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BULLETIN 248

CONODONTS OF THE HULL FORMATION, OTTAWA GROUP (MIDDLE ORDOVICIAN), OF THE OTTAWA-HULL AREA, ONTARIO AND QUEBEC

T. T. Uyeno

1974

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T. T. UYENO

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PREFACE

This report describes some conodonts from the Middle Ordovician rocks in the area of the national capital of Canada. These rocks were deposited contemporaneously with those now exposed in the Mohawk Valley area of New York State and in a northern extension of the same basin. The faunal sequence in the strata of the latter area is considered to represent the North American standard for the Middle Ordovician.

It is by such detailed studies of total faunas that paleontologists are able to fill gaps in the stratigraphic column and provide data for the calibration of the geological time scale that is so necessary for the precise dating and correlation of the rocks that make up the geological framework of Canada.

D.J. McLaren,
Director.

Ottawa
July 4, 1974

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ABSTRACT

A conodont fauna consisting of ten species and seven form-species is described from the Hull Formation of the Ottawa Group of the Ottawa-Hull area in Ontario and Quebec. The collection of over 10,000 specimens indicates that the Hull conodont fauna is typical of the North American Midcontinent Province, and of the eastern subprovince (Barnes *et al.*, 1973), and may be assigned to Fauna 8 of Sweet *et al.* (1971). In New York and Ontario, Fauna 8 ranges from the uppermost part of the Chaumont Formation to the mid-part of the Kings Falls Limestone (Schopf, 1966; Sweet *et al*, 1971). In terms of North American stages, Fauna 8 is of late Porterfieldian through mid-Kirkfieldian age, or approximately late Wildernessian (Bergström, 1971b). The Hull Formation is redefined in lithostratigraphic terms.

RÉSUMÉ

L'auteur décrit une faune de conodontes formée de dix espèces et de sept espèces intermédiaires dans la formation de Hull du groupe d'Ottawa de la région Ottawa-Hull en Ontario et au Québec. La collection de plus de 10,000 spécimens indique que la faune de conodontes de Hull est typique de celle de la province centrale de l'Amérique du Nord et de la sous-province de l'est (Barnes *et al.*, 1973), et peut-être située dans la faune 8 de Sweet *et al.* (1971). Pour New-York et l'Ontario, la faune 8 s'échelonne de la partie supérieure de la formation de Chaumont jusqu'à la partie intermédiaire du calcaire de Kings Falls (Schopf, 1966; Sweet *et al.*, 1971). La formation de Hull est redéfinie en termes lithostratigraphiques.

CONODONTS OF THE HULL FORMATION, OTTAWA GROUP (MIDDLE ORDOVICIAN), OF THE OTTAWA-HULL AREA, ONTARIO AND QUEBEC

INTRODUCTION

Schopf (1966) made a comprehensive study of the conodonts of the Trenton Group in New York and adjacent parts of Ontario and Quebec. He sampled one of the sections reported herein (Canada Cement Co., Ltd. quarry, Hull; Sec. 4), but only at broadly spaced intervals. Six samples were collected from this 116.6-foot section of the formation, and these contained a total collection of 943 specimens (Schopf, ibid., Table 6).

The present report is a more comprehensive study of the conodonts of the Hull Formation only. Twelve sections, which represent all major exposures (outcrops, quarries, and railway cuts) of this formation in the immediate area of the Ottawa-Hull area of Ontario and Quebec (Figs. 1, 3; Appendices I and II), were measured and sampled in detail. A total of 126 samples were collected (Table 2).

Previous paleontological investigations of the Hull Formation have been made by Ami (1896), Billings (1854, 1863), Raymond (1921), Wilson (1946-1961), Fritz (1957), and others. In all, representatives of nearly 150 species of Echinodermata, Brachiopoda, Arthropoda, Mollusca, Bryozoa, and miscellaneous fossils have been described from these beds. Ami (1896, p. 156) was the first to record the occurrence of conodonts from the Ottawa-Hull area, noting that "several obscure conodonts abound in a certain band of limestone in Hull". The exact locality and the stratigraphic position of the rocks to which he referred are not known.

Sincere gratitude is expressed to B. F. Glenister and W. M. Furnish (University of Iowa) for supervision of this study. J. A. McCaleb (now of Amoco Production Ltd., Denver) and P. W. Goodwin (now of Temple University, Philadelphia) assisted in photographing the conodonts. C. R. Barnes (University of Waterloo, Ontario), W. C. Sweet (Ohio State University, Columbus), and A. W. Norris (Geological Survey of Canada) critically read the report during various stages of preparation. T. J. M. Schopf (now of University of Chicago) corresponded with the writer regarding the distribution of Trenton conodonts.

SAMPLING AND PREPARATION

As far as possible, lithologically similar beds were grouped into units and a representative bed was sampled. Where this was impractical, however, channel sampling technique was employed.

The entire content of a sample bag (all bags of uniform size) was dissolved for every sample. Consequently, although a strict record was not kept in every case, the samples are of approximately uniform weight, i.e., 1.5 kilograms.

Conodonts were obtained from nearly every sample. In general, the Hull conodonts are dark brown to amber in colour, and in a fair to excellent state of preservation.

GEOLOGICAL SETTING

The Ottawa-Hull area of Ontario and Quebec lies within the Central St. Lawrence Lowland physiographic subprovince (Bostock, 1970, p. 27). The geology of a part of this subprovince, from the western margin to the Beauharnois Anticline (near the Ontario-Quebec border), was studied by Wilson (1946a), who noted that the bedrock of this area is of Precambrian, Cambrian(?), and Ordovician ages. A large part of that sequence of rocks, deposited during the Champlainian and early Cincinnatian (Edenian) (of Sweet and Bergström, 1971) time interval, was named the Ottawa Formation (Wilson, 1938).

OTTAWA GROUP

Wilson's (1938) Ottawa Formation is herein raised to group status, and the units within it to formational status. The term Ottawa as used herein is essentially that of the "Ottawa Limestone Megagroup", introduced by Swann and Willman (1961, p. 478) and used by Templeton and Willman (1963, Fig. 2) for certain strata in Illinois. The Ottawa Group is composed mainly of limestone, with some shale and minor amounts of sandstone at the base (Wilson, 1946a, p. 21; Sanford *in* Poole *et al.*, 1970, p. 256). A graphic presentation of the Ottawa Group is shown on figure 2. Although no complete section of the group is exposed, borehole data indicate that its maximum thickness is about 730 feet (Sanford, ibid.). The sequence has been subdivided into seven units, previously given a variety of terms such as "beds", "members", or "formations" (*see*, e.g., Raymond, 1914, 1916; Kay, 1937; Wilson, 1946a, p. 24). Wilson, for the most part, was unable to differentiate these units lithologically or paleontologically, and considered them as "faunal associations". She retained Raymond's (1916) original names, but applied the term "beds" to them.

Contrary to Wilson's (1946a) conclusion, there are lithologically distinct, mappable units within the Ottawa Group and, as such, are formations

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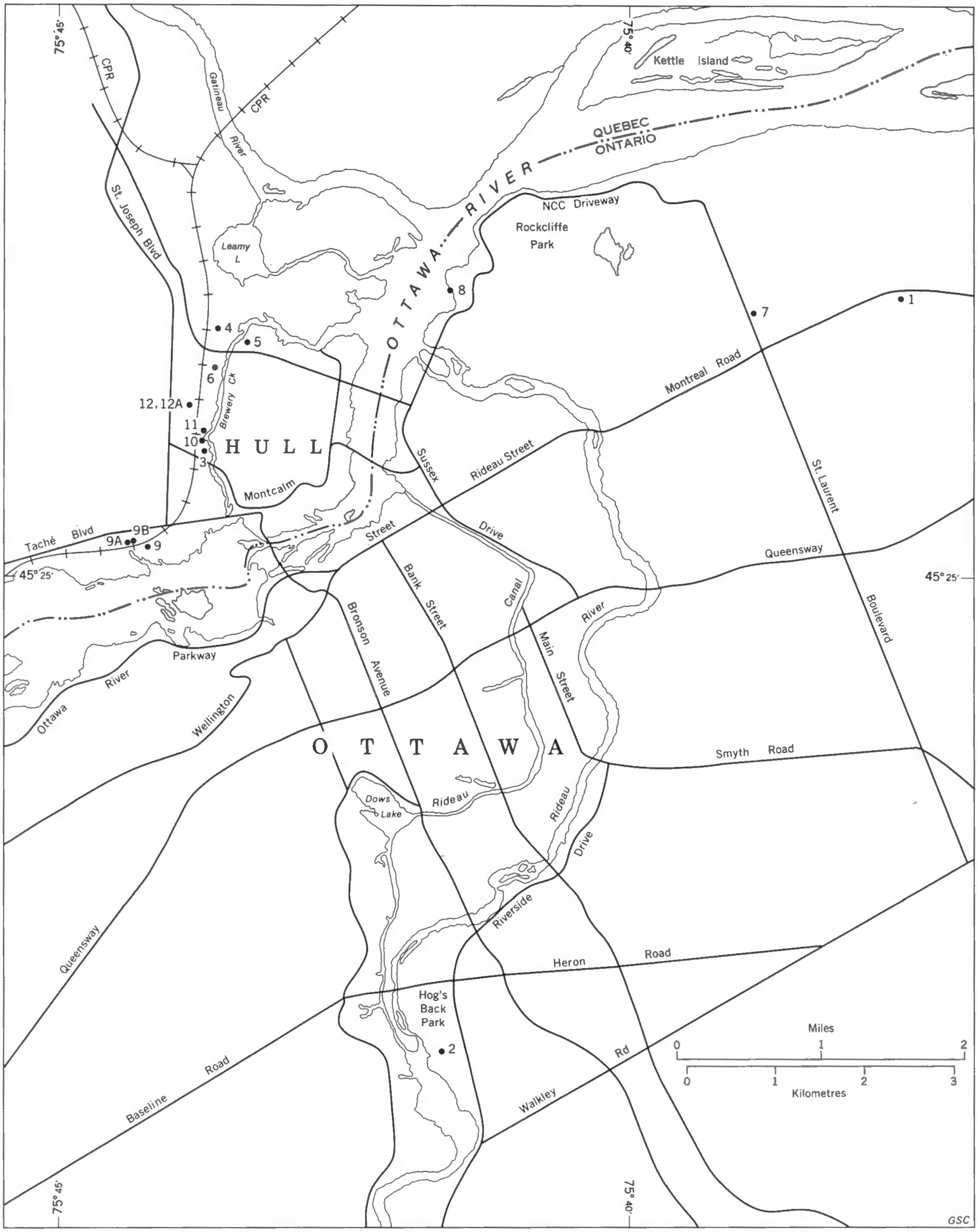

Figure 1. Index map of the Ottawa-Hull area, Ontario and Quebec. Numbers refer to sections (*see* Appendix I for details of sections).

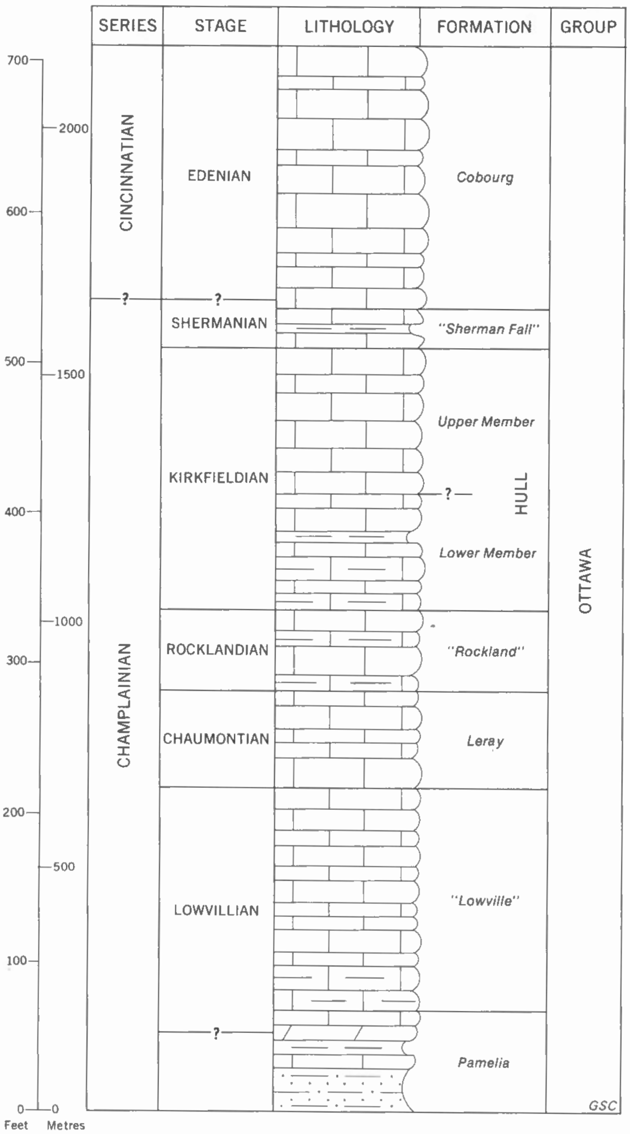

Figure 2. Generalized stratigraphic column of the Ottawa Group in the Ottawa-Hull area, Ontario and Quebec. (Lithology and thickness of formations after Sanford *in* Poole *et al.*, 1970, p. 256; names of formations, in part, after Liberty, 1969; stadial terms after Kay, 1968a and Sweet and Bergström, 1971).

by definition (Am. Comm. Strat. Nomen., 1961, p. 650). The formational boundaries may be independent of the previously established seven units which are essentially of biostratigraphic concept. A similar situation existed in south-central Ontario, southwest of the Frontenac Arch, and in New York State. The problem in these areas was resolved by separating the bio- and lithostratigraphic units, using entirely different sets of names for them (Liberty, 1969; Kay, 1968a). The older, familiar nomenclature is used now only in a time-stratigraphic, or stadial sense (Liberty, 1969; Sweet and Bergström, 1971). Thus, the correlatives of the Hull Formation are: in northern New York State, the Kings Falls Limestone (Kay, 1968a), and in central Ontario, the Middle? and Upper Members of the Bobcaygeon Limestone (Liberty, 1969). No attempt is made in this report to set up a complete lithostratigraphic nomenclature in a manner similar to that of Kay (1968a) and Liberty (1969). Rather only one formation is proposed, the Hull Formation, and the adjacent strata are herein given the established names but are placed in quotation marks.

