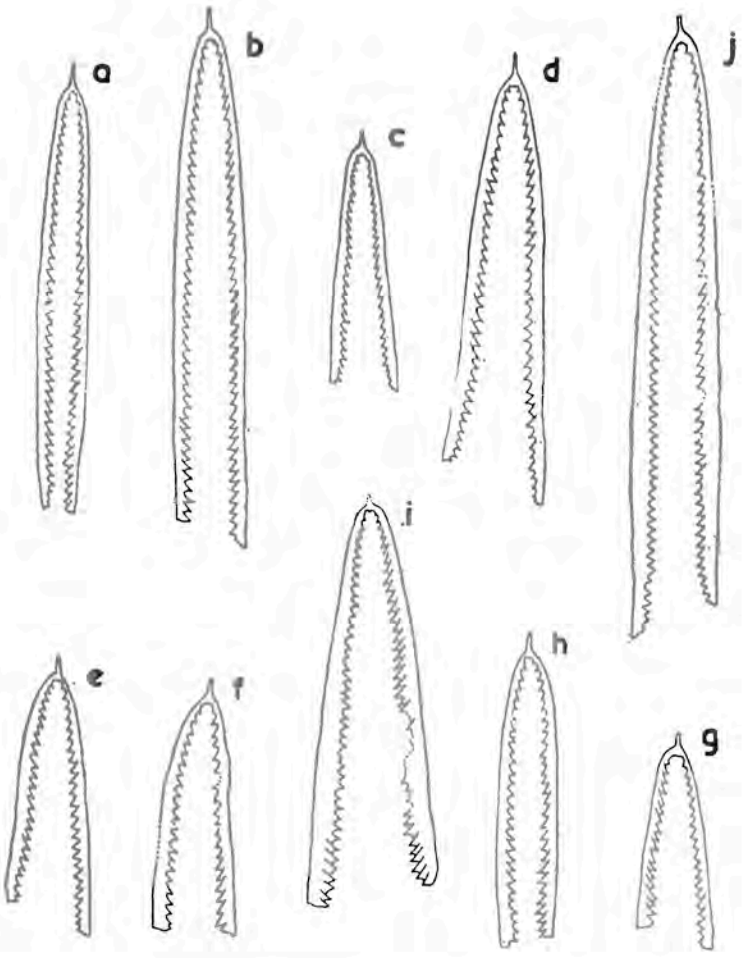
Dictyonema sp.

Small fragments of a radial rhabdosome, overall length 0.7 cm., maximum width 0.8 cm. Stipes irregularly sinuous, radiating to sub-parallel, 0.3 to 0.4 mm. thick, 16 to 18 in 10 mm. Dissepiments very thin and delicate, spaced at intervals of 1.5 to 2.0 mm, normal to the stipe. No details of thecae discernible.

Genus **?Ptilograptus** Hall

?Ptilograptus sp.

Fragment of main stipe 1.4 cm. long and 0.2 to 0.3 mm. wide from which imperfectly preserved lateral branches appear to originate alternately on opposite sides, to the number of 5 in 7 mm. on either side.



Text-fig. 1. a, b, *Didymograptus stabilis* Elles and Wood; c, d, *D. pandus* Bulman; e, f, g, h, *D. protobifidus* Elles; j, *D. protobifidus - bifidus* transient; i, *D. bifidus* (Hall) early mutation. All figures × 2.

B. GRAPTOLOIDEA

Family DICHOGRAPTIDAE Lapworth

(Section TETRAGRAPTI)

Genus **Phyllograptus** Hall

Phyllograptus angustifolius Hall

Plate I, fig. 12, Text-fig. 3f.

Phyllograptus	*angustifolius*	Holm 1895, p. 488, pl. XIV, figs. 1-12.
"	"	Törnquist 1904, p. 12.
"	"	Lapworth 1906, p. 13, fig. 10.
"	"	Hsü 1934, p. 44, pl. III, figs. 5a-c.
"	"	Benson & Keble 1935, p. 288, pl. 33, figs. 16, 19, 20.
"	"	Bulman 1936, p. 39, pl. I, fig. 26, pl. IV, figs. 7-10, text-figs. 13-15.
"	"	Ekström 1937, p. 34, pl. VI, fig. 21, text-fig. 7.
"	"	Goldring 1943, p. 92, fig. 20. 1.
"	"	Ruedemann 1947, p. 315, pl. 53, figs. 2-6.
"	"	Harris and Thomas 1938, p. 72, pl. II, fig. 36.
"	"	Skjeseth 1952, p. 144.
"	"	Hede 1952, p. 39, 72, pl. I, fig. 4.

Several moderately well preserved specimens, typical in size and form of the species, were noted. Immature individuals of small size and more squat shape are abundantly represented and are closely similar to specimes of *P. anna*.

Phyllograptus aff. *anna* Hall

Plate I. fig. 8, Text-fig. 3g.

Phyllograptus	*anna*	Benson and Keble 1935, p. 289.
"	"	Ruedemann 1947, p. 316, pl. 53, figs. 27-32.
"	"	Hede 1952, pp. 39 and 72.

The dimensions of the present specimens are somewhat greater than the limits given by Ruedemann, while the number of thecae in 10 mm. embraces the values given by both that author (16-20) and by Elles and Wood (14-16).

(Section DIDYMOGRAPTI)

Genus **Didymograptus** McCoy

(a) *Dependent forms.*

Dependent didymagraptids form the most important and characteristic element in the present fauna. Examination of nearly 100 specimens has shown seven species to be represented which, for the purposes of preliminary discussion, may be grouped under four headings :

1. Includes a few specimens with characteristically slender stipes assigned to *Didymograptus stabilis* Elles and Wood and *Didymograptus pandus* Bulman.

2. Includes forms in which the thecal spacing is fairly constant at 12 to 15 in 10 mm, but in which there is considerable variation in the width of the stipes and thecal overlap. This assemblage constitutes a fairly closely linked morphological series in which *Didymograptus protobifidus* Elles and *D. bifidus* (Hall) may be considered as the end members; forms with rather slender stipes of nearly constant width being assigned to the former species, while with increasing width of stipe and thecal overlap, and also increase in the rate of widening of the stipe distally, there is an approach to *D. bifidus*. The numerous transient forms are seen to compare closely with those figured by Elles (1933) and Ripper (1937).

3. This group contains those forms included in *Didymograptus amboensis* sp. nov. The species is characterised by closely spaced thecae (18 to 20 in 10 mm.) overlapping from 2/3 to 4/5 their length, rather robust stipes, and a large primary angle of divergence (typically 100° or more). The attitude of the stipes shows some variation, particularly in the distal region, and may be divergent, parallel, or, more rarely, slightly convergent.

4. A group including small forms, rather few in number, assigned to the species *Didymograpttus artus* Elles and Wood and *D. miserabilis* Bulman.

Didymograptus stabilis Elles and Wood

Text-fig. 1a, b.

Didymograptus stabilis	Elles and Wood 1901, p. 49, pl. IV, fig. 2, text-fig. 31 a, b.
" "	Bulman 1931, p. 39.
" "	Ekström 1937, p. 29, pl. V, fig. 6.
" "	Maillieux 1939, p. 11, pl. I, fig. 8.
" "	Hede 1952, p. 73, opp. p. 48.

Three examples of the species have been noted in the present fauna. They agree closely with the specimens described by Elles and Wood,although the angle of inclination of the thecae is somewhat less than in the British form.

Didymograptus pandus Bulman

Plate I, figs. 9 and 10, Text-figs. 1c, d.

Didymograptus pandus	Bulman 1931, p. 39, text-fig. 15 pl. II, figs. 7-9.
" "	Ekström 1937, p. 29, pl. V, figs. 7-8.
Didymograptus cf. pandus	Hede 1952, p. 73, opp. p. 48.

