BULLETIN 165

GEOLOGICAL
SURVEY
OF
CANADA

DEPARTMENT OF ENERGY,
MINES AND RESOURCES

CONTRIBUTIONS TO CANADIAN PALAEONTOLOGY

Part I—Conodonts and Fish Remains from the Stonehouse Formation, Arisaig, Nova Scotia

J. A. Legault

Part II—Osteostraci from Somerset Island

D. L. Dineley

Part III—A Devonian Osteolepidid Fish from British Columbia

H. Jessen

Ottawa,
Canada
1968

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PREFACE

The three papers comprising this bulletin deal with microfossils and vertebrates from Silurian and Devonian rocks of Canada. The first describes conodonts and associated fish fragments from the Stonehouse Formation of Nova Scotia; it is the first study of such faunas of Upper Silurian age from eastern Canada and supplements information on other faunal groups described in Memoir 137 and Bulletin 117 of the Geological Survey.

The other two papers describe and illustrate for the first time some of the well-preserved Devonian fish remains that have recently been discovered in the Canadian Arctic and in western Canada. Early studies on the stratigraphy of the Devonian System in Europe made considerable use of fish remains as time indices, and, aside from their palaeontological importance, these and other recent fossil fish discoveries will assist in a clearer understanding of the overall geochronology of the Devonian rocks of Canada.

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

OTTAWA, February 1, 1968

БЮЛЛЕТЕНЬ 165—МАТЕРИАЛЫ ПО ПАЛЕОНТОЛОГИИ КАНАДЫ

Часть I. Ж. А. Лего. Конодонты и остатки рыб с формации Стонхауз, Арисэг, Новая Шотландия.

Часть II. Д. Я. Дайнли. Osteostraci из о. Сомерсет.

Часть III. Х. Ессен. Рыба Osteolepidid из девона Британской Колумбии.

BULLETIN 165 — Beiträge zur kanadischen Paläontologie

I. Teil: Konodonte und Fischüberreste aus der Stonehouse-Formation von Arisaig (Neuschottland)
Von J. A. Legault

II. Teil: Osteostraci von Somerset Island
Von D. L. Dineley

III. Teil: Ein Fisch der Gattung Osteolepis aus der Devonformation Britisch-Kolumbiens
Von H. Jessen

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PART I

CONODONTS AND FISH REMAINS FROM THE STONEHOUSE FORMATION, ARISAIG, NOVA SCOTIA

J. A. Legault

Abstract

Silurian conodonts from the Stonehouse Formation, Arisaig, Nova Scotia, include species reported by Walliser from the *eosteinhornensis* zone of the Carnic Alps, in Austria. These are: *Ligonodina elegans* Walliser, *Lonchodina detorta* Walliser, *Lonchodina greilingi* Walliser, *Lonchodina* sp. indet., *Ozarkodina typica denckmanni* Ziegler, *Ozarkodina* cf. *O. jaegeri* Walliser, *Spathognathodus steinhornensis eosteinhornensis* Walliser, and *Trichonodella inconstans* Walliser. In addition, two new species of the genus *Neoprioniodus* are present as well as fish fragments.

Résumé

La Formation Stonehouse à Arisaig, Nouvelle-Écosse, a révélé des conodontes siluriennes identiques à celles décrites par Walliser de la zone *eosteinhornensis* des Alpes Carniques, en Autriche. Elles sont: *Ligonodina elegans* Walliser, *Lonchodina detorta* Walliser, *Lonchodina greilingi* Walliser, *Lonchodina* sp. indet., *Ozarkodina typica denckmanni* Ziegler, *Ozarkodina* cf. *O. jaegeri* Walliser, *Spathognathodus steinhornensis eosteinhornensis* Walliser, et *Trichonodella inconstans* Walliser. En plus, deux nouvelles espèces du genre *Neoprioniodus* ont été trouvées ainsi que des fragments de poissons.

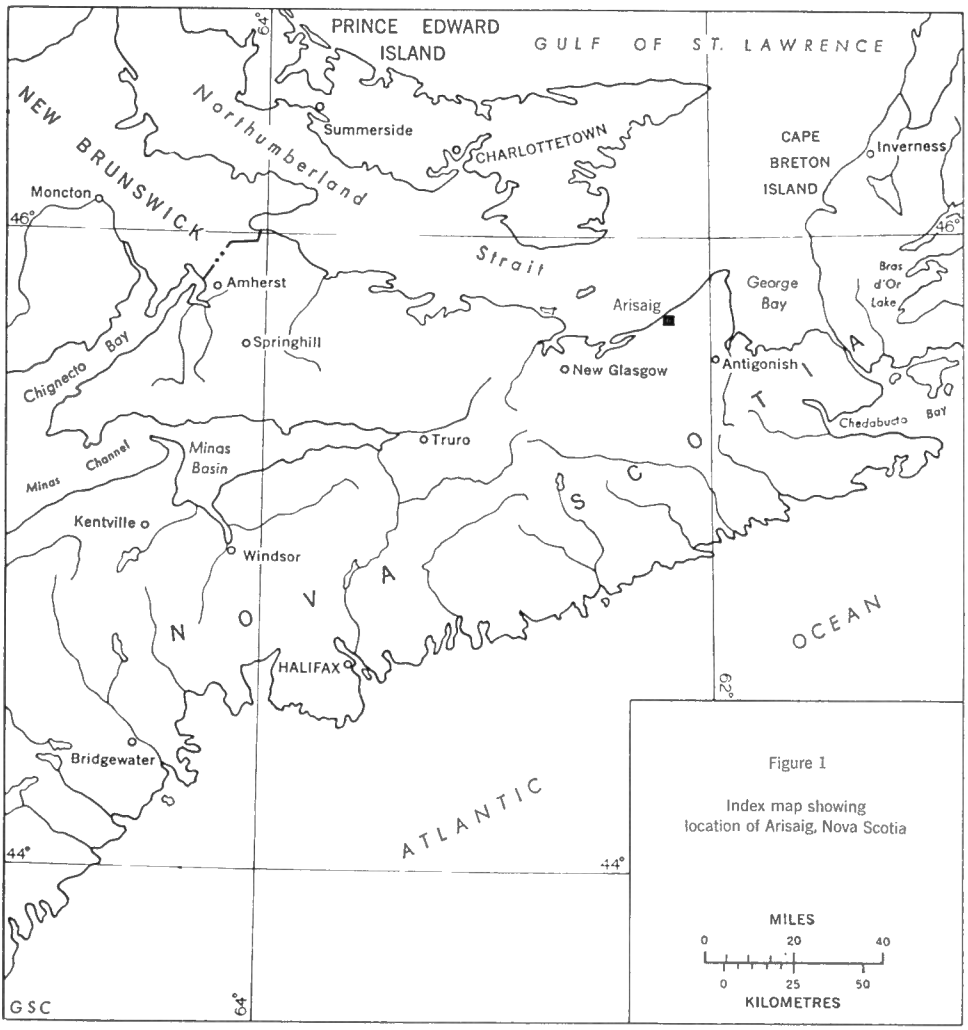


Figure 1

Index map showing location of Arisaig, Nova Scotia

INTRODUCTION

The Arisaig Group, of which the Stonehouse Formation is the youngest stratigraphic unit, is exposed along the shore of Northumberland Strait near Arisaig, Nova Scotia. This report is the first to describe the Stonehouse conodont fauna and to evaluate its stratigraphic significance. The deposits and types of fish fragments, previously mentioned by T. Örvig (*in* Boucot, *et al.*, 1959, p. 1572), are described for the first time.

Upper Silurian–Lower Devonian conodonts are poorly known. The only previously described conodonts of this age in Canada are from the Sutherland River Formation (Walliser, *in* Boucot, *et al.*, 1960) on Devon Island in the Canadian Arctic Archipelago. In the United States, R. Liebe (1962) studied conodonts of the Alexandrian and Niagaran Series from the Illinois Basin, Rexroad, *et al.* investigated conodonts from the Llandoverian of the Cincinnati Arch area (1965), and Rexroad and

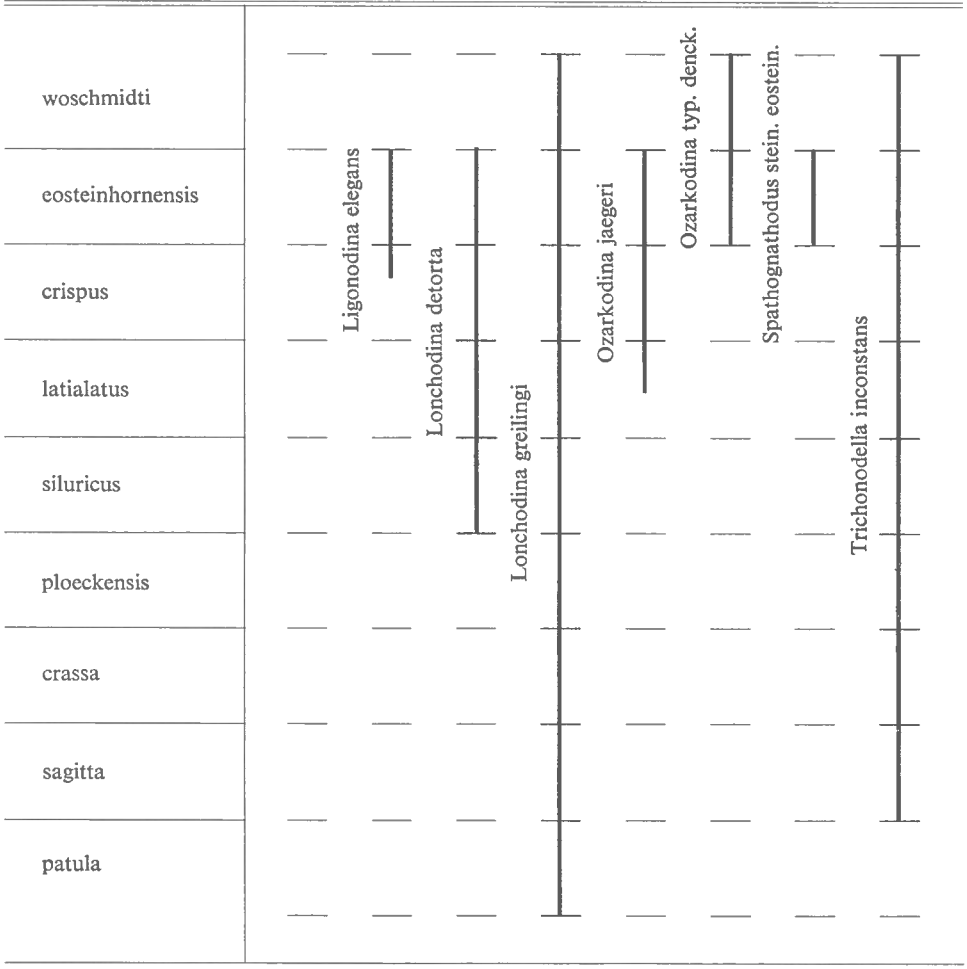
TABLE I — *Conodont Zones of the Silurian (Adapted from Walliser, 1964)*

Series	Conodont Zones	Conodont 'Stufen'
Gedinnian	woschmidti	steinhornensis
	eosteinhornensis	
	crispus	crispus/latialatus
	latialatus	
Upper Ludlovian	siluricus	Kockelella
Middle Ludlovian	ploeckensis	
Lower Ludlovian	crassa	
Wenlockian	sagitta	
	patula	
Valentian	amorphognathoides	Apsidognathus
	celloni	

MS. received July 4, 1966.

Rickard examined the pre-Eramosa strata of the Niagara Gorge (1965). Walliser (1957, 1962, 1964) investigated sections in the Carnic Alps of Austria, and established a zonation based on conodonts for the interval between the Valentian and Gedinnian (Table I). Rexroad and Rickard (1965) substantiated the validity of Walliser's Silurian conodont zonation by applying it to the Early Silurian of the Cincinnati Arch area. They have few reservations about the application of Walliser's zonal terminology to the Niagaran (Middle Silurian) of the Niagara area. Subdivision of the Late Silurian rocks of North America into conodont zones, however, has not yet been accomplished, even with Walliser's work affording a tentative frame of reference.

TABLE II *Stratigraphic Range of Stonehouse Conodonts*



The third, fifth, and seventh species extend above the *woschmidti* zone.

The age of the Stonehouse Formation is a problem of long standing. Boucot (1960) considered it to be Lower Devonian, on the basis of the brachiopod fauna, but Copeland (1960, 1964), using ostracods as index fossils, assigned an Upper Silurian age. This study of the conodonts suggests an Upper Silurian age although correlation is difficult because of the lack of comparative data from other localities.

Previous Work

Williams (1914, pp. 4–24) presented a complete account of the history of the geological work in the Arisaig area. He divided the five formations of the Arisaig sequence (in ascending order: Beechhill, Ross Brook, McAdam, Moydart, and Stonehouse Formations) into twelve zones. The Stonehouse Formation included his zones 11 and 12, distinguished from each other on the basis of relative abundance of trilobite faunas.

Study of the Stonehouse megafauna led McLearn (1924) to subdivide the formation into four assemblage zones (a to d) and to correlate them with the Ludlovian of England. Recent studies of the brachiopods have been undertaken by Boucot (1960) and Harper (1964) who concluded that the Stonehouse is of Gedinnian age and possibly, in part, Skala. Recently, Copeland (1964) concluded from a study of the ostracods that this formation is uppermost Silurian.

Acknowledgments

The author gratefully acknowledges the help and encouragement given by the staff of the Department of Geology, University of Ottawa, and thanks especially to Drs. D. M. Baird and D. L. Dineley. Most of the samples studied were collected by M. J. Copeland of the Geological Survey of Canada. Financial assistance was received in the form of an Ontario Government Graduate Student Fellowship that was renewed for a second year.

Stratigraphy

The type section of the Stonehouse Formation is exposed for about 2,000 feet along the shore of Northumberland Strait, from 2 miles southwest of Arisaig pier, south to the mouth of MacEachern Brook. Exposures along MacEachern Brook show an additional 180 feet of strata overlying those of the shore section. The formation consists of calcareous and non-calcareous red and grey siltstone and shale. It is overlain conformably (?) by the Knoydart Formation of Devonian age (Dineley, 1964; Denison, 1955) and underlain by the older Moydart Formation (McLearn, 1924). A more extensive geological description has been published by Copeland (1964).

The Stonehouse Formation is rich in many types of fossils that are generally well preserved. McLearn (1924, p. 13) reported one hundred and three species of worms, stelleroids, brachiopods, pelecypods, gastropods, pteropods, cephalopods, trilobites, and ostracods. Thirty-nine of these species have been reported from older faunas (twenty-five in the Moydart Formation, eleven in the McAdam (mainly pelecypods), and three in the Ross Brook), but sixty-four of them appear for the first time and are confined to the Stonehouse Formation.

Material

Most of the conodonts extracted from the Stonehouse Formation are incomplete, with bars and blades seldom whole, and denticles rarely completely preserved. All show evidence of wear by breakage; their surfaces, however, have little or no pitting or corrosion. The conodonts are opaque, most of them with dark grey bars and white denticles, whereas blade-types are often medium grey. A few specimens show evidence of breakage and repair (Pl. I, fig. 12; Pl. II, figs. 2, 10, 11) that could only have happened if the unit had been surrounded by tissue. The repair of breakages suggests that the conodonts were internal structures. Such repairs have been reported previously (Lindström, 1964, p. 120).

The material was collected at random intervals (5 to 25 feet) and prepared according to standard procedure: it was broken, crushed to 0.5-inch pieces, treated with 15% acetic acid, sieved, and bromoform was used for heavy-liquid separation. Of the one hundred and thirteen samples processed, forty-seven were unproductive or did not break down.

DISCUSSION OF FAUNA

Conodonts

The following conodonts were recovered from the Stonehouse collections:

Ligonodina elegans Walliser 1964
Lonchodina detorta Walliser 1964
Lonchodina greilingi Walliser 1957
Lonchodina sp. indet.
Neoprioniodus arisaigensis n. sp.
Neoprioniodus williamsi n. sp.
Ozarkodina typica denckmanni Ziegler 1956
Ozarkodina cf. *O. jaegeri* Walliser 1964
Spathognathodus steinhornensis eosteinhornensis Walliser 1964
Trichonodella inconstans Walliser 1957

Table III shows the distribution of these conodonts within the Stonehouse section. Those samples for which there is no measurement indicated on the table were not collected from the shore section; their localities can be found in the Appendix.

Four hundred identifiable units of *Ligonodina elegans* Walliser (Pl. I, figs. 10–12) were recognized. The residues also contained many denticulated bars that probably were fragments of specimens of this species, but, because they could not be indisputably assigned to *Ligonodina elegans* Walliser, they were not counted. This species has a relatively short time range, appearing in only two of Walliser's zones, viz. *crispus* and *eosteinhornensis* (Table II).

Sixty-four specimens of *Lonchodina detorta* Walliser (Pl. II, figs. 1–4) were found. This easily recognizable species is present in the *siluricus* to *eosteinhornensis* zones.

Lonchodina greilingi Walliser (Pl. II, figs. 10–12), of which one hundred and fifty specimens were obtained, is a morphologically variable species that occurs throughout the formation. It has an extensive geological range, from the *patula* zone into the Lower Devonian.

TABLE III *Stratigraphic Distribution of Stonehouse Conodonts and Fish*

Species (Number of Specimens)															
Zonation		GSC Localities	Stratigraphic Thickness from Top of Shore Section (feet)	"Fish"	*Spathognathodus steinhornensis eosteinhornensis* (339)	*Ligonodina elegans* (400)	*Trichonodella inconstans* (309)	*Lonchodina greilingi* (150)	*Lonchodina detorta* (64)	*Lonchodina* sp. indet. (32)	*Neoprioniodus arisaigensis* (188)	*Neoprioniodus williamsi* (32)	*Ozarkodina typica denckmanni* (52)	*Ozarkodina* cf. *O. jaegeri* (18)
McLearn 1924	Copeland 1964													
C	*Neobeyrichia (Nodibeyrichia) pustulosa* (Hall)	70339	15.0	x	x	x	x	x	x		x	x		
		70341	15.0					x			x			
		70342	18.0	x	x		x				x			
		38982	39.0				x	x	x					
		38986	58.0	x	x	x	x	x					x	
		70344	61.0	x			x		x	x	x		x	
		38987	62.5	x		x	x							
		70346	66.0		x	x	x				x			
		70347	70.0		x	x		x	x		x		x	
		70348	72.5	x										
		38989	80.0	x	x	x								
		70349	80.0		x			x			x			
		39076		x	x	x	x	x	x		x	x	x	
		70360		x	x	x	x	x	x		x	x	x	
		38992	97.5	x	x				x					
		70350	112.0			x	x	x						
		70352	126.0	x	x	x	x	x	x	x	x		x	x
		38996	130.5		x	x	x		x		x		x	
		38999	161.5	x	x	x	x		x					
		70355	170.0	x	x	x	x		x		x			
		70356	191.0		x		x	x						
		39004	210.2					x						
		39008	249.2	x										
		39089		x	x	x		x		x	x			
		39009	251.4			x			x		x			
B		39010	263.7			x			x	x				x
		39070		x	x	x	x		x		x	x	x	
		39074				x	x	x	x		x			
		39012	274.2	x	x	x	x	x			x			
		39013	284.2	x	x	x	x	x			x	x	x	
		39014	294.9	x		x			x		x			
		39015	305.4	x		x	x	x	x		x			
		39016	311.4					x						
		39017	324.2	x	x									
		39019	337.2	x	x	x	x	x			x			
		39020	345.7	x		x	x	x	x		x	x		
		39021	352.9	x		x	x	x	x	x	x			
		39022	363.9	x		x	x		x	x	x			
		39023	382.7	x										
		39025	408.3	x			x				x		x	
		39026	422.9	x				x						
		39027	436.5	x		x	x	x						
A	*Aparchites*? *sinuatus* (Hall)	39028	458.3	x	x	x	x							
		39088		x	x	x	x	x			x			
		39032	545.5								x			
		39040	678.8	x										
		39100	678.8	x	x	x	x	x			x	x		
		39048	834.8		x									
		39050	880.8	x	x									
		39052	920.1	x	x		x						x	
		39055	998.9	x	x			x			x		x	
	Londinia arisaigensis Copeland	39056	1016.0	x	x								x	
		39057	1035.8	x	x	x							x	
		39060	1103.5	x	x	x	x							
		39098	1407.0	x	x	x	x						x	
		39096	1426.0	x										
		39094	1451.0	x	x	x	x	x			x	x	x	x
		39093	1457.0	x	x	x	x	x	x		x		x	x
		39091	1476.0	x	x	x								x

Thirty-two individuals of *Lonchodina* sp. indet. (Pl. I, figs. 13–15), a form intermediate between *Lonchodina greilingi* Walliser and *Trichonodella inconstans* Walliser, were obtained. Not enough well-preserved specimens were recovered to establish a new species. Walliser (1964, p. 51) has suggested that there is a continuous morphological sequence between these two species. The Stonehouse form, however, is distinct from both.

Two new species of the long-ranging genus *Neoprioniodus* were determined; they are *Neoprioniodus arisaigensis* n. sp. (Pl. II, figs. 5–7) and *Neoprioniodus williamsi* n. sp. (Pl. II, figs. 8, 9). They are distinct from those species described by Walliser (1964) from Austria.

