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Llandovery trilobites from Washington Land, North Greenland

by

Philip D. Lane

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Abstract

Twenty-eight forms of trilobites obtained from a single block of Lower Silurian limestone are described. Three new species – *Stenopareia somnifer, Cyphoproetus? alyo* and *Harpidella (Harpidella?) helenae* – are erected. The fauna is considered to indicate an upper Lower Llandovery or lowest Middle Llandovery age; it is compared in particular with other faunas from similar lithology.

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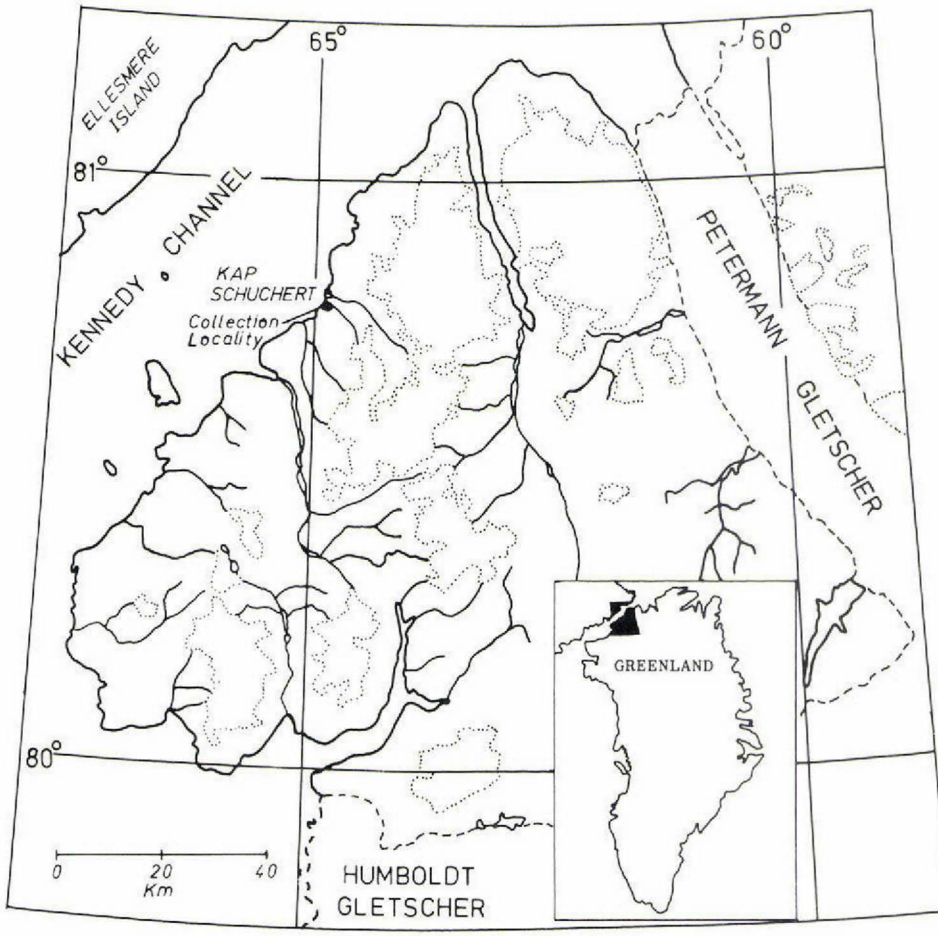

Fig. 1. Locality map, western North Greenland.

INTRODUCTION

The trilobites described in this paper were obtained from a 5 kg block of white/grey coarsely crystalline biostromal limestone of the Cape Schuchert Formation (as defined by Norford, 1972). The block was collected by J. M. Hurst in August 1976 immediately south of Kap Schuchert, Washington Land, North Greenland (Fig. 1). All specimens are from GGU sample 216887. Those with MGUH numbers are deposited in the Geological Museum, Copenhagen. Specimens with GGU numbers (e.g. GGU 216887.1) are stored in the Survey's headquarters.

The trilobites are disarticulated and small, individual elements rarely exceeding 10 mm in maximum dimension. Preservation is excellent, and there appears to be little or no postdepositional distortion of the fossils.

Trilobites account for an estimated 80 per cent of the macrofauna if the abundant crinoid ossicles are ignored. The remainder of the macrofauna is dominated by brachiopods, but includes small numbers of bryozoans, bivalves, rostroconchs, primitiid ostracods and gastropods. As with most of the individual elements of the trilobites the other macrofauna is small. Consequently the block was mostly broken into pieces of around 10 mm in maximum dimension, except where the friable nature of the coarsely crystalline matrix endangered exposed specimens. All trilobite fragments were collected and these form the basis of Table 1.

TERMINOLOGY

Terminology used is essentially that of Harrington *et al.* (*in* Moore, 1959, pp. O117–O126). Lateral glabellar lobes are labelled 'L' and lateral glabellar furrows 'S', and are numbered from the posterior forward. The following terms are used in preference to those listed by Harrington *et al.*: 'anterior pit' for 'fossula', 'cheek' for 'gena', and 'hypostome' for 'hypostoma'. 'Illaenimorph' refers to any trilobite in which the furrows of the dorsal exoskeleton are effaced (Lane & Thomas 1978, p. 356). In describing the raised 'dip-and-scarp' ridges of the exoskeleton of effaced scutelluids and illaenids the term terrace 'ridges' is employed since they differ from the terrace ridges of Miller (1975, p. 157). Miller's term applies only to a structure

Table 1. Taxonomic distribution of trilobite fragments

	Cranidia	Free cheeks	Rostral plates	Hypostomes	Segments	Pygidia
Bumastus? sp. A	14	4	–	–	–	6
Bumastus? sp. B	–	–	–	–	–	1
Kosovopeltis sp.	1	2	–	1	1	2
?scutelluid indet	–	–	–	1	–	–
Stenopareia somnifer	16	14	7	1	24	33
Proetus (Lacunoporaspis) sp.	–	–	–	–	–	1
Cyphoproetus externus	5	6	–	1	–	12
Cyphoproetus? alyo	10	10	–	–	–	–
Tropidocoryphine gen. indet.	1	–	–	–	–	1
Harpidella (Harpidella?) helenae	8	4	–	–	–	1
Scotoharpes sp.	(4)			–	–	–
Hadromeros? sp.	1	–	–	–	–	–
Deiphon cf. *D. dikella*	5	–	–	–	–	–
Youngia sp.	1	–	–	–	–	–
Encrinurus aff. *E. moderatus*	1	–	–	–	–	–
Encrinurus sp. A	10	–	–	–	–	–
Encrinurus sp. B	1	–	–	–	–	–
Encrinurus sp. C	–	8	–	–	–	–
Encrinurus sp. D	–	–	–	5	–	–
Encrinurus sp. E	–	–	–	1	–	–
Encrinurus sp. F	–	–	–	–	–	16
Encrinurus sp. G	–	–	–	–	–	5
Acernaspis (Eskaspis) sp.	–	1	–	–	–	–
Hemiarges sp.	–	–	–	1	–	–
Platylichas sp. A	2	3	–	2	5	2
Platylichas sp. B	1	–	–	–	–	–
Platylichas sp. C	1	–	–	–	–	–
Leonaspis sp.	–	–	–	–	–	1

of the external surface of the exoskeleton; in the taxa described here, the internal surface of the exoskeleton bears a furrow which directly underlies the terrace 'ridge' of the external surface (see for example Plate 2, fig. 14a). 'Visceral surface' is employed for the internal surface of the exoskeleton.

AGE OF THE FAUNA

The fauna described here was collected approximately 10 m stratigraphically below beds containing graptolites indicative of the upper part of the *gregarius* Zone, equating with B1, Idwian stage of the Llandovery (J. M. Hurst, personal communication). The sparse conodont fauna obtained by Dr. R. J. Aldridge from the sample (*Ozarkodina* sp., *Icriodella* sp. and simple cones) although not diagnostic, is compatible with such an age. The small amount of evidence from this trilobite fauna also agrees with a B1 or slightly older age.

(1) *Cyphoproetus externus* only occurs elsewhere in rocks of upper *vesiculosus* to uppermost *gregarius* Zone age in the Girvan area, Scotland.

(2) *Acernaspis (Eskaspis)* sp. of this fauna, represented by a single specimen, falls within the range of variation (so far as eye lens formula is concerned) of a species of this subgenus which occurs in the upper part of the *cyphus* and throughout the *gregarius* Zones of the Girvan region, Scotland.

(3) *Kosovopeltis* sp. is similar to, although probably not conspecific with, *K. cunctatum* from the *cyphus* and *gregarius* Zones of the Girvan area, Scotland.

(4) In British sections, *Hadromeros* is not known to occur in beds younger than *gregarius* Zone.

(5) The *Deiphon* in this fauna is of *dikella* type. *D. dikella* occurs only in rocks of mid Rhuddanian age.

COMPOSITION OF THE FAUNA

Table 1 shows the taxonomic distribution of the 265 trilobite fragments recovered from the limestone block. How far the assemblage may be regarded as representative of a natural association of animals is uncertain. The largest element obtained, an illaenid pygidium of 37 mm maximum dimension, is small in comparison with the largest elements in related species. Many specimens are considerably smaller than this and the implication is that some size sorting has operated, at least removing larger elements from the fauna.

Lane (1972, p. 338) in dealing with a fauna from pure limestone of slightly younger age from Kronprins Christians Land, northern East Greenland, pointed to the occurrence of a preponderance of members of the same trilobite families in faunas from such lithologies. Members of the Illaenidae, Cheiruridae and Harpetidae form a very high proportion of such faunas from rocks of Lower Ordovician to Middle Devonian age, although in Upper Ordovician to Wenlock examples illaenids are increasingly replaced by scutelluids of 'normal' and 'effaced' type; illaenids are not present in Ludlow and younger rocks.

Fortey (1973, p. 340) considered that in the Lower Ordovician of Spitzbergen an

Table 2. Composition of the fauna described in this paper and that from slightly younger rocks in Kronprins Christians Land

	This paper			Lane, 1972		
	% cranidia	% pygidia	% combined	% cranidia	% pygidia	% combined
scutelluids & illaenids	37.3	52.4	44.8	30.2	62.0	39.0
proetaceans	28.9	18.2	23.6	7.9	10.3	8.6
harpetids	4.8	–	2.4	26.3	–	19.0
cheirurids	8.4	–	4.2	27.6	27.5	27.6
encrinurids	14.4	25.6	20.0	–	–	–
phacopids	1.2	–	0.6	–	–	–
lichids & odontopleurids	4.8	3.7	4.2	2.6	–	1.9
calymenids	–	–	–	5.2	–	3.8

assemblage of trilobites dominantly belonging to these families inhabited an algal carbonate bank environment.

Table 2 compares the fauna from northern East Greenland with that described here. In the former example, scutelluid-illaenid, harpetid and cheirurid trilobites form 85.6 per cent of the total fauna (calculated as a proportion of total cranidia + pygidia). In the fauna described in this paper, such trilobites account for only 50.5 per cent of the fauna calculated on the same basis, with proetaceans much more abundant and encrinurids making a significant appearance.

Although it is likely that different proetaceans had different ecological requirements, encrinurids are minor constituents of carbonate bank faunas in Silurian rocks; they seemingly preferred nearshore shelf limestone and shale environments (Thomas, 1979, fig. 2). The fauna described above falls between trilobite associations proposed by Thomas (1979, fig. 3); it has elements referable to those in 'sparry algal limestones' (*Radnoria/Cornuproetus* association) and in 'shelf limestones' (*Proetus/Warburgella* association).

SYSTEMATIC DESCRIPTIONS

Family SCUTELLUIDAE Richter & Richter, 1925

Diagnosis. See Lane & Thomas, 1978 b

Genus *Bumastus* Murchison, 1839

Type species. By monotypy; *Bumastus barriensis* Murchison, 1839, from the Wenlock Series, West Midlands, Britain.

Remarks. The arguments for considering *Bumastus* and some other effaced illaenimorph trilobites to belong to the Scutelluidae have been fully presented in Lane & Thomas (1978 a, b).

Bumastus? sp. A.
Plate 1, figs 1–6, 14–16

Material. MGUH 14136–39, GGU 216887. 1–9 (cranidia), MGUH 14140, GGU 216887. 10, 11 (free cheeks), MGUH 14141–44 (pygidia).

Description. Convex cranidium with axial furrow present posteriorly, where it is weakly impressed and runs a little obliquely inwards and forwards from the posterior margin to the lateral muscular impression; anterior to this impression it is exceedingly indistinct and only visible on the internal mould running a little way forwards and obliquely abaxially. Palpebral lobe long, lacking independent convexity, exsagittally at least one third the sagittal length of the cranidium in palpebral view. Anterior section of facial suture slightly curved convex outwards.

Lateral muscular impression small and ovate, its long axis (exs.) about one fifth the exsagittal length of the palpebral lobe, the mid-lengths of the two features being approximately coincident. On the external surface of the exoskeleton the lateral muscular impression is very indistinct; its adaxial side is much more deeply impressed, especially in the internal mould. Median tubercle small, placed on a transverse line which lies approximately half way between the posterior margin and the posterior of the lateral muscular impression. Anterior pit distinct (on internal mould) placed at about one quarter distance from anterior section of facial suture and the sagittal line, and at this distance from the anterior margin. At least two pairs of cranidial axial muscle impressions preserved; 0g ovate-rectangular, long axis running anteriorly and adaxially at about 45° to sagittal line, about as wide as the exsagittal length of the lateral muscle impression, and the pair about this distance apart anteriorly; anterior margin of 0g on a line with mid length of lateral muscle impression. 1g larger, widening forwards, possibly confluent sagittally, forming a heart-shaped area, reaching from just anterior to 0g, to opposite the widest part of the pre-palpebral portion of the cranidium.

