https://doi.org/10.26749/rstpp.112.137

Papers and Proceedings of the Royal Society of Tasmania, Volume 112, 1978

(ms. received 22.9.1977)

LATE CAMBRIAN FOSSILS FROM THE CLIMIE FORMATION, WESTERN TASMANIA

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(with one table, one text figure and three plates)

ABSTRACT

The Climie Formation, which is about 460 metres thick in the type section of the Dundas Group, contains the youngest known fossils within the Dundas Group. Just south of the Murchison Highway bridge over the Dundas Rivulet the Climie Formation is overturned, sheared and contains poorly preserved fossils in two main horizons, which are well exposed in road cuttings.

The lower fauna occurs about 200 metres below the top of the formation, while the upper fauna occurs about 145 metres below the top of the formation. The lower fauna contains the inarticulate brachiopods *Angulotreta*(?) sp., and *Lingulella*(?) sp., plus the trilobites described herein as *Olenus* sp., *Neoagnostus* sp., *Agnostus* sp., and Ceratopygidae, gen et sp. indet. Five fragmentary trilobite specimens are left in open nomenclature. The upper fauna contains the inarticulate brachiopods described herein as *Lingulella*(?) sp., and Acrotretidae, incertae sedis plus the trilobites *Agnostus* sp., *Lotagnostus*(?) sp., *Peltura*(?) sp., and an unassigned member of the Olenidae. It is suggested that the lower fauna is probably of early post-Idamean age, with the higher fauna being slightly younger. Both faunas are of a cosmopolitan nature and indicate easy communication with the open ocean at the time of deposition.

INTRODUCTION

The purpose of this paper is to describe the Late Cambrian faunas of the Climie Formation, near Dundas in Western Tasmania. Elliston (1954) first mapped the Cambrian sediments of this area and defined the Dundas Group to include thirteen formations with a total thickness of 11,575 feet. This succession was amended slightly by Banks (1956, 1962). Blissett (1962) extensively revised the concept of the Dundas Group, rejected some of Elliston's formations and completely remapped the Dundas area. As noted by Jago (1971) the term Dundas Group should be confined to the section between Razorback and Misery Hills. A. Brown of the Geological Survey of Tasmania is currently investigating the geology of the Dundas area.

The top part of the Dundas Group as detailed by Elliston (1954) and Blissett (1962) is shown in Table 1. As shown in Table 1, Elliston considered that the Misery Conglomerate was part of the Dundas Group and that it was in possible fault contact with the Gordon Limestone of the Junee Group. However, Blissett considered that the Misery Conglomerate was equivalent to the Mt. Zeehan Conglomerate and other basal conglomerates of the Junee Group in Western Tasmania, with the Climie Formation being the top member of the Dundas Group. Blissett considered that the contact between the Climie Formation and the Misery Conglomerate was conformable, a view supported by Williams (1975). Jago (1974) suggested that the contact could be a paraconformity.

Whatever the relationship between the Climie Formation and the Misery Conglomerate, the faunas described below are of considerable significance because they are by far the highest known faunas in the Dundas Group. The top of the Brewery Junction Formation contains a late Mindyallan fauna of *Glyptagnostus stolidotus* Zone age (Jago 1972). Only one fossil, a very poorly preserved olenid trilobite cranidium, is known from the

TABLE 1

COMPARISON OF THE UPPER PART OF DUNDAS GROUP AS DETAILED BY ELLISTON (1954) AND BLISSETT (1962)

(a) Elliston (1954)	Th. (m)	(b) Blissett (1962)	Th. (m)
Ordovician			
JUNEE GROUP		JUNEE GROUP	
Gordon Limestone		Misery Conglomerate	
?Faulted contact?			
Cambrian			
DUNDAS GROUP		DUNDAS GROUP	
Misery Conglomerate	150		
Climie Slate and Tuff	610	Climie Formation	460
Fernflow Conglomerate and Tuff	145	Fernflow Formation	150
Comet Slate and Tuff	320	Comet Formation	150-300
Fernfields Tuff and Conglomerate	595	Fernfields Formation	?0-595
Brewery Junction Slate and Tuff	745	Brewery Junction Formation	610

Th. = Thickness

Fernfields Formation. The Comet Formation contains a few very poorly preserved brachiopod fragments. The Fernflow Formation has yet to yield any fossils.

The Climie Formation is about 460 metres thick in the type section along Dundas Rivulet. As noted by by Blissett (1962, p.31), this sequence is "composed mainly of purple and green greywacke, siltstone and highly cleaved shale." Williams (1975) described the upper part of the Climie Formation in the vicinity of the quarry on the north flank of Misery Hill.

In the vicinity of the Murchison Highway bridge over the Dundas Rivulet, the Climie Formation is overturned and sheared. A short distance south of this bridge the Climie Formation is well exposed in road cuttings, where fossils were discovered in January 1969 by the writer and Dr. B. Daily at lat. 41°54.2'S, long 145°24.2'E. The fossils are generally poorly preserved due to the highly sheared nature of the sediments, and some are seen only as "ghosts" (e.g. pl.3, fig.14), although other fossils are moderately well preserved.