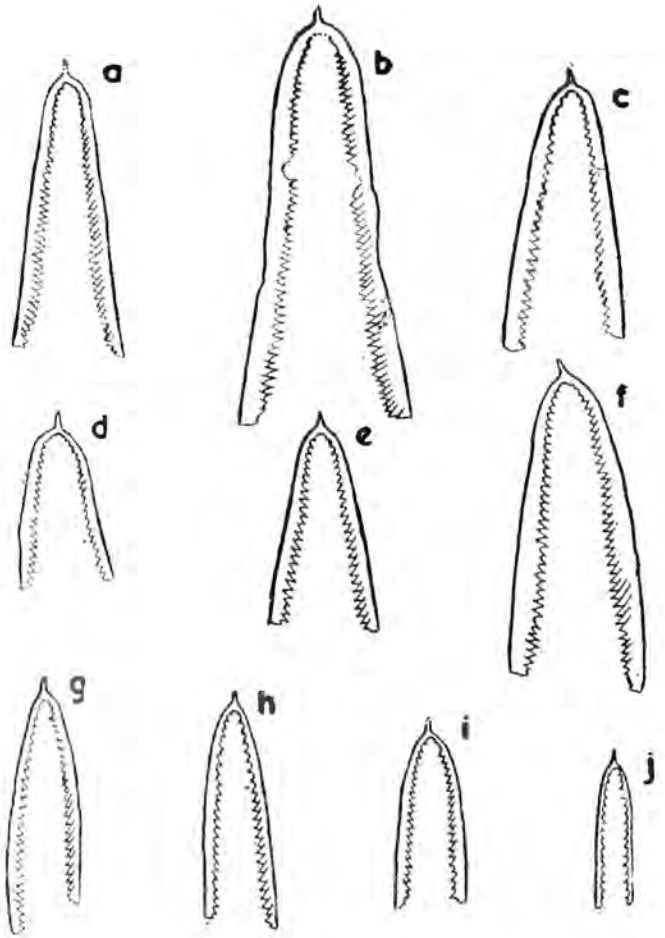
Associated with *D. stabilis* are several specimens closely comparable in form but in which the stipes are slightly diverging. They are thus very similar to *D. pandus* Bulman, described from Bolivia, with which form they are here identified.

Didymograptus protobifidus Elles

Plate I, fig. 7, Text-figs. 1,e,f,g,h,j.

Didymograptus protobifidus	Benson and Keble 1935, p. 285, text-fig. 3.
" "	Ripper 1937, p. 153, figs. 1, 2, 3, and 8. (*protobifidus - bifidus* transients figs. 4, 6, and 7.).
" "	Harris and Thomas 1938, p. 72, pl, 2, fig. 33.
" "	Decker 1941, p. 362, pl. 52, figs. 1-9, pl. 53, figs. 1-15.
" "	Decker 1944, p. 382, figs. 6, 8, 14, 19-22, 24, 25.
" "	Ruedemann 1947, p. 343, pl. 54, fig. 18.

The species is represented by a small assemblage showing some variation in the width of the stipes and probably forming



Text-fig. 2, a - f, *Didymograptus amhoensis* sp. nov.; g - i, *D. artus* Elles and Wood; j, *D. miserabilis* Bulman. All figures × 2.

part of a transient series to *D. bifidus*. Most of the forms are closely comparable with members of similar series described and figured by Elles (1933) and Ripper (1937).

Didymograptus bifidus (J. Hall)

Plate I, fig. 3, Text-fig. 1i.

Didymograptus bifidus		Törnquist 1911, p. 427.
"	"	Hsü 1934, p. 39, pl. II, figs. 10 a-e.
"	"	Ekström 1937, p. 26, pl. II, figs. 9-15.
"	"	Ripper 1937, p. 156, figs. 9 a, b.
"	"	Maillieux 1939, p. 10, pl. I, figs. 5, 6.
"	"	Keble and Benson 1939, p. 79 (for complete Australian bibliography to 1939).
"	"	Decker 1941, p. 158.
"	"	Goldring 1943, p. 92, fig. 20h.
"	"	Decker 1944, p. 382, figs. 29-32.
"	"	Ruedemann 1947, p. 327, pl. 54, fig. 11-16.
"	"	Decker 1952 (2), p. 409.
"	"	Hede 1952, p. 72, opp. p. 48.

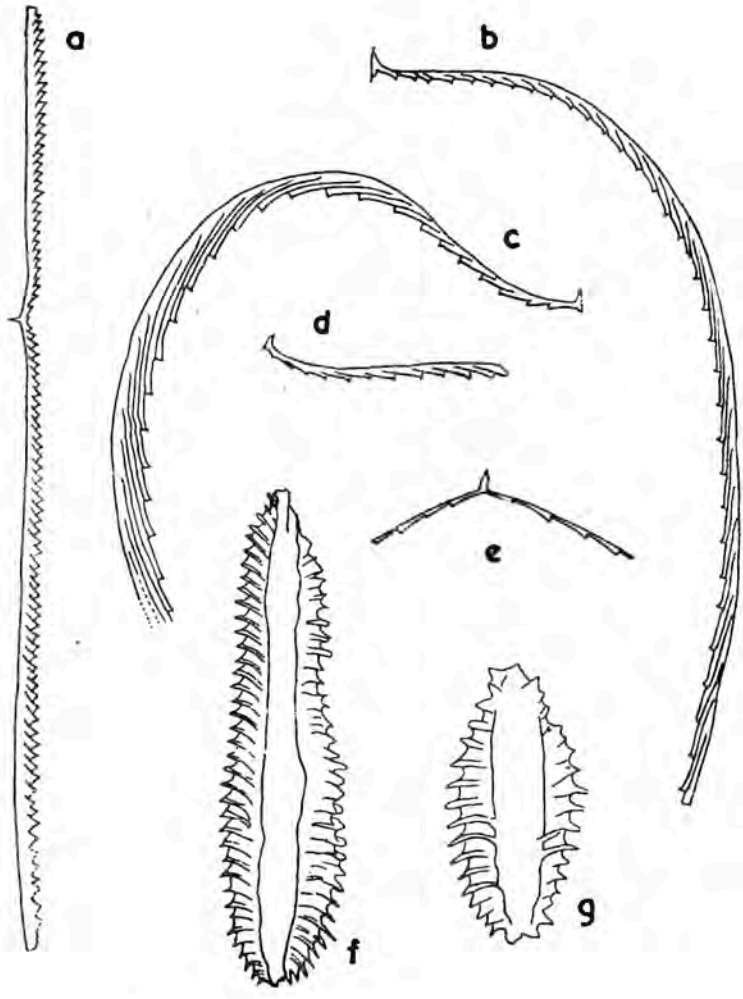
Although numerous moderately well-preserved specimens have been noted, similar in general form to those described by Elles and Wood (1901), Elles (1933), and Ripper (1937), the species is represented here only by an early mutation since in none of the examples do the stipes attain a maximum width greater than 1.9 mm. Transient forms between this species and *D. protobifidus* are not uncommon and the separation is almost arbitrary. Ripper (1937) has compared the dimensions quoted by the various authors for both *D. protobifidus* and *D. bifidus* (p. 156, table 1) and it appears that the width of the stipe (distal) ranges up to 1.7 mm. for the former species and 2.6 mm. for the latter (disregarding the specimen described by J. Hall from Levis, Quebec with a width of up to 6.2 mm.).

Didymograptus amboensis sp. nov.

Plate I, fig. 1, Text-fig. 2a-f.

Holotype : SM. A 45979 (Text-fig. 2b).

Rhabdosome of moderate size, up to 3.5 cm. long, stipes robust, proximally about 1.1 mm. in breadth, increasing rapidly to a



Text-fig. 3. a, *Didymograptus nitidus* (Hall) × 2; b, c, d, *Azygograptus fasciculatus* (Nicholson), × 4; e, *Didymograptus* aff. *cognatus* Harris and Thomas, × 4; f, *Phyllograptus angustifolius* Hall, × 2; g, *P.* aff. *anna* Hall, × 4.

maximum of about 1.9 to 2.4 mm. within 1.5 cm. Primary angle of divergence large, usually greater than 90° (occasionally up to 130°). Attitude of the stipes variable, distally typically divergent or subparallel, rarely converging. Thecae closely spaced, 18 to 20 in 10 mm. (9 to 11 in first 5 mm.), slightly to moderately curved, 4 to 5 times as long as wide, overlapping 2/3 to 4/5 their length, and inclined at between 45° and 55°. The apertural margins are curved and oblique and produced into moderate denticles. The sicula is rather short and blunt, typically 1.4 to 1.7 mm. long.