Cranidium with terrace 'ridges' only in a zone close and parallel to the anterior margin. These ridges closely set, have a reflection on the visceral surface of the exoskeleton and the width of the zone they occupy is about one fifth the sagittal length of the cranidium measured around its circumference.

Free cheek of relatively low convexity, as is the visual surface; socle lacking. Terrace 'ridges' only present marginally (only preserved at anterior) where the most dorsally placed ridge is very strongly developed and is succeeded by a few more, which are placed more ventrally due to the maximum convexity of the free cheek at this point. Field of free cheek (mainly seen as internal mould) apparently lacks terrace 'ridges'. Genal angle and lateral margins not preserved. Doublure

with a few strongly developed terrace 'ridges' dorsally reflexed and convex, and increasingly so posteriorly so that a section through the lateral margin of the exoskeleton in the anterior one third of the free cheek would be U-shaped, but posteriorly would show a 'tube' owing to the close proximity of the reflexed inner margin of the doublure and the visceral surface of the field of the free cheek.

Largest pygidium much less convex than cranidia of similar size. Anterior margin an even curve as far as adaxial end of articulating facet which itself accounts for about one fifth of the anterior margin; curve of anterior margin increases at facet as this lies at about 40° to the transverse line. Convexity in the sagittal line increases over the posterior half of the pygidium. Doublure occupies about one quarter total sagittal length, anteriorly first widening a little and then narrowing near articulating facet. On internal mould the sagittal line has a median ridge occupying a distance from one half to three quarters of the way from anterior, this feature becoming a groove over most of the distance underlain by the doublure. Parallel to posterior and lateral margins there is a faintly developed concave zone. Terrace 'ridges' only present in extreme anterolateral corners.

In smaller pygidia, which have a similar convexity to the larger, the anterior margin is more interrupted by the adaxial part of the articulating facet, there is additionally a faintly raised triangular area occupying one third of the anterior width and reaching about one third way back along pygidium, and the marginal concavity is better marked.

Discussion. Lane & Thomas (1978b, pp. 10, 11) restricted the genus *Bumastus* by considering certain characters to be of critical importance in its diagnosis. Amongst these are the presence on the rostral plate of a strongly reflexed posterior flange. The lack of a rostral plate in the material studied, therefore, precludes but a questionable assignment to the genus. However, the cranidia, free cheek and pygidia described above probably belong to a single species since they are similar to those elements in species referred to *Bumastus*. This material is distinct from such effaced scutelluids as '*Bumastus*' *macallumi* (Salter, 1867, p. 210, pl. 28, fig. 1; pl. 30, figs 2, 3) from the Llandovery of Scotland, and also from Wenlock species of *Bumastus* and *Bumastus*? from Wales and the Welsh Borderland (see Lane & Thomas, 1978b) in the combined characters of a very convex cranidium, free cheek and visual surface of low convexity and the lack of an eye socle. Additionally, the muscle impressions of the cranidial axis have a pattern unknown in any other species, terrace 'ridges' are but sparsely developed on the surface of the exoskeleton, and the pygidia lack the very narrow but distinct marginal ridge and groove common in many effaced scutelluids.

A number of small cranidia are preserved in the fauna, which although of illaenimorph nature are difficult to assign with certainty to either *Bumastus* sp. A or *Stenopareia somnifer* sp. nov. (see below). However, seven such specimens (MGUH 14139, GGU 216887. 4–9) have a relatively longer (exs.) palpebral lobe

(about one third of the sagittal length as opposed to one quarter) and these I consider to be effaced scutelluids. In addition to the relatively longer palpebral lobe the glabella only narrows very slightly from the posterior margin forwards, before widening. I have figured representatives of what I consider to be these two types of small cranidia together on Plate 1 to facilitate comparison.

Poulsen (1934, pl. 3, figs 11, 12) figured as *Bumastus* sp. ind. a portion of thorax and a crushed pygidium. They are undoubtedly of effaced scutelluid type; the pygidium, although larger than any found in the present fauna, is relatively much longer and I do not consider the two to be conspecific. Poulsen also figured a cranidium (1934, pl. 3, fig. 13) as *Illaenus* sp., which since it is only shown in dorsal view is difficult to assign to a genus. The specimen which is an internal mould of relatively small convexity, has an anterior pit (with central node) and anterior node, and also shows the reflection of terrace 'ridges' and pits over most of its visceral surface. For these reasons I consider the specimen to be an effaced scutelluid, and assign it, and the thorax and pygidium discussed above, questionably to *Bumastus*.

The morphology of both surfaces of the exoskeleton have been found of critical importance in defining species of this difficult group. Since these are not known for several parts of the exoskeleton, and there is only a small amount of material available, this species is placed under open nomenclature, although it is without doubt new. Furthermore, until the discovery of a complete specimen, some doubt must always exist as to whether the elements described above have been correctly associated.

Bumastus? sp. B

Plate 1, fig. 7

Material. MGUH 14145 (pygidium).

Discussion. This pygidium differs from those referred to *B*? sp. A in the following points. It is relatively much wider, less convex, has a much more distinct depression behind the anterolateral articulating facets, has an anterior margin less arched forward, lacks a marginal concave zone, and possesses a distinct posterior and lateral marginal ridge and groove.

It is excluded from the Illaenidae because it lacks an anterior margin which would be consistent with the inner part of the thoracic pleurae having a horizontal articulating section. It does not resemble any described effaced scutelluid.

Genus *Kosovopeltis* Šnajdr, 1958

Type species. By original designation; *Kosovopeltis svobodai* Šnajdr, 1958, from the Ludlow of Czechoslovakia.

Diagnosis. See Šnajdr, 1960, p. 247, with amendments outlined by Campbell, 1967, p. 12.

Kosovopeltis sp.
Plate 1, figs 9–13

Material. MGUH 14146 (cranidium) MGUH 14147 (free cheek), MGUH 14148 (hypostome) MGUH 14149 (thoracic segment), MGUH 14150, GGU 216887.12 (pygidia).

Description. Cranidium convex. Glabella decreasing in width from occipital ring to a minimum opposite lateral muscular impression, anterior to this widening at a slightly increasing rate to its widest point close to the anterolateral margin. From posterior margin to anterior, axial furrow is decreasingly distinct so that the anterolateral corner of the frontal lobe of the glabella is apparently confluent with the anterior part of the fixed cheek. 0g incompletely preserved, apparently twice as long (exs.) at the axial furrow as the abaxial part of the occipital ring (exs.). 1g largest of glabellar muscle impressions, placed almost wholly anterior to the lateral muscle impression, just reaching axial furrow; elongate, with long axis parallel to axial furrow, having anterior and posterior divisions, the posterior being slightly depressed. 2g subcircular, small, placed at its own diameter from axial furrow and from 1g, with its posterior margin opposite the anterior of the palpebral lobe. 3g transversely elongate, short (exs.), placed at one and a half times the diameter of 1g in front of that impression. 2g and 3g extend the same distance from the sagittal line, so that 3g is slightly farther placed from the axial furrow.

Fixed cheek weakly convex transversely, more so exsagittally and increasingly so anteriorly. Lateral muscular impression ovate, convex, same size as 2g, subcircular, placed adjacent to axial furrow, on the opposite side of which it largely occupies the gap between 0g and 1g. Palpebral lobe strongly rounded; palpebral rim wide and slightly convex, extending into a straight weak ocular ridge which is directed towards a point on the glabella at the axial furrow just anterior to 3g, but becoming indistinct before reaching axial furrow. Surface of cranidium with terrace 'ridges' extensively developed, only lacking on muscle impressions and axial furrow; these ridges increasingly regular and closely spaced over anterior half of glabella, elsewhere irregularly anastomosing and less closely spaced.

Free cheek with long, pointed, stoutly based genal spine. Field of free cheek, at least posteriorly, gently convex between the wide indistinct furrow parallel to the low, convex eye socle, and a lateral submarginal concave zone which widens rapidly anteriorly. Doublure very wide (anteriorly), reaching almost as far in as beneath the eye socle. Terrace 'ridges' present over almost whole of free cheek, dorsally appearing to radiate from a point where the posterior section of the facial suture cuts the posterior margin; these very irregular, turning markedly forward over the lateral submarginal concave zone, abaxial to this becoming more numerous and turning very sharply back over a lateral convexity. On the wide doublure (anteriorly), terrace 'ridges' are subparallel, widely spaced and exhibit little anastomosing.

Hypostome subtriangular, markedly convex owing to the large anterior lobe of

the middle body. Posterior lobe poorly defined except anterolaterally by the middle furrows behind which lie gently raised maculae. Border furrows deepest where middle furrows join. Lateral border widest opposite anterior lobe of middle body, narrowing posteriorly to join narrow posterior border. Anterior lobe of middle body with terrace 'ridges' subparallel to subtriangular posterolateral outline of hypostome; absent on posterior lobe. Lateral and posterior borders with a single continuous terrace 'ridge'.

Fragment of thoracic segment shows about one third each of an axial ring and articulating half ring, and inner portion of pleura, which are of typical construction for the genus. Terrace 'ridges' on axial ring are irregular and curve convex forwards; on the pleura they are very irregular and approximately exsagittally disposed.

Pygidium wider than long, overall gently convex with a submarginal concave zone laterally and posteriorly. Axis forming about one third of sagittal length, showing about 5 weakly distinct rings. 7 pairs of pleural ridges, with posteriorly wide unpaired median rib. Posterior part of pleural field of pygidium with a few terrace 'ridges' which run close to the transverse direction.

Discussion. Howells (1978, pp. 21, 170) considered both *Eokosovopeltis* (Přibyl & Vaněk, 1971) and *Heptabronteus* (Webby, 1974) as subjective junior synonyms of *Kosovopeltis. Eokosovopeltis* was erected with *Bronteus romanovskii* (Weber, 1948) as type species and with diagnostic characters (when characters typical of non-effaced scutelluids in general are ignored) stated to be the lack of a long (sag.) anterior cephalic border and isolated glabellar muscle impressions placed close to the axial furrow. These characters do not constitute sufficient reason to separate *romanovskii* or the other species referred to *Eokosovopeltis* from *Kosovopeltis.* Webby (1974, p. 215) whilst admitting a close resemblance between *Heptabronteus* and *Kosovopeltis,* also referred *romanovskii* to his new genus, being apparently unaware of Přibyl and Vaněk's taxon. Webby's diagnosis of *Heptabronteus* embraces characters which are typical of non effaced scutelluids in general and of *Kosovopeltis* in particular so that there is no justification for the erection of a new genus. Consequently, in agreement with Howells, *Eokosovopeltis* and *Heptabronteus* are synonymized with *Kosovopeltis.* The stratigraphic range of the genus is Caradoc to Lower Devonian (Bourque & Lespérance, 1977).

In overall proportions the material described here most closely resembles *K. cunctatum* (Reed, 1931, p. 97, pl. 4, figs 1–4; Howells, 1978, p. 23, pl. 1, figs 1–13) from the Llandovery (upper Rhuddanian and Idwian) of the Girvan area of Scotland. Possible significant differences are the possession by the material described here of a transverse elongate 3g (subcircular in *cunctatum*), the rather wider and more triangular hypostome with very narrow posterior border having but a single terrace 'ridge'. *K. borealis* (Poulsen, 1934, p. 27, pl. 3, figs 14–15), from beds in Washington Land stratigraphically a little higher than those from which the present

fauna was obtained, differs from *K.* sp. in its better defined axial furrow anterolaterally, the narrower and more parallel sided posterior part of the glabella, the strongly developed eye ridge and the much more strongly developed terrace 'ridges'.

? scutelluid indet.
Plate 1, fig. 8

Material. MGUH 14151 (hypostome).

Discussion. This small hypostome is subquadrate in outline (ignoring the anterior wings), has well developed lateral and posterior borders and a posterior margin which although possibly incomplete is either broadly rounded or transverse; the middle body is quadrate, posterior lobe poorly defined with prominent maculae. Terrace 'ridges' are present everywhere except on the posterior and lateral border furrows. In general morphology this hypostome is not unlike that figured as *Kosovopeltis cunctatum* (Howells, 1978, pl. 1, figs 9a–c), but differs in having a shorter posterior lobe of the middle body. In view of the small size of the specimen, further comparisons have not been attempted.

Family ILLAENIDAE Hawle & Corda, 1847
Subfamily ILLAENINAE Hawle & Corda, 1847
Genus *Stenopareia* Holm, 1886

Type species. By original designation; *Illaenus linnarssonii* Holm, 1882 from the Ordovician of Dalarne, Sweden.

Diagnosis. See Jaanusson, 1954, p. 570.

Stenopareia somnifer sp. nov.
Plate 1, figs 17–25; Plate 2, figs 1–14; Plate 3, figs 1–2; Plate 5, fig. 3.

Derivation of name. Latin 'sleep-producer' referring to the paucity of morphological characteristics displayed by the species.