Hull Formation

Introduction

The name Hull was introduced by Raymond (1914, p. 348), and he later (1916, p. 225) defined the Hull "Formation", incorporating his previously named "*Tetradium* beds" and "Crinoid beds" (Raymond, 1913, p. 143). The original definition was based primarily on its fossil content, and was, thus, a biostratigraphic rather than a lithostratigraphic concept. The reader is referred to Sinclair (1954, p. 31-33) for a complete history of the Hull Formation. The term "Hull", as a time term, never gained wide popularity so it was largely spared the ambiguous usage which befell other closely associated names, such as Sherman Fall, Kirkfield, and Rockland. The name "Hull", therefore, is retained but, of necessity, redefined in lithostratigraphic terms.

No type section of the Hull Formation was ever designated by Raymond. He did refer, however, to the section of the Canada Cement Co., Ltd. quarry in Hull (Sec. 4 of this report) and the borehole data from the quarry site. He suggested (1913, p. 151) that the upper beds at this locality belong to his "Crinoid beds", and that "Black River beds" (probably Rocklandian age beds in modern terminology) commence 90 feet (27.4 m) below the top of the well. Brachiopods collected by the writer, 87 feet (26.5 m) below the top of section 4, were identified by G. W. Sinclair (pers. comm., 10 April, 1963) as *Sowerbyella curdsvillensis* (Foerste). According to Sinclair (1954, p. 37), *S. curdsvillensis* is a "Rockland" species that is replaced in the Hull by *S. "sericea"* (Sowerby). Conodont data reported in this report and by Schopf (1966, p. 27; Table 6), suggest that the entire section of the Canada Cement quarry belongs to a single lithogenetic and faunal unit. These strata, therefore, were in all probability miscorrelated in the past.

Barnes' (*in* Schopf, 1966, p. 25) suggestion that the upper beds of the Canada Cement quarry resemble the lower Shoreham (="Sherman Fall" in local usage) beds is incorrect, a point with which Barnes

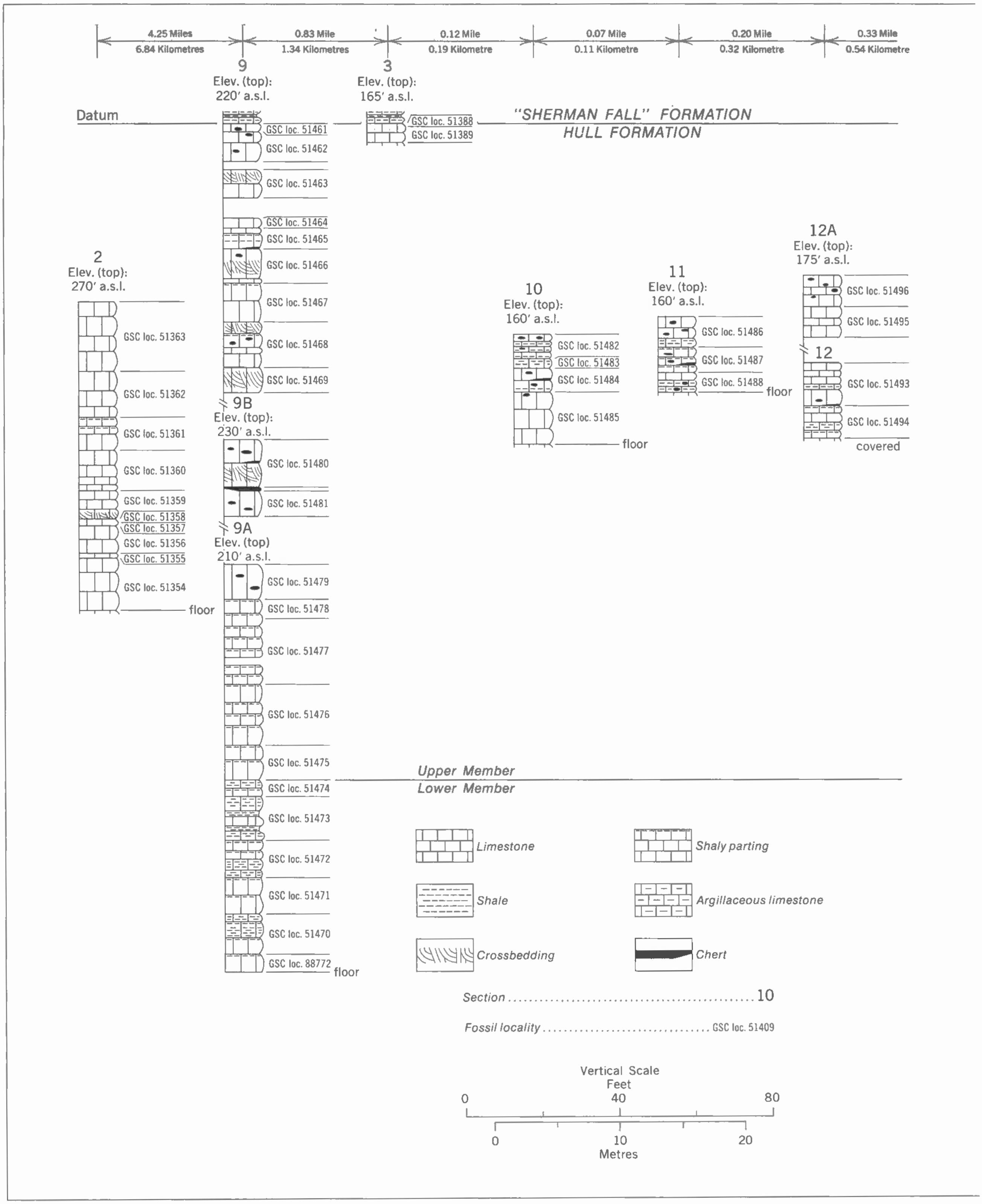

Figure 3. Columnar sections of the Hull Formation, Ottawa Group, and their estimated correlations.

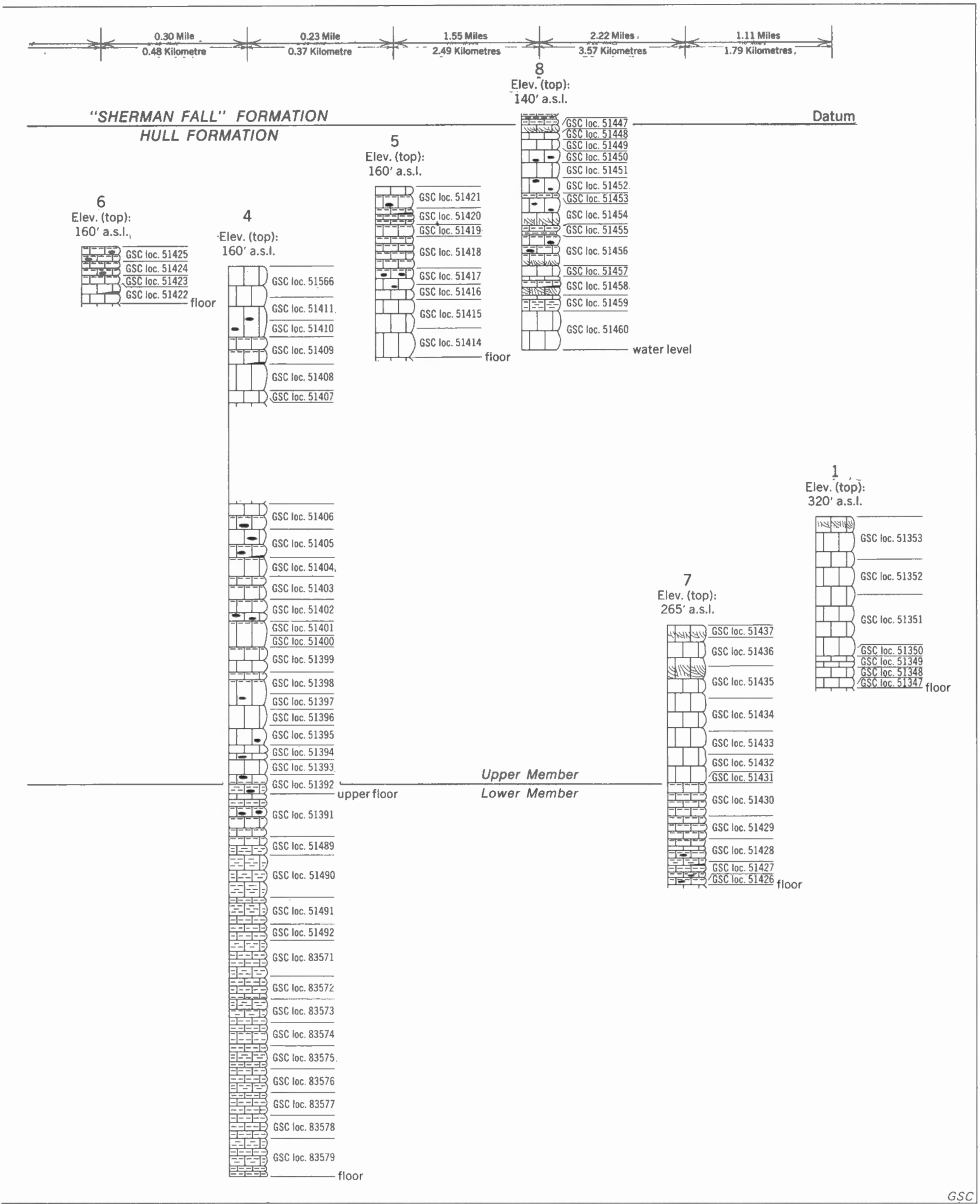

Figure 3. Continued

(pers. com., 11 Jan., 1972) now concurs. Since 1966, new cuttings have been made at the south end of the quarry which allow closer examination of the beds. Furthermore, these same thin beds occur at the top of section 5 (*see* also Goudge, 1935, p. 62). At both localities, these beds are distinctly different from the lower "Sherman Fall" beds. The characteristics of the Hull-"Sherman Fall" contact may be studied at sections 3, 8 and 9A.

Definition

The term Hull Formation is herewith redefined to include all strata lying above the "Rockland" Formation of Raymond (1916, p. 255) (or the Napanee Limestone of Kay, 1937, 1968a, 1968b), and below the "Sherman Fall" Formation of Kay (1929, p. 664) (or the Verulam Formation of Liberty, 1969). As so defined, the formation embraces the lithogenetic unit between the "*Dalmanella* Beds" below and the "*Prasopora* Beds" above (of Raymond, 1913, p. 142, 143).

The formation, as now redefined, consists of two members. The Lower Member consists of relatively pure to argillaceous limestone that is thin to medium bedded, dark brown to brownish grey, very fine to medium grained, with fine sparry matrix, and numerous intercalated shaly partings. The Upper Member, in strong contrast, is composed predominantly of medium- to coarse-grained, in places bioclastic, relatively pure limestone, with coarse sparry matrix. It is medium to thick bedded, with some crossbedding. Black chert, in concretions or nodules and thin beds, occurs throughout the sequence, but is somewhat more common in the Upper Member (*see* Fig. 3 and Appendix II).

It should be stressed that, although these lithologies are generally more characteristic of their respective parts, the generalization does not always hold true. Intervals of various thicknesses with contrasting lithologies occur at scattered intervals within a given sequence, such as at sections 5 and 9 (*see* Fig. 2).

On the basis of its historical precedence, and because it is the location of the most complete exposure in the study-area, the Canada Cement Co., Ltd. quarry in Hull is selected as the type section of the Hull Formation. There, the Lower Member is 51.1 feet (15.6 m) thick and the Upper Member 65.5 feet (20.0 m) thick, with the contact between these members located 1.5 feet (0.5 m) above the upper floor of the quarry. Neither the upper nor lower contact with adjacent formations is exposed at the type section. A detailed description of the quarry section is given in Appendix II.

The top beds of the Canada Cement quarry probably lie only a short stratigraphic distance below the top of the formation. This is indicated if the total thickness of the formation in this quarry (116.6 ft.; 35.5 m) is compared with subsurface data which give a total thickness of 180 feet (54.9 m) (Sanford *in* Poole *et al.*, 1970, p. 256), and by the fact that the Hull-"Sherman Fall" contact is exposed less than a mile to the south at section 3. Between these localities, the beds are essentially flat-lying. At section 4, the dip is approximately 2 to 3 degrees southward, whereas at sections 3 and 12, the beds are flat-lying (*see* also Goudge, 1935, p. 62). The rock types comprising the strata in these exposures are those of the Upper Member. Descriptions given by Goudge (1935, p. 62) of the Wright Crushed Stone Co., Ltd. quarry (now long abandoned, and herein referred to sections 12 and 12A) suggest that most of the formerly exposed, 76-foot (23.2 m) section also is part of the Upper Member. At the time of Raymond's (1913) writing, it is possible that the quarry was not as deeply excavated. In 1961, the quarry was filled with debris, and only the upper 17 feet (5.2 m) were exposed. A suggested correlation of these beds is given on figure 3.

Wilson (1946d) noted the Hull Formation along the Ottawa Valley from the Ottawa-Hull area as far east as Hawkesbury, and thence southward to Cornwall, Ontario.

Stratigraphic relationship with adjacent strata

The upper contact of the Hull Formation with the "Sherman Fall" Formation is exposed at sections 3, 8 and 9A. The boundary is distinct and easily recognized in the Ottawa-Hull area. The lower beds of the "Sherman Fall" Formation, which are composed of rubbly weathering, argillaceous, thin-bedded limestone containing interbedded shale, are in strong contrast to the upper beds of the Upper Member of the Hull Formation (*see* Pl. 3, fig. 20).

The lower contact with the "Rockland" Formation cannot be placed with confidence at any of the sections examined. One possible locality is at section 9 (Val Tetreau quarry, GSC loc. 88772). Here the thin-bedded Lower Member of the Hull Formation rests on a strongly contrasting, *Receptaculites*-bearing, massive, two-foot bed of argillaceous limestone which is fine to medium grained and bioclastic. This bottom bed may represent the uppermost part of the "Rockland" Formation. It certainly is similar lithologically and in bedding characteristics to the type "Rockland" strata exposed at the Stewart Quarry, located south of Rockland, Ontario (*see* Raymond, 1913, p. 142; 1914, p. 348, 349). There the "Rockland" Formation is principally a fine- to medium-grained, argillaceous to clean, bioclastic in part, grey limestone with fine to coarse sparry matrix, and is medium to thick bedded. It is interesting to note, too, that Sinclair (1954, p. 37) stated that *Receptaculites* is very rare in the Hull, in contrast to its abundance in the lower beds.