There are two horizons (fig.1) at which fossils are found in reasonable abundance. The lower fauna occurs about 200 metres below the top of the formation, while the upper fauna occurs about 145 metres below the top of the formation. The lower fauna contains the inarticulate brachiopods *Angulotreta*(?) sp. (common), and *Lingulella*(?) sp. (rare), plus the trilobites described below as *Olenus* sp. (common), *Neoagnostus* sp. (common), *Agnostus* sp. (moderately common), rare examples of Ceratopygidae, gen. et sp. indet, Trilobita sp.1, Trilobita sp.2, Trilobita sp.3, Trilobita sp.4 and Trilobita sp.5. The fossils of the upper fauna are much less abundant that those of the lower fauna. The upper fauna contains the brachiopods described below as *Lingulella*(?) sp., and Acrotretidae, incertae sedis, and the trilobites *Agnostus* sp., *Lotagnostus*(?) sp., *Peltura*(?) sp., and Olenidae gen. et sp. indet. Of these, all are rare except *Agnostus* sp., which is moderately abundant.

The composition of neither fauna is distinctive enough to give an accurate age. The earliest representatives of *Neoagnostus* listed by Shergold (1977) are post-Idamean but pre-Payntonian. The presence of *Olenus* sp. suggests that the lower fauna is no younger than the Australian equivalent of the Scandinavian *Olenus* Zone. In Queensland, *Olenus* ranges at least as high as the *Irvingella tropica* Zone, the top zone of the

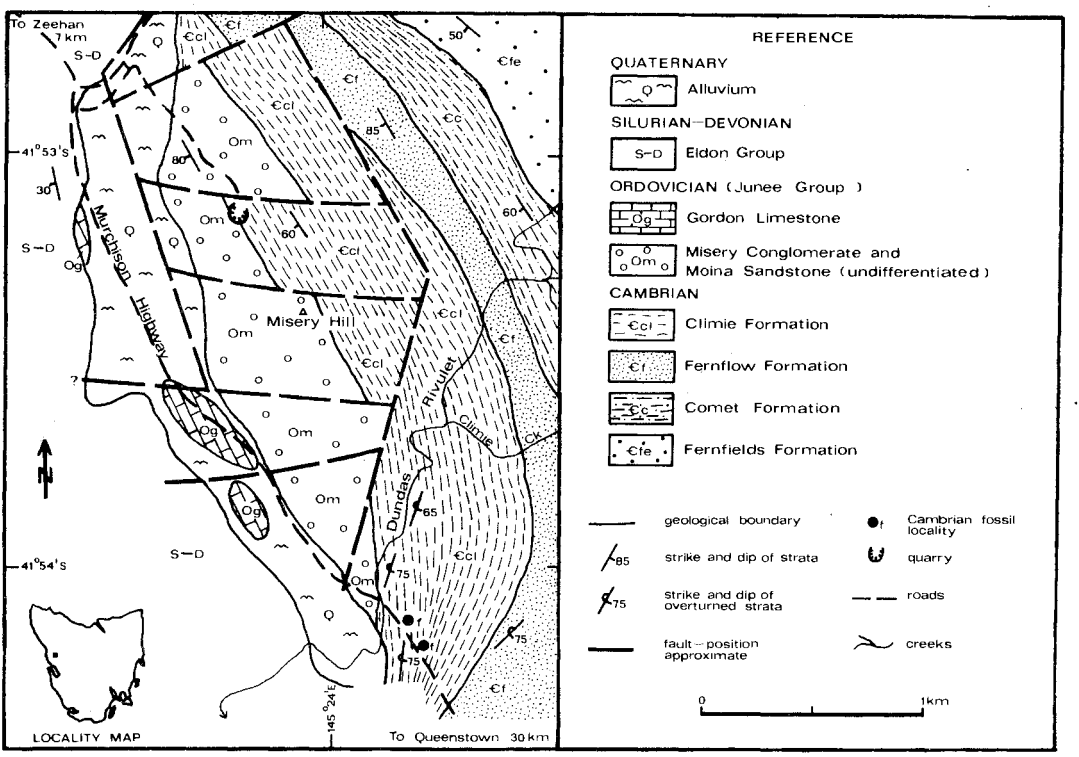

FIG. 1 - Geology of the Misery Hill area (modified after Blissett, 1962).

Idamean (Henderson 1976, p.357). However, as noted by Henderson, correlations between the Australian upper Idamean and the Scandinavian sequences are uncertain.

The presence of a possible *Peltura* and a possible *Lotagnostus* in the upper fauna of the Climie Formation suggests an age somewhat later in the Late Cambrian than those mentioned above. In Scandinavia, *Peltura* does not occur until Zone 5c, which correlates approximately with the pre-Payntonian B "stage" of Queensland (Jones *et al.* 1971). This is consistent with the known age range of *Lotagnostus*.

However, *Peltura*(?) sp. and *Lotagnostus*(?) sp. are known only from single specimens. Hence, it seems better to place more weight on the specimens of the lower fauna for the purposes of age determination. The combination of *Neoagnostus* and *Olenus* suggests a late Idamean or early post-Idamean age, with the later being favoured. Assuming that there was no major depositional break between the time of deposition of the lower and upper faunas, then the upper fauna is presumably slightly younger than the lower fauna.

Williams (1975) noted that the uppermost part of the Climie Formation was of shallow water origin. The faunas noted above are of a cosmopolitan nature indicating

easy communication to the open ocean, and are probably Late Cambrian equivalents to Assemblages 1 and 2 of Jago (1973). However, this does not necessarily imply deep water deposition.