Material. Holotype MGUH 14152 (pygidium). Paratypes MGUH 14153–57, GGU 216887.13–17 (cranidia), MGUH 14158–60, GGU 216887.18–21 (rostral plates), MGUH 14161 (hypostome), MGUH 14162–64, GGU 216887.22–30 (free cheeks), MGUH 14165–66, GGU 216887.31–33 (thoracic segment fragments), MGUH 14167–77, GGU 216887.34–51 (pygidia).

Diagnosis. *Stenopareia* with 12–13 terrace 'ridges' on rostral plate; pygidial doublure with sharp anteromedian projection which is folded in the sagittal line to produce a median ridge on the ventral side of the doublure and a corresponding furrow on its visceral surface.

Description. Cranidium very convex. Axial furrows almost parallel, but slightly convergent anteriorly, continuing only a short distance anterior to the lateral muscular impression, where they are a little divergent anteriorly. Lateral muscular impression represented as a slight deepening of the axial furrow with a weak concavity abaxial to this, placed about four times its own exsagittal length from the posterior margin. Postocular part of fixed cheek bluntly pointed. Anterior section of facial suture slightly curved convex outwards, and slightly convergent anteriorly. Terrace 'ridges' only preserved anteriorly.

Free cheek evenly convex; eye small with very convex visual surface, and placed far back. Terrace 'ridges' irregularly disposed, occupying outer half of field of free cheek, increasing in regularity and proximity towards lateral margin. Distinct narrow groove and ridge developed at lateral margin.

Rostral plate twice as wide as long, with curved anterior margin, lateral margins convergent backwards, posterior margin with increased curvature in mid line, producing a bluntly rounded angle. Overall convexity gentle, increasing posteromedially. Beneath posterior margin is a triangular flange with transverse or gently convex forwards anterior margin, which reaches forwards over about one quarter of the sagittal length of the rostral plate. Terrace 'ridges' approximately evenly spaced, regularly disposed and subparallel to anterior and posterior margins, 12–13 in number, lacking on rostral flange.

Hypostome approximately trapezoid in outline with prominent rounded anterior wings and concave outwards lateral margins. Anterior margin a little concave forwards, posterior margin transverse. Lateral border furrow only distinct over mid and posterior of its course. Anterior lobe of middle body large, convex, posterior lobe of middle body large, convex, posterior lobe indistinct. Posterior and lateral borders narrow; maculae distinct.

Thoracic segments known from fragments, of typical morphology for the genus. Terrace 'ridges' present on articulating facet; internal mould bears small granules which are more common on pleural than axial portions.

Pygidium a little less than one and one half times as wide as long (sag.), and two and one half times as wide as the median arch. Convexity increases in mid line towards posterior. Median arch distinct, behind which a subtriangular area of slight independent convexity lies which reaches about half way back in sagittal line in dorsal view; this convexity flanked by weak concavities, at the posterior of which weakly impressed concave muscle areas are indicated on the internal mould. Articulating facets strongly developed, longer than the portion of the anterior margin between median arch and facet. Lateral and posterior margin of pygidium rounded, the curve increasing slightly towards mid line posteriorly. Doublure convex ventrally, bearing more or less regular terrace 'ridges' parallel to posterior and lateral margins, 9–10 in number. Anteromedially, doublure bears a projection which is reflexed a little downwards in relation to the convex doublure, to parallel the upper surface of the exoskeleton. This projection is folded in the sagittal line to produce a

distinct ridge on the ventral, and furrow on the corresponding visceral surface of the doublure. Terrace 'ridges' are only present dorsally on the articulating facets.

Discussion. Small specimens of *S. somnifer* are more convex than larger ones, particularly in the pygidium. Consequently, small pygidia appear to differ from larger in the length of the articulating facet and position of the widest part of the pygidium. Because of this relatively greater convexity, small pygidia when seen in dorsal view have an apparently longer articulating facet. The widest (tr.) part of the pygidium, which in all specimens lies at the posterior end of this facet appears in small specimens to be at about the mid length (sag.); in larger specimens it lies at about one third from the anterior margin (compare Plate 1, fig. 17a with Plate 3, fig. 2).

There have been differing opinions as to the taxonomic value of the morphology of the anteromedial portion of the doublural margin. Whittington (1963, p. 68) following Jaanusson (1954, p. 574; 1957, p. 109) considered the development of pointed and cuspidate projections important, amongst other characters. Whittington (1963, p. 67) illustrated the pygidia of four species of illaenids from the Middle Ordovician of Newfoundland, each of which had a distinctive outline to the sagittal part of the anterior doublural margin. This character has also been found important in discriminating between species of *Stenopareia* from the Llandovery of the Girvan region, Scotland by Howells (1978, pp. 45–46). She recognizes four species of *Stenopareia,* in which, amongst other characters, the anterior margin of the doublure in the mid line is variously projected forwards, into a point, a cusp or an anteriorly transverse feature. Dean (1978, p. 102) in dealing with illaenid trilobites from the Chair of Kildare Limestone of Ashgill age from Eire, did not consider the morphology of the anterior margin of the doublure important in separating species. He included in *S. linnarssonii* pygidia some having one and some three projections in this position.

The information presented by the present material is important in this respect. Pygidia are known ranging in size from a maximum transverse width of 3.5 mm to 37 mm, and in all of these the morphology of the doublural projection is similar. The implication is that such a character, which is of constant morphology in a series of individuals which range widely in size but which are from a very restricted collection, might be a useful specific indicator. I consider it as such, and include it in the diagnosis.

Although excavation of the specimen was usually necessary where a convenient fracture had not been made in breaking the block, some specimens (e.g. MGUH 14172, Plate 1, fig. 25) showed the doublural projection reflected as a darker coloured patch when looking at the dorsal exoskeleton. Presumably in these specimens the space between the doublure and the dorsal exoskeleton had become filled with some darker sediment prior to or during burial. The feature is not considered to be due to an original colouration.

Few *Stenopareia* hypostomes have been described. That of *S. somnifer* differs from that of *S. linnarssonii* (see Dean, 1978, p. 101, pl. 47, figs 10, 13) in being relatively slightly longer (sag.), in having more laterally projecting anterior wings, a relatively larger anterior lobe of the middle body and better developed maculae. The overall trapezoidal outline, however, seems to be characteristic of the genus.

S. somnifer most closely resembles species of *Stenopareia* from the Llandovery of the Girvan area, Scotland. Its morphology falls between two undescribed species, the older of which ranges from upper Rhuddanian to Idwian, the younger from upper Fronian to lower Telychian. Although both these Scottish species have pointed projections on the anterior margin of the pygidial doublure, the former differs from *S. somnifer* in having a relatively wider doublure and an unfolded projection, although the overall proportions of the pygidium are similar. The younger Scottish species has a relatively much wider and shorter pygidium, but has a folded doublural projection.

Family PROETIDAE Salter, 1864

Diagnosis. See Owens (1973a, p. 6).

Subfamily PROETINAE Salter, 1864

Diagnosis. See Owens (1973a, p. 8).

Genus *Proetus* Steininger, 1831
Subgenus *Lacunoporaspis* Yolkin, 1966

Type species. By original designation; *L. contermina* Yolkin, 1966, from the Eifelian of south-west Siberia.

Diagnosis. See Owens (1973a, p. 15).

Proetus (Lacunoporaspis) sp.
Plate 3, fig. 3.

Material. MGUH 14178 (pygidium).

Description. Axis anteriorly forming less than one third maximum width of pygidium, with seven well defined rings, which towards axial furrow bear a distinct depression. Pleural areas with four well, and a fifth poorly defined pleural ridge, which curve gently back and are truncated at the inner edge of a very narrow border. First and second interpleural furrows rather more distinct than more posterior ones, which themselves are of equal depth to the pleural furrows. Anterior

pleural band wider adaxially than posterior pleural band; the latter widens abaxially to equal the width of the anterior band, just before lateral border narrowing rapidly. In the anterior pleura only, this rapid narrowing is accompanied by a widening of the anterior pleural band.

Discussion. Of species referred to *Proetus (Lacunoporaspis)*, this species most closely resembles *P. (L.) obconicus* Lindstrom, 1885 (see Owens, 1973a, p. 17, pl. 4, figs 11–19, Pl. 5, fig. 1) which occurs in the Ludlow (Leintwardinian and possibly Whitcliffian) of Gotland and Britain. The Greenland pygidium is similar in general outline, but differs in showing fewer axial rings and pairs of pleural ribs (seven and five respectively compared to eight or nine and six in *obconicus*), a narrower border, and the pleural ridges are distinct further abaxially. Both, however, show the lateral depressions of the axial rings and the rapid narrowing of the abaxial part of the posterior pleural bands at least in the anterior ones.

In number of pleural ribs and number and form of axial rings this pygidium agrees well with *Proetus ainae* Warburg, 1925 (see Owens, 1973b, fig. 1L). The pygidium described above, however, has much more distinctly delimited pleural and interpleural furrows, and a very bluntly rounded termination of the axis.

Genus *Cyphoproetus* Kegel, 1927

Type species. Subsequently designated by Přibyl, 1946a, p. 15; *Cyphaspis depressa* Barrande, 1846, from the Wenlock Series of Czechoslovakia.

Diagnosis. See Owens (1973a, p. 27); emended Thomas (1975, p. 34) to allow for the absence of occipital lobes in some species.

Cyphoproetus externus (Reed, 1935)

Plate 3, figs 4–6, 8, 10, 14; Plate 4, figs 5, 10, 11, 15, 16

1935 *Proetus (Cyphoproetus) externus* Reed, p. 42, pl. 2, fig. 15.
1973 *Cyphoproetus externus* (Reed, 1935); Owens, p. 32, pl. 6, figs 6–8.
1978 *Cyphoproetus externus* (Reed, 1935); Howells, p. 48, pl. 8, figs 1–6, 9.

Material, MGUH 14179–82 (cranidia), MGUH 14183–84, GGU 216887.52–55 (free cheeks), MGUH 14185 (hypostome), MGUH 14186–89, GGU 216887.56–62 (pygidia).

Description. Cranidium longer (sag.) than wide. Glabella bluntly rounded anteriorly, convex, slightly constricted opposite anterior of palpebral lobe, otherwise gradually widening posteriorly to a maximum at occipital lobes. 1S deepest at about its mid length, not reaching axial or occipital furrows, thus isolated from these furrows, running at about 45° to the transverse direction and partially defining 1L. 2S and 3S very weakly impressed and short. 2S a narrow (exs.) depression placed just anterior to 1S, 3S a weak and subcircular depression across neither of

which the sculpture is interrupted. 1L triangular, slightly inflated. Occipital furrow narrow. Occipital ring about as wide (sag.) as 1L (exs.); occipital lobe large, one third the size of 1L, subtriangular. Occipital granule placed a little in front of mid length of occipital ring. Preglabellar field absent. Anterior border almost as long (sag. & exs.) as occipital ring, of constant width and weakly convex. Palpebral lobe narrow, about its own exsagittal length from the posterior margin, its mid length opposite anterior part of 1S. With the exception of the occipital, axial, preglabellar and 1S furrows, external surface has a Bertillon pattern of very fine and very closely spaced ridges.

Free cheek with narrow field only one and one half times as wide as the lateral border, the whole weakly convex. Lateral and posterior border furrow distinct, the latter terminating abruptly at the former, extending into a furrow which runs down the genal spine which itself is about as long as the visual surface. Eye socle weakly developed. Visual surface inflated. Bertillon pattern present as on cranidium, except in furrows; additionally the field of free cheek has scattered granules.

Hypostome, excluding anterior wings, subrectangular in outline. Middle body with distinct transverse middle furrow; anterior lobe sagittally slightly longer than posterior lobe by virtue of a slight anteromedial swelling which interrupts the anterior border furrow, and indistinctly reaches the anterior margin. Convexity of anterior lobe greater (sag. & tr.) than posterior lobe which itself reaches the greater transverse width, and overall is subrectangular in outline. Lateral and posterior border furrows distinct. Anterior wings long (exs.), broadly rounded abaxially. Lateral border narrow and convex, widening slightly at posterolateral angles of hypostome where a pointed projection is situated.

Pygidium showing varying overall proportions, but about twice as wide (tr.) as long (sag.), lacking a distinct border, the sagittal part of the posterior margin being a slightly angular curve. Tapering axis broadly rounded behind with five rings indicated, of which only the anterior two are distinct; ring furrows over outer one third transverse. Axis just less than four fifths the pygidial length (sag.), and anteriorly just less than one third the maximum pygidial width. Weak postaxial ridge developed. Pleural areas with furrow a little more strongly curved back than interpleural. Doublure (only seen posteriorly) narrow, but reaching as far forward as posterior of axis, bearing a few subparallel terrace ridges. Whole of pygidium on dorsal surface, except furrows, with a dense fine granulation like that of the cranidium.

Discussion. All figured British material of this species is more or less distorted so that comparison with the present material has proved difficult. However, I consider the pygidia figured here to be indistinguishable from the British material (see Owens, 1973a, pl. 6, fig. 8; Howells, 1978, pl. 8, fig. 5) and consequently refer the Greenland specimens to Reed's species.