The distinct contact between the Lower and Upper Members can be observed at sections 4 (type section), 7 and 9 (*see* Pl. 3, fig. 19).

With the possible exception of a composite sequence of the sections 9, 9A and 9B, nowhere in the study-area is the Hull Formation completely exposed. Consequently, subsurface data are extremely important. Sanford (*in* Poole *et al.*, 1970, p. 256) recorded the total thickness of the formation in the Ottawa Embayment as 180 feet, but gave no indication of the proportions of the two main lithic components.

SPECIES	CONSTITUENT ELEMENTS OR FORM-SPECIES	Upper Member	Lower Member	Total	Per Cent of Total Collection	Absolute Ratio	Suggested Ratio
Acodus mutatus	*Acodus mutatus*	4	2	6	0.1		
? (*see* text)	*Acontiodus* sp. A	2	34	36	0.3		
Belodina compressa	*Belodina compressa*	27	307	334	3.8	10.1:	10:
	Eobelodina fornicala		66	66		2.0	2
Bryantodina? abrupta	*Ozarkodina? abrupta*	21	8	29	0.3	incomplete apparatus	
	prioniodiform	4	1	5			
Drepanoistodus suberectus	*Drepanodus suberectus*	40	23	63	11.4	2.0:	2:
	Oistodus inclinatus	81	76	157		5.0:	4:
	Drepanodus homocurvatus	648	331	979		31.1	30
Icriodella superba	*Icriodella superba*	4		4	0.1	incomplete apparatus	
	Sagittodontus robustus	3		3			
	Sagittodontus dentatus	2		2			
	rhynchognathodiform	2	2	4			
Oulodus cf. *O. mediocris*	oulodiform	4		4	0.1	incomplete apparatus	
	trichonodelliform	5		5			
	zygognathiform	2		2			
Panderodus gracilis	*Panderodus compressus*	537	139	676	20.2	1.0:	1:
	Panderodus gracilis	1036	415	1451		2.2	2
Phragmodus undatus	*Phragmodus undatus*	590	1620	2210	44.3	8.7:	8:
	Dichognathus brevis	204	253	457		5.7:	6:
	Dichognathus typicus	390	596	986			
	Oistodus abundans	338	674	1012		4.0	4
Plectodina aculeata	ozarkodiniform	575	16	591	16.0	32.8:	32:
	prioniodiform	99	1	100		5.6:	6:
	dichognathiform	162	1	163		9.1:	10:
	cyrtoniodiform	16	2	18		1.0:	1:
	cordylodiform	428	20	448		24.9:	24:
	zygognathiform	96	5	101		5.6:	6:
	trichonodelliform	261	9	270		15.0	14
Polyplacognathus ramosus	*Polyplacognathus ramosus*	70	197	267	3.3	6.4:	6:
	Polyplacognathus bilobatus	11	72	83		2.0	2
"Fibrous conodonts"					0.1		
? (*see* text)	*Curtognathus* sp.	1	1	2			
? (*see* text)	*Polycaulodus* spp.	5		5			
? (*see* text)	*Trucherognathus* spp.	1	2	3			
			Total	10,542	100.0		

GSC

Table 1. Summary of the Hull conodont species and form-species

Previous correlations of the Hull Formation

Together with the history of the term "Hull", Sinclair (1954) summarized the previous correlation attempts by various authors. Consequently, only the more significant papers will be mentioned here.

In his study of the Trenton Group, Kay (1937, p. 261) correlated the Hull Formation with the combined "*Dalmanella* beds" and "Crinoid beds" (of Johnston, 1912, p. 257-260) [=Kirkfield Formation, or the upper member (E) of the Bobcaygeon Formation of Liberty, 1969, p. 44] in central Ontario. Sinclair (1942, p. 1833) disagreed with this correlation and, subsequently (1954), stated that the Kirkfield was coeval with the "Rockland" Formation of the Ottawa Valley, although not necessarily with identical limits. According to Sinclair (ibid.), the Hull correlative is missing in central Ontario. Schopf (1966, p. 25) correlated the upper Bobcaygeon beds at Kirkfield with the Kirkfield Formation in New York and with the Hull Formation of the Ottawa-Hull area, and hence assigned a younger age than the "Rockland" at its type section (Stewart Quarry, Rockland, Ontario). Liberty (1969, p. 44) considered the upper member (E) of his Bobcaygeon Formation as Rocklandian in age, and correlated it with the Napanee Limestone.

Other correlations of the Hull Formation were made by Twenhofel *et al.* (1954), Cooper (1956, Chart I), and Templeton and Willman (1963, Figs. 29-A and 29-B).

East of the study-area, Clark (1959, p. 19) correlated the Hull Formation with the Deschambault and St. Casimir Formations of the Grondines-Neuville area in Quebec. Sanford (*in* Poole *et al.*, 1970, p. 256) essentially followed this correlation. Globensky and Jauffred (1971a, 1971b), however, correlated the Hull with the Deschambault Formation in the Grondines-Neuville area, and with the Mile-End Formation in the Montreal area.

BIOSTRATIGRAPHY: THE CONODONT FAUNA AND ITS SIGNIFICANCE

The conodont collection from the Hull Formation, Ottawa Group, consists of 10,542 identifiable specimens, which are assignable to ten species. In addition, there are seven form-species which cannot be assigned satisfactorily to any species at this time. The ratios of constituent form-species or elements of these species are similar to those reported by Schopf (1966), Bergström and Sweet (1966), and Webers (1966) (*see* Table 1). Discrepancies in some cases are probably owing to the relatively much smaller size of the Hull collection.

The Hull conodont fauna is typical of the North American Midcontinent Province, and of the eastern subprovince (Barnes *et al.*, 1973, p. 171, Fig. 11). It belongs to Fauna 8 of Sweet *et al.* (1971, Fig. 1, p. 175, 176), and is dominated by *Phragmodus undatus* Branson and Mehl (44.3 per cent of the total collection) and *Plectodina aculeata* (Stauffer) (16.0 per cent) (*see* Table 1). Also present in Fauna 8, although not restricted to it, are *Polyplacognathus ramosus* Stauffer (3.3 per cent) and *Bryantodina? abrupta* (Branson and Mehl) (0.3 per cent). *Icriodella superba* Rhodes (0.1 per cent) also is represented, and it is in Fauna 8 that European (North Atlantic) elements make their Midcontinent debut. "Fibrous conodonts" still persist in this fauna and are represented in the Hull collection by six form-species (10 specimens, or 0.1 per cent of the total collection). *Oulodus* cf. *O. mediocris* Branson and Mehl is only poorly represented, and only three elements which probably belong to this species are recognizable. The genus apparently appears in the interval dominated by Fauna 8 (Sweet, pers. com., 7 March, 1972). Other species present in the Hull collection include *Belodina compressa* (Branson and Mehl) (3.8 per cent), *Drepanoistodus suberectus* (Branson and Mehl) (11.4 per cent), and *Panderodus gracilis* (Branson and Mehl) (20.2 per cent), but these are long-ranging and do not add anything further to biostratigraphic definition.

The following data on the distribution of Fauna 8 have been drawn heavily from Sweet *et al.* (1971, p. 176). Conodonts of Fauna 8 are present in the lower part of the Lexington Limestone (Kentucky, and adjacent parts of Ohio and Indiana), and in the interval from the uppermost part of the Chaumont Formation through the mid-part of the Kings Falls Limestone (New York and Ontario) (Schopf, 1966). Elsewhere, Fauna 8 occurs in the base of the Platteville through the Decorah Formations (Iowa and Minnesota) (Webers, 1966) and in the upper Plattin through the Decorah (or Barnhart) Formations (Missouri). Elements characteristic of some species of Fauna 8 are present also in the Deer Island Member of the Winnipeg Formation of Manitoba (Oberg, 1966).

According to Barnes (*in* Barnes *et al.*, 1973, p. 175-177, Fig. 14), different conodont communities evolved in different paleotectonic regimes. Thus a community represented by *Polyplacognathus*, *Bryantodina*, and *Plectodina* developed in a shallow shelf environment, whereas *Phragmodus* developed in a deep shelf miogeosyncline, and *Icriodella* in a eugeosyncline. Elements within geosynclinal communities immigrated to shelf environment in staggered fashion. Barnes (1973, p. 297) further noted that in the Lower Trenton faunas of northeastern North America, *Bryantodina* and *Polyplacognathus* came from the west, and the North Atlantic Province (eugeosynclinal) immigrants from the east. Both Barnes (ibid.) and Titus (1974, p. 81) noted the close conformity of conodont distribution with facies patterns, with the suggestion that the conodont-bearing animals may have been benthonic rather than planktonic, as previously assumed.

A small conodont collection (186 specimens) from the Deschambault Formation from the Neuville section, southern Quebec, was described by Globensky and Jauffred (1971a). According to these authors (ibid.; 1971b, Table 1) and Sanford (*in* Poole *et al.*, 1970, Chart II), the Deschambault is a Hull correlative. Included among the Deschambault conodonts are fragmentary specimens assigned to *Amorphognathus ordovicicus* Branson and Mehl; as Globensky and Jauffred (1971, p. 54) submitted, however, these may be more correctly referable to *A. tvaerensis* Bergström. *Amorphognathus ordovicicus* is known from several localities which bear conodonts of

Fauna 10 and younger (Sweet *et al.*, 1971, Fig. 1). It is very unlikely, therefore, to occur in the Deschambault, if its correlation with the Hull is correct. Other species in the Deschambault are long-ranging and include *Drepanoistodus suberectus*, *Panderodus gracilis*, *Phragmodus undatus*, and *Icriodella superba*. On the basis of published data, Deschambault conodonts cannot be assigned with any certainty to any faunal grouping. Barnes (pers. com., 6 Feb., 1974) has recovered *Polyplacognathus ramosus* from the Deschambault Formation in an area between Montreal and Quebec City.

Within the Hull Formation, the conodont distribution is generally fairly uniform (*see* Tables 2 and 3). However, some major discrepancies in the number of specimens in the Upper and Lower Members occur in the distribution of some species. The average number of specimens per sample of *Belodina compressa*, *Phragmodus undatus*, and *Polyplacognathus ramosus* in the Lower Member far exceeds that in the Upper Member. The Lower Member is interpreted as having been deposited farther offshore, in a more quiet environment than the Upper Member. The implication is that these species probably favoured a less turbulent environment than *Plectodina aculeata*, where the frequency of occurrence is exactly the opposite, i.e., greater in the Upper Member. The discrepancy may be more apparent than true owing to the frequency of sampling; 95 samples of the Upper Member yielded conodonts as against only 24 of the Lower Member.

The conodont faunas of the Hull Formation and of the upper part of the middle member (D) and the upper member (E) of the Bobcaygeon Formation, Kirkfield Quarry, are similar. These units contain abundant *Phragmodus undatus*, and probably *Plectodina aculeata* although this is difficult to determine from Schopf's (1966, Table 6) data. Other constituents in common to all these units include *Bryantodina? abrupta* and *Polyplacognathus ramosus*. On the other hand, the Hull fauna is not as similar to the "Rockland" fauna at the Stewart Quarry (Schopf, ibid., Table 5), except for the abundant *Phragmodus undatus*. *Plectodina aculeata* and *Icriodella superba* are represented only sparsely, with *Bryantodina? abrupta* and *Polyplacognathus ramosus* completely absent. Although the conodont collections suggest that the Hull Formation is more closely correlative with the upper part of the middle member (D) plus the upper member (E) of the Bobcaygeon Formation, there probably is some overlap in the correlation with the "Rockland" strata at the Stewart Quarry. This is suggested by the following: (1) the possible "Rockland" bed at section 9 yielded a conodont collection very similar to the overlying Hull beds; (2) Liberty (1969, p. 44) mapped and traced his member E at the Kirkfield Quarry with the Napanee beds at their type section on Selby Creek near Napanee, Ontario.

In summary, the conodont fauna of the Hull Formation is typical of the North American Midcontinent Province and of the eastern subprovince. The Hull conodonts are assignable to Fauna 8 of Sweet *et al.* (1971), with a preponderance of *Phragmodus* and *Plectodina aculeata*. In terms of North American stages, Fauna 8 is of late Porterfieldian through mid-Kirkfieldian age, or approximately late Wildernessian (Bergström, 1971b, Fig. 2). It is difficult to assess the age of the Hull conodonts in terms of European stadial classifications. This is primarily owing to the fact that the Midcontinental conodont faunas have only a few elements that are common with those of the North Atlantic Province. The latter province in the Middle Ordovician occurred along the Appalachian and parts of western North America, and extended to northern Europe (Barnes *et al.*, 1973, Fig. 9; Bergström, 1973, Fig. 3). Sweet and Bergström (1971, Fig. 8) and Bergström (1971b, Fig. 2) have suggested, however, that Fauna 8 is equivalent to an upper part of the *Amorphognathus tvaerensis* Zone of the North Atlantic Province.

The conodont evidence suggests the following correlations of the Hull Formation: with the interval ranging from the uppermost part of the Chaumont Formation through the mid-part of the Kings Falls Limestone (New York and Ontario); with the lower part of the Lexington Limestone (Kentucky, Ohio and Indiana); with the interval from the base of the Platteville through the Decorah Formations (Iowa and Minnesota); with the Deer Island Member, Winnipeg Formation (Manitoba); and with the upper part of member D and member E, Bobcaygeon Formation (south-central Ontario, west of the Frontenac Arch).

SYSTEMATIC PALEONTOLOGY

All figured specimens are reposited in the type collections of the Geological Survey of Canada.

In the following systematics, a multielement taxonomic approach (after Bergström and Sweet, 1966; Webers, 1966; and Sweet and Bergström, 1970) is followed. Form-genera are placed in quotation marks.

Family BALOGNATHIDAE Hass, 1959

Type genus. *Amorphognathus* Branson and Mehl, 1933 (=*Balognathus* Rhodes, 1953).

