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GLYPTAGNOSTUS RETICULATUS FROM THE HUSKISSON RIVER, TASMANIA

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(with one text-figure and one plate)

ABSTRACT

In the Huskisson River area of western Tasmania the stratigraphically important early Upper Cambrian agnostid trilobite *Glyptagnostus reticulatus* (Angelin), occurs about 25 metres below the top of a sparsely fossiliferous Cambrian sequence. The sequence is overlain with apparent conformity by Junee Group sediments. The taxonomic position of two subspecies of *G. reticulatus*, viz: *G. r. angelini* (Resser) and *G. r. reticulatus* (Angelin) is reviewed.

INTRODUCTION

The stratigraphically important agnostid trilobite, *Glyptagnostus reticulatus* (Angelin), has been reported from early Upper Cambrian sediments of the Huskisson River area by several workers (Öpik 1951; Banks 1956, 1962a; Blissett 1962). The importance of the different species of *Glyptagnostus* in intercontinental correlations of early Upper Cambrian rocks has been discussed by Palmer (1962).

The purposes of this paper are to give the first published illustrations of the Huskisson River specimens, to discuss some taxonomic aspects of *Glyptagnostus* and to review the stratigraphy of the Huskisson River area. All specimen numbers in the text refer to the collection of the Geology Department, University of Tasmania.

STRATIGRAPHY

It should be noted that the writer has not visited the fossil localities in the Huskisson River area (fig. 1) due to the problems of access. The geology of the area shown in fig. 1 and discussed below is after Taylor (1954), Banks (1956), Blissett (1962) and from conversations with Mr. A.H. Blissett, now with the South Australian Geological Survey, but formerly with the Tasmanian Mines Department. Figure 1 is modified after fig. 4 of Blissett (1962).

The area under discussion occurs in the north-eastern part of the Zeehan 1-mile map sheet. The geology of the Zeehan sheet has been discussed in some detail by Blissett (1962) who states (p. 38):

> "About 1 3/4 miles upstream from the mouth of the Huskisson River, a sill-like mass of serpentinite and pyroxenite has intruded dark laminated slaty shale which has been altered at the contact to mottled pale grey and greenish chert".

This shale is the basal unit of a sparsely fossiliferous Cambrian sequence first described by Taylor (1954). Banks (1956, p. 180) summarized Taylor's work in a table which listed 19 formations with a thickness of about 1840 metres conformably overlying about 3050 metres of argillite (equivalent to the Late Precambrian and/or Lower Cambrian Crimson Creek Formation) which unconformably overlies a sequence of jasper, shale, quartzite and tuff. The upper 19 formations have been correlated with the Dundas Group on the basis of the discovery of *Glyptagnostus reticulatus* and dendroids in this section (Blissett 1962). However, as shown below (and recognised by Blissett

1962), some of these formations correspond to the Mt. Zeehan Conglomerate and Moina Sandstone which, together with the overlying Gordon Limestone, constitute the Junee Group. In the Zeehan-Dundas area the Junee Group overlies the Dundas Group. The age of the base of the Junee Group in the Huskisson River area is not known although the equivalents of the Moina Sandstone in other parts of Tasmania are of Arenigian age (Banks 1962b).

The dendroids and hydroids in the Huskisson River section have been described by Quilty (1971). Quilty (*op. cit.*, fig. 1) indicated two fossil localities in the Huskisson River area with the more northern one containing hydroids, sponge spicules and *Glyptagnostus reticulatus*. However, as indicated by Blissett (1962, fig. 4), there are four fossil localities in the Huskisson River area. The northern locality of Quilty corresponds to the easternmost fossil locality shown both in Blissett (fig. 4) and here in figure 1. *Glyptagnostus* is not found at this locality, but rather at another fossil locality 1.2 km to the north-west (fig. 1).