All Tasmanian Cambrian fossils have undergone tectonic distortion to some extent. As noted by Henningsmoen (1960, p.207), there are three main types of symmetrical distortion with respect to the orientation of bilaterally symmetrical fossils such as trilobites and brachiopods: (a) a dorso-ventral compression (flattening), (b) sagittal elongation (the L form of Henningsmoen) (e.g. pl. 1, fig. 18), and (c) transverse elongation (the W form) (e.g. pl. 1, fig. 12). Those fossils in which the distortion has been asymmetrical are stated here to have undergone intermediate distortion, (i.e. the compression took place at an oblique angle to the length of the trilobite, e.g. pl. 2, fig. 3). In cases where no comment is made about the type of distortion, it is because the type of distortion is difficult to determine.

All statements made in the descriptions, such as the cephalon is about as wide as is long, are made after taking the effect of distortion into account. Admittedly, this is a subjective assessment, but I feel that, after inspecting and studying several thousand distorted trilobite and brachiopod specimens, such a judgment seems reasonable. Unless otherwise stated, all length measurements of trilobites were taken in a sagittal or exsagittal line, all width measurements were taken in a transverse direction.

All specimens are housed in the collection of the Geology Department, University of Tasmania. The catalogue numbers refer to this collection.

SYSTEMATIC DESCRIPTIONS

Phylum BRACHIOPODA Dumeril, 1806
Class INARTICULATA Huxley, 1869
Order LINGULIDA Waagen, 1885
Superfamily LINGULACEA Menke, 1828
Family OBOLIDAE King, 1846
Genus *LINGULELLA* Salter, 1866

Type species: *Lingula davisi* M'Coy, 1851, p.405

Lingulella(?) sp.
(Pl. 1, figs. 1-3)

Material: Two decorticated specimens of a large inarticulate brachiopod are known from the Climie Formation.
Description: One specimen (UT 96712a, pl.1, fig.3) is a brachial valve from the lower fauna. It is 8.0 mm long and about 6.0 mm wide. It has an elongate-ovate outline. There are closely spaced fine growth lines (microlines of Biernat and Tomczykowa, 1968) plus at least three concentric macrolines, which are most prominent in the anterior part of the shell. There is a faint radial ribbing. The second specimen (UT 96713, pl.1, figs. 2 & 3) is a pedicle valve from the upper fauna; it is about 11.0 mm long and about 9.0 mm wide. It has a slightly more pointed umbo than has the brachial valve. Due to poor preservation it is difficult to determine if the narrow elongate structure at the posterior end of the valve is genuine or simply an artifact caused by the distortion of the shell. There are fine concentric growth lines on this specimen, but no macrolines. Altered chloritic remnants of the shell material in UT 96713 (pl.1, fig. 3) indicate that it was thin shelled. Even allowing for the flattening and distortion of the two specimens, it would appear that the valves were only gently convex.
Discussion: Although the two specimens come from different horizons, they seem to belong to the same genus, and are tentatively placed in *Lingulella*.

Occurrence: Climie Formation, upper and lower faunas.

Order ACROTRETIDAE Kuhn 1949
Suborder ACROTRETIDINA Kuhn 1949
Superfamily ACROTRETACEA Schuchert 1893
Family ACROTRETIDAE Schuchert 1893

Genus *ANGULOTRETA* Palmer 1955

Type Species: *Angulotreta triangularis* Palmer 1955, p. 769, pl. 91, figs. 1-6.

Angulotreta(?) sp.
(pl. 1, Figs. 4-10)

Material: About twenty individual pedicle and brachial valves are available. One very poorly preserved specimen has the valves still joined together.
Description: The pedicle valve has a high proconical profile (pl. 1, fig. 6). The apparent difference in the position of the beak in UT 96714b (pl. 1, fig. 4) as compared with UT 96715a (pl. 1, fig. 7) is due to the slightly different angle at which the specimens were photographed. No details of the valve interior are visible. The brachial valve is gently convex. A short median septum is visible on one specimen (UT 96716a, pl. 1, fig. 10). No other details of the shell interior are visible. Faint concentric growth lines are visible on both valves.
Discussion: The state of preservation is such that no definite generic assignation can be made. However, the overall shape and appearance of the available specimens suggests affiliation with *Angulotreta*, to which genus they are tentatively referred.
Occurrence: Climie Formation, lower fauna.

ACROTREDIDAE Incertae sedis

One poorly preserved acrotretid, which has both valves present, is known from the upper fauna (pl. 1, fig. 11).

Class TRILOBITA Walch, 1771
Order MIOMERA Jaekel, 1909
Suborder AGNOSTINA Salter, 1864
Superfamily AGNOSTACEA M'Coy, 1849
Family AGNOSTIDAE M'Coy, 1849
Subfamily AGNOSTINAE M'Coy, 1849

Genus *AGNOSTUS* Brogniart, 1822

Type species: *Entomostracites pisiformis* Wahlenberg, 1821.

Agnostus sp.
(pl. 1, figs. 12-23)

Material: There are four reasonably complete specimens, plus several individual cephala and pygidia available for description.
Description: Moderately convex cephalon about as wide as is long. Narrow border with shallow, narrow marginal furrow and a narrow convex rim. The posterolateral corners are nowhere well preserved. Smooth cheeks are separated at the anterior by a shallow preglabellar median furrow which extends to the marginal furrow.