Remarks. According to Lindström (1970, p. 435, 436), the apparatus of Balognathidae consists of two kinds of platform elements: ambalodiform and amorphognathiform. Bergström and Sweet (1966, p. 385, 386) and Bergström (1971a, p. 137-142) reconstructed the apparatuses of *Polyplacognathus* and *Eoplacognathus*, respectively, with both apparatuses including these two kinds of elements. On the other hand, the apparatus of *Amorphognathus*, as reconstructed by Bergström (1971a, p. 131-136), consists of these elements plus a holodontiform element and a ligonodiniform-tetraprioniodiform transition series. Whether all these genera should be included within a single family is thus questionable. As only a single genus within this family is dealt with in this report, the problem is not considered further.

SECTION NUMBER		1							2										3		5						
SAMPLE INTERVAL (IN FEET) (0=top)		0-5.5	5.5-10.0	10.0-16.5	16.5-18.0	18.0-19.4	19.4-21.6	21.6-22.0	0-9.0	9.0-14.9	14.9-19.1	19.1-24.3	24.3-27.9	27.9-28.5	28.5-29.0	29.0-32.5	32.5-33.1	33.1-39.8	0-0.5	0.5-2.5	0-2.7	2.7-4.9	4.9-6.4	10.5-12.6	14.6-18.3	18.3-20.6	20.6-21.8
G.S.C. LOCALITY NUMBER		51353	51352	51351	51350	51349	51348	51347	51363	51362	51361	51360	51359	51358	51357	51356	51355	51354	51388	51389	51421	51420	51419	51417	51415	51414	51413
SPECIES	CONSTITUENT ELEMENTS OR FORM-SPECIES																										
Acodus mutatus	*Acodus mutatus*																										
? (*see* text)	*Acontiodus* sp. A																										
Belodina compressa	*Belodina compressa*																										
	Eobelodina fornicala																										
Bryantodina? abrupta	*Ozarkodina? abrupta*									1																1	1
	prioniodiform						1																				
Drepanoistodus suberectus	*Drepanodus suberectus*						1	1		2										1					1		
	Oistodus inclinatus	2										1	2				1		1				1		1	2	2
	Drepanodus homocurvatus	9	16	9	2	2	4	4	2	10	3	4	2	1	4	2	3	9	7	3	6	11			8	11	2
Icriodella superba	*Icriodella superba*				1																						
	Sagittodontus robustus																										
	Sagittodontus dentatus																										
	rhynchognathodiform																										
Oulodus cf. *O. mediocris*	oulodiform	1			1																						
	trichonodelliform									1														1			
	zygognathiform				1																						
Panderodus gracilis	*Panderodus compressus*	9	6	12	5	5	4	6	5	11	3	3	3		2	3	5	10		4	10	3			9	1	2
	Panderodus gracilis	22	28	13	23	1	19	12	30	19	8	14	6	15	5	7	13	17	16	23	11	14			8	11	6
Phragmodus undatus	*Phragmodus undatus*	4	5								4	17	8			2	1	16	11	10	8				2		
	Dichognathus brevis		1		1			1	1	1		3	1					6		1	3	1					
	Dichognathus typicus	3					3		3			3	3		2		3	11	21	4	5	1	1		2		
	Oistodus abundans			1					2		1	3	1	1	2		2	7	2	1		1	1				
Plectodina aculeata	ozarkodiniform	6	6	6	9	3	3	5	1	13	5	10	8	5	7	5	7	2	13	19	14	32	4	3	2	8	7
	prioniodiform					1													1	1	1	1				3	
	dichognathiform	2	3	4	9	1	5	3	1	4		2	1	1	1		2	3	5	2	4	1	1				
	cyrtoniodiform																										
	cordylodiform		3	3			2	2	1	1	4	3	2	2	1	1	2	1	5	6	1	12		1	2	1	3
	zygognathiform	1	5		1	3				1					2	1		2	3		1	1					
	trichonodelliform			3	3		1	1	2	4	2	6	4				1	2	5	8	2	12	3			2	2
Polyplacognathus ramosus	*Polyplacognathus ramosus*																										
	Polyplacognathus bilobatus																										
"Fibrous conodonts"																											
? (*see* text)	*Curtognathus* sp.																										
? (*see* text)	*Polycaulodus* spp.																									1	
? (*see* text)	*Trucherognathus* spp.																										

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Table 2. Conodont distribution, Hull Formation, sections 1-3, 5-8, 10-12 (figures indicate the number of specimens identified)

6			7											8													10			11			12A		12		Subtotal		Total
0-1.9	1.9-3.7	4.7-7.5	0-1.6	1.6-5.3	5.3-9.4	9.4-13.7	13.7-16.7	16.7-19.7	19.7-20.4	20.4-24.6	24.6-27.7	30.7-33.2	33.2-33.7	0-1.0	1.0-1.9	1.9-3.0	3.0-4.8	4.8-6.7	6.7-8.7	8.7-9.4	9.4-13.0	13.0-14.2	14.2-18.1	18.1-19.5	21.9-24.0	24.0-29.0	0-3.1	4.3-7.3	7.3-14.2	0-3.9	3.9-7.1	7.1-9.7	0-4.0	4.0-8.0	0-5.4	5.4-9.7			
51425	51424	51422	51437	51436	51435	51434	51433	51432	51431	51430	51429	51427	51426	51447	51448	51449	51450	51451	51452	51453	51454	51455	51456	51457	51459	51460	51482	51484	51485	51486	51487	51488	51496	51495	51493	51494	Upper	Lower	
																			1														1				2		2
																													1								4		4
																													1								2		2
			2		3	1	2	1	1		1			4				6								2							2				30	1	31
	2	1	4			3	1		2		2	1				6	2	2	3					2		1		2	2	2			1	5			54	3	57
		1	13		8	15	6	14	2	1	11	2	1	23	4	17	16	14	19	1	1	10	1	6	1	11		4	5	10	2		8	10		3	359	15	374
															1										1										1		4		4
														1				1																			2		2
														2																							2		2
																1																					1		1
																												1									3		3
																					1														1		4		4
																																					1		1
			14	1	28	11	6	13	4	1	3	6		18	6	13	9	12	13	1		6	5	14	3	5		7	5	16	3	1	5	15	2		357	10	367
	1		25		72	28	26	31	1	1	10	6		30	8	10	30	21	17		2	24	7	8	4	12		5	8	12	3		18	11		3	758	17	775
			16		22	17	12	19	7	5	29	34		20	1	16	31	8	11	16		18	4	10	1			17	4	17	9		8	20	11	8	411	68	479
			13		5	9		14	1		6	5		9		5	3	6	2	5		2		4		2	3	2		4	1		6	8	1		125	11	136
		1	23		13	4	8	10	2	1	9	10		11	2	15	15	13	2	7		4	2	9	1	6		4		8	3		8	15	2	3	256	28	284
			18		16	9	11	8		1	10	7		22	1	24	16	11	7	3		4	1	6		3		2	3	15			17	14	1	4	241	18	259
2	12	6	15	1	2	1					1			17	7	26	10	13	8	5	3	6	6	16	3			1	5	15	3		5	4	4	7	406	1	407
	3		5		1		1				1					2	3					4	2	8		4			3	2				1			47	1	48
	12	2	2		2	3	5					1		3	3	3	4	3	2		3			1	1	1	1	1	1	8	1		2	3	2		122	1	123
														1		3				1		2		3						4				1			15		15
	3	1	16		1	1	3	2	1		4	1		34	6	2	5	17	7	8	3	12	4	13	2	4	1	2	4	24	1	1	23	20	2	5	287	5	292
	2							2						3	2	5	1	4	2			1		8	1	2		1	1	7			8		2	2	75		75
	4	2	2					1						13	5	9	5	14		7		4	2	4	1	1			5	14	4		5	10	2	4	181		181
																													1								1		1
																													1								2		2

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Table 2. Continued

SECTION NUMBER		4																				
SAMPLE INTERVAL (IN FEET) (0=top)		0-4.0	4.0-7.0	7.0-9.1	9.1-12.6	12.6-16.0	16.0-16.5	29.5-32.9	32.9-36.4	36.4-38.9	44.7-46.6	46.6-48.1	48.1-51.3	51.3-54.1	54.1-56.0	56.0-58.1	58.1-60.7	60.7-62.6	62.6-64.5	64.5-67.0	67.0-72.6	72.6-75.0
G.S.C. LOCALITY NUMBER		51566	51411	51410	51409	51408	51407	51406	51405	51404	51401	51400	51399	51398	51397	51396	51395	51394	51393	51392	51391	51489
SPECIES	CONSTITUENT ELEMENTS OR FORM-SPECIES																					
Acodus mutatus	*Acodus mutatus*						1		1													
? (see text)	*Acontiodus* sp. A																					
Belodina compressa	*Belodina compressa*								3		1		1			1			1			3
	Eobelodina fornicala																					
Bryantodina? abrupta	*Ozarkodina? abrupta*			1	4	2	2		1						1				1			1
	prioniodiform																					
Drepanoistodus suberectus	*Drepanodus suberectus*																		2			
	Oistodus inclinatus			1				1	1		1	1		1					4			2
	Drepanodus homocurvatus			10	16	5	14	17	11	1	3	11	2	9	3	6	7	15	14	3	2	4
Icriodella superba	*Icriodella superba*																					
	Sagittodontus robustus																					
	Sagittodontus dentatus																					
	rhynchognathodiform																					
Oulodus cf. *O. mediocris*	oulodiform					1																
	trichonodelliform																					
	zygognathiform																					
Panderodus gracilis	*Panderodus compressus*			24	9	9	11	7	15	1	2	10	1	6	1	2	2	3	7	2	1	5
	Panderodus gracilis	2		23	15	9	15	8	11	1	8	1	4	10	2	4	1	2	13		2	2
Phragmodus undatus	*Phragmodus undatus*			1	3	2	2		3	1	4	13	7	1	4	1	2	8	3			12
	Dichognathus brevis							1	1			5	1		2	5		2	2			5
	Dichognathus typicus				3				1	1	3	3	3		2	1	9	15	3	3		13
	Oistodus abundans	1		1					2	1		1						1	2			4
Plectodina aculeata	ozarkodiniform	1		6	3	3	13	10	5	2	15	4	3	9	3	5	1	2	6		1	
	prioniodiform	1		6			10	6			3	1	1	4								
	dichognathiform	3					2	1	1		2											
	cyrtoniodiform																					
	cordylodiform	2		10	5	1	18	6	3			3		1	3	2	1		3			
	zygognathiform		2	1			1							4								
	trichonodelliform			1	2		7	4	1		1	3							1			4
Polyplacognathus ramosus	*Polyplacognathus ramosus*							2		1		1		6		3	3	3	8		2	2
	Polyplacognathus bilobatus					1					1	1						1	1			
"Fibrous conodonts"																						
? (see text)	*Curtognathus* sp.																					
? (see text)	*Polycaulodus* spp.			2																		
? (see text)	*Trucherognathus* spp.																					

Table 3. Conodont distribution, Hull Formation, sections 4 and 9, 9A, 9B (figures indicate the number of specimens identified)

4												9									9B		9A											Subtotal		Total
75.0-80.5	80.5-84.0	84.0-86.1	86.1-90.6	90.6-93.6	93.6-96.6	96.6-99.6	99.6-102.6	102.6-105.6	105.6-108.6	108.6-111.6	111.6-116.6	0-1.1	1.1-4.9	6.0-9.6	12.3-13.5	13.5-16.2	16.2-20.7	20.7-25.6	25.6-31.4	31.4-34.8	0-6.2	6.7-9.9	0-4.5	4.5-7.1	7.1-15.6	15.6-23.6	23.6-28.0	28.0-30.2	30.2-35.8	35.8-40.7	40.7-45.3	45.3-50.8	50.8-52.8			
51490	51491	51492	83571	83572	83573	83574	83575	83576	83577	83578	83579	51461	51462	51463	51464	51465	51466	51467	51468	51469	51480	51481	51479	51478	51477	51476	51475	51474	51473	51472	51471	51470	88772	Upper	Lower	
1	1																					1			1									4	2	6
				2	14		4	5	8	1																									34	34
		7	5		83	40	28	40	25	14	16									1	3			10	2		4	5	3	1	6	3	28	27	307	334
1		2	1		16	10	6	8	5	6	2																	2	1				6		66	66
1					1	2			1		1			1						1	2	1						1						17	8	25
						1																2												2	1	3
		1			4	5	4		1	2					3		1			1		1				2					1		4	10	22	32
2	1	2	2	2	10	14	4	6	5	8	3	1		2		1	1	2		5		1	1	2	1			2	1	3	1	1	4	27	73	100
4	2	7	6	2	38	42	46	47	35	19	8	7	2	6	11	2	6	16	4	3	13	13	8	16	11	6	18	8	8	3	8	8	19	289	316	605
														1																				1		1
					1	1							1																					1	2	3
																																		1		1
																			1															1		1
																1																		1		1
4	10	15	2		12	27	15	5	9	2	2	7	5	2	4	2	2	3	1	6	6	11		3	5	10	1	3	2	7	2	1	5	180	129	309
3	12	9	2		31	139	41	50	36	8	8	12	5	9	12	5	6	8	3	20	12	23	2	4	9	12	7	6	12	13	1	3	20	278	398	676
24	32	19	18	9	318	328	238	191	96	48	82		3	6	8	1	8	9			3	11	16	11	14	3	31	24	33	12	11	7	50	179	1552	1731
9	5	2		2	69	37	26	13	15	7	13	2	3	3	6	1	3	3		3	1	3	4	3	4	2	19	9	5	4	3	2	16	79	242	321
27	14	8	3	3	144	83	62	34	45	14	17		2	8	3	2			1		2	3	7	11	7	7	34	11	32	16	5	2	35	134	568	702
11	17	16	4	3	163	96	107	89	53	16	32	5	3	6	4	1	3	7		2	2	6	3	10	10	7	19	3	7	2	1	2	30	97	656	753
			1		5	2					1	16	6	5	11	2	9	13		5	5	4			1	1		3	1				1	169	15	184
												2			2			4		2	4	4		1		1								52		52
												3	6	2	4	1	4	7	2	1	1													40		40
						2						1																						1	2	3
					8	4					2	10	5	12	13			4	2	7	26		1	2		1			1					141	15	156
	2				1	2						2		2		2					3	1		2	1									21	5	26
					2	1						4	6	10	11	2	6			6	4	6	2	2		1		1					1	80	9	89
1					16	36	31	27	16	17	20									2	2			7	2	5	24	2	8	2	1		16	69	197	266
2					7	7	14	11	6	4	12													2			4	2				1	6	11	72	83
						1														1														1	1	2
																										1								3		3
																										1			2					1	2	3

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Table 3. Continued

Genus *Polyplacognathus* Stauffer, 1935b

Type species. *Polyplacognathus ramosus* Stauffer, 1935b.

