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MINES AND RESOURCES

BULLETIN 223

ORDOVICIAN TRILOBITES FROM THE KEELE RANGE, NORTHWESTERN YUKON TERRITORY

W. T. Dean

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By
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PREFACE

Research in systematic paleontology is one of the means by which the Geological Survey provides data for the calibration of the geological time scale so necessary for the precise dating and correlation of the rocks that make up the geological framework of Canada.

In this report, an assemblage of trilobites, which displays marked affinities with that of the middle Table Head Formation of western Newfoundland, is described. The study is valuable in that it contributes to a more accurate understanding of the Paleozoic rocks in this part of the Yukon Territory where exploration for petroleum is currently in progress.

Y.O. Fortier, Director,
Geological Survey of Canada

OTTAWA, September 28, 1972

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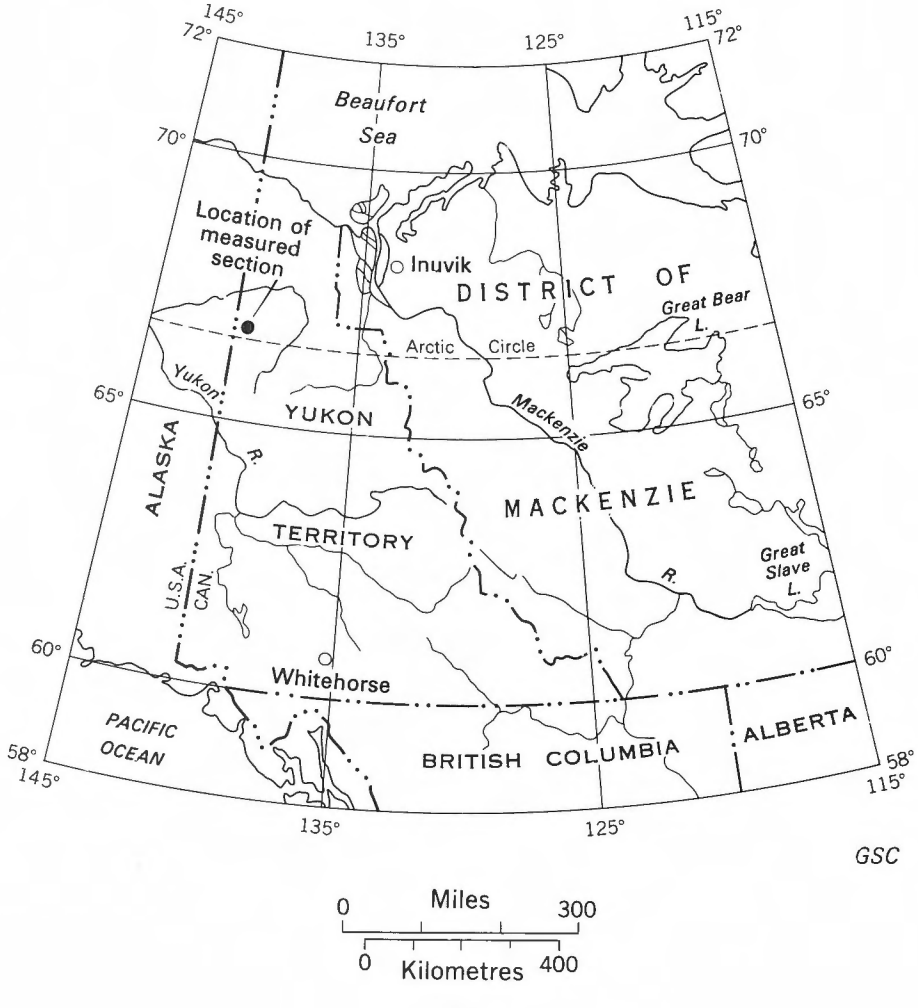
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Arctic Circle
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115°
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GSC
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Miles
300
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Kilometres
400

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ORDOVICIAN TRILOBITES FROM THE KEELE RANGE, NORTHWESTERN YUKON TERRITORY

Abstract

Ordovician trilobites from the lowest portion of Unit 3 of an unnamed carbonate formation at a measured section in the Keele Range, northwestern Yukon Territory include *Geragnostus* cf. *G. longicollis* (Raymond), *Ampyxoides occipitalis* sp. nov., *Shumardia lacrimosa* sp. nov., *Cybelurus occidentalis* sp. nov., *Carolinites* sp., *Remopleurides* sp., *Peraspis yukonensis* sp. nov. and *Nileus gabata* sp. nov. The generic assemblage displays marked affinities with that of the middle Table Head Formation of western Newfoundland, a subdivision generally regarded as being of Lower Llanvirn age, though the new species are not yet known elsewhere. A single graptolite assigned to *Phyllograptus anna* J. Hall suggests an Arenig or early Llanvirn age, whilst associated conodonts confirm the middle Table Head affinities and also indicate a Llanvirn age. Fragmentary trilobites from the upper portion of the underlying Unit 2, though generically indeterminate, suggest an early Ordovician age and associated conodonts of Baltic type (see Appendix I) indicate a Lower Arenig horizon. A pronounced disconformity between Units 2 and 3 is thus inferred.

Résumé

Les trilobites de l'Ordovicien provenant de la partie la plus basse de l'unité n°3 d'une formation sans nom de carbonates dans une section déterminée du chaînon Keele dans le nord-ouest du Yukon comprennent des *Geragnostus* cf. *G longicollis* (Raymond), *Ampyxoides occipitalis* esp. nouv., *Cybelurus occidentalis* esp. nouv., *Shumardia lacrimosa* esp. nouv., *Carolinites* sp., *Remopleurides* sp., *Peraspis yukonensis* esp. nouv. et *Nileus gabata* esp. nouv. L'assemblage générique démontre des affinités avec celui de la formation centrale de Table Head dans l'ouest de Terre-Neuve, subdivision qui est généralement considérée comme du Llanvirnien inférieur, même si l'on n'a pas encoure recontré les nouvelles espèces ailleurs. Un seul graptolith classé comme *Phyllograptus anna* J. Hall porte à croire qu'il s'agit de l'Arénig ou du Llanvirn inférieur alors que des conodontes associés confirment les affinités avec la formation centrale de Table Head et sont aussi indicatifs du Llanvirn. Des trilobites fragmentaires de la partie supérieure de l'unité sous-jacente n° 2, même s'ils ne sont pas classés génériquement, portent à croire qu'il s'agit de l'Ordovicien inférieur et des conodontes associés au type Baltique (voir annexe I) indiquent le début de l'Arénig inférieur. Il en résulte qui'l existe une discordance prononcée entre les unités 2 et 3.

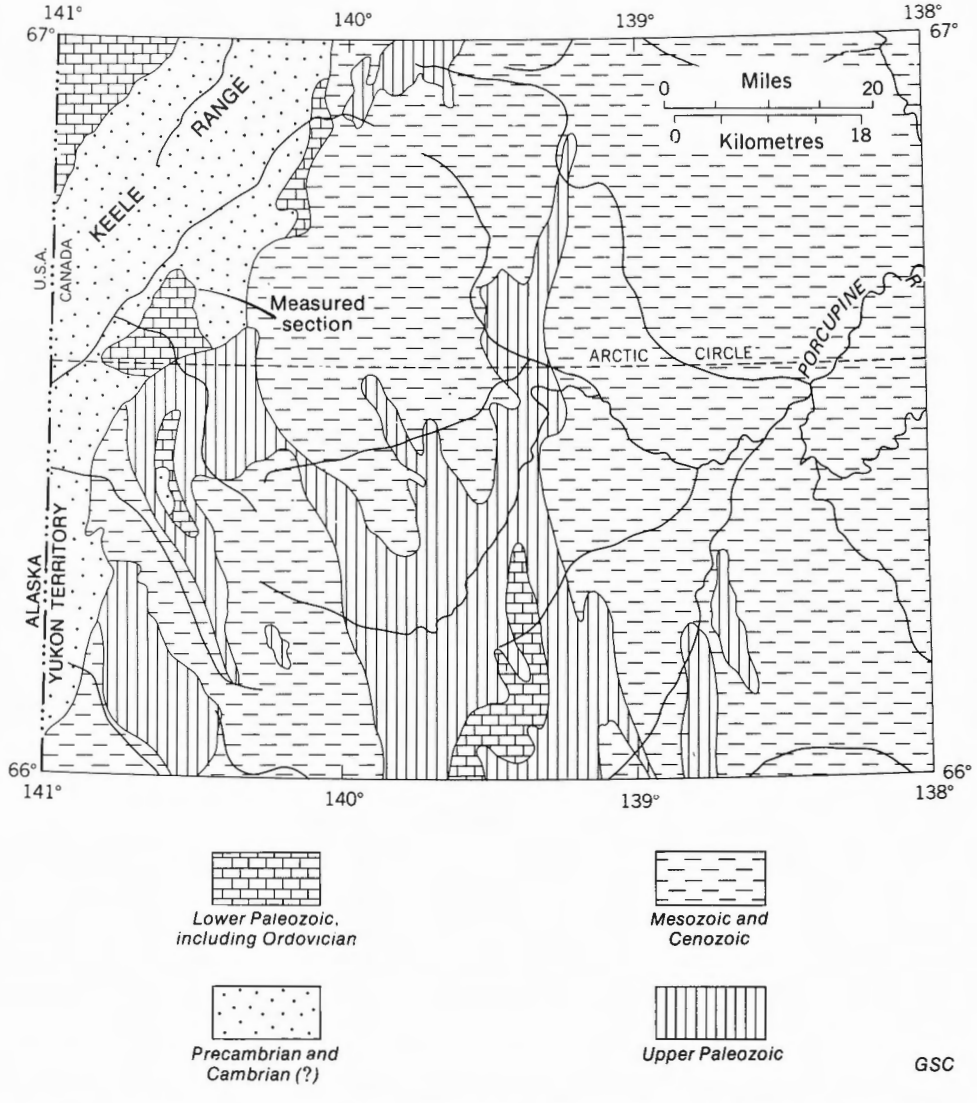

Figure 1. Generalized geological map of the area around the described section.

INTRODUCTION

During summer 1962 extensive reconnaissance mapping and collecting were carried out in the northern Yukon Territory and adjoining parts of the District of Mackenzie in the course of the Geological Survey of Canada's "Operation Porcupine". As a result of this work a 1:1,000,000 scale geological map of the region was compiled by Norris, Price and Mountjoy (1963) and shortly afterwards the preliminary results of investigations on the Ordovician and Silurian strata were summarized in a paper by Norford (1964) which gave faunal lists for a number of measured sections and spot localities. One of the latter is of particular interest in view of the affinities of the contained Ordovician trilobites with faunas of broadly similar type and age in western Newfoundland. The locality in question lies in the southern part of the Keele Range, just north of the Arctic Circle and some 15 miles east of the Alaska border, its approximate position being 66°38'N, 140°32'W (see Fig. 1). Some of the fossils collected there by R.M.Procter and said to be of "upper Lower Ordovician" age were noted by Norford (1964, p. 139) whose list included "cf. *Cybeloides* sp., cf. *Rapiophorous* (sic) sp., *Shumardia* sp., *Trinodus* sp. and *Phyllograptus* sp.". These were referred to subsequently by Norford (in Ross and Ingham, 1970, p. 401), though on this occasion the "cf. *Cybeloides*" was redetermined as *Miracybele*, and their affinites with faunas of the Whiterock Stage were noted briefly.

Although the source of the trilobites now to be described was termed originally a "spot locality", in fact R.M. Procter measured there a succession of almost 3,000 feet of unnamed carbonate rocks. This section, termed "Northern Ogilvie Mountains Section 116K2" is now on Open File at the Geological Survey of Canada, Ottawa, and its essentials are reproduced in Figure 2. The rock succession comprises limestones and dolomites which were subdivided into six units; the lowest 200 feet of Unit 1, though not seen, were presumed to overlie quartzites mapped as Tindir Group (see Norris, Price and Mountjoy, 1963) but are now regarded as being of possible early Paleozoic age.

I am much indebted to Dr. R.J. Ross Jr. and Professor H.B. Whittington, both of whom have kindly read the manuscript and made suggestions for its improvement.

SYSTEMATIC DESCRIPTIONS

The terminology used in the present account is essentially that advocated in the Treatise on Invertebrate Paleontology (Harrington, Moore and Stubblefield in Moore, 1959, p. O 117), though some of the terms were regarded by them as being "less important". Specimen numbers refer to the collections of the Geological Survey of Canada, Ottawa.