The robust stipes and the "broad shouldered" appearance of the rhabdosome are characteristic of the species. Beyond an initial widely diverging portion the stipes change direction abruptly and the angle of divergence lessens to 40° to 30° or less, occasionally the stipes are approximately parallel in this region. Most typically the stipes are only parallel at the distal end, although occasionally they may converge or again diverge.

Affinities : In the general form and dimensions of the rhabdosome the species is somewhat similar to *Didymograptus murchisoni* var. *geminus* but differs in the greater primary angle of divergence and in the much closer spacing of the thecae. *D. artus* is the only species with such closely spaced thecae but this differs in its small size and the form of the rhabdosome.

Didymograptus artus Elles and Wood

Text-figs. 2 g-i.

Didymograptus artus	Benson and Keble 1935, p. 280, pl. 30, figs. 21 and 22.
" "	Decker 1944, p. 379, figs. 26-28.
" "	Ruedemann 1947, p. 326, pl. 54, figs. 3-10.
" "	Decker 1951, p. 1673.

Only two or three specimens have been noted. The dimensions and form of the stipes and the closely spaced thecae, characteristic of the species, enables a fairly certain identification to be made.

Didymograptus miserabilis Bulman

Text-fig. 2j.

Didymograptus miserabilis		Bulman 1931, p. 40, pl. II, fig. 12.
"	"	Ekström 1937, p. 30.

The species is represented in the present fauna by several moderately well preserved examples associated with *D. bifidus* and *D. protobifidus*. In general form and dimensions there is a very close agreement with the type material from the Nordenskiöld collection.

(b) *Declined forms*

Didymograptus aff. *cognatus* Harris and Thomas

Text-fig. 3e.

Didymograptus cognatus		Harris and Thomas 1935, p. 291, fig. 1, nos. 4a-c, fig. 2, nos. 13 and 14.
"	"	Harris and Thomas 1938, p. 70, pl. II, no. 67.
"	"	Keble and Benson 1939, p. 79 (for. complete Australian bibliography).

Four more or less complete specimens and numerous fragments resembling *Didymograptus cognatus* Harris and Thomas have been recognised in the present assemblage. The preservation is not good but they appear to agree in general form and dimensions with the Victorian species, except that the thecae are more closely spaced (10-11 in 10 mm. as compared with 8).

Didymograptus sp.

Three small declined didymograptids have been noted in the present assemblage. Features reminiscent of both *D. nicholsoni* and *D. acutidens* are discernible in the specimens, although the widening of the stipes distally is apparently more rapid than in either of these species. The preservation of the material is poor and it is not possible to make other than generic identification.

(c) *Horizontal forms*

Didymograptus nitidus (Hall)

Text-fig. 3a.

Didymograptus nitidus		Ripper 1932, p. 202.
"	"	Hsü 1934, p. 30, pl. I, figs. 11a-c.
"	"	Benson and Keble 1935, p. 261.
"	"	Sun 1935, p. 7, pl. I, figs. 3a-b.
"	"	Goldring 1943, p. 92, fig. 20g.
"	"	Ruedemann 1947, p. 339, pl. 55, figs. 11-14, pl. 56, fig. 21.
"	"	Loss 1951, p. 39, text-fig. 5, pl. I. fig. 7.

Only one specimen of this species has been found in the present material.

Genus **Isograptus** Moberg

Isograptus caduceus ?*armatus* Ruedemann

Text-figs. 4d, e.

Isograptus caduceus var. *armatus* Ruedemann 1947, p. 352, pl. 57, figs. 20-25.

The Peruvian specimens may be immature individuals since they are considerably smaller than those figured by Ruedemann, and the thecal spacing (7 - 8 in 5 mm.) is somewhat closer. The long thecal spines and the general form of the rhabdosome suggest reference to this variety.

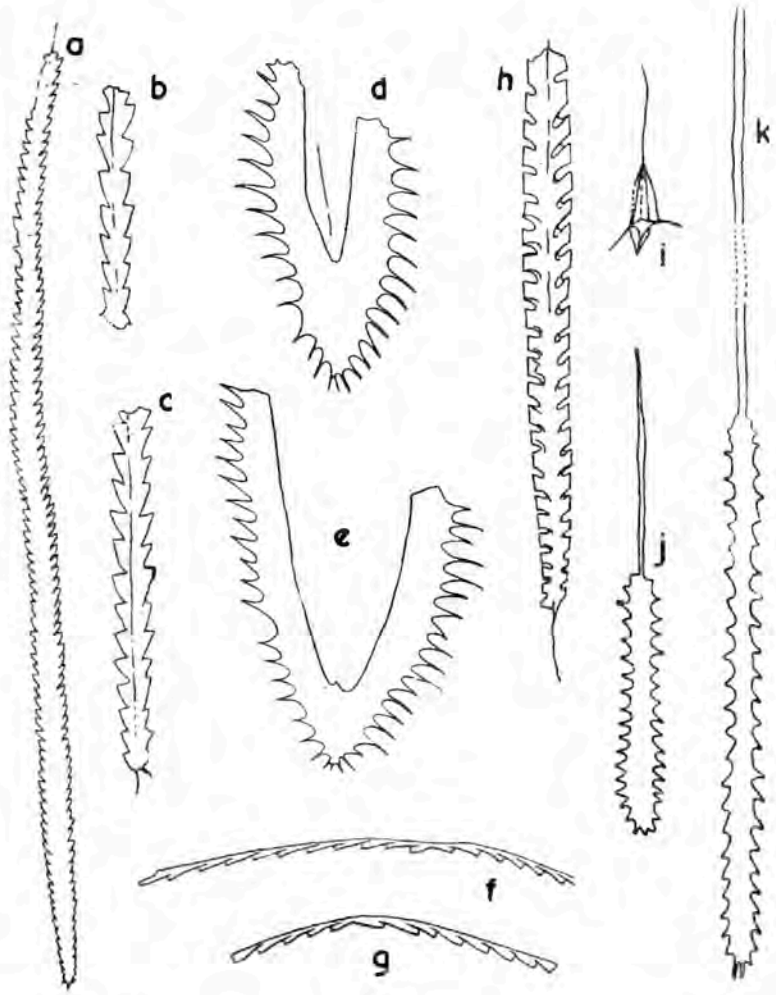
Genus **Janograptus** Tullberg

Janograptus peruviensis sp. nov.

Text-fig. 4g.

Holotype : SM. A. 45993 (Text-fig. 4g).

Fragments of slender, gently curving stipes are present in great abundance in the assemblage and lengths of up to 3.2 cms. have been noted for single stipes. The width is 0.35 to 0.45 mm.



Tex-fig. 4. a, *Glyptograptus dentatus* (Brongniart), × 2; b, c, *G. euglyphus pygmaeus* Ruedemann, × 4; d, e, *Isograptus caduceus parmatus* Ruedemann, × 4; f, *Janograptus peruviensis attenuatus* sp. et var. nov., × 4; g, *J. peruviensis* sp. nov. × 4; h, *Amplexograptus confertus* Lapworth, × 4; i, *Cryptograptus* sp., sicula, × 8; j, k, *C. tricornis schäferi* Lapworth, × 4.

and is fairly constant. The sicula is unknown and the dorsal edge of the stipe is a smooth and unbroken curve forming at the proximal end a shallow parabola with the initial thecae at the apex. The thecae are 1.2 to 1.3 mm. long and number 9 to 12 in 10 mm., the angle of inclination being about 10° and the overlap 1/5 to 1/3 their length. The ventral wall has a very slight sigmoidal curvature and the apertural margin is straight, forming an angle of 80° to 90° with the dorsal wall of the stipe.