Polyplacognathus ramosus Stauffer

Plate 1, figures 1-4

Polyplacognathus ramosa Stauffer, Bergström and Sweet, 1966, p. 386-388, Pl. 28, figs. 9-12.
Polyplacognathus ramosus Stauffer, Ethington and Schumacher, 1969, p. 473, Pl. 69, fig. 20 (amorphognathiform element); Sweet, Ethington and Barnes, 1971, p. 173, Pl. 2, fig. 25 (amorphognathiform element).

Figured specimens. GSC Nos. 17783 and 17784, both from GSC loc. 51394 (Sec. 4).

Family DISTACODONTIDAE Bassler, 1925

Type genus. *Distacodus* Pander, 1856.

Remarks. According to Lindström (1970, p. 430, 431), most genera of the Distacodontidae consist of drepanodiform and oistodiform elements, occurring with a ratio of 2:1 or 4:1.

Genus *Drepanoistodus* Lindström, 1971

Type species. *Oistodus forceps* Lindström, 1955.

Drepanoistodus suberectus (Branson and Mehl)

Plate 1, figures 5-9

Drepanodus suberectus (Branson and Mehl), Bergström and Sweet, 1966, p. 330-333, Pl. 35, figs. 22-27; Weyant, 1968, p. 47, Pl. 2, figs. 11, 12 (drepanodiform element); Ethington and Schumacher, 1969, p. 461, 462 (drepanodiform element); Globensky and Jauffred, 1971a, p. 55, Pl. 4, figs. 3-6; Moskalenko, 1972, p. 52, fig. 6; Moskalenko, 1973, p. 33, 34, Pl. 1, fig. 4 (drepanodiform element).
Drepanodus homocurvatus Lindström, Weyant, 1968, p. 46, 47, Pl. 2, fig. 13 (drepanodiform element); Ethington and Schumacher, 1969, p. 461 (drepanodiform element); Moskalenko, 1973, p. 32, 33, Pl. 1, fig. 3 (drepanodiform element).
Oistodus inclinatus Branson and Mehl, Ethington and Schumacher, 1969, p. 467, Pl. 68, fig. 7 (oistodiform element); Weyant, 1968, p. 53, Pl. 2, fig. 8 (oistodiform element); Moskalenko, 1973, p. 36, Pl. 1, fig. 7 (oistodiform element).
Oistodus sp. 1, Weyant, 1968, p. 53, 54, Pl. 2, fig. 10 (oistodiform element).

Remarks. Moskalenko (1972, p. 52) reported the species from the Chertovsky Subhorizon, Mangazeisky Horizon, on the Podkamennaya Tunguska River, USSR.

Figured specimens. GSC Nos. 17785 to 17789, GSC locs. 51354 (Sec. 2), 51362 (Sec. 2), 51393 (Sec. 4), 51477 (Sec. 9A), and 51460 (Sec. 8), respectively.

Family ICRIODONTIDAE Müller and Müller, 1957

Type genus. *Icriodus* Branson and Mehl, 1938.

Remarks. According to Klapper and Philip (1972, p. 101), representatives of the Icriodontidae have a Type 4 apparatus (of Klapper and Philip, 1971), and include *Icriodus*, *Pelekysgnathus*, *Pedavis*, and *Icriodella*.

Genus *Icriodella* Rhodes, 1953

Type species. *Icriodella superba* Rhodes, 1953.

Icriodella superba Rhodes

Plate 1, figures 14-19

Icriodella superba Rhodes, Bergström and Sweet, 1966, p. 337-340, Pl. 29, figs. 1-11; Kohut and Sweet, 1968, p. 1460; Sweet and Bergström, 1970, p. 169, figs. 6K-O; Globensky and Jauffred, 1971a, p. 55, Pl. 3, fig. 14 (amorphognathiform element); Sweet, Ethington and Barnes, 1971, p. 173, Pl. 2, figs. 2, 11 (amorphognathiform and ambalodiform elements).
Rhynchognathodus divaricatus Rhodes, Globensky and Jauffred, 1971a, p. 58, Pl. 3, fig. 15 (ramiform element).
Sagittodontus dentatus Ethington, Globensky and Jauffred, 1971a, p. 58, Pl. 3, fig. 9 (ambalodiform element).
Sagittodontus robustus Rhodes, Globensky and Jauffred, 1971a, p. 58, Pl. 3, fig. 11 (ambalodiform element).

Remarks. The specimens referred to the ramiform (rhynchognathodiform) element differ from those described in published literature in possessing only weakly denticulated processes.

Figured specimens. GSC Nos. 17793 to 17797, GSC locs. 51493 (Sec. 12), 51477 (Sec. 8), 51477 (Sec. 8), 51449 (Sec. 8), and 51451 (Sec. 8), respectively.

Family PANDERODONTIDAE Lindström, 1970

Type genus. *Panderodus* Ethington, 1959.

Remarks. Lindström (1970, p. 433) included in the Panderodontidae the genera *Panderodus*, *Belodina* Ethington, and *Eobelodina* Sweet, Turco, Warner, and Wilkie. In all probability, *Neopanderodus* Lindström and Ziegler also should be included. *Belodina* and *Eobelodina* were considered synonymous by Bergström and Sweet (1966, p. 312-315) and Webers (1966, p. 23), although this view was questioned by Barnes (1967) and Moskalenko (1973, p. 52, 53). [*See* remarks under *Belodina compressa* (Branson and Mehl).]

Genus *Belodina* Ethington, 1959

Type species. *Belodina compressa* (Branson and Mehl, 1933) [=*Belodus grandis* Stauffer, 1935b, designated by Ethington (1959) as type of *Belodina*].

Belodina compressa (Branson and Mehl)

Plate 1, figures 10-13

Belodina compressa (Branson and Mehl), Bergström and Sweet, 1966, p. 312-315, Pl. 31, figs. 12-19; Weyant, 1968, p. 36, 37, Pl. 2, fig. 6 (belodiniform element); Sweet, Ethington and Barnes, 1971, p. 173, Pl. 2, figs. 27, 28; Moskalenko, 1972, p. 52, 53, figs. 7-3 and 7-4 only; Moskalenko, 1973, p. 56, 57, Pl. 5, figs. 3-6 (belodiniform element).
Belodina grandis (Stauffer), Weyant, 1968, p. 38, Pl. 2, fig. 1 (belodiniform element).
?*Belodina dispansa* (Glenister), Weyant, 1968, p. 37, Pl. 2, figs. 2, 3 (belodiniform element).
Eobelodina fornicala (Stauffer), Weyant, 1968, p. 49, 50, Pl. 2, fig. 7 (eobelodiniform element); Moskalenko, 1973, p. 34, 35, Pl. 1, figs. 5, 6 (eobelodiniform element).

Remarks. Barnes (1967) recovered an assemblage of four fused belodiniform elements, which he considered to be at least a part of the *Belodina* apparatus, from the Cobourg Formation at Ottawa, Ontario. No eobelodiniform element was recovered from the same sample. He suggested that there may have existed more complex combinations of elements than those suggested by others (e.g., Webers, 1966) and that a natural assemblage, without eobelodiniform element, may have been present. Barnes' opinion was supported by Moskalenko (1973, p. 52, 53) on the basis of her study of Siberian platform conodonts. She found in her collection a 155:8 ratio in the number of specimens of belodiniform and eobelodiniform elements, but this ratio includes a third form of belodiniform element, "*Belodina*" *diminutiva* (Branson and Mehl). In addition, form-species "*Culumbodina*" *mangazeica* Moskalenko was included in the *Belodina compressa* apparatus.

In the Hull collection, a ratio of belodiniform:eobelodiniform is 334:66 which is, in absolute terms, 10.2:2.0 or roughly 10:2. This is in close agreement with Schopf's (1966, Table 2) ratio, and in approximate agreement with those of Bergström and Sweet (1966, Table 2) and Webers (1966, Pl. 1).

Moskalenko (1972, p. 53) reported this species from the Baxansky Subhorizon, Mangazeisky Horizon, on the Podkamennaya Tunguska River, USSR.

Figured specimens. GSC Nos. 17790 to 17792, GSC locs. 51399 (Sec. 4), 51480 (Sec. 9B) and 51473 (Sec. 9A), respectively.

Genus *Panderodus* Ethington, 1959
(Emend., Ziegler and Lindström, 1971, p. 629, 630)

Type species. *Paltodus unicostatus* Branson and Mehl, 1933.

Remarks. Ziegler and Lindström (1971, p. 629, 630) revised the original diagnosis of Ethington (1959, p. 284). This revision was based on detailed study of the surface morphology with the aid of scanning electron microscope, of specimens of *Panderodus*.

Panderodus gracilis (Branson and Mehl)

Plate 3, figures 7-14

Panderodus gracilis (Branson and Mehl), Bergström and Sweet, 1966, p. 355-359, Pl. 35, figs. 1-6; Winder, 1966, Pl. 9, fig. 25; Oberg, 1966, p. 140, Pl. 16, fig. 3; Andrews, 1967, p. 896, Pl. 113, fig. 9; Serpagli, 1967, p. 57-59, Pl. 23, figs. 3a-5c; Weyant, 1968, p. 56, 57, Pl. 5, figs. 1, 2; Globensky and Jauffred, 1971a, p. 57, Pl. 4, figs. 1, 2; Moskalenko, 1973, Pl. 1, figs. 13, 14.
Panderodus compressus (Branson and Mehl), Winder, 1966, Pl. 9, fig. 26; Oberg, 1966, p. 140, Pl. 15, fig. 8; Andrews, 1967, p. 895, 896, Pl. 113, fig. 3; Serpagli, 1967, p. 56, 57, Pl. 6, figs. 4a-5b; Weyant, 1968, p. 55, 56, Pl. 6, figs. 1, 2; Moskalenko, 1973, p. 37, 38, Pl. 1, fig. 15.
Panderodus feulneri (Glenister), Winder, 1966, Pl. 9, fig. 19; Weyant, 1968, p. 56, Pl. 5, fig. 4.
Panderodus intermedius (Branson, Mehl, and Branson), Moskalenko, 1973, p. 38, 39, Pl. 1, figs. 16, 17.

Remarks. According to Bergström and Sweet (1966, p. 357), the *Panderodus gracilis* apparatus consists of two form-species: "*Panderodus*" *gracilis* (Pl. 3, figs. 11-14) and "*P.*" *compressus* (Branson and Mehl) (Pl. 3, figs. 7-10).

Figured specimens. GSC Nos. 17832 to 17839, from various localities; *see* plate explanation for details on localities.

Family PERIODONTIDAE Lindström, 1970

Type genus. *Periodon* Hadding, 1913.

Remarks. According to Lindström (1970, p. 435), the Periodontidae is characterized by platform-like ozarkodiniform elements. Furthermore, the symmetry transition occurs within the elements with a large denticle situated posteriorly of the cusp (e.g., phragmodiform element). The family includes *Phragmodus* Branson and Mehl and *Plectodina* Stauffer.

Genus *Phragmodus* Branson and Mehl, 1933
(Emend., Bergström and Sweet, 1966, p. 366)

Type species. *Phragmodus primus* Branson and Mehl, 1933.

Remarks. The *Phragmodus* apparatus has the basic prioniodid plan and consists of phragmodiform, dichognathiform, and oistodiform elements (Bergström and Sweet, 1966, p. 366; Sweet and Bergström, 1970, p. 167). In addition to these components, Moskalenko (1972, p. 48-50, Table 2) included in this apparatus cordylodiform-gothodiform and plectodiniform-cyrtoniodiform transition series, making a total of at least five morphologically distinct elements.

Phragmodus undatus Branson and Mehl

Plate 1, figures 26-30

Phragmodus undatus Branson and Mehl, Bergström and Sweet, 1966, p. 369-372, Pl. 28, figs. 13-20; Ethington and Schumacher, 1969, p. 472, Pl. 67, fig. 15 (phragmodiform element); Sweet and Bergström, 1970, p. 167, fig. 5A-D; Globensky and Jauffred, 1971a, p. 57, Pl. 4, figs. 7-13; Sweet, Ethington and Barnes, 1971, p. 173, Pl. 2, figs. 7-10; Moskalenko, 1972, p. 50.

Figured specimens. GSC Nos. 17802 to 17806, all from GSC loc. 51427 (Sec. 7).

Genus *Plectodina* Stauffer, 1935a

Type species. *Plectodina aculeata* (Stauffer, 1930).

Plectodina aculeata (Stauffer)

Plate 2, figures 1-26

Cyrtoniodus flexuosus (Branson and Mehl), Bergström and Sweet, 1966, p. 324-327, Pl. 32, fig. 11 only.
Ozarkodina? obliqua (Stauffer), Bergström and Sweet, 1966, p. 348-351, Pl. 33, figs. 6-9; Pl. 24, figs. 7, 8; textfig. 10A-F.
Plectodina aculeata (Stauffer), Bergström and Sweet, 1966, p. 373-377, Pl. 32, figs. 15, 16; Pl. 33, figs. 22, 23; Pl. 34, figs. 5, 6; textfig. 9A-F; Sweet and Bergström, 1970, p. 167; Sweet and Bergström, 1972, p. 36, fig. 4F.

Remarks. *Plectodina aculeata* is the type and the oldest known species of *Plectodina* (Sweet and Bergström, 1972, p. 36). According to these authors (ibid.; 1966, p. 350), the dichognathiform element of *P. aculeata* is of robust construction, with short processes and stout denticles. The dichognathiform element that consistently occurs with other elements of *P. aculeata* differs somewhat from this description. Rather it exhibits an overall appearance very similar to that of the prioniodiniform element (Pl. 1, figs. 8-11, 24, 25; compare with figs. 2, 3, 17, 18) in the denticulation of the processes and the size and construction of the cusp. The dichognathiform element has a distinct keel on the inner and anterior side of the cusp, which continues downward as a lateral process. The anterior process, therefore, is distinctly offset from the planar surface of the posterior process and the cusp, and the element takes on a quadraxial form. In contrast, the prioniodiniform element has an anterior process which is an extension of the anterior edge of the cusp.

