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BULLETIN 210

ORDOVICIAN TRILOBITES FROM THE CENTRAL VOLCANIC MOBILE BELT AT NEW WORLD ISLAND, NORTHEASTERN NEWFOUNDLAND

W.T. Dean

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PREFACE

It has long been known that the fossil faunas of the Cambrian rocks of parts of maritime Canada have strong affinities with those of northwestern Europe rather than with continental North America. The author of this report has shown that these affinities persisted into Ordovician times. His conclusions are based on a systematic study of a group of Ordovician trilobites from northeastern Newfoundland which show strong resemblances with faunas of similar age in Scotland, Ireland, and Norway. Studies such as this add considerably to our knowledge of the paleogeography, nature, and interrelationships of the sedimentary basins in which the rocks were deposited.

Research in systematic paleontology is one of the means by which the Geological Survey of Canada 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.

Y. O. FORTIER,

Director, Geological Survey of Canada

OTTAWA, April 27, 1971

BULLETIN 210 — Ordovizische Trilobiten aus dem zentralen faltbaren vulkanischen Raum um die New-World-Insel im nordöstlichen Neufundland

Von W. T. Dean

Trilobiten aus sechzehn Gattungen und Untergattungen sowie eine neue, noch unbenannte Art der Gattung *Bergamia* werden beschrieben. Diese Fauna ist der Tappins-Gruppe bei Girvan (Schottland) am nächsten verwandt, zeigt aber auch starke Ähnlichkeiten mit norwegischen und irischen Faunen.

БЮЛЛЕТЕНЬ 210 — Ордовикские трилобиты центрального подвижного пояса на о-ве Нью Уорлд Айлэнд, северовосточная часть Ньюфаундленда

У. Т. Дин

Описываются трилобиты, относящиеся к 16 родам и подродам, включая новый, еще не определенный вид *Bergamia*. Фауна ближе всего коррелируется с группой *Tappins* вблизи Джирвэн, Шотландия, однако близко напоминает фауны Норвегии и Ирландии.

CONTENTS

Illustrations

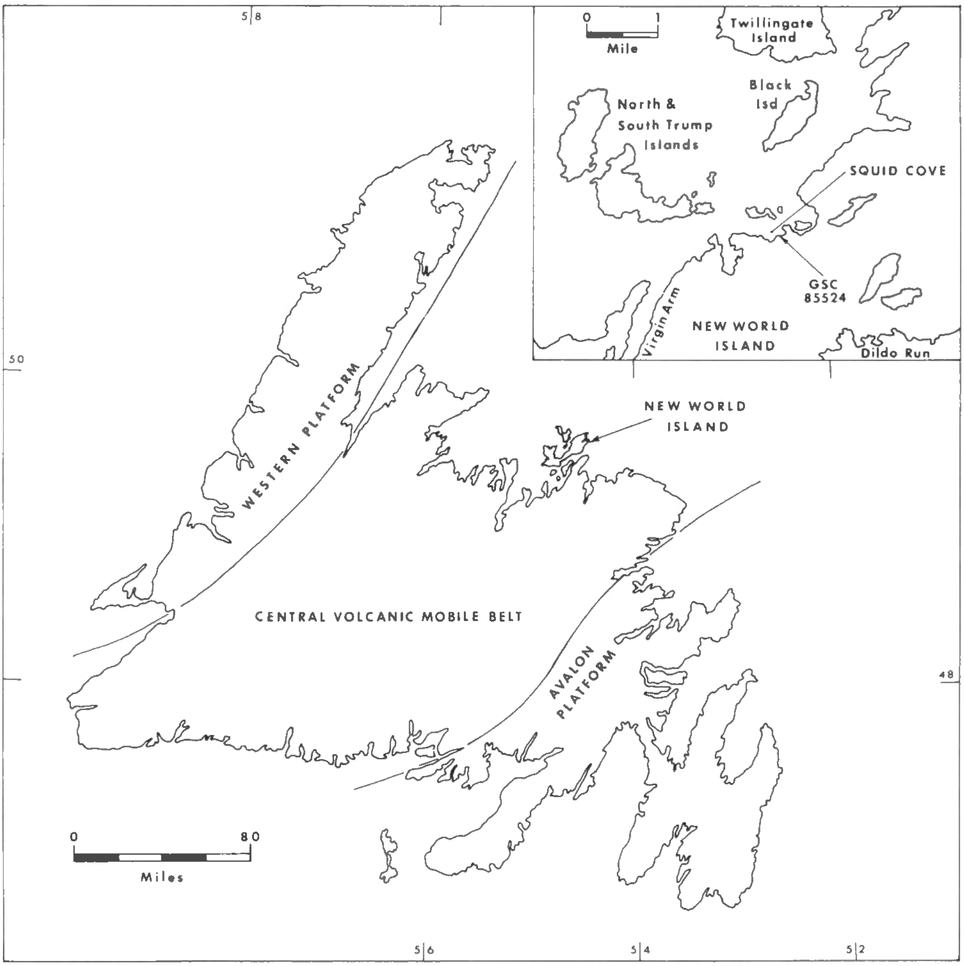
ORDOVICIAN TRILOBITES FROM THE CENTRAL VOLCANIC MOBILE BELT AT NEW WORLD ISLAND, NORTHEASTERN NEWFOUNDLAND

Abstract

Trilobites belonging to at least sixteen genera and subgenera are described from the Summerford Group (Ordovician) at Squid Cove, on the northwestern coast of New World Island, Newfoundland. The fauna includes a new but unnamed species of *Bergamia*, the first record of the Subfamily Trinucleinae from eastern North America. The remainder of the fauna comprises *Trinodus*, *Ampyx*, *Sphaerexochus costabilis* sp. nov., *Pliomerella*, *Atractopyge condylosa* sp. nov., *Carrickia*, *Remopleurides*, *Otarion*, *Raymondaspis arcuata* sp. nov., *Bronteopsis*, *Amphilichas*, *Nileus nesiotes* sp. nov., *Symphysurus*, *Illaenus*, and *I.* (*Parillaenus*). The age of the fauna is Porterfield Stage by analogy with the Appalachian region but Llandeilo Series in terms of Anglo-Welsh usage, and exhibits closest affinities with the Albany Division of the Tappins Group near Girvan, Scotland, though a strong resemblance to corresponding Norwegian and Irish faunas is noted. Associated conodonts match those of the Crassicauda Limestone, upper Llandeilo Series, of Sweden, and graptolites from overlying argillites suggest a correlation with the Peltifer–Wilsoni Zones of the Southern Uplands of Scotland.

Résumé

L'auteur décrit des trilobites appartenant à au moins seize genres et sous-genres provenant du groupe de Summerford (Ordovicien) de Squid Cove, sur la côte nord-ouest de l'île du Nouveau-Monde, à Terre-Neuve. La faune comporte une espèce nouvelle, et sans appellation, de *Bergamia*, le premier exemplaire de la sous-famille des Trinucleinae trouvé dans l'est de l'Amérique du Nord. Le reste de la faune est constitué de *Trinodus*, d'*Ampyx*, de *Sphaerexochus costabilis* sp. nov., de *Pliomerella*, d'*Atractopyge condylosa* sp. nov., de *Carrickia*, de *Remopleurides*, d'*Otarion*, de *Raymondaspis arcuata* sp. nov., de *Bronteopsis*, d'*Amphilichas*, de *Nileus nesiotes* sp. nov., de *Symphysurus*, d'*Illaenus* et d'*I.* (*Parillaenus*). La faune date de l'étage de Porterfield, par analogie avec la région appalachienne, mais se rattache à la série de Llandeilo dans la classification anglo-galloise; elle présente des affinités très étroites avec la division d'Albany du groupe de Tappins près de Girvan en Écosse, bien qu'on remarque également une très grande ressemblance avec la faune correspondante en Norvège et en Irlande. Les conodontes qui s'y trouvent rappellent ceux des calcaires de Crassicauda, de la série supérieure de Llandeilo en Suède; tandis que les graptolites provenant des couches supérieures d'argilites rappellent les zones de Peltifer-Wilsoni du sud des hautes-terres de l'Écosse.



TEXT-FIGURE 1. The position of New World Island with reference to the principal geological subdivisions of Newfoundland. The inset map shows the location of Squid Cove and GSC fossil locality 85524, from which all the trilobites described in this paper were obtained. For geological boundaries of the area *see* Williams, 1963.

INTRODUCTION AND ACKNOWLEDGMENTS

New World Island lies in Notre Dame Bay, off the northeastern coast of Newfoundland and a short distance from the mainland, to which it is connected by a causeway. The island exhibits a considerable sequence of Ordovician and Silurian sedimentary and volcanic rocks, together with intrusives of Devonian (?) age. The area has attracted the attention of numerous geologists, particularly during recent years. The history of research was summarized by Williams (1963) who described the geology and produced a detailed 1 inch to 1 mile geological map of the island as well as the neighbouring Twillingate district and smaller islands. Williams demonstrated that the area was divided by large-scale regional faults into four northeasterly trending belts (Northern, Central, and Southern Belts, and Port Albert Peninsula), and he subdivided the stratigraphic sequence into a number of map-units whose distribution was shown on his map. Map-units 4, 5, 6, and 7 were assigned to Ordovician rocks later in age than the Snooks Arm and Lush's Bight Groups, and their individual lithologies were defined briefly as follows: map-unit 4, green pillow lava and pyroclastic rocks, minor sedimentary rocks; map-unit 5, grey sandstone, siltstone, and argillite; map-unit 6, crystalline limestone, minor limy shale; map-unit 7, black graptolite-bearing argillite and slate, grey slate, siltstone, minor sandstone, and limestone. The locality from which the fossils described in the present paper were obtained is situated on the shore near the eastern end of a small bay named Squid Cove, on the northwestern coast of New World Island one mile north–northeast of the village of Fairbanks East (*see* Text-fig. 1). The rocks there fall within map-unit 6, judging from the map of Williams who stated (1963, p. 8, 9) that at both Squid Cove and Cobbs Arm (at the northeastern end of New World Island) "the volcanic rocks of map-unit 4 are overlain by limestones (map-unit 6) and black slates (map-unit 7)". Williams also noted that in general the same limestones and black slates form the uppermost beds of the dated Ordovician section in the Central Belt (*see* earlier), though neither is believed to be continuous there. Graptolites recorded from the eastern shore of Squid Cove (Williams, 1963, p. 9) included *Dicellograptus ramosus* Hall and *D. caduceus* Lapworth, species which were held to indicate a Middle or Middle to Upper Ordovician age, though no particular graptolite zone was suggested. Fossils in map-unit 6 were said by Williams to be both rare and highly distorted so that although crinoid stems, brachiopods, and gastropods were recorded, no genera or species were listed.

The Ordovician–Silurian sedimentary strata of New World Island were later divided by Kay (1967a, p. 588) into four "sequences": the southernmost on Farewell Peninsula, followed in turn to the north by the Dildo, Cobbs Arm, and Toogood Sequences, which were separated from each other by the Dildo, Cobbs Arm, and Toogood Faults. Both the sequences and the faults delimiting them run approximately northeast and the sediments within a sequence were said to display considerable variation. The rocks concerned in the present paper form part of the Cobbs Arm Sequence of Kay, who reported from it fossils of both Canadian age (nautiloids and rare trilobites) and late Chazyan or Valcourian age (brachiopods). These were

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found in the southwestern part of New World Island, in the vicinity of Village Arm, near Summerford. More recently Horne and Helwig (1969, p. 393) claimed that the Cobbs Arm Sequence occupies most of southwestern New World Island and separated the lower part of the sequence as the Summerford Group, which comprises lower and middle Ordovician volcanic and sedimentary rocks and crops out immediately to the north of the Cobbs Arm Fault. They described the volcanic rocks at Cobbs Arm as being succeeded by 100 feet of tuffs, grading upward into 150 feet of horizontally discontinuous calcarenite beds which, according to Kay, yielded fragmentary fossils of probable Llandeilo age. Professor Marshall Kay has since informed me (pers. com., 1970) that the fossils in question are brachiopods of Chazy type. Horne and Helwig (1969) stated that the calcarenites were succeeded by black argillites (presumably map-unit 7 of Williams, 1963) in which Caradoc graptolites represented zones 9 to 13 of the British succession, though not, apparently, at any one locality.

More specific information regarding the Ordovician rocks at and near Squid Cove was given by Kay in a guide for field trips at the Gander Conference, held in Newfoundland in 1967. In the itinerary for Gander to New World Island, Kay (1967b, p. 3) noted "excellent exposures of tuff, interbedded calcarenite . . ." (presumably those of Horne and Helwig's Summerford Group), along the east shore of Squid Cove, followed by "overlying distorted black graptolite-bearing Ordovician siliceous argillite" (clearly map-unit 7 of Williams, 1963). According to Kay, "The tuffs bear Upper Chazyan (Valcourian, about Llandeilian) faunas in nearby sections", but no mention was made of fossils at the Squid Cove section itself.

During the early summer of 1970 the writer searched the rocks at Squid Cove for shelly fossils, paying particular attention to the interbedded calcarenites noted by Kay. For the most part fossils proved too fragmentary or too poorly preserved for even generic identification, but the lowest 1 inch to 2 inches of a bed of calcarenite as much as 1 foot 2 inches thick situated in the highest part of Williams' map-unit 6 yielded the trilobites described below. The matrix is a tough, dark grey limestone, much compacted, containing shale fragments and numerous patches of pyrite. The age of the trilobites is discussed later and their evidence is generally borne out by that of the conodonts, which have been kindly identified by Dr. T. T. Uyeno of the Geological Survey of Canada (*see* Appendix I).

I am much indebted to Professor H. B. Whittington, who has read and criticized the manuscript, and also to Dr. C. P. Hughes for helpful discussion of the trilobite *Bergamia* and for providing extracts from his 1971 paper prior to its publication.

SYSTEMATIC DESCRIPTIONS

The terminology followed is essentially that proposed by Harrington, Moore, and Stubblefield (*in* Moore, 1959, p. O 117), but for describing trinucleid trilobites the usage suggested by Whittard (1955), with minor modifications, is preferred.

Family AGNOSTIDAE M'Coy, 1849
Genus ***Trinodus*** M'Coy, 1846

Type species. *Trinodus agnostiformis* M'Coy, 1846.

Trinodus cf. *T. doulargensis* Tripp
Plate 1, figures 1, 2

Trinodus doulargensis Tripp, 1965, p. 578, Pl. 80, figs. 1–4.

Figured specimens. GSC 29091 (Pl. 1, fig. 1), GSC 29092 (Pl. 1, fig. 2).

Dimensions. GSC 29091: Length of cranidium = 3.1 mm; breadth of cranidium = 3.8 mm (estd.); length of glabella = 2.0 mm; breadth of glabella = 1.6 mm; GSC 29092: length of pygidium = 2.4 mm (estd.); maximum breadth of pygidium = 2.2 mm (estd.); length of axis = 1.1 mm (estd.); frontal breadth of axis = 0.8 mm.

A single cranidium from Squid Cove has the cephalic breadth slightly exaggerated by compression but otherwise agrees well with the holotype of Tripp's species, described from the Albany Division of the Tappins Group in the Girvan District. An associated pygidium is still less well preserved but the length and proportions of the axis are broadly comparable with those of the Scottish species.

Trinodus elspethi (Raymond) from the Edinburg Formation of the Appalachian Valley in Virginia (*see* Cooper, 1953, p. 7, Pl. 1, figs. 1–12) has a glabella of similar length but the sides are more convergent and the frontal glabellar lobe is narrower. The pygidial axis of *T. elspethi* is notably shorter and more tapered, a feature it shares with *Trinodus tardus* (Barrande), a species widespread in the Ashgill Series of Europe and the British Isles, and recently reviewed by Whittington (1968, p. 97). *T. elspethi* has been redescribed by Hunt (1967) whose illustrations indicate some variation in the outline of both glabella and pygidial axis. Although the material from Squid Cove compares most readily with *T. doulargensis*, Tripp's species may eventually prove to be a synonym of *T. elspethi* and the relatively minor differences could be the result of preservation in a mudstone matrix.

Family RAPHIOPHORIDAE Angelin, 1854
Genus ***Ampyx*** Dalman, 1827

Type species. *Ampyx nasutus* Dalman, 1827.

Ampyx sp.
Plate 1, figures 3, 5, 6

Figured specimens. GSC 29093 (Pl. 1, fig. 5), GSC 29094 (Pl. 1, fig. 3), GSC 29095 (Pl. 1, fig. 6).

Description. The cranidium is represented by only a single fragment (Pl. 1, fig. 3) which shows the glabella expanding forward gently, its sides bearing traces of at least one pair of indentations representing glabellar furrows, but with no sign of alae. The long (sag.), convex occipital ring is confluent with the posterior border which expands a little abaxially, delimited by a shallow transversely straight posterior border furrow.

The larger and more complete of two pygidia (Pl. 1, fig. 5) is more than twice as broad as long, semielliptical in plan, with straight anterior margin. The axis has a frontal breadth just more than one quarter of the pygidial breadth and its straight sides converge backward about twenty-five degrees to a low, blunt tip that extends to and merges with that of the pygidium. In addition to the articulating half-ring there is one axial ring faintly visible, though others may have been obliterated. The pleural regions are large, quadrant shaped, each with an anterior half-rib that expands in breadth (exsag.) abaxially, bounded by a pleural furrow that flexes gently backward at first and then more strongly forward, dying out without quite reaching the pygidial margin. The border was apparently steeply declined, ornamented with fine terrace-lines running subparallel to the margin.

Dimensions (*mm*).

	Cranidium				Pygidium		
GSC Number	Basal breadth	Median length	Length of glabella	Basal breadth of glabella	Frontal breadth	Median length	Frontal breadth of axis
29093	–	–	–	–	16.4	7.5	4.6
29094	6.8*	–	–	1.9*	–	–	–
29095	–	–	–	–	–	1.5*	1.3

*Denotes estimated measurement.