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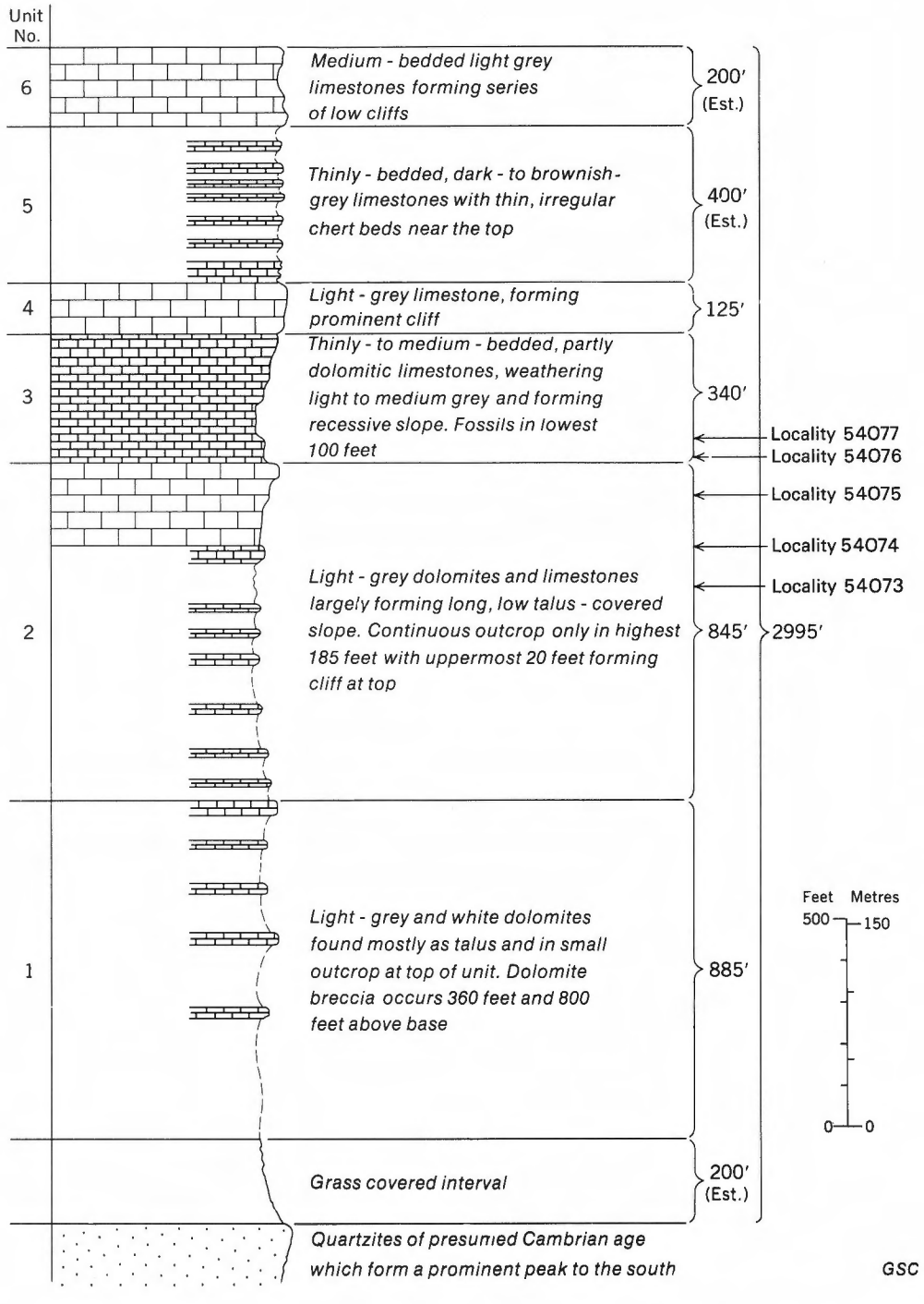

Figure 2. Stratigraphic section (Northern Ogilvie Mountains Section 116K2).

Family AGNOSTIDAE M'Coy, 1849

Genus Geragnostus Howell, 1935

Type Species. *Agnostus sidenbladhi* Linnarsson, 1869 from the Lower Ordovician of Sweden.

Geragnostus cf. *G. longicollis* (Raymond)

Plate 1, figures 1-6

Arthrorhachis longicollis Raymond, 1925, p. 12, Pl. 1, fig. 5 only.

Geragnostus longicollis (Raymond), Whittington, 1965, p. 301, Pl. 1, figs. 1-12, 14, 16, 17.

Figured specimens. GSC 29329 (Pl. 1, figs. 1, 2, 4, 6), GSC 29330 (Pl. 1, fig. 3), GSC 29331 (Pl. 1, fig. 5).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description and discussion. The best-preserved specimens agree in most respects with the material from the middle Table Head Formation of Newfoundland described and illustrated by Whittington (1965, p. 301). The glabella of GSC 29392 (Pl. 1, fig. 1) is slightly wider and the cranidium a little more quadrate than in the Newfoundland specimens, and there is a more distinct break in the outline of the pygidial axis. The surface of the latter and that of the pleural fields is covered with minute, closely-packed granules, visible only under high magnification, which are sometimes arranged in lines subconcentric around the outline of the axis. This granulation appears to extend across part of the border furrow but then dies out, so that the border is smooth. Only faint traces of similar ornamentation are visible on the cranidium, which is otherwise smooth. Whittington's material, described as having an apparently smooth exoskeleton, exhibits minor variation in pygidial outline and proportions and this may also be the case for the Yukon specimens, though they are insufficient to demonstrate such variation satisfactorily. The affinites of *G. longicollis* have been discussed by Whittington (loc. cit.).

Dimensions (mm).

	GSC 29329	GSC 29330	GSC 20331
Length of cranidium	3.3 (EM)	-	-
Breadth of cranidium	3.5 (EM)	-	-
Length of glabella	2.0 (EM)	-	-
Breadth of glabella	1.5 (EM)	-	-
Length of pygidium	-	2.6 (IM)	2.3*(EM)
Max. breadth of pygidium	-	3.2*(IM)	2.7*(EM)
Length of axis	-	1.7 (IM)	1.3 (EM)
Frontal breadth of axis	-	1.4 (IM)	1.1 (EM)

* Denotes estimated measurement (EM) = external mould (IM) = internal mould.

Family RAPHIOPHORIDAE Angelin, 1854

Genus Ampyxoides Whittington, 1965

Type Species. *Ampyx semicostatus* Billings, 1865 from the Table Head Formation, Ordovician, of western Newfoundland.

Ampyxoides occipitalis sp. nov.

Plate 1, figures 7-9, 13, 15, 16

Diagnosis. Outline of cranidium (excluding frontal glabellar spine) sub-semicircular except medially where about one fifth glabellar length projects beyond traces of small anterior border. Glabellar outline well-rounded anterolaterally, broadest medially, but sharply constricted posteriorly where glabella is of humped appearance and overhangs occipital furrow. Large, quadrant-shaped fixigenae do not meet in front of glabella. Pygidium about five times as broad as long with four axial rings and two and a half pairs narrow (exsag.) pleural ribs.

Holotype. GSC 29333 (Pl. 1, fig. 9).

Paratypes. GSC 29332 (Pl. 1, figs. 7, 8, 15), GSC 29334 (Pl. 1, fig. 16), GSC 29422 (Pl. 1, fig. 13).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description. The cranidium is sub-semicircular in outline with overall breadth only slightly less than twice the median length (excluding the frontal glabellar spine, which is not preserved). The fixigenae are relatively large, of low convexity and almost quadrant-shaped in outline; they narrow adaxially around the front of the glabella and die out without attaining the axial line, where the cranidial outline is truncated by the remnants of a very small, transversely-straight anterior border. The facial suture does not form a uniform curve but is slightly angular anterolaterally, behind which points it is almost imperceptibly concave, so that the librigenae must have been very small and narrow. The glabella is about one and one quarter times as long as broad, its almost lozenge-shaped outline transversely truncated by the occipital furrow. It is strongly convex transversely, stands well above the fixigenae, and in plan view almost one fifth of the glabellar length protrudes beyond the front of the cranidium. Shallow but distinct axial furrows diverge forwards for about half their length and then curve adaxially to meet frontally in an unbroken curve. Posteriorly the axial furrows widen markedly opposite the hindmost one fifth to one quarter of the glabella which not only has a constricted appearance in plan view but also slightly overhangs the occipital furrow and so has a curiously humped appearance when viewed laterally. The front of the constricted portion of the glabella is marked, just above the axial furrows, by a pair of small depressions which represent lp glabellar furrows. In front of them the glabellar outline expands and the lateral portions become less convex than the centre, but there is no further evidence of glabellar lobation. As already noted, the occipital furrow is overhung slightly by the glabella and appears broad (sag.) and deep on the internal mould. The occipital ring is narrow (sag.) and extends a little way beyond the sides of the glabella; it is almost continuous with the posterior border which stands higher than the adjacent fixigenae and, particularly over the abaxial two thirds, is sharply defined by a deep, narrow posterior

border furrow that curves slightly forwards laterally. Remnants of the exoskeleton show the outer surface ornamented with closely spaced fine punctae.

The single available pygidium is very small, sub-semiellipitical in outline with a maximum breadth almost five times the median length. The tapered axis is of low convexity with three clearly defined, transversely-straight axial rings and traces of a fourth, whilst the diminutive terminal piece merges with the steeply bevelled pygidial border. The pleural fields, separated from the border by a low rim, are composed of a pair of narrow (exsag.) anterior half-ribs and two pairs of ribs, all of which run slightly backwards abaxially and are separated by deep pleural furrows. The ribs are divided by faint pleural furrows into unequal anterior and posterior bands, the latter of which are the larger, and are followed by very small, smooth, triangular areas. No ornamentation is visible.

Dimensions (mm).

	GSC 29332	GSC 29333	GSC 29334	GSC 29422
Max. breadth of cranidium	4.6*(IM)	5.6*(IM)	3.7 (IM)	-
Median length of cranidium (excluding frontal spine)	2.2*(IM)	2.8*(IM)	1.7*(EM)	-
Max. breadth of glabella	1.7 (IM)	2.0 (IM)	1.1 (EM)	-
Basal breadth of glabella	0.8 (IM)	0.9 (IM)	0.6 (EM)	-
Frontal breadth of pygidium	-	-	-	3.2*(IM)
Length of pygidium	-	-	-	0.7 (IM)
Frontal breadth of axis	-	-	-	0.7 (IM)

* Denotes estimated measurement (EM) = external mould, (IM) = internal mould.

Discussion. The frontal extension, strong convexity and greater median breadth of the glabella, the large, rounded fixigenae and the short pygidium of the Yukon species exclude it from the related raphiophorid genus *Ampyx*, the type species of which, *A. nasutus* Dalman, 1827, was redescribed by Whittington (1950, p. 554). A closer resemblance may be noted to *Ampyxina*, the type and other species of which have been reviewed by Whittington (1950, p. 577; 1959, p. 481 *et seq.*), but in this instance the presence of well-developed alae is regarded as a critical feature. The cranidium of *Ampyxoides* Whittington (1965, p. 319) was stated to differ from *Ampyxina* by its lack of alae and possession of a frontal glabellar spine that is quadrilateral in cross-section (a feature reminiscent of *Lonchodomas*); unfortunately the latter criterion cannot be applied to the Yukon material, but otherwise the cranidia appear to be best referred to *Ampyxoides*. The type species *A. semicostatus* (Billings, 1865) has been redescribed by Raymond (1925, p. 31, Pl. 1, figs. 14, 15) and, more particularly, by Whittington (1965, p. 319, Pl. 12, figs. 13-20; Pl. 13, figs. 1-10, 12). The fixigenae are of approximately similar shape and size in *A. semicostatus* and the new species, but the former has additional indications of glabellar furrows whilst the latter's glabella, with its greater forward extension forwards and the unusual protuberance in front of the occipital furrow, is distinctive. The pygidium of *A. semicostatus* appears to be proportionately the longer, with a narrower axis and a greater number (four and a half) of pairs of ribs, but that assigned to the new species is only a very small specimen with possibly immature characters and is included with some hesitation only because it is the sole specimen available, though all the other material suggests that the

species is a small one. The pygidium of *Ampyx* sp. from the Antelope Valley Limestone of Nevada described by Ross (1967, p. 22, Pl. 7, figs. 20, 21) has ribs and axial rings similar in number to those of the present specimen though less strongly developed. The Nevada pygidium, of approximately similar size to that from the Yukon, was considered by Ross to be immature.