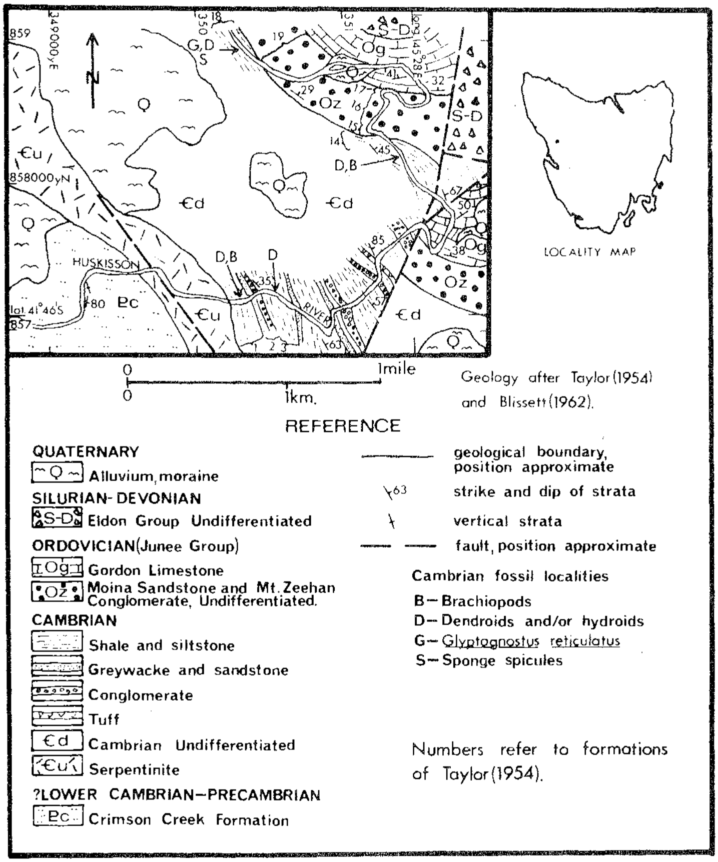

FIG. 1. - Geology of the Huskisson River area.

Blissett (*op. cit.*, p. 38) has shown that units 1-13 (measuring upstream from the serpentinite contact, i.e., No. 1 is the lowest unit) are in sequence, but the units 14-19 described by Taylor are almost certainly a repetition. Taylor noted the presence of *Glyptagnostus reticulatus* in a black shale (lat. 41°45.1'S, long. 145° 27.2'E) about 25 m from the top of unit 18 (Blissett 1962, fig. 14 and *pers. comm.*).

TABLE 1

HUSKISSON RIVER SECTION

(modified after Taylor 1954; Banks 1956, Blissett 1962)

Formation	Lithology	Thickness (metres)
Gordon Limestone	limestone with minor mudstone	335
Moina Formation (17, top of 19)	sandstone with subsidiary conglomerate	16
Mt. Zeehan Conglomerate equivalent (15 & 16; bottom of 19)	conglomerate (19), coarse conglomerate (16), chert breccia (15)	128-174
14, 18	black pyritic shale with *Glyptagnostus reticulatus*, dendroids and hydroids (18); black slate with inarticulate brachiopods, sponge spicules, dendroids and hydroids (14)	34-92
13	thin bedded shales with tuffaceous bands	272
12	cherty conglomerate	80
11	thin bedded grey shales	186
10	massive feldspathic tuff	28
9	thin bedded shale	49
8	conglomerate with quartz and chert pebbles in coarse sandy matrix	49
7	thin bedded blue-grey shale	92
6	shale formation with 3 bands of fine grey conglomerate with rounded quartz pebbles	107
5	thick-bedded yellow-brown to grey shale	80
4	coarse blue-grey sandstone	52
3	fine grained thin-bedded dark grey shales with dendroids and hydroids	120
2	coarse quartzites, dark shales, fine conglomerates with light quartzites at top	107
1	thin bedded black shale with dendroids and inarticulate brachiopods	116
----- contact with serpentinite -----		
Crimson Creek Formation equivalent		3050

The overlying unit (19) is a poorly exposed conglomerate, about 122 m thick, composed of rounded pebbles of sandstone and grey chert, up to about 1 cm in diameter, set in a sandy matrix. At the top of unit 19 Taylor noted fine conglomerate and sandstone which may be equivalent to the Moina Sandstone (Blissett 1962, p. 39, and *pers. comm.*). Formation 19 is overlain with apparent conformity by the Gordon Limestone (Blissett 1962, p. 58 and pers. comm.). Considering the situation further downstream, Blissett (1962, p. 38) states that, "Mapping indicates that Formation 14 is overlain by a correlate of the Mt. Zeehan Conglomerate, and that it may be equivalent to the *Glyptagnostus reticulatus* shale." Above Formation 14 are 37 m of chert breccia (Formation 15) which is conformably overlain by 137 m of coarse conglomerate (Formation 16). This conglomerate is overlain by about 16 m of sandstone (Formation 17) which Blissett (1962, p. 39) considered may be equivalent to the Moina Sandstone. Formation 17 is overlain by the Gordon Limestone.

