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STRATIGRAPHY AND PALEONTOLOGY OF THE LOWERMOST UPPER DEVONIAN SLAVE POINT FORMATION ON LAKE CLAIRE AND THE LOWER UPPER DEVONIAN WATERWAYS FORMATION ON BIRCH RIVER, NORTHEASTERN ALBERTA

A.W. Norris
T.T. Uyeno

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A.W. Norris
T.T. Uyeno

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H.R. Belyea
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L.E. Fåhraeus

Authors' Addresses

Institute of Sedimentary and Petroleum Geology
3303 – 33rd. Street N.W.
Calgary, Alberta T2L 2A7

Artwork by Cartographic Unit, ISPG

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Preface

This is the first description of the stratigraphy, and some of the faunas of an isolated outcrop of the Slave Point Formation on the southwest side of Lake Claire and outcrop of part of the Waterways Formation on Birch River in northeastern Alberta. The study is based mainly upon field work and collections made in 1979. General locations of the outcrops have been known since the late 1950's but they have not been described previously, presumably because of their isolation in a remote wilderness area and also because the sequences are relatively thin. Data obtained are exceedingly valuable in providing an important link between the much better known Devonian outcrop successions at Gypsum Cliffs on Peace River to the north, and those in the Athabasca-Clearwater Rivers area to the south.

The report is part of a current systematic study of the brachiopods of the lower Upper Devonian (lower Frasnian) Waterways Formation of northeastern Alberta. The associated conodonts provide an independent and precise means of dating the brachiopods for correlations within and outside North America. Such biostratigraphic studies assist in the ongoing search for fossil fuels and minerals.

W.W. Hutchison
Director General
Geological Survey of Canada

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Abstract

Parts of the lowest Upper Devonian (lowest Frasnian) Slave Point Formation and lower Upper Devonian (lower Frasnian) Waterways Formation outcrop in the Lake Claire-Birch River area of northeastern Alberta. Slave Point beds consist of calcarenitic limestone and the part of the Waterways Formation represented consists of a thin sequence of calcareous mudstone, argillaceous limestone and limestone.

The Slave Point contains a sparse poorly preserved megafauna suggestive of the Desquamatia (Independatrypa) sp. cf. D. (I.) independensis Fauna that characterizes the upper part of the formation at Gypsum Cliffs, north of Lake Claire, where the fauna contains conodonts suggestive of the Lower Polygnathus dengleri Subzone. The Waterways contains a diverse but numerically sparse megafauna dominated by brachiopods that have their strongest affinities with forms in the Calumet and Christina Members of the Athabasca-Clearwater Rivers area of northeastern Alberta. The brachiopods represent a single assemblage here referred to as the Ladogioides asmenista-Eleutherokomma jasperensis Fauna after its more diagnostic forms. Associated conodonts include Ancyrodella rotundiloba binodosa Uyeno, Ancyrodella rotundiloba rotundiloba (Byrant), Pandorinellina insita (Stauffer) and ?Mesotaxis asymmetrica (Bischoff and Ziegler) as the more diagnostic elements that indicate assignment to the Lower Polygnathus asymmetricus Zone.

Eighteen brachiopod and fourteen conodont taxa are discussed and illustrated from the Waterways beds on Birch River.

Résumé

Des parties de la formation de Slave Point du Dévonien supérieur le plus ancien (Frasnien le plus ancien), ainsi que de la formation de Waterways du Dévonien supérieur ancien (Frasnien ancien) affleurent dans la région du lac Claire et de la rivière Birch (nord-est de l'Alberta). Les couches de Slave Point se composent de calcaire calcarénitique tandis que la partie de la formation de Waterways représentée se compose d'une mince succession de mudstone calcaire, de calcaire argilleux et de calcaire.