Ozarkodina typica denckmanni Ziegler (Pl. I, figs. 5, 6) is not abundant but enough well-preserved specimens were found to warrant the subspecific assignment. This subspecies ranges from the *eosteinhornensis* zone into the Lower Devonian.

Eighteen individuals of *Ozarkodina* cf. *O. jaegeri* Walliser (Pl. I, fig. 4) were found. *Ozarkodina jaegeri* ranges from the *latialatus* to the *eosteinhornensis* zones.

Many specimens of *Spathognathodus steinhornensis eosteinhornensis* Walliser (Pl. I, figs. 1–3) were found. This subspecies is the index for Walliser's *eosteinhornensis* zone, and is restricted to it. It is a difficult subspecies to identify because it grades imperceptibly into the subspecies *Spathognathodus steinhornensis remscheidensis* Walliser, but enough individuals were found to substantiate the identification.

Trichonodella inconstans Walliser (Pl. I, figs. 7–9) is plentiful in the Stonehouse collection. It ranges from the *sagitta* zone into the Lower Devonian.

All the conodonts mentioned above are found throughout the Stonehouse Formation, except *Lonchodina* sp. indet., which has not been recovered from McLearn's zone A.

If the zonation established by Walliser (Table II) is used as a frame of reference, the Stonehouse Formation is Upper Silurian and is contained within Walliser's *eosteinhornensis* zone. This zone is contained within his Upper Ludlovian to Gedinnian interval. According to Collinson and Druce (1966, p. 608): "... the top of the Ludlovian Series correlates essentially with the top of the Bohemian Budňany (E-beta-two) and implies that the Ludlow and Budňany are approximately equivalent. In terms of graptolite zones, the Silurian–Devonian boundary should occur at the base of the *Monograptus uniformis* zone inasmuch as it marks the upper limit of Walliser's *eosteinhornensis* zone." From the foregoing, it follows that the Stonehouse conodonts are contained within rocks of Silurian age, which may represent the youngest Silurian strata in the Arisaig sequence.

Fish Fragments

Phosphatic fish remains occur throughout the Stonehouse Formation and have been recovered in varying quantities from most of the samples processed. No relationship has been found between their presence and abundance and the presence of conodonts.

The fish remains are white, pink, green, or grey, rarely colourless and transparent. It is unusual to find more than one colour represented in one sample. Dark red

specimens are present, but their colour is probably due to post-depositional alteration and their surfaces are slightly pitted. The unaltered remains generally have shiny surfaces. Most of these fossils are well preserved but some have been chipped. Because of their denser and sturdier structure, they have suffered less breakage than the conodonts.

Fragments of fish found in this formation are grouped into six taxa:

Acanthoides dublinensis (Stauffer) 1938
Cheiracanthoides venustus Wells 1944
Cheiracanthoides stonehousensis n. sp.
Onychodus sp.
Petrodus? sp.
"tooth" indet.

Specimens of the latter three species in this collection are rare, numbering six, eight, and five fragments, respectively, but the others are common.

The term species as used by Wells (1944) and others, denotes form-species. His taxa are clearly defined and minute morphological differences are given great importance. Many of these differences could be included within the description of one form-genus because: 1) there is no reason to believe that the present day wide variety in form of dermal elements of any one modern fish did not exist in the past, and 2) there is an overall resemblance between the various genera defined by Wells, i.e., *Acanthoides*, *Cheiracanthoides*, and *Helolepis*. These three genera are defined on the basis of coronal ornamentation. In the Stonehouse collection gradation exists between ornamentation types: the smooth-surfaced forms (Pl. III, fig. 4) grade into slightly indented forms (Pl. III, fig. 5), these into finely ribbed ones (Pl. III, fig. 8), and the latter into coarsely ribbed ones (Pl. III, fig. 7). Nevertheless, for descriptive and comparative purposes Wells' scheme is followed in the treatment of this material.

The descriptive term "scale" is used with some reservation. The dermal elements of the fish under consideration are not, strictly speaking, scales. They are small, thick, phosphatic plates that formed a shagreen on the fish. These fish remains are virtually identical with forms from the Middle Devonian of the Cincinnati Arch area (Wells, 1944), the Upper Devonian of Ohio (Stauffer, 1938), and the Pennsylvanian of Missouri (Gunnell, 1933). They are of interest principally because such remains have rarely been found so low in the stratigraphic column.

For detailed and complete descriptions of *Acanthoides dublinensis* (Stauffer) and *Cheiracanthoides venustus* Wells, refer to Wells (1944).

Conclusions

Conodont fauna from the Stonehouse Formation is sparse, but useful stratigraphically. It is definitely indicative of Walliser's Upper Silurian *eosteinhornensis* zone, because it contains the restricted index fossil as well as several forms that are of limited vertical range.

In his original conodont zonal succession of the Carnic Alps of Austria, Walliser (1964) did not make the position of the Silurian–Devonian boundary clear. Collinson and Druce (1966), however, considered that this boundary was at the top of the

eosteinhornensis zone. The absence of exclusively Devonian conodonts in the Stonehouse Formation supports this conclusion. Fish remains do not aid in solving this problem because they are indistinguishable from those in younger strata. Division of the Stonehouse Formation into zones based on conodonts is not at present possible because the conodont fauna does not vary throughout the formation.

SYSTEMATIC PALAEONTOLOGY

Conodonts

Ligonodina elegans Walliser, 1964

Plate I, figures 10–12

1962 *Hindeodella* sp., ETHINGTON and FURNISH, p. 1268, Pl. 173, fig. 1.
1964 *Ligonodina elegans* WALLISER, p. 41, Pl. 9, fig. 19; Pl. 32, figs. 16–21.

Description. Unit consisting of a denticulated posterior bar and a denticulated, posteriorly directed lateral process at the anterior extremity. Posterior bar long and sturdy. Cross-section subovate, oral edge wider than aboral edge. Shallow longitudinal constriction approximately one-half to two-thirds of the way down the bar. Aboral edge thin. Denticles on posterior bar discrete and posteriorly oriented at about 55 degrees to the bar. Cross-section round. Distal tapering very slight. Denticles separated by a distance about equal to their diameter. In a few specimens the first denticle posterior to cusp is very small. Large cusp situated at anterior end of bar, at junction with lateral process. Cusp directed posteriorly at an angle of 55 degrees to bar. Cross-section circular to ovate with anterior tapering. Diameter about twice that of denticles on bar. Base slightly wider than cusp, with slight oral tapering. Denticulated lateral process directed downward and away from main bar at about 55 degrees. Five discrete denticles on lateral process, circular in cross-section. Inclined posteriorly with inclination decreasing away from cusp. Deep basal cavity beneath cusp, extending some distance into it and along both bars as a well-defined groove. Little or no exterior expression of basal cavity on surface of unit.

Discussion. No complete unit has been found in this collection. The only part that is commonly intact is the lateral process. Denticles are always broken. Sinistral and dextral forms are found. The denticles on the posterior bar are often separated from the cusp by a wide gap that may be one and a half times the diameter of the cusp. This may be due to suppression of germ denticles. In some fossils, however, the denticulation is constant up to the base of the cusp. In some specimens, the size of the denticles increases slightly to the fifth denticle and then decreases again.

Generally, the lateral process carries four or five denticles. On two specimens, one of which is figured (Pl. I, fig. 11), the lateral process is very long and possesses at least nine denticles. A similar specimen has also been figured by Walliser (1964, Pl. 32, fig. 19). The basal cavity has no external expression; some specimens are found with a

cone of infilling material supported by the posterior and lateral processes, and often extending to the end of the lateral process.

This species closely resembles *Ligonodina silurica* Branson and Mehl, 1933. Walliser distinguishes these two species on the basis of the length of the posterior process. He fails to mention, however, that in *Ligonodina elegans* Walliser, the lateral process is at a smaller angle to the posterior bar. In *Ligonodina silurica*, this angle is about 90 degrees.

Range. Crispus to *eosteinhornensis* zones.

Occurrence. See Table III.

Types. Hypotypes, GSC Nos. 21921, 21922, 21923.

Lonchodina detorta Walliser, 1964

Plate II, figures 1–4

1957 *Lonchodina* n. sp. (a) WALLISER, p. 39, Pl. 3, figs. 29, 30.
1964 *Lonchodina detorta* WALLISER, p. 43, Pl. 9, fig. 20; Pl. 30, figs. 34–37.

Description. Unit consisting of two arched and considerably twisted denticulated bars. Cusp assumed to be posterior in direction; anterior branch extending in direction of anterior extension of cusp. Posterior branch more strongly curved. Bars of moderate height and narrow cross-section, vertically arched at about 90 degrees to each other. Sigmoidally curved in oral view. Anterior bar nearly straight, bearing strong discrete denticles with ovate cross-section. Denticles tapering very slightly distally, separated by approximately one-quarter their diameter, oriented posteriorly at an angle of about 50 degrees to the bar. Posterior bar twisted as much as 90 degrees to anterior, convex inwardly, with maximum convexity directly posterior to cusp, beyond which it straightens out. Discrete denticles perpendicular to bar, up to twice as large as those on the anterior bar, with flattened ovate cross-sections. Cusp placed at junction of anterior and posterior bars, but mainly situated on posterior one, directed posteriorly, approximately one and a half times to twice the diameter of denticles. Flattened ovate cross-section with anterior and posterior edges. Basal cavity, situated below cusp at junction of bars, consisting of a narrow, deep, triangular, conical excavation extending as a deep groove along the aboral edge of each bar. Expansion over basal cavity following the trends of the bars, but extending out at one side to form the apex of the triangle. Mainly visible in aboral view.

Discussion. No complete specimen of this species has been found in the Stonehouse Formation. The strong distinct curvature of the bars of the Stonehouse specimens, however, definitely places them in Walliser's species. The amount of curvature of the posterior bar varies; in some samples it is nearly straight (Pl. II, fig. 1), whereas in others it is strongly convex (Pl. II, fig. 4). Despite this variation, the angle between the bars seems to remain constant. Sinistral and dextral forms are found.

Some of the variants of this species could be confused with *Lonchodina walliseri* Ziegler, 1960. The specimens from the Stonehouse Formation are more strongly arched

and twisted than *Lonchodina walliseri*. They agree closely with *Lonchodina detorta* Walliser, although a smaller range of variations than Walliser allows is found. As with *Trichonodella inconstans* Walliser (*see* page 18), only a restricted number of the variants reported by Walliser is found in the Stonehouse rocks.

Range. Siluricus to *eosteinhornensis* zones.

Occurrence. See Table III.

Types. Hypotypes, GSC Nos. 21924, 21925, 21926, 21927.

Lonchodina greilingi Walliser, 1957

Plate II, figures 10–12

1957 *Lonchodina greilingi* WALLISER, p. 38, Pl. 3, figs. 20–26.
1958 *Lonchodina greilingi* KOCKEL, pp. 258, 259.
1960 *Lonchodina greilingi* WALLISER, p. 31, Pl. 8, figs. 17, 18.
1960 *Lonchodina greilingi* ZIEGLER, p. 188, Pl. 14, figs. 15, 16, 18, 20.
1962 *Lonchodina greilingi* ETHINGTON and FURNISH, p. 1274, Pl. 173, fig. 10.
1962 *Lonchodina greilingi* WALLISER, p. 283, fig. 1, no. 22.
1964 *Lonchodina greilingi* WALLISER, p. 44, Pl. 8, fig. 7; Pl. 30, figs. 7–9.

Description. Unit consisting of two highly arched, slightly twisted, denticulated lateral bars and a posteriorly oriented cusp. Lateral bars wide, slightly twisted relative to each other. Narrow in cross-section approaching blade configuration. In vertical plane, bars divergent from each other at an angle of about 80 degrees, the bar with the more posterior orientation being of lesser height. Denticles coarse, discrete, asymmetrically disposed, and posteriorly inclined. Cross-section varying in one unit from ovate to circular. No basal thickening; distal tapering very slight. Some denticles separated by a distance of approximately half their diameter, some more crowded. Large cusp, situated at junction of lateral bars, tapering distally. Cross-section circular to subovate. Strongly inclined posteriorly. Basal cavity beneath cusp, outline elliptical, oriented asymmetrically with respect to bars, situated diagonally across the general trend of the bars. Cavity not extending into cusp, but produced along bars as a narrow shallow groove. Basal cavity lip beneath cusp expanded on anterior surface and more so on posterior surface.

Discussion. In Walliser's original description (1957) of this species he defined the bars as lateral. In a later description of other species of this genus (1964), he called the bars anterior and posterior, but did not redefine the orientation of *Lonchodina greilingi*. Accordingly, his original terminology is followed in this report. The species shows a wide range of variation within the Stonehouse Formation. These variants can be found within one sample, and, therefore, no stratigraphical significance can be attached to them. Sinistral and dextral forms are found.

Some bars are rounded (Pl. II, fig. 11), others are blade-like (Pl. II, fig. 10). The twisting is never great but it seems less pronounced when the bar is flat. The cross-section of the denticles also varies with the bar shape. Where the bar is blade-like, the denticles have compressed cross-sections and sharp edges, as does the cusp. Where the bar is rounded, the cross-sections of the denticles and the cusp are also rounded. In

some specimens, each bar has denticles of approximately the same size; in others the size variation on any one bar is great. The amount of posterior orientation of the denticles is proportional to the amount of twisting of the bar.

A cone of basal filling extending slightly beyond the edges of the basal cavity is sometimes preserved.

Range. *Patula* zone to Lower Devonian.

Occurrence. *See* Table III.

Types. Hypotypes, GSC Nos. 21928, 21929, 21930.

Lonchodina sp. indet.

Plate I, figures 13–15

Description. Unit consisting of two relatively straight, denticulated bars twisted relative to each other, a large cusp, and an expanded basal cavity. Lateral bars at an angle of about 60 degrees to each other, but slightly twisted at the apex of their junction, one bar being slightly higher and thicker in cross-section than the other. Wide, discrete denticles on the higher bar, separated by more than a third of their diameter and tapering distally, compressed in cross-section with their long diameter at a low angle to the bar. On the lower bar, denticles narrower in diameter, rounder in cross-section with their long diameter parallel with bar, separated by half their diameter; tapering slightly. Size of denticles not constant. Cusp situated at apex of angle between lateral bars. Near base, cross-section rectangular, lateral diameter about equal to that of larger bar denticles, prolonged posteriorly to form sharp edge. Antero-posterior diameter approximately twice lateral diameter at base. Cusp trending posteriorly. Deep, triangular, conical basal cavity beneath cusp extending aborally along bars as a shallow and very narrow groove. Expansion for basal cavity only visible on posterior surface conforming to the axis of the cusp.

Discussion. This species is almost identical to *Trichonodella inconstans* Walliser from which it differs only in the lack of symmetry about the cusp, and in the inequality of the bars. Because of this resemblance between the present species and *Lonchodina greilingi* Walliser, the same orientation is maintained. The species resembles a trichonodellid that has been sufficiently squeezed in a lateral direction to reorient the cusp and the expansion for the basal cavity. In *Trichonodella inconstans* Walliser, the bars and denticles are unquestionably equal on both sides of the cusp (Pl. I, figs. 7–9), but in *Lonchodina* sp. indet., the bars differ in height, thickness, and orientation, and the denticles differ in size and cross-section.

Previously, it was thought that this could be a pathological development of *Trichonodella inconstans* Walliser, but thirty-two specimens of this species have been found over a vertical distance of about 203 feet. Repetition of a pathological case is rare, and is certainly not to be expected over such a large stratigraphical interval. These specimens seem to belong to a natural taxon.

In his description of *Lonchodina greilingi*, Walliser (1957, p. 39) pointed out that the species is an example of a twisted *Trichonodella*. However, in the Stonehouse

collection, the *Lonchodina* described above seems distinct from *Lonchodina greilingi* Walliser, and possibly a new species should be established. In the Stonehouse section, this species does not occur in McLearn's lowest zone (A). *Lonchodina greilingi* Walliser, on the other hand, is present throughout the section.

Occurrence. See Table III.

Types. Figured specimens, GSC Nos. 21931, 21932, 21933.

Neoprioniodus arisaigensis n. sp.

Plate II, figures 5–7

Diagnosis. "Pick-like" conodont with greatly expanded basal cavity.

Description. Unit consisting of denticulated posterior bar with an anterior cusp, anticusp, and a large basal cavity. Wide posterior bar with compressed cross-section approaching blade configuration, thickening slightly near aboral edge. Oriented at 145 degrees to cusp. Outer side forming a convex curve. Subparallel, subequal denticles on posterior bar, fused or closely appressed for most of their lengths; tips discrete; cross-section ovate. Oriented at 60 degrees to bar, toward cusp. Terminal cusp at anterior end of bar, approximately four times wider than adjacent denticles. Cross-section strongly compressed away from base, with sharp anterior and posterior edges. Interior curvature evident orally. Non-denticulated anticusp extending downward from cusp, forming a slightly convex line with cusp. Conical basal cavity with triangular outline situated directly beneath cusp, extending slightly into cusp, and following bar and anticusp as a deep narrow groove. Lip of cavity flaring with an upward tilt on inner side; no expression of cavity on outer side.

Discussion. This species exhibits a slight variation. In some specimens, the denticles on the posterior bar are not fused but are very close. The line formed by the cusp and the anticusp may be nearly straight (Pl. II, fig. 7) to convex. Sinistral and dextral forms are found. The lip of the basal cavity extends away from the cusp at an obtuse, but variable angle. The large sizes of the cavity and its lip are distinctive features of this species.

Occurrence. See Table III.

Types. Holotype, GSC No. 21934; Paratypes, G.S.C. Nos. 21935, 21936.

Neoprioniodus williamsi n. sp.

Plate II, figures 8, 9

Diagnosis. "Pick-like" conodont with denticulated anticusp.

Description. Unit consisting of a denticulated posterior bar with anterior, denticulated anticusp and slightly expanded basal cavity. Narrow posterior bar with compressed cross-section, oriented at 145 degrees to cusp; narrowing posteriorly.

Parallel, slightly tapering, discrete denticles, subovate in cross-section, separated by approximately a quarter of their diameter and oriented orally at about 50 degrees to posterior bar. Terminal cusp at anterior end of bar. Cross-section compressed with sharp anterior and posterior edges, approximately four times wider than other denticles. Anticusp extending aborally from cusp, bearing two discrete denticles with ovate cross-sections and directed orally, subparallel with the bar denticles. Anticusp directed at 25 degrees from exterior line of cusp, separated from cusp by a slight indentation. Basal cavity situated directly beneath cusp, not extending deeply into it. Outline of cavity triangular, shape conical. No expression on outer side, but inner side slightly expanded from base of cusp to aboral edge.

Discussion. Specimens of *Neoprioniodus arisaigensis* n. sp. are approximately six times more numerous than those of *Neoprioniodus williamsi* n. sp. Both new species show sinistral and dextral forms. *Neoprioniodus williamsi* n. sp. bears a denticulated anticusp unlike the non-denticulated anticusp of *Neoprioniodus arisaigensis* n. sp. The former differs from the latter by the aboral tapering of the posterior bar and by the size of the basal cavity expansion which, in *Neoprioniodus arisaigensis* n. sp., varies in size and is generally larger. In *Neoprioniodus williamsi* n. sp. this expansion does not flare as widely, but may be slightly constricted. This slight flare of the basal cavity, the denticulation of the anticusp as well as the angle between the anticusp and cusp are distinguishing features of this species.

These two species can be found in the same sample and are present in all of Copeland's ostracod zones (1964, p. 5). The conclusion is that they hold no stratigraphic significance within the Stonehouse Formation. Until more are found at equivalent or different horizons, their importance cannot be determined.

Occurrence. See Table III.

Types. Holotype, GSC No. 21937; Paratype, GSC No. 21938.

Ozarkodina typica denckmanni Ziegler, 1956

Plate I, figures 5, 6

1956 *Ozarkodina denckmanni* ZIEGLER, p. 103, Pl. 6, figs. 30, 31; Pl. 7, figs. 1, 2.
1960 *Ozarkodina denckmanni* ZIEGLER, p. 190, Pl. 15, figs. 13–15.
1960 *Ozarkodina denckmanni* WALLISER, p. 31, Pl. 8, figs. 13, 14.
1962 *Ozarkodina denckmanni* WALLISER, p. 283, fig. 1, no. 32.
1964 *Ozarkodina typica denckmanni* WALLISER, p. 61, Pl. 9, fig. 14; Pl. 26, figs. 3–11.

Description. Laterally compressed arched unit consisting of denticulated anterior and posterior blades and apical denticle over basal cavity. At mid-length, blades arched at about 150 degrees to each other. Cross-section compressed. Height increasing gradually apically; rate of increase greater for anterior blade. Barely discernible inner lateral curvature with apex of concavity near mid-length. Subparallel, subequal denticles on both blades fused basally, but free at tips. Cross-section flattened with sharp anterior and posterior edges. Denticles on anterior blade directed posteriorly at

about 60 degrees, those on posterior at about 80 degrees to blade. Eleven or twelve denticles on anterior blade; ten or more on posterior. Apical denticle situated at apex of arch, and directed posteriorly at about 60 degrees to anterior blade. Diameter at least twice that of denticles. Cross-section compressed with sharp anterior and posterior edges. Small, shallow conical basal cavity located directly beneath apical denticle, prolonged along aboral edge of blades as a very narrow and shallow groove. Very slight expansion on exterior surface of blade at apex of arch.