Affinities : In general form this species is rather similar to *J. gracilis* Ekström; the stipes are, however, more slender and the thecae more closely spaced, while the slightly sigmoidal curvature of the thecae in the Peruvian species is another point of difference.

Ianograptus peruviensis attenuatus var. nov.

Plate I, fig. 2, Text-fig. 4f.

Holotype : SM. A 45994 (Text-fig. 4f).

Closely associated with *J. peruviensis* are still more slender stipes of similar general form but differing sufficiently in detail to warrant recognition as a distinct variety. The width is constant at 0.20 to 0.25 mm. and the thecae number 9 to 11 in 10 mm. The angle of inclination of the thecae is very low typically 5° or less, and the overlap is about 1/4 to 1/3 the length which is about 1.3 mm. The ventral wall and the apertural margin are straight, the latter making an angle of about 85° to 90° with the dorsal wall of the stipe.

Genus **Azygograptus** Nicholson and Lapworth

Azygograptus fasciculatus (Nicholson)

Text-figs. 3b, c, and d.

Didymograptus fasciculatus	Nicholson 1869, p. 241, pl. XI, figs. 21-22.
Didymograptus fasciculatus	Elles and Wood 1901, p. 50, pl. II, figs. 8a-c, text-figs. 32a-b.
Azygograptus falciformis	Ekström 1937, p. 32, text-fig. 5 (non. 6), pl. 6, figs. 12-16.
„ „	Hede 1952, Table 3 facing, p. 48 and p. 73.

and is fairly constant. The sicula is unknown and the dorsal edge of the stipe is a smooth and unbroken curve forming at the proximal end a shallow parabola with the initial thecae at the apex. The thecae are 1.2 to 1.3 mm. long and number 9 to 12 in 10 mm., the angle of inclination being about 10° and the overlap 1/5 to 1/3 their length. The ventral wall has a very slight sigmoidal curvature and the apertural margin is straight, forming an angle of 80° to 90° with the dorsal wall of the stipe.

Affinities : In general form this species is rather similar to *J. gracilis* Ekström; the stipes are, however, more slender and the thecae more closely spaced, while the slightly sigmoidal curvature of the thecae in the Peruvian species is another point of difference.

Ianograptus peruviensis attenuatus var. nov.

Plate I, fig. 2, Text-fig. 4f.

Holotype : SM. A 45994 (Text-fig. 4f).

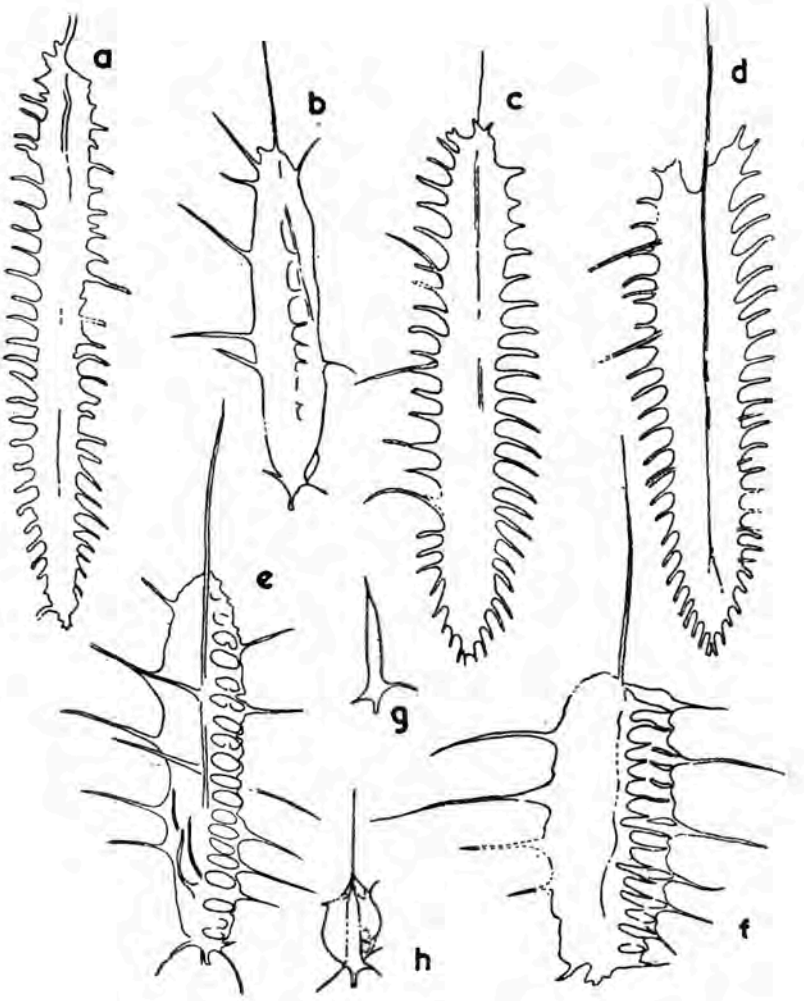
Closely associated with *J. peruviensis* are still more slender stipes of similar general form but differing sufficiently in detail to warrant recognition as a distinct variety. The width is constant at 0.20 to 0.25 mm. and the thecae number 9 to 11 in 10 mm. The angle of inclination of the thecae is very low typically 5° or less, and the overlap is about 1/4 to 1/3 the length which is about 1.3 mm. The ventral wall and the apertural margin are straight, the latter making an angle of about 85° to 90° with the dorsal wall of the stipe.

Genus **Azygograptus** Nicholson and Lapworth

Azygograptus fasciculatus (Nicholson)

Text-figs. 3b, c, and d.

Didymograptus fasciculatus	Nicholson 1869, p. 241, pl. XI, figs. 21-22.
Didymograptus fasciculatus	Elles and Wood 1901, p. 50, pl. II, figs. 8a-c, text-figs. 32a-b.
Azygograptus falciformis	Ekström 1937, p. 32, text-fig. 5 (non. 6), pl. 6, figs. 12-16.
„ „	Hede 1952, Table 3 facing, p. 48 and p. 73.



Text-fig. 5, *Glossograptus hincksii* (Hopkinson). a, Normal biprofile view, thecal spines only, × 4; b, Sub-scalariform view, dorsal and lateral spines with traces of thecal spines in centre of rhabdosome; × 4; c, Biprofile view, thecal spines and also four lateral or dorsal spines below, × 4; d, Biprofile view, thecal spines and two dorsal or lateral spines above, × 4; e, Sub-scalariform view, dorsal and lateral spines with thecal apertures and spines preserved, × 4; f, Almost full scalariform view, long lateral and dorsal spines, thecal apertures and spines preserved, × 4; g, Early growth stage, sicula and possibly the first theca, × 8; h, Early growth stage, the sicula and the first three or four thecae developed, × 8.

The stipe measures about 0.2 mm. in width at its proximal end, increasing steadily to a maximum of 1.2 mm. (average 0.7 mm at about the ninth or tenth theca). Fragments of large specimens may reach 6.0 cms. in length but many individuals, complete with sicula, measure less than 2.0 cms. and are probably immature stages. The thecae are very long and narrow and increase in length distally along the stipe from about 0.8 to 5.0 mm. the breadth remains fairly constant at 0.2 to 0.3 mm. The thecae are inclined at 10° to 15° and number from 10 to 12 in 10 mm. proximally and 8 to 10 in 10 mm. distally. Overlap at the proximal end is usually about 1/3 to 1/2 but distally this increases to 4/5 or more. Many specimens show a small hook-like spine or lip at each thecal aperture 0.1 to 0.2 mm. long and approximately normal to the length of the stipe. The sicula ranges from 0.8 to 1.5 mm. in length, but is most commonly about 1.0 mm. long and 0.3 mm. wide, and may show a slender virgella. A short nema is also occasionally present. The first theca commences at about ¼ the distance up from the sicular aperture and is at first downwardly directed before turning outwards. The stipe at first assumes a "reflexed" shape, the dorsal wall being concave, but at about the seventh or ninth theca the curvature becomes broadly convex resulting in a sickle shaped stipe.