The ozarkodiniform element (Pl. 1, figs. 15, 19, 20) that occurs in the same sample as the other elements of *P. aculeata* somewhat resembles "*Ozarkodina*" *polita* (Hinde) in form-taxonomy. This element, too, differs from the ozarkodiniform element described by Bergström and Sweet (1966, p. 350) in having longer processes and less distinct overall sinuosity.

The trichonodelliform element displays a considerably wide morphological range. The posterior process may be free of denticulation (Pl. 2, fig. 13), or weakly (Pl. 2, fig. 7) to prominently denticulated (Pl. 2, figs. 6, 22, 23). The denticles on the lateral processes differ markedly in these varieties also. They can be peglike, discrete and erect (Pl. 2, fig. 6), confluent at least partly, and strongly recurved posteriorly (Pl. 2, figs. 21, 22), or elongated in the plane of the processes, and subparallel to the cusp (Pl. 2, figs. 7, 13). Such variation in denticulation is exhibited to a certain extent in other elements, such as the cordylodiform (Pl. 2, figs. 1, 4, 5), ozarkodiniform, and dichognathiform (Pl. 2, figs. 8-11, 25, 26) elements.

Figured specimens. GSC Nos. 17807 to 17819, from various localities; *see* plate explanation for details on localities. GSC Nos. 17820 to 17825, all from GSC loc. 51424 (Sec. 6).

Family UNCERTAIN

Genus *Acodus* Pander, 1856

Type species. *Acodus erectus* Pander, 1856.

Acodus mutatus (Branson and Mehl)

Plate 1, figure 23

Acodus mutatus (Branson and Mehl), Bergström and Sweet, 1966, p. 303-305, Pl. 35, figs. 7, 9.

Remarks. In the Hull collection, only the acodiform element is present. According to Bergström and Sweet (1966, p. 304), the apparatus of *Acodus mutatus* also includes a distacodiform element.

Figured specimen. GSC No. 17800, GSC loc. 51405 (Sec. 4).

Genus "*Acontiodus*" Pander, 1856

Type species. "*Acontiodus*" *latus* Pander, 1856.

"*Acontiodus*" sp. A

Plate 1, figures 24, 25

Remarks. The specimens of "*Acontiodus*" sp. A somewhat resemble "*A.*" *alveolaris* Stauffer in exhibiting a deep conical basal cavity, and the lateral carinae with re-entry near their base, although the re-entries are only very weakly developed in these specimens. They differ from "*A.*" *alveolaris* in possessing a low, narrow mid-posterior costa which is restricted to the area of maximum cusp curvature. This costa is flanked on either side by rounded costae of height equal to the central one, but which traverse almost the entire length of the cusp.

"*Acontiodus*" *lindstroemi* Ethington (="*A.*" *falcatus* Ethington, 1959 not Hadding, 1913) exhibits only the mid-posterior costa which extends almost the entire cusp length. Trenton specimens reported by Schopf (1966, p. 35) were considered as possible intermediate forms between these two form-species as they exhibit both the lateral costae with strong re-entry and the mid-posterior costa. The present specimens differ from the three distinct forms mentioned above but, owing to sparsity of material, no taxonomic addition nor revision is attempted herein.

?"*Acontiodus*" sp. of Ethington and Schumacher (1969, p. 453) from the Copenhagen Formation of

Nevada differs in cross-section of the cusp: the Hull specimens have a rounded anterior cusp face, whereas this face is flat to concave in the Copenhagen specimens.

"*Acontiodus*" presently is considered only in terms of form-taxonomy as its apparatus is still unknown (Sweet and Bergström, 1972, p. 40).

Figured specimens. GSC No. 17801, GSC loc. 51452 (Sec. 8).

Genus *Bryantodina* Stauffer, 1935a

Type species. *Bryantodina typicalis* Stauffer, 1935a.

Remarks. Barnes (*in* Barnes and Poplawski, 1973, p. 776) has a study currently underway on conodonts from the Black River and Trenton Groups of northeastern North America. He has noted from this study that the apparatus of *Bryantodina* includes five or six elements of types similar to those of *Plectodina*.

Bryantodina? abrupta (Branson and Mehl)

Plate 1, figures 20-22

Bryantodina? abrupta (Branson and Mehl), Bergström and Sweet (1966, p. 318-321, Pl. 30, figs. 9-12, textfig. 8A-D; Sweet, Ethington and Barnes, 1971, p. 173, Pl. 2, fig. 36 (bryantodiniform element).
Bryantodina abrupta (Branson and Mehl), Globensky and Jauffred, 1971a, p. 54, Pl. 2, fig. 11 (bryantodiniform element).

Remarks. Only the prioniodiniform and bryantodiniform elements have been assigned to this species. As presently reconstructed, it is thus an incomplete apparatus.

Figured specimens. GSC Nos. 17798 and 17799, GSC locs. 51348 (Sec. 1) and 51407 (Sec. 4).

Genus *Oulodus* Branson and Mehl, 1933
(Emend., Bergström and Sweet, 1966, p. 342)

Type species. *Oulodus mediocris* Branson and Mehl, 1933.

Oulodus cf. *O. mediocris* Branson and Mehl

Plate 3, figures 15-18

cf. *Oulodus mediocris* Branson and Mehl, 1933, p. 116, Pl. 10, figs. 8, 9 (oulodiform element)

Remarks. The apparatus of *Oulodus* includes oulodiform and prioniodiniform (or ozarkodiniform) elements, and the trichonodelliform-cordylodiform transition series (Sweet and Bergström, 1972, p. 36). There is an addition of a crytoniodiform element in the older species, e.g., *O. serratus* (Stauffer). Sweet and Bergström (ibid.) noted the similarity in the mode of denticulation in the central form-transition series of *Oulodus* and *Plectodina*. The important difference between these apparatuses is the presence of only one type of ozarkodiniform or prioniodiniform element in the *Oulodus*, instead of two types in the *Plectodina* apparatus.

The Hull collection includes an oulodiform element which is questionably referable to the form-species "*Oulodus*" *mediocris* Branson and Mehl. After careful search, only a partial reconstruction of the apparatus is possible. The following elements are assigned tentatively to the apparatus of *Oulodus* cf. *O. mediocris*. One is a slightly asymmetrical trichonodelliform element (Pl. 3, fig. 16) with very short, non-denticulated posterior process. The cusp and the denticles on the lateral processes are strongly curved posteriorly so that the posterior process is at a right angle to the distal portion of the cusp. The denticles, like those of oulodiform and zygognathiform elements, are round, peglike, and confluent in at least part of their length. The lower surface of the cusp is deeply excavated, with shallow grooves under the lateral and posterior processes. The second is a zygognathiform element (Pl. 3, figs. 17, 18) which is morphologically similar to the trichonodelliform element, but differs from it in its higher degree of asymmetry. Similarities include strongly recurved cusp and similarly recurved denticles on the posterior and anterior processes, and the deep pit.

Figured specimens. GSC Nos. 17840 to 17842, GSC locs. 51350 (Sec. 1), 51362 (Sec. 2), and 51350 (Sec. 1), respectively.

"Fibrous conodonts"

Plate 3, figures 1-6

Remarks. Only a few "fibrous conodont-elements" are present in the Hull collection. These are assignable, in terms of form-taxonomy, to "*Curtognathus*" *limitaris*, "*Polycaulodus*" *bidentatus*, "*P.*" *normalis*, "*P.*" *tridentatus*, "*Trucherognathus*" *disparilis*, and "*T.*" *irregularis*, all Branson and Mehl's species. Owing to the extremely small number of specimens involved, these are figured but not described. As in the case of the Lexington collection (Bergström and Sweet, 1966, p. 333, 334), they are mentioned here primarily to complete the record of their occurrence.

Figured specimens. GSC Nos. 17826 to 17831, from various localities; *see* plate explanation for details on localities.

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APPENDIX I

LOCATIONS AND REMARKS ON THE STUDIED SECTIONS OF THE HULL FORMATION, OTTAWA GROUP

Exposures of the Hull Formation of the Ottawa Group in the Ottawa-Hull area were mapped by Wilson (1938, 1953). Twelve sections were sampled and measured in detail for this report. The locations are indicated on figure 1, and are numbered from 1 to 12. Detailed stratigraphic descriptions of the type section (Sec. 4) follow in Appendix II. General stratigraphic columnar sections, and the suggested correlations, are given on figure 2.

Section 1

The abandoned quarry of the Laurentian Stone Co., Ltd. is located a short distance south of the Montreal Road and west of the National Research Council grounds, Ottawa. This is the easternmost of the large quarries in this area (*see* Goudge, 1938, p. 54, 55). The section is located on the southeast face of the quarry. The entire section is considered to be Upper Member, Hull Formation. The total thickness is 22.0 feet (6.7 m) and the beds dip 3 to 4 degrees southward.

Section 2

This abandoned quarry is located a short distance south of Hog's Back Road, and immediately east of Mooneys Bay beach, Ottawa (*see* Wilson, 1956a, p. 28, 29). The section is located on the east and southeast faces of the quarry. The entire section is considered to be Upper Member, Hull Formation, and has a total thickness of 39.8 feet (12.1 m). The beds dip about 9 degrees southeastward, but dip more steeply near the fault at the southwest corner of the quarry.

Section 3

The small abandoned quarry located on the west side of Brewery Creek, and a short distance north of Montcalm Street, Hull. The Hull-"Sherman Fall" contact is well exposed (*see* Raymond, 1913, p. 150). Owing to extensive filling, collections were taken from only the upper two and one-half feet of the Upper Member. The total thickness is 2.5 feet (0.8 m).

Section 4

The large quarry, presently in active operation by the Canada Cement Co., Ltd. located at the junction of Blvd. Père Reboul and Brewery Creek in Hull. The quarry has two main floors, the upper floor located 67 feet (20.4 m) below the surface, and the lower floor 49.6 feet (15.1 m) below that. The beds gently dip southward at about 2 degrees (*see* Raymond, 1913, p. 151; Goudge, 1935, p. 63-66).

The Upper Member was sampled on the east face. This member is represented by that part of the quarry section above the upper floor. A 13-foot (4.0 m) interval located about midsection in the Upper Member was inaccessible to sampling owing to the sheer cliff face in the quarry (*see* Fig. 2).

The Lower Member was sampled on the west face exposed along the road leading from the upper to the lower floor. Total thickness of the section is 116.6 feet (35.5 m), of which the Upper Member comprises 65.5 feet (20.0 m) and the Lower Member 51.1 feet (15.5 m).

The uppermost 9-foot (2.7 m) interval consists, in greater part, of thin-bedded layers. This interval has been stripped off over a wide area, including the part of the quarry that was sampled and measured and, where exposed on the west face, was inaccessible to sampling. New cuttings at the south end of the quarry, made since 1966 (and subsequent to the sampling), now allow easy access to these beds.

Section 5

This section was measured in the abandoned quarry located on the east side of Brewery Creek, southeast of the Canada Cement Co., Ltd. quarry, and a short distance north of the intersection of Montclair and St. Rédempteur Streets, Hull (*see* Goudge, 1935, p. 66). The uppermost 9-foot (2.7 m) thick, thin-bedded interval is well exposed here. The southeast face of the quarry was sampled. The entire section is considered to be Upper Member, Hull Formation, and has a total thickness of 21.8 feet (6.6 m).

Section 6

The abandoned quarry of Oscar Noël, located on Mangin Road near the intersection of Breadner Street, on the west side of Brewery Creek, Hull (*see* Goudge, 1935, p. 63; Raymond, 1913, p. 151). The south face of the quarry was sampled. The entire section is considered to be Upper Member, Hull Formation, and has a total thickness of 7.5 feet (2.3 m).

Goudge (1935, p. 63) suggested that the beds in this quarry are in the same stratigraphic position as the upper beds along the west side of the quarry of the Wright Crushed Stone Co., Ltd. (Secs. 12 and 12A). These beds also are similar lithologically to the strata exposed on the north face of the Wright quarry, which is the only face that is still accessible. Raymond (1913, p. 151) regarded the beds of this quarry as belonging to his "crinoid zone".

Section 7

This section is in the abandoned quarry of T. Sidney Kirby Co., Ltd. located on the south side of Brittany Road, and a short distance east of the intersection with St. Laurent Blvd., Ottawa (*see* Goudge, 1938, p. 53, 54). The section is in the south face of the quarry and has a total thickness of 33.8 feet (10.3 m).

A distinct lithological break occurs at 13.4 feet (4.1 m) above the floor of the quarry (*see* Pl. 3, fig. 20). This is interpreted as the boundary between the Lower and Upper Members of the Hull Formation.

Section 8

These beds comprise a bank exposure located at Governor Bay, an inlet on the south bank of the Ottawa River at Rockcliffe Park, Ottawa. The Hull-"Sherman Fall" contact is well exposed (*see* Raymond, 1913, p. 153, 154). The entire section belongs to the Upper Member, Hull Formation and has a total thickness of 29.0 feet (8.8 m).

Farther eastward along the bank, the beds are faulted against stratigraphically lower strata. There the dip is much steeper and measures about 30 degrees to the southwest. The lower beds of the section are exposed to the water level near the fault (*see* Wilson, 1946a, Pl. III, fig. B).

Sections 9, 9A, and 9B

Sections 9, 9A and 9B occur in an abandoned quarry and railway excavation near and along the Canadian Pacific Railway tracks, located a short distance south of Taché Blvd. (=Quebec Highway No. 8), in the Val Tetreau area, Hull. Each section is separated from another by a covered interval, and the exact relative stratigraphic positions are difficult to determine. The total composite section is 97.5 feet (29.7 m) thick.

Section 9 is located along the south side of the tracks. The Hull-"Sherman Fall" contact is well exposed (*see* Raymond, 1913, p. 155, 156; also *see* Pl. 3, fig. 19 of this report). The entire section belongs to the Upper Member, Hull Formation, and has a total thickness of 34.8 feet (10.6 m).