Discussion. Because no complete specimen of the subspecies has been found in this collection, the full number of denticles cannot be determined. There is little variation among representatives of this collection. This subspecies has the most delicate units of the Stonehouse conodonts.

Range. Eosteinhornensis zone to Lower Emsian.

Occurrence. See Table III.

Types. Hypotypes, GSC Nos. 21939, 21940.

Ozarkodina cf. *O. jaegeri* Walliser, 1964

Plate I, figure 4

1964 *Ozarkodina jaegeri* WALLISER, p. 57, Pl. 9, fig. 16; Pl. 25, figs 11–18; Abb. 3n, o.

Description. Unit consisting of arched denticulated blades, with apical denticle over basal cavity at mid-point. Blades of equal height and length arched medially at about 130 degrees to each other. Cross-section compressed but with longitudinal expansion beginning at base of denticles and disappearing aborally about two-thirds of the way down the blade. Very slight distal tapering of blades. Nine, equal, discrete but closely appressed denticles on anterior blade. Angle to bar decreasing apically from 65 to 50 degrees. Cross-section compressed. Denticles on posterior blade smaller in diameter, discrete, with more rounded cross-sections. Oriented at about 90 degrees to blade. Smaller, poorly developed denticles alternating with larger ones. Apical denticle at mid-length, at least three times as wide as other denticles. Cross-section compressed with sharp anterior and posterior edges. Oriented at about 40 degrees to anterior bar. Proximal denticle on anterior blade confining the diameter of the apical denticle; no restriction on posterior side. Basal cavity shallow, conical, extending aborally along blades as a narrow shallow groove. Very slight expansion on lateral surfaces.

Discussion. The specimen figured (Pl. I, fig. 4) agrees in many respects with the one shown by Walliser (Pl. 25, fig. 17). There is a faint longitudinal ridge on the holotype; in the Stonehouse specimen it is more strongly defined. The denticles on the anterior blade of Walliser's specimen are not at a constant angle to the blade, varying from 50 to 90 degrees, and those on the posterior blade are equal to each other. In the Stonehouse specimen the anterior blade denticles are at a constant angle to the blade and those on the posterior blade vary in size.

Although these differences are encountered, the Stonehouse specimens appear conspecific with *Ozarkodina jaegeri* Walliser. Only eighteen specimens were found and they are present throughout the Stonehouse Formation. These specimens are noticeably thicker than those of *Ozarkodina typica denckmanni* Ziegler.

Range. *Latialatus* to *eosteinhornensis* zones.

Occurrence. *See* Table III.

Type. Hypotype, GSC No. 21941.

Spathognathodus steinhornensis eosteinhornensis Walliser, 1964

Plate I, figures 1–3

1964 *Spathognathodus steinhornensis eosteinhornensis* WALLISER, p. 85, Pl. 9, fig. 15; Pl. 20, figs. 7–16, 19–25; Abb. 9.

Description. Unit consisting of denticulated blade with subcentral cusp and basal cavity. High blade tapering anteriorly with narrow cross-section flaring slightly near aboral edge, flare lessening away from basal cavity. Very slight longitudinal swelling about halfway down the blade. Oral view showing slight curvature at anterior end. Six or seven discrete, subequal denticles on both blade portions; cross-sections very compressed giving sharp anterior and posterior edges. Distal tapering abrupt. Denticles oriented perpendicular to blade, closely set, some fused near base. Subcentral to central cusp parallel with other denticles, and slightly larger and coarser. Cross-section compressed with sharp anterior and posterior edges. Groove extending aborally along blade, shallowing and narrowing distally, beneath cusp forming a cavity extending orally to longitudinal swelling. Edges of basal cavity expansion lobe-like, unequal, with largest expansion of lobes posterior. Outline subrectangular; anterior margin about 90 degrees to blade; angle of posterior margin variable. Smaller lobe on side of concavity of anterior portion of blade.

Discussion. The basal cavity in most of these specimens is nearly heart-shaped, but in 32 per cent of the specimens it shows a subrectangular outline. Denticle development is uniform in most specimens. There is some variation in the height of the blades, but most are high. There is also a wide range in denticle development: some are discrete and taper abruptly, others are long and fused along much of their length. In a few specimens the anterior portion of the blade tapers to about a third of the central height. Rare individuals show the cusp much the same size as the other denticles and therefore difficult to distinguish. The number of denticles varies from four to ten per blade portion, but averages six. The longitudinal swelling is not always present.

Three hundred and thirty-nine specimens of this subspecies have been found in the Stonehouse Formation. This subspecies can be differentiated from *Spathognathodus steinhornensis remscheidensis* Ziegler only if many specimens are available for study. In *remscheidensis* the denticles are not equally developed nor is the basal cavity as

rectangular as in *eosteinhornensis*. The blade height of *eosteinhornensis* is greater and more constant in the Stonehouse and Austrian specimens than in Walliser's figures of *remscheidensis*.

Range. Eosteinhornensis zone.

Occurrence. See Table III.

Types. Hypotypes, GSC Nos. 21942, 21943, 21944.

Trichonodella inconstans Walliser, 1957

Plate I, figures 7–9

1957 *Trichonodella inconstans* WALLISER, p. 50, Pl. 3, figs. 10–17.
1960 *Trichonodella inconstans* WALLISER, p. 35, Pl. 7, figs. 11–12.
1960 *Trichonodella inconstans* ZIEGLER, p. 197, Pl. 14, figs. 14, 17.
1962 *Trichonodella inconstans* ETHINGTON and FURNISH, p. 1287, Pl. 173, fig. 7.
1962 *Trichonodella inconstans* REICHSTEIN, p. 538.
1962 *Trichonodella inconstans* WALLISER, p. 283, fig. 1, no. 2.
1964 *Trichonodella inconstans* WALLISER, p. 90, Pl. 8, fig. 8; Pl. 30, figs. 10–12.

Description. Bilaterally symmetrical unit consisting of two arched denticulated lateral bars and a strong, central cusp. Lateral bars of moderate height and compressed cross-section with median divergence of about 85 degrees decreasing distally to give a U-shaped aspect in posterior view. Numerous discrete posteriorly inclined denticles with slightly compressed ovate cross-sections. Distal tapering slight; basal widening apparent. Regularly spaced, separated from each other by about half their diameter. Central cusp curved posteriorly and approximately twice the diameter of the denticles. Cross-section compressed near base, becoming square distally. Cusp extending posteriorly and forming a buttress-like process. Basal cavity triangular in outline, compressed conical in shape, lying beneath cusp and extending along bars as narrow shallow groove. No expression of basal cavity on anterior face; posterior face with basal cavity expansion extending up and along trend of cusp.

Discussion. This species varies widely and is found at every horizon within the Stonehouse Formation.

The bars are generally compressed, but some are thicker and tend to be rectangular in cross-section. The angle between the bars is constant at 85 degrees in the Stonehouse samples; however, a wide range is permissible according to the original description of the species (Walliser, 1957, p. 50). The denticles are variably compressed in cross-section. Usually distal tapering is slight, but it can be very obvious in some units (Pl. II, fig. 8). Generally, the Stonehouse specimens of this species are more U-shaped than those figured by Walliser.

The Stonehouse specimens appear to occupy one extreme within the wide range of characteristics described by Walliser (1957) for this variable species. In these specimens, even when the bars thicken to attain a rectangular cross-section, they maintain their height and do not become rod-like; the denticles are always discrete and the basal cavity is extended as a groove under the blades. Also, the angle between the bars is always 85 degrees. Because these properties are constant throughout the Stonehouse

Formation, it would appear that they characterize a distinct group within *Trichonodella inconstans* Walliser. Possibly an arbitrary division could be made on the angle of divergence of the bars. This difference may be seen between *Trichonodella excavata* (Branson and Mehl) and *Trichonodella inconstans* Walliser; the angle of the former is larger.

Range. *Sagitta* zone to Lower Devonian.

Occurrence. *See* Table III.

Types. Hypotypes, GSC Nos. 21945, 21946, 21947.

Fish Fragments

(All specimens deposited in the National Museum of Canada)

Acanthoides dublinensis (Stauffer), 1938

Plate III, figure 4

1938 *Acanthodes? dublinensis* STAUFFER, p. 442, Pl. 53, figs. 21–24, 31–34.
1944 *Acanthoides dublinensis* (Stauffer), WELLS, p. 29, Pl. 2, fig. 42; text fig. 5h.

Discussion. This species has an unornamented coronal surface. The main point of difference between it and previously described specimens of this species is the amount of convexity of the coronal surface. Generally in the Stonehouse specimens, this surface is quite flat, but a slight convexity can be detected on a few specimens. This is not sufficient evidence to warrant placing these few specimens in the somewhat similar species *Acanthoides hardyi* Wells 1944.

Occurrence. *See* Table III.

Type. NMC[1] No. 10615.

Cheiracanthoides venustus Wells, 1944

Plate II, figure 13; Plate III, figures 5–8

1944 *Cheiracanthoides venustus* WELLS, p. 25, Pl. 2, figs. 28–32; text figs. 4i, j.

Discussion. A great variability in ornamentation is found in these fish "scales". This ornamentation can consist of strong ridges of high relief or of faint indentations on the anterior coronal edge. The outline of the coronal surface varies from rhombic (Pl. III, fig. 5), through triangular (Pl. III, figs. 6–8), to posteriorly acute (Pl. II, fig. 13). The triangular shape is the most common in this collection. This species is present throughout the Stonehouse Formation.

Occurrence. *See* Table III.

Types. NMC Nos. 10616, 10617, 10618, 10619, 10620.

[1]National Museum of Canada.

Cheiracanthoides stonehousensis n. sp.

Plate III, figures 13a, b

Diagnosis. "Scale" with large spatulate posterior extension to coronal surface.

Description. Smooth, convex, rhombic basal surface. Neck slightly constricted. Coronal surface strongly ornamented with five ridges converging posteriorly from the anterior edge to a point directly above the outer corner of the base. Posterior expanded as a flange from the two lateral corners. Flange more finely ornamented than anterior portion of surface with fifteen subparallel ribs.

Discussion. This form is rare in the Stonehouse Formation. The figured specimen is the largest recovered; the others more closely approximate the rest of the dermal fragments in size.

Occurrence. See Table III.

Type. Holotype, NMC No. 10621.

Onychodus sp.

Plate III, figures 1–3

Description. "Scale" fragment with flat base and nodose ornamentation. Some units with upper surface studded with dome-like tubercles and ridges radiating toward the margins. Another unit ornamented with branch-like ridges oriented in one general direction. Two units with light amber bases (Pl. III, figs. 1, 3); another is black (Pl. III, fig. 2). All with smooth shiny surfaces and ranging in size from 0.9 to 1.4 mm.

Discussion. The six specimens of this type were found at three localities spanning most of the stratigraphic interval of the Stonehouse Formation: 31 feet from the base of the formation (GSC loc. 39094), and 126 feet and about 75 feet from the top of the shore section (GSC locs. 70352 and 70360).

Two of the figured units (Pl. III, figs. 1, 3) appear complete while the third (Pl. III, fig. 2) may be fragmentary. The third specimen is comparable to those figured by Wells (1944, Pl. 3, figs. 35, 36) as *O. sigmoides* Newberry, from the Middle Devonian Delaware Formation of Ohio.

Occurrence. See Table III.

Types. NMC Nos. 10622, 10623, 10624.

Petrodus? sp.

Plate III, figures 9–11

1933 *Petrodus*?, GUNNELL, p. 296, Pl. 32, fig. 28.

Description. Domed and radiate "scale" with flat edges and conically hollowed base. Five to seven rays extending away from central peak which has a small, hollow depression at the summit. In some samples these rays bifurcate near the outer margin.

They are high and are joined at the bottom only by a thin web-like extension of the base.

Discussion. A similar "scale" was figured by Gunnell (1933) from the Pennsylvanian Cherryvale Shale of the Kansas City Group in Missouri. In that specimen, two of the rays do not reach the centre but diverge from the other rays. This is the only figure known to the author of a unit resembling the Stonehouse specimens. These forms are rare in the Stonehouse Formation. They have been found only in two samples, both within 31 feet of the base of the formation.

Occurrence. *See* Table III.

Types. NMC Nos. 10625, 10626, 10627.

"tooth" indet.

Plate III, figure 12

Description. Large conical "tooth" fragment 1.8 mm high and 1.1 mm wide at base. Dull white surface with some red to pink coloration that may be due to post-depositional alteration. Slight ridges widely spaced along unit. Base widens. Unit broken off both at top and bottom.

Discussion. Five dissimilar units were found that could be placed in this category. The figured specimen is the largest; the others are approximately half its size.

Occurrence. *See* Table III.

Type. NMC No. 10628.

REFERENCES

Boucot, A.J.
1960: Lower Gedinnian brachiopods of Belgium; *Mém. Inst. Géol.*, Univ. Louvain, Vol. 21, pp. 279–344.

Boucot, A. J., Fletcher, R., and Griffin, J.R.
1959: Middle or Upper Ordovician in Nova Scotia; *Bull. Geol. Soc. Amer.*, Vol. 70, No. 12, pt. 2, p. 1572.

Boucot, A. J., *et al.*
1960: A Late Silurian fauna from the Sutherland River Formation, Devon Island, Canadian Arctic Archipelago; *Geol. Surv. Can.*, Bull. 65.

Branson, E. B., and Mehl, M. G.
1933: Conodonts from the Bainbridge (Silurian) of Missouri; *Univ. Missouri Studies*, No. 8, pp. 39–52.

Collinson, C., and Druce, E. C.
1966: Upper Silurian conodonts from Welsh borderland; *Bull. Am. Assoc. Petrol. Geol.*, Vol. 50, No. 3, pt. I, p. 608 (Abstract).

Copeland, M. J.
1960: Ostracoda from the Upper Silurian Stonehouse Formation, Arisaig, Nova Scotia, Canada; *Palaeontology*, Vol. 3, pt. 1, pp. 93–103.
1964: Canadian fossil ostracoda: some Silurian species; *Geol. Surv. Can.*, Bull. 117.

Denison, R. H.
1955: Devonian vertebrates from the Knoydart Formation of Nova Scotia; *Fieldiana Zool.*, Vol. 37, pp. 449–464.

Dineley, D. L..
1964: New specimens of *Traquairaspis* from Canada; *Palaeontology*, Vol. 7, pt. 2, pp. 210–219.

Ethington, R. L., and Furnish, W. M.
1962: Silurian and Devonian conodonts from Spanish Sahara; *J. Paleontol.*, Vol. 36, No. 6, pp. 1253–1290.

Gunnell, F. H.
1933: Conodonts and fish remains from the Cherokee, Kansas City, and Wabaunsee Groups of Missouri and Kansas; *J. Paleontol.*, Vol. 7, No. 3, pp. 261–297.

Harper, C. W. Jr.
1964: The brachiopod fauna of the Arisaig Series (Silurian-Lower Devonian) of Nova Scotia; California Inst. Technology, Ph.D. Thesis.

Kockel, F.
1958: Conodonten aus dem Paläozoikum von Malaga (Spanien); *Neues Jahrb. Geol. Paläontol., Mh.*, pp. 255–263.

Liebe, R. M.
1962: Conodonts from the Alexandrian and Niagaran Series (Silurian) of the Illinois Basin; State Univ. Iowa, Ph.D. Thesis.

Lindström, M.
1964: Conodonts; Elsevier Publishing Co.

McLearn, F. H.
1924: Palaeontology of the Silurian rocks of Arisaig, Nova Scotia; *Geol. Surv. Can.*, Mem. 137.

Reichstein, M.
1962: Conodonten und graptolithen aus einem Kalk-Mergel-Geschiebe des Unter-Ludlov; *Geologie*, Jarhg 11, Heft. 5, pp. 538–547.

Rexroad, C. B., and Rickard, L. V.
1965: Zonal conodonts from the Silurian strata of the Niagara Gorge; *J. Paleontol.*, Vol. 39, No. 6, pp. 1217–1220.

Rexroad, C. B., *et al.*
1965: The Silurian formations of east-central Kentucky and adjacent Ohio; *Kentucky Geol. Surv.*, ser. 10, Bull. 2.

Stauffer, C. R.
1938: Conodonts of the Olentangy shale; *J. Paleontol.*, Vol. 12, No. 5, pp. 411–443.

Walliser, O. H.
1957: Conodonten aus dem oberen Gotlandium Deutschlands und der Karnischen Alpen; *Hessischen Landesamtes für Bodenforschung, Notizblatt;* Band 85, pp. 28–52.
1962: Conodontenchronologie des Silurs (Gotlandium) und des tieferen Devons mit besonderer Berücksichtigung des Formationgrenze; Symposiums—Band z. internat. Arbeitstagung Silur/Devon Bonn-Bruxelles 1960, Stuttgart, pp. 281–287.
1964: Conodonten des Silurs; *Hessischen Landesamtes für Bodenforschung, Abh.*, Heft. 41.

Wells, J. W.
1944: Fish remains from the Middle Devonian bone beds of the Cincinnati Arch region; *Palaeontographica Americana*, Vol. 3, No. 16.

Williams, M. Y.
1914: Arisaig-Antigonish district, Nova Scotia; *Geol. Surv. Can.*, Mem. 60.

Ziegler, W.
1956: Unterdevonische Conodonten, insbesondere aus dem Schönauer und dem Zorgensis-Kalk; *Hessischen Landesamtes für Bodenforschung, Notizblatt*, Band 84, pp. 93–106.
1960: Conodonten aus dem Rheinischen Unterdevon (Gedinnium) des Remscheider Sattels Rheinisches Schiefergebirge); *Paläontol. Z.*, Band 34, pp. 169–201.

APPENDIX

Fossil Localities

GSC Loc. No.	Location
39070	500 feet upstream from mouth of North Branch of McAdam Brook. Coll. M. J. Copeland, 1959
39074	96 feet above mouth of North Branch, McAdam Brook. Coll. M. J. Copeland, 1959
39076	Traverse up Brook no. 1. North of old Government wharf, north of McAras Brook. 54 feet from mouth of creek (top). Coll. M. J. Copeland, 1959
39087	McAdam Brook. Just below contact with Knoydart Formation. Coll. M. J. Copeland, 1959
39088	McAdam Brook at falls near faults north of the main road. Coll. M. J. Copeland, 1959
39089	Blocks from ditch, north side of McAdam Brook, along highway. Coll. M. J. Copeland, 1959
70360	Traverse up Brook no 1. North of old Government wharf, north of McAras Brook. 54 feet from mouth of creek (bottom). Coll. J. A. Legault, 1964

PLATES I TO X

PLATE I

(all figures x45)

Figures 1–3. *Spathognathodus steinhornensis eosteinhornensis* Walliser (Page 17)

1a, b. Lateral and oral views; locality 70352.
Hypotype, GSC No. 21942.
2a, b. Lateral and aboral views; locality 70360.
Hypotype, GSC No. 21943.
3a, b. Lateral and aboral views; locality 70360.
Hypotype, GSC No. 21944.

Figure 4. *Ozarkodina* cf. *O. jaegeri* Walliser (Page 16)

Lateral view; locality 39093. Hypotype, GSC No. 21941.

Figures 5, 6. *Ozarkodina typica denckmanni* Ziegler (Page 15)

5. Lateral view; locality 70360. Hypotype, GSC No. 21939.
6. Lateral view; locality 39070. Hypotype, GSC No. 21940.

Figures 7–9. *Trichonodella inconstans* Walliser (Page 18)

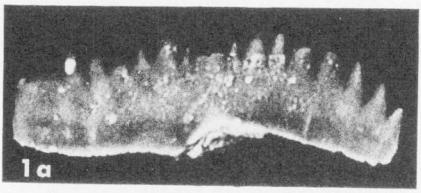
7. Posterior view; locality 70360. Hypotype, GSC No. 21945.
8. Posterior view; locality 39022. Hypotype, GSC No. 21946.
9. Posterior view; locality 38992. Hypotype, GSC No. 21947.

Figures 10–12. *Ligonodina elegans* Walliser (Page 10)

10. Inner lateral view; locality 39013. Hypotype, GSC No. 21921.
11. Inner lateral view; long lateral process with nine denticles; locality 39085. Hypotype, GSC No. 21922.
12. Inner lateral view; repaired fracture from base of cusp to basal cavity; locality 70360. Hypotype, GSC No. 21923.