There is close agreement between the present specimens and *Azygograptus falciformis* Ekström, although the thecal overlap is somewhat greater than in the Scandinavian forms. In general size, the sickle-like form of the stipe, the narrow thecae, and the thecal spacing, there is also a striking resemblance to *Didymograptus fasciculatus* Nicholson as described and figured by Elles and Wood. This similarity was noted for the first time by one of the authors (J.S.C.) who was given the oportunity to examine the original material (now in the Lapworth collection) from which Elles and Wood made their figures. He came to the conclusion that a sicula was, in fact, present, a feature apparently overlooked by Elles and Wood. Since no second stipe has ever been shown to exist *Didymograptus fasciculatus* would seem, by definition, to be an *Azygograptus*. This conclusion finds strong support in the apparent identity of the present specimens with those figured by Elles and Wood, and also with *Azygograptus falciformis* Ekström. Ekström's species would appear, in fact, to be synonymous with

Didymograptus fasciculatus, the trivial name of which has priority and is accordingly used here.

In China Hsü has reported *Didymograptus fasciculatus* var. *praelongus* from the upper part of the Ningkuo shale. This variety is similar to the present specimens in general form and in the appearance of the thecae, but is much larger, attaining a length of up to 20 cms. with a maximum width of 2.5 mm.

Dichograptid stipe indet.

Large fragments (maximum observed length 11.5 cms.) of straight, or occasionally gently curving, saw-like stipes of uniform type are abundant on some bedding planes. The thickness varies from 1.7 to 2.5 mm. The thecae number 10 to 12 (rarely 13) in 10 mm. and overlap about half their length; in form they are simple, straight or gently curving and about 2 to 3 times as long as broad. They are inclined at 45° to 55° (rarely 65° to 70° — possibly a result of compression) to length of the stipe; the apertural margin is straight or slightly concave.

Family CRYPTOGRAPTIDAE Hadding

Genus **Cryptograptus** Lapworth

Cryptograptus tricornis schäferi Lapworth

Text-figs. 4 j, k.

Cryptograptus schäferi	Harris and Thomas 1935, p. 304, fig. 3, nos 11, 12.
" "	Harris and Thomas 1938, p. 62, pl. II, fig. 57.
Criptograptus tricornis var. *schäferi*	Ruedemann 1947, p. 447.
Cryptograptus schäferi	Hede 1952, opp. pp. 48 and 64, p. 73, pl. 2, fig. 3.

There is close agreement between the specimens examined here and those described by Elles and Wood, although the thecal spacing of 12 to 14 in 10 mm. is slightly closer than in the British material (11 in 10 mm.)

A sicula, probably referable to this species, is shown in Text-fig. 4i. (and pl. I, fig. 4).

Genus **Glossograptus** Emmons

Glossograptus hincksii (Hopkinson)

Plate I, figs. 13, 14, Text-figs. 5a-f, 6-7.

Diplograptus hincksii	Hopkinson 1872, p. 507, pl. 12, fig. 9.
Glossograptus hincksii	Lapworth 1876, pl. 2, figs. 57.
" "	Lapworth 1877, p. 134, pl. VI, fig. 24.
" "	Elles and Wood 1908, p. 309, pl. XXXIII, figs. 2 a-j, text-figs. 205 a-f.
" "	Hadding 1913, p. 38, pl. II, figs. 1-7.
" "	Hadding 1915, p. 310, pl. V, figs. 1-7.
" "	Hsü 1934, p. 89, pl. VI, figs. 14 a-g.
" "	Ekström 1937, p. 40, pl. 8, fig. 9.
" "	Harris and Thomas 1938, p. 70, pl. II fig. 69.
" "	Keble and Benson 1939, p. 83 (complete Australian bibliography to 1939).
" "	Decker 1952 (1) p. 60 ff., pl. 1, fig. 46, pl. II, fig. 75.
" "	Hede 1952, opp. pp. 48 and 64, p. 74, pl. 3, fig. 2.

Rhabdosome 1.1 to 1.8 cms. long and in biprofile view 1.8 to 2.4 mm. wide (excluding spines), scalariform view 1.0 to 1.5 mm. wide. Thecae 13 to 15 (more rarely 12 — 16) in 10 mm. 8 — 9 in proximal 5 mm. Apertural spines 1.0 to 1.5 mm. long, rather expanded at base, slighfly to moderately curved in proximal direction. The first and second thecae each bear an additional spine, downwardly curved and lying in a plane normal to that of the apertural spines. Lateral or dorsal spines, seen usually in scalariform view, up to 5 or 6 mm. in length, slender, typically slightly curved in a proximal direction. In the proximal region they are closely spaced but distally become more widely spaced. Sicula about 1.5 mm. long bearing two short, stiff, downwardly directed spines, usually seen in biprofile view, commonly crushed and fused into a single spine in scalariform view.

In a biprofile view the rhabdosome is seen to be fringed by rather blunt apertural spines; in the proximal region they are short and directed downwards but distally they become longer (reaching an average length of 1.0 to 1.5 mm. at about the sixth or seventh theca) and more or less horizontal or slightly curved downwards. In some specimens a second set of spines can be

seen intercalated at intervals with the apertural spines. These lateral and dorsal spines (see text-figure 6) are typically longer and more delicate than the apertural spines. Proximally they are closely spaced and at first are positioned alternately with the apertural spines, distally they become more widely spaced and separated by first two, then three, and finally, in mature individuals, four apertural spines.

Text-fig. 6. Reconstruction of *Glossograptus hincksii* (Hopkinson).

In a scalariform view the lateral and dorsal spines are much more prominent and the apertural spines may be invisible or seen only as impressions associated with the trace of the thecal apertures.

Numerous siculae and early growth stages can be identified as belonging to *Glossograptus* and probably to this species. The siculae are typically 1.5 to 1.7 mm. long and about 0.25 mm. wide at the aperture. One, or occasionally two, blunt, downwardly directed apertural spines are usually discernible, and in individuals where budding has commenced two slender and slightly curving spines are seen to project at right angles to the axis of the sicula and at the level of its aperture.

In slightly later growth stages, with the first two or three thecae developed, traces of apertural and early lateral and dorsal spines are sometimes visible. In some cases the sicula may be more or less obscured by rounded, lateral expansions, similar in appearance to the "vesicular bodies" described by Bulman (1931) in *G. holmi.*

In more mature individuals these structures have not been noted in biprofile view, but in one sub-scalariform view a rather rounded and inflated proximal region, suggests that such structures may be disposed or project in a direction normal to the plane of the apertural spines.

Affinities : In the general form and dimensions of the rhabdosome and in the spacing of the thecae, the present specimens agree closely with *Glossograptus hincksii*. The disposition and spacing of the dorsal and lateral spines does not appear to have been noted in detail before, but since this may have been due to the poor preservation of previously described material it is not proposed to recognise varietal differences in the Peruvian specimens at this stage.

Remarks : Although the Peruvian assemblage contains only crushed samples, biprofile, scalariform, and intermediate views are present and show sufficient detail to make possible some surmise as to the original appearance of the rhabdosome. The fact that these different views occur suggests that there was little or no preferred orientation of the rhabdosome on settling on the sea bed, the most likely explanation for this being that the various series of spines were set at right angles to one another. However, it is significant that biprofile specimens are by far the most numerous type encountered and it is suggested that the rather delicate dorsal and lateral spines, in many cases, quickly collapsed under the weight of superincumbent sediment so that the flat side of the rhabdosome with the apertural spines projecting on either side came to lie parallel to the bedding. This might also account for the considerable variation in width of the rhabdosomes seen in numerous "biprofile" views. It also seems likely that in specimens lying in any attitude other than scalariform or nearly scalariform were later crushed during compaction of the sediment, the more robust apertural spines would be the more commmonly preserved.