From the above remarks it is seen that Blissett's suggestion that units 14 and 18 are equivalent is probably correct. This means that units 15, 16, and 17 (total thickness 190 m) are equivalent to unit 19 (thickness 122 m) and in turn to the Mt. Zeehan Conglomerate plus the Moina Sandstone. Such thickness variations are common within the Junee Group conglomerates and sandstones. The stratigraphy of the area, somewhat modified after Taylor (1954), Banks (1956) and Blissett (1962), is given in Table 1. The above discussion also indicates that the fossiliferous Cambrian sediments are overlain with apparent conformity by the Junee Group sediments in the Huskisson River area as previously suggested by Blissett (1962, p. 49).

In Queensland *Glyptagnostus reticulatus* is known from the two lower Idamean Zones, i.e., the *Glyptagnostus reticulatus* - *Olenus ogilviei* Zone and the *G. reticulatus* - *Proceratopyge nectans* Zone (Öpik 1967). The presence of *G. reticulatus* in unit 18 of the Huskisson River sequence indicates correlation with one of these zones.

Phylum ARTHROPODA Siebold and Stannius, 1845
Class TRILOBITA Walch, 1771
Order MIOMERA Jaekel, 1909
Suborder AGNOSTINA Salter, 1864
Superfamily AGNOSTACEA M'Coy, 1849
Family DIPLAGNOSTIDAE Whitehouse, 1936
Subfamily GLYPTAGNOSTINAE Whitehouse, 1936
Genus GLYPTAGNOSTUS Whitehouse, 1936

Glyptagnostus Whitehouse 1936, p. 101; Kobayashi 1939, p. 155; 1949 p. 1; Shimer & Shrock 1944, p. 600; Westergård 1947, p. 5; Hupé 1953, p. 63; Pokrovskaya 1960, p. 60; Öpik 1961, p. 428; 1963 p. 38; 1967 p. 167; Palmer 1962, p. 15; 1968 p. 27.

Type Species. *Glyptagnostus toreuma* Whitehouse (1936, p. 102, pl. 9, figs. 17-20) = *Agnostus reticulatus* Angelin (1851, p. 8, pl. 6, fig. 10).
Diagnosis: See Palmer 1962, p. 15.
Discussion: Öpik (1961, 1963) and Palmer (1962) have discussed *Glyptagnostus* in considerable detail. Some aspects of Palmer's work are discussed below in the discussion of *Glyptagnostus reticulatus* (Angelin). Öpik (1967, p. 169) erected *Lispagnostus* as a new subgenus within *Glyptagnostus*. Öpik (*op. cit.*) had only one cephalon at his disposal. The writer considers that more material is required before the erection of a new subgenus can be justified.

Glyptagnostus reticulatus (Angelin)
pl. 1, figs. 1-9

Synonymy. See Palmer 1968, p. 27.
Diagnosis. See Palmer 1962, p. 18.
Material. Two almost complete specimens and several individual cephala and pygidia are available. All specimens are reasonably well preserved although all are flattened to some extent.
Discussion. *Glyptagnostus reticulatus* (Angelin) has been described and discussed in considerable detail by Öpik (1961) and Palmer (1962). The Huskisson River specimens give no new taxonomic information and thus are not described in detail. The exceedingly flattened nature of most of the Huskisson River specimens makes it a little difficult to compare them with those illustrated from other parts of the world. Even the flattened specimen of *G. reticulatus* from Queensland, illustrated by Öpik (1963, pl. 2, fig. 6), appears to show more convexity than most of the Tasmanian specimens. Apart from this factor the Huskisson River specimens are a little distorted. One

pygidium (UT 89517c) and three cephala (UT 89517a, b, d) are distinctly more convex than the other specimens (see pl. 1, figs. 8, 9, 7, 3, respectively), and it can be seen that the convexity slightly alters the overall appearance of the specimens. Both the cephalon and the pygidium of the Huskisson River form have a dense reticulate pattern of scrobiculae. Thus they belong in *G. reticulatus* (Angelin) rather than *G. stolidotus* Öpik in which the pleural areas of both the cephalon and the pygidium have a radial distribution of scrobiculae. There are three described subspecies of *G. reticulatus*, viz: *G. r. nodulosus* Westergård 1947, *G. r. reticulatus* (Angelin) and *G. r. angelini* (Resser). The latter two subspecies were erected by Palmer (1962) with *angelini* being slightly older than *reticulatus*.