Figures 13–15. *Lonchodina* sp. indet. (Page 13)

13. Posterior view; locality 70360. Fig. Spec., GSC No. 21931.
14. Posterior view; locality 39087. Fig. Spec., GSC No. 21932.
15. Posterior view; locality 70360. Fig. Spec., GSC No. 21933.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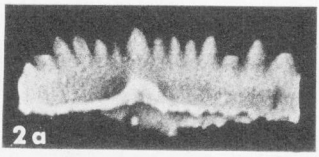
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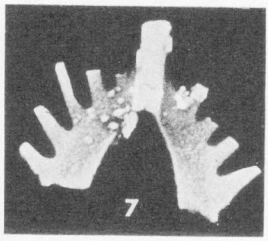
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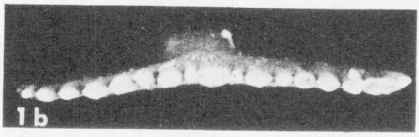
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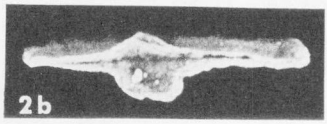
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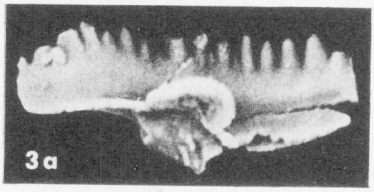
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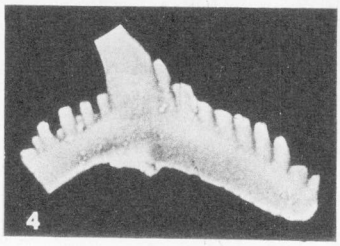
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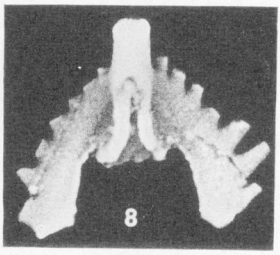
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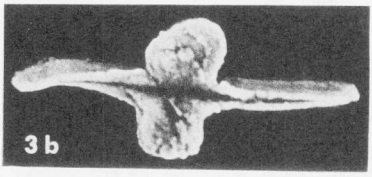
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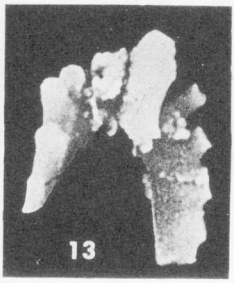
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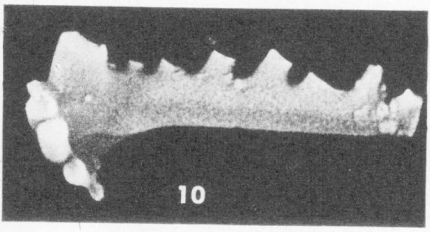
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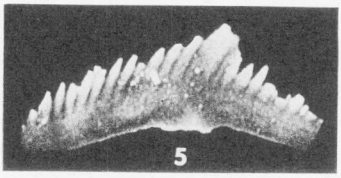
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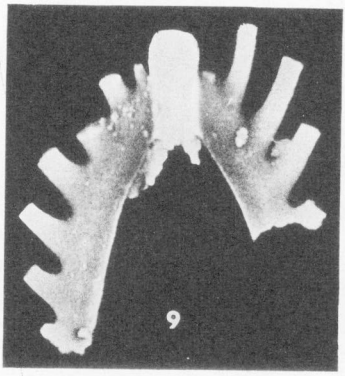
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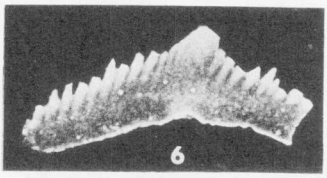
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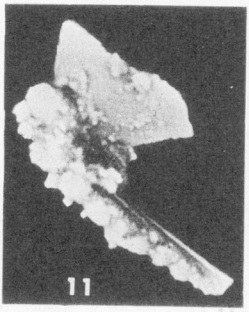
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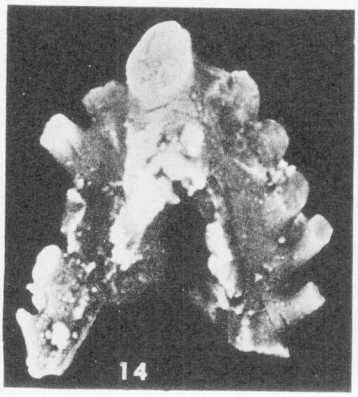
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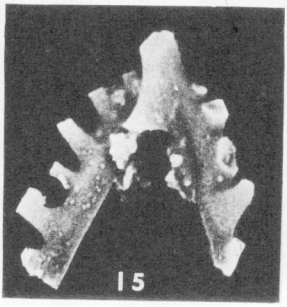
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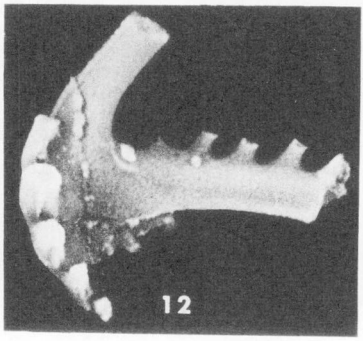
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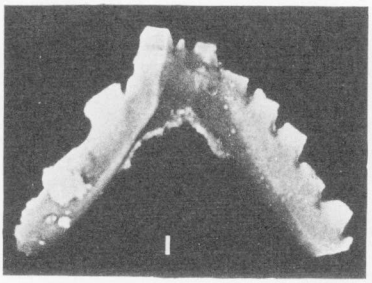
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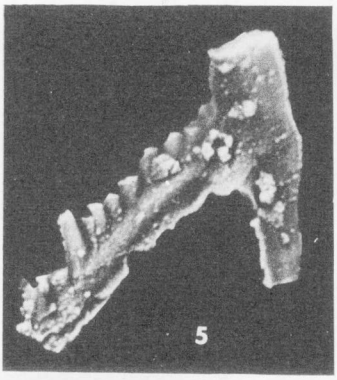
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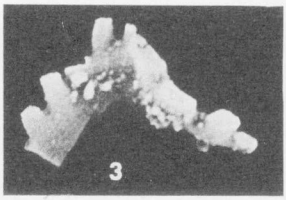
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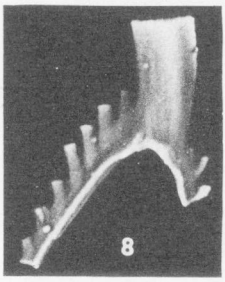
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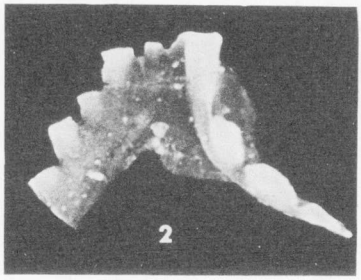
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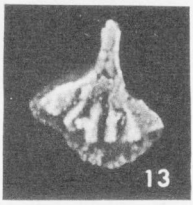
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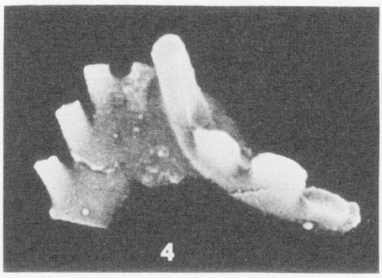
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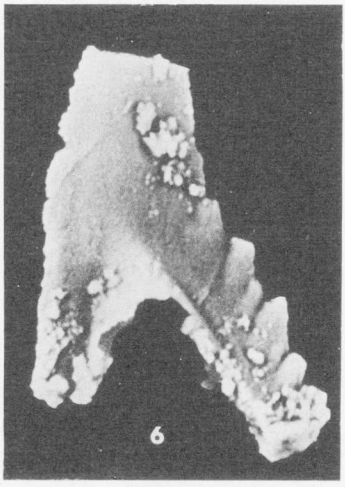
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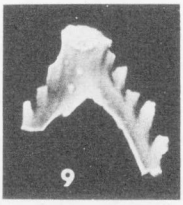
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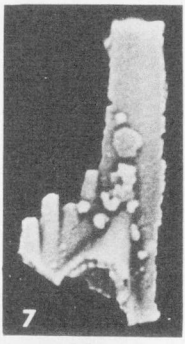
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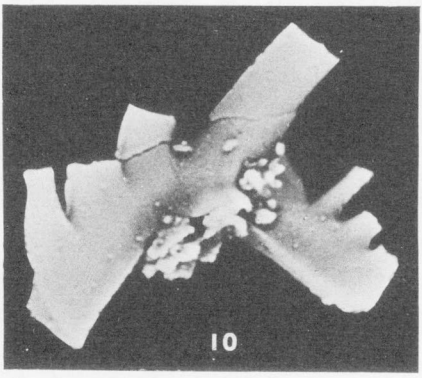
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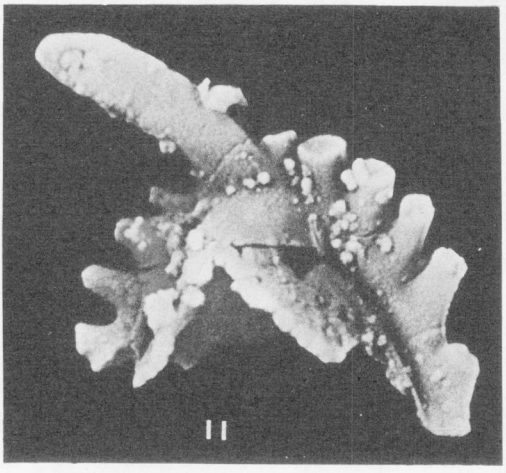
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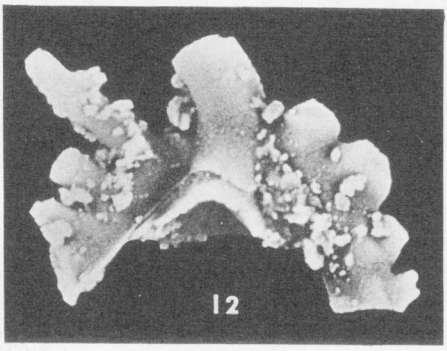
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PLATE II

(all figures x45)

Figures 1–4. *Lonchodina detorta* Walliser (Page 11)

1. Lateral view; locality 70360. Hypotype, GSC No. 21924.
2. Lateral view; repaired fracture from base of cusp to second denticle of anterior bar; locality 39019. Hypotype, GSC No. 21925.
3. Lateral view; locality 70352. Hypotype, GSC No. 21926.
4. Lateral view; locality 70360. Hypotype, GSC No. 21927.

Figures 5–7. *Neoprioniodus arisaigensis* n. sp. (Page 14)

5. Lateral view; locality 39021. Paratype, GSC No. 21935.
6. Lateral view; locality 70360. Holotype, GSC No. 21934.
7. Lateral view; locality 39012. Paratype, GSC No. 21936.

Figures 8, 9. *Neoprioniodus williamsi* n. sp. (Page 14)

8. Lateral view; locality 70360. Holotype, GSC No. 21937.
9. Lateral view; locality 38996. Paratype, GSC No. 21938.

Figures 10–12. *Lonchodina greilingi* Walliser (Page 12)

10. Posterior view; repaired fracture at base of cusp and first denticle on lateral bar; locality 70352. Hypotype, GSC No. 21928.
11. Posterior view; repaired fracture at base of cusp; basal filling; locality 70360. Hypotype, GSC No. 21929.
12. Posterior view; basal filling; locality 70360. Hypotype, GSC No. 21930.

Figure 13. *Cheiracanthoides venustus* Wells (Page 19)

Top view; locality 39012. NMC No. 10616.

PLATE III

(all figures x45, except figure 13 which is x22.5)

Figures 1–3. *Onychodus* sp. (Page 20)

1. Top view; locality 70352. NMC No. 10622.
2. Top view; locality 39086. NMC No. 10623.
3. Top view; locality 70352. NMC No. 10624.

Figure 4. *Acanthoides dublinensis* (Stauffer) (Page 19)

Top view; locality 39014. NMC No. 10615.

Figures 5–8. *Cheiracanthoides venustus* Wells (Page 19)

5. Top view; locality 39014. NMC No. 10617.
6. Top view; locality 39014. NMC No. 10618.
7. Top view; locality 39014. NMC No. 10619.
8. Top view; locality 39012. NMC No. 10620.

Figures 9–11. *Petrodus*? sp. (Page 20)

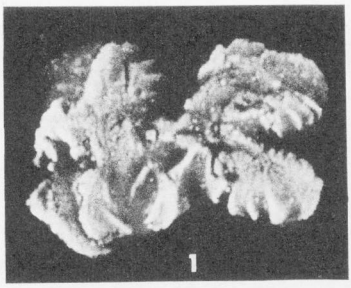
9. Top view; locality 39094. NMC No. 10625.
10. Top view; locality 39093. NMC No. 10626.
11. Top view; locality 39093. NMC No. 10627.

Figure 12. "tooth" indet. (Page 21)

Lateral view; locality 70341. NMC No. 10628.

Figure 13. *Cheiracanthoides stonehousensis* n. sp. (Page 20)

a, b. Top and bottom views; locality 38999. Holotype, NMC No. 10621.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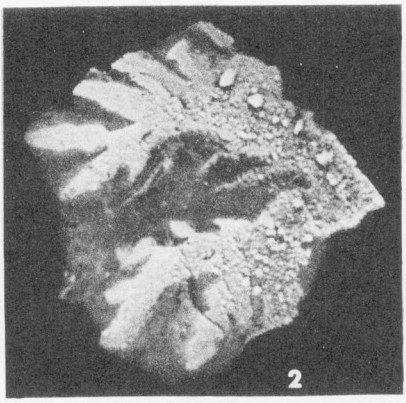
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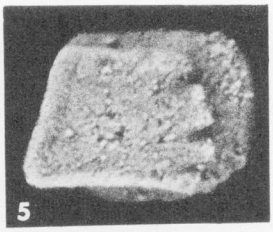
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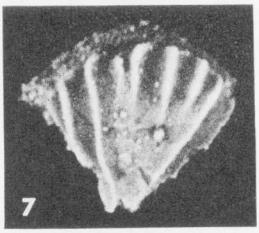
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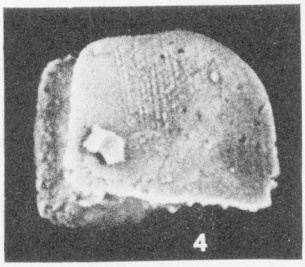
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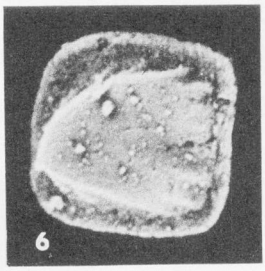
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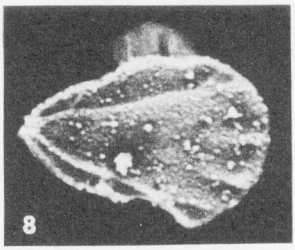
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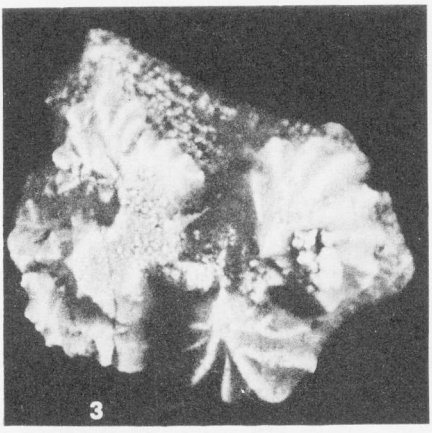
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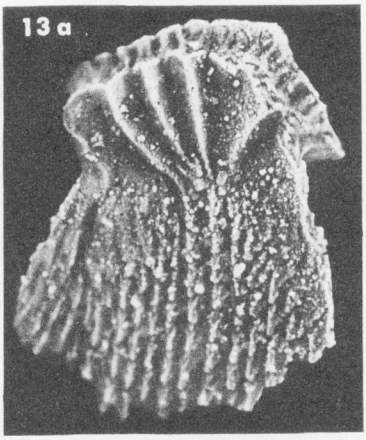
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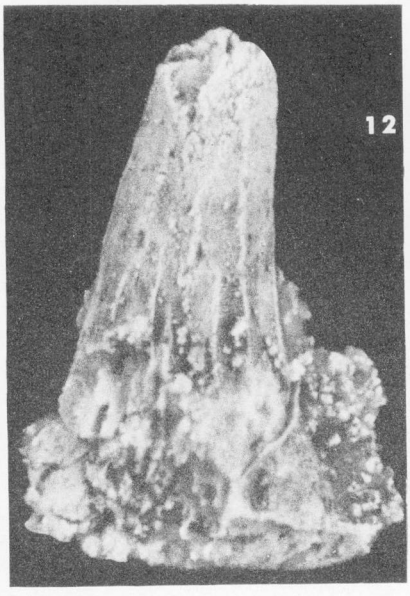
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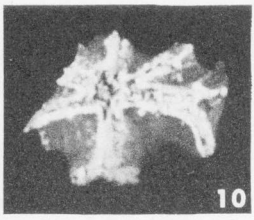
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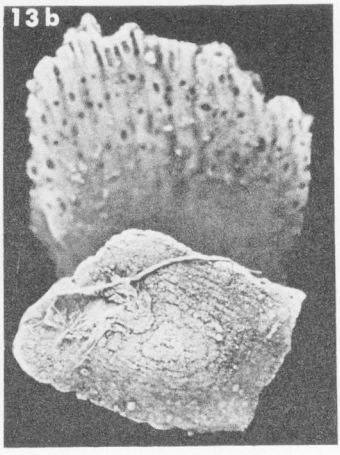
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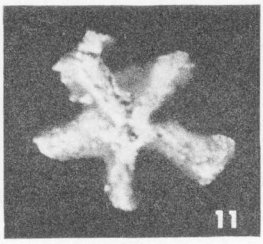
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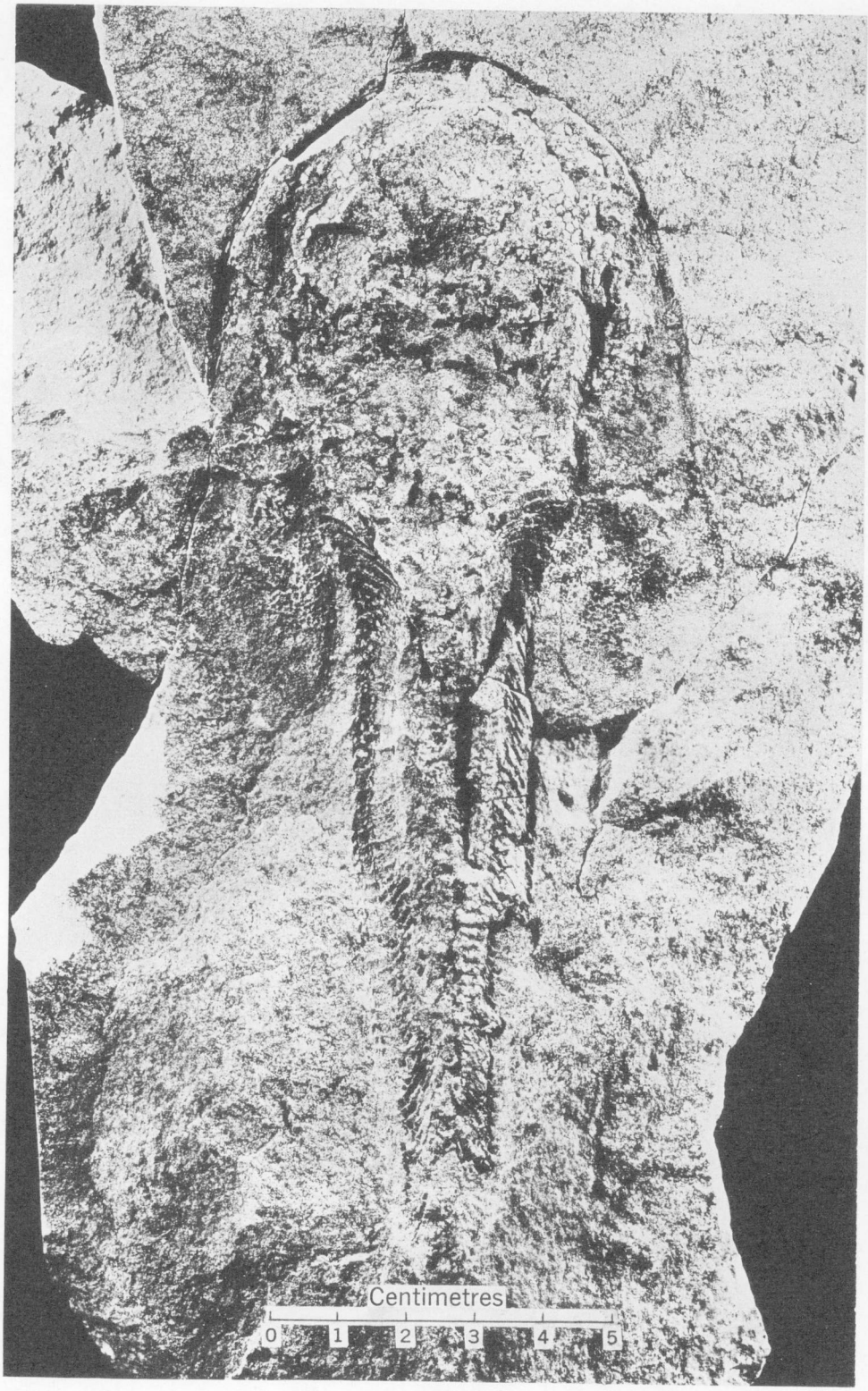
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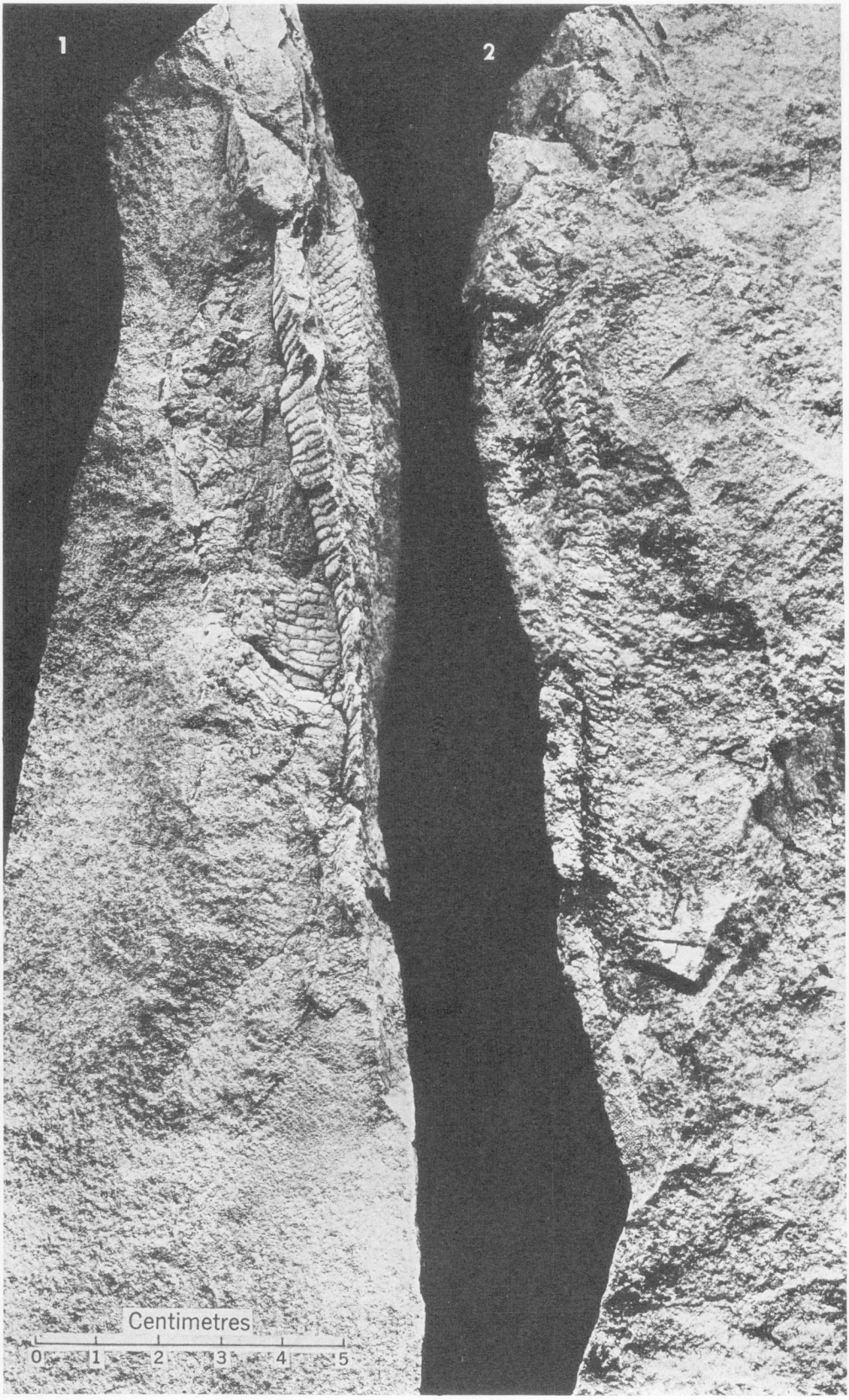
Plate IV