Family SHUMARDIIDAE Lake, 1907

Genus Shumardia Billings, 1862

Type Species. *Shumardia granulosa* Billings, from the Lower Ordovician of Lévis, Québec.

Shumardia lacrimosa sp. nov.

Plate 1, figures 10-12, 14

Diagnosis. *Shumardia*-like trilobites with base of glabella relatively broad, and pair of large, drop-like, tear-shaped anterolateral lobes that are sited behind centre with reference to the glabella and converge forwards at an acute angle. Front of glabella forms poorly defined tongue-like projection which extends forwards almost to anterior margin of cephalon. Pygidium has long, very convex axis with six axial rings extending to tip of pygidium; pleural fields have four pairs ridge-like pleurae ornamented by tubercles on anterior bands.

Holotype. GSC 29335 (Pl. 1, fig. 14).

Paratypes. GSC 29336 (Pl. 1, fig. 12), GSC 29337 (Pl. 1, fig. 10), GSC 29423 (Pl. 1, fig. 11).

Horizon and locality. Ordovician, unnamed formation GSC locality 54076.

Description. The largest cranidium is one and a half times as broad as long, subsemicircular in plan and strongly convex. The glabella exhibits some variation in relative size and form, depending on the size of the cranidium. In the largest specimen, the maximum breadth of the glabella equals half that of the cranidium and is measured just behind centre and across a pair of large, subelliptical lobes, structures that Ross (1967, p. 10) has termed anterolateral lobes, though there seems little doubt they form part of the glabella. The overall glabellar outline bears a superficial resemblance to an arrowhead, the barbs of which are formed by the tear-shaped anterolateral lobes. The front of the glabella is very narrow and extends well forwards on the smallest available cranidia (see esp. Pl. 1, fig. 12) but is broader and more rounded on the largest specimen, and the junction of the frontal glabellar lobe with each anterolateral lobe is an unbroken, abaxially concave curve. The hindmost portion of the glabella is subparallel-sided with a pair of faint swellings giving a suggestion of basal lobes immediately in front of the incised, transversely-straight occipital furrow. The large occipital ring is of even breadth (sag.), extends beyond the sides of the glabella and bears a suggestion of a median node. In plan view it projects behind the adaxial portions of the fixigenae, the posterior margins of which run backwards slightly towards the genal angles. There is no posterior border furrow and the smooth, convex fixigenae appear to join frontally as a small preglabellar area, though this is not clearly

demonstrable as the front of the glabella is so poorly defined. The axial furrows are deep posteriorly as they diverge slightly across the extremities of the occipital ring and around the curved abaxial margins of the anterolateral lobes, but suddenly diminish and become almost obsolete, so that the outline of the frontal half of the glabella is scarcely discernible. Opposite the base of the glabella the axial furrows expand to form a pair of deep depressions that extend adaxially forwards as notches delimiting the rounded tips of the anterolateral lobes. The outer margin of each depression forms a sharply defined edge, a feature which then diminishes as it curves posterolaterally to meet the posterior cephalic margin, apparently rather less than halfway to the genal angles, though this part of the exoskeleton is not well preserved. The structures resemble those in *Shumardia exopthalma* described by Ross (1967, p. 10) as furrows running from the genal angles. The cranidial margin is marked frontally by a diminutive rim and its otherwise even curvature becomes slightly concave anterolaterally to accommodate what must have been very small librigenae.

The pygidium is sub-semicircular in outline, blunted posteriorly, with a smooth, narrow, rim-like border that is bounded by a shallow border furrow. In plan view the almost straight-sided axis, with a frontal breadth about one third that of the whole pygidium, tapers gently to the rounded tip, just short of the posterior margin. In lateral view the axis is of unusually convex appearance, its dorsal surface arching upwards and back from the articulating furrow and then declining steeply to the axial tip. A well-defined, narrow (sag.) first axial ring and a second, slightly broader but less well defined ring carry traces of turbercles; an additional four rings occupy almost the whole of the remainder of the axis and although less well demarcated by furrows are clearly marked, each ring having from one to three pairs of tubercles. The pleural fields are of low convexity and show evidence of four fused segments followed by a pair of smooth, subtriangular areas. Each of the first pair of pleurae is bounded by a shallow interpleural furrow and is divided by a pleural furrow into two unequal bands the anterior of which is the larger, ornamented with five or possibly six tubercles. Succeeding pleurae become progressively less well defined but the positions of the anterior bands are denoted by transverse rows of tubercles.

Dimensions (mm).

	GSC 29335	GSC 29336	GSC 29337	GSC 29423
Length of cranidium	-	0.7	1.4	1.0 est.
Breadth of cranidium	-	1.2	2.1	1.4
Max. breadth of glabella	-	0.6	1.2	0.7
Length of pygidium	0.85 est.	-	-	-
Max. breadth of pygidium	1.7	-	-	-
Length of axis	0.7	-	-	-
Frontal breadth of axis	0.6	-	-	-

Discussion. The new species described above bears the closest resemblance, at least as far as the cranidium is concerned, to *Shumardia sagittula* Whittington (1965, p. 330) from the middle Table Head Formation of western Newfoundland. The glabella of *S. lacrimosa* is proportionately a little wider overall than that of *S. sagittula* and the occipital ring is notably larger, but the two species clearly have much in common. In both the glabella differs markedly from that of the type

species of *Shumardia, S. granulosa* Billings, 1862, from the Shumardia Limestone of Lévis, Québec, which has been redescribed in detail by Whittington (1965, p. 327, Pl. 16). In *S. granulosa* very large lateral lobes are sited beside the frontal glabellar lobe, which is bluntly pointed in plan and does not extend to the front of the cranidium. *S. lacrimosa* has a larger occipital ring and the front of the glabella forms a tongue-like extension reaching forwards to the anterior margin. The pygidium of *S. sagittula* is unknown but may well prove to resemble that of *S. lacrimosa* which is, in turn, notably different from that of *S. granulosa* and it may be doubted whether the last should be regarded as congeneric with the two former species. The pygidium of *Shumardia granulosa* is subtriangular in outline, almost as long as broad, with a proportionately large, wide axis which occupies two thirds of the median length. On the other hand the pygidium of *Shumardia lacrimosa* is nearly twice as broad as long, subquadrate in plan, the axis occupies almost all the median length, the pleurae are less strongly curved backwards, and the small, brim-like border is continuous around the periphery.

The differences enumerated above could be interpreted as suggesting that *S. lacrimosa*, and probably also *S. sagittula*, be separated under a different generic name but it is not yet clear whether a new name is necessary. The pygidium of *S. lacrimosa* appears to be closest to that of trilobites from the Shineton Shales, Tremadoc Series, of Shropshire, in the Welsh Borders, that have been customarily assigned to the Norwegian species *Shumardia pusilla* (Sars, 1835), for instance by Stubblefield (1926). Whether these Shropshire specimens are truly synonymous with *S. pusilla* is debatable but they are conspecific with material from Shineton described originally as *Conophrys salopiensis* Callaway (1877, p. 667, Pl. 24, fig. 7). Although *Conophrys* has been regarded by some authors, for example Reed (1903, p. 43), Stubblefield (1926, p. 346) and Poulsen (in Moore, 1959, p. O 245), as a junior subjective synonym of *Shumardia*, there appear to be grounds for regarding it as a separate genus, as was advocated by Brøgger (1882, p. 125).

There is an undoubted resemblance to *Shumardia exopthalma* Ross (1967, p. 9, Pl. 10, figs. 23-33) from the Ninemile Formation and Antelope Valley Limestone of Nevada. The largest cranidia of Ross's species have a distinctively large occipital ring in front of which the occipital furrow is poorly defined and the glabellar outline appears constricted; the latter feature is less well marked in smaller cranidia, which bear a correspondingly closer resemblance to *S. lacrimosa* though the anterolateral lobes are set farther back. The pygidial outline is comparable in both species and the number of segments, indicated by four transverse rows of tubercles, is the same, but the axis of *S. lacrimosa* is longer and has more axial rings.

To summarize: — a. *Conophrys* and *Shumardia* can probably be regarded as two separate genera; b. on the basis of the cranidium *S. lacrimosa* is probably congeneric with *S. sagittula* and *S. exopthalma*, and all three differ from *Shumardia granulosa* and perhaps also *Conophyrys*; c. the pygidium of *S. sagittula* is unknown but that of *S. lacrimosa* and *S. exopthalma* resembles *Conophyrys* rather than *Shumardia*. Consequently it appears that three distinct generic groupings may prove to be involved, but the small samples available for *Shumardia sagittula* and *S. lacrimosa* are insufficient for the establishment of a new name.

Family CHEIRURIDAE Hawle and Corda, 1847

Cheirurid genus and species undetermined

Plate 2, figures 1, 4.

Figured specimens. GSC 29338 (Pl. 2, fig. 4), GSC 29339 (Pl. 2, fig. 1).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description and discussion. The internal mould of an incomplete hypostoma (Pl. 2, fig. 4) is estimated to have been about as long as broad (excluding the anterior wings which are not preserved), its outline becoming narrower behind centre with the sides almost straight posterolaterally. Most of the structure is occupied by the large middle body, divided into two unequal lobes by a median furrow which deepens laterally but is only faint at and near the sagittal line. The larger anterior lobe is subcircular in plan whilst the posterior lobe is sharply crescentic, terminating laterally at points almost opposite the centre of the middle body. The anterior border is not preserved but the hindmost two thirds of the overall length are occupied by a pair of rim-like posterior wings, separated from the middle body by a broad, shallow furrow. Although incomplete the remains of the posterior border are almost transversely straight with a faint suggestion of a median indentation. The surface of the middle body and posterior wings is ornamented with fine granules, scattered low tubercles and interspersed shallow pits.

The affinities of the specimen are not clear and it does not correspond to any of the genera described in this paper. Some comparison may perhaps be made with the "Cheirurid hypostome" from the middle Table Head Formation of Newfoundland illustrated by Whittington (1965, Pl. 65, figs. 9, 12, 15), particularly with reference to the middle body, but the posterior wings of the Yukon specimen are conspicuously narrower and the posterior border is both smaller and less convex in plan.

A fragment of a pygidium (Pl. 2, fig. 1) shows at least the anterior portion of a well-defined axis, composed of three axial rings which are almost transversely straight and are separated by deep, narrow (sag.), slightly curved ring furrows. There remains but a trace of the terminal piece, narrower (tr.) than and set well below the level of the third axial ring. The surviving portion of the right pleural region is of low convexity with a small, narrow (exsag.) articulating facet, and comprises two large pleurae that are strongly curved back posterolaterally, followed by part of a third pleura. The first two pleurae broaden (exsag.) a little abaxially and each carries a median, transverse row of pits, those of the first pleura small, numerous and somewhat irregular, those of the second pleura fewer and larger. Most of the surface, excluding pits and furrows, is covered with densely crowded, fine granules but scattered tubercles also occur, particularly along the anterior and posterior margins of the pleurae and the posterior margins of the axial rings. The material is insufficient for certain generic identification.

Family ENCRINURIDAE Angelin, 1854

Genus Cybelurus Levitsky, 1962

Type Species. *Cybelurus planus* Levitsky, 1962 from the Middle Ordovician of the Altai Mountain region, U. S. S. R.

Subjective synonym. *Miracybele* Whittington, 1965.

Cybelurus occidentalis sp. nov.

Plate 2, figures 2, 3, 5-10; Plate 3, figures 1, 2, 4.

Diagnosis. *Cybelurus* with three inequisized pairs glabellar lobes, 3p pair joined abaxially to tips of pair small triangular lobes bounded by deep, short furrows that run adaxially forwards. Anterior border narrow (exsag.) laterally, widening to form median projection of flattened form. Frontal glabellar lobe with deep, narrow longitudinal furrow. Eyes approximately opposite 2p glabellar lobes and at ends of pair eye ridges extending from near front of 3p lobes. Pygidium longer than broad, subtriangular in plan. Pleural regions with four pairs pleurae divided into anterior and posterior bands; latter are larger, forming conspicuous ridges and ending in free points. Approximately seventeen narrow (sag.) axial rings present.

Horizon and locality. Ordovician, Unit 3 of unnamed formation. Most of the material is from GSC locality 54076, but the species occurs also at 54077.

Holotype. GSC 29340 (Pl. 2, figs. 2, 9, 10).