In one or two examples showing scalariform or subscalariform views the rhabdosome is seen to be flanked by widely spaced, long, slender spines with the traces of a third set of similar spines impressed on to the middle region of the rhabdosome. Between the latter spines and one of the peripheral series (that is lying to one side of the rhabdosome axis) is a row of thecal apertures with

short apertural spines. These facts support the reconstruction of *Glossograptus* proposed by Hadding (1913, fig. 16, p. 37, and 1915 fig. 1, p. 310) and Bulman (1955, p. V82 fig. 3c) with the two series of thecae lying side by side in two obliquely opposed rows. On the other hand the appearance of specimens of *Glossograptus holmi* in the Nordenskiöld collection led Bulman (1931) to reconstruct the species with a diprionid arrangement of the thecae. Whether or not the "biserial" appearance of the specimens in figures 3 and 4, plate 18, can be reconciled with Hadding's reconstruction by appeal to the vagaries of preservation, with the one series of thecae "impressed through" the other, is difficult to say, but it is possible.

More recently Hadding's interpretation has returned to favour. A specimen from Bygd in the Palaeontological Museum, Oslo (no. 20247) examined by Bulman would seem to confirm it beyond doubt, and in the most recent discussion of *Glossograptus* (Bulman 1955) a diprionid interpretation has been abandoned and the thecae are shown with a side by side arrangement (figure 3c, page V82).

The longer spines, of wich there are considered to be four rows, occur in pairs on either side of the thecal apertures, spaced along the rhabdosome as described above. In Hadding's interpretation a series of spines is shown arising at intervals from the dorsal wall of each thecal series. In the present interpretation two rows of long spines are believed to arise in this manner and are here termed "dorsal spines". The other two series of long spines presumably arise laterally from the side of the rhabosome close to the thecal apertures. A possible alternative arrangement is one in which both members of a pair of long spines might be associated with the thecal series, arising as symmetrically placed lateral spines on either side of the thecal apertures. With the material at hand it would not seem possible to decide which of the above alternatives is more corresct, so that for the moment, at least, that closest to Hadding's original interpretation is adopted.

The appearance of crushed specimens on a bedding plane varies considerably. Most commonly seen is the biprofile view as shown in text-fig. 7a, in which the impressions of lateral and dorsal spines may or may not be seen in addition to the apertural

spines. The appearance of specimens preserved in other attitudes is shown in text-figs. 7b - e.

In less crushed material careful removal of the matrix may reveal all the spines preserved and what at first appears to be a scalariform view with only dorsal and lateral spines showing, might be found to be, in fact, a biprofile view with the apertural spines embedded in a lower layer within the matrix.

The precise disposition of the four spines at the proximal end of the rhabdosome is not yet clear. The few scalariform or subscalariform views available show additional spines arising from thecae 1^1 and 1^2 and suggest that they lie in a plane normal to that of the apertural spines. In the case of the two short sicular spines the opposite seems to hold since they are best seen in biprofile view and are invariably crushed together in scalariform view.

Family DIPLOGRAPTIDAE Lapworth

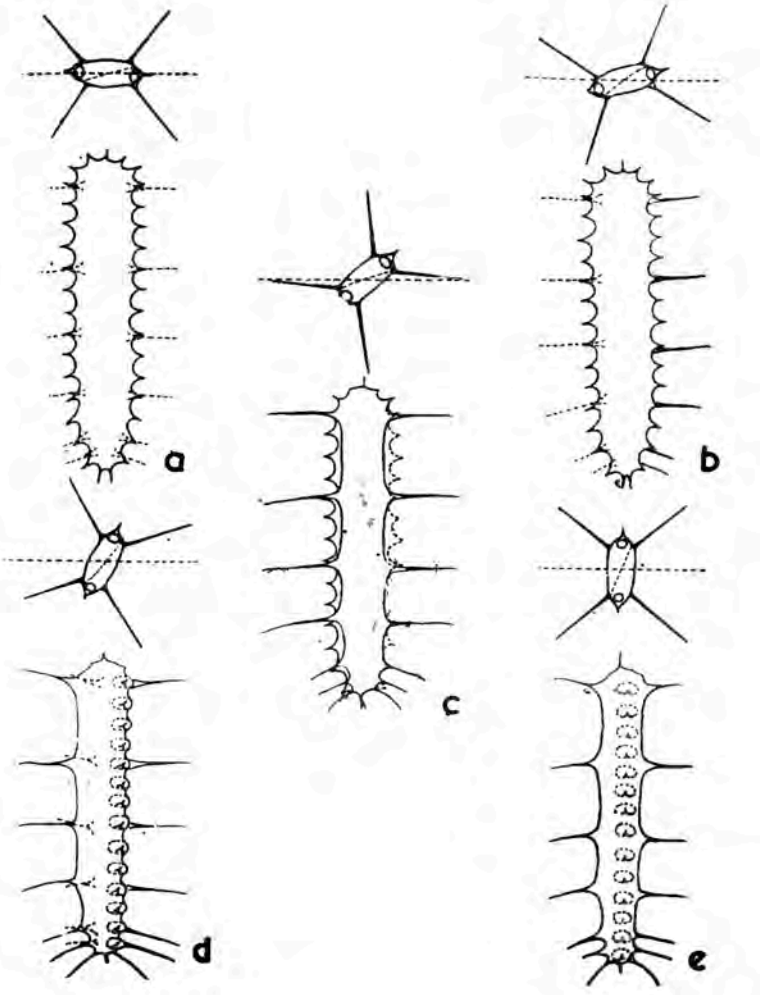
Subfamily DIPLOGRAPTINAE Lapworth

Glyptograptus dentatus (Brongniart)

Text-fig. 4a.

Diplograptus pristiniformis	Malaise 1901, p. 8.
Diplograptus (*Glyptograptus*) *dentatus*	Elles & Wood 1907, p. 253, pl. XXXI, figs. 4a-d, text-fig. 174 a-c.
" "	Hsü 1934, p. 78, pl. VI, figs. 3a-g, text-fig. 28a-c.
" "	Maillieux 1939, p. 4, pl. I, fig. 4.
Diplograptus dentatus	Goldring 1943, p. 92, fig. 20 j, k.
Diplograptus (*Glyptograptus*) *dentatus*	Ruedemann 1947, p. 404, pl. 68, fig. 30, pl. 69, figs. 1-8.
Glyptograptus dentatus	Bulman 1950, p. 2.
Glyptograptus aff. *dentatus*	Spjeldnaes 1953, p. 180, pl. I, figs. 12-13.

The present specimens appear to have some features in common with both *G. dentatus* and *G. teretiusculus* as described by Elles and Wood 1907. In the character of the thecae and of the proximal region there is close agreement with the former species, while the general dimensions and the spacing of the thecae correspond to those of the latter. This apparent transience between *G. dentatus* and *G. teretiusculus* has also been noted in specimens of *G. dentatus* mut. from Bolivia (Bulman 1931).



Text-fig. 7. Variation in the appearance of *Glossograptus hincksii* due to differences in the attitude of the stipe on settling on the sea bed. a, biprofile; b, sub-biprofile; c, intermediate; d, sub-scalariform; e, scalariform.

Glyptograptus euglyphus pygmaeus Ruedemann

Plate I, fig. 11, text-fig. 4b, c.

Diplograptus (*Glyptograptus*) *euglyphus* Lapworth var. *pygmaeus* Ruedemann 1947, p. 406, pl. 69, figs. 51-53.
Diplograptus (*Glyptograptus*) *euglyphus* var. *pygmaeus* Decker 1952 (1) p. 19 ff., pl. I, figs. 32 and 38, pl. II, fig. 54.
Diplograptus (*Glyptograptus*) *euglyphus* var. *pygmaeus* Decker 1952 (3) p. 1455, fig. 11.

Only two specimens of this variety have been found in the present material. The preservation is not good and it is not possible to make out full details of the character of the thecae.

There is a close similarity in general shape and dimensions to *Glyptograptus euglyphus pygmaeus* Ruedemann and, so far as can be ascertained, the thecae are similar in form. The thecal spacing (12 to 14 in 10 mm.) is, however, a little closer than that quoted by Ruedemann and in this feature the specimens here compare rather with *G. angustifolius* (Hall) with 11 to 14 thecae (Ruedemann 1908) or 13 to 15 thecae as noted by Bulman (1931) in specimens from strata of Upper Llandeilian age in Perú.