As compared to the distorted British material, the Greenland cranidia show differences in having a slightly less constricted glabellar outline, possibly even shorter preglabellar field and anterior border of constant width. In view of the unknown effects of distortion and great similarity of the pygidia, these differences are not thought to be of specific importance. Smaller cranidia differ from larger in being rather more convex overall, the anterior part of the glabella rising steeply from the preglabellar furrow. In other respects, for instance general proportions and sculpture, however, no differences have been observed, and for this reason the material from Greenland is considered conspecific. The free cheek has been associated with the cranidia since the Bertillon pattern developed on both is similar.

Cyphoproetus? *alyo* sp. nov.

Plate 3, figs 7, 9; Plate 4, figs 1–4, 6

Derivation of name. Greek 'alyo' – 'at a loss', referring to the difficulty of assigning this species to a genus.

Material. Holotype. MGUH 14190 (cranidium). Paratypes. MGUH 14191–94, GGU 216887.63–67 (cranidia), MGUH 14195–96, GGU 216807.68–70 (free cheeks).

Diagnosis. Anterior border and preglabellar field of equal sagittal length. 1S only indistinctly reaches axial and occipital furrows; 2S transverse; 3S trending slightly anteriorly adaxially. Sculpture of small densely packed granules.

Description. Cranidium of low to moderate convexity, about one and one quarter times as long as wide (tr.). Glabella only slightly independently inflated, maximum width (tr.) at occipital lobes, broadly rounded anteriorly, slightly constricted immediately anterior to 1S, and curved outwards adjacent to 1L. 1S distinctly impressed for only half its course, reaching axial and occipital furrows as very indistinct features, the sculpture not interrupted posteriorly; the furrow gently curved behind, and increasingly so anteriorly to run almost transversely near axial furrow. 2S and 3S hardly impressed, mainly recognized as interruptions of the sculpture, both reaching the axial furrow. 2S transverse, less than one third width of glabella at that point, placed at about one half the exsagittal length of 1L in front of the anterior of 1S. 3L exsagittally shorter than 2L; 3S trending slightly forwards adaxially, a little shorter than 2S and even less well impressed. 1L ovate, exsagittally one third the length of the glabella, gently inflated. Occipital ring one fifth the sagittal length of the glabella, narrowing behind 1L, where weakly developed subtriangular occipital lobes are indicated. Occipital granule centrally placed. Axial furrow distinct; preglabellar furrow widening sagittally. Preglabellar field sagittally as wide as 3L (exs.) and widening a little abaxially. Anterior border of constant width, in sagittal line equal in width to the preglabellar field. Palpebral lobe narrow, placed at half its own exsagittal length from the posterior margin and reaching as far forward as mid 2L. With the exception of the furrows and the outer part of the

anterior border, the surface is covered with small densely packed granules; additionally the anterior border has a few terrace ridges anteriorly.

Free cheek with field wider than the weakly convex border, especially posteriorly. Posterior border furrow more distinct than lateral border furrow, the two coalescing to form a furrow which runs the length of the genal spine. Eye socle narrow, distinct, with a furrow running parallel to it on the adaxial part of the field of the free cheek. Visual surface inflated. Surface of free cheek, except in furrow, with a sculpture like that of the cranidium, with terrace ridges on the outer part of the lateral border, and also on the short (tr.) doublure of which a small portion has been observed.

Discussion. It should be noticed that internal moulds differ greatly in important characters from external moulds. For instance, 1S on the internal mould clearly reaches both axial and occipital furrows, and furrows and ribs in general are much more distinct. Care must obviously be exercised in comparing internal mould material with specimens retaining the exoskeleton.

Generic placement of this material presented problems. Certain characters shown (for instance occipital ring not distinctly wider than the rest of the glabella, occipital granule not anteriorly placed, 1S not distinctly impressed adjacent to occipital and axial furrows, only weakly impressed occipital lobes and anterior border and preglabellar field of about equal length) are not typical of *Cyphoproetus*. These characters, however, are differences of degree rather than fundamental structure and the overall aspect of the material is not dissimilar to species of *Cyphoproetus* such as *C. insterianus* Schrank (1972, p. 20, pl. 5, figs 11–14, pl. 6, figs 1, 2). Consequently the material is referred to *Cyphoproetus* with some doubt.

In view of the differences in cranidial structure of species referred to *Cyphoproetus* (e.g. of *externus* type, and *insterianus* type) it is possible that the genus as presently defined is not a natural phylogenetic group.

Subfamily TROPIDOCORYPHINAE Přibyl, 1946b

Tropidocoryphine gen. et sp. indet.

Plate 3, figs 15, 16

Material. MGUH 14197 (cranidium), MGUH 14198 (pygidium).

Description. Glabella subquadrate anteriorly, possibly very weakly constricted. An indefinite shaped area lacking sculpture which is placed towards the posterior corner of the glabella may represent 1S, but no impression is present here. 2S and 3S possibly indicated by very weakly impressed area of small size, over which the sculpture is not interrupted. Occipital furrow wide and deep over most of course, shallowing near axial furrow, which itself is narrower, but distinct. Occipital furrow widest (exs.) adjacent to axial furrow, where large, ovate occipital lobes are situated, which are but weakly delimited behind. Occipital lobes about one third

the transverse width of the occipital ring. Surface sculpture of densely packed granules of low relief.

Pygidium with 8 pairs of imbricate pleural ribs, pleural furrows weakly developed. Pleural ribs anteriorly join a narrow convex lateral border, but more posteriorly end close to the margin where a weak concave border is developed. Axis (only posterior part seen) with at least three rings and a terminal piece (although the number of axial rings must have been around ten); semicircular behind. Doublure (seen posteriorly) narrow, dorsally concave and apparently lacking terrace ridges. Sculpture weakly developed, granules similar to those of the cranidium are weakly developed on the posterior pleural band of the most posteriorly placed ribs.

Discussion. These two fragments have been associated under the designation tropidocoryphine gen. indet. on the purely circumstantial evidence that they are larger than any other proetid elements in the fauna from all of which they differ in morphology. There is no convenient genus to which to refer them. The cranidium does not have a preglabellar field preserved, but in the distinct delimitation of lateral glabellar furrows most resembles *Decoroproetus*. When considering this cranidium, additional difficulties are the large occipital lobes which are usually absent in *Decoroproetus* species, and the sculpture, which being granular is unlike the continuous or discontinuous striation usually found in that genus. The pygidium has 8 pairs of pleural ribs, whereas a maximum of 6 is present in described species of *Decoroproetus,* although the characteristic imbrication of these ribs is present.

Family AULACOPLEURIDAE Angelin, 1854

Diagnosis. See Thomas & Owens (1978, p 55).

Subfamily AULACOPLEURINAE Angelin, 1854

Diagnosis. See Thomas & Owens (1978, p 56).

Genus *Harpidella* McCoy, 1849

Type species. By monotypy; *Harpes?* megalops McCoy, 1849, from the Upper Llandovery of Galway, Eire.

Diagnosis. See Thomas & Owens (1978, p. 61).

Subgenus *Harpidella* McCoy, 1849

Diagnosis. See Thomas & Owens (1978, p. 62).

Harpidella (Harpidella?) helenae sp. nov.
Plate 4, figs 7–9, 12–14, 17

Derivation of name. For my wife.
Material. Holotype MGUH 14199 (cranidium). Paratypes MGUH 14200–202, GGU 216887. 71–74 (cranidia), MGUH 14203–04, GGU 216887.75 (free cheeks), MGUH 14205 (pygidium).

Diagnosis. Species of *Harpidella (Harpidella?)* with anterior border longer sagittally than exsagittally; 2S absent. Coarse granules present on cranidium (few on borders). Free cheek with pits and few granules on field, and terrace ridges on doublure; pygidium with four axial rings and four pleural ribs.

Description. Cranidium as wide posteriorly as long. Glabella convex, semicircular in front, about two thirds of the cranidial length (sag.), and narrowing markedly forwards from widest point across 1L. Occipital ring convex, shorter exsagittally than sagittally where it is about equal in length to the anterior border. Occipital granule sharply pointed, backwardly placed. Occipital furrow distinct, slightly shorter sagittally than exsagittally. Axial furrow wider than this, distinct. 1S arises at axial furrow more than half way forwards along glabella, is distinct and curves rapidly back to run exsagittally, isolating inflated, oval 1L. Preglabellar field sagittally a little longer than combined anterior border and border furrow, widening laterally, convex. Anterior border furrow deep and distinct, anterior border convex and roll-like, widening abaxially. Outline of anterior margin and anterior border furrow a broadly rounded angle. Anterior branch of facial suture diverges at about 30° from exsagittal line. Palpebral lobe half the length of the preoccipital part of glabella, reaching almost as far dorsally as highest part of glabella, its mid-length opposite 1S at axial furrow, its posterior limit opposite mid-1L. A slight change in slope running from anterior of palpebral lobe to anterior part of glabella may indicate the presence of an eye ridge. Posterior section of facial suture curves sigmoidally back on a line approximately 30° to transverse line. Posterior border furrow very distinct; posterior border convex, widening a little abaxially. Anterior and posterior borders, and an area of the fixed cheek adaxial to the palpebral lobe with a few scattered granules; the rest of the cranidium (except furrows) with large, distinct pointed granules.

Free cheek with convex lateral border which is roll-like; lateral border furrow wide. Field of free cheek rises steeply to convex visual surface. Posterior border weakly convex, posterior border furrow more distinct than lateral border furrow, running into a weak genal spine furrow. Lateral margin curved inwards a little at base of genal spine, which itself (of unknown length) curves outwards posteriorly. Doublure convex ventrally, narrow, with lateral border forming a tube in cross section. Lateral border dorsally with a few discontinuous and anastomosing terrace ridges, field pitted and with scattered granules.

Pygidium twice as wide (tr.) as long (sag.), gently convex. Axis anteriorly one third width of maximum pygidial width which occurs on a line with the fourth axial

ring. Axial furrow converging rapidly, dying out posteriorly so that axis is indistinct behind. Four axial rings and a terminal piece present; an ankylosed articulating half ring is present between anterior two rings. Pleural field with four pairs of pleural ribs, from anterior to posterior becoming less distinct, defined by interpleural furrows which are equally distinct as pleural furrows. Pleural ribs reach close to margin; border absent. Articulating half ring half the sagittal length of anterior axial ring. Sculpture of fine granules.

Discussion. This species is assigned to *Harpidella (Harpidella)* with some doubt because it apparently lacks 2S furrows and has a larger number of rings in the pygidial axis than is seen in other described species of the genus. These features, the relative sagittal lengths of anterior border and preglabellar field and the coarse sculpture of the cranidium, serve to distinguish this species from others assigned to the subgenus.

Family HARPETIDAE Hawle & Corda, 1847
Genus *Scotoharpes* Lamont, 1948

Type species. By monotypy; *Scotoharpes domina* Lamont, 1948, from the upper Llandovery of Lothian, Scotland.

Diagnosis. See Lane, 1972, p. 353 (diagnosis of synonymous *Selenoharpes*)

Scotoharpes sp.
Plate 5, figs 3–6

Material. MGUH 14206–09 (fragmentary cephala).

Description. Glabella widest across 1L, where it is two thirds of the sagittal length, tapering gently forwards; less than half the sagittal length of the cephalon. Occipital ring longest sagittally, tapering strongly abaxially, its posterior margin curved convex backwards. 1S shallow, dying out before reaching occipital furrow. 1L small and triangular, slightly inflated. Cheek lobe very convex; posterior border furrow long (exs.), posterior border ridge-like. Axial furrow indistinct especially adjacent to 1L, widening to form a depression adjacent to the eye lobe. Preglabellar field narrow (sag.). Eye lobe situated well forward, gently convex, its anterior margin about the exsagittal length of the lobe behind a transverse line drawn to the anterior of the glabella. Eye ridge transverse, indistinct, running just anterior to the axial furrow depression. Ala about one quarter the maximum glabellar length, gently convex, defined by a shallow furrow laterally and anteriorly, and by the distinct posterior border furrow behind, anteriorly reaching just farther forward than 1S. Cheek lobe convexity continued by cheek roll, anterior to glabella with a sagittally elongate swelling which bows the girder forward; cheek roll constant in

width laterally. Brim gently concave, external rim prominent, convex dorsally. Prolongation convex dorsally just posterior to where girder meets posterior border, with prominent internal and external rims. Girder a smooth plane band with prominent pits adjacent to it on both sides, curving round to meet internal rim of prolongation about half the sagittal length of the glabella behind the posterior margin of the occipital ring. Cheek roll and brim with indistinct ridge-like caecae. Cheek line absent. Minute pits between caecae number about 10–12 in width of cheek roll anterolaterally, and about 20–22 on the brim in the same region.

Discussion. Of described species of *Scotoharpes* (and its synonyms *Aristoharpes* and *Selenoharpes*), this material most resembles in general proportion *S. loma* (Lane, 1972, p. 353) from the late Llandovery or Wenlock of Kronprins Christians Land, north-eastern Greenland. From that species it differs in having less distinct caecae, an eye placed slightly further back and fewer pits between the caecae anterolaterally. In *S. loma* the pits number 15–17 in the width of the cheek roll and about 40 on the brim in this region as opposed to 10–12 and 20–22 in *Scotoharpes* sp.

Family CHEIRURIDAE Hawle & Corda, 1847

Diagnosis. See Lane (1971, p. 7).

Subfamily CHEIRURINAE Hawle & Corda, 1847

Diagnosis. See Lane (1971, p. 11).