Discussion. The type species of *Ampyx*, *A. nasutus* Dalman, 1827 from the upper Arenig Series of Sweden, has been redescribed by Whittington (1950, p. 554, Pl. 74, figs. 3–9) whose illustrations show that the Newfoundland pygidium has a more rounded outline, larger pleural regions, and a slightly narrower axis that is poorly segmented and has a less pointed tip. A closer comparison may be made with *Ampyx mammilatus* Sars, 1835, from the Ogygiocaris Shale (Etage 4aα) and Ampyx Limestone (Etage 4aβ) of the Oslo District, Norway, redescribed by Størmer (1940, p. 130, Pl. 2, figs. 7, 12). The pygidium of this species has similar proportions, and apparent differences include only the better segmented axis and more bevelled border, features liable to alteration by compression.

Another comparable species is *Ampyx americanus* Safford and Vogdes, 1889, from the Athens Formation (correlated with the Edinburg Formation of early Caradoc age) in Tennessee and Virginia (Cooper, 1953, p. 15, Pl. 5, figs. 3–5, 8, 9). The pygidium of the American species has a slightly more convergent, better segmented axis with smaller axial tip, and the outline is apparently less rounded, but the overall form is generally similar to that of the Newfoundland specimen. No useful comparison of the cranidium is possible for any of the above species.

Family TRINUCLEIDAE Hawle and Corda, 1847
Subfamily TRINUCLEINAE Hawle and Corda, 1847

Genus *Bergamia* Whittard, 1955

Type species. *Bergamia rhodesi* Whittard, 1955.

The terminology employed in the following description of the cephalic fringe is essentially that advocated by Whittard (1955, p. 27–29) which in turn was based on the earlier work of Bancroft. More recently Hughes (1970, p. 3) suggested that it would be advantageous to use the term 'arc' for concentric rows of pits to obviate confusion with the radial rows. The suggestion is followed here. Hughes also noted the desirability of using pit-counts for the whole cephalon rather than merely the right or left halves. He based his view on the fact that abundant, well-preserved cephala of *Trinucleus fimbriatus* from the Llandrindod Wells district of South Wales showed some asymmetry in their pit-counts. Unfortunately such perfection, however desirable, is seldom attained by workers collecting from tectonically disturbed successions in which incomplete trinucleid cranidia are the rule rather than the exception. Consequently it is some relief to find that Hughes (1970, p. 8) considered the use of half-fringes adequate so long as the existence of variation within a species were borne in mind. This applies to the species described below, the remains of which are all fragmentary and difficult to extract from a tough pyritic limestone. Unfortunately the state of the present fragmentary material is such that even half-fringe pit-counts cannot be given accurately, although it is believed that the margin of error in the estimated numbers of pit-radii is small. Certain features of the fringe, however, suggest that the species is new but a new specific name will not be erected until better material becomes available.

Bergamia sp. nov.

Plate 1, figures 4, 7–9; Plate 2, figures 1–11; Plate 3, figure 8

Figured specimens. GSC 29096 (Pl. 1, fig. 4), GSC 29097 (Pl. 2, fig. 3), GSC 29098 (Pl. 2, fig. 10), GSC 29099 (Pl. 2, fig. 11), GSC 29100 (Pl. 2, fig. 8), GSC 29101 (Pl. 3, fig. 8), GSC 29102 (Pl. 2, fig. 5), GSC 29103 (Pl. 1, fig. 9), GSC 29104 (Pl. 2, fig. 6), GSC 29105 (Pl. 1, fig. 8), GSC 29106 (Pl. 2, fig. 1), GSC 29107 (Pl. 2, fig. 7), GSC 29108 (Pl. 2, fig. 9), GSC 29109 (Pl. 1, fig. 7), GSC 29110 (Pl. 2, fig. 4), GSC 29157 (Pl. 2, fig. 2).

Description. The complete cephalon, though not found, is estimated to have been about twice as broad as long, subsemicircular in outline (excluding librigenal spines) and subangular anterolaterally. The glabellar outline is clavate, with almost two thirds of its length occupied by the subspherical pseudo-frontal glabellar lobe. The latter is separated by a pair of large ovoid depressions, representing the 2p glabellar furrows, from the stalk-like occiput (*see* Stäuble 1953, p. 87) of the glabella. The occiput comprises two ring-like segments, the basal one of which is the longer (tr.), separated from each other by shallow transverse furrows, and the outer ends of these rings form the 1p and 2p glabellar lobes. The cheek-lobes are large and quadrant shaped, each surmounted by a small tubercle or lateral ocellus; traces of a similar ocellus have also been found at the apex of the frontal glabellar lobe. The surface of the test on both glabella and cheek-lobes is only poorly preserved but shows traces of a reticulate pattern of thin raised lines similar to that found on the cephala of many other trinucleid genera.

The dorsal lamella of the pitted fringe is of almost uniform breadth, becoming only slightly broader anterolaterally and posterolaterally. The fringe-pits have a relatively simple arrangement and most are contained within deep radial sulci. The sulci extend posterolaterally to within five or six radial rows from the genal angles, at which point their straight, radiating pattern is lost and each sulcus tends to break into two unequal parts which form an obtuse angle about a point approximating in position the girder on the ventral lamella (*see* Pl. 2, figs. 6, 11). None of the available cranidia is sufficiently complete to enable a direct pit-count for even the half-fringe to be made, but reasonable approximations may be given. For example in Plate 1, figure 8, part of a ventral lamella, there are sixteen radial rows of pits (involving arcs E_1 plus $I_{1-3 \text{ or } 4}$) which extend from the axial furrow to the genal angle and there is room for about twenty radii in half the cranidium. Similarly the dorsal lamella of Plate 2, figure 11 has seventeen radii, eleven of which are set in sulci, between the axial furrow and the genal angle, and the half-fringe must have had approximately twenty or twenty-one radii. Although the radial sulci are such a conspicuous feature of the dorsal fringe lamella, such structures are almost absent from the ventral lamella, though the radial arrangement of pits there is still strong. The most complete example of the fringe, though not preserved frontally (Pl. 1, fig. 8), shows arcs I_1 and I_2 extending posterolaterally for five or six radii from the axial furrow, after which three I arcs are developed. Normally the innermost arc would be classified as I_3 using Whittard's (1955) terminology, but in this instance it is clear that the original I_2 remains the innermost arc and I_3 is developed midway between it and I_1. As thus interpreted, this example of I_3 has eleven pits and forms the adaxial boundary of a heterogeneous group of nine pits, seven of which might be interpreted as forming a rudimentary I_4 arc. The marginal suture follows the usual trinucleid pattern. On the ventral lamella the girder is strongly developed and extends along the underside of the prismatic librigenal spine, the dorsal surface of which carries a shallow longitudinal groove (*see* Pl. 2, fig. 3).

The cephalic fringe characters of the species may be summarized as follows: approximately twenty or twenty-one radial rows of pits in half-fringe; most pits on dorsal lamella are sited in simple radial sulci which extend to within about six radii of the genal angles, the radial arrangement then becoming less well defined; arc E_1 extends to genal angles; arc E_2 present anterolaterally, but E_1 and E_2 converge to form large, possibly twinned pits both frontally and posterolaterally, though not as far as the genal angles; I_1 and I_2 probably present frontally, but I_3 developed only from about R11 and inserted between I_1 and I_2; trace of I_4 developed posterolaterally; genal prolongations small; girder well developed.

Two pygidia probably referable to *Bergamia* were found, one small and compressed (Pl. 2, fig. 4), the other relatively large (Pl. 1, fig. 7). The larger specimen is of characteristic outline with median length slightly less than one third of the frontal breadth. The axis stands slightly higher than the pleural regions and extends backward to the pygidial margin, which is marked by a low rim. The internal mould shows the axis to be completely segmented with ten, or perhaps eleven, axial rings and a minute terminal piece. The pleural regions are not well preserved and show only faint traces of two pairs of ribs in addition to the anterior half-rib, though there is sufficient space for about two additional pairs.

Discussion. Bergamia has a relatively restricted geographical distribution, having been previously recorded from only the Anglo–Welsh area, southern Ireland, and Norway. The type species, *B. rhodesi* Whittard (1955, p. 32, Pl. 3, figs. 8–13) was described originally from the *Didymograptus hirundo* Zone of the Arenig Series in the Shelve Inlier of west Shropshire, but the genus, as interpreted by Whittard, has an extended vertical range and the youngest recorded species is from the *Nemagraptus gracilis* Zone of the Caradoc Series. The dorsal lamella of *B. rhodesi* is not shown clearly in any of Whittard's published photographs but the ventral lamella is distinct from that of the present species, and the fuller development of arc E_2 is shown in Whittard's fringe formula by E_1 1–19, E_2 1–18, plus a few pits in e_{1-2}. The

Dimensions (mm).

	Cranidium				Pygidium		
GSC Number	Basal breadth	Median length	Length of glabella	Basal breadth of glabella	Frontal breadth	Median length	Frontal breadth of axis
29097	10.4*	–	4.2*	3.0*	–	–	–
29098	–	–	5.9*	4.4	–	–	–
29102	19.0*	–	–	–	–	–	–
29105	18.0*	–	–	–	–	–	–
29109	–	–	–	–	23.0	7.8	4.7
29110	–	–	–	–	10.5	–	2.5

*Denotes estimated measurement.

formula shows only I_1 1–15 and I_2 1–5, and this part of the fringe obviously has fewer arcs than has the Newfoundland species. Generally similar criteria apply to *Bergamia matura* Whittard (1966, p. 280, Pl. 48, figs. 11, 12), said to occur at only one locality in the lower Arenig rocks of Shelve, at which place it is associated with three other, related trinucleids—*Lordshillia*, *Incaia*, and *Coccliorrhoe*. Of these, *Coccliorrhoe* is now placed in synonymy with *Bergamia*, and the supposed *Incaia* is referred to a new genus *Anebolithus* Hughes and Wright (1970, p. 688; *see* also Hughes, 1971). *Bergamia matura* has arc E_2 almost as fully developed as E_1, together with some e_2 pits, and I_1 is of similar extent but I_2 is developed only posterolaterally. Again, I_3 and subsequent arcs are absent.

Another early Ordovician species *Bergamia gibbsi* (Salter), from the (probably) upper Arenig of Pembrokeshire, South Wales (*see* Whittard, 1955, p. 34, Pl. 4, figs. 1, 2), was founded on poorly preserved material. Like the foregoing species it has arcs E_1 and E_2 almost equally developed, which alone would separate it from the present species, but it is also conspicuous for having apparently both I_1 and I_2 developed only frontally. This feature may, however, be the result of mechanical deformation.

The *Bergamia* from Squid Cove differs markedly from the species considered so far in its possession of numerous well-developed radial sulci. These contain almost all the pits present on the dorsal lamella and closely resemble the sulci of *Trinucleus* sensu stricto, a genus whose geographical distribution differs little from that of *Bergamia*. The type species *T. fimbriatus* Murchison was described first from supposed 'Llandeilo' strata in the Builth–Llandrindod Inlier of Radnorshire, Wales, but as Whittard (1956, p. 45) pointed out, Elles (1940, p. 416) recorded it there also from the *Nemagraptus gracilis* Zone of the Caradoc Series. The Builth trilobites are currently under revision by Dr. C. P. Hughes, who has kindly provided me with extracts from his forthcoming paper on the trinucleids of the inlier (Hughes, 1971). From these and an earlier account of *T. fimbriatus* (Hughes, 1970) it appears that the Newfoundland specimens, with their development of arc E_2, cannot be placed in *Trinucleus*; but a much closer comparison can be made with the trilobite described originally as *Trinucleus fimbriatus* mut. *primus* Elles (1940, p. 424, Pl. 30, figs. 1–5) and now transferred to *Bergamia* by Hughes. The latest illustrations of *Bergamia prima* (*see* Hughes, 1971, Pl. 4, figs. 1, 2, 6; Pl. 5, figs. 1–6; Pl. 6, figs. 1–6, 8), a species of Llandeilo age, show that the dorsal lamella has numerous deep radial sulci and it is perhaps the species of *Bergamia* most comparable with the material from Newfoundland. However, the number of pits in E_1 is probably larger than in *B.* sp. nov., and arc E_2 is developed not only posterolaterally (as in *B.* sp. nov., though with arcs E_1 and E_2 set closer together) but also frontally, diminishing anterolaterally where it forms twinned pits with E_1. *Bergamia whittardi* Hughes (1971, Pl. 6, fig. 7; Pl. 7, figs. 1–11; Pl. 8, figs. 1–9, 11), also from the Builth district and based on specimens that are mostly of uppermost Llandeilo age, has numerous radial sulci on the dorsal lamella but they are less well developed posterolaterally than on *Bergamia* sp. nov., the genal prolongations are longer, and the number of I arcs (as much as I_6 posterolaterally) is greater.

Several examples of *Trinucleus* from the Ogygiocaris Series and Ampyx Limestone of the Oslo region of Norway, were described or redescribed by Størmer (1930) and include *T. foveolatus* Angelin, *T. foveolatus* var. *intermedius* Størmer, *T. bronni* (Sars and Boeck), *T. bucculentus* Angelin, and *T. hibernicus* var. *bröggeri* Størmer. The first three are devoid of arc E_2 and so are retained in *Trinucleus*. Each has radial sulci on the dorsal lamella strikingly similar in both form and number to those on the Newfoundland species, but in general the fringe becomes narrower posterolaterally where there is a smaller development of I arcs. On the other hand Størmer's description of *T. bucculentus* mentions a "distinct girder within the one or two outer rows (= arcs) of pits . . ." (p. 21), and states later (p. 23) that "the outer band contains one or two rows (= arcs) of pits anteriorly". Consequently it seems reasonably certain that *T. bucculentus* represents a species of *Bergamia*; but Størmer's figured material is sparse and poorly preserved and as the genus is not identified with certainty it is excluded from those on which the Index of Faunal Resemblance is based (*see* later in this paper). *Bergamia*? *bucculenta* has thirty-two pits in the outermost arc according to Størmer—that is to say less than in *Bergamia* sp. nov. and there appear to be fewer I arcs posterolaterally, but further comparison is impracticable.

Trinucleus hibernicus Reed (1895, p. 52, Pl. 3, figs. 2–7) was described from the Tramore Limestone Series of southeastern Ireland and although the precise age is not yet clear it may be in part approximately Llandeilo Series. No detailed modern description of a sample of *T. hibernicus* has been published but the species was reviewed briefly by Whittard (1955, p. 35) who claimed that Reed's interpretation of the fringe was incorrect and suggested that it may belong in *Bergamia*. The fringe formula given by Whittard for one of Reed's syntypes includes a well-developed E_2 arc. Although the extent to which I arcs are present is unclear, the species falls within the diagnosis of *Bergamia* employed by Hughes (1971). Whittard noted that a cranidium attributed to *T. hibernicus* by Lamont (1941, Pl. 1, fig. 1) could not be retained in *Trinucleus* but hesitated to place it in *Bergamia* without additional information. This specimen, said to come from the *Nemagraptus gracilis* Zone, has a fringe that, judging from Lamont's photograph, appears to broaden posterolaterally and has more radial rows of pits than *Bergamia hibernica*. Both these features are more suggestive of the Newfoundland species, but the evidence is inconclusive. Whittard remarked that Lamont's specimen was "stratigraphically much younger" than *B. hibernica*, but the age difference may not, in fact, be unduly great.

By analogy with *B. hibernica*, the trilobite described from the Ampyx Limestone, basal Caradoc Series, of the Oslo region as *Trinucleus hibernicus* var. *bröggeri* Størmer (1930, p. 24, Pl. 3, figs. 1–14) should probably be termed *Bergamia hibernica broeggeri* or perhaps *B. broeggeri*. It is easily distinguished from the Newfoundland species by the small number (twenty-seven on the holotype) of radial sulci, each containing two to three pits, on the dorsal lamella. The ventral lamella shows the area outside the girder to be conspicuously broad (sag.) frontally with conspicuous radial sulci, each containing apparently two pits, that pass into large single pits as the fringe narrows toward the genal angles.

Family Cheiruridae Salter, 1864
Subfamily sphaerexochinae Öpik, 1937
Genus ***Sphaerexochus*** Beyrich, 1845

Type species. *Sphaerexochus mirus* Beyrich, 1845.

Sphaerexochus costabilis sp. nov.
Plate 4, figures 2, 3, 5, 6, 8

Diagnosis. Sphaerexochus with pygidium twice as broad as long. Large axis has two transversely straight axial rings. Axial furrows generally broad and deep but obsolete at front of triangular terminal piece, the latter confluent here with third pair pleurae. First pair pleurae straight in plan, directed posterolaterally, second pair curve more strongly back and slightly inward, third pair curve inward and back still more strongly and tips converge posteriorly.

Holotype. GSC 29113 (Pl. 4, figs. 3, 5, 8).

Paratypes. GSC 29114 (Pl. 4, fig. 2), GSC 29115 (Pl. 4, fig. 6).