Hemicyclaspis murchisoni (Egerton). Specimen 1038A5. Cephalic shield, pectoral appendages, and part of squamation of trunk in dorsal view. Approximately natural size.

PLATE V

Figure 1. *Hemicyclaspis murchisoni* (Egerton).
Specimen 1038B. Right lateral view. Small fragment of cephalic shield, squamation of trunk together with disarranged scutes, dorsal fin, and tail fin. Approximately natural size.

Figure 2. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10385B, ventral view. Part of left dorsal exoskeleton, left pectoral appendage, ventral squamation of trunk and tail. Approximately natural size.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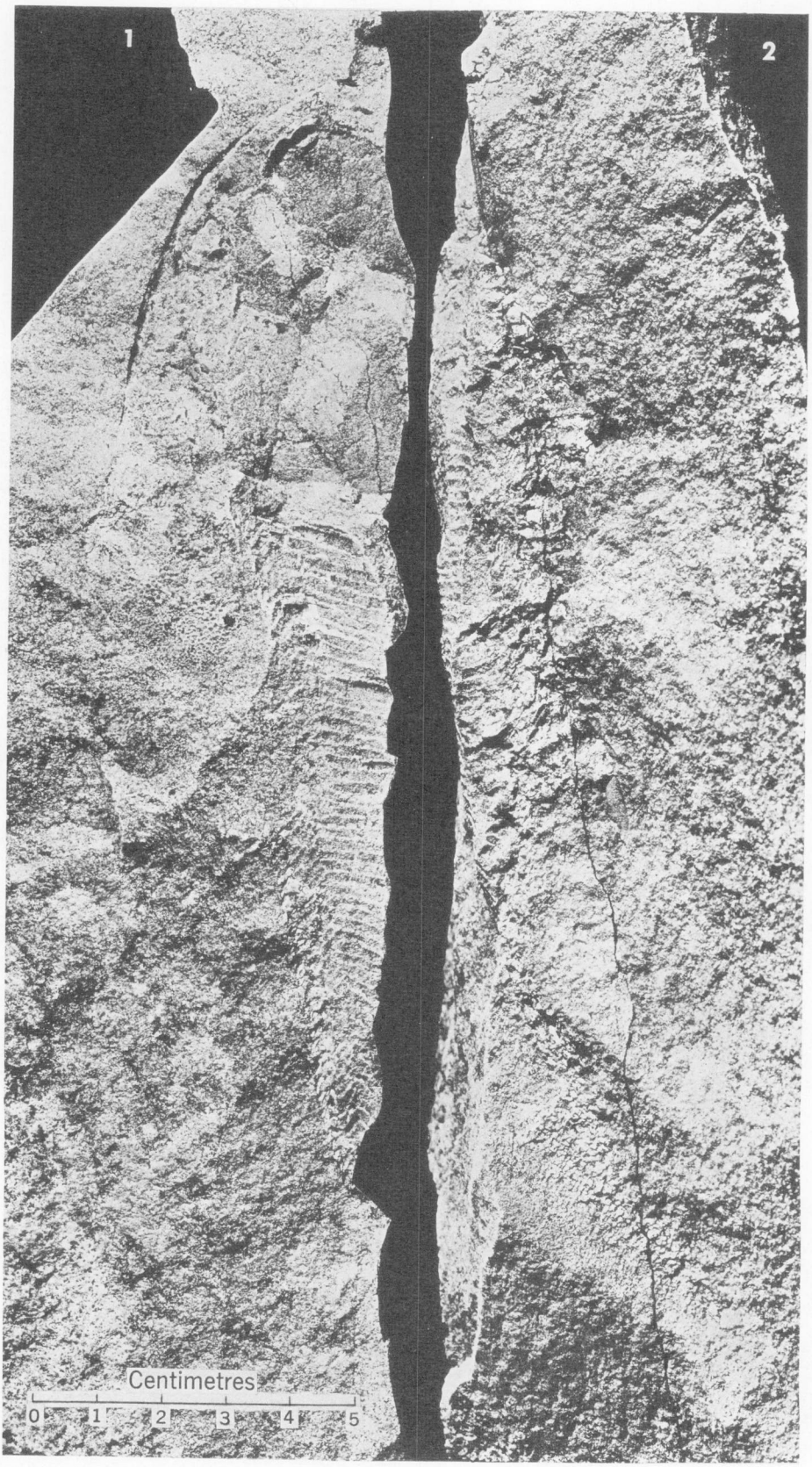
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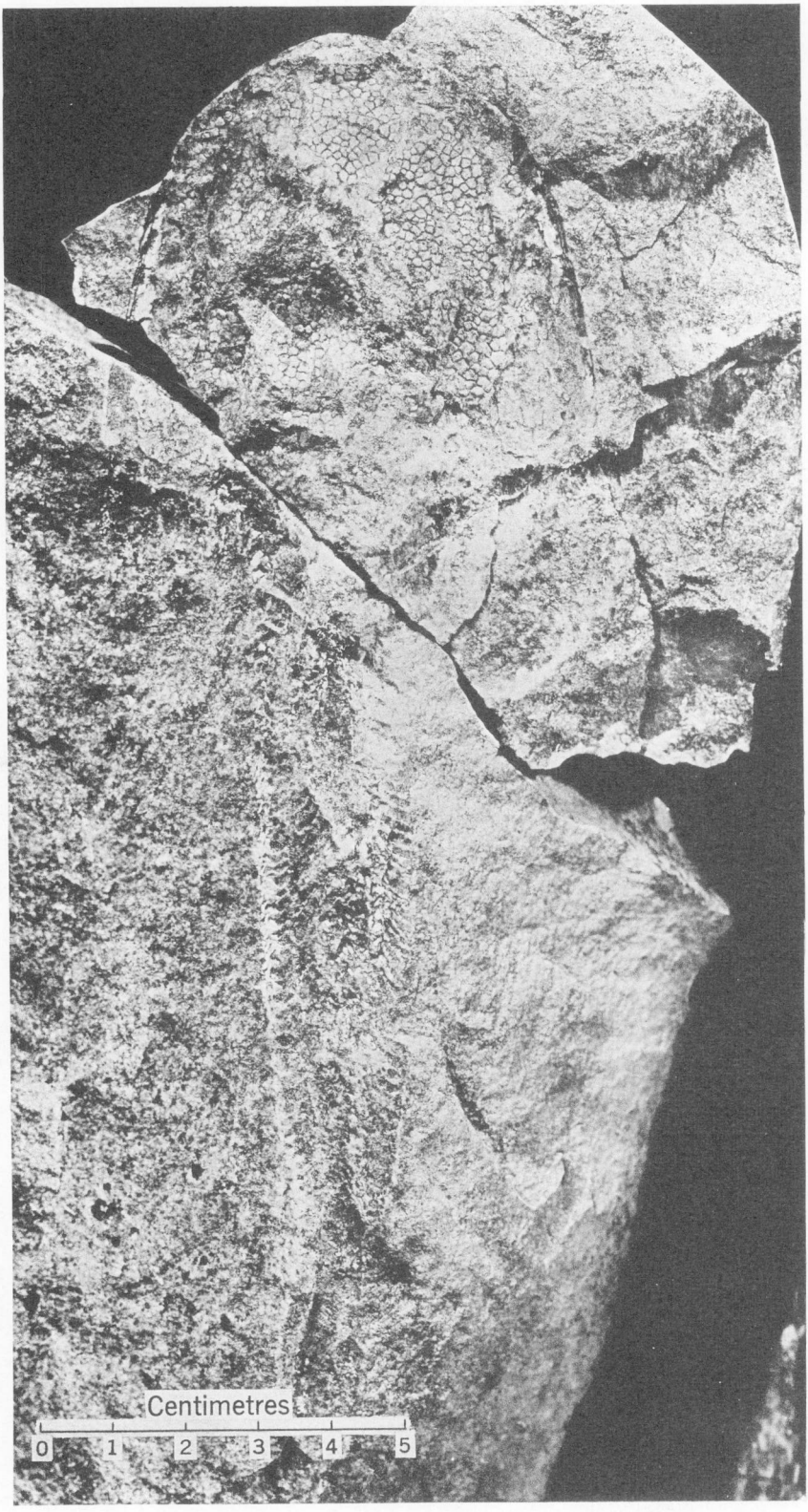
PLATE VI

Figure 1. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10385C. Impression of right dorsal exoskeleton, right pectoral appendage, and left lateral scale rows of trunk. Approximately natural size.

Figure 2. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10385C. Lateral view shows some squamation and profile of tail fin with some scales near leading edge of fin. Approximately natural size.

Plate VII

Hemicyclaspis murchisoni (Egerton). Specimen 10386A. Cephalic shield showing traces of lateral sensory fields and inter-areal canals; impression of ventral surface of both pectoral appendages and traces of scale rows as far back as the base of the tail. Approximately natural size.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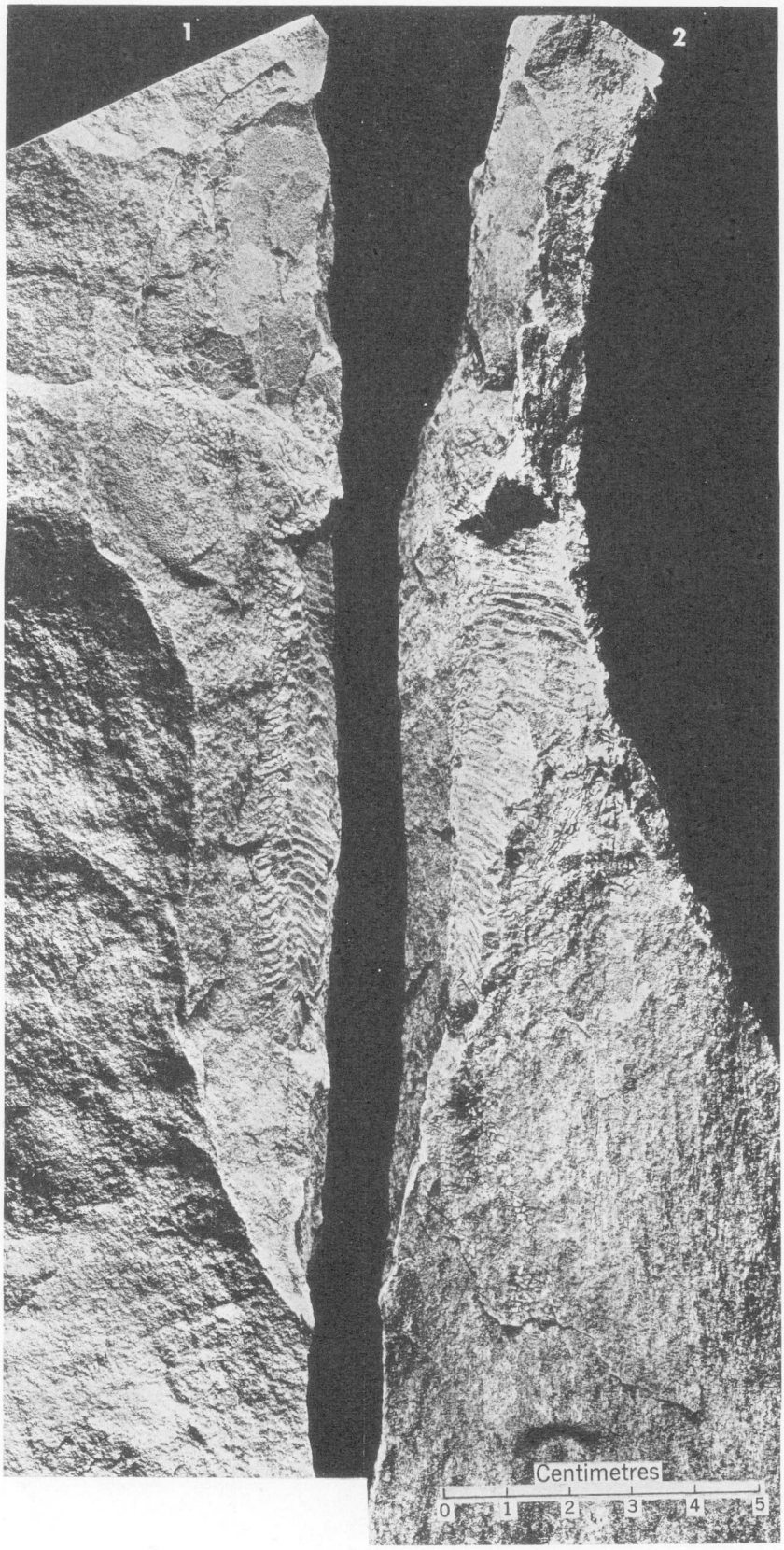
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PLATE VIII

Figure 1. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10386B. Ventral view of impression of dorsal exoskeleton of right half of cephalic shield with traces of lateral sensory field; ventral surface of right pectoral appendage and scale rows of the trunk; the squamation of the ventral lobe of the tail is faintly seen. Approximately natural size.

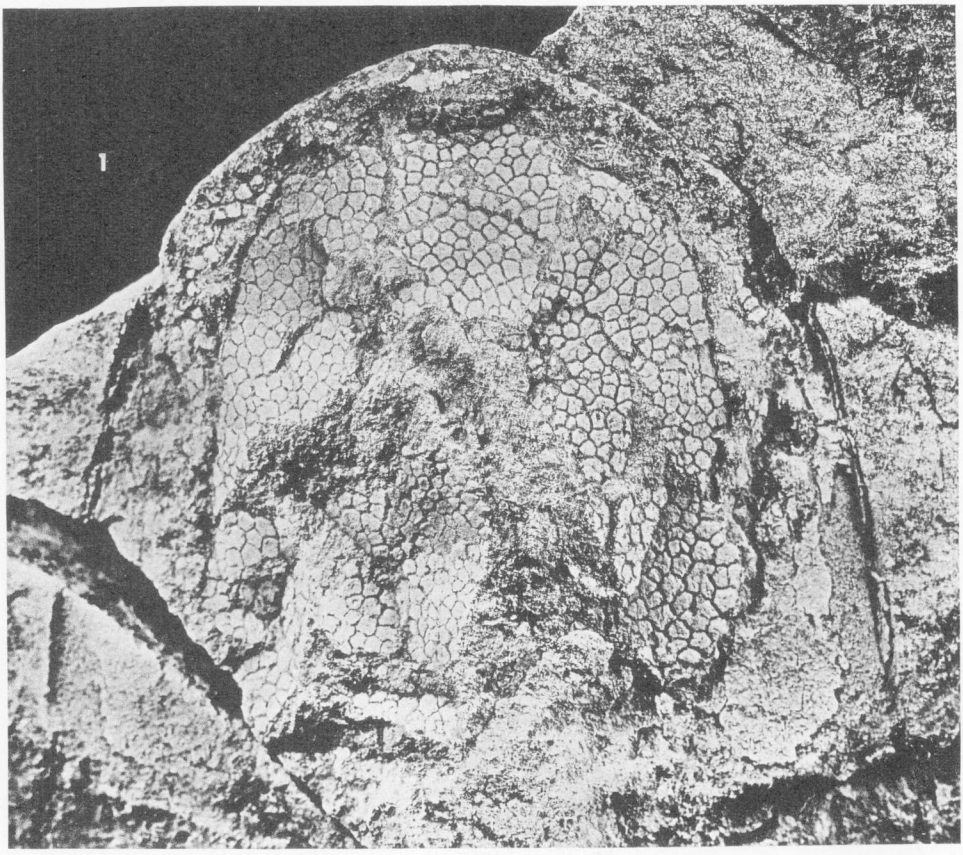
Figure 2. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10386B. Lateral view showing principally the lateral scale rows with the scutes of the dorsal crest rather scattered; the tail has some scales preserved near the lower end of the leading edge. Approximately natural size.

PLATE IX

Figure 1. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10386A. Details of the dorsal exoskeleton of the cephalic shield, showing lateral sensory fields and inter-areal canals. Approximately twice natural size.

Figure 2. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10386B. Details of ventral surface of right pectoral appendage with adjacent parts of cephalic shield and scale rows of trunk. Approximately twice natural size.