Glabella is outlined by narrow, moderately deep axial furrows, which shallow slightly to the anterior. Glabella is slightly more convex than the cheeks; it has a length about 0.7 that of cephalon. Broadly rounded glabellar rear; small, simple

basal lobes.

The narrow, shallow, transverse glabellar furrow is arched posteriorly. Anterior glabellar lobe has a subpentagonal outline; it has a length about 0.35-0.4 that of the glabella. Immediately to the posterior of the transverse glabellar furrow, the glabella widens slightly, and immediately behind this slight expansion, there is a slight constriction of the glabella. The posterior glabellar lobe has a faint node at its centre.

The moderately convex pygidium is about as wide as is long. The border is slightly wider than that of the cephalon with a shallow marginal furrow and a narrow, slightly elevated, almost flat rim at the posterior which becomes more convex to the anterior. Short border spines; narrow, shallow shoulder furrows; the shoulders are narrow, convex and elevated. The fulcra appear to be close to the axis. Neither the facets nor the articulating device are preserved. The pleural areas are smooth; there is no post-axial median furrow.

The moderately wide trilobate axis is outlined by moderately deep, narrow furrows. The axis has a length about 0.7-0.75 that of the pygidium. The first two axial lobes have a combined length about 0.4-0.45 that of the axis; they are separated by narrow, shallow lateral furrows which are directed quite strongly inwards and forwards. The second axial lobe is separated from the posterior lobe by an almost straight transverse furrow which is bent back at its centre around the posterior of an elongated, convex ridge which extends the length of the anterior pair of axial lobes. This ridge separates the anterior laterial furrows. The posterior axial lobe is slightly expanded; the axial rear is evenly rounded; the axis is constricted at the second axial lobe.
Discussion: This species belongs in *Agnostus* Brongniart, 1822. However, it is not well enough preserved to be referred to either an existing species or be the basis of a new species.
Occurrence: Climie Formation, upper and lower faunas.

Genus *LOTAGNOSTUS* Whitehouse, 1936

Type Species: *Agnostus trisectus* Salter, 1864, p.10, pl. 1, fig. 11

Lotagnostus(?) sp.
(pl. 2, fig. 1)

Only one large cephalon, UT 92571, is known from the upper fauna. It is a poorly preserved internal mould (length, 4.7 mm, width, 7.3 mm). There is a narrow, shallow marginal furrow and a flat, moderately wide rim. The little of the acrolobe that is preserved shows strong scrobiculation.

This cephalon could possibly belong in *Lotagnostus* Whitehouse, *Xestagnostus* Öpik, or *Agnostus* Brongniart. It is placed questionably in *Lotagnostus* until more specimens are known.

Family DIPLAGNOSTIDAE Whitehouse 1936 emend. Öpik 1967
Subfamily PSEUDAGNOSTINAE Whitehouse 1936

Genus *NEOAGNOSTUS* Kobayashi 1955

Type Species: *Neoagnostus aspidoides* Kobayashi 1955, p. 473, pl. 7, fig. 5 (holotype cephalon), *non* pl. 7, fig. 4 (pygidium).

Diagnosis: See Shergold 1977, p. 93.
Discussion: Shergold (1977) has comprehensively discussed *Pseudagnostus* and the

related genera *Neoagnostus* and *Rhaptagnostus*. He has divided *Neoagnostus* into four species groups; Shergold's concept and terminology are followed here.

Neoagnostus sp.
(pl. 2, figs. 2-15)

Material: A total of about forty individual cephala and pygidia are available. Two very poorly preserved complete specimens are available.
Description: Moderately convex, spectaculate cephalon is about as wide as is long. The acrolobes are unconstricted. Narrow rim; moderately wide marginal furrow. Short preglabellar median furrow appears to be present in some specimens (e.g. UT 96724b; pl.2, fig. 7), but not in others (e.g. UT 96720b; pl.2, fig. 3). It may be significant that the specimens, in which the furrows appear to be present are mostly internal moulds, whereas those in which the furrow is absent are external moulds. Small basal lobes do not meet behind the glabellar rear. Distinct axial furrows shallow forwards. Length of glabella about two-thirds that of cephalon. Glabella is widest at anterolateral lobes, where it is about one-third the width of the cephalon. The shallow transverse glabellar furrow is arched gently to the posterior. Large anterolateral lobes are separated from the posterior part of the glabella by shallow furrows which curve inwards and forwards. Slightly elongated glabellar node is placed at anterior end of posterior lobe and between the posterior parts of the anterolateral lobes.

The gently convex pygidium may be slightly longer than is wide. It has unconstricted acrolobes. The pygidial borders are slightly wider than the cephalic borders. Marginal furrows narrow anteriorly. Short, thick spines placed opposite end of deuterolobe. Anterior part of axis is well defined by axial furrow; the axis narrows posteriorly to the rear of the more posterior of two faintly outlined axial lobes. The shallow furrow at the posterior of the second axial lobe is deflected posteriorly at its centre by the prominent elongated node which runs almost the full length of the anterior pair of axial lobes. Accessory furrows are well defined anteriorly but fade posteriorly, although, in most specimens their faint outline can be traced to the posterior border. The accessory furrows meet the posterior border on the adaxial side of the marginal furrows. The intranotular axis is faintly outlined in most specimens, particularly at the posterior end where there is a well defined posterior node.