La formation de Slave Point contient une mégafaune éparse et mal conservée rappelant la faune à Desquamatia (Independatrypa) sp. cf. D. (I.) independensis qui caractérise la partie supérieure de la formation à Gypsum Cliffs, au nord du lac Claire, où la faune contient des conodontes rappelant la sous-zone inférieure à Polygnathus dengleri. La formation de Waterways contient une mégafaune diverse mais éparse dominée par des brachiopodes trés apparentés aux niveaux de Calumet et de Christina de la région des rivières Athabasca et Clearwater du nord-est de l'Alberta. Les brachiopodes représentent un seul ensemble désigné ici sous le nom de faune à Ladogioides asmenista-Eleutherokomma jasperensis d'après ses éléments les plus caractéristiques. Parmi les conodontes qui les accompagnent, mentionnons Ancyrodella rotundiloba binodosa Uyeno, Ancyrodella rotundiloba rotundiloba (Byrant), Pandorinella insita (Stauffer) et ?Mesotaxis asymmetrica (Bischoff et Ziegler), éléments les plus caractéristiques qui assignent la formation à la zone inférieure à Polygnathus asymmetricus.

On traite de 18 taxons de brachiopodes et de 14 taxons de conodontes, tous illustrés, provenant des couches de Waterways sur la rivière Birch.

INTRODUCTION

Purpose

Fossils collected from bedrock exposures on Birch River were sent for identification to the Geological Survey of Canada in the late 1950's. They provided good evidence that equivalents of part of the lower Upper Devonian Waterways Formation were present. Although the general location and composite fauna of the Waterways Formation were known from these collections (see Norris, 1963, p. 66), the precise locations, lithology, and stratigraphy of the outcrops and distribution of the fossils remained unknown. The results of this study are an attempt to meet this need.

Norris is currently engaged in a detailed study of the brachiopods of the Waterways Formation outcropping along the Clearwater and lower Athabasca Rivers and at Gypsum Cliffs on Peace River in northeastern Alberta. Birch River stratigraphy and faunas will provide additional distribution data and assist in the overall interpretation of the Waterways brachiopods. The associated conodonts, described herein, provide an independent dating of the Waterways beds on Birch River and assist in the comparison and correlation with other areas.

Location

The Devonian rocks described in this report comprise an outcrop of the Slave Point Formation at Pointe de Roche (station 356NB; 58°22'25"N; 112°07'05"W) on the southwest side of Lake Claire and scattered outcrops of the Waterways Formation along the upper reaches of Birch River (see Figs. 1 and 2). The discontinuous outcrops on Birch River extend from station 10NB (58°18'50"N; 113°04'05"W) to station 17NB (58°18'20"N, 113°09'00"W) a river distance of approximately 15.7 km. The lowest or most easterly outcrop on Birch River is located approximately 112 km upstream from the mouth of the winding river. Birch River can be reached by boat or canoe from Fort Chipewyan by use of the Quatre Fourches Channels connecting the west end of Lake Athabasca with Mamawi Lake, and Prairie River connecting Mamawi Lake with Lake Claire. The distance of the water route between Fort Chipewyan and the mouth of Birch River is approximately 74 km.