Description. The species is known with certainty only from the pygidium, though an associated fragment of cranidium (*see* later) may belong here. The holotype pygidium is strongly convex transversely, steeply declined posteriorly, and the projected breadth is more than twice the median length. The large axis, excluding the articulating half-ring, is triangular in plan, and the sides converge at approximately 45 degrees. It stands high above the pleural regions and its frontal breadth is two fifths that of the pygidium. There are two large axial rings which together occupy almost half the length of the axis and are bounded by deep, broad (sag.), transversely straight ring furrows. The conspicuous terminal piece is triangular in plan, ends in a blunt point (*see* Pl. 4, fig. 8) and is bounded by axial furrows that are deep and broad posteriorly but become shallower forward, where they are traversed by the third pair of pleurae, here coalesced with the anterolateral corners of the terminal piece. The pleural regions decline steeply toward the pygidial margins and carry three pairs of thickened, ridge-like pleurae, separated by broad (exsag.), deep interpleural furrows. The first pair of pleurae, although more steeply declined beyond the fulcrum, appear straight in plan view, almost uniformly broad (exsag.), and are directed posterolaterally so that they appear to diverge posteriorly at about 120 degrees. The second pair of pleurae not only decline posterolaterally but also become wider (exsag.) toward the tips and are strongly curved, almost sickle shaped in plan. Similar widening is even more apparent on the third pleurae, which curve inward still more strongly than those of the second pair and converge posteriorly along the sides of the terminal piece. As already noted the inner ends of the third pleurae are continuous with the front of the terminal piece. The characteristic widening of the second and third pairs of pleurae toward the tips, and their marked adaxial curvature are apparent even on a dorsally compressed specimen such as that shown in Plate 4, figure 2. Part of the ventral side of the pygidium, illustrated here as a latex cast (Pl. 4, fig. 6), shows the pleural tips produced to form bluntly pointed pleural spines when preserved entire. The inner margin of the doublure has a pair of large, flange-like projections opposite the second pleurae in much the same manner as that shown by *Sphaerexochus hapsidotus* Whittington and Evitt (1954, Pl. 33, fig. 41).

The remainder of the exoskeleton is not known but an associated fragment of a cranidium is figured here as a latex cast (GSC 29158, Pl. 4, fig. 7). The occipital ring is of almost uniform length (sag.), separated from the glabella by a narrow, transversely straight occipital furrow. A pair of large 1p glabellar lobes is visible, delimited by 1p glabellar furrows that are deep at the axial furrows but become shallower toward the occipital furrow, which they appear to intersect. The 1p lobes are less subcircular and more transversely elongated than is usual for *Sphaerexochus*. Adaxial shallowing of 1p glabellar furrows is found also in *Pseudosphaerexochus* but in that genus it is likely that traces of 2p glabellar furrows would have been visible. For the present the specimen is referred only questionably to *Sphaerexochus.*

Dimensions (mm).

GSC Number	Pygidium: Maximum breadth	Pygidium: Median length	Pygidium: Frontal breadth of axis
29113	11.0*	4.2	4.4
29114 (dorsally compressed specimen)	15.0*	9.6*	5.3

*Denotes estimated measurement.

Discussion. The manner in which the inner ends of the third pleurae coalesce with the anterolateral corners of the terminal piece is reminiscent of that found in *Sphaerexochus filius* Tripp (1967, p. 63, Pl. 3, figs. 39–41), from the Upper Stinchar Limestone of the Girvan District. However, the Scottish species, which is of Porterfield age, carries traces of a third axial ring, with a conspicuous pit in the axial furrows at either end of the incipient third ring furrow. The second and third pairs of pleurae are less curved in plan, and the first pleurae turn backward more strongly. *Sphaerexochus eurys* Tripp (1962, p. 19, Pl. 3, fig. 7a, b), from the Confinis Flags (of lower Porterfield age) near Girvan, similarly has the terminal piece and third pleurae confluent, but in this instance there is a distinct third axial ring, behind which the terminal piece becomes narrower, and the second and third pleurae are less strongly curved.

In the Appalachians of Virginia, presumed adult pygidia of *Sphaerexochus pulcher* Whittington and Evitt (1954, p. 87), from the Edinburg Limestone, have the pleurae curved inward less strongly than those of *S. costabilis,* although those of small and transitory pygidia exhibit a marked degree of curvature. The terminal piece of *S. pulcher* is conspicuously smaller and more pointed, with a pair of pits in the axial furrows marking the position of the third ring furrow. The pygidium of *Sphaerexochus hapsidotus* Whittington and Evitt (1954, p. 92), from the Lincolnshire Limestone of the same region, is even more distinct from *S. costabilis* and may easily be recognized by the straighter, more clavate pleurae, the more pointed terminal piece, and by the deep, wide axial furrows separating the third pleurae and terminal piece.

Family PLIOMERIDAE Raymond, 1913
Genus *Pliomerella* Reed, 1941

Type species. *Pliomerella serotina* Reed, 1941.

Pliomerella sp.
Plate 4, figures 1, 4

Figured specimens. GSC 29111 (Pl. 4, fig. 4), GSC 29112 (Pl. 4, fig. 1).

Description. The glabella, although fragmentary, was probably originally subpentagonal in outline, with the sides parallel or slightly convergent forward. There are two pairs of glabellar lobes, each occupying at the axial furrows about one third of the median glabellar length. The 1p glabellar furrows run inward and slightly backward almost to the centre of the glabella, and the 1p glabellar lobes thus delimited are also indented from the rear by the forward curvature of the median third of the otherwise transversely straight occipital furrow. The anterior border is low and well defined, separated from the glabella by a deep, narrow (sag.) furrow; the border is narrowest (sag.) frontally, widens a little to form an obtuse angle projecting backward at each axial furrow, and then narrows again laterally, though its continuation is not known. Part of the right fixigena remains and is relatively broad for the genus, with a breadth estimated to have been about one third that of the glabella. There is a suggestion of part of a palpebral furrow opposite the 2p glabellar lobe, but the palpebral lobes are not preserved. The posterior border is notably narrow (exsag.) at the axial furrow but widens a little abaxially.

A large, incomplete hypostoma has the median body subpentagonal in plan, ending posteriorly in a blunt point and with the sides subparallel. The median body is of low convexity and its breadth is about two thirds of its length. The specimen retains part of a small anterior wing, sharply reflexed dorsally to form an angular anterior process, and only the posterior portion of the broad, level border is preserved. The test of the median body exhibits traces of granular ornamentation.

Dimensions. Length of cranidium = 9.5 mm (estd.); length of glabella = 7.0 mm (estd.); breadth of glabella = 9.2 mm (estd.).

Discussion. Pliomerella was founded by Reed (1941, p. 268, Pl. 5, figs. 1, 2) on *P. serotina* from the Balclatchie Group (Caradoc Series *pars*) of Dow Hill, Girvan, and embraces a few species that differ apparently in only minor details and have a relatively restricted vertical range from Llandeilo Series to low in the Caradoc Series. The Newfoundland species is probably new and differs from *P. serotina* in having a proportionately longer glabella, a narrower (exsag.) anterior border, and narrower fixigenae.

Pliomerella girvanensis, from the Superstes Mudstone of the Girvan District, was described as a species of *Pliomera* (*Pliomerops*) by Reed (1930, p. 196, Pl. 9, figs. 3, 3a) and has recently been discussed by Tripp (1967, p. 70). *P. girvanensis* is distinguished from the Squid Cove species by having relatively broader (exsag.) 1p and 2p glabellar lobes and apparently shorter (tr.) glabellar furrows, those of the 2p pair being less strongly arched backward. Lack of illustrations of the Scottish species precludes further comparison.

Pliomerella craigensis (Reed 1931, p. 20) was redescribed in detail by Tripp (1967, p. 68, Pl. 4, figs. 18–38) who recorded it from the Lower and Upper Stinchar Limestone of the Girvan District. His illustrations show that the cranidium of the Scottish trilobite exhibits some variation but in general the 2p glabellar furrows are less divergent forward than those of *Pliomerella* sp.; the 1p furrows are more curved, and concave forward; the fixigenae are narrower and much smaller; the median body of the hypostoma is proportionately shorter, more pointed posteriorly, and the sides are more convergent backward.

Pliomerella americana Cooper (1953, p. 26, Pl. 10, figs. 1–4), from the Edinburg Formation of Virginia, has small, narrow fixigenae like those of *P. craigensis*, but it differs from *Pliomerella* sp. in having more curved 1p and 2p glabellar furrows, the 2p furrows are less divergent forward, whilst the confluent 1p lobes are relatively larger and longer (sag.).

Amphion pauper Salter (1864, p. 83, Pl. 6, fig. 32), founded on a single incomplete cranidium from Tramore, southern Ireland, appears to be a typical *Pliomerella*. The 2p glabellar furrows are less divergent forward than those of *Pliomerella* sp., the 1p furrows are flexed instead of transversely straight, and the outline of the frontal glabellar lobe appears to be more convex anteriorly. However, these comments are based solely on Salter's illustration, and photographs of the holotype of *Pliomerella pauper* have not yet been published.

Family Encrinuridae Angelin, 1854
Subfamily cybelinae Holliday, 1942
Genus ***Atractopyge*** Hawle and Corda, 1847

Type species. *Calymene verrucosa* Dalman, 1828.

Atractopyge condylosa sp. nov.
Plate 3, figures 1–5, 7, 10

Diagnosis. Atractopyge with glabellar outline strongly expanded frontally, its surface carrying three pairs of large tubercles arranged longitudinally in pairs. Three pairs almost equisized glabellar lobes present. Glabellar furrows and pair of large anterior pits deep with apodemes. Pedunculate eyes sited opposite 2p glabellar lobes and furrows. Pygidium with pleural regions of four pairs fused pleurae, each pleura divided into almost equisized anterior and posterior bands, the latter slightly ridged. Axis with approximately thirteen axial rings that are less well defined along the sagittal line.

Holotype. GSC 29119 (Pl. 3, figs. 1–3).

Paratypes. GSC 29120 (Pl. 3, fig. 10), GSC 29121 (Pl. 3, fig. 7), GSC 29122 (Pl. 3, fig. 4), GSC 29123 (Pl. 3, fig. 5).

Description. The cranidium has a basal breadth about two and a half times the median length and is only moderately convex both longitudinally and transversely. The glabella is slightly longer than broad, parallel sided as far forward as the 3p glabellar furrows. It then expands markedly in breadth to form the frontal glabellar lobe which occupies almost half the glabellar length and is strongly convex anteriorly. Three pairs of glabellar lobes increase slightly in size from 1p to 3p and are separated from one another by glabellar furrows that are represented on the internal mould by large pits indicating the position of apodemes. Similar pits are within the ends of the occipital furrow and still larger anterior pits are sited in the axial furrows at either end of the broad (sag.), shallow preglabellar furrow. The axial furrows are shallow, broad, almost semicircular in cross-section. They extend anterolaterally beyond the anterior pits to cut the anterior border which is narrowest (sag.) medially but expands abaxially and continues as the lateral border. The latter, seen only on a single right librigena (Pl. 3, fig. 10) is broad (exsag.) and flat, bounded by a broad, shallow lateral border furrow. The occipital ring, though incompletely preserved, is narrowest (exsag.) just inside the axial furrows and expands medially so that the occipital furrow is arched forward. The eyes are situated opposite the 2p glabellar lobes and furrows at the apices of the strongly convex fixigenae and at a distance from the axial furrows equal to about two thirds of the glabellar breadth at that point. Judging from an incomplete left librigena (Pl. 3, fig. 7) the eyes were tall, slender, and pendunculate. The posterior border furrow is broad, shallow, and turns forward sharply at its outer ends to coincide with the lateral border furrow. It delimits a posterior border that is narrow (exsag.) and transversely straight over its adaxial third but turns down posterolaterally at the fulcra and becomes broader (exsag.) toward the acute genal angles. The anterior branches of the facial suture run subparallel to the axial furrows and the anterior halves of the fixigenae so formed are high and broad. The posterior branches run slightly convergent to the posterior border furrow, a short distance in front of which they intersect the lateral margins.

The surface of the glabella carries three prominent pairs of large tubercles arranged longitudinally along the sagittal line. The anterior and largest pair is situated a little behind the preglabellar furrow; the second pair is positioned just in front of the 3p glabellar furrows; and the third pair is opposite the junction of 2p furrows and 3p glabellar lobes. The first and second pairs are broken off and may well represent the bases of spines. Similar large spinose tubercles occur at either end of the anterior border, the median portion of which has a transverse row of three large tubercles. Slightly smaller tubercles are arranged symmetrically elsewhere on the glabella: at the inner ends of the 3p glabellar lobes; just in front of the 3p furrows and transversely in line with the second pair of large tubercles; and near the extremities of the frontal glabellar lobe. A pair of thick, low eye-ridges runs from the eyes to meet the axial furrows immediately in front of the 3p glabellar furrows. Anterior to the eye-ridges the fixigenal surface is coarsely pitted with a few tubercles. Similar pitting is almost obsolete on the fixigenae behind the eye-ridges but tubercles are evenly distributed, except posterolaterally.

Two pygidia are available, the more complete of which is slightly broader than long and of the form characteristic for the genus. The axis stands well above the pleural regions, bounded by shallow axial furrows that are semiobsolete and moderately convergent as far as the fourth ring furrow and then become slightly less convergent toward the pointed tip. Thirteen transversely straight axial rings are visible, the first four bounded by ring furrows that become shallow medially. The remaining ring furrows diminish medially to leave a nearly smooth median band almost half as broad as the axis. On the axis of the larger pygidium (Pl. 3, fig. 5) a pair of tubercles is visible on the sixth ring and a single tubercle on the tenth and twelfth rings. The pleural regions are composed of four fused pairs of pleurae that become more strongly arched backward from first to fourth. The first three pairs of pleurae are separated by clearly incised interpleural furrows, but the third and fourth pairs are continuous with each other. Each pleura is divided by a pleural furrow into two equal bands, the posterior of which is raised and ridge-like, produced posteriorly to form one of four pairs of short, slightly splayed free points. The pleural furrows of the first three pairs of pleurae are clearly visible but those of the fourth pair are obsolete. In many other, generally younger species of *Atractopyge*, the anterior bands of the pygidial pleurae become reduced in breadth (exsag.) so that the pleural regions appear to be formed of four pairs of ridge-like posterior bands, separated by narrow furrows that represent the diminished anterior bands. A few low tubercles occur on the posterior bands.

Dimensions (mm).

GSC Number	Cranidium: Basal breadth	Cranidium: Median length	Cranidium: Length of glabella	Cranidium: Frontal breadth of glabella	Cranidium: Basal breadth of glabella	Pygidium: Maximum breadth	Pygidium: Median length	Pygidium: Frontal breadth of axis	Pygidium: Length of axis
29119	23.0*	8.8*	7.4*	6.3	4.6	–	–	–	–
29122	–	–	–	–	–	4.4*	4.2*	1.7	3.7*
29123	–	–	–	–	–	7.0*	–	2.7	7.0*

*Denotes estimated measurement.

Discussion. A redescription of the neotype and other specimens of *Atractopyge verrucosa* (Dalman), the type species of the genus from the Ashgill Series of South Wales (*see* Dean 1971, in press), shows that the Welsh species differs from *A. condylosa* in several respects: the posterior half of the glabella is broader and the frontal glabellar lobe expands forward less markedly; on the internal mould the impressions of the apodemes in the glabellar furrows are notably smaller; the surface of the cranidium is covered with closely grouped large tubercles; the pygidial axis is more tapered and pointed, with several additional axial rings; the pleural regions have more tubercles on the posterior bands of the pleurae—but even more noticeable is the manner in which the anterior bands are less well differentiated and appear only as deep, broad furrows except in the case of the first pleura, the anterior band of which is conspicuously narrower (exsag.).

Species of *Atractopyge* approximately contemporaneous with *A. condylosa* occur in strata of Llandeilo or early Caradoc age in the British Isles, though the genus is not yet recorded from other parts of the Appalachian region. Whittard (1960, p. 126, Pl. 17, figs. 12–16) recorded *Atractopyge michelli* (Reed) from the Meadowtown Beds, Llandeilo Series, of the Shelve Inlier, in the Welsh Borders. His illustrations show a fragmentary cranidium apparently similar to that of the Newfoundland species, though few details are visible, and the Shelve pygidium—with no more than fourteen axial rings, and median tubercles on the first, fourth, seventh, and tenth axial rings—has the anterior bands of the pleurae narrower and the axis less elongated than in *A. condylosa*. Whittard's material may not, in fact, be identical with *A. michelli*, which was described by Reed (1914, p. 42, Pl. 7, fig. 7, a–c) from the Balclatchie Group of the Girvan District and is therefore probably younger than either the Shelve or Newfoundland specimens. Reed's illustrations show that *A. michelli* has the cranidium covered with closely grouped tubercles of moderate size, and only rare evidence of large, paired tubercles at the front. In addition, the eyes are set farther back, opposite the 2p glabellar lobes and 1p glabellar furrows, and the pygidium, although carrying a comparable number of axial rings, has a more tapered, less elongated axis, and the pleurae are more strongly curved in plan.

Elsewhere in the Welsh region *Atractopyge sedgwicki* MacGregor (1963, p. 805, Pl. 117, figs. 17, 18) and *A. williamsi* MacGregor (1963, p. 806, Pl. 117, figs. 12–16; Pl. 118, figs. 1–7) were both described from the Upper Llandeilo Series of the Berwyn Hills, Montgomeryshire. *A. sedgwicki*, founded on a single cranidium, has two pairs of tubercles on the frontal glabellar lobe. The eyes are sited opposite the 2p glabellar lobes, but the glabellar outline expands forward less strongly than that of *A. condylosa* and the frontal glabellar lobe is relatively longer. The rest of the glabella lacks paired tubercles and the fixigenae are smaller with the eyes closer to the glabella. *Atractopyge williamsi* also lacks paired glabellar tubercles and the frontal glabellar lobe is larger and more inflated than that of the new species. The pygidium of *A. williamsi* is less elongated and more quadrate in outline, the sides of the axis are more convergent and the anterior bands of the pleurae are narrower, ending in shorter free points, though the number of axial rings, eleven or twelve, is similar.

The pygidium of *Atractopyge* ind. sp. from the Derfel Limestone, early Caradoc Series, of the Bala District (Whittington and Williams, 1955, p. 423, Pl. 40, fig. 109 only; not fig. 110 which is probably referable to *Cybeloides*), although too poorly preserved for positive identification, nevertheless matches that of *A. condylosa* fairly well. Approximately eleven axial rings are discernible; the anterior bands of the pleurae are equally broad, and the posterior bands end in long free points.