Paratypes. GSC 29342 (Pl. 3, fig. 2), GSC 29343 (Pl. 2, fig. 7), GSC 29344 (Pl. 3, fig. 1), GSC 29345 (Pl. 3, fig. 4), GSC 31605 (Pl. 2, fig. 5).

Description. The glabella is only moderately convex, both longitudinally and transversely, and its outline expands forwards, the sides forming gentle, abaxially concave curves. Basal breadth is approximately three quarters of the frontal breadth, but is not consistent owing to slight deformation. There are three pairs of glabellar furrows which end adaxially in-line to leave a smooth median band slightly more than one third the basal glabellar breadth. Three pairs of glabellar lobes decrease progressively in size from front to back. The 1p lobes are narrow (exsag.) and swing forwards abaxially to accommodate adaxial widening of the 1p furrows to form apodemes. The 2p lobes are transversely rectangular in outline, bounded by deep, slot-like 2p furrows which widen only slightly towards their inner ends. The large 3p lobes are subrectangular in plan, their long axes directed slightly forwards adaxially, parallel to narrow 3p furrows which are well defined to within a short distance of the axial furrows but then diminish abruptly to barely perceptible depressions. Immediately in front of these a short (tr.) deep pair of slot-like furrows is directed strongly forwards adaxially, and the tips of the subtriangular ancillary lobes so formed are fused with those of the 3p lobes. The anterior margin of the frontal glabellar lobe is gently arched forwards in plan, bounded by a narrow (sag.) preglabellar furrow which is shallow for the most part but deepens medially. At this point the preglabellar furrow is continuous with a conspicuous V-shaped depression which narrows posteriorly to form a furrow that runs longitudinally across the anterior third of the frontal glabellar lobe and then dies out. A pair of deep anterior pits is situated in the axial furrows at the ends of the preglabellar furrow. The anterior border is narrowest (exsag.) distally, broadens medially to form a spatulate frontal projection, and its convexity is continuous with that of the front of the glabella. The occipital ring has a breadth (sag.) equal to one fifth of the glabellar length, is surmounted by a median tubercle sited behind centre, and narrows abaxially to form a pair of occipital lobes that are directed anterolaterally, bounded by apodemes at the ends of the transversely-straight occipital furrow. The large fixigenae, though incomplete, are notably convex, stand

higher than the glabella and decline steeply to the axial furrows. The eyes are not preserved but their position opposite the 2p glabellar lobes is indicated by a pair of thick, straight eye-ridges which run forwards slightly to meet the axial furrows opposite the outer ends of the 3p glabellar furrows. The anterior branches of the facial suture converge forwards strongly in almost straight lines to cut the axial furrows a short distance in front of the anterior pits. The posterior branches are not preserved but must have been only slightly curved, judging from the relatively far back position of the eyes, which are sited only a short distance in front of the transversely-straight posterior border furrow. Remnants of the posterior border show it to be narrow (exsag.) near the axial furrows, from which it extended on either side for a distance at least one and a half times the basal glabellar breadth. Along either side of each eye-ridge is a conspicuous row of large pits. The remainder of the cheek surface is covered with a reticulate ornamentation of ridges and pits which is more weakly developed on the librigenae (Pl. 3, fig. 4) and, apparently, on the fixigenae anterior to the eye-ridges.

A single hypostoma has the frontal margin transversely straight, and the breadth, excluding anterior wings, is a little less than two thirds the median length. The posterior margin, though incomplete, is evidently entire, probably bluntly pointed, and the lateral and posterior borders form a continuous, flange-like rim which broadens (sag.) posteriorly. The anterior wings are notably large, expanding slightly in breadth (exsag.) from a pair of lateral notches. The middle body is subelliptical in outline, divided by a shallow median furrow into two lobes, the posterior of which is much the larger. The posterior lobe is crescentic with a conspicuous pair of raised, elliptical maculae sited anterolaterally. The surface of the anterior lobe is ornamented by numerous coarse tubercles, between which is fine granulation that extends on to the anterior wings and occurs also on the posterior lobe.

An associated almost complete pygidium, GSC 29341 (Pl. 2, figs. 3, 6, 8) differs from that of a typical *Cybelurus* and is therefore excluded from the type material of *C. occidentalis*, though referred questionably to that species. The specimen is strongly convex transversely, its dorsal surface is gently declined posteriorly, and the maximum breadth is three quarters of the median length. The straight-sided axis tapers gently to a minute, bluntly-rounded terminal piece which grades into a poorly-defined axial ridge; the latter is flanked by elongated, slightly inflated, pitted areas of exoskeleton corresponding to the hindmost portions of the pleural regions. Seventeen axial rings are present, separated by transversely-straight ring furrows which, from the fifth onwards, become shallower medially, although there is no well-developed smooth median band, even on the internal mould. The pleural regions are composed of four fused pairs of pleurae, with traces of a fifth pair denoted by the elongate areas (described above) on either side of the axial tip. Each first pleura is distinct, divided by a deep pleural furrow into anterior and posterior bands, of which the latter is ridge-like in form and curves strongly back posterolaterally. The succeeding three pairs of pleurae are represented by only the posterior bands, separated from each other and from adjacent pleurae by deep furrows similar to the pleural furrow of the first pygidial segment. All the pairs of posterior bands are flexed, at first adaxially opposite the posterior portion of the axis, and then abaxially, terminating in small free points. The overall appearance is not unlike the pygidium of *Cybeloides (Paracybeloides)*, though it lacks the latter's extravagant development of spines (see, for example, Ingham, 1968), whilst the hypostomata of the two also have much in common. Ornamentation is poorly preserved and consists only of traces of tubercles along the posterior bands, and pitting of the hindmost pleural regions as noted earlier.

Dimensions (mm).

	GSC 29340	GSC 29341	GSC 29342	GSC 29343	GSC 29344
Length of cranidium	4.7*(IM)	-	-	4.6*(EM)	-
Length of glabella	3.6 (IM)	-	-	3.7 (EM)	-
Max. breadth of glabella	3.9 (IM)	-	-	3.3 (EM)	-
Length of pygidium (excl. free points)	-	6.0*(IM)	-	-	6.3*(EM)
Breadth of pygidium	-	4.5*(IM)	-	-	4.6*(EM)
Length of axis	-	4.8*(IM)	-	-	5.0*(EM)
Breadth of axis	-	2.0 (IM)	-	-	-
Length of hypostoma	-	-	4.0*(EM)	-	-
Length of median body	-	-	3.0 (IM)	-	-
Breadth of median body	-	-	1.8 (EM)	-	-

* Denotes estimated measurement (EM) = external mould (IM) = internal mould.

Discussion. Jaanusson (in Ross and Ingham, 1970, p. 406) first drew attention to the fact that *Miracybele* is probably synonymous with *Cybelurus*, a suggestion borne out by the available illustrations of Russian species of the latter genus. The type species, *Cybelurus planus* Levitsky, although proposed in 1962, was based on two almost complete exoskeletons of supposed Llandeilo age from the Altai region of the U.S.S.R. that had been erroneously assigned to *Cybele planifrons* Weber, 1948 by Semenova (1960, p. 426, Pl. O-20, figs. 8, 9). The two type specimens, though indifferently illustrated and perhaps somewhat compressed, appear to be generically similar to the type species of *Miracybele, Encrinurus mirus* Billings, 1865 from the middle Table Head Formation of northwestern Newfoundland (see Whittington, 1965, p. 422-427). The cranidium of *Cybelurus* [*Miracybele*] *mirus* has a glabellar outline similar to that of the new species, and the eyes are in a comparable position. However, the 3p glabellar lobes of the Newfoundland species are proportionately somewhat larger and less rectangular, whilst the "ancillary lobes" are, as noted by Whittington, formed apparently by a branching of the 3p glabellar furrows. In *C. occidentalis* the "ancillary lobes" are smaller but extend to the axial furrows, coalesce with the tips of the 3p lobes, and the deep transverse furrows which define them anteriorly are quite distinct from the 3p furrows. The form of the anterior portion of the frontal glabellar lobe, bounded by the "ancillary lobes" and cut by a longitudinal median furrow, invites comparison with the "false preglabellar field" as employed by Tripp (1957) for *Encrinurus*. The apparently undistorted pygidium figured here as *C. occidentalis*? is much narrower than that of *C. mirus* and there are fewer axial rings, but the two are of basically similar plan. The distance between posterior bands of adjacent pleurae is relatively much smaller in *C. occidentalis*, and no discrete anterior bands are visible as in *C. mirus*. The latter has also larger pitted areas flanking the hindmost portion of the axis and bounded by the fourth pair of posterior bands. Corresponding areas are equally conspicuous on the pygidium of *Cybelurus altaicus* Levitsky (1962, Figs. 3, 5) but are very small on *C. occidentalis*. The anterior bands of the pygidial pleurae are more prominently developed in *C. altaicus* than in the Yukon species but are not significantly different from those of *C. mirus*. Somewhat similar discrepancies in the development of anterior bands are exhibited by the various species of the encrinurid *Atractopyge*, but their significance is not

yet apparent. Levitsky's illustrations (1962, Figs. 1, 2) of the cranidium of *C. altaicus* show only specimens that are slightly distorted, but the Russian species appears to differ from *C. occidentalis* in having a longer frontal glabellar lobe; less rectangular 3p glabellar lobes; a more prominent anterior border; and larger fixigenae with the eyes set farther from the glabella.

As noted by Whittington (1965, p. 427) the incomplete Norwegian cranidium figured as *Pliomerops* sp. by Nikolaisen (1961, p. 295, Pl. 2, fig. 4) clearly represents a *Cybelurus* [=*Miracybele*]. The glabellar lobes resemble those of *C. mirus* rather than *C. occidentalis*, but the glabellar outline expands forwards more strongly than in either species, and the posterior halves of the fixigenae are larger. The Norwegian specimen is said to be from the Ogygiocaris Shale (4aα) north of Oslo, and may possibly be younger than both the species from Canada. *Miracybele*? sp. 1 from the Antelope Valley Limestone of Nevada described by Ross (1967, p. 25, Pl. 8, figs. 23-25) has a pygidium generally similar to that of the new species but the cranidium differs in having the anterior border extended much farther forwards whilst the glabellar lobation in front of the 2p furrows is less well defined and the eyes are situated nearer to the glabella. *Miracybele*? sp. 2 from the same horizon (Ross, 1967, p. 26, Pl. 8, figs. 26, 27) was based on only two small pygidia, one fragmentary, of the form appropriate for the genus but proportionately broader than that now referred questionably to *C. occidentalis*. Other occurrences of as yet undescribed species of *Cybelurus* (as *Miracybele*) in Scotland and Spitzbergen have been noted by Ross and Ingham (1970). Among Scottish faunas we may note in particular *Cybele (Cybelina) monoceros* Reed (1931, p. 101, Pl. 5, figs. 1-3) from the Balclatchie Group of Balclatchie, near Girvan. The species was founded on a cranidium (pygidia from the same locality being of less certain systematic position) which has the same general configuration as *Cybelurus* and was said to be identical with one described earlier by Reed (1906, p. 130, Pl. 17, fig. 5) as *Cybele* sp. ind. (a). Points of resemblance include the glabellar outline and lobation; the presence of stalk-like eyes at the outer ends of strong eye-ridges that run from points opposite the 3p glabellar furrows; the large size of the fixigenae and posterior border; and the frontal prolongation of the median portion of the anterior border. The last-named feature is narrower and more pronounced than in many described species of *Cybelurus*, but detailed comparison is impossible until Reed's drawings have been supplemented by adequate photographs, though the Girvan trilobite is of particular interest as it is notably younger than most known species of the genus.

?Family KOMASPIDIDAE Kobayashi, 1935

Genus Carolinites Kobayashi, 1940

Type Species. *Carolinites bulbosus* Kobayashi, 1940 from the Lower Ordovician of Caroline Creek, Tasmania.

Subjective synonyms. *Dimastocephalus* Stubblefield, 1950; *Keidelia* Harrington and Leanza, 1957.

Carolinites sp.

Plate 3, figures 3, 6, 7, 9, 12.