Palmer (1962, p. 18) states that one of the diagnostic features of *G. r. reticulatus* is that the length of the third pygidial axial lobe (Lb_3) averages more than 0.7 the length (Lb_2) of the second pygidial axial node, whereas one of the diagnostic features of *angelini* is that Lb_3 averages less than 0.7 Lb_2. His equations for plots of Lb_3 v. Lb_2 for both *reticulatus* and *angelini* are as follows:

G. r. angelini $Lb_3 = 0.69Lb_2 + 0.14$ ($N = 36$; $r = 0.91$)

G. r. reticulatus $Lb_2 = 0.70Lb_2 - 0.09$ ($N = 14$; $r = 0.86$)

Palmer apparently derived this diagnostic feature from the slopes of the lines drawn from the above equations. It is doubtful if this is a valid deduction due to the fact that the two slopes are almost equal. Dr. S. Morris, formerly of the Department of Mathematics, University of Adelaide, supports this statement.

It should also be noted that the areas occupied by the points representing the two subspecies overlap to some extent (see Palmer 1962, fig. 11). A further point is that in three of the thirty-five points plotted by Palmer for *G. r. angelini* $\frac{Lb_3}{Lb_2} \geq 0.70$ and in *G.r.reticulatus* $\frac{Lb_3}{Lb_2} < 0.7$ in two of the fourteen plotted points. Thus, it is doubtful if the relative lengths of the third and second pygidial axial lobes should be used as a diagnostic feature.

However, it is true that in general Lb_3/Lb_2 is greater in *G. r. reticulatus* than in *G. r. angelini*. This can be seen very clearly on figure 11 of Palmer (1962) and may be demonstrated by means of a "Student's 't' test". Using this test on a null hypothesis that the populations of the supposedly different subspecies in fact belong to the same population, a value of $t = 7.89$ was obtained (see Appendix for calculations). The tables of Simpson *et al.* (1960, p. 422) indicate that the probability that the two samples belong to the same population is less than 0.001. This implies that the two subspecies, as recognized by Palmer, do, in fact, generally differ in the ratio of the lengths of the second and third pygidial axial lobes, but, as noted above, it is a general rather than a diagnostic feature.

A second difference between *G. r. reticulatus* and *G. r. angelini* noted by Palmer is that in the former the posterior part of the axis usually has well-developed, longitudinal furrows outlining lateral lobes whereas in *angelini* these longitudinal furrows are poorly developed. Again this is a general feature used to assist in diagnosing the differences between the two subspecies rather than a completely diagnostic feature. Palmer (*op. cit.*, fig. 11 and p. 18) indicates that there is an evolutionary sequence within *G. reticulatus*, with *G. r. angelini* being the older morphological extreme and *G. r. reticulatus* being the younger morphologic extreme. He also notes that there is "complete stratigraphic gradation between the two morphologic extremes." It would seem that Palmer has shown a valid evolutionary series within *G. reticulatus*.

In such circumstances (where complete gradation can be shown) it seems doubtful to the writer that new subspecies and formal diagnoses should be set up. Rather it would seem better to do what Palmer (*op. cit.*, p. 18) has, in fact, done in his discussion and indicate what features change, how they change, and the relationship between the changes of different morphologic features. This seems more realistic as it looks at the evolving animals rather than putting them in arbitrarily defined classificatory "boxes".

Occurrence and Age: *Glyptagnostus reticulatus* (Angelin) comes from a black pyritic shale along the Huskisson River at lat. 41°45.1'S, long. 145°27.2'E; its age is early Upper Cambrian, either the *Glyptagnostus reticulatus - Olenus ogilviei* Zone or the *G. reticulatus - Proceratopyge nectans* Zone.

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APPENDIX

The Appendix contains the tables and calculations used to derive the value of "t" in the "Student's 't' Test" noted above. The values of Lb_2 and Lb_3 shown in the tables below were taken directly from Palmer (1962, fig. 11). It will be noted that in the case of *Glyptagnostus reticulatus angelini*, Palmer has N = 36 although only 35 points are plotted on his fig. 11 and used in my calculations. Presumably two specimens had the same dimensions for Lb_2 and Lb_3. However, this should not effect the results of the subsequent calculations to any significant extent.