The Irish trilobite described by Reed (1899, p. 752, Pl. 49, fig. 8) as *Cybele sextuberculata*, though of uncertain generic position, has three pairs of glabellar tubercles generally similar to those of the Newfoundland species. It differs, however, in having very large eye-ridges and there are fewer and larger tubercles on the fixigenae. *C. tuberculata* was judged by Reed to come from Stage 2 of the Tramore Limestone Series of southeastern Ireland, and is therefore probably of Llandeilo age.

Family Komaspididae Kobayashi, 1935
Genus ***Carrickia*** Tripp, 1965

Type species. *Carrickia pelagia* Tripp, 1965.

Carrickia cf. *C. pelagia* Tripp

Plate 6, figure 11

Carrickia pelagia Tripp, 1965, p. 580, Pl. 81, figs. 17–21.
Carrickia pelagia Tripp, 1967, p. 44, Pl. 1, fig. 1.

Figured specimen. GSC 29125.

Description. A small, incomplete cranidium agrees with that of the holotype, as far as comparison is possible, and is also of similar size. Tripp's type material was from the Albany Mudstones, of Porterfield age, in the Girvan District, and the cranidia show the preglabellar field discontinuous in front of the glabella, so that the anterior border and frontal glabellar lobe are in juxtaposition, separated by a deep, narrow (sag.) furrow. The same condition obtains in the specimen from Squid Cove, but two cranidia from the Stinchar Limestone of Girvan have a narrow (sag.) preglabellar field but were nevertheless considered by Tripp (1967, p. 44) to belong to *C. pelagia.*

Dimensions. Length of cranidium = 3.6 mm; breadth of glabella = 2.8 mm (estd.); length of glabella = 2.4 mm.

Family Remopleurididae Hawle and Corda, 1847
Genus *Remopleurides* Portlock, 1843

Type species. *Remopleurides colbii* Portlock, 1843.

Remopleurides sp.
Plate 3, figures 6, 9; Plate 5, figure 7

Figured specimens. GSC 29126 (Pl. 3, fig. 9), GSC 29127 (Pl. 3, fig. 6), GSC 29128 (Pl. 5, fig. 7).

Description. The most complete of the three specimens is a small cranidium which has the characteristic cranidial outline of the genus, with a parallel-sided glabellar tongue that is more than twice as broad as long, its frontal margin transversely straight. The occipital ring is approximately as broad (tr.) as the glabellar tongue. Palpebral lobes are well defined, narrow (tr.), widening a little posteriorly, and have a smooth surface contrasting markedly with that of the remainder of the cranidium which, except for the glabellar furrows, is covered with small, closely grouped tubercles of uniform size. Two pairs of equispaced glabellar furrows and traces of a third pair arch slightly forward from just inside the palpebral furrows, and then more strongly backward, ending in line to leave an unfurrowed median band occupying about one quarter the breadth of the cranidium. The narrow (exsag.) incised glabellar furrows are seen also on a slightly larger specimen (Pl. 3, fig. 9) which exhibits even more clearly the ornamentation of the cranidium.

The pygidium is only represented by part of the doublure, the inner margin of which forms a parabolic curve. Two pairs of broadly based pleural spines are visible, ending in slightly splayed acute points separated from each other by large, subtriangular notches, with a slightly larger median notch separating the spines of the hindmost pair.

Dimensions (mm).

	Cranidium			
GSC Number	Median length	Maximum breadth	Basal breadth of glabella	Breadth of glabellar tongue
29126	–	9.5*	–	4.7*
29127	3.8*	4.2*	1.8	1.8*

*Denotes estimated measurement.

Discussion. Some comparison of the Newfoundland pygidium may, perhaps, be made with that of *Remopleurides biaculeatus* Tripp (1954, p. 664), from the Craighead Mudstones of supposed higher Caradoc age in the Girvan District of Scotland; but this species has the glabellar surface more finely granulated, the glabellar tongue is relatively shorter and smaller, and there is a small median tubercle on the anterior portion of the occipital ring.

In the Appalachians of Virginia several species of *Remopleurides* were described by Whittington (1959) and of these only *R. caelatus* Whittington (1959, p. 401) has a pygidium approaching that of the present species. The pygidium of *R. caelatus* has the pleural spines more longitudinal in direction, separated by smaller notches, and ending more nearly in line. The cranidium of *R. caelatus* is even more distinct, with tubercles only on the marginal portions of the median body of the glabella and occipital ring; the glabellar furrows are scarcely visible on the outer surface of the test.

Remopleurides tuberculatus Reed (1899, p. 748, Pl. 49, fig. 5) from the Tramore Limestone Series of southeastern Ireland, although in need of modern revision, shows a marked resemblance to *Remopleurides* sp., particularly in the type of ornamentation, but apparently has only two pairs of glabellar furrows and the pygidium is unknown.

Family Otarionidae R. and E. Richter, 1926

Genus ***Otarion*** Zenker, 1833

Type species. *Otarion diffractum* Zenker, 1833.

Otarion sp.
Plate 6, figure 9

Figured specimen. GSC 29129.

A very small cranidium with frontal breadth 2.0 mm, although incomplete, is figured here as the only representative of the genus in the Squid Cove faunule. The glabella has straight sides slightly convergent forward, and the frontal glabellar lobe is broadly rounded in plan. The characteristic 1p glabellar lobes are not preserved but traces remain of the 1p glabellar furrows. The anterior halves of the fixigenae merge with the long (sag.) preglabellar field which is separated from the low, flattened anterior border by a broad (sag.), shallow, indistinct anterior border furrow. The whole of the test, excluding furrows, is covered with closely grouped small tubercles.

Family Styginidae Vogdes, 1890

Genus ***Raymondaspis*** Přibyl, 1949

Type species. *Holometopus limbatus* Angelin, 1854.

Raymondaspis arcuata sp. nov.
Plate 6, figures 1–3, 7, 10

Diagnosis. Raymondaspis with glabellar outline broadly rounded frontally. Transversely straight occipital furrow, in front of which upper surface of glabella is strongly convex, giving effect of transverse ridge. Eyes opposite hindmost part of glabella and short distance outside axial furrows. Pygidium subsemicircular with tapered axis just over half its length. Axis has one distinct axial ring and traces of two more; tip of axis continuous with postaxial ridge that does not attain margin. Pleural fields are moderately arched down to margin and carry one pair pleural furrows.

Holotype. GSC 29150 (Pl. 6, fig. 1).

Paratypes. GSC 29147 (Pl. 6, figs. 7, 10), GSC 29148 (Pl. 6, fig. 2), GSC 29149 (Pl. 6, fig. 3).

Description. The exoskeleton is known only from the cranidium and pygidium. The cranidium is transversely convex and strongly arched down frontally, its median length about five eighths of the basal breadth. The posterior one third to one half of the glabella is parallel sided, but the outline expands forward to one and a half times the basal breadth. The front of the glabella is only slightly convex forward in plan, broadly rounded, and meets the sides at rounded right-angles. One paratype (Pl. 6, fig. 2) shows clearly the low, narrow (sag.) rim-like anterior border, a structure less clearly discernible on the remaining cranidia. There are no glabellar furrows, and the glabella and occipital ring are separated by a transversely straight occipital furrow which becomes shallower abaxially and appears deepest medially, where it truncates the swollen, hindmost portion of the glabella (*see* Pl. 6, figs. 7, 10). The axial furrows are deep, narrow and parallel posteriorly, but become broader and shallower as they diverge frontally. The occipital ring is parallel sided for most of its length (tr.) but narrows (exsag.) abaxially and curves forward slightly to form a pair of poorly defined occipital lobes. The palpebral lobes are semicircular in plan, situated only a short distance outside the axial furrows, equal to less than one quarter of the basal breadth of the glabella. The anterior branches of the facial suture diverge forward subparallel to the sides of the glabella, and the anterior halves of the fixigenae so delimited broaden (tr.) only a little anteriorly. Opposite the anterolateral extremities of the glabella the anterior branches of the facial suture curve inward through more than a right-angle and meet frontally in a broad, unbroken arc. The posterior branches of the facial suture run outward and slightly backward from the eyes, are almost straight for the most of their length (tr.), and then curve back to cut the cephalic margin. The posterior halves of the fixigenae are transversely elongated, triangular in plan, and show no sign of a posterior border furrow. The largest cranidium (Pl. 6, fig. 10), although mainly exfoliated, shows traces of a surface ornamentation of raised anastomosing ridges; those on the occipital ring are arranged subparallel to the occipital furrow, but those on the glabella appear to have exhibited a Bertillon pattern, though the evidence is incomplete.

The hypostoma, librigenae, and thorax are unknown.

A large, almost complete pygidium has a frontal breadth twice the median length, is almost semicircular in outline, and its gently convex surface is moderately declined both posteriorly and laterally. The axis has a frontal breadth slightly more than a quarter of that of the pygidium, its length is two thirds that of the pygidium, and its straight sides converge posteriorly at thirty-five degrees. The axis ends in a bluntly pointed tip merging with a postaxial ridge that narrows posteriorly and dies out just over halfway to the posterior margin. In addition to the small articulating half-ring the axis carries a single clearly defined axial ring and there are faint traces of two more ring furrows. Anterolaterally the pygidium exhibits a pair of conspicuous facets, behind each of which is a pair of pleural furrows that are deep at the fulcrum but become fainter both adaxially and toward the margin. The pleural fields are otherwise smooth, arch down abaxially, and coalesce behind the postaxial ridge.

Dimensions (mm).

	Cranidium					Pygidium			
GSC Number	Basal breadth	Median length	Basal breadth of glabella	Frontal breadth of axis	Distance between palpebral lobes	Maximum breadth	Median length	Frontal breadth of axis	Length of axis
29147	10.0*	7.0	3.5	5.7*	7.6*	–	–	–	–
29148	7.6*	7.3	3.8	5.8	8.0*	–	–	–	–
29149	–	–	1.5	2.4	–	–	–	–	–
29150	–	–	–	–	–	11.2*	5.0	2.8	2.9

*Denotes estimated measurement.

Discussion. Whittington (1950, p. 549, Pl. 72, figs. 11–14) described and illustrated two pygidia from the type locality of *Raymondaspis limbata* (Angelin) which he believed to belong to that species. Recently Poulsen (1969) redescribed Angelin's original type material and excluded from the species the specimens figured by Whittington, though he confirmed identifications of *R. limbata* made by Skjeseth (1955, p. 21, Pl. 4, figs. 2, 4–9; Pl. 5, figs. 6, 8) from Norway. The cranidium of *R. limbata* is distinguished from that of the new species by its longer anterior border and larger, wider fixigenae, and the pygidium has a shorter, narrower axis and a concave border. According to Poulsen and Skjeseth *Raymondaspis limbata* occurs in the Billingen Substage of Sweden and lower Didymograptus Zone of Norway, and is thus considerably older than *R. arcuata.* Poulsen (1969, p. 414) stressed the importance of the concave border as a distinctive feature of *R. limbata* and claimed that Whittington's figured pygidia (*see* above) must represent a new species because of their convex border. The new species shares a convex border not only with Whittington's pygidia but also with the stratigraphically older *Raymondaspis brevicauda* Tjernvik (1956, p. 262, Pl. 10, fig. 18), a shorter form with smaller axis from the Lower Arenig of Sweden, as well as *R. nitens* (Wiman) (*see* Skjeseth, 1955, p. 22, Pl. 4, figs. 1, 3), from the Ampyx Limestone and Lower Chasmops Limestone (lower Caradoc Series) of Norway and Sweden, a species in which the pygidium is relatively longer with a less tapered, better segmented axis and a stronger postaxial ridge.

Bronteopsis gregaria Raymond (*see* Cooper, 1953, p. 24, Pl. 9, figs. 1–7, 12–16) and *B. brumleyi* Cooper (1953, p. 25, Pl. 9, figs. 8–10), both from the Porterfield Stage of Virginia, lack furrowed pleural regions and glabellar furrows of the type found in *Bronteopsis* and are perhaps better placed in *Raymondaspis.* The glabella of *B. gregaria* is narrower posteriorly than that of the new species and the anterior halves of the fixigenae carry a well-defined border furrow continued from the librigenae. The cranidium of *B. brumleyi* is ornamented like that of the original of Plate 6, figure 10 and the occipital ring has a similar median tubercle, but the glabella is narrower posteriorly and the fixigenae are broader.

Genus *Bronteopsis* Nicholson and Etheridge, 1879

Type species. As employed originally the type species is *Bronteopsis scotica* Nicholson and Etheridge (1879, p. 167) by monotypy, and this was accepted by Whittington (1950, p. 544) in providing a new description and placing the genus in the Family Scutellidae. More recently Skjeseth (1955, p. 15) claimed *B. scotica* as a synonym of *Ogygia*? *concentrica* Linnarsson, 1869, and the latter was judged type species by Whittington (*in* Moore, 1959, p. O 366) who accepted also Skjeseth's reassignment of *Bronteopsis* to the Family Styginidae.

Bronteopsis sp.
Plate 5, figure 9

Figured specimen. GSC 29146.

Description. A single fragmentary pygidium preserved as an external mould is figured here in the form of a latex cast. The anterior margin is almost transversely straight, running backward slightly to the articulating facets (not preserved) and the remainder of the outline is broadly rounded, with a median length judged to be almost two thirds of the maximum breadth. The apparently straight-sided, gently tapered axis occupies three fifths of the median length of the pygidium and stands well above the low, gently convex side lobes, from which it is separated by shallow axial furrows. The subrounded axial tip is sharply defined and there is a suggestion of a low postaxial ridge. The remaining side lobe shows a narrow (exsag.) well-defined anterior half-rib, followed by six, or possibly seven, flattened pleural ribs, separated from each other by broad (exsag.), shallow pleural furrows that curve backward abaxially and become still shallower toward the pygidial margin, which they scarcely attain. The pleural ribs thus become slightly broader toward the margin. There is a suggestion of a broad, gently concave border.

Dimensions. Length of pygidium = 10.2 mm (estd.); breadth of pygidium = 16 mm (estd.).

Discussion. The pygidium illustrated, although incomplete, shows sufficient features to warrant its assignment to *Bronteopsis*. The pygidium of the type species, *B. concentrica* (Linnarsson, 1869), illustrated by Skjeseth (1955, Pl. 5, figs. 2, 3, 5), is of similar form but relatively shorter and although the number of pleural ribs is comparable, the axis is both notably shorter and less well segmented. *B. concentrica* is recorded from Norway, Sweden, and Scotland in strata probably a little younger than those yielding the Newfoundland species. *Bronteopsis holtedahli* Skjeseth (1955, p. 17, Pl. 5, figs. 4, 7), from the lowest Ogygiocaris Shale (4aα) of Mjøsa, Norway, though approximately contemporaneous with *Bronteopsis* sp., has a relatively shorter pygidium, the axis is slightly longer with a more pointed tip, and six pairs of pleural ribs which curve backward less strongly.

Family Lichidae Hawle and Corda, 1847
Genus *Amphilichas* Raymond, 1905

Type species. *Platymetopus lineatus* Angelin, 1854.

Amphilichas sp.
Plate 6, figures 4, 6

Figured specimens. GSC 29116 (Pl. 6, fig. 4), GSC 29117 (Pl. 6, fig. 6).

Lichid remains are few in the present sample and comprise only part of a cranidium and an incomplete right librigena, though occasional fragments of exoskeleton occur bearing the characteristic ornamentation of tubercles of various sizes.

The portion of a cranidium now illustrated shows most of the left lateral glabellar lobe and part of the central lobe separated by a well-defined longitudinal furrow. The lateral lobe broadens anteriorly, accompanied by abaxial flexing of the axial furrow and there is a suggestion of part of the left palpebral lobe level with the point of flexure of the axial furrow. The posterior half of the left fixigena is small, triangular, bounded by a transversely straight posterior border furrow and a posterior border that broadens (exsag.) abaxially. The type species *Amphilichas lineatus* (Angelin), from the Boda Limestone, Ashgill Series, of Dalarne was redescribed by Warburg (1925, p. 326, Pl. 8, figs. 39, 40; 1939, p. 140) whose illustrations show the longitudinal furrows of the glabella to be almost effaced posteriorly. However, other species included in the genus by Warburg and subsequent authors have the longitudinal furrows well developed backward to the occipital furrow; this is true also of the specimen from Newfoundland. The latter is inadequate for specific determination but the relative size of fixigena and lateral glabellar lobe, and more particularly the manner in which the longitudinal lobe expands anteriorly, accompanied by marked flexing of the axial furrow near the eye is reminiscent of *Amphilichas priscus* Tripp (1965, p. 598, Pl. 83, figs. 12–16) from the Albany Division of the Tappins Group near Girvan, Ayrshire.

The librigena shows part of a well-developed genal spine, the flattened surface of which is ornamented with closely set granules. There is no genal notch and the ventral surface exhibits numerous anastomosing terrace-lines. No useful specific comparison can be made.

Family Nileidae Angelin, 1854
Genus *Nileus* Dalman, 1827

Type species. *Asaphus* (*Nileus*) *armadillo* Dalman, 1827.

Nileus nesiotes sp. nov.

Plate 5, figures 1–5, 8

Diagnosis. *Nileus* with glabella subparallel sided as far as front of palpebral lobes, then widening sharply to well-rounded frontal lobe. Eyes extend forward level with centre of cranidium and backward almost to narrow (sag.) occipital ring. Hypostoma has semielliptical median body bounded by broad shallow furrows and divided into two unequal lobes, the posterior the smaller. Anterior portion of hypostoma narrow in front of pair of large, rounded posterior wings, the latter separated from small median projection by pair of rounded notches in posterior margin.

Holotype. GSC 29130 (Pl. 5, fig. 1).

Paratypes. GSC 29131 (Pl. 5, fig. 3), GSC 29132 (Pl. 5, fig. 8), GSC 29133 (Pl. 5, fig. 2), GSC 29134 (Pl. 5, fig. 5), GSC 29135 (Pl. 5, fig. 4).