Discussion: The rather distinctive cephalon of the Climie Formation specimens indicates affiliation with *Neoagnostus*. It may be a new species distinguished by clearly outlined accessory furrows, a well defined intranotular axis and a prominent posterior node. However, the preservation of the Climie Formation specimens is such that the erection of a new species is undesirable.

Shergold (1977) places four species groups within *Neoagnostus*. However, the poor preservation makes determination of the group into which the Climie Formation species falls rather difficult.
Occurrence: Climie Formation, lower fauna.

Superfamily OLENACEA Burmeister 1843
Family OLENIDAE Burmeister 1843
Subfamily OLENINAE Burmeister 1843

Genus *OLENUS* Dalman 1827

Type Species: *Entomostracites gibbosus* Wahlenberg 1821
Diagnosis: See Henningsmoen 1957, p.96.

Olenus sp.
(pl. 3, figs. 3, 5-15)

Material: Several almost complete specimens are available. However, these are all poorly preserved and in some cases are simply "ghosts" (e.g. pl. 3, fig. 14). The description of the cranidium is based largely on the well preserved specimen, UT 92678 (pl. 3, fig. 5). Several other cranidia in various states of preservation are available.

Description

Cranidium: The glabella is quite convex and stands out well above the rest of the rather flat cephalon. Length of glabella (including occipital ring) is about two-thirds that of cranidium. From the posterior the glabella expands very slightly up to the level of the 1p furrows; anterior of the 1p furros it tapers gently forwards. It has a bluntly rounded front, which may have a small centrally placed indentation. Occipital ring is short (sag.), elevated and gently convex, with a small central node. Well developed occipital furrow. Three pairs of glabellar furrows. The most posterior pair (1p) are deep, slightly sigmoidal, and directed strongly backwards; they are deepest at their centre. The second pair (2p) of furrows are shallower, straighter and not as strongly backward directed as the 1p furrows. The anterior pair of furrows (3p) are quite close to the glabellar front and are situated close to the points where the ocular ridges meet the glabella. They are more a pair of depressions than distinct furrows.

The palpebral areas of the fixed cheeks have a width about half that of the glabella. The straight postocular facial sutures diverge greatly. The preocular facial sutures are gently curved. Well developed, narrow palpebral lobes are situated opposite the centroanterior part of the glabella. Narrow, well-developed ocular ridges run inwards and slightly forwards from the anterior part of the palpebral lobes. Very wide preglabellar field has a length (sag.) about one-third that of the cranidium. Faint genal caecae present in preglabellar field of the best preserved specimen (UT 92678; pl. 3, fig. 5). Narrow anterior border, widest at its midpoint; narrow, shallow marginal furrow. Almost straight, wide posterior marginal furrows widen abaxially. Posterior border of moderate width.

Librigenae: Librigenae are attached to two poorly preserved cranidia (UT 96742 and UT 9674b; pl. 3, figs. 7 and 10 respectively). They are transversely narrow, with narrow lateral borders which continue on to long genal spines. Narrow lateral border furrows are continuous with the posterior border furrows.

Thorax: At least 13 thoracic segments are present on the very poorly preserved almost complete specimen UT 96744b (pl. 3, fig. 10), although the exact number is difficult to determine because of the poor preservation. There is a well developed axial region, the pleural furrows are well developed and there are short spines at the end of each thoracic segment.

Pygidium: Well-developed axial region of four or five rings, well rounded posterior stops just short of the posterior border. Axis has a width about 0.3 that of pygidium. Two or three pairs of ribs on pleural areas; at least two of these ribs extend into short spines.

Discussion:

The overall appearance of this species indicates affiliation with *Olenus*. However, it differs from all known species of *Olenus* in the possession of a very long preglabellar area, e.g. none of the several species of *Olenus* discussed and described by Henningsmoen (1957) has a preglabellar area anywhere near as large as the Climie Formation species. With respect to the size of the preglabellar field, the Climie Formation species is probably closest to *Hunanolenus* Liu. However, the species of *Hunanolenus* described and figured by Liu (1977) have twenty-three thoracic segments, whereas the Climie Formation species has about thirteen or fourteen segments, as have some species of *Olenus*. Thus, I prefer to place the Climie Formation specimens in *Olenus*. They almost certainly belong in a new species of *Olenus*, but until better material is found

it is inadvisable to formally erect a new species.
Occurrence: Climie Formation, lower fauna.

OLENINAE, gen et sp. indet
(pl. 3, fig. 4)

Material: One very poorly preserved cephalon and two anterior thoracic segments (UT 96740).
Remarks: This specimen, from the upper fauna of the Climie Formation, may belong in *Olenus*. However, the preglabellar field of this specimen seems to be shorter (sag.) than *Olenus* sp. from the lower fauna.

Subfamily PELTURINAE Hawle and Corda, 1847

Genus *PELTURA* Milne Edwards, 1840

Type Species: *Entomostracites scarabaeoides* Wahlenburg 1821
Diagnosis: See Henningsmoen 1957, p.231.

Peltura(?) sp.
(pl. 3, fig. 2)

Material: One very poorly preserved almost complete specimen, UT 96739. The preservation is such that a formal description is unwarranted.
Remarks: The form of the glabella and of the fixed cheeks of this specimen are similar to that of *Peltura*. However, until better preserved specimens are found, this species will be only tentatively referred to that genus.
Occurrence: Climie Formation, upper fauna.