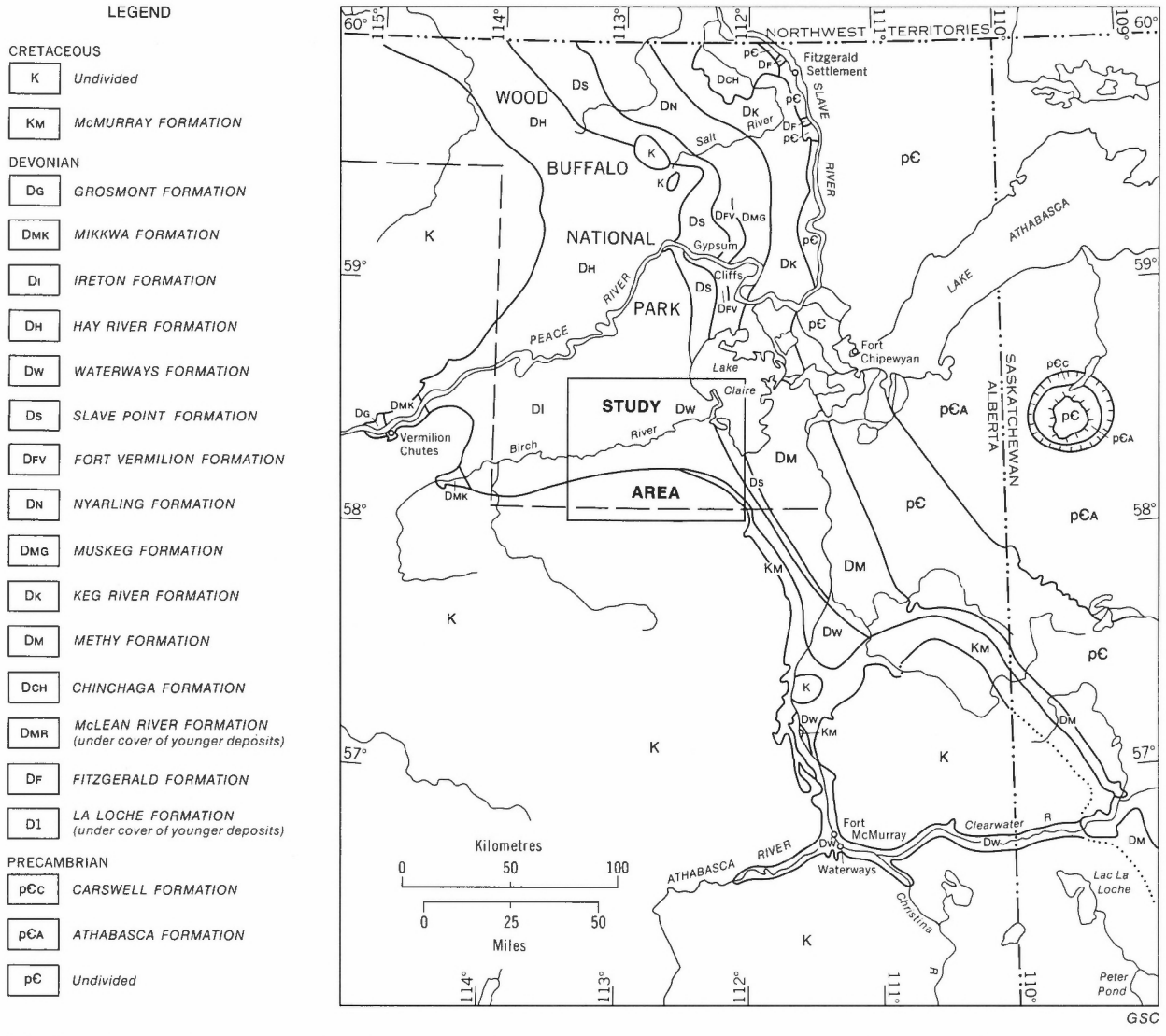

FIGURE 1. Sketch map showing location of the Lake Claire-Birch River study area, general geology of northeastern Alberta, and distribution of Devonian rocks.

All of the outcrops are located within the southern half of the Lake Claire map-sheet (NTS 84I) in northeastern Alberta. This area is within and about 26 km north of the southern boundary of Wood Buffalo National Park. Fort Chipewyan is the nearest settlement which is located on the north shore and near the west end of Lake Athabasca on a bearing of 077T at an air distance of about 66 km from the mouth of Birch River. The nearest large town to the south is Fort McMurray located at the junction of the Athabasca and Clearwater Rivers which bears 161T at an air distance of about 158 km from the mouth of Birch River. Fort McMurray is connected by scheduled air services, rail and hard surfaced roads to larger centres in the south, and is the point where bulky and heavy freight is transferred from rail cars or trucks to boats and barges for shipment down the Athabasca River.

Previous geological investigations

Norris (1963, p. 66) recorded and listed fossils collected by D. Merrill of the Forest Inventory Section, Department of Northern Affairs, from between approximately longitudes 113°00'W and 113°12'W on Birch River. They were submitted to the Geological Survey of Canada for identification. On the basis of the mixed assemblage of fossils, Norris (1963, p. 66) suggested that probably parts of the Peace Point and Calumet Members of the Waterways Formation were represented in the outcrops along Birch River.