Description. The species is known only from the cranidium and hypostoma. Glabella and occipital ring together have a median length almost one and a half times the median breadth. The glabella is straight sided, bounded on the internal mould by shallow traces of axial furrows which converge forward gently and separate the glabella from a pair of elongated, semielliptical palpebral lobes. The latter are set immediately in front of the occipital furrow and extend forward until opposite the midpoint of the glabella, and on the internal mould the palpebral furrows appear shallow posteriorly and die out anteriorly. Immediately in front of the palpebral lobes the outline of the cranidium has a markedly constricted appearance but the frontal lobe then expands and the anterior branches of the facial suture curve at first outward and then sharply inward to meet frontally in a smooth, well-rounded curve. The occipital furrow is shallow, broad (sag.), and transversely straight on the internal mould, delimiting a narrow (sag.) occipital ring that is set slightly lower than the glabella. A median glabellar tubercle is situated opposite the midpoints of the palpebral lobes. The posterior branch of the facial suture runs posterolaterally and cuts the posterior margin of the cephalon in a left librigena at about 45 degrees (Pl. 5, fig. 8) so that the posterior half of the fixigena is very small. The same librigena exhibits a concave eye platform below the visual surface, and the genal angle is broadly rounded.

The hypostoma is large, with median length estimated at about two thirds the maximum breadth. The anterior margin is transversely straight and the median body semielliptical in plan, bounded laterally and posteriorly by a continuous broad, shallow furrow and divided into two lobes by a median furrow. The latter is almost obsolete at the sagittal line but deepens abaxially to form a pair of large, transverse, pit-like depressions. The semielliptical posterior lobe so delimited occupies about two fifths the length of the median body. Anterolaterally the median body merges with a pair of small, incompletely preserved, dorsally reflexed anterior wings. Approximately three quarters of the median length of the hypostoma is occupied by a pair of large, subrounded posterior wings which expand so that the line of maximum breadth is slightly behind centre of the hypostoma, after which the outline narrows more rapidly. At the sagittal line the posterior margin has a small pointed projection that extends backward very slightly beyond the posterior wings, from which it is separated by a pair of curved notches (*see* especially Pl. 5, fig. 5). The surface of the hypostoma is ornamented with numerous anastomosing terrace-lines arranged transverse to the sagittal line and crossing the furrows bounding the median body.

Dimensions (mm).

	Cranidium			Hypostoma			
GSC Number	Median length	Frontal breadth	Distance across palpebral lobes	Maximum breadth	Median length	Length of median body	Breadth of median body
29130	8.4	7.3	8.6*	–	–	–	–
29131	10.6*	7.9*	12.0*	–	–	–	–
29133	–	–	–	15.5*	10.5*	–	7.0*
29134	–	–	–	12.4*	7.5*	6.0*	6.4

*Denotes estimated measurement.

Discussion. The type material of *Nileus armadillo* (Dalman, 1827, p. 236, Pl. 4, fig. 3) is said to come from strata of probably upper Arenig age in Östergötland (Tjernvik, 1956, p. 208). Russian material assigned to the species was illustrated and described by Schmidt (1904, Pl. 8, figs. 12–18), whose figures of the cephalon showed a strong median ridge running forward along the glabella from the median tubercle, a shorter frontal glabellar lobe than that of *N. nesiotes*, proportionately longer eyes, and axial furrows that are deeper and more convergent forward as far as the front of the palpebral lobes. The glabellar outline of Schmidt's specimens does not agree with that of the restoration of *N. armadillo* given by Tjernvik (1956, Text-fig. 33A) and may perhaps be better compared with that of *Nileus orbiculatus* Tjernvik (1956, p. 210), of lower Arenig age in Sweden. The trilobite described by Moberg and Segerberg (1906, p. 93, Pl. 6, figs. 1–6) as *Nileus armadillo* has a relatively narrow glabella not unlike that of *N. nesiotes*, but the eyes and median tubercle are set farther forward and the posterior halves of the fixigenae are correspondingly longer. According to Tjernvik (1956, p. 208), Moberg and Segerberg's material is more correctly referred to *Nileus limbatus* Brøgger (1882, p. 62), of upper Tremadoc and lower Arenig age in both Sweden and the Oslo region of Norway. Also in the Oslo region, Størmer (1953, p. 58, 62, 72, 83, 90, 97, 103, 109, 122) recorded *Nileus armadillo* from the Ogygiocaris Shale (4aα_3) and the species was said to range upward into the succeeding Ampyx Limestone (4aβ). Such records imply an unusually extended vertical range and it is possible that other species may be represented, though no specimens have yet been illustrated.

In western Newfoundland three species of *Nileus* described originally from the Table Head Formation (of approximately lower Llanvirn age) by Billings (1865, p. 273–5) have been revised and refigured by Whittington (1963, 1965). Of these, *Nileus macrops* Billings (Whittington, 1965, p. 361) need hardly concern us here because of the distinctive, very large eyes and notably short frontal glabellar lobe of truncated appearance. *Nileus affinis* Billings (Whittington, 1963, p. 53; 1965, p. 358) has a relatively broader, shorter cranidium than *N. nesiotes*, with a shorter frontal glabellar lobe and larger eyes set proportionately farther forward. The cranidium of *Nileus scrutator* Billings (Whittington, 1965, p. 360) is perhaps most like that of the new species but may be distinguished by the following characteristics: the eyes are longer; the frontal margin of the cranidium is less convex forward; the anterior branches of the facial suture diverge forward from the eyes less sharply. The last-named feature is less apparent in one cranidium figured by Whittington (1965, Pl. 32, figs. 1, 3), but in this instance the glabella is relatively broader and the frontal margin transversely straighter.

The hypostoma of *Nileus armadillo* was described and illustrated by Lindström (1901, p. 62, Pl. 5, fig. 13) and that of *N. nesiotes* clearly has the same basic plan with the median body bounded by shallow longitudinal furrows, in contrast to that of *Nileus affinis* Billings (Whittington, 1965, p. 360, Pl. 31, figs. 1–6). However, the new species exhibits marked differences from *N. armadillo*—the posterior wings are shorter (exsag.), appear to project laterally to a greater degree, and the median body extends much farther forward, so that the foremost quarter of the hypostomal outline has a constricted appearance (*see* especially Pl. 5, fig. 2)—and these serve also to separate it from all other described species.

Genus *Symphysurus* Goldfuss, 1843

Type species. *Asaphus palpebrosus* Dalman, 1827.

Symphysurus sp.
Plate 7, figure 7

Figured specimen. GSC 29144.

Description. A single incomplete pygidium is moderately convex, about twice as broad as long, with posterior margin broadly semielliptical. The median half of the anterior margin is transversely straight, but the outer quarter, though broken, appears truncated anterolaterally in plan, being reflexed ventrally to form an articulating facet. The axis occupies just over half the pygidial length, has straight sides bounded by broad, shallow axial furrows that converge backward at about thirty-five degrees (estd.), and appears to end in a blunt tip. No distinct axial ring furrows are visible though the ornamentation, and traces of indentations suggest at least four axial rings. The pleural regions carry a single pair of broad (exsag.), shallow pleural furrows that run parallel to the articulating facets and die out before reaching the margin. The test of the pygidium is ornamented with a conspicuous pattern of thin, anastomosing ridges. These are arranged transversely on the pygidial axis, of which they cover the median third and much of the pleural region, and they may be traced across the axial furrows. Near the anterolateral margins the pattern curves forward slightly, and the ridges die out toward the posterior margin.

Dimensions. Maximum breadth = 21.0 mm (estd.); length = 10.0 mm (estd.); frontal breadth of axis = 5.2 mm (estd.); length of axis = 5.4 mm (estd.).

Family Illaenidae Hawle and Corda, 1847
Genus *Illaenus* Dalman, 1827

Type species. *Entomostracites crassicauda* Wahlenberg, 1821.

Illaenus sp.

Plate 5, figure 6; Plate 7, figures 6, 8–10

Figured specimens. GSC 29136 (Pl. 5, fig. 6), GSC 29138 (Pl. 7, fig. 10), GSC 29140 (Pl. 7, fig. 9), GSC 29141 (Pl. 7, fig. 8), GSC 29142 (Pl. 7, fig. 6).

A fragment of cranidium (Pl. 7, fig. 10) shows that the eyes were situated far back, just in front of the posterior margin of the cephalon and only a short distance outside the axial furrows. The latter are deep posteriorly, converging forward until level with the front of the eyes, at which point they flex abaxially, diverge forward slightly, and quickly die out. The remaining palpebral lobe is strongly convex in plan, with faint traces of a palpebral furrow. Similar axial furrows are seen on the cephalon of *Illaenus crassicauda* (Wahlenberg) (*see* Jaanusson, 1954, Pl. 1, figs. 1, 6) but in that species they begin to diverge at a point farther forward, the glabella is better defined, and the eyes are set much farther from the glabella. Traces of anastomosing ridges may be discerned on the Newfoundland cranidium, and fine punctae cover most of the surface.

A largely exfoliated left librigena (Pl. 7, fig. 9) lacks the visual surface of the eye, but the base of the latter is bounded by a suggestion of a broad eye platform, outside which the dorsal surface of the librigena is gently convex and steeply declined. The shape and position of the eye, set high above the lateral margin, may be compared with *Illaenus crassicauda* (*see* Jaanusson, 1954, Pl. 1, figs. 2, 4, 6), but the Newfoundland librigena is relatively longer (exsag.). An associated pygidium (Pl. 5, fig. 6), though resembling that described later as *Illaenus* (*Parillaenus*) sp., has a wider doublure and an apparently wider, less well-defined axis. It is referred merely to *Illaenus* sp.

Two small pygidia are unlike the large specimen described later in this paper as *I.* (*Parillaenus*) sp. and clearly belong to a different species. The larger example, GSC 29141 (Pl. 7, fig. 8), is about one and a half times as broad as long with small anterolateral facets, and the posterior and lateral margins form a broad, continuous curve. The axis is only faintly discernible as the axial furrows are almost obsolete, but it appears to be subtriangular in outline with a frontal breadth just over one third that of the pygidium. The specimen does not agree entirely with any described species but comparison may be made with the pygidium of *Illaenus crassicauda* (*see* Holm, 1882, Pl. 2, fig. 25; Jaanusson, 1954, Pl. 1, fig. 9), though the latter is slightly longer, its outline is more strongly curved, and the longer axis is better defined.

The smaller pygidium, GSC 29142 (Pl. 7, fig. 6), is proportionately shorter, the facets are more conspicuous, and the axis is smaller and relatively narrower. It may belong to the same species as GSC 29141 above, and could well represent a less mature individual. Only minor differences separate this specimen from the pygidium of *Illaenus transversus* Tripp (1967, p. 50, Pl. 1, figs. 37, 38) from the Upper Stinchar Limestone of the Girvan District; the latter has a similar ratio of length to breadth but the axis is slightly better defined and the outline forms a less convex curve.

Subgenus ***Parillaenus*** Jaanusson, 1954

Type species. *Illaenus fallax* Holm, 1882.

Introduced as '*Parillaenus*-Gruppen', the subgenus was described briefly by Jaanusson (1954, p. 574) and said to include a number of species, which were listed. All mention of the name was omitted from the *Treatise on Invertebrate Paleontology* (Moore, 1959) but it has been used subsequently by other authors.

Illaenus (*Parillaenus*) sp.
Plate 7, figures 1–5.

Figured specimens. GSC 29137 (Pl. 7, figs. 1, 3, 5), GSC 29139 (Pl. 7, fig. 2), GSC 29143 (Pl. 7, fig. 4).

A slightly compressed pygidium (Pl. 7, fig. 4) from Squid Cove has proportions similar to that of *Illaenus fallax* Holm (1882, Pl. 2, figs. 15–20) from the Chasmops Limestone (higher Caradoc Series) in Dalarne, Sweden. Jaanusson (1954, Text-fig. 10C) gave an outline drawing of the pygidial doublure of *I.* (*P.*) *fallax*, showing it to be almost uniformly broad with an evenly curved inner margin, this last a feature stated subsequently by Whittington (1966, p. 69) to be characteristic of the subgenus. Holm's original illustrations of the pygidium of the type species show the doublure widening (sag.) posteriorly, and this is particularly true of his Plate 2, figure 20, showing a specimen with a triangular axis like that of the present example and a doublure which shows also a shallow sulcus on its dorsal surface. Both widening and sulcus are found also on the Newfoundland pygidium.

A single rostral plate (Pl. 7, fig. 2) is wide, arched forward in plan and projects backward medially. Although Holm did not illustrate the rostral plate of *Illaenus fallax*, examples similar to that illustrated here have been referred to *I.* (*Parillaenus*), for example, by Whittington (1966, p. 67, Pl. 20, fig. 17) when describing *I.* (*P.*) *davisii* Salter from the Rhiwlas Limestone, Ashgill Series, of North Wales. The rostral plate of *I.* (*P.*) *davisii* shows only minor differences of outline from the present specimen and is ornamented with closer set terrace-lines. Also of similar outline is the rostral plate of *Illaenus roemeri* Volborth figured by Warburg (1925, Pl. 1, fig. 27) from the Boda Limestone, Ashgill Series, of Kallholn, Dalarne. This species was placed in *I.* (*Parillaenus*) by Jaanusson (1954, p. 574) and judging from Warburg's illustration has a rostral plate relatively shorter than the present specimen.

Only one incomplete cranidium (GSC 29137, Pl. 7, figs. 1, 3, 5) may possibly belong to *I.* (*Parillaenus*) but it is incomplete and the eyes are missing. However the relative length of the specimen is generally similar to that of *I. fallax* figured by Holm (1882, Pl. 2, figs. 11, 12), with deep, broad, almost straight axial furrows extending forward for about half the cephalic length.

Dimensions (*mm*).

GSC Number	Cranidium: Maximum breadth incl. palpebral lobes	Cranidium: Median length	Cranidium: Basal breadth of glabella	Pygidium: Maximum breadth	Pygidium: Median length	Pygidium: Frontal breadth of axis	Pygidium: Length of axis
			Illaenus sp.				
29141	–	–	–	9.6*	6.0*	3.6	–
29142	–	–	–	7.4*	3.0*	1.8	1.2*
			Illaenus (*Parillaenus*) sp.				
29137	–	11.8	11.2*	–	–	–	–
29143	–	–	–	15.0*	11.0	4.0	3.5

*Denotes estimated measurement.

Genus and Species undetermined
Plate 6, figures 5, 8

Figured specimens. GSC 29118 (Pl. 6, fig. 5), GSC 29145 (Pl. 6, fig. 8).

A left librigena preserved as an internal mould (Pl. 6, fig. 5) lacks most of the eye but shows traces of a narrow eye-platform, below which the cheek surface declines to a well-defined lateral border furrow that curves backward and inward to merge with the posterior border furrow. The flattened lateral border is strongly developed and almost uniformly broad except at the genal angle where it broadens to (presumably) form a librigenal spine (not preserved) and coalesce with the posterior border. The surface, excluding furrow, is covered with closely grouped tubercles of two sizes, those on the anterior half of the lateral border becoming slightly smaller. The ornamentation and shape are comparable with the librigena of *Otarion* but the course of the posterior branch of the facial suture is unclear and the anterior branch seems unduly divergent forward for that genus.

Part of an unusual pygidium is figured here as a latex cast (Pl. 6, fig. 8). The axis, though incomplete, is long and relatively narrow, and the straight sides taper gently to a narrow, almost pointed tip. Two axial rings, separated by transversely straight ring furrows, together occupy only one third of the length of the axis, the sides of which become less well defined posteriorly. It is not obvious whether the straight posterolateral margin is entire or a line of fracture: it may be a combination of both. What remains of the left pleural region is composed of two fused pleurae followed by an unfurrowed triangular area. Both pleurae widen (exsag.) slightly toward the margin and are delimited by well-defined interpleural furrows. Each pleura carries a pleural furrow which, at the axial furrow, is sited midway between the interpleural furrows but then curves slightly backward abaxially and dies out without attaining the margin; the pleura is thus divided into two bands, the anterior of which is much the larger. The broad (exsag.) pleurae and small segmented portion of the axis are features reminiscent of the Lichidae but the posterior half of the axis lacks the characteristic constricted outline. No satisfactory comparison has yet been made.

AGE AND AFFINITIES OF THE TRILOBITES

The evidence of age that can be adduced from the trilobites varies in its reliability and although some genera are of little stratigraphic value, others have a relatively restricted distribution. The agnostid *Trinodus* is not recorded from rocks older than Porterfield Stage in the Appalachian region, and occurs at about that horizon in the Albany Mudstones Division, as well as the probably slightly younger Balclatchie Group, of the Girvan District, Scotland. However, the genus appears to have had a long Ordovician history, having been recorded as early as Arenig Series in both Scandinavia and the Mediterranean region, and was widespread in European faunas of Ashgill age. Again, the raphiophorid *Ampyx*, although not recorded in eastern North America below the Porterfield Stage, was founded on a type species of Lower Ordovician age and is recorded from numerous areas and geological horizons, including the Arenig and, especially, Lower Llanvirn Series of the Welsh Borders. *Otarion*, a rare trilobite at Squid Cove, is a genus known also from the Arenig Series elsewhere in Europe, though it was not widespread until late Ordovician times and became more prolific and cosmopolitan only in the Silurian and Devonian.

The cheirurid *Sphaerexochus* is of little significance here, though the species present shows some resemblance to a Girvan species of Porterfield age (*see* earlier), and other more distinctive species occur in rocks of similar age at Girvan and in the Appalachians. Probably the oldest genuine *Sphaerexochus* is found in the Chazy Group of New York State but the genus was widely distributed in Europe and Scandinavia during Ashgill times and was cosmopolitan in the Silurian. *Remopleurides*, known first, probably, from the Table Head Group of lower Llanvirn age in western Newfoundland, is well represented in faunas of Porterfield age in the Appalachians and the Girvan District, but its vertical range extends upward into the Ashgill Series, at which level it is widespread in European faunas.