Superfamily CERATOPYGACEA Linnarsson 1869
Family CERATOPYGIDAE Linnarsson 1869

Genus et sp. indet
(pl. 2, figs. 16, 20)

Material: Two internal moulds of incomplete pygidia (UT 96732 and UT 96733) from the lower fauna are available.
Description: The pygidium has a very wide border which exhibits faint terrace lines. The axis of the more complete specimen has six axial rings. The axis stops just short of the border and has a length about 0.7 that of the pygidium. The anterior pleurae are well developed, although only the base of the spines which emerge from these pleurae are present in the available specimens. There are three other pairs of ribs on the pleural areas.
Discussion: The well developed anterior pleurae and attached spine bases indicate that both specimens belong in the Ceratopygidae. However, there is insufficient material to make a definite generic or specific assignment.

TRILOBITA INCERTAE SEDIS

Specimen 1
(pl. 2, fig. 2)

Material: One poorly preserved incomplete cranidium UT 96737.
Description: The little of the specimen that is visible shows a well developed occipital furrow. The moderately deep 1p glabellar furrows are strongly backwards directed and almost meet at the glabellar axis. The well developed 2p furrows do not extend as far into glabellar centre as do the 1p furrows. The 3p furrows appear as short,

shallow and directed slightly forwards. Palpebral areas of fixed cheeks are small. Prominent, wide palpebral lobes extend from opposite the occipital furrow to about opposite the 3p glabellar furrows.

Discussion: The well developed occipital furrow, the prominent palpebral lobes, small palpebral areas of the fixed cheeks and forwards directed 3p glabellar furrows all suggest affiliation of this specimen with *Stigmatoa*. However, until further, and better preserved material is found then this specimen must remain in open nomenclature.

Occurrence: Climie Formation, lower fauna.

Specimen 2
(pl. 2, fig. 17)

Material: One large partial cranidium, UT 96734, in which only the anterior part of the glabella and the preglabellar area are preserved.
Description: The only pair of glabellar furrows visible are wide shallow depressions placed well to the posterior of the bluntly rounded glabellar front. A small part of a low ocular ridge is preserved. The preglabellar area is long, wide, and has a narrow raised rim. The furrows outlining the glabellar are quite prominent.

Discussion: This specimen may belong in *Briscoia* or a related genus, but more material is required before an accurate identification can be made. This specimen may be part of the same species as the specimens described under Specimen 3.

Occurrence: Climie Formation, lower fauna.

Specimen 3
(pl. 2, fig. 18)

Material: Two large, poorly preserved pygidia, the better preserved of which (UT 96735) is figured.

Description: Large pygidium with axis which stops well short of posterior border. Pygidial margins are entire and non-spinose. Pygidial axes consists of six rings. There are four pairs of pleural ribs which extend almost right across the very wide border area.

Discussion: See Specimen 2 discussion.

Occurrence: Climie Formation, lower fauna.

Specimen 4
(pl. 2, fig. 19)

Material: A few spinose free cheeks are present in the lower fauna. The best preserved of these (UT 96736b) is figured.

Description: These free cheeks are characterized by a long, thin genal spine, a posterior border of moderate width, a shallow posterior marginal furrow and a moderately wide lateral border. Genal caecae are present on the genal field.

Discussion: It is possible that either of the free cheeks described here as specimens 4 and 5 were associated in life with specimens 2 and 3.

Occurrence: Climie Formation, lower fauna.

Specimen 5
(pl. 3, fig. 1)

Remarks: One large free cheek, UT 96738, is present. It apparently has no well developed border, lateral or posterior marginal furrows, or a genal spine.
Occurrence: Climie Formation, lower fauna.

ACKNOWLEDGEMENTS

This work was supported by a grant from the Australian Research Grants Committee (Grant No. E72/15101). Professor G. Henningsmoen (University of Oslo), Dr. B. Daily (University of Adelaide) and Dr. J. Shergold (Bureau of Mineral Resources, Canberra) are thanked for valuable advice. Dr. M.R. Banks and Mrs. P. Green (University of Tasmania) arranged the cataloguing of the specimens.

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PLATE 1

Figs. 1-3. *Lingulella*(?) sp.
1. UT 96712b, brachial valve, rubber cast of external mould, L form,X5.5.
2. UT 96712a, internal mould of specimen figured in fig. 1, X5.
3. UT 96713, pedicle valve, W form,X2.7.

Figs. 4-10. *Angulotreta*(?) sp.
4. UT 96714b, pedicle valve, L form, X5.3.
5. UT 96714b, brachial valve, W form, X7. 6 and 7, UT 96715a, internal mould of pedicle valve exterior.
6. profile, X6.5.
7. X4.6.
8. UT 96715b, rubber cast of pedicle valve exterior, same specimen as figured in figs. 6 and 7, X6.
9. UT 96712b, rubber cast of poorly preserved brachial valve, W form, X9.3.
10. UT 96716a, brachial valve showing poorly preserved median septum, W form,X6.5.

Fig. 11. Acrotretidae, Incertae sedis, UT 96717, X10.

Figs. 12-23. *Agnostus* sp.
12. UT 92535, nearly complete specimen, W form, X7.8.
13. UT 92540, partial pygidium, X10.
14. UT 96714b, partial pygidium, L form, X19.
15. UT 92541, cephalon, L form, X10.
16. UT 92537, pygidium, L form, X10.8.
17. UT 92536, almost complete specimen, L form, X5.8.
18. UT 92536, internal mould of specimen figured in fig. 17, X5.5.
19. UT 96718b, nearly complete specimen, L form, X8.5.
20. UT 92539, poorly preserved partially complete specimen, W form,X5.
21. UT 96714b, cephalon, L form, X8.5.
22. UT 96711, pygidium, W form, X8.
23. UT 96712b, internal mould of pygidium, W form, X8.