Section 9A is located in the abandoned quarry a short distance north of the tracks, and approximately 500 feet (152.4 m) west of section 9. According to Goudge (1935, p. 68), the beds here strike north 32 degrees west and dip 15 degrees northeastward. At the north end of the quarry, a massive limestone bed containing *Receptaculites* is exposed, which is in sharp contrast to the overlying thin-bedded units. The contact between the Lower and Upper Members is thought to be at 26 feet (7.9 m) above the quarry floor. The total thickness is 52.8 feet (16.1 m).

Section 9B is located along the north side of the tracks, about 300 feet (91.4 m) west of section 9. The entire section is considered to be Upper Member, Hull Formation, with a total thickness of 9.9 feet (3.0 m).

Section 10

This section was measured at the small exposure (an abandoned quarry?) located between the Canadian Pacific Railway tracks and the Brewery Creek, and about 600 feet (182.9 m) north of section 3, Hull. The entire section is considered to be Upper Member, Hull Formation, and has a total thickness of 14.2 feet (4.3 m).

Section 11

Section 11 is the small exposure (an abandoned quarry?) located between the Canadian Pacific Railway tracks and the Brewery Creek, and about 200 feet (61.0 m) north of section 10,in Hull. The entire section (9.7 feet or 3.0 m) is considered to be Upper Member, Hull Formation.

Sections 12 and 12A

These strata occur in the abandoned quarry of the Wright Crushed Stone Co., Ltd. located on the west side of the Canadian Pacific Railway tracks, near the intersection of Amherst Street and St. Joseph Blvd. in Hull. Raymond (1913, p. 150, 151) suggested that the strata of this quarry are about 25 feet (7.6 m) lower stratigraphically than those at section 3. Presumably this is in reference with the quarry floor, but the total depth of the quarry at section 3, at the time of Raymond's writing, is nowhere recorded. Raymond (ibid.) considered these beds to belong to his "crinoid zone", and listed a few fossil species found in them. Goudge (1935, p. 62, 63) recorded the depth of this quarry as 76 feet (23.2 m), and included lithologic descriptions of beds exposed in it. These descriptions, in addition to the 17-foot (5.2 m) interval that was still exposed in 1961, strongly suggest that the beds of the Wright quarry belong to the Upper Member of the Hull Formation. The quarry was being actively filled in 1961.

Section 12 is located on the north face of the quarry and has a total thickness of 9.7 feet (3.0 m).

Section 12A is located about 50 feet (15.2 m) east of section 12. The area between these sections is covered so that their exact relative positions are difficult to determine, although 12A is stratigraphically higher than 12. The strata in these sections contrast sharply in lithology. The flaggy-weathering feature of the upper beds of this section is similar to that in the higher beds at section 1. The total thickness is 8.0 feet (2.4 m).

APPENDIX II

LITHOLOGIC DESCRIPTION OF THE TYPE SECTION OF THE HULL FORMATION
IN THE CANADA CEMENT CO., LTD. QUARRY IN HULL, QUEBEC
(Sec. 4 of this report; *see* Appendix I, and Figs. 1 and 2)

Remarks

In this description, suggestions were used that were made by McLaren and Thorsteinsson (1955) for field note taking on Operation Franklin. Hence thick bedded indicates 2 feet (0.6 m) or somewhat more between bedding planes; medium bedded, 3 inches (7.6 cm) to 2 feet (0.6 m); and thin bedded, 3 inches (7.6 cm) or less. Grain size terminology is essentially that of Wentworth (1922), with the exception of aphanitic which designates a size smaller than 0.062 mm.

The following description is from the top of the quarry downward.

Unit	Lithology	Thickness (feet and metres)	Height Above Base (feet and metres)
	Hull Formation (116.6 feet; 35.5 m)		
	Upper Member (65.5 feet; 20.0 m)		
20	Limestone, bioclastic, light brownish grey, fine to medium grained, becoming coarse grained toward top; fine sparry matrix; thick bedded; extremely fossiliferous near top	5.2 (1.6 m)	65.5 (20.0 m)
19	Limestone, as above, with fine laminations in some parts; layers of lenticular black chert common	4.0 (1.2 m)	60.3 (18.4 m)
18	Limestone, as above, with some thin shaly partings and lenticular black chert in places; shaly parting at bottom	3.5 (1.1 m)	56.3 (17.2 m)
17	Limestone, as above, with fine lamination and stylolites throughout; weathers dull whitish grey	3.8 (1.2 m)	52.8 (16.1 m)
16	Inaccessible, and not sampled	13.0 (3.9 m)	49.0 (14.9 m)
15	Limestone, light brownish grey, grading from fine grained at bottom to medium and coarse grained at top; thick bedded, fine sparry matrix, finely laminated near bottom; weathers whitish grey	1.5 (0.5 m)	36.0 (11.0 m)
14	Limestone, dark greyish brown, aphanitic, medium bedded with almost conchoidal fracturing; weathers light grey; in places layers of calcite-filled brachiopod interiors, chert concretions common; fine laminations more common towards top; separated by shaly parting at bottom	3.8 (1.2 m)	34.5 (10.5 m)
13	Limestone, very similar to above, but no macrofossils observed	0.6 (0.2 m)	30.7 (9.3 m)
12	Limestone, slightly argillaceous, brownish black, aphanitic; medium bedded, individual beds separated by shaly partings	1.1 (0.3 m)	30.1 (9.1 m)
11	Limestone, as above, abundant chert concretions; a vuggy layer, 6 inches (15.2 cm) thick, formed from the interior cavities of brachiopods, partly filled with calcite, some trilobite fragments; shaly parting at bottom	2.4 (0.7 m)	29.0 (8.8 m)

Unit	Lithology	Thickness (feet and metres)	Height Above Base (feet and metres)
10	Limestone, bioclastic, dark greyish brown to brownish black, medium to coarse grained; medium bedded, fine sparry matrix; a 2-inch (5.1 cm) vuggy interval similar to unit above; thin layers of shaly intervals; shaly parting at bottom	1.1 (0.3 m)	26.6 (8.1 m)
9	Limestone, light to dark brownish grey, fine to medium grained; becoming darker and fine grained at top; medium bedded, with coarse sparry matrix; stylolites common; shaly parting at bottom	3.7 (1.2 m)	25.5 (7.8 m)
8	Limestone, similar to above, with abundant dark shaly laminae	0.7 (0.2 m)	21.8 (6.6 m)
7	Limestone, similar to above; top 3 inches (7.6 cm) with black chert layers; a distinctive unit; shaly parting at bottom	3.7 (1.1 m)	21.1 (6.4 m)
6	Limestone, similar to above, but coarse grained; shaly parting at bottom	3.2 (0.9 m)	17.4 (5.3 m)
5	Limestone, as above, with stylolites and black chert layers; shaly parting at bottom	0.9 (0.3 m)	14.2 (4.4 m)
4	Limestone, similar to above, but thick bedded with coarse sparry matrix; some scattered stylolites, with fine laminations of dark shaly bands at intervals; small chert concretions, about 1 inch (2.5 cm) in diameter; shaly parting at bottom	8.5 (2.6 m)	13.3 (4.1 m)
3	Limestone, bioclastic, light brownish grey, medium to coarse grained; medium bedded, with fine to coarse sparry matrix; fine laminations of dark shaly bands throughout; lenticular black chert common; shaly parting at bottom	1.0 (0.3 m)	4.8 (1.5 m)
2	Limestone, similar to above but without chert; calcite-filled vugs common, up to 1 inch (2.5 cm) in diameter; brachiopods and trilobites	0.8 (0.3 m)	3.8 (1.2 m)
1	Limestone, similar to above, with large black chert concretions common, up to 6 inches (15.2 cm) in diameter	3.0 (0.9 m)	3.0 (0.9 m)
	Lower Member (51.1 feet; 15.5 m)		
10	Limestone, very argillaceous, dark grey to greyish black, aphanitic to fine grained; thin to medium bedded, with numerous shaly partings	1.5 (0.4 m)	51.1 (15.5 m)
	Upper floor.		
9	Limestone, brownish grey, coarse grained, medium bedded, fine sparry matrix; some brachiopod fragments; shaly parting below	0.7 (0.2 m)	49.6 (15.1 m)
8	Limestone, slightly argillaceous, dark brownish grey, very fine to fine grained, thin to medium bedded; interbedded with shale layers, one-half inch (1.2 cm) thick; almost conchoidal fracturing in places; shaly parting below	1.1 (0.3 m)	48.9 (14.9 m)
7	Limestone, similar to above, with numerous irregularly bedded shaly partings throughout; medium bedded; chert concretions up to 2 inches (5.1 cm) in diameter common toward bottom; shaly parting at bottom	3.8 (1.2 m)	47.8 (14.6 m)

Unit	Lithology	Thickness (feet and metres)	Height Above Base (feet and metres)
6	Limestone, brownish grey, coarse grained; coarse sparry matrix; tiny vugs filled with calcite in places; trilobite fragments common; shaly parting below	1.2 (0.4 m)	44.0 (13.4 m)
5	Limestone, very argillaceous, dark brown, aphanitic to fine grained; thin to medium bedded, with fine shaly laminations throughout, almost conchoidal fracturing in places; numerous shaly partings throughout; tiny partly calcite-filled vugs common; weathers light grey; shaly parting below	6.7 (2.0 m)	42.8 (13.0 m)
4	Limestone, bioclastic, coarse grained, coarse sparry matrix; shaly parting below	0.8 (0.2 m)	36.1 (11.0 m)
3	Limestone, argillaceous, dark brown, fine to medium grained; medium bedded, with 4 or 5 irregular shaly partings; irregularly fracturing surfaces; smooth ostracodes; shaly parting below	1.6 (0.5 m)	35.3 (10.8 m)
2	Limestone, in part very argillaceous, brownish grey to dark grey, fine to medium grained; thin to medium bedded, with numerous shaly partings; in part almost conchoidal fracturing, and in part fine-grained sparry matrix; numerous brachiopod fragments in shaly partings	3.2 (1.0 m)	33.7 (10.3 m)
1	Limestone, similar mixture in lithologies as above, but megafossils not as abundant	30.5 (9.3 m)	30.5 (9.3 m)

PLATE 1
(all figures x40)

Figures 1-4. *Polyplacognathus ramosus* Stauffer
1, 2: upper and lower views of an amorphognathiform element, GSC No. 17783;
3, 4: Upper and lower views of an ambalodiform element, GSC No. 17784; both specimens from section 4, GSC loc. 51394.

Figures 5-9. *Drepanoistodus suberectus* (Branson and Mehl)
5: lateral view of a drepanodiform element, GSC No. 17785, section 2, GSC loc. 51354;
6: posterolateral view of a drepanodiform element, GSC No. 17786, section 2, GSC loc. 51362;
7-9: inner lateral views of three oistodiform elements, GSC Nos. 17787 to 17789, from section 4, GSC loc. 51393, section 9A, GSC loc. 51477, and section 8, GSC loc. 51460, respectively.

Figures 10-13. *Belodina compressa* (Branson and Mehl)
10: inner lateral view of a belodiniform element, GSC No. 17790, section 4, GSC loc. 51399;
11, 12: outer and inner lateral views of a belodiniform element, GSC No. 17791, section 9B, GSC loc. 51480;
13: inner lateral view of an eobelodiniform element, GSC No. 17792, section 9A, GSC loc. 51473.

Figures 14-19. *Icriodella superba* Rhodes
14, 15: outer lateral and upper views of an amorphognathiform element, GSC No. 17793, section 12, GSC loc. 51493;
16, 17: posterior and anterolateral views of two ambalodiform elements, GSC Nos. 17794 and 17795; both specimens from section 8, GSC loc. 51447;
18: posterolateral view of a ramiform (rhynchognathodiform) element, GSC No. 17796, section 8, GSC loc. 51449;
19: posterior view of an ambalodiform element, GSC No. 17797, section 8, GSC loc. 51451.

Figures 20-22. *Bryantodina? abrupta* (Branson and Mehl)
20: inner lateral view of a prioniodiniform element, GSC No. 17798, section 1, GSC loc. 51348;
21, 22: outer and inner lateral views of a bryantodiniform element, GSC No. 17799, section 4, GSC loc. 51407.

Figure 23. *Acodus mutatus* (Branson and Mehl)
Inner lateral view of an acodiform element, GSC No. 17800, section 4, GSC loc. 51405.

Figures 24, 25. "*Acontiodus*" sp. A
Posterior and lateral views of GSC No. 17801, section 8, GSC loc. 51452.

Figures 26-30. *Phragmodus undatus* Branson and Mehl
26: outer lateral view of a dichognathiform element, GSC No. 17802;
27: outer lateral view of a dichognathiform element, GSC No. 17803;
28: inner lateral view of an oistodiform element, GSC No. 17804;
29, 30: inner lateral views of two phragmodiform elements, GSC Nos. 17805 and 17806.
All specimens from section 7, GSC loc. 51427.