Pliomerella is a stratigraphically useful genus with a fairly restricted distribution, both horizontally and vertically, and is known elsewhere only from the Appalachian Valley of Virginia, the Girvan District of Scotland, where the shelly faunas are of Appalachian type, and the Tramore District of southeastern Ireland. In Virginia and Scotland the occurrences are of Porterfield age. The Irish species *Pliomerella pauper* (Salter) was described originally from 'Caradoc Slate' at 'Tramore', and until the faunas there have been revised it is impossible to say whether the species is from the Tramore Limestone Series (and therefore probably of Llandeilo age) or from the Raheen Shales, assigned to the *Nemagraptus gracilis* Zone, basal Caradoc Series. The komaspidid *Carrickia*, a compact genus that is never common, is known first from the Garden City Formation of Utah (Ross, 1951, Pl. 18, figs. 21, 23, 24) and the last-known species occurs in the Ashgill Series of eastern Ireland. The species are all very distinctive and the close resemblance of the Newfoundland form to one described from the Porterfield of Girvan may reasonably be taken as strong evidence of its age.

All the genera discussed so far may be found in both European and eastern North American strata, but in other instances the affinities are undoubtedly European and Scandinavian. Stratigraphically *Bergamia* is a significant genus and although the oldest-known species comes from the Arenig Series of the Shelve Inlier, the species showing most resemblance to the Newfoundland form was described from the Llandeilo strata of the Builth–Llandrindod Inlier of Wales, a series in which the genus occurs, probably, in the Oslo region (as *Bergamia*? *bucculenta*; *see* earlier). However, in both Wales and Norway *Bergamia* ranges upward into the basal Caradoc Series, and in the absence of a common species it is not possible to use it to distinguish between Llandeilo and lowest Caradoc. Elsewhere *Bergamia* is known from the Tramore district, Ireland as *B. hibernica* (Reed, 1895, p. 52). The systematic position of *Trinucleus forosi* Størmer (1932, p. 172) in the Trondheim area of Norway is in need of modern revision, and the species may be younger than the Arenig age assigned to it by Størmer.

Further indications of Norwegian or Baltic affinities in the Newfoundland faunule are furnished by the genus *Nileus*. A few species have been described from the Table Head Formation (lower Llanvirn Series) of western Newfoundland, where they are members of faunas which, although not yet fully documented, are known now to extend around the cratonic margin into northwestern parts of North America. However, the Squid Cove *Nileus* seems rather to be allied to Scandinavian–Baltic members of the genus, such as *N. armadillo* (Dalman), which have been recorded from supposedly Arenig faunas in western Ireland (Reed, 1910, p. 273) and as far eastward as Yunnan in rocks of lower Llanvirn age (Reed, 1917, p. 49), but which figure commonly in records from Llandeilo, and to a lesser extent early Caradoc, strata in Norway (Størmer, 1953). The figured pygidium of *Symphysurus* also emphasizes the Balto–Scandinavian aspect of the described faunule, though the genus had an extended range there and too much significance should not be attached to a single specimen. The styginid *Raymondaspis* is particularly widespread in the Middle Ordovician of southern Norway where it occurs at a variety of horizons. It is also well documented from Porterfield strata at Girvan, and *Bronteopsis* occurs at the same horizon at Girvan as well as in corresponding strata in the Appalachian region.

The evidence of the encrinurid *Atractopyge* is difficult to assess in the absence of specific identity. The genus is known first from the Llandeilo Series of Wales, the Welsh Borders, and Norway, and several species have been described from Porterfield strata near Girvan. So far as is known, the new species represents the westernmost occurrence of the genus, which is otherwise unrecorded from North America. *Atractopyge* became more abundant in the late Caradoc and Ashgill Series of Britain, but did not survive into the Silurian. A few species have been described from the Baltic region (for revision, *see* Männil, 1958), but all are slightly younger than the Newfoundland example.

It became apparent at an early stage of the present work that the age of the Squid Cove faunule was likely to prove to be approximately Llandeilo Series or earliest Caradoc Series in terms of British and Norwegian stratigraphic usage, though there were obvious affinities with Appalachian faunas assigned to the Porterfield 'Stage'. Consequently the list of genera present was compared with those from a number of approximately analogous horizons in different regions (*see* Table I), using as basis for comparison the Index of Faunal Resemblance, a relatively simple but effective technique introduced by Simpson (1962) and employed subsequently for trilobite faunas by Whittington (1968, p. 118). The Index of Faunal Resemblance (I) is given by the equation $I = \frac{C}{N} \times 100$, where C = number of taxa common to both samples, and N = total taxa in the smaller sample. The results are shown in Table I and it will be seen at once that the Index of Faunal Resemblance for areas in Wales and the Welsh Borders is very small, so that columns one to three are included merely to emphasize the lack of common genera.

The Squid Cove trilobites show strongest faunal resemblance to those from the Albany Division of the Tappins Group in the Girvan District, but the affinity with those of the Ogygiocaris Shale and Bronni Beds of the Oslo region, Norway, would be equally strong if the

TABLE I | *Comparison of the Squid cove trilobites with those of other regions, using Simpson's Index of Faunal Resemblance*

Trilobite Genera found at Squid Cove		Llandeilo Series, type area, South Wales	Meadowtown Beds (Llandeilo Series), Shelve Inlier	Upper Llandeilo Series, Berwyn Hills, North Wales	Upper half of Ogygiocaris Series ($4a\alpha_3$ and α_4), Oslo region, Norway	Ampyx Limestone ($4a\beta$), Oslo region, Norway	Tramore Limestone Series, southeastern Ireland	Upper Stinchar Limestone, Girvan District, Scotland	Albany Division of Tappins Group, Girvan District, Scotland	Confinis Flags, Girvan District, Scotland	Lincolnshire Limestone, Appalachian Valley, Virginia	Edinburg Formation, Appalachian Valley, Virginia	Chazy Group, type area, New York State
		1	2	3	4	5	6	7	8	9	10	11	12
Amphilichas		–	–	–	–	–	x	x	x	x	x	–	x
Ampyx		–	–	–	x	x	x	–	x	x	–	x	–
Atractopyge		x	x	x	x	x	x	–	–	–	–	–	–
Bergamia		–	–	–	?	x	x	–	–	–	–	–	–
Bronteopsis		–	–	–	x	x	–	–	–	–	–	–	–
Carrickia		–	–	–	–	–	–	x	x	–	–	–	x
Illaenus		–	–	–	–	–	x	x	x	x	–	–	–
Nileus		–	–	–	x	x	–	–	x	–	–	–	–
Otarion		–	–	–	–	–	–	x	x	x	–	–	x
Pliomerella		–	–	–	–	–	x	x	–	–	–	x	–
Raymondaspis		–	–	–	–	x	–	x	x	x	–	x	–
Remopleurides		–	–	–	x	x	x	x	x	x	x	x	x
Sphaerexochus		–	–	–	–	–	x	x	x	x	x	x	–
Symphysurus		–	–	–	–	–	–	–	–	–	–	–	–
Trinodus		–	–	–	–	–	x	–	x	–	–	x	–
Total genera in deposit	15	9	16	11	9	12	23	29	25	26	12	26	33
Index of Faunal Resemblance	—	11	7	9	56	58	60	53	67	47	25	40	27

The data shown in the numbered districts were obtained from the following publications: 1. Williams, A., 1953; 2. Whittard, 1966; 3. MacGregor, 1963; 4. Nikolaisen, 1961; Skjeseth, 1955, Størmer, 1953; 5. Størmer, 1953; 6. Reed, 1899 (no revision of the Tramore Limestone trilobites has yet been published, and the data used here represent the writer's attempt to bring Reed's nomenclature up to date); 7. Tripp, 1967; 8. Tripp, 1965; 9. Tripp, 1962; 10. Cooper, B. N., 1953, Whittington, 1959 (includes compilation of faunal lists based on previous publications); 11. Cooper, B. N., 1953; Whittington, 1959; 12. Shaw, 1968. The data for the Index of Faunal Resemblance do not include doubtful genera.

now provisional generic assignment of *Bergamia*? *bucculenta* should prove correct. A slightly lower resemblance to the Tramore Limestone fauna of Ireland and Ampyx Limestone of Norway is also indicated. The Albany Division was described first and equated with the Upper Stinchar Limestone by Williams (1962, p. 45–47) who assigned the contained brachiopods to the Porterfield Stage because of their close relationship with faunas from the southern Appalachians. Subsequently Tripp (1965) described the Albany trilobites, the relationships of which amply confirmed Williams' findings. On the basis of their Appalachian elements, therefore, the Squid Cove trilobites are most likely of Porterfield age. On the other hand certain genera are of British and Scandinavian type and the Index of Faunal Resemblance favours a Llandeilo rather than an early Caradoc horizon by analogy with the Norwegian succession, and one must attempt to relate the two lines of evidence.

The Porterfield Stage was proposed by G. A. Cooper (1956, p. 8), with type locality at and in the vicinity of Porterfield Quarry, near Saltville, Virginia. It was said by Cooper to be "characterized by the prolific and exotic fauna that floods into the Appalachians and blots out and absorbs the Lincolnshire [Limestone] fauna". In lithologic terms it was stated to occupy most of the Edinburg Formation of the Appalachians. The latter term had been introduced earlier by B. N. Cooper and G. A. Cooper (1946, p. 78) "for the stratigraphic interval above the Lincolnshire limestone and below the *Reuschella* '*edsoni*' zone in the Shenandoah Valley". The Edinburg was stated to comprise two principal facies—Liberty Hall (black limestones and shales) and Lantz Mills (cobbly to nodular limestones)—with the qualification that beds of similar lithology need not necessarily be of exactly the same age. In some areas of the Shenandoah Valley Cooper and Cooper (1946, p. 80, 84, 85) recorded *Nemagraptus* from the lower portion of the Edinburg Formation immediately above its basal Botetourt Member, when the latter was developed, but from the basal Edinburg elsewhere in the region (op. cit. 1946, p. 91). Thus, provided that the presence of *Nemagraptus* is held to be indicative of the *Nemagraptus gracilis* Zone, the lowest graptolite zone of the Caradoc Series, then the Porterfield Stage, occupying as it does, by definition, "most of the Edinburg Formation", must be interpreted in its type area as extending downward no farther than the lowest limit of *Nemagraptus*, i.e., the lower boundary of the Caradoc Series, coincident with the base of the *Nemagraptus gracilis* Zone. This was the course followed by Berry (1960, Text-fig. 3; Table II).

If this is so then at New World Island there is an apparently anomalous situation in which trilobites of Porterfield type, and hence supposedly lowest Caradoc in age, are intermingled with others whose closest affinities lie with the Ogygiocaris Shale (Etage 4aα_3) and Bronni Beds (Etage 4aα_4) of southern Norway—strata which were together equated with the Llandeilo Series by Størmer (1953, p. 130), though Berry (1964, p. 79) has since moved the lower boundary of the Ogygiocaris Shale downward slightly to include the uppermost *Didymograptus murchisoni* Zone. The limestone containing the trilobites at Squid Cove has been examined for conodonts by Dr. T. T. Uyeno, whose report is appended (*see* Appendix I). His determinations show that the conodont fauna is of Swedish type and can be equated with that from the Crassicauda Limestone of Sweden which is Llandeilo in age, confirming the correlation with the Ogygiocaris Shale and Bronni Beds of the Oslo region suggested by the trilobites. Thus at Squid Cove is an admixture of trilobites of Porterfield age and Appalachian affinities, trilobites of Llandeilo age and Norwegian affinities, and conodonts of Llandeilo age and Swedish type, and a number of explanations are possible to reconcile the evidence of these assemblages: (a) the Porterfield trilobites appeared in central Newfoundland slightly earlier than in the southern Appalachians; (b) *Nemagraptus* may appear slightly earlier than the base of the *Nemagraptus gracilis* Zone in the Appalachians; (c) the Porterfield trilobites have a longer vertical range than was previously thought; (d) the lower limit of the Porterfield Stage must be extended downward to include part of the higher Llandeilo Series in addition to the lowest Caradoc Series.

No evidence for or against (a) is yet available. Likewise there is no evidence as yet for (b) in the Appalachian region, though in Scania, Sweden, Hede (1951, p. 73, Table IV) has recorded *Nemagraptus subtilis* Hadding throughout the Llandeilo Series, in a succession where *N. gracilis* is present to indicate the base of the Caradoc. There is no firm evidence for (c) but it must be remembered that we are dealing in part with a graptolite zone (of *N. gracilis*) which not only is cosmopolitan in distribution but also coincides with an unconformity of regional dimensions in some parts of the world (including the type area of the Caradoc Series), so that in theory the vertical distribution and migration of faunas may have been affected.

Support for explanation (d) is afforded by Sweet and Bergström's (1962) discovery of conodonts of Swedish type, analogous to the fauna from the Crassicauda Limestone and equivalent Swedish shales of Upper Llandeilo age, in the Pratt Ferry Formation, in the southern Appalachians of Alabama. The term 'Pratt Ferry' was proposed by B. N. Cooper and G. A. Cooper (*in* G. A. Cooper, 1956, p. 85) and described as comprising bituminous calcarenites overlain by black shale with *Nemagraptus* and underlain by grey limestone containing the '*Christiania* fauna' of the Little Oak Formation of Alabama (Cooper, 1956, p. 74). All these limestones were placed by Cooper in the lowest part of the Porterfield Stage. According to Helwig (*in* Kay, 1969, p. 567) some of the shales with *Nemagraptus* at Lawrence Harbour, Bay of Exploits, northeastern Newfoundland and west of New World Island, from which Decker (1952, p. 95) had earlier listed graptolites that included *N. gracilis*, may belong to the upper Llandeilo. The trilobites from Squid Cove probably occupy a similar stratigraphic position and lend support to suggestions, e.g., Kay, 1969, Table I, that the lowest Porterfield Stage belongs to the Llandeilo Series.

In northeastern Maine Whittington (1964, p. 25–34) described trilobites from volcanic rocks of the Shin Brook Formation and assigned them to the Whiterock Stage, of approximately lower Llanvirn age. The Shin Brook fauna includes *Ampyx*, *Illaenus* (s.l.), *Nileus* and *Raymondaspis*, all of which occur also at Squid Cove, but the associated genera, including *Annamitella*?, have not been found there. Neuman (*in* Zen, *et al.*, 1968, p. 37) recorded *Annamitella*? and a harpid in association with brachiopods said to be of "Arenig to Llandeilo" age from Village Cove, at the southwestern end of New World Island. This faunule occurs in map-unit 4 of Williams (1963) and is thus presumably older than the Squid Cove material. Whether or not it may be correlated with the Whiterock trilobites from Shin Brook is not yet apparent, but such a correlation would agree generally with the Llandeilo age of the Squid Cove trilobites. Elsewhere in New World Island a Caradoc age was assigned by Neuman (*in* Zen, *et al.*, 1968, p. 41) to two brachiopod faunas from unnamed formations at Cobbs Arm and Intricate Harbour. Their relationship to the Squid Cove trilobites is not yet known.

Fauna of the Black Argillites

Graptolites collected by the writer from the youngest exposed portion of the succession of black slates and argillites at the eastern end of Squid Cove (GSC loc. 86163), together with a collection obtained earlier by H. Williams (GSC loc. 52294), have been examined by Dr. P. Toghill of the British Museum (Natural History), London who has kindly submitted the following faunal list and remarks:

"List of graptolites present: cf. *Amplexograptus arctus* Elles and Wood, *Climacograptus brevis* Elles and Wood, ?*Climacograptus caudatus* Lapworth, *Climacograptus*? sp., *Crypto-*

graptus? sp., *Dicellograptus* sp. nov. aff. *caduceus* Lapworth, *D. forchammeri* (Geinitz), *Orthograptus calcaratus* (Lapworth) sensu lato, *O. calcaratus* cf. *basilicus* Elles and Wood, *O. truncatus* (Lapworth) sensu lato, *O. truncatus intermedius* Elles and Wood.

Comments on age: I would place this fauna about the position of the boundary between the Peltifer Zone and Wilsoni Zone of the Caradoc Series in the Southern Uplands of Scotland, that is to say in what would be called Multidens Zone in the Welsh Borders. It is somewhat confusing, however, as it contains *Climacograptus caudatus* and a *Dicellograptus* approaching *D. caduceus* which, on their own, could be held to suggest the Clingani Zone, but the latter form is certainly a new species and the former may range lower than we know at present. On the other hand *Amplexograptus*, *Climacograptus brevis*, and *Cryptograptus* do not usually occur later than the Peltifer Zone. The similarity between these samples and the Glenkiln Shales is too good not to mention, and they would be very much at home in the Peltifer Zone of Dobbs Linn."

Dr. Toghill's remarks on the close resemblance of the Squid Cove graptolites to assemblages at Dobbs Linn, in the Moffat District at the eastern end of the Southern Uplands of Scotland, are of particular interest because of the affinities of the trilobites described in this paper with faunas from the Girvan District, at the western end of the Southern Uplands. No evidence for the Gracilis Zone has yet been found at Squid Cove and it is not known whether this is the result of collection failure in both tuffs and argillites or whether the latter are disconformable on the former.

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APPENDIX I

Conodonts from GSC loc. 85524, Squid Cove, New World Island
by T. T. Uyeno, Geological Survey of Canada, Calgary

List of genera and species: Acontiodus spp., *Drepanodus homocurvatus* Lindström, *Falodus prodentatus* (Graves and Ellison), *Haddingodus serra* (Hadding), *Oistodus venustus* Stauffer, *Panderodus gracilis* (Branson and Mehl), *Paracordylodus* n. sp. 2 of Lindström (1960), *Periodon aculeatus* Hadding, *Prioniodina macrodentata* (Graves and Ellison), *Pygodus anserinus* Lamont and Lindström, *Roundya pyramidalis* Sweet and Bergström, *Scandodus* spp., *Scolopodus* spp., *Tetraprioniodus lindstroemi* Sweet and Bergström, *T.* cf. *T. asymmetricus* Bergström.