Figured specimens. GSC 29346 (Pl. 3, figs. 7, 9, 12), GSC 29347 (Pl. 3, figs. 3, 6).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description. The genus is represented by two small, fairly well-preserved cranidia. Cranidium and glabella are strongly convex both longitudinally and transversely, and the latter is bluntly rounded frontally, slightly broader than long, excluding the preoccipital nodes (see below). The large occipital ring extends laterally just beyond the base of the glabella, is parallel-sided for most of its length (tr.) and is divided into two unequal bands, the anterior of which is the narrower (sag.), by a sharply-defined intraoccipital furrow which does not reach the axial furrows and is obsolete at the sagittal line, immediately in front of a small median tubercle. The posterior border is notably narrower (exsag.) than the occipital ring and is delimited by a deep posterior border furrow which widens a little abaxially, where it curves forwards slightly. The occipital furrow is set well in advance of the posterior border furrow and the junction of the two is marked on the fixigenae by a pair of oval protuberances which are set lower than the main body of the glabella. These structures have been termed preoccipital lobes or preoccipital nodes by Ross (1951, p. 83; 1967, p. 10) whose contention that they do not form part of the glabella derives some support from the present material. Each node is bounded adaxially by a deep furrow which may be considered as the true axial furrow judging from its continuation both frontally and posteriorly. The abaxial boundary of the frontal half of the node comprises a shallow depression which becomes still less distinct posteriorly and cannot be traced to the posterior border furrow on the exoskeleton of one specimen, though it attains the furrow on the second specimen, an internal mould. The nodes are set lower than might be expected if they were true 1p glabellar lobes and they occupy a position comparable to that of the paraglabellar areas or alae in certain genera of the Calymenacea. The small, lip-like anterior border is sharply upturned, separated from the frontal glabellar lobe by a deep furrow, and becomes narrower laterally towards the front of the palpebral lobes. The latter form narrow, rim-like structures around the steeply declined fixigenae and are abaxially convex, bow-like in plan and notably elongated, extending posterolaterally from opposite the front of the glabella until approximately in-line with the mid-points of the preoccipital nodes. The anterior branches of the facial suture are very short and converge forwards to intersect the cephalic margin approximately in-line with the axial furrows; the posterior branches, only slightly longer, are strongly curved, running abaxially to the posterior border furrow and then turning adaxially before cutting the posterior margin of the cephalon. The surface of the glabella is ornamented with closely-spaced, large, low tubercles which die out towards the axial furrows. Slightly smaller tubercles ornament the fixigenae whilst the preoccipital nodes are covered with still smaller tubercles more densely crowded than on either glabella or fixigenae. All the ornamentation is less distinct on the internal than on the external mould and the former shows also a suggestion of a shallow median depression on the frontal glabellar lobe that is not visible on the exoskeleton.

Dimensions (mm).

	GSC 29346	GSC 29347
Median length of cranidium	4.6 (IM)	3.7 (EM)
Overall breadth of cranidium	7.0*(IM)	7.0*(EM)
Max. breadth of glabella	3.2 (IM)	2.9 (EM)
Distance across preoccipital nodes	4.4*(EM)	4.1*(EM)

* Denotes estimated measurement (EM) = external mould (IM) = internal mould.

Discussion. *Carolinites* is a cosmopolitan genus known almost entirely from rocks of Arenig of Lower Llanvirn age, the single exception being a species supposedly from the Caradoc Series of South America. Several species have been described, a few of which may be compared with the present material. The cranidium of *Carolinites genacinaca* Ross (1951, p. 84, Pl. 18, figs. 25, 26, 28-36) from Zone J of the Garden City Formation in Utah is less convex and both the fixigenae and preoccipital nodes are proportionately smaller. Although Ross's illustrations do not show a median indentation of the glabella, such a feature is shown on a specimen figured by Hintze (1952, Pl. 20, fig. 7). *Carolinites killaryensis* Stubblefield sp. (1950, p. 344) from the Arenig Series of western Ireland has the fixigenae larger and less convex anterolaterally in plan, whilst the preoccipital nodes are much smaller. Its subspecies *C. k. utahensis* Hintze (1952, p. 145, Pl. 20, figs. 10-13) from Zone M of Utah also has very small preoccipital nodes but the fixigenae are conspicuously narrower than those of the present specimens. None of the species so far considered shows furrowing of the occipital ring, nor is there any sign of the coarse tuberculation of the cranidial surface. In glabellar outline, ornamentation, size and form of the preoccipital nodes, fixigenae and palebral lobes the Yukon species much resembles "*Carolinites* sp. ind. 1" described by Whittington (1965, p. 373, Pl. 39, figs. 3, 4, 11) from the middle Table Head Formation of Newfoundland. The latter differs, however, in the structure of the occipital ring which is subdivided into three transverse bands, the central one produced to form a long, slim occipital spine.

Family REMOPLEURIDIDAE Hawle and Corda, 1847

Genus Remopleurides Portlock, 1843

Type Species. *Remopleurides colbii* Portlock 1843 from the Upper Ordovician of Ireland.

Remopleurides sp.

Plate 3, figures 5, 8.

Figured specimens. GSC 29348 (Pl. 3, fig. 5), GSC 29349 (Pl. 3, fig. 8).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description. Only two cranidia are available. The larger and better preserved has the glabella almost as broad as long, with slightly less than half the glabellar length occupied by the frontal glabellar lobe or so-called glabellar tongue. The latter appears strongly convex in lateral view, is turned-down frontally through almost a right angle, and broadens slightly towards the transversely-straight anterior margin. The posterior half of the glabella is only slightly convex, transversely oval in plan, bounded by well-defined, broad furrows which die out anteriorly, and is truncated by the transversely-straight occipital furrow, immediately behind which is a median tubercle. The long, crescentic palpebral lobes form flat, rim-like structures which become slightly narrower frontally, where they are continuous with very narrow, rim-like flanges that run along the sides of the glabellar tongue. The occipital ring is of even breadth (sag.) medially but becomes narrower abaxially, where it extends beyond the basal limits of the glabella. The surface of the glabella is ornamented with closely-set granules which are more densely crowded on the glabellar tongue and in a band alongside the axial furrows. Granules are less conspicuously developed on the glabellar surface, where two, possibly three, pairs of narrow (exsag.) smooth, arcuate areas represent the location of glabellar furrows. The smooth areas appear proportionately larger on the smaller of the two cranidia.

Dimensions (mm).

	GSC 29348	GSC 29349
Median length of cranidium	2.7	-
Breadth of frontal glabellar lobes	1.5	0.8 est.
Basal breadth of glabella	1.0	-
Distance across palpebral lobes	2.5	2.0

Discussion. A number of *Remopleurides* species from the Table Head Formation of western Newfoundland have been described by Whittington, but none shows much resemblance to the present specimens. *Remopleurides* sp. ind. (Whittington, 1965, p. 375, Pl. 40, figs. 1-4) has the edges more granulose than the remainder of the glabella, but is otherwise dissimilar and lacks the large, expanded glabellar tongue of the Yukon material. *Remopleurides caelatus* Whittington (1959, p. 401, see esp. Pl. 1, figs. 1, 2), from the Edinburg Formation of Virginia, has granulate ornamentation particularly prominent along the edges of the glabella, and the glabellar tongue widens anteriorly, but the latter is much shorter than that of the present material and the centre of the glabella is ornamented with a Bertillon pattern of thin ridges. A better comparison may, perhaps, be made with the type species of *Robergiella, R. sagittalis* Whittington (1959, p. 432, Pl. 6, figs. 16-33) from the lower Edinburg Limestone, Liberty Hall facies, of Virginia. This agrees in glabellar outline, especially the frontal expansion of the glabellar tongue, and the glabellar lobes are of similar form, but the glabellar furrows, like those of *Robergia,* are narrow (exsag.) and incised.

Family NILEIDAE Angelin, 1854

Genus Nileus Dalman, 1827

Type Species. *Asaphus (Nileus) armadillo* Dalman, 1827 from the Lower Ordovician of Östergötland, Sweden.

Nileus gabata sp. nov.

Plate 5, figures 1, 2, 4-7.

Diagnosis. *Nileus* species with short, bluntly-rounded frontal glabellar lobe which expands laterally in front of semicircular palpebral lobes sited slightly behind centre with reference to cranidium. Pygidium of low convexity, well-rounded in plan and circumscribed by well-defined low border. Straight-sided, moderately-tapered axis is poorly defined on both internal and external moulds and has four faintly-marked, transversely-straight axial rings.

Holotype. GSC 29362 (Pl. 5, fig. 2).

Paratypes. GSC 29360 (Pl. 5, fig. 5), GSC 29361 (Pl. 5, fig. 4), GSC 29363 (Pl. 5, fig. 1), GSC 29364 (Pl. 5, fig. 6), GSC 31235 (Pl. 5, fig. 7), GSC 31236.

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description. The species is known only from isolated fragments, most of which are too incomplete to be described. Axial furrows are almost indiscernible on the larger of the two available cranidia but on the smaller example, an internal mould (Pl. 5, fig. 4), they are broad (tr.) and shallow, running in laterally convex curves which extend along the sides of the combined glabella and occipital ring as far as the front of the palpebral lobes. The latter are almost flat, approximately semicircular in plan, their length equal to about half that of the cranidium, and in front of them the glabellar outline expands rapidly, with the anterior branches of the facial suture meeting frontally in a broad, continuous curve. From behind the palpebral lobes the posterior branches of the facial suture run posterolaterally in almost straight lines to cut the posterior cephalic margin at sharply acute angles and at points longitudinally in-line with the abaxial margins of the palpebral lobes. No occipital furrow is visible on the external surface but on the internal mould it is represented by a shallow depression which extends across the here obsolete axial furrows and is thus continuous with the posterior border furrow. The small occipital ring so delimited becomes narrower (exsag.) towards, and is almost continuous with, the even smaller posterior border, which quickly dies out abaxially. A short distance farther forwards a small median tubercle is positioned on the glabella slightly in front of a line joining the hind ends of the palpebral lobes; in front of the tubercle is a low axial ridge that dies out farther forwards and is visible only on the internal mould. The librigenae have not been found, but a portion of the cephalic doublure joining them (Pl. 5, fig. 5) is of the form characteristic for the genus, its ventral surface strongly ornamented with closely-set anastomosing ridges, and the median portion of the posterior margin flexed dorsally to form a narrow (sag.) flange, the transverse margin of which forms the hypostomal suture.

The most complete hypostoma (Pl. 5, fig. 6) is small with maximum breadth (excluding anterior wings) slightly more than one and a half times the median length. The middle body is proportionately large, subpentagonal in outline, and its transversely straight anterior margin coincides with that of the hypostoma. A pair of large, deep, subtriangular notches indents the sided of the middle body dividing it into anterior and posterior lobes which, on this specimen, are of almost equal median length (sag.). An incomplete but larger hypostoma (GSC 31236) has the posterior lobe proportionately shorter and of more obviously crescentic outline than that of the small specimen. A deep, broad border furrow separates the middle body from a flange-like border which is broadest laterally, where it forms an elongated (exsag.) pair of rounded posterior wings. At the sagittal line the posterior margin of the smaller (probably immature) hypostoma is a gently convex curve with only a faint suggestion of a median projection, but such a structure is clearly visible on the larger specimen, together with a pair of similar marginal projections situated posterolaterally. A well-developed transverse pattern of anastomosing terrace lines covers the surface of the whole hypostoma but becomes slightly weaker along the outer side of the border furrow.

The pygidium is best represented by the holotype, an almost exfoliated specimen well rounded in outline with a median length, excluding the small articulating half-ring, about three quarters of the maximum breadth. Particularly conspicuous is the low, broad border, rounded in cross-section and separated from the pleural fields by a broad, shallow border furrow; the border narrows anterolaterally where it is continuous with a pair of small articulating facets. The low, poorly-defined axis occupies three fifths of the median length and approximately one third of the overall breadth of the pygidium and is scarcely differentiated from the pleural fields; its straight sides converge at about 35 degrees to the small terminal piece and narrow, rounded axial tip. There are traces of four transversely-straight axial rings, separated by ring furrows which are faint on the internal mould and almost indiscernible on the external surface. Low, anastomosing ridges forming a Bertillon pattern are visible on the exterior of the exoskeleton, particularly near the lateral margins where they curve backwards, but appear much fainter on the internal mould.

Dimensions (mm).

	GSC 29361	GSC 29362	GSC 29363	GSC 31235
Length of cranidium	5.4*(IM)	-	-	10.2*(EM)
Max. breadth of glabella	3.7 (IM)	-	-	8.0*(EM)
Distance across palpebral lobes	6.4*(IM)	-	-	10.6*(IM)
Max. breadth of pygidium	-	12.6 (IM)	9.5 (EM)	-
Length of pygidium (excluding half-ring)	-	8.8*(IM)	5.7 (EM)	-
Frontal breadth of axis	-	4.2 (IM)	3.7 (EM)	-
Length of axis	-	5.2 (IM)	3.6 (EM)	-

* Denotes estimated measurement (EM) = external mould (IM) = internal mould.