Unless otherwise stated, all figures of trilobites are of rubber casts of external moulds. All specimens were whitened with magnesium oxide prior to photography. The specimens illustrated in figures 3, 11, 12, 15, 16, 17, 18 and 20 come from the upper fauna of the Climie Formation. All other specimens come from the lower fauna.


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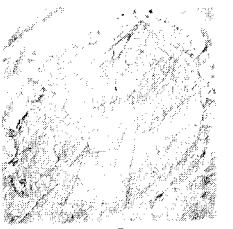
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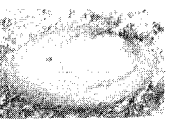
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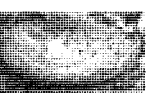
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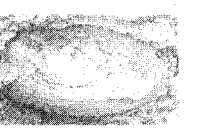
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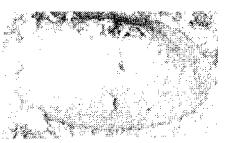
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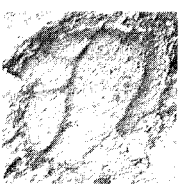
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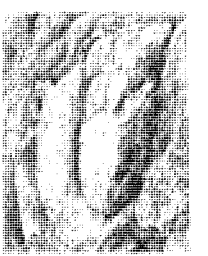
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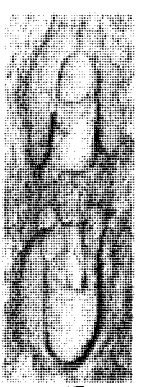
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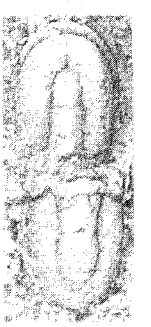
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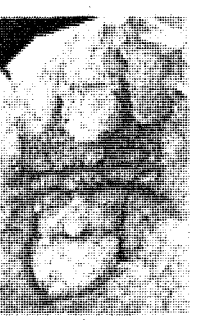
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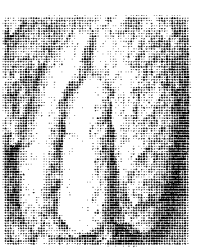
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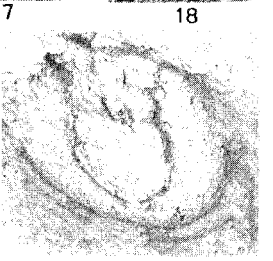
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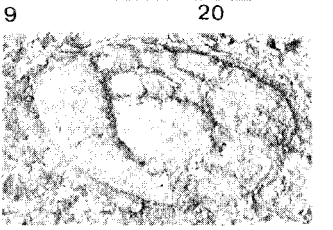
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PLATE 1

PLATE 2

Fig. 1. *Lotagnostus*(?) sp., UT 92571, internal mould of a poorly preserved cephalon, W form, X4.7.

Figs. 2-15. *Neoagnostus* sp.
2. UT 96719, poorly preserved, small complete specimen, L form, X8.
3. UT 96720b, cephalon, intermediate distortion, X10.
4. UT 96721a, cephalon, intermediate distortion, X9.
5. UT 96722, internal mould of pygidium, intermediate distortion, X10.5.
6. UT 96723a, pygidium, W form, X11.
7. UT 96724b, internal mould of cephalon, intermediate distortion, X8.6.
8. UT 96725a, pygidium, L form, X8.
9. UT 96726, cephalon, W form, X10.
10. UT 96727, pygidium, L form, X7.8.
11. UT 96728, pygidium, intermediate distortion, X8.5.
12. UT 96729, pygidium, W form, X6.5.
13. UT 96730, internal mould of pygidium, intermediate distortion, X11.
14. UT 96725a, pygidium, L form, X10.
15. UT 96731, internal mould of cephalon, intermediate distortion, X10.

Figs. 16, 20. Ceratopygidae, gen. et sp. indet.
16. UT 96732, internal mould of partial pygidium, X6.3.
20. UT 96733, pygidium, intermediate distortion, X5.7.

Fig. 17. Trilobita incertae sedis, Specimen 2, UT 96734, partial cranidium, W form X2.5.

Fig. 18. Trilobita incertae sedis, Specimen 3, UT 96736, partial pygidium, W form, X2.

Fig. 19. Trilobita incertae sedis, Specimen 4, UT 96736b, librigena, X5.

Fig. 21. Trilobita incertae sedis, Specimen 1, UT 96737, incomplete cranidium, X7.5.

The specimen illustrated in fig. 1 comes from the upper fauna of the Climie Formation. All other specimens come from the lower fauna.