Weight of sample: 2,950 gm.

Age of faunule: The faunule is of European–Scandinavian aspect and is also very similar to that of the Pratt Ferry Formation of Alabama, which is well dated by means of megafossils as early Porterfield Stage (Sweet and Bergström, 1962). As with the Pratt Ferry faunule, the Newfoundland conodonts may be correlated with Lindström's (1960) fauna VI: 2(B) from the upper part of the Crassicauda Limestone of the Isle of Öland, Sweden. The latter conodonts occur in the *Climacograptus haddingi* Subzone, the upper part of the *Glyptograptus teretiusculus* Zone, and thus belong to the upper Llandeilo Series. Viira (1967) reported the same faunule from the Uhaku Stage (with *Tetraprioniodus lindstroemi* occurring in the lower part of the stage) in the Ohesaare core on the Island of Saaremaa, Estonia.

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PLATES 1 to 7

Plate 1

	Trinodus cf. *T. doulargensis* Tripp	Page 3
Figure 1.	Internal mould of cranidium. GSC 29091. x9.5.	
Figure 2.	Internal mould of pygidium. GSC 29092. x9.	
	Ampyx sp.	Page 3
Figure 3.	Internal mould of incomplete cranidium. GSC 29094. x5.	
Figure 5.	Internal mould of large pygidium. GSC 29093. x4.	
Figure 6.	Internal mould of fragmentary pygidium. GSC 29095. x10.	
	Bergamia sp. nov.	Page 5
Figure 4.	Latex cast showing part of cranidium, including posterior border with impression of doublure. GSC 29096. x8.	
Figure 7.	Internal mould of large pygidium. GSC 29109. x3.5.	
Figure 8.	Ventral side of incomplete cephalon with part of ventral lamella of fringe and right librigenal spine. GSC 29105. x5.5.	
Figure 9.	Part of right side of cranidium showing radial sulci of fringe. GSC 29103. x6.	

PLATE 1

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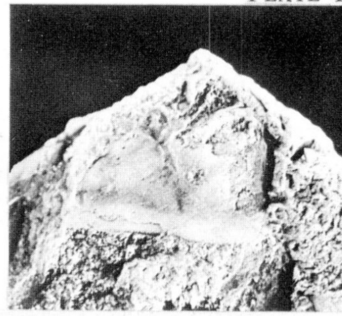

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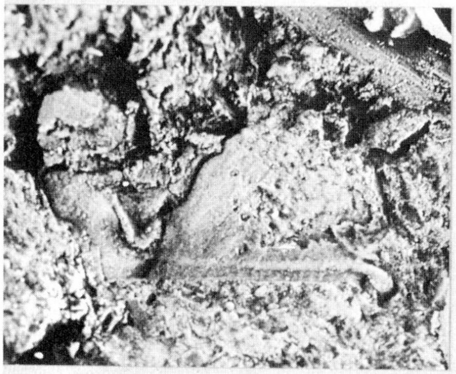

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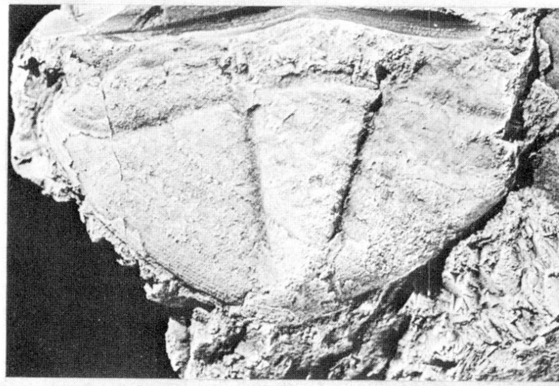

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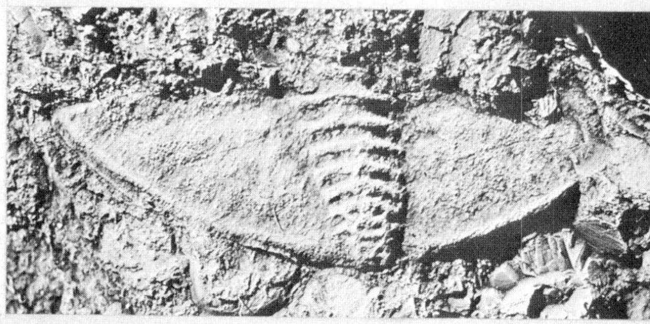

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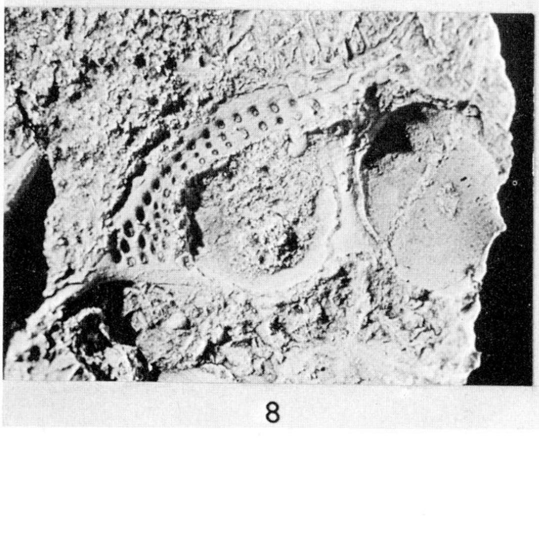

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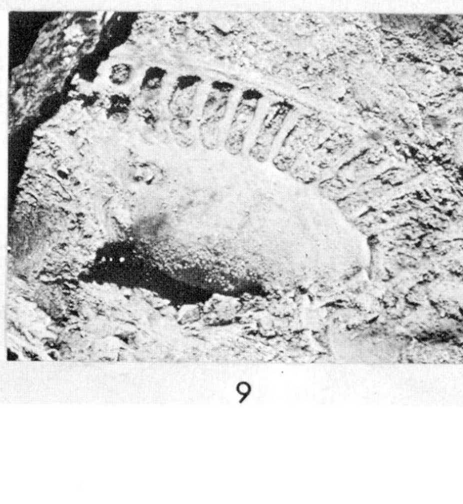

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Plate 2

Bergamia sp. nov. — Page 5

Figure 1.	Part of ventral lamella of fringe near left genal angle, showing girder and twinned E pits. GSC 29106. x6.
Figure 2.	Fragment of ventral fringe lamella with left librigenal spine, girder, and both E and I pit arcs. GSC 29157. x7.
Figure 3.	Latex cast of incomplete cephalon. GSC 29097. x5.
Figure 4.	Internal mould of small distorted pygidium. GSC 29110. x5.
Figure 5.	Internal mould of right half of cephalic fringe. GSC 29102. x5.
Figure 6.	Right genal angle showing radial sulci and marginal suture. GSC 29104. x6.
Figure 7.	Fragment of ventral side of fringe, with pits of E arcs set in radial sulci. GSC 29107. x7.
Figure 8.	Part of dorsal fringe surface. Note that all the pits are set in radial sulci. GSC 29100. x5.
Figure 9.	Fragment of ventral side of fringe. Some E pits are set in radial sulci; other pits (right side of photo) are large and probably twinned. GSC 29108. x7.
Figure 10.	Internal mould of damaged glabella and right cheek-lobe. GSC 29098. x5.
Figure 11.	Left cheek-lobe with part of fringe and left librigenal spine. GSC 29099. x5.

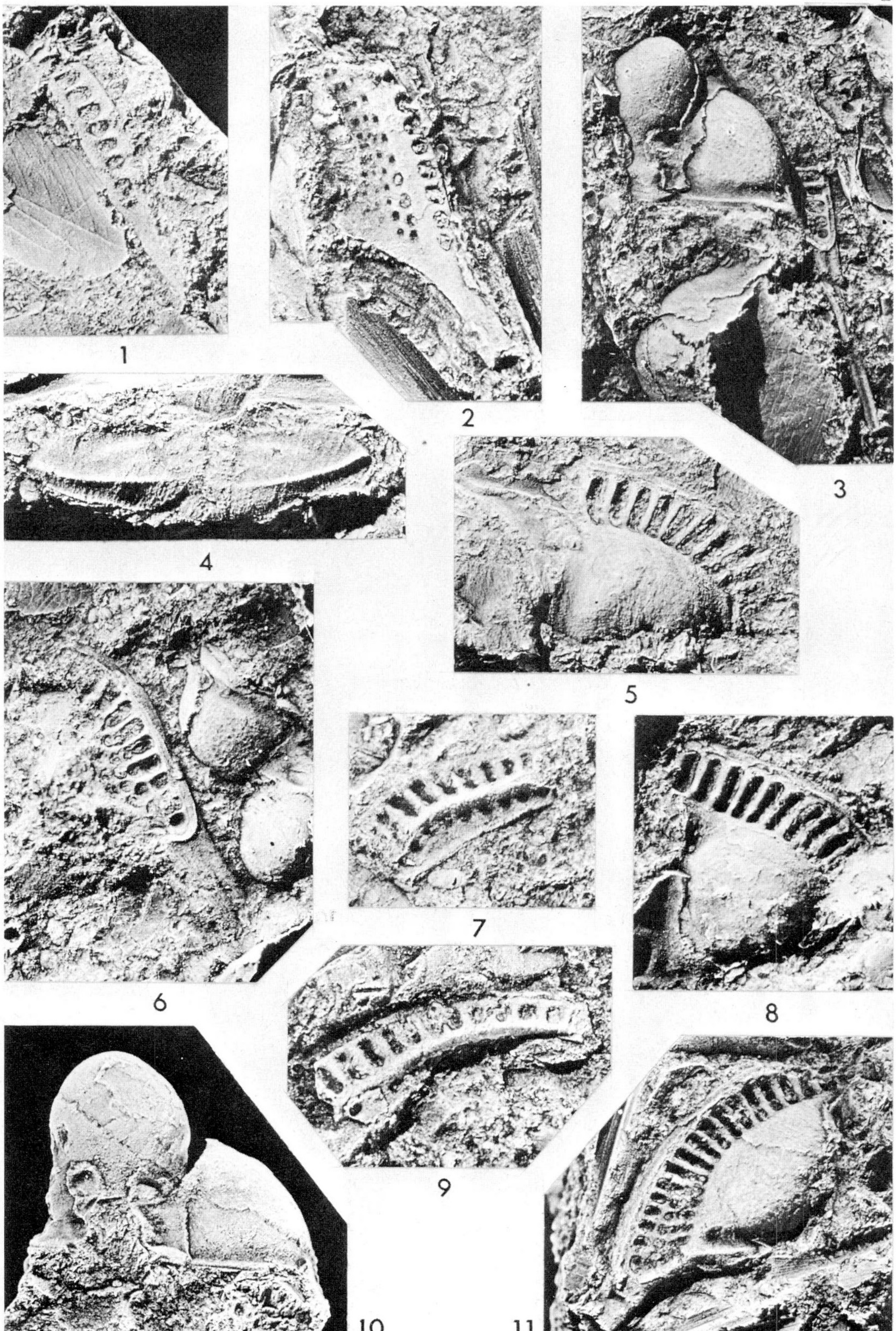
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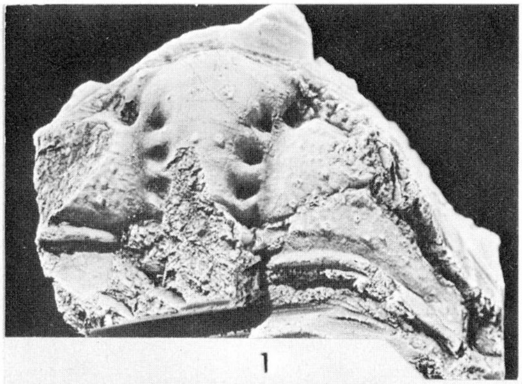
Plate 3

	Atractopyge condylosa sp. nov.	Page 12
Figures 1–3.	Plan, anterior and right lateral views of internal mould of almost complete cranidium. Holotype. GSC 29119. x3.	
Figure 4.	Latex cast of small pygidium. Paratype. GSC 29122. x7.	
Figure 5.	Internal mould of pygidium. Paratype. GSC 29123. x7.	
Figure 7.	Latex cast of inner portion of left librigena. Note scattered tubercles and pedunculate eye-lobe. Paratype. GSC 29121. x8.	
Figure 10.	Internal mould of right librigena showing tubercles along raised lateral border. Paratype. GSC 29120. x7.	
	Remopleurides sp.	Page 16
Figure 6.	Internal mould of small cranidium. GSC 29127. x8.	
Figure 9.	Latex cast of incomplete compressed cranidium. Note glabellar furrows and granulated surface. GSC 29126. x6.	
	Bergamia sp. nov.	Page 5
Figure 8.	Latex cast of right half of cranidium. GSC 29101. x5.	



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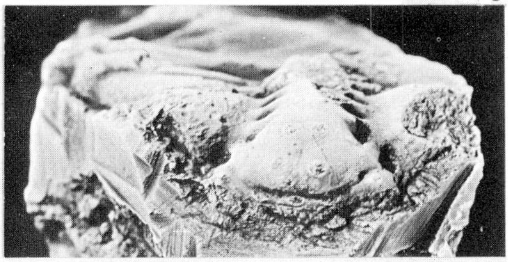

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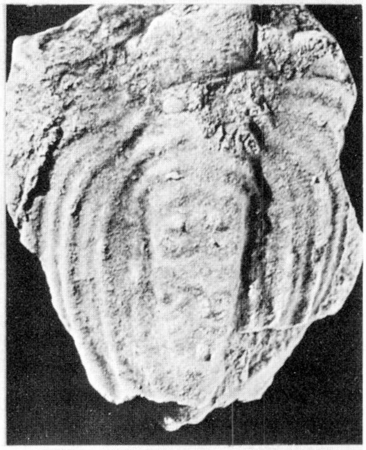

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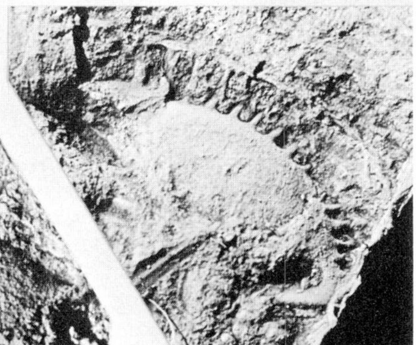

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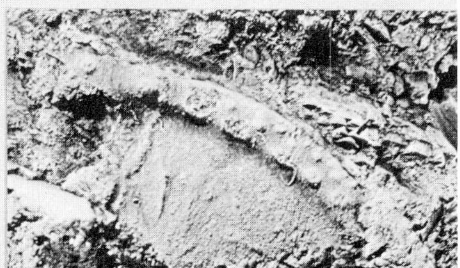

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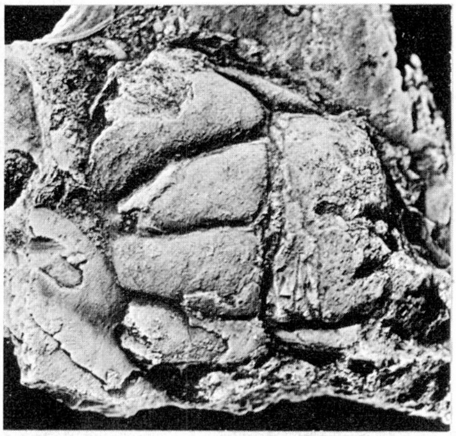
PLATE 4

	Pliomerella sp.	PAGE 11
Figure 1.	Internal mould of right half of cranidium. GSC 29112. x4.5.	
Figure 4.	Internal mould of large hypostoma. GSC 29111. x3.	
	Sphaerexochus costabilis sp. nov.	PAGE 9
Figure 2.	Internal mould of compressed pygidium. Paratype. GSC 29114. x4.	
Figures 3, 5, 8.	Plan, left lateral and posterior views of internal mould of pygidium. Holotype. GSC 29113. x6.	
Figure 6.	Latex cast of pygidial doublure and pleural spines. Paratype. GSC 29115. x7.	
	Sphaerexochus? sp.	PAGE 10
Figure 7.	Latex cast of occipital ring and part of glabella. GSC 29158. x4.5.	