Genus *Hadromeros* Lane, 1971

Type species. By original designation; *Cheirurus keisleyensis* Reed, 1896, from the Ashgill of Cumbria.

Diagnosis. See Lane (1971, p. 24).

Hadromeros? sp.

Plate 5, fig. 1

Material. MGUH 14210 (cranidium).

Description. Glabella at occipital ring less than one third width of cranidium; expanding forwards gently and evenly except across 1L which are bowed outwards laterally. Maximum glabellar width (tr.) at frontal lobe, which is sagittally almost one third the total length of the glabella. 3L parallel sided, 2L narrowing abaxially. 1L isolated, subtriangular, one third the width of the glabella, inflated. 1S deep and distinct; 2S and 3S less than one third width of glabella, curved convex forwards,

and directed slightly obliquely back adaxially. Occipital ring sagittally as long as 3L (exs.) narrowing markedly abaxially. Axial furrow deep and distinct, continuing forward as narrow, distinct preglabellar furrow. Cheeks triangular, convex, with distinct lateral and posterior border furrows, and convex borders. Genal spine directed outwards and backwards, slightly curved, at least two thirds of the sagittal glabellar length. Palpebral lobe placed at one third distance from axial furrow to lateral margin, its mid length opposite 2S, and extending from mid 3L to almost 1S. Posterior section of facial suture initially transverse, curving strongly back over lateral margin. Inside border furrows, cheeks coarsely pitted. Glabella with many coarse granules, and a few present on lateral and posterior borders.

Discussion. The characters described above indicate that this specimen probably belongs to *Hadromeros,* but in the absence of a pygidium this assignment cannot be made without question. A complete preglabellar furrow is seen in small specimens of some Silurian species referred to *Hadromeros* although larger specimens do not possess such a feature (e.g. *H. elongatus* (Reed, 1931); see Lane, 1971, p. 28, pl. 5, fig. 6). Owing to the small size of this solitary cranidium, further comparisons with named cheirurine species are not attempted.

Subfamily DEIPHONINAE Raymond, 1913

Diagnosis. See Lane (1971, p. 58).

Genus *Deiphon* Barrande, 1850

Type species. By original designation; *Deiphon Forbesi* Barrande, 1850, from the Wenlock of Czechoslovakia.

Diagnosis. See Lane (1971, p. 59).

Deiphon cf. *D. dikella* Whittard, 1934

Plate 5, figs 7–10

Material. MGUH 14211–14, GGU 216887.76 (fragmentary cranidia).

Description. Glabella anterior to 1S hemispherical, unfurrowed, circular in plan view. Occipital-1S furrow distinct, axial furrow less so. External surface with closely spaced granules of differing sizes which are not seen on the internal mould.

Discussion. The only specific character available for comparison is the character of the surface granulation. Of described species the granulation of *D. dikella* (see Lane 1971, pl. 15, fig. 1) is most similar to that of these specimens.

Subfamily ACANTHOPARYPHINAE Whittington & Evitt, 1954

Diagnosis. See Lane (1971, p. 66).

Genus *Youngia* Lindström, 1885

Type species. Subsequently designated by Vogdes, 1917, p. 115; *Cheirurus trispinosus* Young, 1868, from the Llandovery of Strathclyde, Scotland.

Youngia sp.

Plate 5, fig. 2

Material. MGUH 14215 (fragmentary glabella).

Description. This fragment shows part of the right side of a glabella. Two furrows (2S and 3S probably) are distinctly impressed. Granules of different sizes are closely packed together.

Discussion. It seems certain that this fragment allows the recording of *Youngia* from the fauna, the short (exs.) gently curved furrows and granulation being typical of the genus.

Family ENCRINURIDAE Angelin, 1854
Subfamily ENCRINURINAE Angelin, 1854
Genus *Encrinurus* Emmrich, 1844

Type species. Subsequently designated; *Entomostracites punctatus* Wahlenberg, 1818, p. 32, pl. 2, fig. 1. from the ?Wenlock of Gotland.

Discussion. Specimens referable to *Encrinurus* are common in the fauna. Three types of cranidia, a free cheek, two types of hypostomes and two types of pygidia have been recognized. Probably two or three species of the genus are represented in the fauna but as it is impossible to definitely associate different parts of the exoskeleton most of the material is described under open nomenclature.

Encrinurus aff. *E. moderatus* Poulsen, 1934

Plate 5, fig. 19

Material. MGUH 14216 (cranidium).

Description. Cranidium of low convexity (sag. & tr.). Lateral glabellar lobes 2L–4L larger than glabellar granules, which apart from I-1, II-1 are irregularly arranged and become slightly larger anteriorly. 1L small and ridge-like, in deep furrow formed by combined 1S and occipital furrow. Anterior glabellar furrow distinct. Anterior border of cranidium shortening slightly (exs.) adaxially, bearing six

granules on each side. Longitudinal median glabellar furrow distinct, crossing preglabellar furrow onto anterior border of cranidium. Fixed cheek of low convexity, palpebral lobes opposite 3L. Field of fixed cheek with a few large granules.

Discussion. This material resembles the cranidium figured by Poulsen as *E. moderatus,* and the two may be conspecific. No pygidia of the type figured under the same name have been found in the present fauna, and it is considered better not to imply definite specific identity until the fauna of the Cape Schuchert formation has been revised. This Greenland material also resembles the cranidium of *E. schmidti* Mannil (1968, p. 273, pls 1, 2) from the Adavere-Stufe (Llandovery) of Estonia.

Encrinurus sp. A

Plate 5, figs 11, 14, 15, 18

Material. MGUH 14217–20, GGU 216887.77 (cranidia).

Description. Cranidium increasing markedly in convexity anteriorly so that anterior border of cranidium is vertically placed. Glabella about twice as wide (tr.) across frontal lobe as posteriorly. 1L small and ridgelike, 2L–4L about same size as larger glabellar tubercles. Glabellar granules of varying sizes, apparently randomly distributed. Longitudinal median glabellar furrow short and distinct, and crossing preglabellar furrow onto anterior border of cranidium, which itself is of constant length (exs.) and bears on each side three small and widely spaced granules. Preglabellar furrow narrow and weakly impressed. Fixed cheek very convex, posterior border and border furrow distinct. Palpebral lobe small, placed opposite 3S. Field of fixed cheek with scattered granules varying in size as on glabella, and a small pointed pair at the base of the genal spine, which is of unknown length.

Discussion. See after *Encrinurus* sp. B.

Encrinurus sp. B

Plate 5, fig. 12

Material. MGUH 14221 (cranidium).

Description. Convexity of cranidium about even in sagittal line. 1L not seen, 2L and 3L about as large as largest glabellar granules; 4L very large, itself bearing small granules. Preglabellar furrow very strongly impressed laterally, indistinct sagittally. Anterior border of cranidium decreasing in length (exs.) adaxially bearing two large and widely spaced granules. Glabellar granules randomly distributed, predominantly of two sizes, large and small, with few of intermediate dimensions.

Discussion. The three types of cranidia in the fauna may be readily distinguished on relative convexity, types of glabellar granules and their size relative to the lateral

glabellar lobes, character of anterior border of cranidium and its granulation, character of preglabellar and longitudinal median glabellar furrows and the position of the palpebral lobe.

Encrinurus sp. C

Plate 3, figs 11–13

Material. MGUH 14222–24, GGU 216887.78–80 (free cheeks).

Description. Free cheek with pedunculate eye. Field of cheek convex, lateral border more so and two thirds as wide as adjacent field, narrowing forwards. Precranidial lobe convex, with two rows of granules; field of free cheek with a few granules and a greater number of distinct pits. Border with irregularly placed small and large granules.

Encrinurus sp. D

Plate 5, figs 13, 16

Material. MGUH 14225–26, GGU 216887.81–83 (hypostomes).

Description. Overall very convex, rounded anteriorly and more pointed behind in outline. Middle body very convex. Rhyncos bluntly rounded, projecting very little farther forward than rest of middle body and reaching about as far forward as anterior margin, less than half the sagittal length of middle body, wide in dorsal view, and defined by furrows which curve inwards posteriorly. Maculae prominent, set at about 20° to the transverse direction, directed obliquely back adaxially. Border furrows everywhere distinct, especially wide adjacent to macula. Anterior wing prominent. Borders narrow and ridge-like.

Discussion. See after description of *Encrinurus* sp. E.

Encrinurus sp. E

Plate 5, fig. 17

Material. MGUH 14227 (hypostome).

Description. Differs from *E.* sp. D. described above in that the rhyncos is more pointed, apparently does not reach as far forward as the anterior margin, is placed much farther ventrally from the anterior margin, and the anterior border furrow is much wider.

Discussion. No attempt has been made to compare these hypostomes with those of described species. The hypostomes of many encrinurine species are not known, or are doubtfully associated with other elements of the exoskeleton.

Encrinurus sp. F
Plate 6, figs 1, 2, 4–6, 9

Material. MGUH 14228–33, GGU 216887.84–85 (pygidia).

Description. Broadly triangular, one and one half times as wide as long (sag.). Axis one third width of pygidium anteriorly, with 10–12 completely delimited rings, granules never occurring on anterior ring, but on any of next 10 rings, 3–5 in number but no regular pattern observed. Pleural areas with 8 ribs, all but posterior prolonged into short spines.

Discussion. See after *Encrinurus* sp. G.

Encrinurus sp. G
Plate 6, figs 3, 7

Material. MGUH 14234–35, GGU 216887.86–87 (pygidia).

Description. These small pygidia are similar in general proportions to the pygidia described above, but have only 7 pleural ribs, and 8 axial rings.

Discussion. It is thought likely that these pygidia are not conspecific with *Encrinurus* sp. F, because of the smaller number of pleural ribs and axial rings. It is difficult to adequately compare either type of pygidium with described species because of the small amount of material and the lack of any definite association of different elements of the encrinurine material described here.

Family PHACOPIDAE Hawle & Corda, 1847
Subfamily PHACOPINAE Hawle & Corda, 1847

Remarks. This subfamily has been discussed by Campbell (1967, p. 28).

Genus *Acernaspis* Campbell, 1967

Type species. By original designation; *Phacops fecundus communis* Barrande 1852, from the Ludlow of Czechoslovakia.

Diagnosis. See Campbell (1967, p. 35).

Subgenus *Eskaspis* Clarkson, Eldridge & Henry, 1977

Type species. By original designation; *Eophacops sufferta* Lamont 1947, from the Upper Llandovery of Borders Region, Scotland.

Diagnosis. See Clarkson *et al.* (1977, p. 123).

Acernaspis (Eskaspis) sp.
Plate 6, fig. 8

Material. MGUH 14236 (conjoined free cheeks).

Description. Visual surface steeply inclined, with lenses in 16 dorsoventral files. Lenses decrease in size to dorsal and ventral margins, and including the smallest lenses the formula for the preserved visual surface is 345 455 554 544 443 2, maximum 5 per file, 66 in total. Beneath visual surface, free cheek wide and concave, border vertical. Anterior section of facial suture running subparallel to anterior margin. Doublure approximately one third the glabellar length (sag.) narrowing posteriorly. Hypostomal suture bowed forward. Vincular furrow continuous over whole doublure, deeper laterally with at least 7 oval notches.

Discussion. This specimen has characters very similar to an undescribed species from the Girvan area of Scotland. This species occurs in the upper part of the *cyphus* Zone and throughout the *gregarius* Zone. The lens count of the single visual surface known falls within the range of variation observed in that species.

Family LICHIDAE Hawle & Corda, 1847
Subfamily CERATARGINAE Tripp, 1957
Genus *Hemiarges* Gürich, 1901

Type species. By original designation; *Lichas wesenbergensis* Schmidt, 1885, from the Ordovician of Estonia.

Diagnosis. See Tripp (1958, p. 577).

Hemiarges sp.
Plate 6, fig. 18

Material. MGUH 14237 (hypostome).

Description. Hypostome almost as long (sag.) as wide. Anterior margin convex forwards. Middle body subtrapezoid in outline, weakly convex, and with weakly defined middle furrows which are backwardly placed and only seen laterally. Border furrow broad. Lateral border gently convex, widening posteriorly, sagittally two thirds the length of the middle body. Posterior margin with sagittally placed broad curve forwards. Middle body with distinct pits of varying sizes, lateral and posterior border with less distinct pits and additionally terrace ridges and small granules.

Discussion. This characteristic *Hemiarges* hypostome is similar to one found in the upper Rhuddanian of the Girvan region, Scotland. This hypostome is as yet undescribed, and unfortunately Howells (personal communication) has been unable to find other elements of a *Hemiarges* species associated with it.

Subfamily HOMOLICHINAE Phleger, 1936
Genus *Platylichas* Gürich, 1901

Type species. By original designation; *Lichas margaritifer* Nieszkowski, 1857 from the Ordovician of Estonia.

Diagnosis. See Tripp (1958, p. 576).

Platylichas sp. A
Plate 6, figs 10–14, 17

Material. MGUH 14238 (fragmentary cranidium), MGUH 14239, GGU 216887.88 (free cheeks), MGUH 14240, GGU 216887.89 (hypostomes), MGUH 14241 (thoracic segment), MGUH 14242–43 (pygidia).

Description. Free cheek with eye socle increasingly distinct posteriorly, anterior part of field gently concave, becoming gently convex posteriorly. Lateral border vertical. Dorsal surface with many granules of different sizes, the eye socle with many large ones closely packed together. Vertical border with five subparallel terrace ridges, and minute granulation.