Discussion. *Nileus scrutator* Billings (1865, p. 274, Fig. 260; see also Whittington, 1965, p. 360) from the middle Table Head Formation of Newfoundland resembles *N. gabata* in the size and position of the palpebral lobes and in the degree of definition of the pygidial border, but differs in having a longer, less rounded frontal

glabellar lobe, whilst the pygidium is proportionately shorter but has a longer, less well-defined axis with more axial rings. The eyes of *Nileus macrops* Billings (1865, p. 273, Fig. 259; Whittington, 1965, p. 361), also from the middle Table Head Formation, are both distinctly large and set well forwards, whilst the short frontal glabellar lobe has a narrow, truncated outline. These features serve to distinguish the Newfoundland species from *N. gabata*. *Nileus affinis* Billings (1865, p. 275, Figs. 261a, b), described originally from the Lévis Formation of Québec and redescribed more recently by Whittington (1963, p. 53) using also additional material from Lower Head, Newfoundland, has certain features in common with *N. gabata*. In particular the glabellar outline is broadly similar in both species, but *N. affinis* has a much wider (sag.) doublure; the hypostoma is conspicuously wider and has a less distinct middle body; the eyes are proportionately shorter and set notably farther forwards, so that the posterior branches of the facial suture are longer and meet the cephalic margin at a larger angle; and the pygidium is relatively shorter with a longer, wider axis and a less conspicuous border. *N.* cf. *N. affinis* from the Antelope Valley Limestone of Nevada as illustrated, but not described, by Ross (1970, Pl. 18, figs. 19-24) has a cranidial outline generally similar to that of *N. gabata* but the pygidium of the American trilobite is less rounded in outline and its border is less well defined. The eyes of *N.* cf. *N. affinis* are not set well forwards as in the true *N. affinis*, and this feature would appear to exclude the Nevada material from Billings' species.

Genus Peraspis Whittington, 1965

Type Species. *Niobe lineolata* Raymond, 1925 from the Table Head Formation, Ordovician, of western Newfoundland.

Peraspis yukonensis sp. nov.

Plate 3, figures 10, 11; Plate 4, figures 1-10; Plate 5, figure 3.

Diagnosis. *Peraspis* species with thin exoskeleton and lacking anterior border. Glabellar outline widens just behind centre and, to greater degree, frontally. Eyes large, sited close to and opposite posterior half of glabella. Hypostoma ends posteriorly in obtuse point flanked by long, rounded posterior wings; median furrow poorly defined; posterior lobe with pair of large maculae. Pygidium sub-semicircular with narrow, straight-sided axis and four axial rings; pleural fields indistinctly furrowed except behind pair of anterior half ribs. Doublure broad with terrace-lines.

Holotype. GSC 29350 (Pl. 4, fig. 5).

Paratypes. GSC 29351 (Pl. 4, figs. 4, 6, 10), GSC 29352 (Pl. 4, fig. 9), GSC 29353 (Pl. 5, fig. 3), GSC 29354 (Pl. 4, fig. 2), GSC 29355 (Pl. 4, fig. 7), GSC 29356 (Pl. 3, fig. 11), GSC 29357 (Pl. 3, fig. 10), GSC 29358 (Pl. 4, figs 1, 3), GSC 29359 (Pl. 4, fig. 8).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54076.

Description. The cranidium is only moderately convex both longitudinally and transversely, and the glabella and occipital ring together form a single almost continuous structure that is broken only by a vestige of an occipital furrow.

Slightly less than one third of the cranidial length is occupied by the frontal glabellar lobe, which is broadly rounded in outline and expands markedly in breadth to almost one and a half times that of the rest of the glabella. Behind the frontal lobe the glabellar outline expands backwards more gently and its gently curved sides are bounded by shallow, broad axial furrows which converge as far as the almost obsolete occipital furrow and then die out. The holotype cranidium shows traces of two indistinct pairs of glabellar lobes approximately opposite the palpebral lobes, but no such lobation is visible on smaller paratypes. One of the latter (see Pl. 4, fig. 6) has a feebly-developed median ridge which dies out on the frontal glabellar lobe and terminates posteriorly a short distance in front of the occipital furrow, at a small median tubercle that is most clearly observed on the internal mould. The eyes are large, almost semicircular in plan, their length between one third and one half that of the cranidium, and the flat, unfurrowed palpebral lobes are gently declined adaxially. Their holochroal visual surfaces bulge slightly over a shallow furrow which separates them from the remainder of the librigenal surface. The anterior branches of the facial suture diverge forwards from the eyes at about 90 degrees almost to the cephalic margin and then turn adaxially through more than a right angle to meet frontally in an unbroken gentle curve. The posterior branches run gently backwards abaxially to cut the posterior cephalic margin approximately in-line with the outer margins of the palpebral lobes; the posterior halves of the fixigenae so formed are very small, triangular in outline and continuous with the occipital ring and hindmost portion of the glabella. The posterior border is scarcely discernible but must have run back very slightly to the genal angles, which are produced to form a pair of slim, moderately-long librigenal spines (see Pl. 4, fig. 9). No lateral border is visible on the dorsal surface of the librigena but the ventral surface shows a broad doublure with a panderian protuberance, or enrollment stop, a short distance in front of the genal angle.

Excluding the anterior wings, which are narrow (exsag.) and turn dorsally through a right angle, the hypostoma is only slightly longer than broad. The middle body is of angular appearance, its boundaries poorly defined. Frontally it merges with the gently convex anterior margin, no anterior border being developed, whilst laterally and posteriorly it grades into a pair of large, curved posterior wings which extend forwards to the anterior wings and backwards to meet medially in a slightly obtuse point. There is no clear division into anterior and posterior lobes but the latter is indicated by a slight swelling, the outer extremities of which are enlarged to form a pair of large angular projections which end in maculae.

The thorax is not known.

The pygidium is of low convexity, sub-semicircular in outline with a straight-sided axis that occupies about one quarter of the overall breadth and three quarters of the length. Frontally the axial furrows are well defined but they become shallower towards the blunt axial tip. There are traces of up to four poorly defined axial rings, separated by shallow, transversely-straight ring furrows. The pleural regions carry a pair of anterior half-ribs which are particularly well defined near the axial furrows but become less distinct laterally, where they form a pair of articulating facets continuous with a low, lip-like border that is bounded by a broad, shallow furrow (see especially Pl. 4, fig. 8). Behind the half-ribs there are only feeble traces of pleural furrows on the pleural fields. A partially exfoliated pygidium (Pl. 4, fig. 2) shows the doublure to be ornamented with subparallel terrace-lines and notably broad except posteriorly, where it is deeply indented and forms a flange-like rim immediately beneath and slightly narrower than the tip of the axis.

The exoskeleton is thin and the surface of the cephalon mostly smooth apart from a group of low, anastomosing ridges arranged approximately in semicircular arcs subconcentric about the midpoint of the posterior margin of the occipital ring. The smallest available cranidium (see Pl. 3, fig. 11) shows fine punctae arranged in irregular lines on the glabella but lacks the ridges of larger specimens. Ornamentation similar to that of the cephalon occurs on the pygidium but is usually poorly preserved. One incomplete specimen (Pl. 4, fig. 8) shows particularly clearly that on the pygidial border the ridges are closely grouped and subparallel to the margin, whereas they become widely spaced on the pleural fields. The ridges are seen to traverse the axial and ring furrows, and although their overall pattern is subconcentric it changes on the anterior half-ribs, where several ridges crowd together and turn sharply towards the lateral margins. The surface of the hypostoma though incompletely known shows well-developed ridges, subparallel to the axial line, ornamenting the anterior wings; similar but weaker ridges run along the sides of the middle body but then turn adaxially (see Pl. 4, fig. 1) and must have formed part of an originally subconcentric pattern.

Dimensions (mm).

	GSC 29350	GSC 29351	GSC 29354	GSC 29356
Median length of cranidium	9.0	7.3	-	4.2
Median breadth of cranidium	5.2	3.3	-	1.9
Frontal breadth of cranidium	7.7	4.9	-	2.8
Distance across palpebral lobes	9.0 est.	5.9	-	3.6 est.
Frontal breadth of pygidium	-	-	8.6 est.	-
Length of pygidium	-	-	4.8	-
Frontal breadth of axis	-	-	2.0	-

Discussion. The cranidium of the new species is easily distinguished from that of *Peraspis lineolata* (Raymond, 1925, p. 79; see also Whittington, 1965, p. 364) by the more convex sides of the glabella; by the pronounced lateral expansion of the frontal glabellar lobe; and by the virtual absence of a distinct anterior border. *Peraspis erugata* Ross (1970, p. 83, Pl. 14, figs. 21, 22; Pl. 15, figs. 1-5) from the Antelope Valley Limestone of Ikes Canyon, Nevada was said by its author to differ from *P. lineolata* in its "lack of preglabellar furrow on the cranidium". The glabellar outline of *P. erugata*, like that of *P. yukonensis*, becomes broader, though to a lesser degree, opposite the smaller palpebral lobes, whilst the glabella is less elongated and does not expand frontally to the same extent. The pygidial axis of *P. erugata* is slightly more tapered, the overall outline is a little broader, and there is a wider, better-developed border. According to Ross the only hypostoma associated with the type material of *P. erugata* was regarded by him as belonging probbably to that species, though possibly being assignable to *Niobe*. The Nevada specimen certainly differs from the hypostoma of both *Peraspis lineolata* (Whittington, 1965, Pl. 35, figs. 6, 8) and the present species, and it is very doubtful whether it belongs to *Niobe*; for the present it is regarded as being of uncertain genus. The librigena of *P. lineolata* (see Whittington, 1965, Pl. 35, fig. 2) shows a panderian protuberance almost identical with that of the new species but the hypostoma is notably different, being broader overall with the middle body almost undifferentiated from the posterior wings.

In certain respects, for example lack of anterior border, the frontal expansion of the glabella and the position of the median glabellar tubercle, *Peraspis yukonensis* might be considered as being intermediate between *Peraspis* and *Nileus*, and its characters bear out Whittington's assertion of the nileid rather than asaphid nature of *P. lineolata*.

Family ASAPHIDAE Burmeister, 1843

Asaphid genus and species undetermined

Plate 5, figures 8-12.

Figured specimens. GSC 29365 (Pl. 5, fig. 8), GSC 29367 (Pl. 5, figs. 9, 10, 12), GSC 29368 (Pl. 5, fig. 11).

Horizon and locality. Ordovician, unnamed formation, GSC locality 54075.

Description. These, the oldest trilobite remains collected from the measured section, though too fragmentary for detailed assignment are of asaphid type. The most informative are two large, incomplete cranidia of low transverse convexity which have in lateral view a flattened appearance except anteriorly, where the front of the glabella declines more steeply to the remains of the indistinct anterior border. The poorly-defined glabella has a median length about one and half times the basal breadth, and there is no distinct occipital ring. The conspicuous palpebral lobes are semi-circular in plan, moderately well defined by shallow palpebral furrows; their length is slightly more than one third that of the glabella, the mid-point of which marks the limit of their extension forwards. The glabellar outline expands slightly both behind and in front of the palpebral lobes, so that the frontal and basal breadth are approximately equal. Only traces of glabellar segmentation are indicated on the internal mould, the most conspicuous being a pair of large lobes of flattened appearance which are indistinct frontally but better defined posteriorly (see Pl. 5, figs. 8, 12) where their boundaries curve strongly forwards from just in front of the cephalic margin towards, though not quite touching, a prominent median tubercle that is positioned almost in-line with the posterior margins of the palpebral lobes. These structures correspond to what Henningsmoen (1960, p. 212, Fig. 2), when dealing with *Ogygiocaris*, termed L 0 lobes, regarded by him as forming part of the occipital ring and shown as terminating adaxially at the median tubercle. Behind the median tubercle a faint longitudinal ridge extends towards, but does not attain, the occipital furrow; in front of the tubercle, the ridge is better defined until in-line with the front of the palpebral lobes, and then dies out anteriorly. Further signs of glabellar lobation are less distinct but, using Henningsmoen's terminology, there is a pair of narrow (exsag.) L 1 lobes opposite the hindmost part of the palpebral lobes and an equisized pair of L 3 lobes opposite the front of the palpebral lobes, the two being separated by a pair of larger L 2 lobes which merge laterally into the fixigenae. The remains of the front of the cranidium suggest that the anterior border is narrow (sag.) and indistinct, and the facial suture of isotelinid type. The posterior halves of the fixigenae, though damaged and incomplete, are seen to be narrow (exsag.), with the posterior branches of the facial suture cutting the cephalic margin well outside the abaxial margins of the palpebral lobes.