In August of 1961 Norris examined the Slave Point beds at Pointe de Roche on Lake Claire, and using a small aircraft pin-pointed from the air the locations of outcrops of the Waterways Formation along Birch River. Unusually low water levels in northern Alberta in 1961 prevented a canoe traverse up Birch River.

In 1965, M.A. Carrigy and R. Green noted the locations of outcrops of the Slave Point Formation at Pointe de Roche on Lake Claire and the Waterways Formation on Birch River as well as on Alice Creek in the same general vicinity. These observations were incorporated by Green (1970) on a map showing the bedrock geology of northern Alberta, and by Bayrock (1972b) on a map of the surficial geology of the Lake Claire area. Presumably, their work was done by helicopter because the tributary streams of Birch River are narrow and shallow and would be exceedingly difficult if not impossible to traverse using a canoe or rubber boat.

Present work

The present report describes and illustrates for the first time the stratigraphy, brachiopods and conodonts of beds of the Waterways Formation outcropping along Birch River in northeastern Alberta based upon observations and collections made by Norris in 1979. The Slave Point beds outcropping 56 km to the east at Point de Roche on Lake Claire are also described for the first time, based on field work by Norris in 1961. The very sparse megafossils from beds of the Slave Point Formation are not illustrated because of very poor preservation, and samples from these beds investigated for conodonts by T.T. Uyeno, unfortunately, proved to be barren.

Study of the fossils from the Waterways Formation is based on 30 samples from 13 measured sections. Cuts of most of the samples were made and processed for conodonts to obtain an independent dating of the beds. In a few instances where species of brachiopods from Birch River are highly fragmentary, better preserved material of that species from equivalent beds on Athabasca River area were used to augment the illustrations.

In this collaborative study, Norris is responsible for the field observations and sampling, lithostratigraphy, and the brachiopod taxonomy and biostratigraphy; Uyeno is responsible for the conodont taxonomy and biostratigraphy.

Acknowledgments

Norris was very ably assisted in the field in 1961 by P.A. Bolton, and in 1979, by R. Schulz.

The field work and sampling on Birch River in Wood Buffalo National Park were done under park collecting Permit No. 79-33. Personnel of the Park, including P. Galbraith (Area Manager) and W. Nelson, helped by transporting some of our supplies to a cache in the Birch River delta so that we were able to cross the large stretch of open water of Lake Claire with a light load. Norris extends appreciation for this and other courtesies received while in Fort Chipewyan.

The brachiopods were photographed by B.C. Rutley and W.B. Sharman of the Geological Survey of Canada. Uyeno is grateful to R.S. Tipnis for arranging for the photography of some conodont specimens on the scanning electron microscope (SEM). Constructive comments on the manuscript were provided by Drs. Helen R. Belyea, L.E. Fåhraeus and G.O. Raasch.

STRATIGRAPHY

Geological setting

The thin sequences of the Slave Point and Waterways Formations exposed in the Lake Claire-Birch River area are located near the mid eastern erosional edge of Devonian sediments on the craton of the Interior Platform of western Canada. The distribution and relationships of these formations in northeastern Alberta are shown in a general way in Figure 1 of this report, and in more detail on a geological map of northern Alberta by Green, Mellon and Carrigy (in Green, 1970). Variations in thickness and lithofacies of the Slave Point and Waterways Formations and equivalent rocks throughout the Western Canada Sedimentary Basin are illustrated by Belyea et al. (1964, Fig. 6-2, p. 61), Bassett and Stout (1968, Figs. 9 and 10), Jansa and Fischbuch (1974, Fig. 3), and others.

In the report area the Slave Point and Waterways Formations form the upper part of a wedge of westward dipping Devonian rocks nonconformably overlapping the Canadian Shield along Slave River to the east. This wedge thickens westward to about 274 m (900 ft) in the Lake Claire-Birch River area (see isopach map in Grayston et al., 1964, Fig. 5-3, p. 51). The Devonian succession throughout a large part of northern Alberta and southern District of Mackenzie rests directly on Precambrian crystalline and metasedimentary rocks or erosional remnants of Cambrian sedimentary rocks (Belyea, in Douglas et al., 1970, Fig. VIII-13, p. 393; Bassett and Stout, 1968, Fig. 7, p. 731). The top of the Devonian succession is an erosion surface unconformably overlain by Lower Cretaceous or Quaternary and Recent deposits in the report area, with progressively younger Devonian rocks being overlapped in a westerly direction.