Hypostome overall gently convex, almost as long (sag.) as wide (tr.). Anterior margin curved forward almost in a semicircle. Lateral border furrows distinct, almost straight, running obliquely back adaxially at about 30° to the sagittal line. Posterior margin of middle body slightly curved convex backwards, posterior border furrow narrower than lateral. Lateral border concave behind lateral notch, posterior to this gently convex. Posterior border two thirds the width (sag.) of middle body. Posterior margin with quadrate invagination over median one third of its width, this invagination with flanking rounded projections. Middle body gently convex; middle furrows distinct, one quarter width of middle body, bifurcating adaxially. Ventral surface except in furrows with pits and scattered granules, anterior part of lateral border with terrace ridges. Doublure posteriorly at least half the length (exs.) of posterior border.

Fragment of thoracic segment shows axis well defined. Pleurae with distinct oblique furrow at least adaxially, which originates at axial furrow near anterior margin. Sculpture of closely spaced granules of different sizes.

Pygidium approximately semicircular, slightly angular sagittally on posterior margin. Axis anteriorly one third of pygidial width, narrows gently back over two thirds of its length, then more rapidly, indistinctly delimited behind. Three distinct axial rings anteriorly, behind which a knoblike protruberance occurs on the terminal piece. Three pairs of pleural ribs, posterior pleural bands of first two confluent with very small free backwardly directed projections. Pleural furrow of third rib curving round adaxially and joined to the posterior extension of the axial furrow by less distinct feature, so isolating a pear-shaped lobe. Posterior margin with narrow sagittal indentation, flanked by backwardly directed small projections. Sculpture everywhere, except in furrows, like that of thoracic segment.

Discussion. A fragment of a cranidium has also been associated with this material (Plate 6, fig. 17) since it is lichid in character, and bears a sculpture which is very similar to that of the free cheek, thoracic segment and pygidium described above. The fragment shows two furrows, one distinct and curved, the other straight and rather less well impressed. The former furrow separates two areas with sculpture typical of other fragments which have been associated, and the latter one of these areas and an unsculptured gently convex ridge. I have interpreted this ridge as the anterior border of the cranidium. If this is so, the cranidium is unusual amongst species of *Platylichas* in having a straight and transverse anterior border and border furrow, and the anterior part of the median glabellar lobe expands exceedingly rapidly.

The pygidium is rather shorter than in other described species of *Platylichas* and it seems likely that the material belongs to a new species.

Platylichas sp. B

Plate 6, fig. 15

Material. MGUH 14244 (fragmentary cranidium).

Description. Occipital ring strongly curved back laterally, with distinct occipital furrow, posterolateral corner of median glabellar lobe with triangulate swelling. Also visible in the fragment are the adaxial parts of occipital lobe (which is rounded), 1L and bullar lobe, the furrow between these latter lobes being adaxially transversely directed where it joins the distinct longitudinal glabellar furrow. Sculpture is of granules of many sizes everywhere closely spaced, though lacking in the furrows.

Discussion. See after *Platylichas* sp. C.

Platylichas sp. C

Plate 6, fig. 16

Material. MGUH 14245 (fragmentary cranidium).

Description. Occipital furrow distinct. Median glabellar lobe with subquadrate swellings at posterolateral corners, immediately in front of which a weakly impressed furrow runs across the lobe. Narrowest part of median glabellar lobe is about the same distance in front of this transverse furrow as between it and the occipital furrow. Anterior to narrowest part, median glabellar lobe increases in width more rapidly than the posterior portion increases posteriorly. Occipital lobe small. 1L expanding rapidly from distinct longitudinal glabellar furrow. Bullar lobe subtriangular. Furrow between latter two running at 45° to transverse direction forward abaxially. Sculpture of a few large granules especially on the median glabellar lobe, and many more of varying smaller sizes.

Discussion. Although the sculpture of *Platylichas* sp. B and sp. C described above is similar, the two fragmentary cranidia differ sufficiently in general proportions to allow discrimination between them. The sculpture of both is different from that of the elements united above under the designation *Platylichas* sp. A.

Family ODONTOPLEURIDAE Burmeister, 1843
Subfamily ODONTOPLEURINAE Burmeister 1843
Genus *Leonaspis* Richter & Richter, 1917

Type species. By original designation; *Odontopleura leonhardi* Barrande, 1846, from the Ludlow of Bohemia.

Leonaspis sp.
Plate 6, fig. 19

Material. MGUH 14246 (pygidium).

Description. Axis convex, with one distinct ring behind which a convex trapezoidal area has very indistinct furrows laterally which probably represent interring furrows separating a second ring from a small terminal piece. Anterior border of pleural areas convex, transverse. Major spines exsagittally directed, continuing forward as convex ridges which curve adaxially near anterior border and are almost continuous with the anterior axial ring from which they are separated only by a change in slope. Anteriorly, two secondary spines are developed which are directed at about 30° and 60° to the transverse direction. Between major spines a pair of long exsagittally directed spines arise at the convex posterior border. Surface bears a few large scattered granules.

Discussion. In the number and disposition of the major and secondary spines, the pygidium described here most resembles that of *Leonaspis centrina* (Dalman, 1828) from the Lower Llandovery of Västergötland figured by Bruton (1967, pl. 35, fig. 11; textfig. 1). The Greenland pygidium differs in having an indistinctly delimited second axial ring, and in the orientation of the anterior secondary spines, which in *centrina* are exsagittally directed.

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Plates

Almost all specimens were painted with black 'John T. Barlow Opaque' and lightly coated with ammonium chloride sublimate before photography. Photographs were taken on Ilford Pan F film with a Nikon F2 and Micro-Nikkor 55 mm lens. Specimen MGUH 14172 (Plate 1, fig. 25) was uncoated, and MGUH 14185 (Plate 3, fig. 6) and MGUH 14246 (Plate 6, fig. 19) were photographed on a scanning electron microscope.

All specimens are from GGU sample 216887.

Plate 1

Bumastus? sp. A

Fig. 1. MGUH 14136; cranidium, palpebral view, ×4.
Fig. 2. MGUH 14141; pygidium, dorsal view, ×4.
Fig. 3. MGUH 14142; pygidium, dorsal view, ×4.
Figs 4a, b. MGUH 14140; free cheek, lateral and dorsal views, ×4.
Fig. 5. MGUH 14143; pygidium, dorsal view, ×4.
Fig. 6. MGUH 14144; pygidium, dorsal view, ×4.
Figs 14a, b. MGUH 14137; cranidium, dorsal and oblique anterior views, ×10.
Figs 15a, b. MGUH 14139; cranidium, dorsal and oblique anterior views, ×10.
Fig. 16. MGUH 14138; cranidium, dorsal view, ×8.

Bumastus? sp. B

Fig. 7. MGUH 14145; pygidium, dorsal view, ×4.

?scutelluid indet.

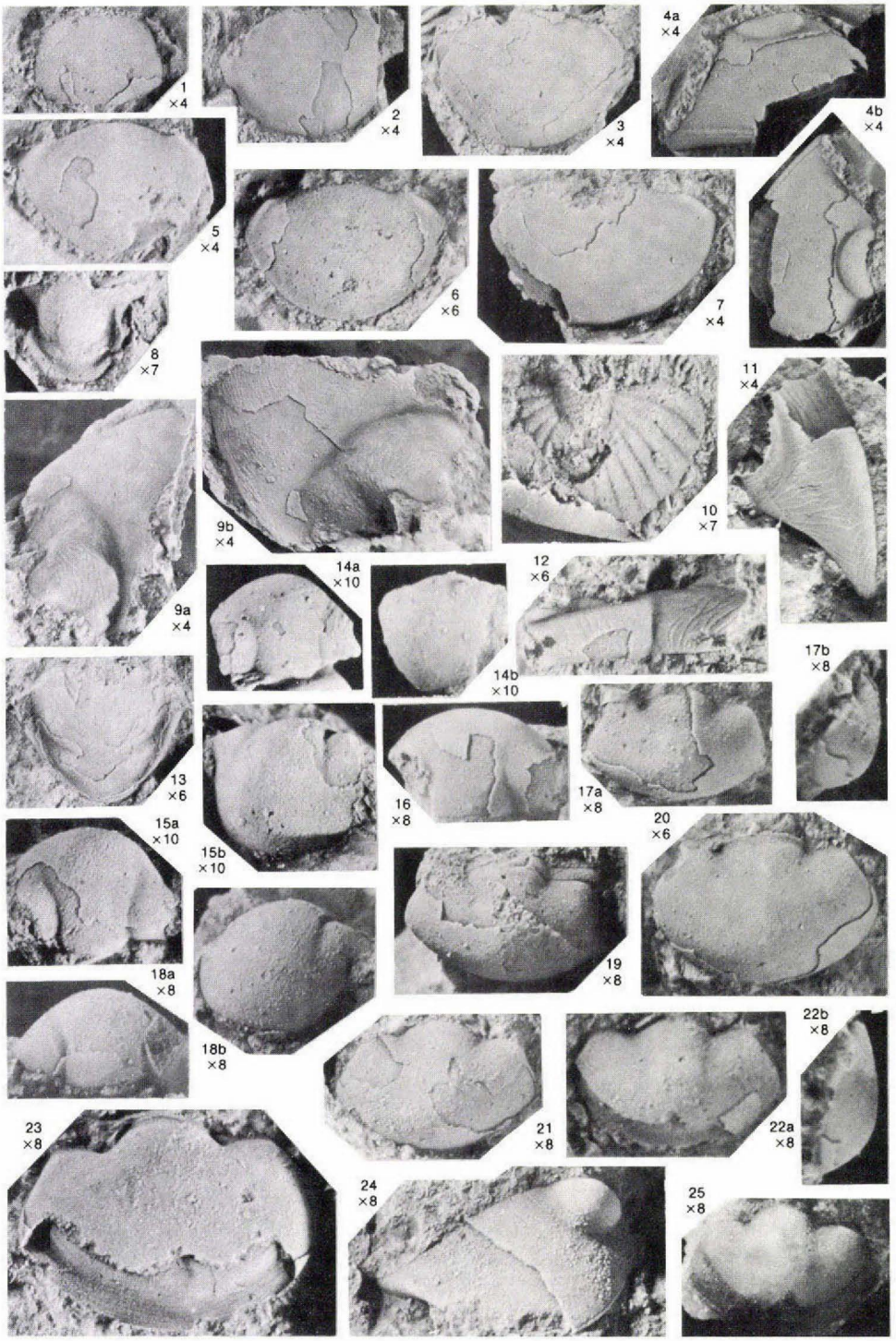
Fig. 8. MGUH 14151; hypostome, ventral view, ×8.

Kosovopeltis sp.

Figs 9a, b. MGUH 14146; cranidium, dorsal and oblique lateral views, ×4.
Fig. 10 MGUH 14150; pygidium, dorsal view, ×7.
Fig. 11. MGUH 14147; free cheek, dorsal view, ×4.
Fig. 12. MGUH 14149; fragmentary thoracic segment, dorsal view, ×6.
Fig. 13. MGUH 14148; hypostome, ventral view, ×6.

Stenopareia somnifer sp. nov.

Figs 17a, b. MGUH 14167; paratype pygidium, dorsal and left lateral views, ×8.
Figs 18a, b. MGUH 14153; paratype cranidium, dorsal and oblique anterior views, ×8.
Fig. 19. MGUH 14168; paratype pygidium and thoracic segment, dorsal view, ×8.
Fig. 20. MGUH 14169; paratype pygidium, dorsal view, ×6.
Fig. 21 MGUH 14170; paratype pygidium, dorsal view, ×8.
Figs 22a, b. MGUH 14171; paratype pygidium, dorsal and left lateral views, ×8.
Fig. 23. MGUH 14176; paratype pygidium, dorsal view, ×8.
Fig. 24. MGUH 14162; paratype free cheek, lateral view, ×8.
Fig. 25. MGUH 14172; paratype pygidium, dorsal view, ×8. (Photographed without opaque or ammonium chloride sublimate).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22a ×8
22b ×8
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25 ×8

Plate 2

Stenopareia somnifer sp. nov.

Figs 1a, b. MGUH 14154; paratype cranidium, dorsal and right oblique anterior views, ×4.
Fig. 2. MGUH 14155; paratype cranidium, dorsal view, ×8.
Figs 3a, b. MGUH 14156; paratype cranidium, dorsal and right oblique anterior views, ×8.
Fig. 4. MGUH 14163; paratype free cheek, dorsal view ×3.
Figs 5a, b. MGUH 14157; paratype cranidium, dorsal and anterior views, ×4.
Figs 6a, b. MGUH 14158; paratype rostral plate, ventral and posterodorsal views, ×4.
Figs 7a, b. MGUH 14161; paratype hypostome, ventral and left lateral views, ×4.
Fig. 8. MGUH 14165; paratype thoracic segment, dorsal view, ×4.
Fig. 9. MGUH 14164; paratype free cheek, posterior view, ×8.
Figs 10a, b. MGUH 14152; holotype pygidium, posterior view, ×8, dorsal view ×4.
Fig. 11. MGUH 14159; paratype rostral plate, ventral view, ×4.
Fig. 12. MGUH 14166; paratype thoracic segment, dorsal view, ×4.
Fig. 13. MGUH 14175; paratype pygidium, dorsal view, ×2.
Figs 14a, b. MGUH 14160; paratype rostral plate, ventral and posterodorsal views, ×4.