Some of the larger pygidial fragments are of large size and one of the better preserved is illustrated (Pl. 5, fig. 11). The median length is estimated to be about two thirds of the maximum breadth and in this instance the well-rounded outline is slightly blunted behind the axis whereas another, smaller specimen (GSC 29366) shows no such break in curvature. The axis occupies approximately two thirds the median length and one third of the maximum breadth and its straight sides, bounded by shallow axial furrows, taper to a small, blunt, narrow tip. The surface of the pleural regions is insufficiently preserved but that of the axis shows traces of seven or eight poorly defined, transversely-straight axial rings. The doublure extends forwards medially to just in front of the axial tip, whence its inner margin runs forwards just inside the line of the axial furrows for about half the length of the axis, and then curves sharply towards and just inside the anterolateral angles of the pygidium. Immediately below the terminal piece of the axis, the doublural margin is slightly reflexed dorsally to form a flange-like rim which diminishes anteriorly. The rim, which must have been situated below and within the cavity formed by the axis, is bounded by a furrow that corresponds in turn to the ventral flexure of the dorsal exoskeleton along the axial furrows. The dorsal surface of the doublure is ornamented with terrace-lines which run subparallel to the margin and are less well-defined than those on the ventral surface. Slightly more than half way from the top of the axis to the posterior pygidial margin the dorsal surface of the doublure shows a small but conspicuous, somewhat elongated indentation which must have corresponded to a ventral projection not unlike a Panderian protuberance.

Discussion. The trilobites from this horizon and locality, although insufficiently well preserved for certain generic determination, nevertheless are seen to be quite distinct from those at localities 54076 and 54077 in Unit 3, and share several features with a number of asaphid genera described from the Lower Ordovician of the Baltic–Scandinavian region. In particular the cranidia bear a striking resemblance to *Megalaspides (Megalaspides)* Brøgger, 1866 the type species of which, *M. (M.) dalecarlicus* (Holm, 1882), has been redescribed by Tjernvik (1956, p. 247, Pl. 8, figs. 7-13, text-fig. 40a) and characterizes a zone in the Billingenian Substage, Latorpian Stage, of the lower Arenig Series in Sweden (see Tjernvik, 1956, p. 185; Jaanusson, 1960, p. 346). In both the Swedish trilobite and that from the Yukon, the anterior border is of approximately similar size whilst the glabellar outline, lobation and median ridge are comparable, though the glabella of *M. (M.) dalecarlicus* is slightly narrower. *Megalaspides (M.) paliformis* Tjernvik (1956, p. 249, Pl. 8, figs. 14, 15) has a broader (sag.) anterior border than either of the two above but its glabella is comparable. Tjernvik's illustrations show clearly the L 0 lobes of the occipital ring which are very like those of the Yukon form, though the latter has both median tubercle and palpebral lobes set farther forwards than in either of the above Swedish species. The pygidia from locality 54076 are of asaphid type and the well-rounded, almost semicircular outline and relatively narrow, straight-sided axis are features found in *M. (M.) dalecarlicus* though not in *M. (M.) paliformis*, which has a more elongated, semielliptical outline. The pygidium of *M. (M.) dalecarlicus* has the axis, particularly its tip, less well defined than that of the present material, but the Swedish species has more distinct axial rings and the pleural fields are slightly furrowed, a feature not observable here. The doublure of the Yukon pygidia is unusually broad, and no satisfactory comparison has yet been made.

AGE AND AFFINITIES OF THE TRILOBITES

Macrofossils are available from only three levels within the measured section, the two highest of which, GSC localities 54076 and 54077, are respectively 20 feet and 80 feet above the base of Unit 3 (see Fig. 2). Most of the material described in the present paper comes from locality 54076 and even a cursory glance at the trilobites there, preserved in dark grey crystalline limestone, is sufficient to show their marked resemblance, at least at generic level, to those of the middle Table Head Formation of western Newfoundland, which were listed by Whittington and Kindle (1963, p. 751) and later described in detail by Whittington (1965) who emphasized their affinity with the fauna of the Whiterock Stage, proposed by G. A. Cooper and B. N. Cooper (in Cooper, G. A., 1965, p. 7, 8) for the succession in Whiterock Canyon, Monitor Range of Nevada. The Yukon sample is small by comparison with the large collections available from Newfoundland, but all the named genera from locality 54076 occur also in the middle Table Head Formation so that in this instance the Index of Faunal Resemblance, proposed originally by Simpson (1962) and applied since then to trilobites by Whittington (1965, p. 288), is 100. The age of the middle Table Head Formation has been given as approximately Lower Llanvirn Series by Whittington and Kindle (1963, p. 757) and the trilobites from locality 54076 should therefore indicate a similar age, though there are some reservations. The species of *Geragnostus* in this Yukon sample is compared with *G. longicollis* (Raymond) from Table Head, though one can detect minor differences, whilst the remaining trilobites have no species in common with those from previously described faunas. It was noted by Ross and Ingham (1970) that broadly similar trilobite generic assemblages – named by them the "Toquima–Table Head Faunal Realm" after its development in Nevada and Newfoundland – are widespread in a subcircular distribution and include the fauna described here. Their new terminology was devised primarily to obviate incorrect usage of the term "Whiterock", a stage name that has been shown by Ross (1970, p. 44) to have distinct disadvantages when used without qualification. Emphasis was placed by Ross and Ingham (1970, Table 2) on the presence in the Girvan District of certain trilobites, including *Cybelurus* (previously *Miracybele*), of so-called "Whiterock" type and it was claimed that such assemblages may be of different ages, ranging from approximately Arenig to Llandeilo or early Caradoc Series. On the other hand Whittington (1965, p. 294) considered that few of the Table Head genera persisted into younger strata and we may note that the genera of "Non-Whiterock" type recorded from the Albany Mudstones by Ross and Ingham (1970, p. 396) include several that have not so far been recorded from the Table Head Formation or from strata as old as Lower Llanvirn. Thus, although the Girvan fauna contains certain Table Head genera, the total generic list is far from being biased in that direction and the appearance of new taxa is of particular importance, though differences in facies may also be relevant and in this respect the Albany Mudstones represent an environment very different from those of Table Head and the Keele Range. Since the completion of this manuscript Whittington and Hughes (1972, p. 270) have discussed the resemblance of the Table Head and Albany Mudstone faunas, and attribute it to the presence of long-ranging genera in both faunas.

At GSC locality 54077, also in Unit 3 and 60 feet stratigraphically higher than locality 54076, a small sample of dark grey limestone, finer grained and less crystalline than that of the latter locality, proved also to be less fossiliferous. The few trilobite remains extracted include the following: – one pygidium and an incomplete small cranidium of *Nileus gabata* sp. nov.; a fragment of the glabella of a large *Niobe* sp. indet.; one pygidium of *Peraspis yukonensis* sp. nov.; and an

incomplete cranidium, left librigena and fragmentary pygidium of *Cybelurus occidentalis* sp. nov. Clearly this assemblage resembles the one from locality 54076 and, as far as the trilobite evidence is concerned, is of presumably similar age.

Until such time as the trilobite species from localities 54076 and 54077 are found in association with others whose age is well established, it is necessary to augment their indication of a Lower Llanvirn age with evidence obtained from other groups of fossils. Only a single graptolite, from locality 54076, is available. This specimen, numbered GSC 31574, has been determined as *Phyllograptus anna* J. Hall by Dr. R.B. Rickards who points out (personal communication) that the species indicates an Arenig (*Extensus* Zone, *Deflexus* Subzone to *Hirundo* Zone) or possibly early Llanvirn age, at which latter horizon it has been recorded in western Newfoundland by Morris and Kay (1966, p. 1224).

The lowest level from which macrofossils were obtained is at GSC locality 54075, in the highest portion of Unit 2 and 80 feet below the base of Unit 3 (see Fig. 2). The trilobites there comprise fragments of large asaphids which, although not identifiable with certainty, nevertheless show some features suggestive of genera, particularly *Megalaspides*, that occur in the Lower Arenig Series of Scandinavia (see discussion earlier). It is of some interest that although similar trilobites have not yet been reported from elsewhere in North America, Ross (1970) has described and illustrated Lower Ordovician material from Nevada that he attributes to other Swedish asaphid genera.

Considered in isolation the trilobites from locality 54075 do not provide unequivocal evidence of age but their early Ordovician, especially Arenig, aspect is amply borne out by the conodonts from Unit 2. Samples from localities 54073, 54074 and 54075, sited respectively 310, 210 and 80 feet below the base of Unit 3 (see Fig. 2) have been examined by Dr. T.T. Uyeno whose determinations form an Appendix to the present paper. Dr. Uyeno considers these three fossil localities to contain the same conodont fauna, which he equates with that from part of the Billingenian Substage, Latorpian Stage of Sweden, that is to say their age is Lower Arenig in terms of the Ordovician in the Anglo–Welsh area. Dr. Uyeno confirms the affinities of the faunas from locality 54076 in Unit 3 with those of the middle Table Head Formation and assigns them to the Llanvirn Series, though in this instance the conodonts (by analogy with Sweden) suggest an early Upper Llanvirn age rather than the Lower Llanvirn age customarily assigned to them (see earlier). The evidence of conodonts and trilobites from the measured section is thus broadly in agreement and suggests that a marked faunal break, involving the upper half of the Arenig Series and the lowest Llanvirn Series, occurs at the presumably disconformable juction of Units 2 and 3.

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PLATES I - V

PLATE I

Geragnostus cf. *G. longicollis* (Raymond) Page 2

GSC Locality 54076

Figures 1, 2, 4, 6. Plan, anterior, posterior and right lateral views of cranidium. GSC 29329. X 8. Note lateral genal area.

Figure 3. Plan view of internal mould of pygidium. GSC 29330. X 8.

Figure 5. Plan view of incomplete pygidium. GSC 29331. X 8.

Ampyxoides occipitalis sp. nov. Page 3

GSC Locality 54076

Figures 7, 8, 15. Anterior, left lateral and plan views of internal mould of incomplete cranidium. Paratype. GSC 29332. X 10.

Figure 9. Plan view of cranidium. Holotype. GSC 29333. X 10.

Figure 13. Plan view of pygidium. Paratype. GSC 29422.

Figure 16. Plan view of cranidium. Paratype. GSC 29334. X 10.

Shumardia lacrimosa sp. nov. Page 5

GSC Locality 54076

Figure 10. Plan view of cranidium. Paratype. GSC 29337. X 10.

Figure 11. Plan view of cranidium. Paratype. GSC 29423. X 10.

Figure 12. Plan view of cranidium. Paratype. GSC 29336. X 10.

Figure 14. Plan view of pygidium. Holotype. GSC 29335. X 10.

PLATE I

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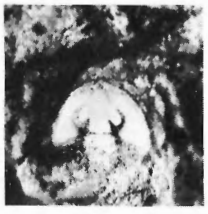

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PLATE II

Cheirurid gen. et sp. undetermined — Page 8

GSC Locality 54076

Figure 1. Internal mould of incomplete pygidium. GSC 29339. X 5.

Figure 4. Internal mould of hypostoma. GSC 29338. X 6.

Cybelurus occidentalis sp. nov. — Page 9

GSC Locality 54076

Figures 2, 9, 10. Plan, left anterolateral and anterior views of incomplete internal mould of cranidium. Holotype. GSC 29340. X 6.

Figure 7. Latex cast of glabella and part of left fixigena. Paratype. GSC 29343. X 8.

GSC Locality 54077

Figure 5. Latex cast of fragmentary cranidium showing frontal projection formed by anterior border. Paratype. GSC 31605. X 8.

Cybelurus occidentalis sp. nov. ? — Page 11

GSC Locality 54076

Figures 3, 6, 8. Posterior, plan and right lateral views of exfoliated pygidium. GSC 29341. X 8.

PLATE II

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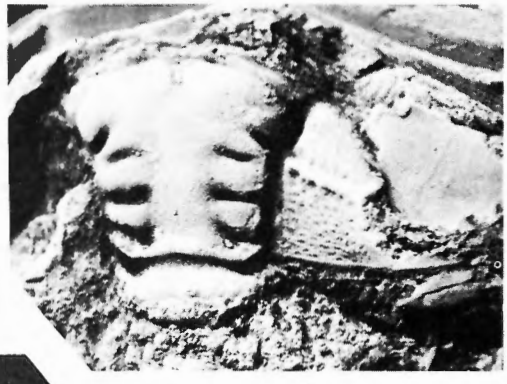

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PLATE III

Cybelurus occidentalis sp. nov. Page 9

GSC Locality 54076

Figure 1. Latex cast of incomplete pygidium. Paratype. GSC 29344. X 7.