(a) Calculations for *Glyptagnostus reticulatus angelini*.

(Na = 35)

Lb_3 (mm)	Lb_2 (mm)	Lb_3/Lb_2	$(Lb_3/Lb_2)^2$
.19	.50	.38	.1444
.24	.55	.44	.1936
.26	.56	.46	.2116
.24	.60	.40	.1600
.26	.61	.43	.1849
.40	.75	.53	.2809
.45	.75	.60	.3600
.40	.80	.50	.2500
.40	.86	.47	.2209
.34	.86	.40	.1600
.36	.87	.41	.1681
.50	.86	.58	.3364
.50	.90	.56	.3136
.60	.91	.66	.4356
.44	.96	.46	.2116

Lb_3(mm)	Lb_2(mm)	Lb_3/Lb_2	$(Lb_3/Lb_2)^2$
.50	.95	.53	.2809
.48	.97	.49	.2401
.51	.97	.53	.2809
.60	.96	.62	.3844
.65	1.01	.64	.4096
.79	1.01	.78	.6084
.74	1.06	.70	.4900
.49	1.11	.44	.1936
.63	1.12	.56	.3136
.65	1.11	.59	.3481
.66	1.12	.59	.3481
.75	1.26	.60	.3600
.85	1.31	.65	.4225
.80	1.36	.59	.3481
.74	1.37	.54	.2916
.65	1.42	.46	.2116
.79	1.42	.56	.3136
1.09	1.46	.75	.5625
.89	1.51	.59	.3481
.75	1.52	.49	.2401

$$\sum\left(\frac{Lb_3}{Lb_2}\right) = 18.98 \qquad \sum\left(\frac{Lb_3}{Lb_2}\right)^2 = 10.6274$$

Mean $\dfrac{Lb_3}{Lb_2} = .5423$

If Sa is standard deviation then

$$Sa^2 = \frac{\sum\left(\frac{Lb_3}{Lb_2}\right)^2 \qquad \frac{\sum\left(\frac{Lb_3}{Lb_2}\right)^2}{Na}}{Na - 1} = .00985$$

(b) Calculations for *Glyptagnostus reticulatus reticulatus.*

(Nr = 14)

Lb_3(mm)	Lb_2(mm)	Lb_3/Lb_2	$(Lb_3/Lb_2)^2$
.54	.75	.72	.5184
.60	.75	.80	.6400
.54	.85	.64	.4096
.60	.85	.71	.5041
.79	.86	.92	.8464
.79	.91	.87	.7569
.65	.96	.68	.4624
.74	.96	.77	.5929
.75	.97	.77	.5929
.79	.96	.82	.6724
.84	.96	.88	.7744
.84	1.01	.83	.6889

Lb_3(mm)	Lb_2(mm)	Lb_3/Lb_2	$(Lb_3/Lb_2)^2$
.84	1.11	.76	.5776
1.09	1.51	.72	.5184

$$\sum \frac{Lb_3}{Lb_2} = 10.89 \qquad \sum \left(\frac{Lb_3}{Lb_2}\right)^2 = 8.5553$$

$$\text{Mean} \quad \frac{Lb_3}{Lb_2} = .7779$$

If Sr is the standard deviation of sample then

$$Sr^2 = \frac{\sum \left(\frac{Lb_3}{Lb_2}\right)^2 - \frac{\left(\sum \frac{Lb_3}{Lb_2}\right)^2}{Nr}}{Nr - 1} = .00649$$

(c) Calculations of "t"

$$t = \frac{\left(\text{Mean } \frac{Lb_3}{Lb_2} \text{ retic} - \text{Mean } \frac{Lb_3}{Lb_2} \text{ ang}\right) \sqrt{\frac{NrNa}{Nr + Na}}}{\sqrt{\frac{(Nr - 1)\ Sr^2 + (Na - 1)\ Sa^2}{Na + Nr - 2}}} = 7.888$$

PLATE 1

Glyptagnostus reticulatus (Angelin)

All specimens come from Unit 18 (see table 1) at lat. $41^{\circ}45.1'S$, long. $145^{\circ}27.2'E$.

FIG. 1. - UT 54143a, almost complete specimen, x6.4.

FIG. 2. - UT 54129, cephalon, x11.