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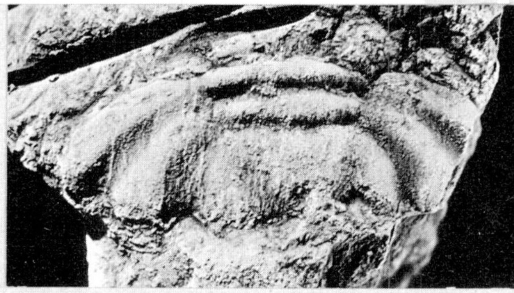

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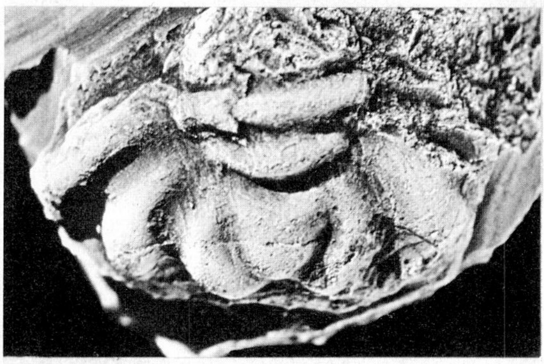

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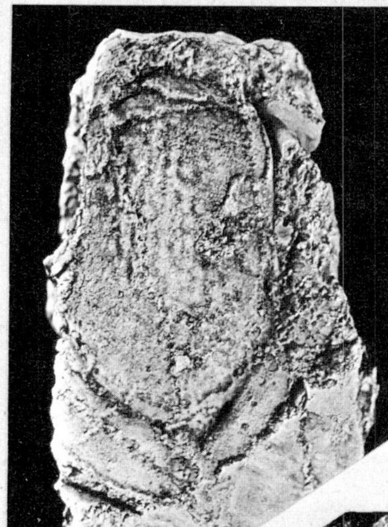

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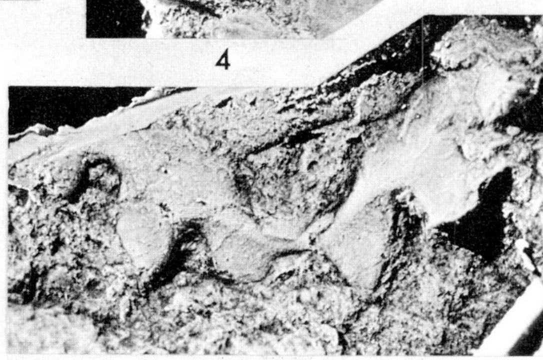

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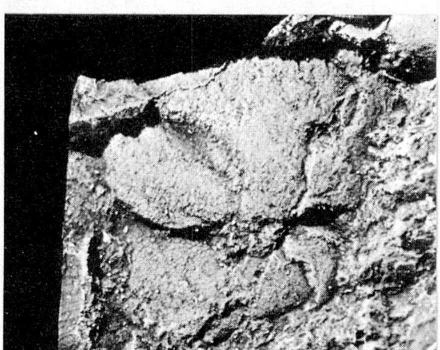

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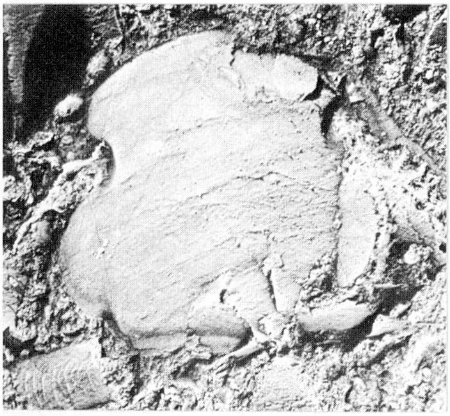
Plate 5

	Nileus nesiotes sp. nov.	Page 21
Figure 1.	Latex cast of cranidium. Holotype. GSC 29130. x5.	
Figure 2.	Latex cast of large hypostoma with part of test preserved. Paratype. GSC 29133. x4.	
Figure 3.	Internal mould of large, incomplete cranidium. Paratype. GSC 29131. x5.	
Figure 4.	Part of cephalic doublure showing terrace-lines. Paratype. GSC 29135. x5.	
Figure 5.	Incomplete hypostoma. Paratype. GSC 29134. x5.	
Figure 8.	Latex cast of left librigena. Paratype. GSC 29132. x4.	
	Illaenus sp.	Page 23
Figure 6.	Latex cast of pygidium. GSC 29136. x6.	
	Remopleurides sp.	
Figure 7.	Latex cast of pygidial doublure showing pleural spines. GSC 29128. x7.	Page 16
	Bronteopsis sp.	
Figure 9.	Latex cast of incomplete pygidium. GSC 29146. x5.	Page 19



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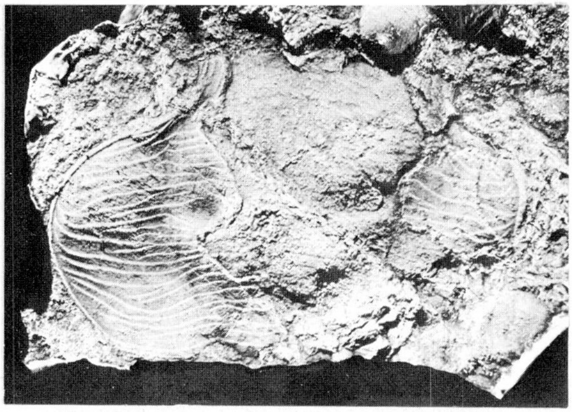

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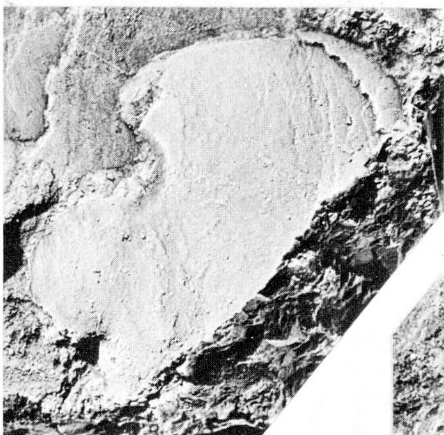

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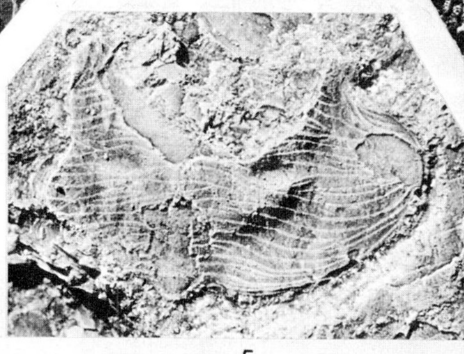

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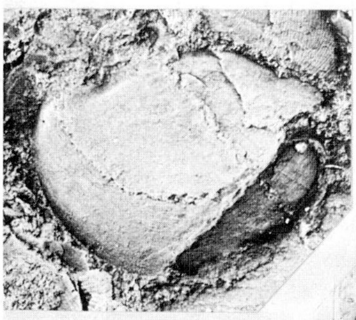

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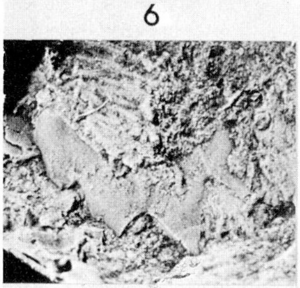

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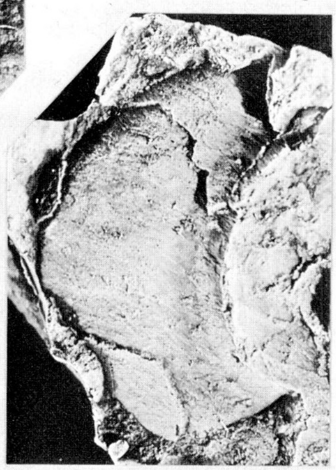

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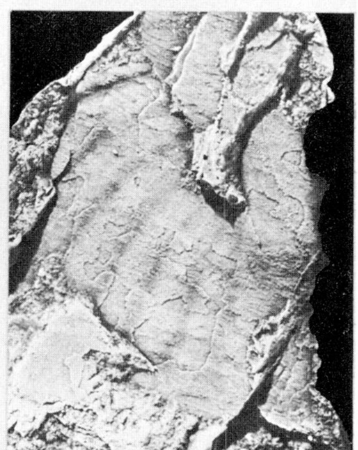

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PLATE 6

	Raymondaspis arcuata sp. nov.	PAGE 17
Figure 1.	Partly exfoliated pygidium. Note faint ring furrows on internal mould of axis. Holotype. GSC 29150. x6.	
Figure 2.	Latex cast of cranidium. Paratype. GSC 29148. x5.	
Figure 3.	Latex cast of small cranidium. Paratype. GSC 29149. x9.	
Figures 7, 10.	Incomplete, partly exfoliated cranidium. Paratype. GSC 29147. x5.	
	Amphilichas sp.	PAGE 20
Figure 4.	Latex cast of fragmentary cranidium. GSC 29116. x10.	
Figure 6.	Right librigena, preserved mostly as the external mould of the ventral surface. GSC 29117. x5.	
	Otarion sp.	PAGE 17
Figure 9.	Incomplete, small cranidium. GSC 29129. x10.	
	Carrickia cf. *C. pelagia* Tripp	PAGE 15
Figure 11.	Plan view of small cranidium. GSC 29125. x10.	
	Genus and species undetermined	PAGE 26
Figure 5.	Left librigena. GSC 29118. x7.	
Figure 8.	Latex cast of fragmentary pygidium. GSC 29145. x5.	

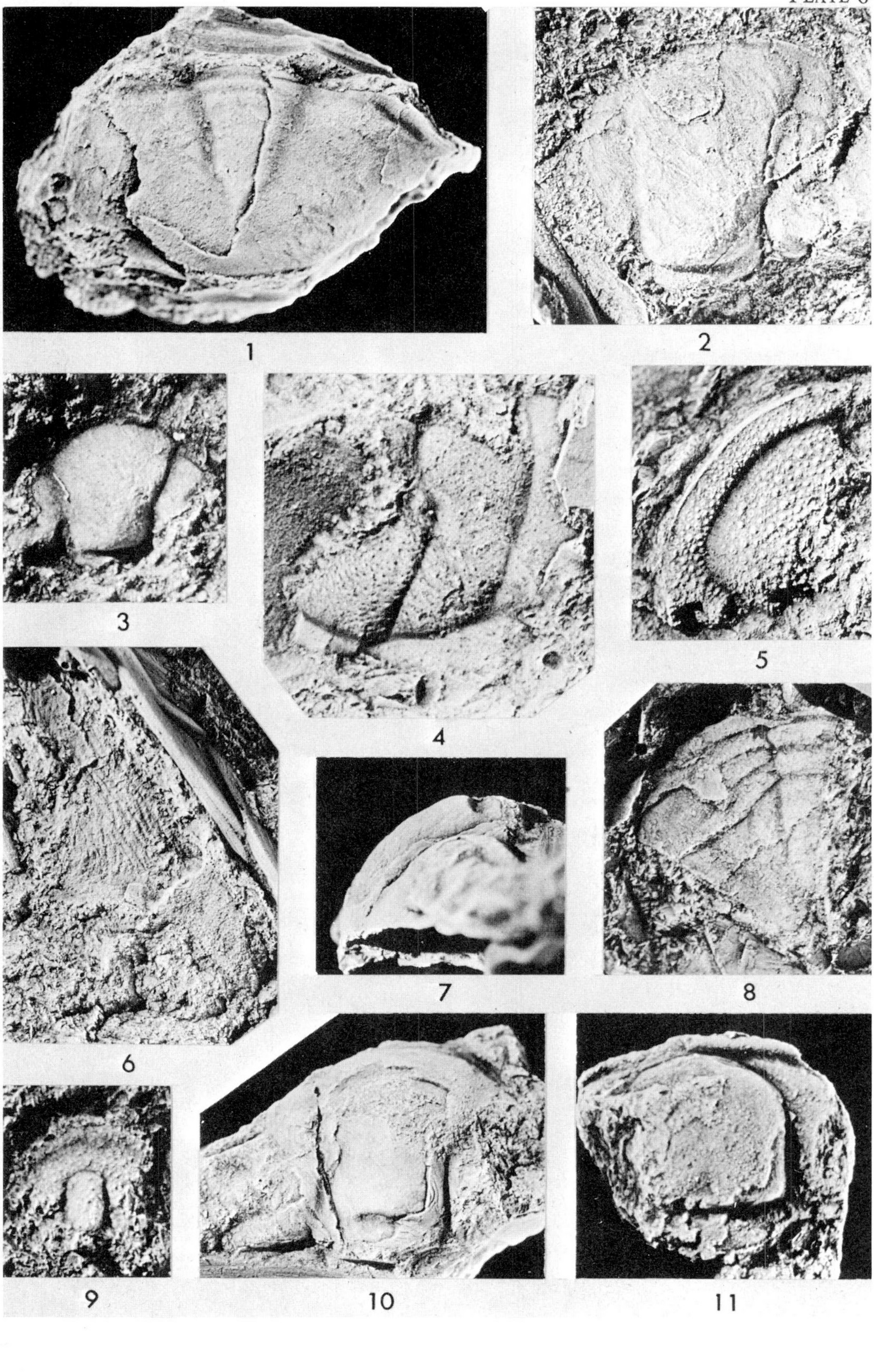
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PLATE 7 PAGE 24

Illaenus (*Parillaenus*) sp.

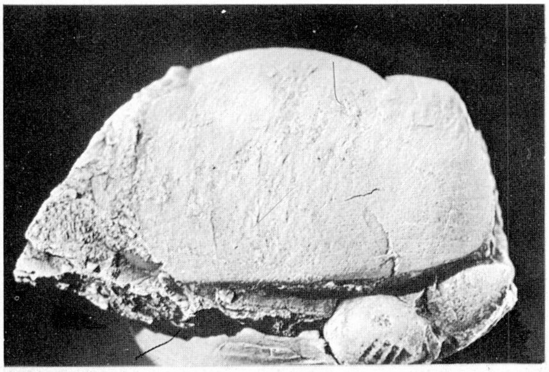
Figures 1, 3, 5.	Anterior, plan and left lateral views of incomplete large cranidium. GSC 29137. x2.5.
Figure 2.	Latex cast of rostral plate. GSC 29139. x5.
Figure 4.	Partly exfoliated pygidium. GSC 29143. x3.

Illaenus sp. PAGE 23

Figure 6.	Small pygidium. GSC 29142. x7.
Figure 8.	Exfoliated pygidium. GSC 29141. x4.5.
Figure 9.	Almost exfoliated, large left librigena showing part of anterior branch of facial suture. GSC 29140. x4.
Figure 10.	Fragmentary cranidium showing left palpebral lobe and punctate surface of test. GSC 29138. x2.5

Symphysurus sp. PAGE 23

Figure 7.	Fragmentary pygidium showing ornamentation of fine, anastomosing ridges. GSC 29144. x3.



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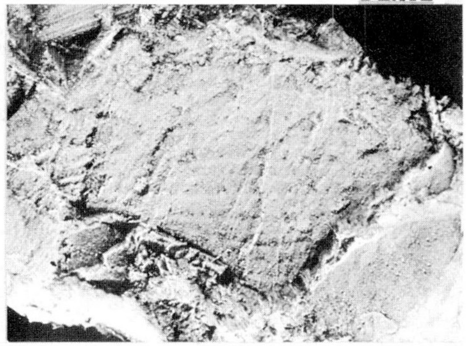

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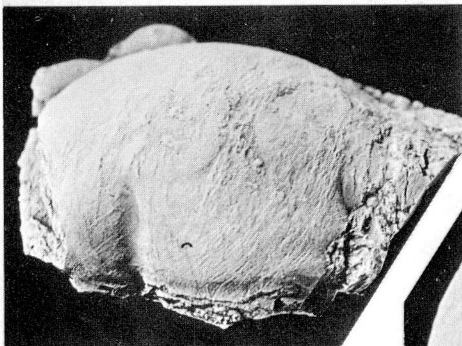

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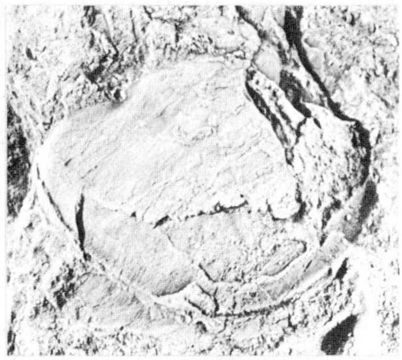

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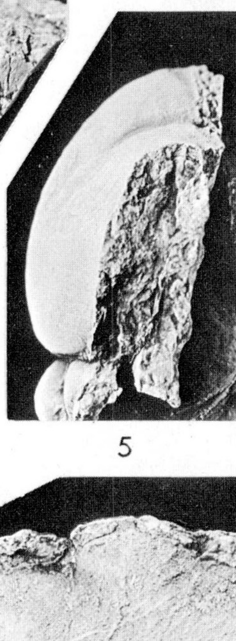

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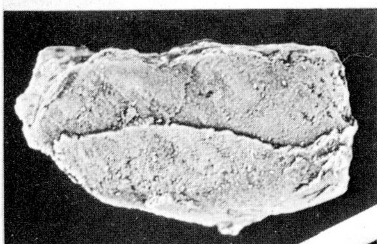

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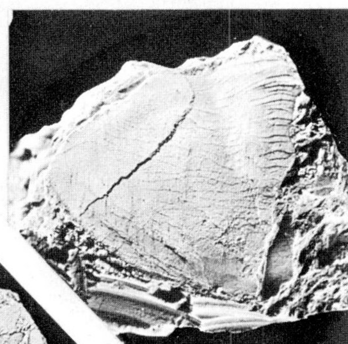

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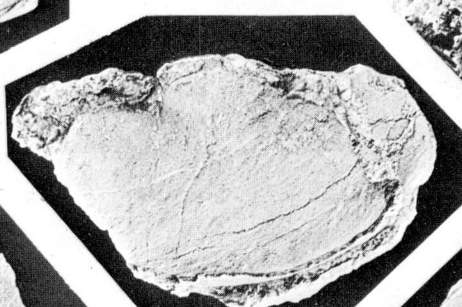

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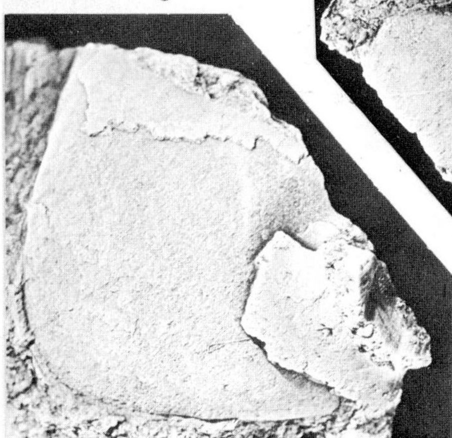

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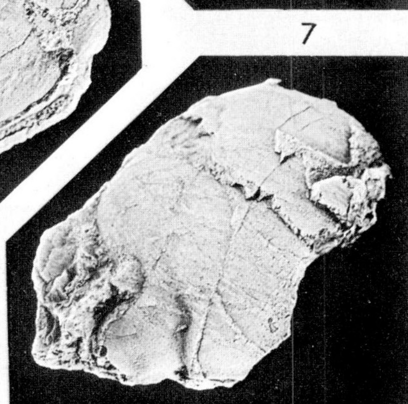

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