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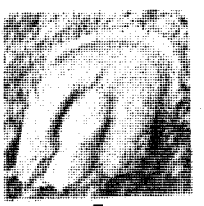
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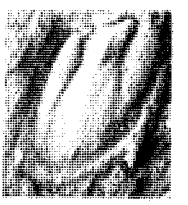
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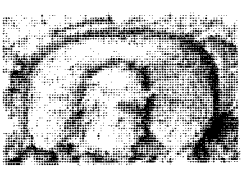
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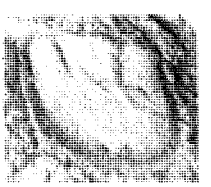
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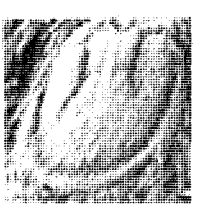
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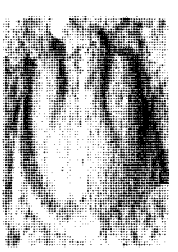
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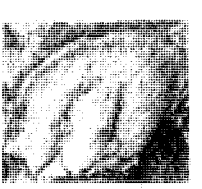
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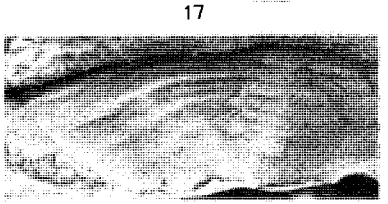
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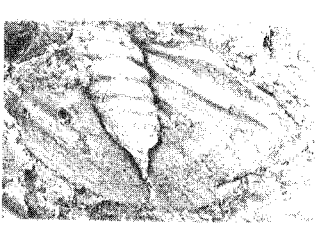
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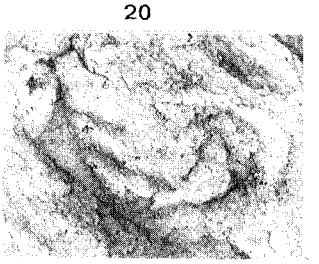
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PLATE 2

PLATE 3

Fig. 1. Trilobita incertae sedis, Specimen 5, UT 96738, internal mould of large librigena, X2.8.

Fig. 2. *Peltura*(?) sp., UT 96739, poorly preserved almost complete specimen, L form, X5.

Fig. 4. Oleninae, gen. et sp. indet, UT 96740, poorly preserved cephalon and two anterior thoracic segments, W form, X5.

Figs. 3, 5-15. *Olenus* sp.

3. UT 96741, internal mould of librigena, X2.5.
5. UT 92678, cranidium, intermediate distortion, X5.
6. UT 96730, internal mould of partial cranidium, X8.
7. UT 96742, partial cephalon and anterior part of thorax, X2.
8. UT 96714a, small badly preserved internal mould of almost complete specimen, X7.
9. UT 96743, internal mould of pygidium and posterior part of thorax, X6.
10. UT 96744b, tectonically broken up almost complete specimen, X2.5.
11. UT 96745a, cranidium and anterior thoracic segment, X5.
12. UT 96746a, internal mould of pygidium, W form, X4.
13. UT 96747a, cranidium associated with small pygidium of *Agnostus* sp., W form, X4.
14. UT 96748, "ghosted" internal mould of almost complete specimen, W form, X2.3.
15. UT 96749, broken up thorax of at least 13 segments, X2.3.

The specimens illustrated in figures 2 and 4 come from the upper fauna of the Climie Formation. All other specimens come from the lower fauna.

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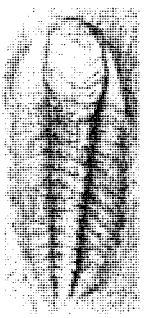

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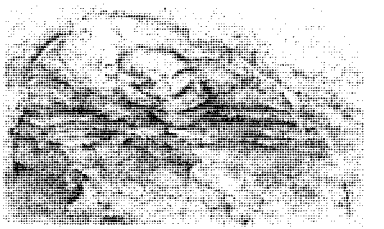

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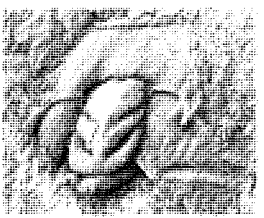

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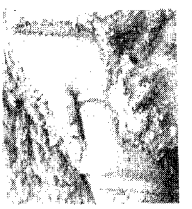

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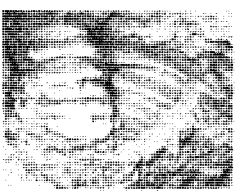

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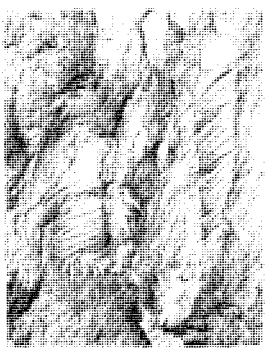

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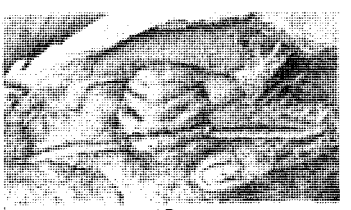

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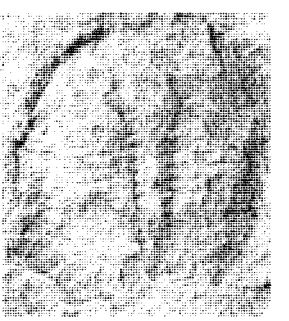

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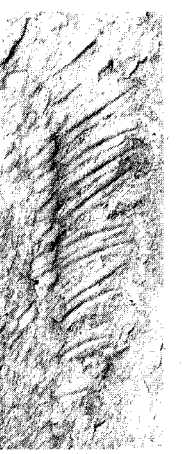

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PLATE 3