The precise thickness of the total Devonian succession down to the Precambrian basement in the Lake Claire-Birch River area is unknown for lack of drill holes within Wood Buffalo National Park, but it is estimated to be approximately 274 m (900 ft). Of this total, the incomplete succession of Slave Point and Waterways beds represented in the Lake Claire-Birch River area is estimated to be about 82 m (269 ft) thick, including covered intervals within the outcrop succession.

Related Devonian outcrop sequences with Slave Point and Waterways equivalents nearest to the Lake Claire-Birch River area comprise that to the north at Gypsum Cliffs on Peace River described by Norris (1963) and Norris and Uyeno (in press) and that to the southeast along the Athabasca-Clearwater Rivers described by Carrigy (1959), Norris (1963, 1973) and others. Older Devonian rocks outcrop to the northeast along Slave River and in the escarpment west of the river described by Norris (1963, 1965), and others. Younger Devonian beds outcrop to the west in the Vermilion Chutes area on Peace River described by Norris (1963).

The parts of the Slave Point and Waterways Formation outcropping in the Lake Claire-Birch River area are shown diagrammatically in Figure 2. Their description is augmented in Appendix I, a detailed description of the composite section including lists and locations of megafaunas in each of the units.

Slave Point Formation

The name Slave Point Formation is applied to the thin sequence of limestone outcropping on the south side of Point de Roche, a small peninsula on the southwest side of Lake Claire. The term "Slave Point limestone" was introduced by Cameron (1918, p. 25-26) to apply to the upper part of the Middle Devonian succession on the north and south shores of the west arm of Great Slave Lake. Various usages of the term in the Great Slave Lake and adjacent areas are discussed by Belyea and Norris (1962), Norris (1965), Griffin (1965a), Skall (1975), and others. The name Slave Point Formation was extended by Law (1955a, b) into the subsurface of northern Alberta, and approximately the same usage was continued in the subsurface of northeastern British Columbia by Belyea and Norris (1962) and Gray and Kassube (1963). On a cross-section, Griffin (1965a) traced the Slave Point Formation in the subsurface from the Kotcho Lake area of northeastern British Columbia across northern Alberta to the Fort McMurray area.

The nearest outcrops of the Slave Point Formation to that on Lake Claire are those at Gypsum Cliffs on Peace River described by Norris (1963) and Norris in Norris and Uyeno (in press). Gypsum Cliffs is 91.2 km north northwest of the Lake Claire outcrop. At Gypsum Cliffs the Slave Point conformably overlies evaporites of the Fort Vermilion Formation and is unconformably overlain by shale and argillaceous limestone of the Peace Point Member of the Waterways Formation. Thickness of the formation in the Gypsum Cliffs area varies between 15.2 and 21.3 m (50 to 70 ft). In the California Standard Mikkwa 12-23-98-21W4 well located about 116 km southwest of the Lake Claire outcrops, the thickness of the Slave Point Formation is estimated to be about 13.7 m (45 ft) thick (Griffin, 1965a, Fig. 6). The formation thins southward from a maximum of 21.3 m (70 ft) at Gypsum Cliffs to less than 3.05 m (10 ft) in Birch Mountains (Green, 1970) to 1.7 m (5.5 ft) in the Fort McMurray area (Crickmay, 1957).

At the south end of Pointe de Roche on the southwest shore of Lake Claire about 1.8 m (6 ft) of Slave Point beds are exposed immediately above lake level. The lithology consists of light grey to medium brown calcarenitic limestone in irregular thin beds up to 10 cm (3.9 in.) thick that weather light tan brown. Hand specimens under the microscope show light brown, angular, calcarenitic lithic fragments in a matrix of darker brown micritic limestone associated with scattered sparry calcite. Megafossils, fragmentary and sparse, are discussed in a succeeding part of this report.