FIG. 3. - UT 89517d, cephalon, x7.6.

FIG. 4. - UT 54143b, almost complete specimen, x7.6.

FIG. 5. - UT 54129, pygidium, x8.

FIG. 6. - UT 54133, pygidium, x.79.

FIG. 7. - UT 89517b, cephalon, x9.

FIG. 8. - UT 89517c, pygidium, x7.6.

FIG. 9. - UT 89517a, cephalon, x8.

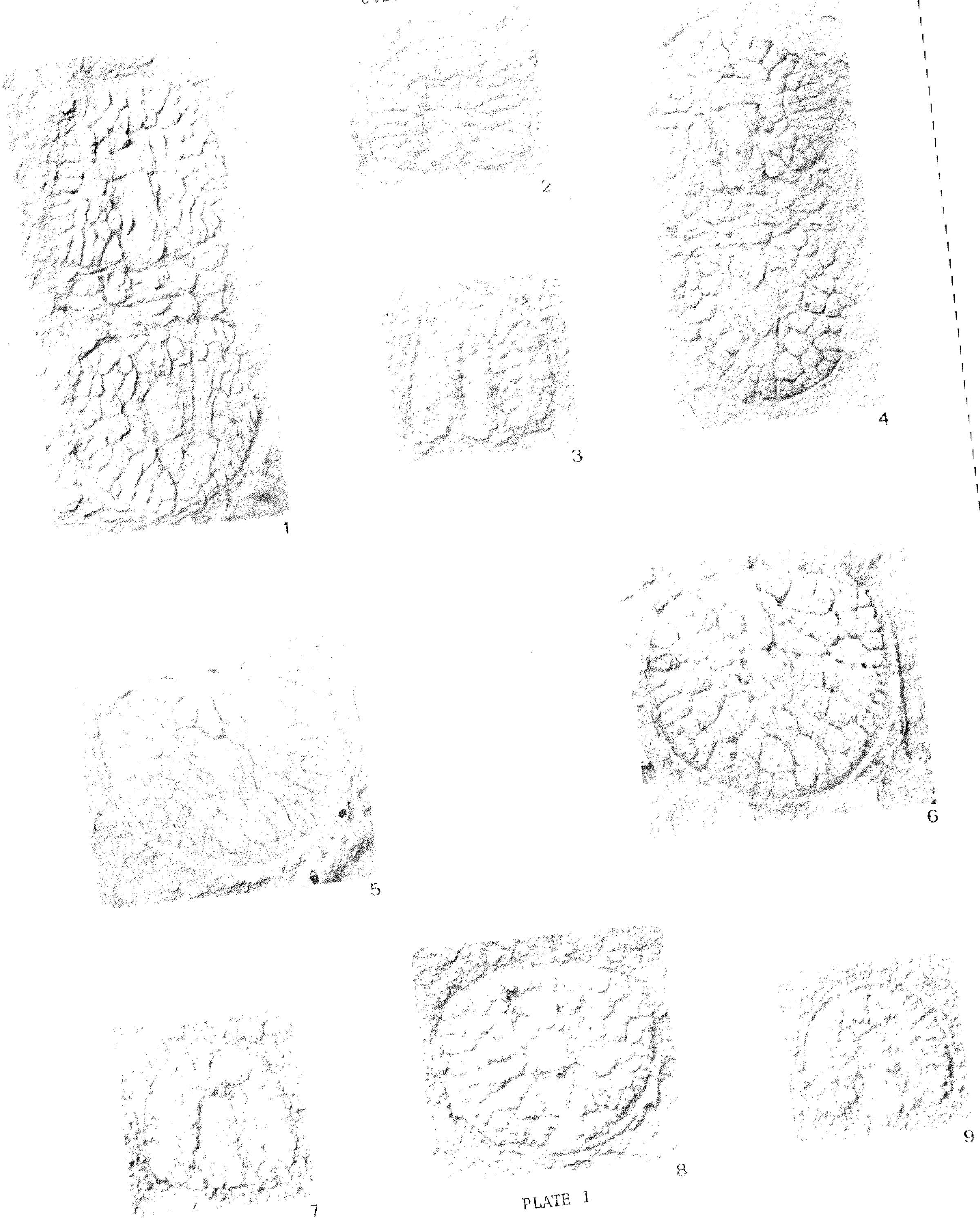

PLATE 1