Amplexograptus confertus Lapworth

Text-fig. 4h.

Amplexograptus cf. *confertus*	Bulman 1931, p. 60, pl. 5, figs. 1, 7-9, text-fig. 28.
Amplexograptus confertus	Harris and Thomas 1935, p. 300, pl. I, nos. 14a, b.
Diplograptus (*Amplexograptus*) *confertus*	Harris and Thomas 1938, pl. II, fig. 55.
Amplexograptus cf. *confertus*	Newell and Tafur 1944, p. 544, pl. 92, figs. 10-11.
Diplograptus (*Amplexograptus*) *confertus*	Ruedemann 1947, p. 412, pl. 70, figs. 23-26.
Amplexograptus cf. *confertus*	Bulman 1950, p. 3.
Amplexograptus confertus	Hede 1952, opp. p. 48, p. 74.

The species is here represented by about a dozen specimens which agree closely in general form and dimensions with the description by Elles and Wood (1907). There is also a close

similarity to the Victorian specimens described by Harris and Thomas (1935) although the thecal spacing quoted by those authors (10-14 in 10 mm.) is somewhat lower than for our Peruvian specimens with 12-15 thecae. A late form of *A. confertus* from Upper Llanvirnian beds at localities in Bolivia and Peru (Bulman 1931) has wider apertural excavations but is otherwise similar.

General Remarks on the Fauna

The graptolite fauna from Huacar comprises seventeen previously described species and varieties, with two new species and one new variety. Having regard to the abundance of pendant didymograptids, particularly of *D. protobifidus* and *protobifidus/bifidus* transients, there can be little doubt that the general horizon of this fauna is Lower Llanvirnian. It may be about the same age as the lowermost beds inferred (Bulman, 1931) at Korpa, Bolivia, but is certainly older than the main faunas recorded from there, and seems to be more nearly comparable with the Balston Collection of graptolites from Chaquimayo, Peru.

Among various features of interest in the fauna is the first recognition of the genus *Janograptus* from South America. It is true that Rusconi (1950) has reported *Janograptus* in material from the Mendoza region (Argentina), and distinguished four new species, but an examination of his figures (p. 121, figs. 8-12) shows that three of the species are really species of *Dicellograptus* (figured upside down), and the fourth (*J. alfaense*, fig. 8) is probably also a *Dicellograptus*, though it might possibly be a species of *Isograptus*. On the other hand, Rusconi's *Pterograptus longissimus* may in fact be a species of *Janograptus*! (It may also be noted that *Phyllograptus gracii* Rusconi, is probably a retiolitid).

Glossograptus is represented by numerous specimens referred to *G. hincksii*, and the material includes several early growth stages. Details are unfortunately obscure, but the general resemblance to early stages of *Cryptograptus schaeferi* may well be significant in view of the interpretation placed on the structure of adult rhabdosomes which supports the reference of *Glossograptus* to the Cryptograptidae.

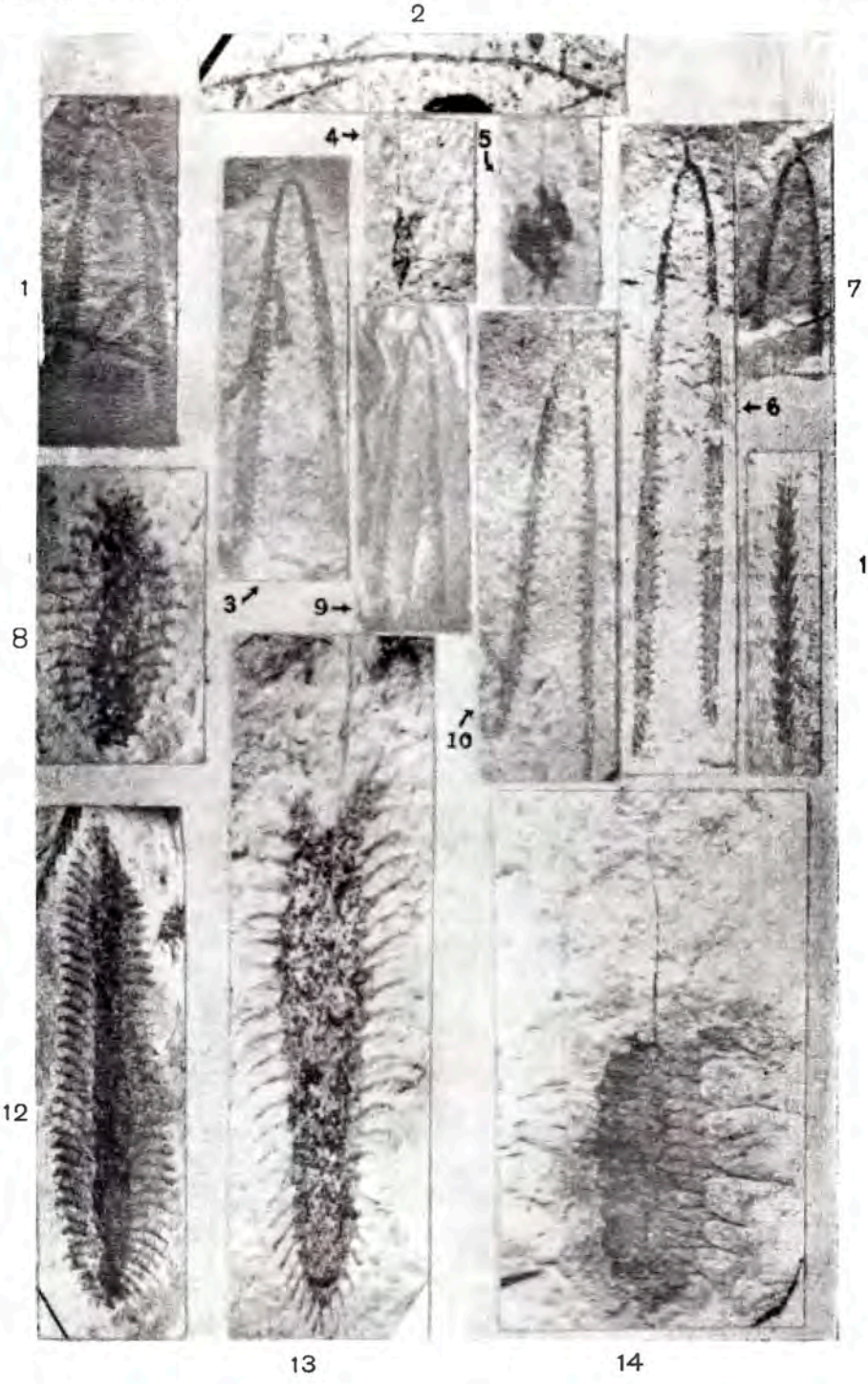
Considering the geographical distribution of the previously described species and varieties represented here, it is seen that numerically the strongest affinities are with North America and Australia, and J.C.E. Turner (*) has also commented upon the Australian affinities of several of the graptolite faunas of South America. Scandinavian affinities are also indicated, however, by the presence of *Janograptus*, and further links are provided by the recognition of the South American *D. pandus* and *D. miserabilis* in South Sweden (Ekström, 1937), while Ekström's *Azygograptus falciformis* is probably a synonym of *A. fasciculatus* (Nicholson), here recognized as an *Azygograptus* and recorded from South America for the first time.

(*) *The Graptolite Faunas of South America*. Thesis presented at the University of Cambridge for the degree of Ph. D., 1950.

Plate I.

Fig. 1. *Didymograptus amboensis* sp. nov. × 2.
2. *Janograptus peruviensis attenuatus* sp. et var. nov. × 4.
3. *Didymograptus bifidus* (Hall), early mutation. × 2.
4. *Cryptograptus* sp., sicula, × 8.
5. *Glossograptus* sp., early growth stage, × 8.
6. *Didymograptus protobifidus-bifidus* transient, × 2.
7. *D. protobifidus* Elles, × 2.
8. *Phyllograptus* aff. *anna* Hall, × 4.
9. *Didymograptus pandus* Bulman, × 4.
10. *D. pandus* Bulman, × 4.
11. *Glyptograptus euglyphus pygmaeus* Ruedemann, × 4.
12. *Phyllograptus angustifolius* Hall, × 2.
13. *Glossograptus hincksii* (Hopkinson), × 4.
14. *G. hincksii* (Hopkinson), × 4.