Figure 2. Partly exfoliated hypostoma. Paratype. GSC 29342. X 9.

Figure 4. Latex cast of right librigena. Paratype. GSC 29345. X 8.

Carolinites sp. Page 13

GSC Locality 54076

Figures 3, 6. Oblique left lateral and plan views of incomplete cranidium. GSC 29347. X 8.

Figures 7, 9, 12. Left lateral, anterior and plan views of almost exfoliated cranidium. GSC 29346. X 8.

Remopleurides sp. Page 15

GSC Locality 54076

Figure 5. Plan view of cranidium. Note smooth areas coincident with pairs of glabellar furrows. GSC 29348. X 10.

Figure 8. Plan view of small cranidium. GSC 29349. X 11.

Peraspis yukonensis sp. nov. Page 19

GSC Locality 54076

Figure 10. Small, transitory pygidium. Paratype. GSC 29357. X 8.

Figure 11. Incomplete cranidium showing right palpebral lobe and posterior area of fixigena. Paratype. GSC 29356. X 8.

PLATE III

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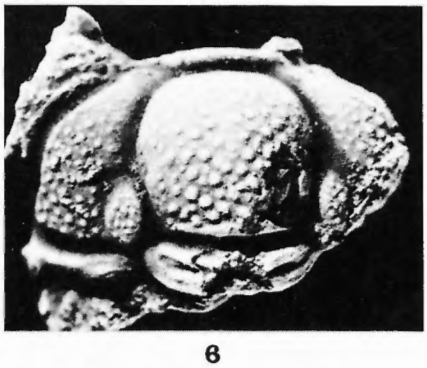

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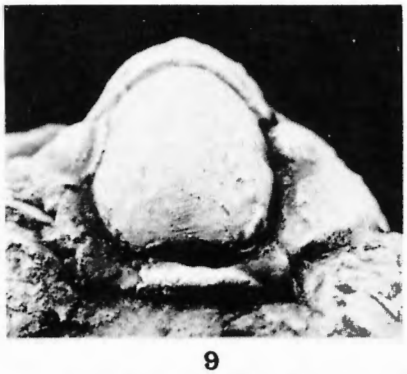

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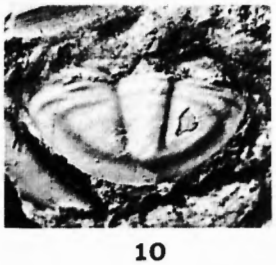

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PLATE IV

Peraspis yukonensis sp. nov. Page 19

GSC Locality 54076

Figures 1, 3. Plan and left lateral views of partly exfoliated hypostoma showing left anterior wing and ornamentation of ridges. Paratype. GSC 29358. X 7.

Figure 2. Pygidium showing external mould of ventral side of doublure. Paratype. GSC 29354. X 6.

Figures 4, 6, 10. Plan, anterior and right lateral views of partly-exfoliated cranidium. Paratype. GSC 29351. X 6.

Figure 5. Plan view of large cranidium. Note medium glabellar tubercle. Holotype. GSC 29350. X 5.

Figure 7. Small pygidium. Paratype. GSC 29355. X 7.

Figure 8. Fragmentary pygidium showing pattern of anastomosing ridges on dorsal surface. Paratype. GSC 29359. X 4.

Figure 9. Damaged left librigena showing eye and external mould of doublure with panderian protuberance. Paratype. GSC 29352. X 4.

PLATE IV

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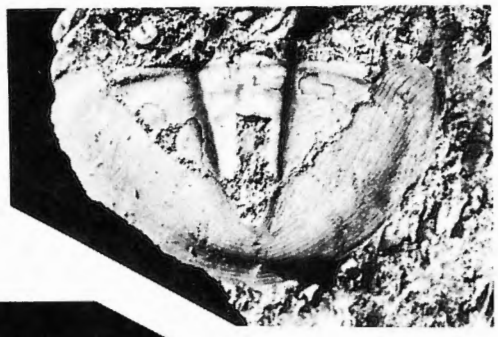

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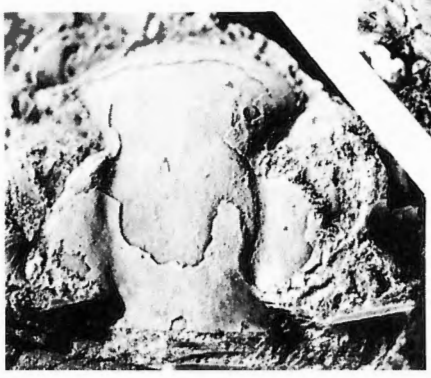

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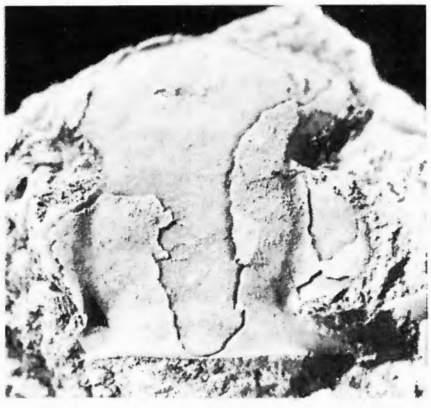

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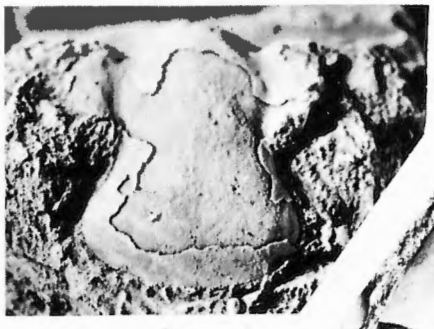

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PLATE V

Nileus gabata sp. nov. Page 16

GSC Locality 54076

Figure 1. Latex cast of pygidium. Paratype. GSC 29363. X 5.

Figure 2. Large, almost exfoliated pygidium. Holotype. GSC 29362. X 4.

Figure 4. Internal mould of small cranidium. Paratype. GSC 29361. X 5.

Figure 5. Part of cephalic doublure showing hypostomal suture. Paratype. GSC 29360. X 6.

Figure 6. Latex cast of hypostoma. Paratype. GSC 29364. X 8.

Figure 7. Incomplete cranidium with most of exoskeleton preserved. Paratype. GSC 31235. X 3.

Peraspis yukonensis sp. nov. Page 19

GSC Locality 54076

Figure 3. Plan view of small pygidium. Paratype. GSC 29353. X 6.

Asaphid genus and species undetermined Page 22

GSC Locality 54075

Figure 8. Internal mould of incomplete cranidium. GSC 29365. X 4.

Figures 9, 10, 12 Left lateral, anterior and plan view of internal mould of cranidium. Note median ridge and tubercle. GSC 29367. X 3.

Figure 11. Incomplete large pygidium showing external mould of doublure which forms a flange below tip of axis. Note also median "node" on doublure behind axis. GSC 29368. X 2.5.

PLATE V

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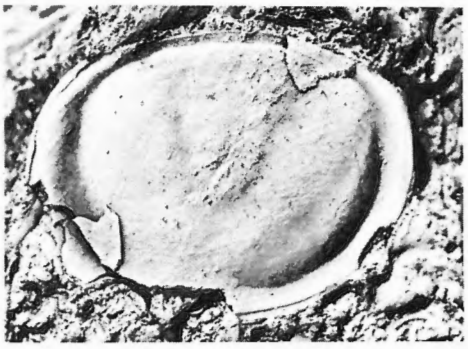

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APPENDIX

Ordovician conodonts from the Keele Range, by T. T. Uyeno, Geological Survey of Canada, Calgary

Conodonts from Unit 2 of measured section (see earlier)

The samples from GSC localities 54073, 54074 and 54075 are treated together as they yielded essentially the same conodont fauna.

List of genera and species: *Acodus* sp., *Drepanodus* cf. *arcuatus* Pander, *D. suberectus* (Branson and Mehl), *Histiodella*? sp., *Oistodus*? *extensus* Graves and Ellison, *O. forceps* Lindström, Multielement species *Prioniodus evae* Lindström: *Prioniodus evae* Lindström, *Oepikodus smithensis* Lindström and *Oistodus longiramis* Lindström, *Pygodus*? sp., *Scandodus pipa* Lindström, *Scolopodus* cf. *rex* Lindström, *Tetraprioniodus* sp., hyaline elements.

Age of faunule: Probably *Prioniodus evae* Zone of Sergeeva (1964) and Lindström (1971) (=about middle Arenig Series; Latorpian Stage; upper part of Billingenian Substage (BIβ); *Phyllograptus angustifolius elongatus* and *P. densus* Zones).

Conodonts from Unit 3 of measured section

All the material listed below is from GSC locality 54076.

List of genera and species: *Acontiodus cooperi* Sweet and Bergström, *Ambalodus* sp., *Diplododella*? sp. cf. *Roundya* n. sp. of Sweet and Bergström, 1962, *Drepanodus homocurvatus* Lindström, *D.* sp., Multielement species *Eoplacognathus* cf. *suecicus* Bergström: *Amorphognathus* sp. (= *A. variabilis* Sergeeva of *Fåhraeus*, 1970, Fig. 3E) and *Ambalodus* n. sp. 4 Lindström, 1960, *Falodus prodentatus* (Graves and Ellison), *F.* n. sp. 2 of Lindström, 1960, *Histiodella* cf. *sinuosa* (Graves and Ellison), *Oistodus venustus* Stauffer, *O.* aff. *venustus* Stauffer, *Periodon aculeatus* Hadding, *Prioniodina macrodentata* (Graves and Ellison), *Prioniodus* cf. *navis* Lindström, *Scandodus unistriatus* Sweet and Bergström, *S.* sp., *Scolopodus* cf. *gracilis* Ethington and Clark, *S. varicostatus* Sweet and Bergström, *Tetraprioniodus* cf. *asymmetricus* Bergström, *T.* cf. *quadrangulum* (Lindström).

Age of faunule: Probably *Pygodus serrus* Zone, *Eoplacognathus suecicus* Subzone of Bergström (1971) (= Llanvirn Series; Aseri and early Lasnamägi Stages; lower part of the *Didymograptus murchisoni* Zone).

Comments

GSC localities 54073-54075 yielded essentially the same conodont fauna and so are discussed together for this preliminary report. The fauna is of Baltoscandian aspect and, so far as is known, is reported here for the first time from North America. It has also been reported from a locality west of Crawford, Lanarkshire in the Southern Uplands of Scotland by Lamont and Lindström (1957). A similar but far from identical fauna was reported from the Marathon Formation of the Marathon area of Texas (Graves and Ellison, 1941), and was placed by Ethington and Clark (1971) in their Faunas D and E.

Oistodus? extensus was previously recorded by Graves and Ellison in the Marathon Formation, from the top beds of the Lower Member (just below the Monument Springs Member) and from about the central part of the Upper Member. According to Berry (1960) graptolites from the Monument Springs Member fall within his zone 3, which in turn is dated as early Arenig. The central part of the Upper Member lies approximately in Berry's zone 5, which is about middle Arenig.

Ethington (1971) placed the conodonts from the Ninemile Formation (middle of Pogonip Group) of central Nevada in the Billingenian Substage.

GSC locality 54076 yielded a large conodont fauna, also of Baltoscandian aspect. A very similar fauna has been reported from the lower and middle parts of the middle Table Head Formation of western Newfoundland (Fåhraeus, 1970). Fåhraeus recorded the upper boundary of this middle unit as being high in the Lasnamägi Stage (upper part of the *Didymograptus murchisoni* Zone). Similar conodont faunas have also been reported from the Lévis Formation (zone D1 of Raymond, 1914) at Lévis, Québec (Uyeno and Barnes, 1970), and from the lower and middle parts of the Fort Peña Formation of the Marathon area, Texas (Bradshaw, 1969; Bergström, 1971). In Sweden the fauna has been reported from the Segerstad and Skärlöv Limestones (Bergström, 1971).

There is a considerable age difference between the collections from GSC locality 54076 (early Llanvirn) and those from localities 54073-75 (middle Arenig), yet the vertical separation of 54075 and 54076 is only about 95 feet. The conodont evidence thus suggests a possible disconformity between Units 2 and 3.

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