Figure 3. *Hemicyclaspis murchisoni* (Egerton).
Specimen 10385B. Details of squamation on ventral surface of ventral lobe of tail, with lozenge-shaped overlapping scales in anterior part and a flat mosaic-like shagreen of scales at the rear. Approximately twice natural size.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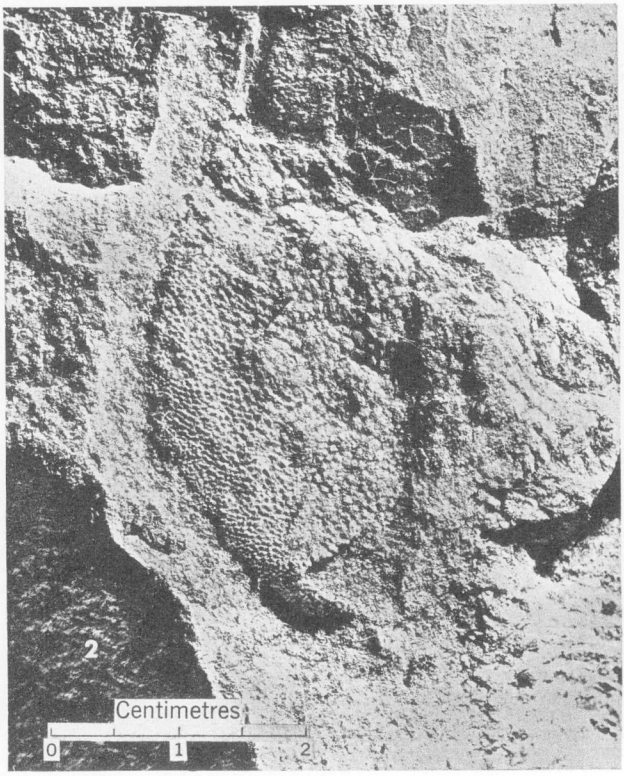
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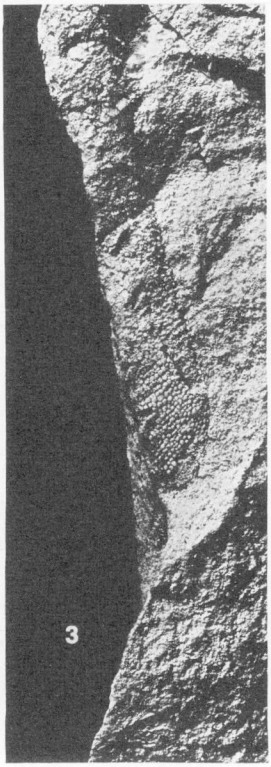
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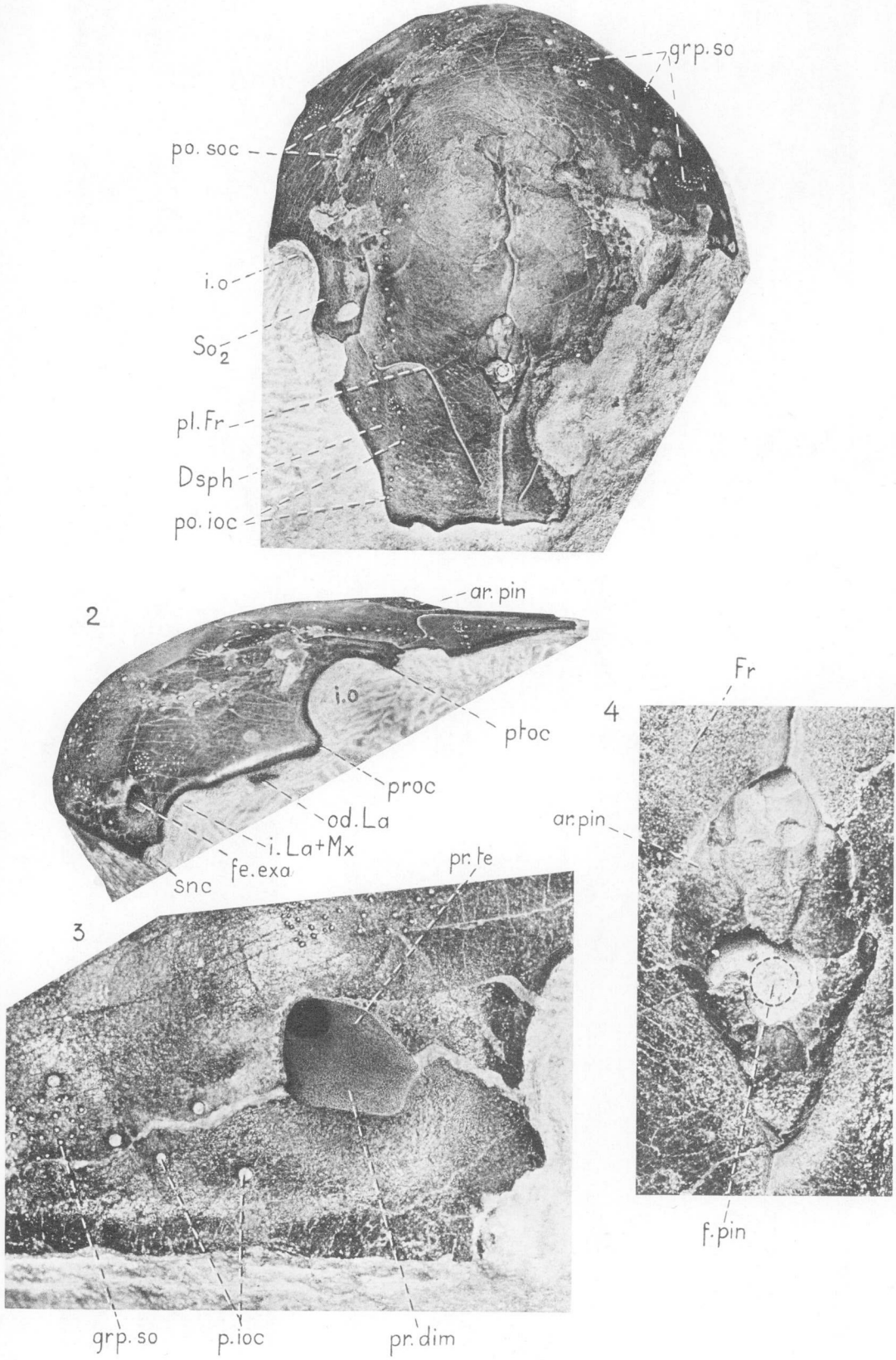
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PLATE X

(All figures retouched)

Gyroptychius? *taylori* n.sp. Holotype, NMC No. 10554. From the Nahanni (Hume) Formation west of Wokkpash Creek, north-central British Columbia.

Figures 1–2. Imperfect fronto-ethmoidal shield in dorsal and lateral views, x2.

Figure 3. Part of the shield showing the fenestra exonarina anterior of the left side in antero-lateral view, x8.

Figure 4. Detail of the shield showing the pineal area in dorsal aspect, x8.

Dsph, Dermosphenotic; Fr, frontal; So_2, posterior supraorbital; ar.pin, pineal area; fe.exa, fenestra exonarina anterior; f.pin, pineal foramen; grp.so, groups of pores probably for nerves to cutaneous sensory organs; i.La + Mx, lachrymo-maxillary notch; i.o, orbital notch; od.La, area of fronto-ethmoidal shield overlapped by lachrymal; pl.Fr, frontal pit-line; po.ioc, po.soc, pores of infraorbital and supraorbital sensory canals; pr.dim, processus dermintermedius; proc, preorbital corner; pr.te, processus tectalis; ptoc, postorbital corner; snc, subnarial corner.

PART II

OSTEOSTRACI FROM SOMERSET ISLAND

D. L. Dineley

Abstract

Osteostracans are rare among the early vertebrate faunas of the Arctic Islands, but two excellent specimens of *Hemicyclaspis murchisoni* and several other fragments of cephalaspids are recorded from the lower part of the Lower Devonian Peel Sound Formation in northwestern Somerset Island.

Résumé

Les ostéostracanidés sont rares parmi les premières faunes vertébrées des îles de l'Arctique; cependant, on a trouvé deux magnifiques échantillons de *Hemicyclaspis murchisoni*. On y a aussi découvert plusieurs autres fragments de céphalaspides dans la partie inférieure de la formation du Dévonien inférieur du détroit de Peel, dans le nord-ouest de l'île Somerset.

INTRODUCTION

Field work in the Arctic Islands is yielding an increasing number of Palaeozoic vertebrates. Devonian vertebrates were collected from Ellesmere Island as long ago as 1900 (Kiaer, 1915), but interest was rekindled with Thorsteinsson's discoveries of Silurian and Devonian ostracoderms on Cornwallis and other islands in the District of Franklin (Thorsteinsson, 1958; Fortier, *et al.*, 1963). Despite the local abundance of ostracoderms near the base of the Peel Sound Formation on Somerset Island (Dineley, 1965a, 1966), osteostracans are remarkably rare. Most of the fossils are cyathaspidids or other pteraspidomorphs. During field work in 1964 a single large slab of sandstone was found bearing parts of two cephalaspids within a few inches of one another and orientated parallel (Dineley, 1965a, 1965b). In 1965 the remainder of one of these fossils and most of the missing parts of the other were collected. Apart from these, the entire season's labours produced only three further small and poorly preserved remnants of osteostracans. These fossils are described below.

Although they form an important part of the ostracoderm faunas of certain Downtonian–Dittonian rocks in northern Europe and Spitsbergen, cephalaspid osteostracans are not common in North America. They have been recorded from eastern Canada (Traquair, 1890, 1893; Ami, 1901; Russell, 1939, 1954; Robertson, 1936, 1937, 1941; Denison, 1955; Örvig, 1957) and the western United States (Branson and Mehl, 1931; Bryant, 1933; Denison, 1952), but never in large numbers. Apart from Örvig's *nomina nuda Escuminaspis* and *Alaspis* from Escuminac Bay, Quebec, all have been referred to the genus *Cephalaspis*.

Thus the discovery of *Hemicyclaspis murchisoni* (Egerton) in the Peel Sound Formation on Somerset Island is of much interest. The species has previously been recorded in Britain (see Stensiö, 1932; Wills, 1947, 1948; Ball, 1951) and Norway (Kiaer, 1931). It is regarded as an index fossil for the lowest Downtonian of Britain (White, 1950), and the present discovery is in accord with this stratigraphic designation. *Hemicyclaspis* has been placed in the family Ateleaspidae by Traquair (1899) and in the group Hemicyclaspinae by Heintz (1939). These are well defined natural entities as described by Heintz (1939), Westoll (1945), and Denison (1951), and range from Lower Ludlow to Downtonian in age.

A distinctive and interesting feature of the family is the possession of conspicuous pectoral appendages ('fins'), the evolution of which both Heintz (1939) and Westoll (1945) have discussed. Unfortunately, as Denison (1951, pp. 187–188) points out, the evolution of the pectoral appendages does not coincide with that of other diagnostic features in the group and so far ". . . study of the evolution of this family is

Ms. received 28 December, 1966.

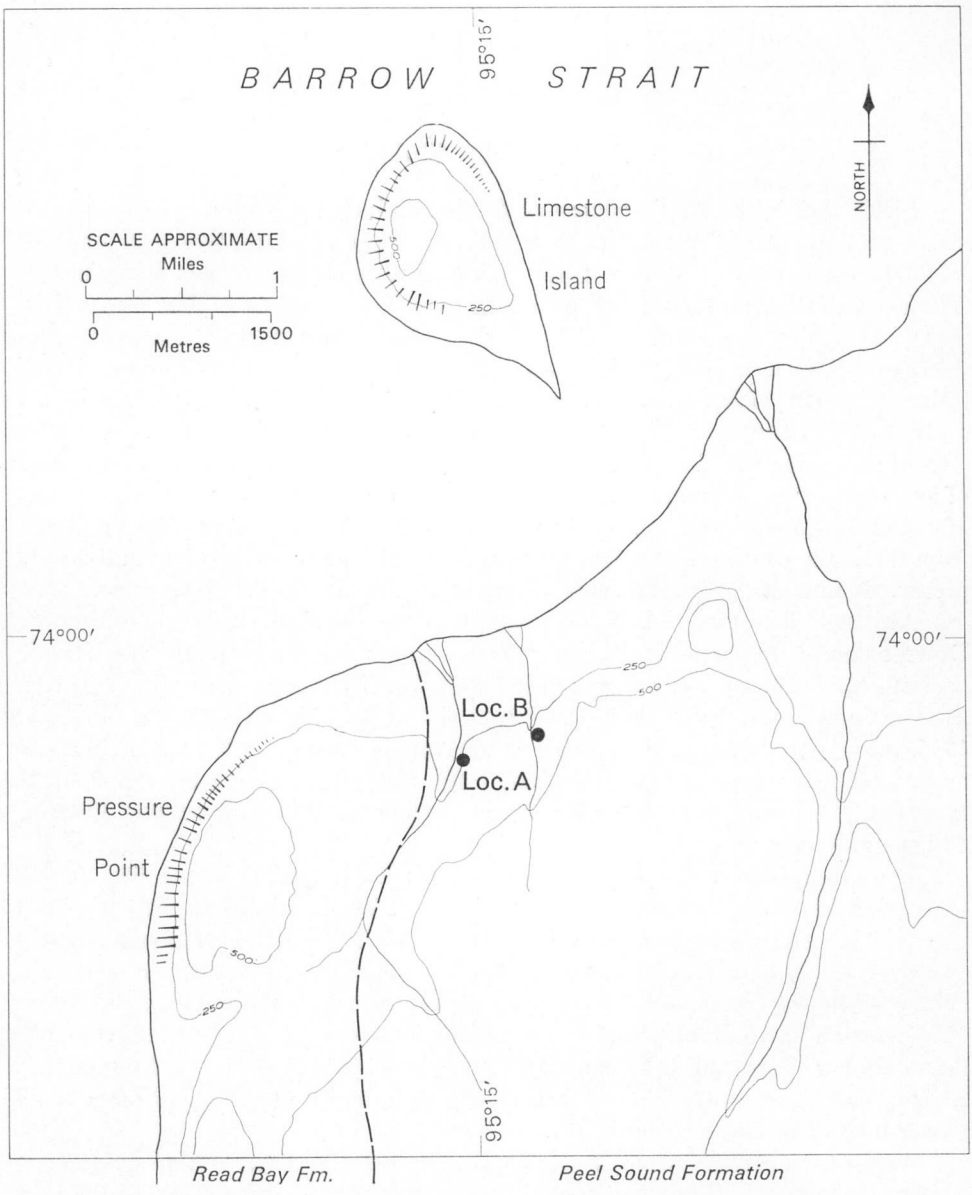

FIGURE 2. Northwestern corner of Somerset Island, Northwest Territories, *Hemicyclaspis* locality, Loc. A; cephalaspid locality, Loc. B.

impractical since the relative stratigraphic position of most of the known forms is highly controversial" (Denison, *op. cit.*). With this in mind, an intensive search of the local vertebrate horizons of the Peel Sound and underlying Read Bay Formations was made. More and more vertebrate localities within the Read Bay Formation are coming to light and the search continues.

The *Hemicyclaspis* fossils (NMC numbers 10385 and 10386)[1] were found in a fine, white crossbedded sandstone, about 5 feet thick, some 40 feet above the floor of a stream gorge immediately east of the hill at Pressure Point in northwestern Somerset Island (Fig. 2, loc. A). The stream flows north and lies no more than 100 yards east of the boundary between the Peel Sound and Read Bay Formations. The horizon, located at the northern end of the gorge, about three-quarters of a mile from the shore, is between 50 and 60 feet above the base of the Peel Sound Formation. The bed yielding the other cephalaspids (NMC Cat. Nos. 10387, 10388, 10389) is located at the mouth of a smaller gully some 250 feet higher in the succession and half a mile to the east (Fig. 2, loc. B). A similar fauna occurs at each locality, and includes both small and large cyathaspidids, traquairaspids, *Corvaspis*, acanthodians, and perhaps other vertebrates (Dineley, 1966).

SYSTEMATIC PALAEONTOLOGY

Order OSTEOSTRACI Lankester 1868

Family ATELEASPIDAE Traquair 1899

(HEMICYCLASPINAE Heintz 1939)

Genus ***Hemicyclaspis*** Lankester 1870

Hemicyclaspis murchisoni (Egerton)

Plates IV–IX

Cephalaspis murchisoni	Egerton, 1857, p. 284, Pl. ix, fig. 1.
Cephalaspis ornatus	Egerton, 1857, p. 285, Pl. ix, figs. 2, 3.
Hemicyclaspis murchisoni	Lankester, 1870, p. 51, Pl. viii, fig. 6; Pl. ix, fig. 1; Pl. xii, figs. 3. 4.
Cephalaspis murchisoni	Woodward, 1891, p. 185, text-figs. 24, 25; Pl. ix, fig. 6; Pl. x, figs. 1–4.
Cephalaspis murchisoni	Patten, 1903, p. 847 etc., Pl. i, figs. 1, 3, 5; Pl. ii, figs. 7, 8.
Cephalaspis murchisoni	Jaekel, 1911, p. 35, text-fig. 21.
Hemicyclaspis	Stensiö, 1927, p. 246.
Hemicyclaspis murchisoni	Stensiö, 1932, p. 77, text-figs. 5A, 7, 8, 15–17, 18A, 19, 22–26; Pls. 1–7; Pl. 8, figs. 1, 3; Pl. 9; Pl. 10, fig. 2; Pl. 16, fig. 1; Pls. 57, 60; Pl. 64, fig. 1; Pl. 65, figs. 1–3.
Hemicyclaspis murchisoni	Heintz, 1939.
Hemicyclaspis murchisoni	Wills, 1948, Pl. II

[1]All specimens are deposited in the Vertebrate Palaeontology collections of the National Museum of Canada, Ottawa; Catalogue numbers are given.

Diagnosis. A *Hemicyclaspis* with rostral angle fairly obtuse. Cornual angles rather pointed. Exoskeleton with well-developed, continuous superficial layer, with or without tubercular ornament. Pore-canal system enclosed in exoskeleton, either consisting of simple inter-areal canals and networks of fine intra-areal canals or developed as more or less uniform, fine-meshed network. (Holotype is a cephalic shield, No. 8103, in the Geological Survey Museum, London, England.)

Material. Two fairly complete specimens (NMC Nos. 10385 and 10386), of which one is in three parts (10385 A, B, C) and the other in two (10386 A, B) (Pls. IV–IX).

Description. Both specimens are preserved in almost full relief, though they have suffered through the inward collapse of the body walls. The fossils are each broken into similar longitudinal fragments with the ventral surface separating from each of the dorso-lateral surfaces. The left dorso-lateral part of specimen 10386 has not been found. Most of the bony tissue has gone, but a little remains in the head shields and on the trunk and appendages. The fine sandstone matrix preserves the external form of the fossil with considerable local detail.

The cephalic shields do not appear to have been very greatly flattened, only the central parts have been crushed by post-mortem pressure. The tail fin in each specimen is preserved remarkably in the living position and with no obvious distortion.

Measurements	10385	10386
Total length from rostral angle to tip of caudal fin	25.5 cm approx.	24.5 cm approx.
Length of cephalic shield from rostral angle to posterior end of interzonal part	6.4 cm approx.	6.8 cm approx.
Maximum height of cephalic shield	1.9 cm approx.	1.8 cm approx.
Maximum breadth of cephalic shield	7.0 cm	6.9 cm

Specimen number 10385, although broken into three pieces, preserves an impression of the greater part of the *Hemicyclaspis* exoskeleton. The three fragments correspond roughly to the ventral surface and the two dorso-lateral surfaces of the animal. Each piece had been separated from the others for some time before they were discovered: the rock surfaces are no longer fresh. Fragment 10385A (Pl. IV) preserves the outline of the cephalic shield, pectoral appendages and trunk almost to the tail. Little of the bony tissue remains. Although the rim of the cephalic shield appears unbroken, the more central parts are crushed or missing. Nothing can be seen of the ventral surface of the shield but patches of the dorsal exoskeleton are attached, revealing the inter-areal canals. The outlines of both pectoral appendages can be distinguished but there is nothing to indicate more than a few patches of squamation, except where a few tiny scales remain near the antero-lateral margins. The trunk is narrow, tapering from 3.4 cm at the anterior end to about 1.2 cm at the rear. Most

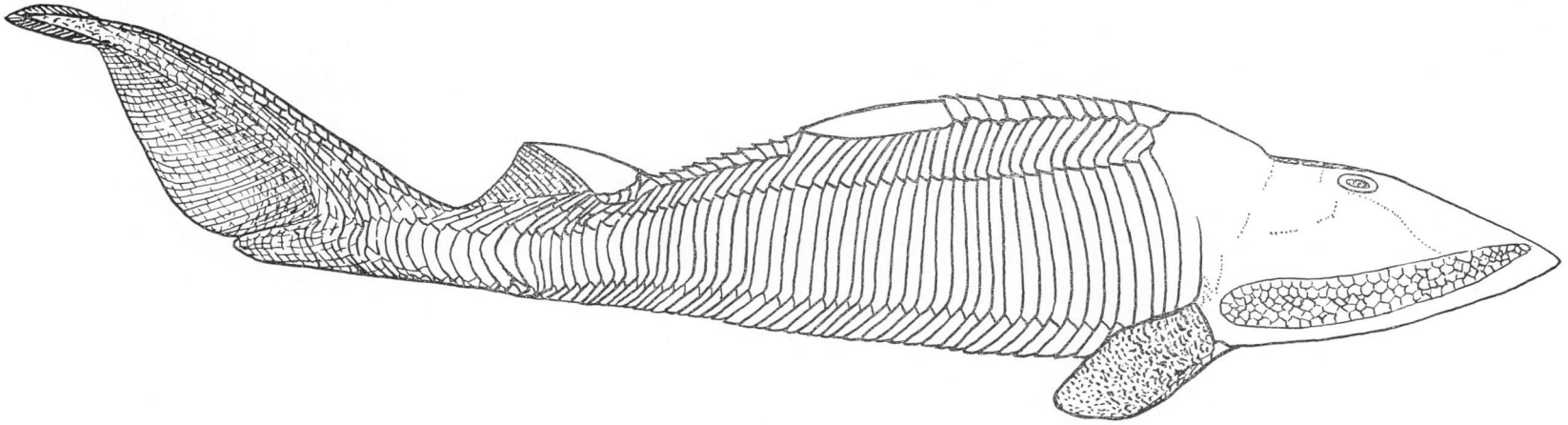

FIGURE 3. Restoration of *Hemicyclaspis murchisoni* (Egerton), based on the specimens from Somerset Island and on Stensiö (1932). This restoration differs from Stensiö's in the shape and orientation of the tail and in the size and shape of the pectoral "fin". Approximately x0.9.