Although contact relations with underlying and overlying rock units are not evident in the single outcrop, comparison with Slave Point sequences to the north and south suggests that the beds exposed at Pointe de Roche belong in the upper part of the formation.

Waterways Formation

The name Waterways Formation was first proposed by Warren (1933) for the sequence of Devonian strata overlying an evaporitic sequence and unconformably underlying Lower Cretaceous rocks in the lower Athabasca River area. Crickmay (1957) subdivided the Waterways Formation into five members: the Firebag, Calumet (Calmut), Christina, Moberly and Mildred. He selected the Bear Biltmore No. 1 well at 7-11-87-17-W4 located about 76.8 km west-southwest of Fort McMurray as his standard of comparison with the incomplete outcrop succession on the Athabasca and Clearwater Rivers. In this well the Waterways Formation consists of a sequence, 213.8 m (701.5 ft) thick, of shale and argillaceous limestone alternating with mainly limestone units lying between the top of the Slave Point Formation and the base of the Devonian Cooking Lake Formation of the Woodbend Group.

In the subsurface of the Edmonton area of central Alberta the name Beaverhill Lake Formation was proposed by the geological staff of Imperial Oil Limited (1950) for the sequence of shale and limestone between the Elk Point and Cooking Lake Formations. Additional information provided by more drill holes prompted the Committee on Slave Point and Beaverhill Lake Formations (Belyea et al., 1964) to consider the five subdivisions of the Waterways Formation as members within the Beaverhill Lake Formation. A thick reefal carbonate development within the Beaverhill Lake Formation of the Swan Hills area was named the Swan Hills Member by Fong (1959, 1960) and informally subdivided into lower dark brown and upper light brown units. Murray (1965, 1966) and others have shown that the lower dark brown unit is the approximate equivalent of the Slave Point Formation. More recently, Leavitt and Fischbuch (1968) have raised the Beaverhill Lake to group status and included in it the Waterways, Swan Hills and Fort Vermilion Formations.

Northwest of the Athabasca-Clearwater Rivers area, the Waterways Formation becomes more shaly and is approximately equivalent to the lower half of the Hay River Formation as defined by Belyea and McLaren (1962) in the Great Slave Lake area (Braun, 1968, Fig. 8). About half way between these two areas, at Gypsum Cliffs on Peace River, the name Peace Point Member was applied by Norris (1963) to the lower part of the Waterways Formation. The name Peace Point beds was introduced by Kindle (1928) and has priority over the term Firebag Member introduced by Crickmay (1957). Beds assigned to the Peace Point Member at Gypsum Cliffs are equivalent to the lower part of the Firebag Member of the Waterways Formation of the Athabasca-Clearwater Rivers area (Norris, 1963; Norris and Uyeno, in press).

Beds of the Waterways Formation are discontinuously exposed at twelve localities along Birch River between stations 10NB (58°18'50"N, 113°04'50"W) and 17NB (58°18'20"N, 113°09'00"W), a river distance of approximately 15.7 km (9.8 miles). The uppermost or most westerly outcrop

Table of Devonian Formations

Erathem	Series or Stage	Formation and Thickness (metres & feet)	Member and Thickness (metres & feet)	Unit and Thickness (metres & feet)	Lithology
Cenozoic	Recent and Quaternary				Silt, clay, sand, gravel and soil.
		Erosional unconformity			
Paleozoic	Upper Devonian	Waterways Formation (parts only) 22.05 m 72.34 ft	Christina and Calumet (Calmut) Members (parts only) 22.05 m 72.34 ft	VII 0.7 m 2.3 ft	Medium to dark brown micritic limestone.
				VI 2.9 m 9.5 ft	Light greenish grey slightly argillaceous micritic limestone.
				V 0.9 m 2.9 ft	Medium greenish grey highly calcareous mudstone.
				IV 3.35 m 11 ft	Light brown to light greenish grey very slightly argillaceous micritic limestone.
				III 4.5 m 14.8 ft	Greenish grey highly calcareous mudstone.
				II 0.7 m 2.3 ft	Greenish grey highly argillaceous micritic limestone.
				I 9 m 27 ft	Poorly exposed interval of greenish grey highly argillaceous micritic limestone.
				?55 m ?180 ft	Covered.
		Unconformity			
	Upper Devonian	Slave Point Formation (part only) ?		?3 m ?9.8 ft	Covered.
				1.8 m 6 ft	Light grey to medium brown calcarenitic limestone; sparsely fossiliferous.
				?	Covered.