The originals of these specimens, and those illustrated in the text-figures, are preserved in the Sedgwick Museum, Cambridge.



Graptolites from Huacar

REFERENCES CITED

BENSON, W. N. and KEBLE, R. A. 1935. The geology of the regions adjacent to Preservation and Chalky Inlets, Fiordland, New Zealand. Part IV. Stratigraphy and palaeontology of the fossiliferous Ordovician rocks. *Trans. Roy. Soc. N. Z.* LXV, 244 - 294.

BULMAN, O. M. B. 1931. South American Graptolites, with special reference to the Nordenskiöld collection. *Arkiv för Zoologi*, 22A, N:o 3, 1 - 111.

BULMAN, O. M. B. 1933. Report on the graptolites of the Quitari area. *Quart. Journ. Geol. Soc.*, LXXXIX, 348 - 353.

BULMAN, O. M. B. 1936. On the graptolites prepared by Holm, VII. *Arkiv för Zoologi*, 28A, N:o 17, 1 - 107.

BULMAN, O. M. B. 1950. On some Ordovician graptolite assemblages of Belgium. *Inst. Roy Sci. Nat. de Belgique* XXVI, No. 5, 1 - 8.

BULMAN, O. M. B. 1955. *Treatise on Invertebrate Palaeontology, V, Graptolithina.* Geol. Soc. Amer. and Univ. Kansas.

DECKER, C. E. 1941. *Didymograptus protobifidus* in North America. *Journ. Pal.* XV, 362 - 365.

DECKER, C. E. 1944. Pendent graptolites of Arkansas, Oklahoma, and Texas. Journ. Pal., XVIII, 378 - 386.

DECKER, C. E. 1951. Small graptolite determines Ordovician horizon. *Amer. Assoc. Petroleum Geol. Bull.*, XXXV, 1673 - 1674.

DECKER, C. E. 1952. (1). Stratigraphic significance of graptolites of Athens shale. *Amer. Assoc. Petroleum Geol. Bull.*, XXXVI, 1 - 145.

DECKER, C. E. 1952. (2). Faulted graptolite shows Joins formation deep near Edmond, Oklahoma. *Amer. Assoc. Petroleum Geol. Bull.*, XXXVI, 409 - 411.

DECKER, C. E. 1952. (3). Oklahoma well core shows graptolites through 400 feet of Viola limestone. *Amer. Assoc. Petroleum Geol. Bull.*, XXXVI, 1454 - 1457.

EKSTRÖM, G. 1937. Upper Didymograptus shale in Scania. *Sver. Geol. Unders.*, Ser. C, N:o 403, 1 - 53.

ELLES, G. L. 1933. Lower Ordovician graptolite faunas with special reference to the Skiddaw slates. *Geol. Survey Gt. Brit. Summ. Progr.* 1932, 94 - 111.

ELLES, G. L. and WOOD, E. M. R. 1901 - 18. Monograph of British graptolites, Pts. I - XI. *Palaeont. Soc.*, London.

GOLDRING, W. 1943. Geology of the Coxsackie Quadrangle, New York. *N. Y. State Mus. Bull.*, 332.

HADDING, A. 1913. Undre Dicellograptusskiffern i Skane. *Lunds Univ. Årsskr., N. F. afd. 2*, IX, No. 15.

HADDING, A. 1915. Om Glossograptus, Cryptograptus och tvenne dem närstaende graptolitsläkten. *Geol. Fören*, XXXVII, 303 - 336.

HARRIS, W. J. and THOMAS, D. E. 1935. Victorian graptolites (New Series), part. III. *Proc. Roy Soc. Victoria*, xlvii (N. S.), 288 - 313.

HARRIS, W. J. and THOMAS, D. E. 1938. (2). Revised classification and correlation of the Ordovician graptolite beds of Victoria. *Mining and Geol. Journ.*, I, 62 - 72.

HEDE, J. E. 1952. Boring through Middle Ordovician — Upper Cambrian strata in the Fagelsang district, Scania (Sweden). *Acta Univ. Lund.*, N. S. xlvi, Nr. 7, 1 - 84.

HOLM, G. 1895. Om Didymograptus, Tetragraptus, och Phyllograptus. *Geol. Fören. Förh.*, xvii, 1 - 43.

HOPKINSON, J. 1872 On some new species of Graptolites from the South of Scotland. *Geol. Mag.*, IX, 501 - 509.

HSÜ, S.C. 1934 The graptolites of the Lower Yangste valley. *Mon. Nat. Research Inst. Geol.* Ser. A, 4, 1 - 106.

KEBLE, R. A. and BENSON, W. N. 1939. Graptolites of Australia: bibliography and history of research. *Mem. Nat. Mus. Melbourne*, xi. 11 - 99.

LAPWORTH, C. 1876 (In ARMSTRONG, J., YOUNG, J. and ROBERTSON, D) *Catalogue of the western Scottish fossils*, Glasgow.

LAPWORTH, C. 1877. The graptolites of County Down. *Proc. Belfast Nat. Field Club*, 1876 - 77. Appendix 125 - 144.

LAPWORTH, C. 1906 Notes on the graptolites from Bratland, Gausdal, Norway. *Norges. Geol. Unders.*, Nº 39, 1 - 15.

LOSS, R. 1951. Contribuciones al conocimiento de las faunas graptolíticas del norte Argentino. *Revista Asoc. Geol. Argentina*, VI, Nº 1, 21 - 61.

MAILLIEUX, E. 1939. L'Ordovicien de Sart-Bernard. *Mém. Mus. roy. d'Hist nat. de Belgique*, Nº 86, 1 - 59.

MALAISE, C. 1901 Sur le terrain silurien de la Belgique. *Compte rendu Congr. géol. internat.*, VIIIe Session, 1900.

NEWELL, N. D. and TAFUR, I. 1944 Fossiliferous Ordovician in lowlands of eastern Peru. *Journ. Pal.*, XVIII, 540 - 545.

NICHOLSON, H. A. 1869. On some new species of graptolites. *Ann. Mag. Nat. Hist.*, Ser. 4, IV, 231 - 242.

RIPPER, E. 1932 The distribution of the zones of the Castlemaine and Darriwil series near Ingliston. *Proc. Roy. Soc. Victoria*, xliv. (N.S.), 200 - 211.

RIPPER, E. 1937 A note on the occurrence of *Didymograptus protobifidus* Elles in the Lower Ordovician of Victoria. *Proc. Roy. Soc. Victoria*, xlix (N.S.), 153 - 164.

RUEDEMANN, R. 1947. Graptolites of North America. *Geol. Soc. Amer., Mem.* 19.

RUSCONI, C. 1950. Primera contribución al conocimiento de los graptolitos Paleozoicos de Mendoza. *Revista Mus. Hist. Nat. Mendoza*, IV, 95 - 164.

SKJESETH, S. 1953. (1) Lower Didymograptus Zone (3B) at Ringsaker, and contemporary deposits in Scandinavia. *Norsk. Geol. Tidssk.*, XXX, 138 - 182.

SPJELDNAES, N. 1953 Middle Ordovician of Oslo region, Norway, Nº 3, Graptolites dating the beds below the Middle Ordovician. *Norsk. Geol. Tidssk.* XXXI, 171 - 184.

SUN, Y. C. 1935 Lower Ordovician graptolite fauna of north China. *Palaeont. Sinica*, Ser. B, XIV.

TÖRNQUIST, S. L. 1904. Graptolites of the Lower Zones of the Scanian and Vestrogothian Phyllo-Tetragraptus beds. *Lunds Univ. Årsskr.*, Bd. XL. Nº 2.

TÖRNQUIST, S. L. 1911. Graptolitologiska bidrag, Nº 4. Geol. *Fören. Förh.*, XXXIII, 426 - 432.