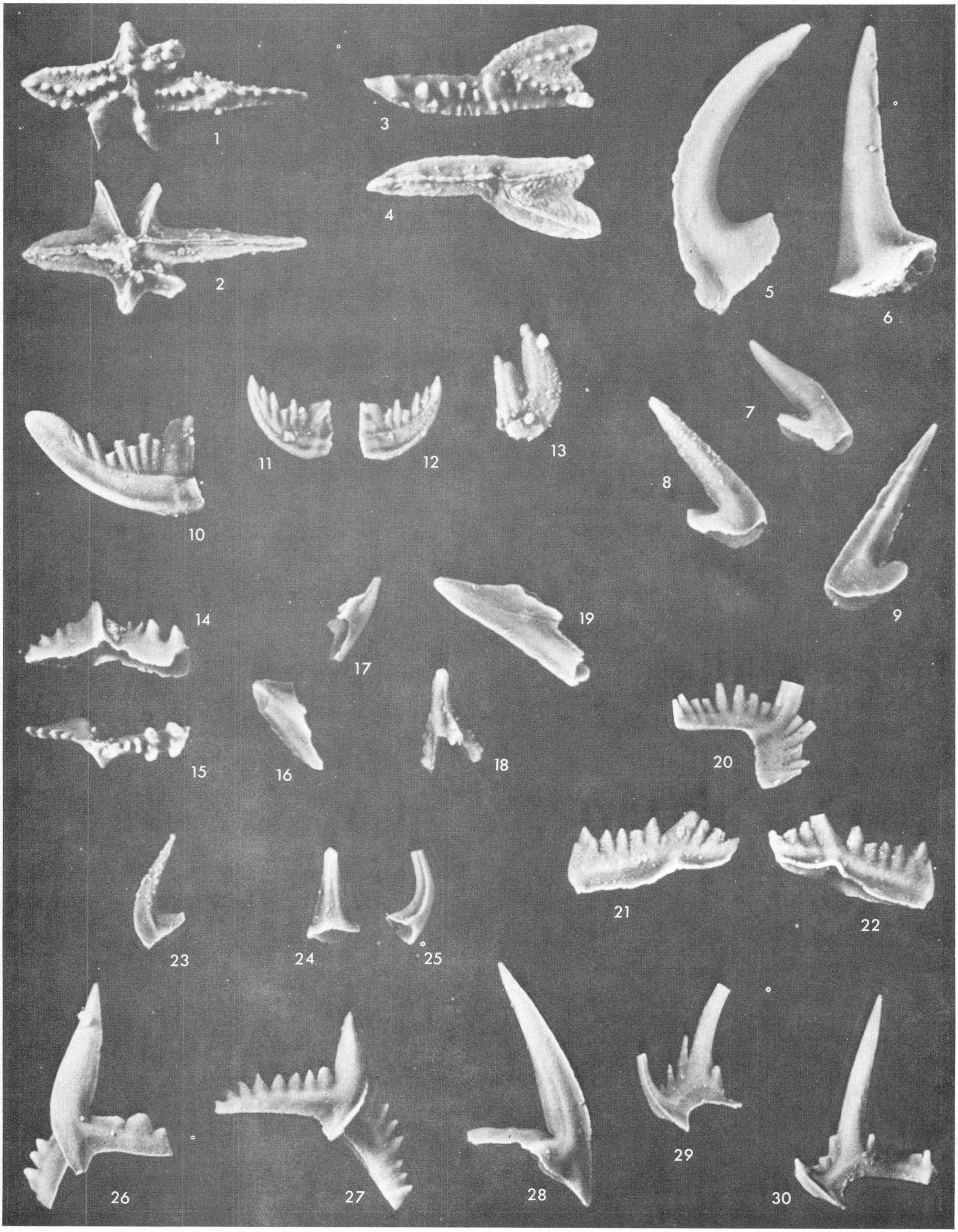
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PLATE 2
(all figures x40)

Figures 1-26. *Plectodina aculeata* (Stauffer)

1, 4, 5: inner lateral views of three cordylodiform elements, GSC Nos. 17807 to 17809, from section 2, GSC loc. 51355, section 4, GSC loc. 51393, and section 7, GSC loc. 51427, respectively;

2, 3: inner lateral views of two prioniodiniform elements, GSC Nos. 17810 and 17811, from section 9B, GSC loc. 51480, and section 9A, GSC loc. 51478, respectively;

6, 7, 13: posterior views of three trichonodelliform elements, GSC Nos. 17812 to 17814, from section 4, GSC loc. 51401, section 7, GSC loc. 51437, and section 3, GSC loc. 51389, respectively;

8-11: inner and outer lateral views of two dichognathiform elements, GSC Nos. 17815 and 17816, section 5, GSC loc. 51419 and section 4, GSC loc. 51401, respectively;

12: inner lateral view of a cyrtoniodiform element, GSC No. 17817, section 8, GSC loc. 51453;

14, 17: outer lateral views of two ozarkodiniform elements, GSC Nos. 17818 and 17819, from section 1, GSC loc. 51348, and section 4, GSC loc. 51405, respectively;

15, 16: inner and outer lateral views of a cordylodiform element, GSC No. 17820;

18, 19: inner and outer lateral views of a prioniodiniform element, GSC No. 17821;

20, 21: inner and outer views of an ozarkodiniform element, GSC No. 17822;

22, 23: posterior and lateral views of a trichonodelliform element, GSC No. 17823;

24: posterior view of a zygognathiform element, GSC No. 17824;

25, 26: inner and outer lateral views of a dichognathiform element, GSC No. 17825.

Specimens of figures 15, 16, 18-26 are from section 6, GSC loc. 51424.

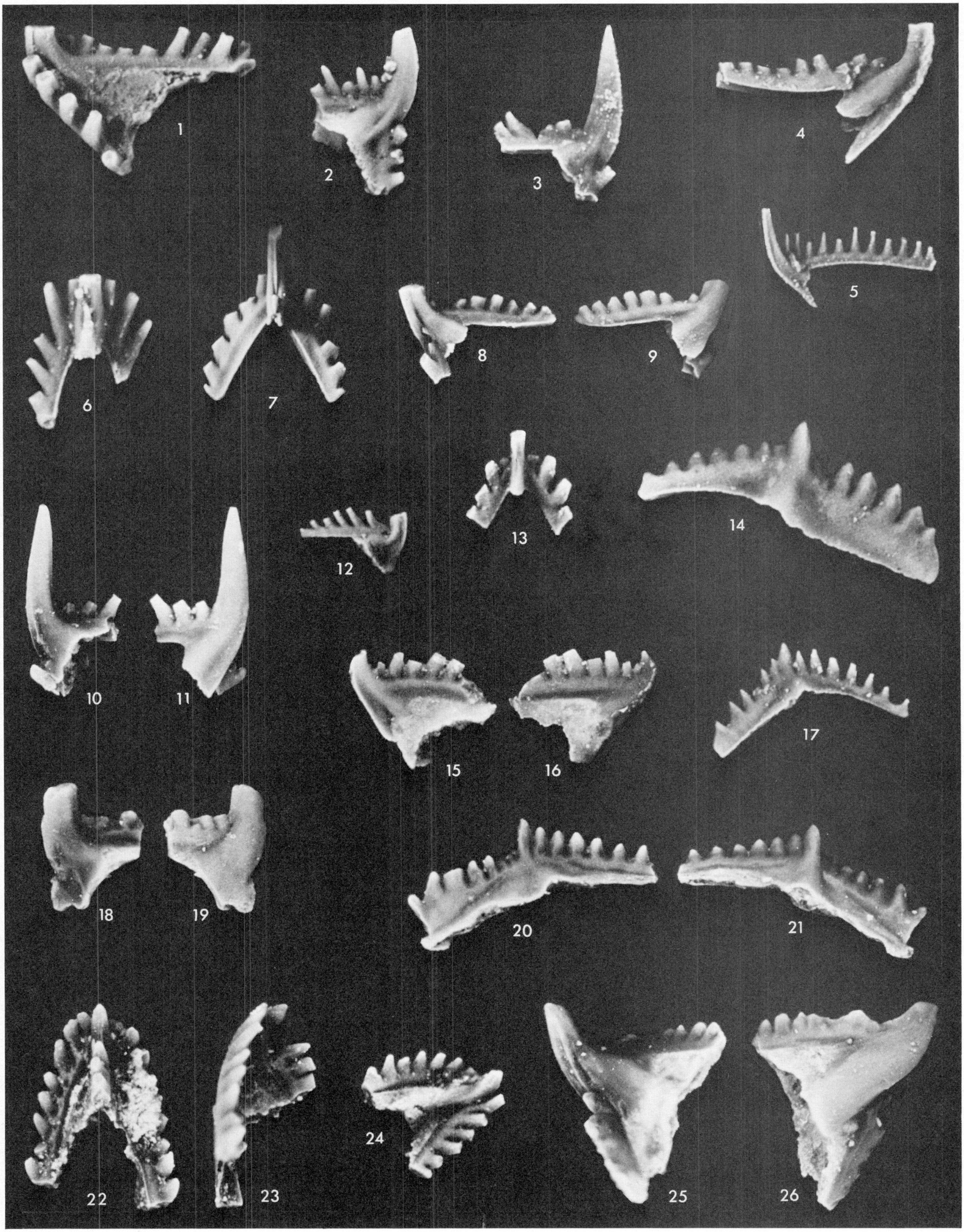
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PLATE 3
(all figures x40)

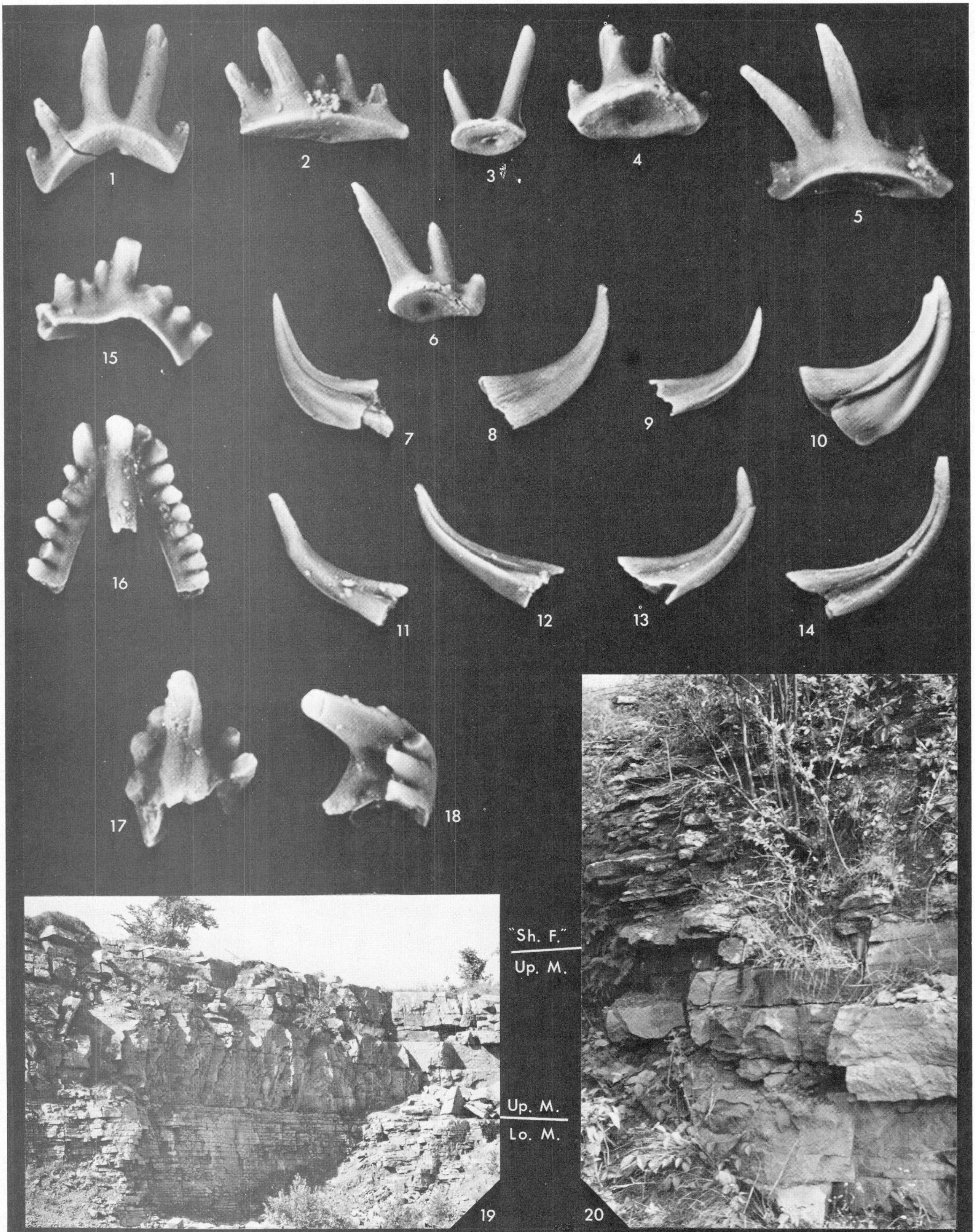
Figures 1-6. "Fibrous conodonts", all showing inner lateral views.
1: "*Curtognathus*" *limitaris* Branson and Mehl, GSC No. 17826, section 9, GSC loc. 51469;
2: "*Trucherognathus*" *irregularis* Branson and Mehl, GSC No. 17827, section 9A, GSC loc. 51476;
3: "*Polycaulodus*" *bidentatus* Branson and Mehl, GSC No. 17828, section 10, GSC loc. 51485;
4: "*Polycaulodus*" *normalis* Branson and Mehl, GSC No. 17829, section 4, GSC loc. 51410;
5: "*Trucherognathus*" *disparilis* Branson and Mehl, GSC No. 17830, section 9A, GSC loc. 51473;
6: "*Polycaulodus*" *tridentatus* Branson and Mehl, GSC No. 17831, section 5, GSC loc. 51414.

Figures 7-14. *Panderodus gracilis* (Branson and Mehl)
7-10: inner lateral views of "*Panderodus*" *compressus* (Branson and Mehl), GSC Nos. 17832-17835, from section 7, GSC loc. 51429, section 7, GSC loc. 51427, section 7, GSC loc. 51435, and section 1, GSC loc. 51350, respectively;
11-14: inner lateral views of "*Panderodus*" *gracilis*, GSC Nos. 17836-17839, from section 4, GSC loc. 51398, section 1, GSC loc. 51347, section 4, GSC loc. 51394, and section 4, GSC loc. 51394, respectively.

Figures 15-18. *Oulodus* cf. *O. mediocris* Branson and Mehl
15: inner lateral view of an oulodiform element, GSC No. 17840, section 1, GSC loc. 51350;
16: posterior view of a trichonodelliform element, GSC No. 17841, section 2, GSC loc. 51362;
17, 18: posterior and inner lateral views of a zygognathiform element, GSC No. 17842, section 1, GSC loc. 51350.

Figure 19. Section 7, showing the contact of the Upper (Up. M.) and Lower (Lo. M.) Members of the Hull Formation. A yardstick (0.9-metre stick) in the centre of the figure, just below the contact, gives the scale. The Upper Member is 20.4 feet (6.2 m) thick, the Lower 13.4 (4.1 m). (GSC Photo 122063)

Figure 20. Section 9, showing the contact of the "Sherman Fall" Formation ("Sh. F.") and the Upper Member (Up. M.) of the Hull Formation. The hammer in the central part of the figure gives scale. The boundary is abrupt and easily recognizable in the Ottawa-Hull area. (GSC Photo 122085)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"Sh. F."
Up. M.
Up. M.
Lo. M.

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Geological Survey of Canada

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