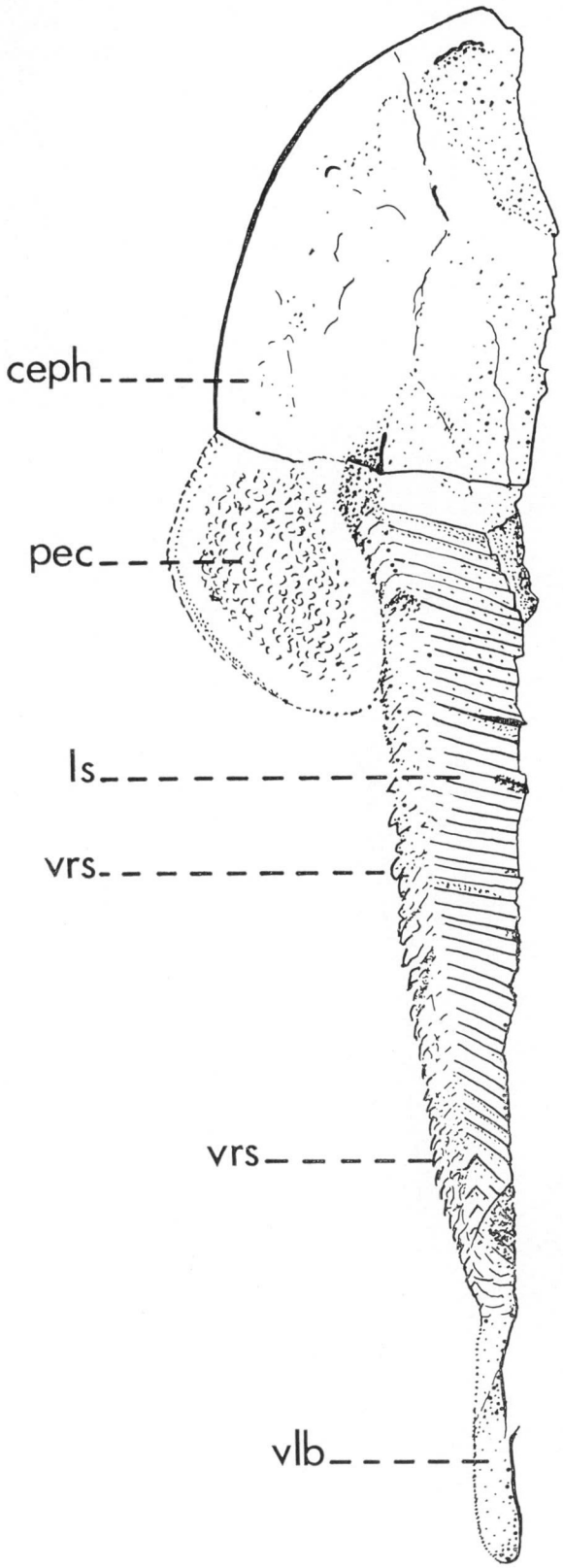

FIGURE 4.

Hemicyclaspis murchisoni (Egerton). Sketch of ventral aspect of specimen 10385C. Ceph, cephalic shield; pec, right pectoral appendage; ls, lateral scale; vlb, ventral lobe of tail; vrs, ventral scale. Natural size.

of this part of the fossil shows the internal impressions of the flank scales, but some ventral squamation can be seen rather indistinctly on the left side. The right side shows traces of some 40 lateral scale rows, with lateral and ventro-lateral scales represented.

Fragment 10385B (Pl. V) shows much of the left side of the head in ventral aspect, the left pectoral appendage, the larger part of the ventral and right lateral squamation, the dorsal crest of the trunk, and the profile of the tail fin. The inner parts of the impression of the head shield are badly crushed but a small patch of the dorsal exoskeleton showing the polygonal pattern of inter-areal canals remains, as does a part of the hind median region of the ventral surface (a broken mosaic of small plates). The pectoral appendage lacks the outer edge and shows a little of the ventral scales near the outer front end as well as the scales of much of the dorsal surface.

The ventral scale rows of the trunk appear to have been pushed up into the body cavity, but remain fairly intact at the left lateral edge. Some 53 scale rows have been counted, but the hindmost are indistinct. They are replaced by lozenge-shaped scales about 0.2 cm in diameter which occupy about 1 cm of the trunk just in front of the flat ventral surface of the ventral lobe of the tail. This latter feature is 0.6 cm wide and 2.2 cm long, covered in tiny scales.

In lateral view (Pl. V, fig. 1) this specimen shows the lateral scale rows crushed downwards, and separated from the dorsal crest in the anterior-most 4–5 cm. The dorsal crest is represented by 15 small dorsal scutes, more or less in place, and by faint impressions of both the large dorsal scute and the dorsal fin. The caudal fin retains its typical shape but nothing of the squamation is preserved except a number of disarranged tiny scales at the proximal end. The remarkable upright position of this fin must indicate rapid burial of the corpse.

The remaining fragment of this fossil, 10385C (Pl. VI), is largely the counterpart of the two pieces just described. Almost no trace of skeletal material remains except in the dorsal scutes, ventro-lateral scales, and the antero-dorsal part of the tail. The dorsal surface of the cephalic shield is badly crushed but indicates a smooth external surface; the right lateral sensory field with its irregular mosaic of small plates is represented. Although the cornual and posterior parts of the cephalic margin are more or less intact, no detail of the attachment of the pectoral appendage can be seen. The scale rows and dorsal crest have suffered damage from weathering and the crest appears to have been greatly disrupted before lithification of the sediment took place. The tail reflects the outline and characters seen in fragment 10385B but with rather more of the tiny scales indicated near the leading edge of the upper lobe. They are diamond- or lozenge-shaped, perhaps with relatively large overlap areas.

Specimen 10386, in two parts, shows much the same details as its fellow. The dorsal surface and outline of the cephalic shield, traces of the pectoral appendages, and of the trunk and tail remain in fragment 10386A (Pl. VII), whereas fragment 10386B shows considerable detail of the squamation of appendage, trunk, and tail. Once again, the dorsal crest is crushed and scattered. In this individual much of the dorsal exoskeleton survives showing the inter-areal canals (Pls. VII, IX). The left lateral sensory field can be distinguished but no details of the dorsal field, orbits, etc.,

are to be seen. Fragment 10386A shows only indistinct and incomplete outlines of the pectoral appendages. The scales of the trunk and base of the tail are also preserved somewhat indistinctly, most of the actual tissue and some of the matrix having been weathered away.

The other fragment 10386B (Pl. VIII) of this fossil shows the right dorsal surface of the head shield in ventral aspect, the ventral surface of the right appendage, and parts of the squamation of the trunk and tail. The dorsal crest is badly crushed and the dorsal fin not discernible, but the tail is well preserved in vertical outline, and, although the scales are disarranged, there are many remaining in the front part of the upper lobe of the tail.

There is typically a very rounded rostral angle in both specimens and cornua are lacking. Specimen 10385C shows the small postero-lateral angle (Stensiö, 1932, text-fig. 23 C) and a posterior margin to the shield corresponding closely to that in Stensiö's figure (1932, text-fig. 23).

It is unfortunate that little can be said of the detailed cranial morphology. The dorsal sensory fields, orbits, nasal openings, etc., are not distinguishable in either specimen but the right lateral field is seen in both (10385C, 10386B). Each field is covered by the usual mosaic of small polygonal plates and is somewhat affected by crushing.

The outer surface of the cephalic shield seems to be smooth, without tubercles or striae, as far as can be seen, except for faint striations on the ventral side of the cephalic rim. In both specimens the pore-canal system is locally well enough preserved so that patches of inter-areal canals in the usual tight plexus arrangement can be distinguished. Except for a very small area of polygonal plates in specimen 10385B, the visceral exoskeleton is not preserved nor can the position of the external branchial openings be seen. There is no trace of the mouth.

The abdominal region of the trunk seems to have possessed the usual triangular cross-section. This is emphasized by the inward collapse of the dorso-lateral walls and by the marked concavity of the ventral surface. Because of the way in which the fossils have broken into several fragments, the position of the anal opening, reputedly between the 36th and 39th transverse rows of scales (Stensiö, 1932, p. 81) is not seen. The dorsal scutes have been thrown into much disarray but are clearly small, rather scimitar-shaped in lateral profile, and arranged in a single line along the entire dorsal crest. Although most of the lateral and ventral scale rows have been broken, the basic pattern of dorso-lateral scales, lateral scales, and ventro-lateral scales can be observed. The area of overlap with the scale behind is about half the width of the scale. The ventral scale rows are preserved best in specimen 10385B and are most indistinct in the other fragments. It is not possible to see how on the ventral surface the scales of the one side articulate with those on the other side of the mid-line. Stensiö (1932, p. 59) thought it likely that about the mid-line each scale of the one side articulated with two of the other.

The caudal region of the trunk is said by Stensiö (1932, p. 81) to assume "a narrow, oval shape" (cross-section). In specimen 10385B just anterior to the tail fin

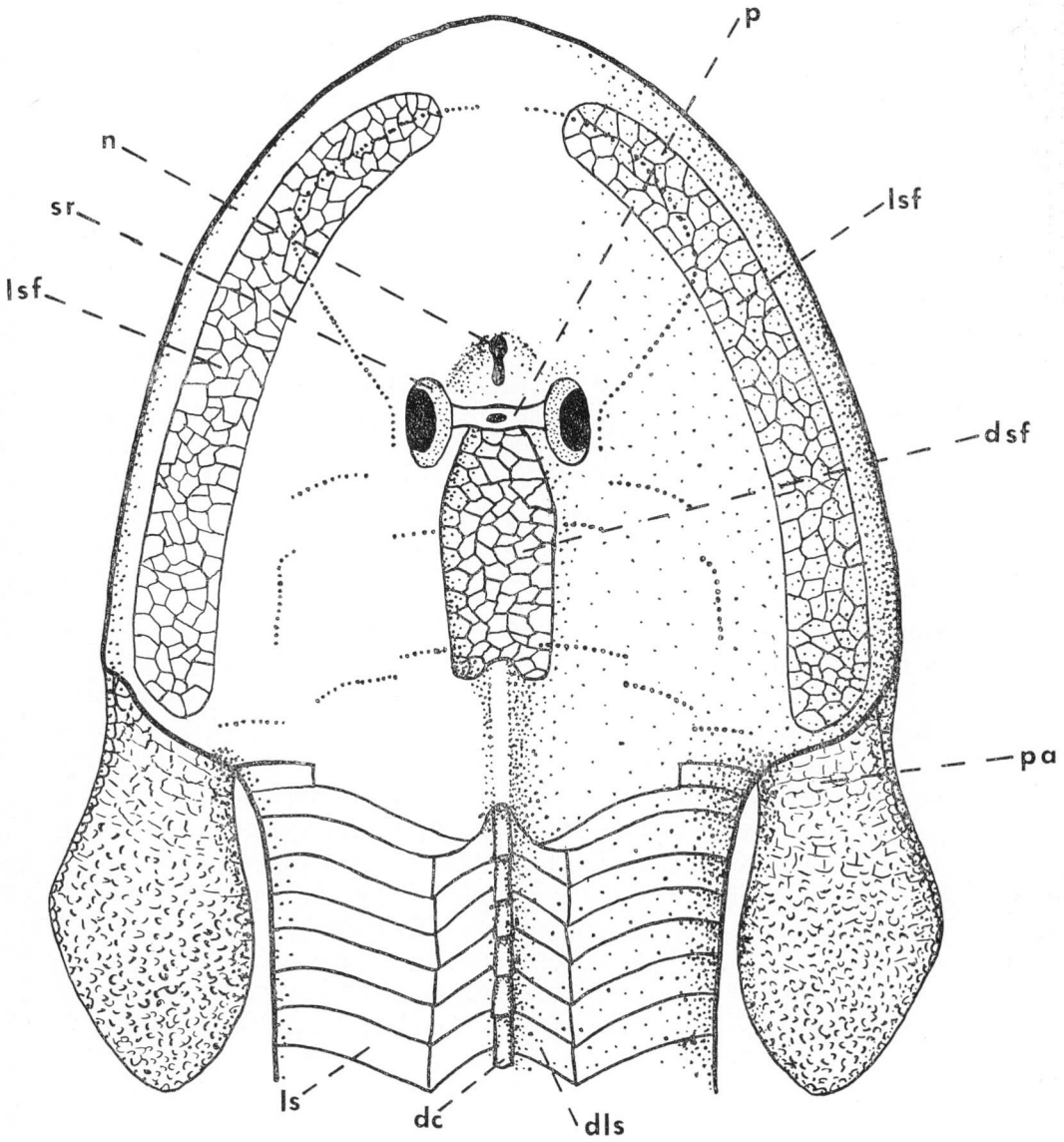

FIGURE 5. Restoration of cephalic shield and pectoral appendages of *Hemicyclaspis murchisoni* (Egerton) based on the specimens from Somerset Island and on Stensiö (1932). dc., dorsal crest of scutes; dls., dorsolateral scale; dsf., dorsal sensory field; lsf., lateral sensory field; n., nasohypophysial opening; p., pineal plate with pineal opening; pa., pectoral appendage; sr., sclerotic ring. Natural size.

is about 1 cm of small rhomboidal overlapping scales on the ventral surface. These are clearly adapted to a rounded body surface unlike the flatter surface farther forward.

The dorsal fins are poorly preserved but the large unpaired imbricating scales are present, the hindmost scute of the anterior dorsal fin crest being about 1 cm long in 10385B. The posterior dorsal fin in this same specimen is rather large with a leading scute or spine about 1.2 cm long. The fin membrane with its small closely set scales has been ruptured.

The caudal fin is well preserved in outline though details of the lateral squamation are obscure. At the base of this fin a ventral axis has been recognized in European specimens. In the Somerset Island fossils, it is an apparently sturdy, well-developed feature, the ventral surface of which is flat and covered by a fine shagreen of tiny rhomboidal scales. It is 0.7 cm wide and at least 3 cm long in each specimen, and tapers dorsally into the proximal part of the fin membrane.

The pectoral appendages are well developed, stout, and both dorsal and ventral surfaces are covered by a mosaic of very small irregular scales. These scales are as much as 0.2 cm across in the proximal part of the appendage, but at the outer edge and distally they are less than 0.05 cm. It is not easy to see that these scales imbricate as stated by Stensiö (1932, p. 81). The thickness of the appendages (2–3 cm) suggests that they were probably strong, muscular, and flexible, not stiff. The appendages in the present specimens seen to be somewhat shorter and broader than those in the British specimens but the difference is minor.

Remarks. So many of the specific diagnostic characters can be observed in the Somerset Island specimens that there can be no doubt of their identity with *Hemicyclaspis murchisoni* (Egerton). They are of the same general size and proportions as those in the British Museum (Natural History), particularly the material Stensiö (1932, p. 84) proposed as the new variety *ludlowensis*. The condition of the dorsal sensory field in the present material does not allow closer comparison.

The isolated presence of ostracoderms retaining in place the bony scales of body and tail is quite remarkable. The only other instances of similarly complete animals in the Peel Sound Formation comprise much less well-preserved small cyathaspidids in a fine sandstone higher in the same gorge near Pressure Point. These two *Hemicyclaspis* specimens appear to have suffered little decomposition or disintegration before being interred. Although the body walls collapsed and the dorsal crest was shattered, the tail fin remained upright after death. This suggests that burial was rapid, immediately following death. The parallel alignment, close proximity, and attitude of these two ostracoderms may indicate that they perished together in a sand-laden current at the present site.

Cephalaspis sp.

Figure 6 a, b, c

Material. Three poorly preserved incomplete cephalic shields, NMC Nos. 10387, 10388, 10389, of similar size and proportions.

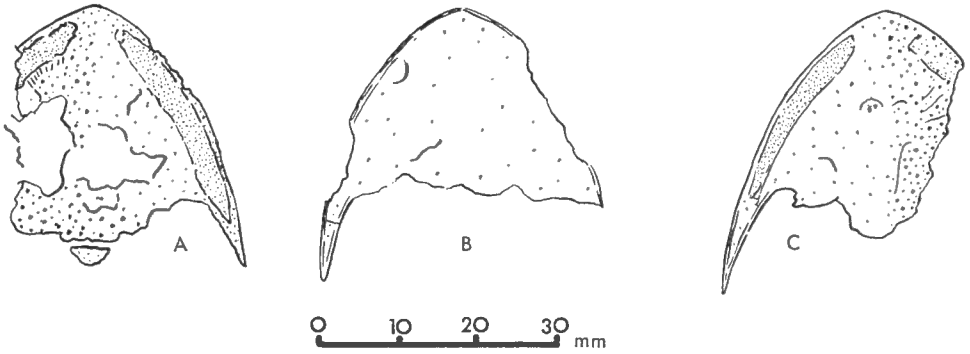

FIGURE 6. *Cephalaspis* sp. Peel Sound Formation; imperfect cephalic shields. A: N.M.C. No. 10387; B: N.M.C. No. 10388; C: NMC No. 10389.

Horizon and locality. The material was collected from a red and green mottled, fine, hard siltstone at the mouth of the small gully half a mile east of the *Hemicyclaspis* locality and some 250 feet higher in the succession.

Description. Each of the specimens consists of the greater part of the cephalic shield. Most of the skeletal material has gone but the rock retains enough impression to distinguish several features. The dimensions are as follows (in mm).

	10387	10388	10389
Length from rostrum to tip of cornu	36	38	36
Length of cornu	10	11	10
Length of lateral field	20	—	—
Maximum width (estimated)	36	38	39
Estimated length along mid-line	26	24	28

These indicate a species of small size for the genus, with headshield narrow to moderately wide for its length.

No. 10387 consists of the greater part of the left side and central portion of the dorsal headshield, seen from the underside. It lacks the left cornu and part of the left lateral margin and field. The central area is weathered and obscured by matrix: the dorsal sensory field, eyes, etc., are not seen. At the posterior end, the height of the fragment is about 3 mm. No. 10388 is an imperfect impression of the ventral margin, left cornu, and central part of the ventral surface of the headshield. No details of the surface remain and the right cornu is missing. No. 10389 retains the left cornu but not the right. The hind margin is incomplete and too irregular to suggest a definite outline, but there is clearly a small, well-rounded pectoral sinus. No details of the right lateral or dorsal sensory fields or of the axial area remain, but a height of about 5 mm is attained at the mid-point of the hind margin.

Discussion. These fossils indicate a small species of *Cephalaspis* with smoothly rounded lateral margins to the headshield, a distinct rostral angle or point and somewhat laterally directed cornua. In only two specimens (10387 and 10389) is a distinct small pectoral sinus preserved, and the shape of the rear margin remains obscure.

The lateral fields seem, from specimen 10387, to be long and almost parallel-sided. No details of the innervation can be seen, nor is the ornamentation of either dorsal or ventral surface known.

Despite the incomplete nature of these fossils, it seems possible that they represent a form close to *Cephalaspis cradleyensis* Stensiö (Stensiö, 1932, pp. 130–131, text-fig. 44; Pl. 15, fig. 6). Stensiö's material from the lower Dittonian of western England, was also poor and he made two reconstructions of the cephalic shield in dorsal view. Of these, B is very similar to the material from Somerset Island. A single specimen from Spitsbergen is attributed to this species by (Wängsjö, 1952, pp. 255–258, fig. 24, Pl. 2). In each of these latter specimens the cornua bear denticles on their inner margins; none can be seen in the Somerset Island material. The Spitsbergen horizon (the Plant horizon, Red Bay Series) is at a comparable stratigraphic level to the one yielding the fossils in Britain and, as far as can be judged, can not be far removed from that of the Somerset Island fossils. It is notable that the British *Cephalaspis* species group, *C. lyelli*, *C. lankesteri*, *C. cradleyensis*, *C. whitbachensis*, and *C. websteri* (comprising similar small forms), is virtually confined to the lower Dittonian as understood by Stensiö (1932, pp. 200–203), that part now falling into the *leathensis* and *crouchi* zones of White (1950).

Osteostraci indet.

Figure 7

Material. A poorly preserved impression of squamation, with a few tiny fragments of bony scale adhering, in a fine-grained, calcareous, buff, pink, and grey sandstone. NMC No. 10390.

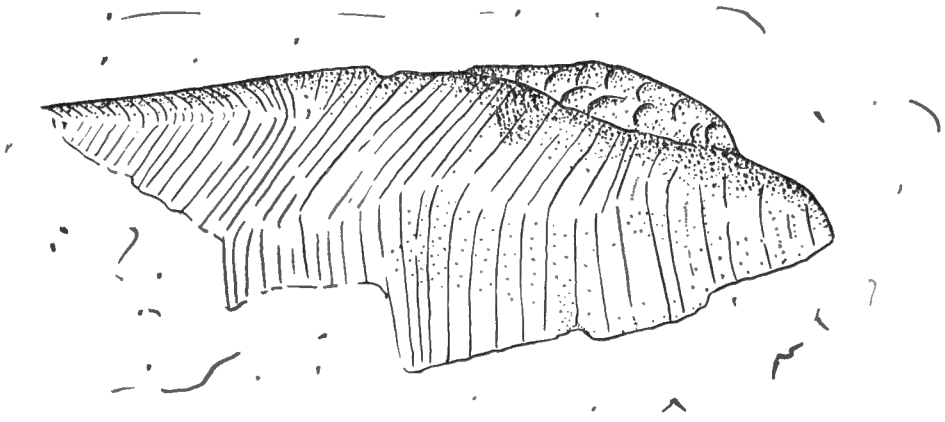

FIGURE 7. *Osteostraci* indet. Peel Sound Formation; imperfect impression of squamation, possibly the long flank scales of a cephalaspid. NMC. No. 10390.

Horizon and locality. The specimen was obtained from the same scree slope as the *Hemicyclaspis* specimens and clearly must be derived from a bed outcropping in this gorge. It is thus located about 45 feet above the base of the Peel Sound Formation.

Description. The impression is some 11.5 cm long and is about 4.5 cm at its widest. It comprises the traces of several series of long, narrow scales. Originally the scaled surface would appear to have been very plane and flat but the specimen is slightly arched along its short axis. There seem to be traces of an axial or ridge row of scales near one end of one of the longer margins of the specimen.