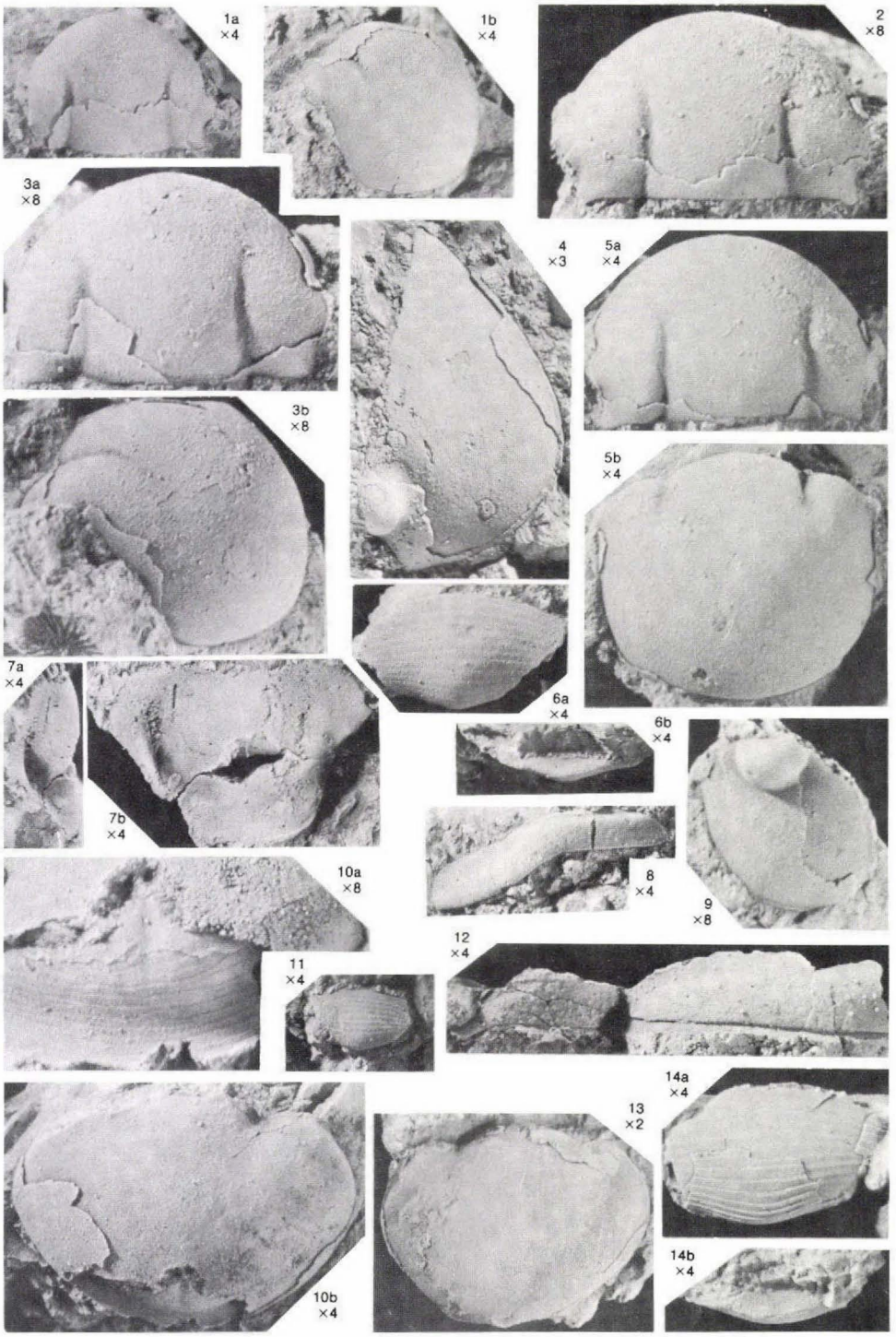
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Plate 3

Stenopareia somnifer sp. nov.

Fig. 1. MGUH 14173; paratype pygidium, dorsal view, ×1.
Figs 2a, b. MGUH 14174; paratype pygidium, dorsal and left lateral views, ×1½.

Proetus (Lacunoporaspis) sp.

Fig. 3. MGUH 14178; pygidium, ×8.

Cyphoproetus externus (Reed, 1935)

Figs 4a, b. MGUH 14179, latex cast of cranidium, dorsal and left anterior oblique views, ×10.
Figs 5a, b. MGUH 14180; cranidium, dorsal and right anterior oblique views, ×10.
Fig. 6. MGUH 14185; hypostome, ventral view, ×15 (S.E.M.)
Fig. 8. MGUH 14183; left free cheek, dorsal view, ×8.
Figs 10a, b. MGUH 14181; cranidium, dorsal and right lateral oblique views, ×10.
Figs 14a, b. MGUH 14182; cranidium, dorsal and left anterior oblique views, ×10.

Cyphoproetus? alyo sp. nov.

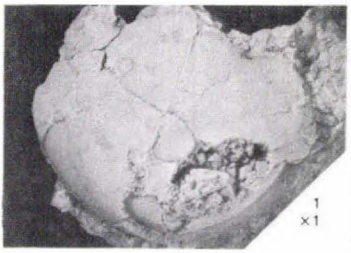
Fig. 7. MGUH 14195; right free cheek, dorsal view, ×10.
Fig. 9. MGUH 14196; right free cheek, dorsal view, ×10.

Encrinurus sp. C.

Fig. 11. MGUH 14222; right free cheek, lateral view, ×6.
Fig. 12. MGUH 14223; left free cheek, lateral view, ×6.
Fig. 13. MGUH 14224; right free cheek, lateral view, ×6.

Tropidocoryphine gen. et sp. indet.

Fig. 15. MGUH 14197; fragmentary cranidium, dorsal view, ×4.
Fig. 16. MGUH 14198; fragmentary pygidium, dorsal view, ×8.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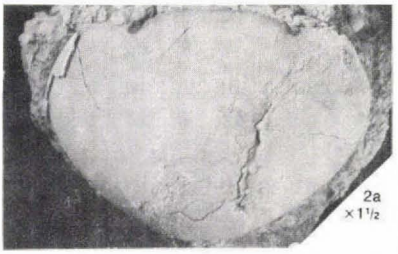
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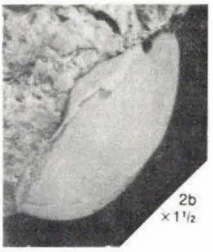
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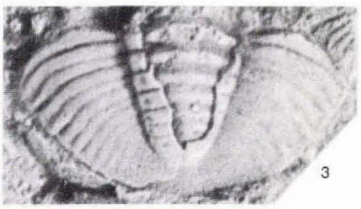
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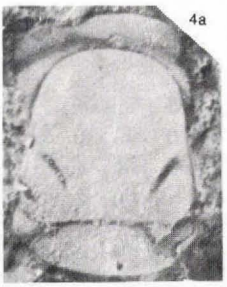
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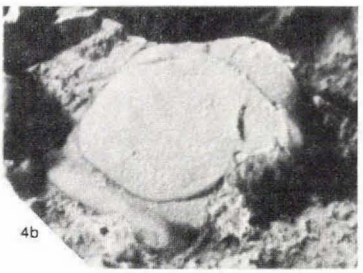
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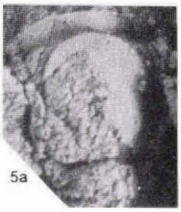
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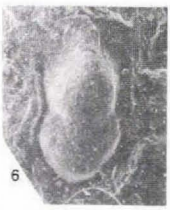
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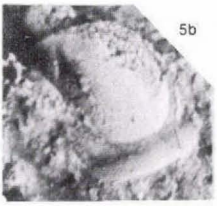
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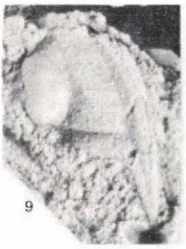
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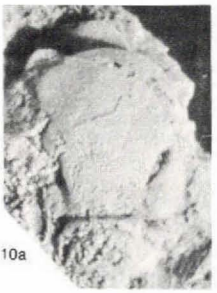
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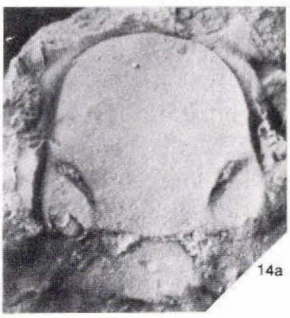
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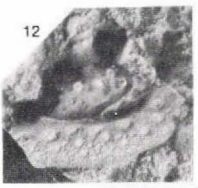
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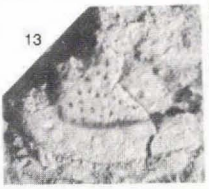
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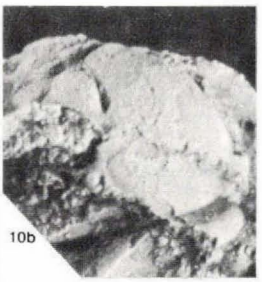
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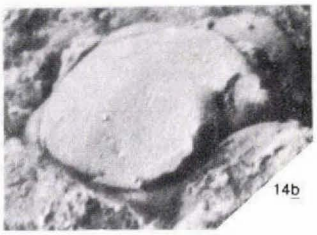
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Plate 4

Cyphoproetus? alyo sp. nov.

Figs 1a, b. MGUH 14190; holotype cranidium, dorsal and left anterior oblique views, ×8.
Figs 2a, b. MGUH 14194; paratype cranidium, dorsal and left anterior oblique views, ×8.
Figs 3a, b. MGUH 14193; paratype cranidium, right lateral and dorsal views, ×8.
Figs 4a, b. MGUH 14191; paratype cranidium, dorsal and left anterior oblique views, ×8.
Figs 6a, b. MGUH 14192; paratype cranidium, dorsal and right anterior oblique views, ×8.

Harpidella (Harpidella?) helenae sp. nov.

Figs 7a, b. MGUH 14200; paratype cranidium, right anterior oblique and dorsal views, ×8.
Figs 8. MGUH 14201; paratype cranidium, dorsal view, ×8.
Figs 9a-d. MGUH 14199; holotype cranidium, dorsal, right lateral, anterior and right anterior oblique views, ×8.
Figs 12. MGUH 14203; paratype left free cheek, lateral view, ×8.
Figs 13. MGUH 14202; paratype cranidium, dorsal view, ×8.
Figs 14. MGUH 14205; paratype pygidium, dorsal view. ×8.
Fig. 17. MGUH 14204; paratype left free cheek, lateral view, ×8.

Cyphoproetus externus (Reed, 1935)

Fig. 5. MGUH 14184; right free cheek, dorsal view, ×6.
Fig. 10. MGUH 14186; pygidium, dorsal view, ×8.
Fig. 11. MGUH 14187; pygidium, dorsal view, ×8.
Fig. 15. MGUH 14188; pygidium, dorsal view, ×8.
Fig. 16. MGUH 14189; pygidium, dorsal view, ×8.

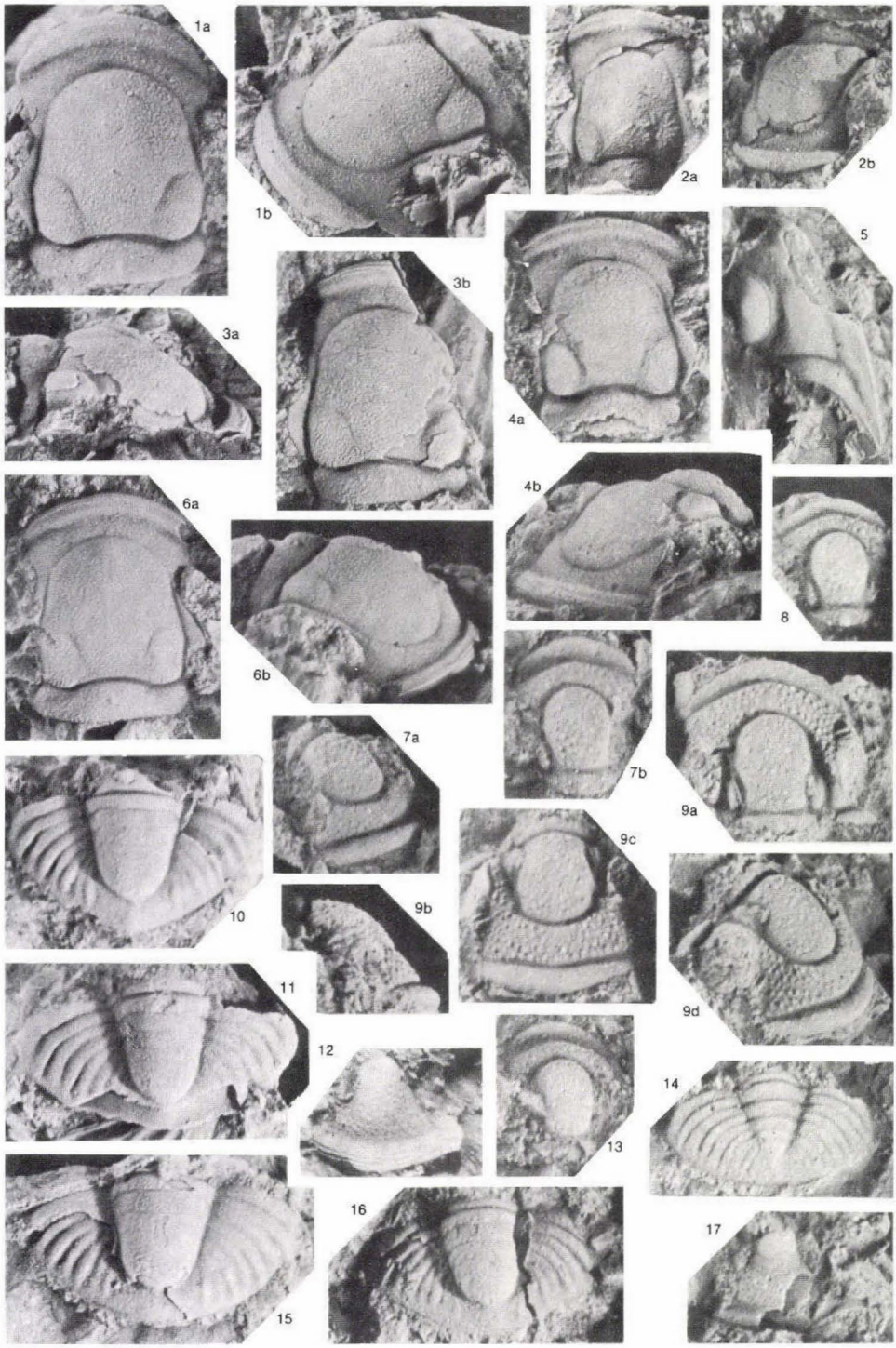
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Plate 5

Hadromeros? sp.