Throughout the major part of the fossil the scales must have overlapped along their long (?) posterior sides in the manner of osteostracan scales. For description the specimen is orientated as shown with the anterior half showing some 29 long narrow scale rows, each made up of two scales. The longer of these scales runs directly normal to the axis of the specimen, whereas the other (above) is inclined forward at about 60 degrees; each is about 2 to 3 mm wide. A small lobate impression at the dorsal margin of this half of the fossil is about 25 mm long and 4 mm wide. It suggests a collection of small irregular scales but whether these may have been part of a dorsal crest, an appendage, or other structure cannot be determined. The posterior half of the specimen contains much narrower individual scale impressions in which the lower part is parallel with the normally directed scales of the anterior half. The upper part of this area, however, indicates narrower scales curving towards the rear. The bony scale fragments suggest an osteostracan scale with a smooth inner surface and an area of overlap somewhat greater than half the width of the scale, i.e., about 1.5 mm. No external ornamentation is visible.

The fossil is reminiscent of cephalaspid flank squamation from the front third to mid-third of the trunk. However, the scaled trunk of the cephalaspids is very rarely preserved. Stensiö has described it in *Hemicyclaspis* (1932) and in *Cephalaspis* (1927, 1932). Wängsjö added some data and discussion in 1952.

The scales in the present specimen by analogy might be labelled (antero) dorso-lateral, lateral, and perhaps postero dorso-lateral. The lobe-like protrusion might represent a 'dorsal fin', but this is hypothetical. Such a structure has been tentatively postulated for *Cephalaspis pinnifera* (Wängsjö, 1952, pp. 232–233) and of course described in *Aceraspis* (Heintz, 1939, p. 59, Figs. 19–20) and *Ateleaspis* (Heintz, 1929, Fig. 34). The present specimen suggests an animal comparable in size to the local *Hemicyclaspis* but it is not preserved well enough to establish its true identity, and *Hemicyclaspis* lacks a scaled dorsal fin over the deep anterior part of the trunk.

REFERENCES

Ami, H. M.
1901: Knoydart Formation of Nova Scotia; *Bull. Geol. Soc. Am.*, Vol. 12, pp. 301–312.

Ball, H. W.
1951: The Silurian and Devonian Rocks of Turner's Hill and Goonal South Staffordshire; *Proc. Geol. Assoc.*, Vol. 62, pp. 225–236.

Branson, E. B. and Mehl, M. G.
1931: Fishes of the Jefferson Formation of Utah; *J. Geol.*, Vol. 39, pp. 509–531, figs. 1–2, pls. 1–3.

Bryant, W. L.

1933: The fish fauna of Beartooth Butte, Wyoming, Part I: The heterostraci and osteostraci; *Proc. Am. Phil. Soc.*, Vol. 72, pp. 285–314, figs. 1–8, pls. 1–21.

Denison, R. H.

1951: Evolution and classification of the osteostraci; *Fieldiana:* Geology, Vol. 11, pp. 157–196, figs. 20–31.

1952: Early Devonian fishes from Utah, Part I. Osteostraci. *Fieldiana*: Geology, Vol. 11, No. 6, pp. 265–287, figs. 50–60.

1955: Early Devonian vertebrates from the Knoydart Formation of Nova Scotia; *Fieldiana*, Zoology, Vol. 37, pp. 449–464, figs. 109–113.

Dineley, D. L.

1965a: Ostracoderms from the Siluro-Devonian of Somerset Island, Arctic Canada; *Proc. Geol. Soc. London*, Vol. 1624, pp. 97–98.

1965b: Notes on the scientific results of the University of Ottawa Expedition to Somerset Island, 1964; *Arctic*, Vol. 18, pp. 55–56.

1966: *in* Jenness, S. E., Report of Activities, May to October, 1965; *Geol. Surv. Can.*, Paper 66-1, pp. 12–14.

Fortier, Y. O., *et al.*,

1963: Geology of the north-central part of the Arctic Archipelago: "Operation Franklin"; *Geol. Surv. Can.*, Mem. 320, pp. i–xviii, 1–671, figs. 1–56, pls. 1–12.

Heintz, A.

1929: Die downtonischen und devonischen Vertebraten von Spitzbergen. 2 Acanthaspida. *Skrifter om Svalbard og Ishavet*, Nr. 22, pp. 1–81, Oslo.

1939: Cephalaspida from the Downtonian of Norway; *Oslo Norsk Videnskaps-akademi skr.* (Math. Nat. Kl.), pp. 1–119.

Kiaer, J.

1915: Upper Devonian fish remains from Ellesmere Land, with remarks on Drepanaspis. Rept. 2nd Norw. Arctic Exp. "Fram" 1898–1902, no. 33, *Norsk Videnskaps-akademi*, Kristiania.

1931: Hemicyclaspis murchisoni-faunaen i den downtoniske sandsten pa Jeløen i Oslofjorden; *Norsk. Geol. Tidsak.*, Vol. 12, pp. 419–433.

Örvig, T.

1957: Remarks on the vertebrate fauna of the Lower Upper Devonian of Escuminac Bay, P.Q., Canada, with special reference to the Porolepiform Crossopterygians. *Arkiv för Zool.*, 2, 10, pp. 367–426.

Robertson, G. M.

1936: New Cephalaspids from Canada; *Am. J. Sci.*, Vol. 31, pp. 288–295, figs. 1–3.

1937: A new Cephalaspis from the Upper Devonian of Canada. *N. England Zool. Club*, Proc., Vol. 16, pp. 85–88, fig. 1, pl. 4.

1941: A second specimen of *Cephalaspis patteni* from the Upper Devonian of Scaumenac Bay; *J. Paleontol.*, Vol. 15, pp. 322–323.

Russell, L. S.

1939: Notes on the occurrence of fossil fishes in the Upper Devonian of Maguasha, Quebec, *Contrib. Roy. Ontario Mus. Paleont.*, Vol. 12, pp. 1–6.

1954: A new species of *Cephalaspis* from the Devonian Gaspé Sandstone at d'Aiguillon. *Nat. Canadien*, Vol. 81, pp. 245–254.

Stensiö, E. A.

1927: The Downtonian and Devonian Vertebrates of Spitsbergen. 1. Family Cephalaspidae *Skr. om Svalbard og Nordishavet*, Nr. 12, pp. i–xii, 1–391, figs. 1–102, pls. I–CII.

1932: The Cephalaspids of Great Britain. *British Museum (Natural History)*, London, pp. i–xiv, pp. 1–220, figs. 1–70, pls. I–LXVI.

Thorsteinsson, R.

1958: Cornwallis and Little Cornwallis Islands, District of Franklin, Northwest Territories; *Geol. Surv. Can.*, Mem. 294, pp. i–v, 1–134, figs. 1–5, pls. I–VIII.

Traquair, R. H.

1890: Notes on the Devonian fishes of Scaumenac Bay and Campbelltown in Canada; *Geol. Mag.*, Dec. 3, Vol. 7, pp. 15–22.

1893: Notes on the Devonian fishes of Scaumenac Bay and Campbelltown in Canada; *Geol. Mag.*, Dec. 3, Vol. 10, pp. 145–149.

1899: Report on fossil fishes collected by the Geological Survey of Scotland in the U. Silurian rocks of Scotland; *Trans. Roy. Soc. Edinburgh*, Vol. 39, pp. 827–864.

Wängsjö, G.

1952: The Downtonian and Devonian vertebrates of Spitsbergen. IX. Morphologic and systematic studies of the Spitsbergen Cephalaspids; *Norsk Polarinstitutt Skr.*, Nr. 97, pp. 1–616, figs, 1–109, pls. 1–118.

Westoll, T. S.

1945: A new Cephalaspid fish from the Downtonian of Scotland, with notes on the structure and classification of Ostracoderms; *Trans. Roy. Soc. Edinburgh*, Vol. 61, pp. 341–357, figs. 1–7, pl. 1.

White, E. I.

1950: The Vertebrate faunas of the Lower Old Red Sandstone of the Welsh Borders; *Bull. Brit. Mus.* (*Nat. Hist.*) *Geol.*, Vol. 1, pp. 51–67, figs. 1, 2.

Wills, L. J.

1947: Midland Group Field Meeting Reports: 1; Ellows Park and Turner's Hill; *Proc. Geol. Assoc.*, Vol. LVIII, p. 71.

PART III

A DEVONIAN OSTEOLEPIDID FISH FROM BRITISH COLUMBIA

H. Jessen

Abstract

The almost complete fronto-ethmoidal shield of an undoubted osteolepidid fish is recorded from the Upper Middle Devonian Nahanni (Hume) Formation of north-central British Columbia. It is ascribed to a new species, *Gyroptychius*? *taylori*.

Résumé

La carapace fronto-ethmoïde presque intacte d'un osteolepis authentique a été identifiée dans la formation de Nahanni (Hume) du Dévonien moyen supérieur dans le centre-nord de la Colombie-Britannique. On l'attribue à une nouvelle espèce appelée *Gyroptychius*? *taylori*.

INTRODUCTION

The specimen described in this paper is part of the skull of a Crossopterygian fish, embedded in a fine-grained, grey limestone. It was collected by Dr. G. C. Taylor, in the Upper Middle Devonian Nahanni (Hume) Formation in north-central British Columbia, and is the first osteolepidid fish recorded from western Canada. The writer thanks the Geological Survey of Canada for permission to study this specimen; the investigation was made in the Palaeozoological Section of the Swedish Museum of Natural History, Stockholm.

SYSTEMATIC PALAEONTOLOGY

Class CROSSOPTERYGII

Order OSTEOLEPIFORMES

Family OSTEOLEPIDIDAE

Genus *Gyroptychius* McCoy 1848

Syn. *Diplopterus* Traill (1841), *Diplopterax* McCoy (1855)

Type species: *Gyroptychius agassizi* (Traill)

Gyroptychius? *taylori* n. sp.

Plate X; Figure 8

Material. A single nearly complete fronto-ethmoidal shield, the holotype of the species, National Museum of Canada, Ottawa, fossil vertebrate collection catalogue number 10554. The material is illustrated by Plate X and Figure 8.

Diagnosis. An osteolepidid fish of moderate size with rather broad fronto-ethmoidal shield. Breadth at the preorbital corner, at the orbital notch, and at the posterior margin is about 0.93, 0.72, and 0.45, respectively, of its total length. Snout between the subnasal corners slightly overhanging. Cranial roof above the lachrymo-maxillary notch bent strongly downwards. Fenestra exonarina anterior somewhat

Ms. received 28 December, 1966.

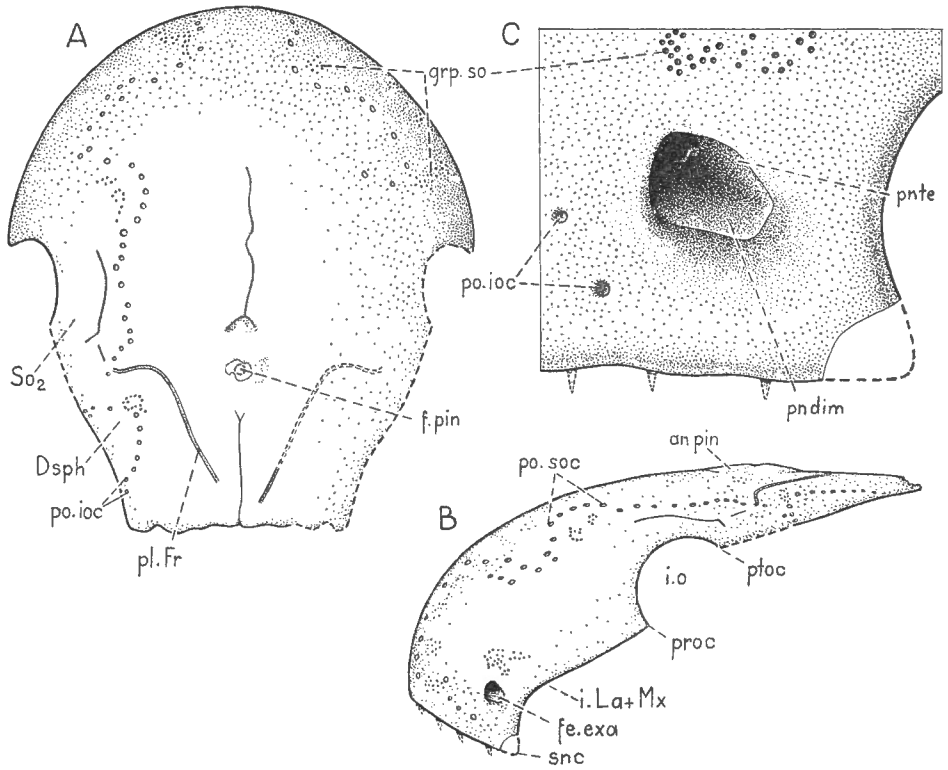

FIGURE 8. *Gyroptychius? taylori* n. sp. Restorations of *A-B*, the fronto-ethmoidal shield without overlapped areas in dorsal and lateral views (x2), and of C the fenestra exonarina anterior of the left side in antero-lateral aspect (x8). Based on the holotype, NMC No. 10554 shown in Plate X. Dsph, dermosphenotic; So_2, posterior supraorbital; ar. pin, pineal area; fe. exa, fenestra exonarina anterior; f. pin, pineal foramen; grp. so, groups of pores probably for nerves to cutaneous sensory organs; i. La+Mx, lachrymo-maxillary notch; i.o, orbital notch; pl. Fr, frontal pit-line; po. ioc, po. soc; pores of infra-orbital and supraorbital sensory canals; pr. dim, processus dermintermedius; proc, preorbital corner; pr. te, processus tectalis; ptoc, postorbital corner; snc, subnarial corner.

triangular, situated far ventrally close to the anterior margin of the lachrymo-maxillary notch and not visible when the snout is viewed from above. Lachrymo-maxillary notch long and angular. Preorbital corner moderately acute and situated postero-ventrally to the anterior end of the orbital notch. Orbital notch about twice as long as it is deep and situated relatively far forward. Orbital division short. Preorbital and postorbital divisions rather long. Pineal foramen relatively far back, postero-medially to the postorbital corner and medially to the anterior end of the frontal pit-line. Elevated pineal area extending forwards to the level of the postorbital corners. Frontal pit-line long.

Description. The specimen is a very well preserved and nearly complete fronto-ethmoidal shield, showing the natural shape of the snout of an osteolepidid. It possesses the processus dermintermedius and processus tectalis (*pr. dim*, *pr. te*) in the fenestra exonarina anterior (*fe. exa*), the position of which, together with that of the pineal

foramen (*f. pin*), and the course of the frontal pit-line (*pl. Fr*), indicate the osteolepidid character. As is usual in these fish, the individual dermal bones are more or less fused superficially and most of the sutures cannot be traced.

The postorbital corner (*ptoc*) is formed by the posterior superaorbital (So_2). The dermosphenotic (*Dsph*) seems to be long and narrow. The pineal foramen is situated far back, behind a transverse line running through the postorbital corners and between the antero-lateral ends of the frontal pit-lines. The distance between the foramen and the posterior margin of the frontals is about 0.3 of the length of the shield. The foramen is surrounded by an elevated rhombic area (*ar. pin*), the position and extent of which are similar to those of the pineal area in certain other osteolepidids (Säve-Söderbergh, 1933; Jarvik, 1948, 1950a). There are a few faint furrow-like depressions and parts of sutures indicating the presence of independent pineal plates.

The breadth of the shield at the preorbital corner (*proc*), at the deepest point of the orbital notch (*i.o*), and at the posterior margin amounts to about 0.92–0.93, 0.72, and 0.45 of its length, respectively. The somewhat triangular fenestra exonarina anterior is situated far ventrally, antero-dorsally to the subnarial corner (*snc*) and rather close to the anterior margin of the lachrymo-maxillary notch (*i. La+Mx*). The fenestra is not visible when the snout is viewed from above. Along the ventral and postero-dorsal border of the fenestra exonarina anterior the processus dermintermedius and the processus tectalis are seen extending into the nasal cavity. The lachrymo-maxillary notch is rather long and angular, being about 0.38 of the length of the shield. The preorbital corner is moderately acute and protrudes slightly backwards. The small orbital notch is about twice as long as it is deep and its length is not more than about 0.22 of the length of the shield.

Discussion. The osteolepidid character of this fossil is beyond question, and in a comparison with sufficiently well known osteolepidids (*inter alia* Jarvik, 1948, 1949, 1950a, 1950b, 1950c; Gross, 1956; Jessen, 1966) it lies closest to the genus *Gyroptychius*. With *Gyroptychius* it shares a cranial roof which is bent strongly downwards above the lachrymo-maxillary notch, a fenestra exonarina anterior that is situated far ventrally and close to the anterior margin of the lachrymo-maxillary notch, a small orbital notch, a pineal foramen set far back, and a rather long postorbital region.

The proportions of the shield, especially the breadth at the moderately acute preorbital corner, are highly reminiscent of *G. groenlandicus* Jarvik and the Scottish species *G. milleri* Jarvik. On the other hand, it differs from these species in having a cranial roof proportionally broader at the orbital notch and with a decidedly longer postorbital division. It is distinguished from *G. groenlandicus* and *G. agassizi* by the proportionally longer preorbital division. In contrast with the latter species it is proportionally broader at the preorbital corner, and the lachrymo-maxillary notch is more angular. Because it is also clearly distinguished from the specimens described as *G.* cf. *agassizi*, G.sp.inc.1, G.sp.inc.2, *G? kiaeri* Jarvik (1948, 1949), this fronto-ethmoidal shield is referred to a new species *Gyroptychius? taylori*.

Gyroptychius? taylori n.sp. is, as far as the author can ascertain, the first unquestionable instance of an osteolepidid (*sensu stricto*) from Canada. The fish *Thursius? clappi* Romer (1942) from the Upper Devonian of Escuminac Bay is probably not an

osteolepidid (cf. Jarvik, 1948, p. 199). The new species is most closely related to *Gyroptychius*, and especially to the species *G. milleri* and *G. groenlandicus* present in the Middle Devonian of Scotland and east Greenland, respectively.

Occurrence. The specimen was obtained from talus about 250 metres (760 feet) above the base of the Nahanni (Hume) Formation (Upper Middle Devonian), on the ridge to the west of Wokkpash Creek, long. 124°56′W, lat. 58°32′N.

REFERENCES

Gross, W.

1956: Über Crossopterygier und Dipnoer aus dem baltischen Oberdevon im Zusammenhang einer vergleichenden Untersuchung des Porenkanalsystems paläozoischer Agnathen und Fische; *Stockholm, Kungl. Sv. Vet. Akad. Handl.*, Ser. 4, Vol. 5, no. 6, pp. 7–14, text-figs. 1–6, pls. 1–3.

Jarvik, E.

1948: On the morphology and taxonomy of the Middle Devonian osteolepid fishes of Scotland; *Stockholm, Kungl. Sv. Vet. Akad. Handl.*, Ser. 3, Vol. 25, no. 1, pp. 5–294, 85 text-figs., 37 pls.

1949: On the Middle Devonian crossopterygians from the Hornelen field in western Norway; *Bergen, Univ. Årbok 1948, naturv. rekke*, no. 8, pp. 5–29, text-figs. 1–8, 8 pls.

1950a: Middle Devonian vertebrates from Canning Land and Wegeners Halvö (East Greenland); Part II. *Crossopterygii. København, Medd. om Grønl.*, Vol. 96, no. 4, pp. 5–100, text-figs. 1–29, pls. 1–23.

1950b: On some Osteolepiform crossopterygians from the Upper Old Red Sandstone of Scotland; *Stockholm, Kungl. Sv. Vet. Akad. Handl.*, Ser. 4, Vol. 2, no. 2, pp. 3–25, text-figs. 1–7, pls. 1–9.

1950c: Note on Middle Devonian crossopterygians from the eastern part of Gauss Halvö, East Greenland. With an appendix: An attempt at a correlation of the Upper Old Red Sandstone of East Greenland with the marine sequence; *Medd. om Grønl.*, Vol. 149, no. 6, pp. 3–9, text-figs. 1–2.

1966: Remarks on the structure of the snout in *Megalichthys* and certain other rhipidistid crossopterygians; *Stockholm, Kungl. Sv. Vet. Akad. Ark. Zool.*, Vol. 19, no. 2, pp. 41–94, 19 text-figs., 5 pls.

Jessen, H.

In press: Die Crossopterygier des Oberen Plattenkalkes (Devon) der Bergisch-Gladbach-Paffrather Mulde (Rheinisches Schiefergebirge) unter Berücksichtigung von amerikanischem und europäischem *Onychodus*-Material; *Stockholm, Kungl. Sv. Vet. Akad, Ark. Zool.*

Romer, A. S.

1942: Notes on certain American Paleozoic fishes; *Am. J. Sci.*, Vol. 240, pp. 216–218, 1 pl.

Säve-Söderbergh, G.

1933: The dermal bones of the head and the lateral line system in *Osteolepis macrolepidotus* Ag. With remarks on the terminology of the lateral line system and on the dermal bones of certain other Crossopterygians; *Uppsala, Reg. Soc. Sci. Ups. Nov. Acta*, Ser. 4, Vol. 9, no. 2, pp. 3–118, 22 text-figs., pls. 1–15.

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