Figs 1a, b. MGUH 14210; cranidium, dorsal and left anterior oblique views, ×8.

Youngia sp.

Fig. 2. MGUH 14215; fragmentary glabella, dorsal view, ×4.

Scotoharpes sp.

Fig. 3. MGUH 14208; cephalon, dorsal view; with MGUH 14177, paratype pygidium of *Stenopareia somnifer,* dorsal view, ×6.
Fig. 4. MGUH 14206; fragmentary cephalon, dorsal view, ×6.
Fig. 5. MGUH 14207; fragmentary cephalon, dorsal view, ×6.
Fig. 6. MGUH 14209; fragmentary cephalon, dorsal view, ×6.

Deiphon cf. *D. dikella* Whittard, 1934

Fig. 7. MGUH 14211; glabella, left lateral view, ×6.
Figs 8a, b. MGUH 14212; glabella, right lateral and dorsal views, ×6.
Figs 9a, b. MGUH 14213; glabella, left lateral and dorsal views, ×6.
Fig. 10. MGUH 14214; glabella, dorsal view, ×8.

Encrinurus sp. A

Figs 11a-c. MGUH 14217; cranidium, dorsal, right lateral oblique and anterior views, ×6.
Fig. 14. MGUH 14218; cranidium, dorsal view, ×6.
Fig. 15. MGUH 14220; cranidium, dorsal view, ×6.
Fig. 18. MGUH 14219; cranidium, dorsal view, ×6.

Encrinurus sp. B

Figs 12a, b. MGUH 14221; fragmentary cranidium, dorsal and left anterior oblique views, ×8.

Encrinurus sp. D

Fig. 13a, b. MGUH 14225; hypostome, ventral and right lateral views, ×6.
Figs 16a-c. MGUH 14226; hypostome, ventral, anterior and right lateral views, ×6.

Encrinurus sp. E

Fig. 17. MGUH 14227; hypostome, ventral view, ×6.

Encrinurus aff. *E. moderatus* Poulsen, 1934

Figs 19a–c. MGUH 14216; cranidium, left anterior oblique, anterior and dorsal views, ×6.

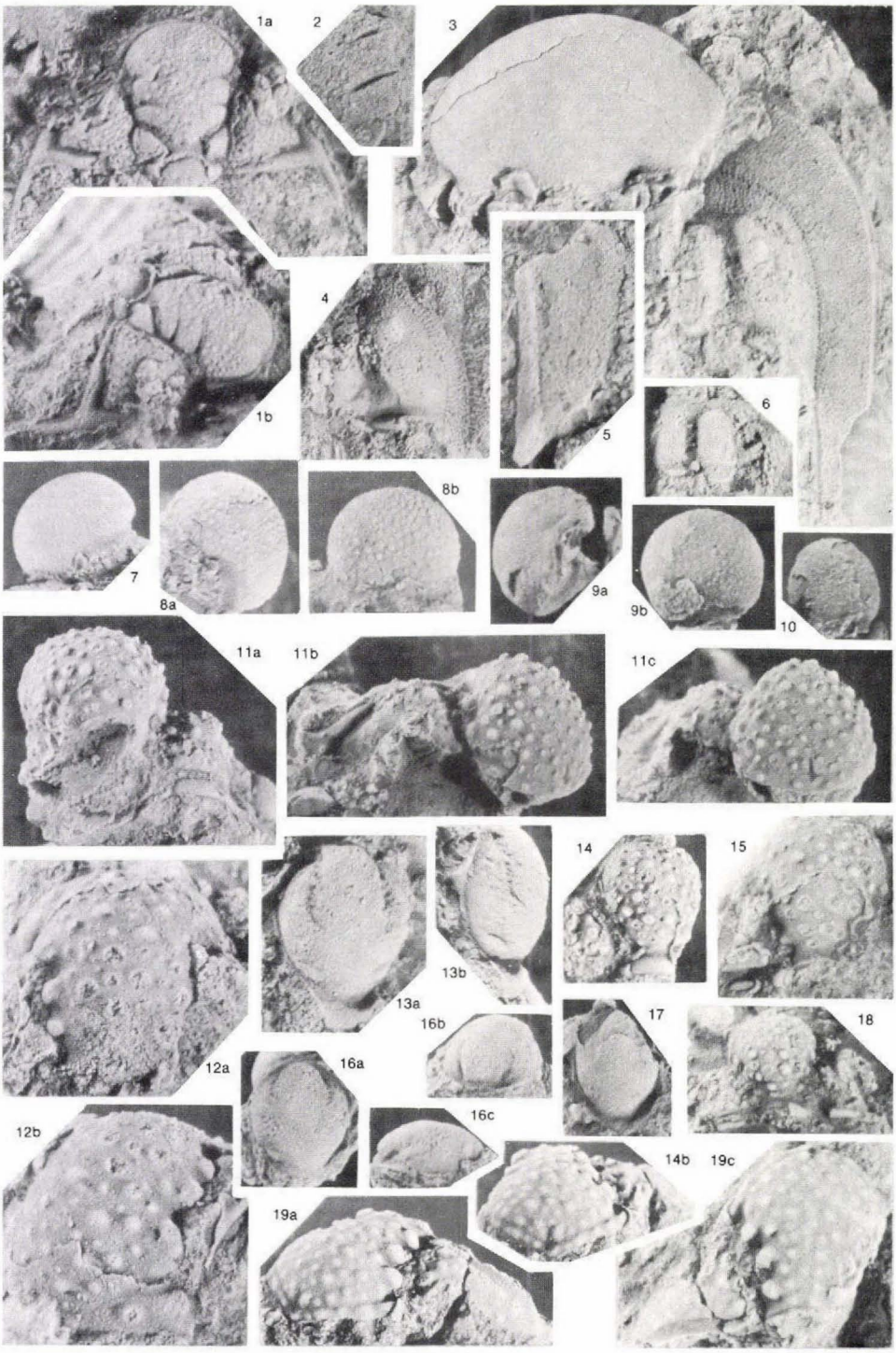
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Plate 6

Encrinurus sp. F

Fig. 1. MGUH 14228; pygidium, dorsal view, ×6.
Fig. 2. MGUH 14229; pygidium, dorsal view, ×6.
Fig. 4. MGUH 14230; pygidium, dorsal view, ×6.
Fig. 5. MGUH 14231; pygidium, dorsal view, ×6.
Figs 6a, b. MGUH 14232; pygidium right posterior oblique and dorsal views, ×6.
Fig. 9. MGUH 14233; pygidium, dorsal view, ×6.

Encrinurus sp. G

Fig. 3. MGUH 14234; pygidium, dorsal view, ×8.
Fig. 7. MGUH 14235; pygidium, dorsal view, ×8.

Acernaspis (Eskaspis)

Fig. 8a-c. MGUH 14236; free cheek; ventral view, ×4; left lateral oblique and posterior views, ×6.

Platylichas sp. A

Fig. 10. MGUH 14239; right free cheek, lateral view, ×6.
Figs 11a-c. MGUH 14240; hypostome, ventral, right anterior oblique and right lateral views, ×6.
Fig. 12. MGUH 14242; pygidium, dorsal view, ×6.
Fig. 14. MGUH 14241; fragmentary thoracic segment, dorsal view, ×4.
Fig. 14. MGUH 14243; latex cast of pygidium, dorsal view, ×4.
Fig. 17. MGUH 14238; fragmentary ?cranidium, right anterior oblique views, ×6.

Platylichas sp. B

Fig. 15. MGUH 14244; fragmentary cranidium, dorsal view, ×4.

Platylichas sp. C

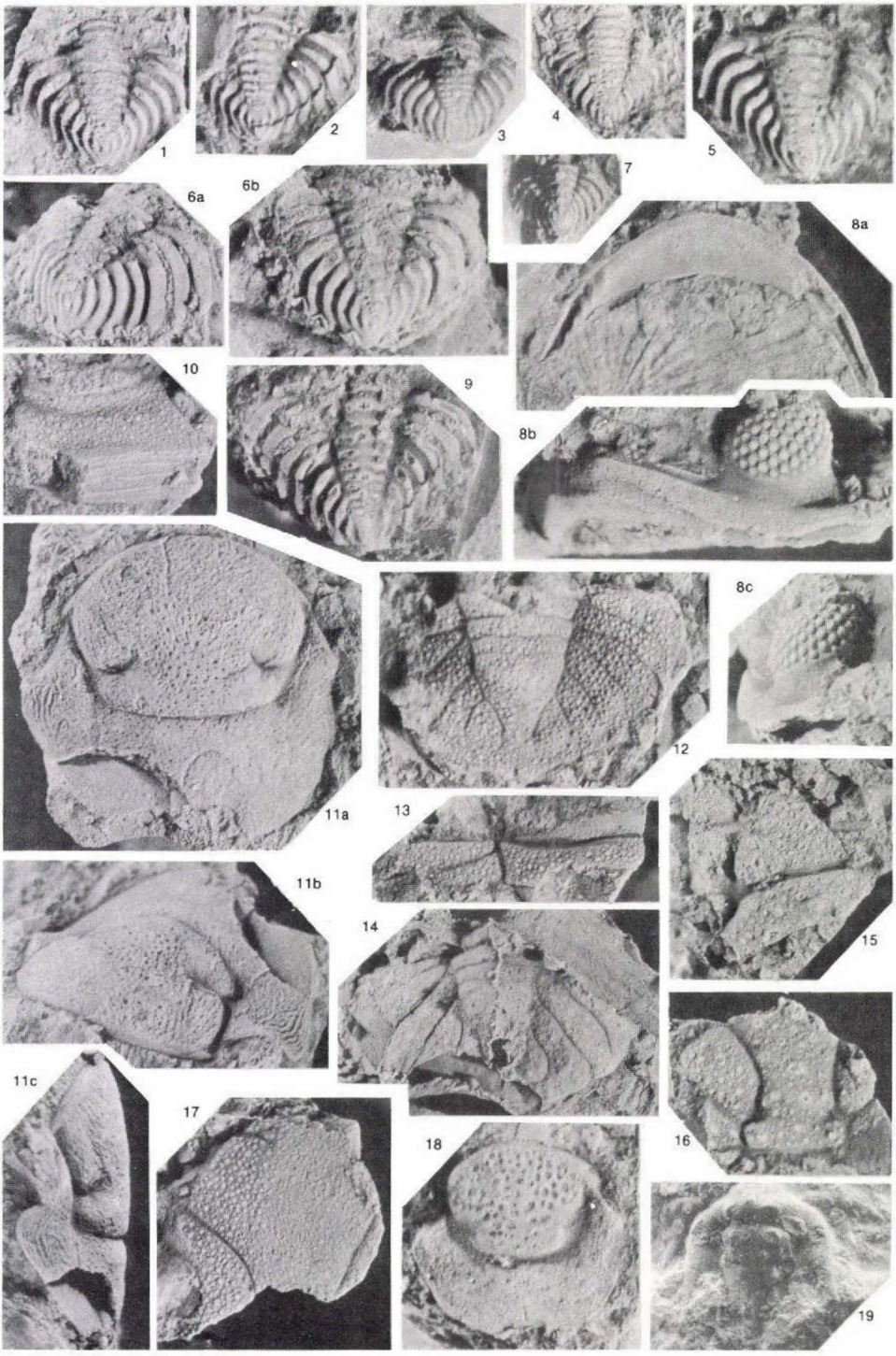
Fig. 16. MGUH 14245; fragmentary cranidium, dorsal view, ×6.

Hemiarges sp.

Fig. 18. MGUH 14237; hypostome, ventral view, ×6.

Leonaspis sp.

Fig. 19. MGUH 14246; pygidium, dorsal view, ×15. (S.E.M.)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