at station 17NB is located about 5.8 km (3.6 miles) river distance downstream from the mouth of Alice Creek. The lowermost or most easterly outcrop at station 10NB is located approximately 112 km (70 miles) river distance up from the mouth of Birch River (see Fig. 2).

The composite section of the Waterways Formation represented on Birch River is about 22 m (72 ft) thick outcropping in a very narrow belt about 5.1 km wide.

Lithologies represented on Birch River may be subdivided into seven rock units designated as I to VII in ascending sequence that have been pieced together from the discontinuous scattered outcrops (see Fig. 2). The lower part of unit I, estimated to be about 4.5 m (14.8 ft) thick, is represented by loose fragments and consists of light brown micritic, in part argillaceous, thin bedded limestone. The upper part of unit I consists of very poorly exposed recessive weathering, irregularly thin bedded, greenish grey highly argillaceous micritic limestone with about 4.5 m (14.8 ft) represented. Unit II is 0.7 m (2.3 ft) thick and consists of irregularly thin bedded, resistant, greenish grey, moderately argillaceous micritic limestone containing abundant abraded fossils. Unit III is about 4.5 m (14.8 ft) thick and is partly exposed at three localities comprising stations 10NB, 11NB and 12NB. It consists of recessive, poorly exposed, sparsely fossiliferous, greenish grey, highly calcareous mudstone. Unit IV is estimated to be about 3.35 m (11 ft) thick and because of its resistant character is partly represented at six localities along Birch River comprising stations 10NB, 11NB, 22NB, 21NB, 20NB and 18NB. It consists of light brown to light greenish grey, highly resistant, irregular and in part nodular bedded, in part slightly argillaceous micritic limestone with scattered beds containing abundant macerated megafossils. The contact between units IV and III is one of the more reliable markers evident in the eastern part of the Birch River sequence. Unit V is 0.9 m (3 ft) thick and is represented at stations 21NB and 18NB and possibly station 22NB. It consists of a recessive, poorly fossiliferous sequence of interbedded medium greenish grey highly calcareous mudstone, and medium greenish grey, irregular thinly bedded and nodular argillaceous micritic limestone. Unit V is one of the more distinctive marker units used for relating sections in the western part of the Birch River succession. The succeeding unit VI is 2.9 m (9.5 ft) thick and is partly exposed at stations 14NB, 15NB, 23NB, 21NB, 19NB, 18NB and 17NB. It consists of resistant, irregular bedded, light greenish grey, micritic limestone with partings of slightly argillaceous limestone, and contains an abundant megafauna in some beds. Unit VII is the uppermost rock unit exposed on Birch River and is present only at station 17NB where 0.7 m (2.3 ft) was measured. It consists of a sparsely fossiliferous sequence of medium to dark brown resistant micritic limestone interbedded with recessive, light greenish grey, rubbly bedded, argillaceous limestone.

Bedding attitudes of the discontinuous scattered outcrops of the Waterways Formation along Birch River indicate moderately spaced irregular undulations of the strata. It is highly unlikely that the undulations are tectonically controlled but are more probably related to volume changes and differential subsidence, caused by changes in composition and solution of underlying Middle Devonian evaporites. Similar undulations and subsidence features have been noted in the belt of Devonian strata bordering the margin of the Canadian Shield in southwestern Manitoba, northeastern Alberta and southern District of Mackenzie.

The covered interval separating the base of the outcrop succession from the base of the Waterways Formation on Birch River is estimated to be about 55 m (180 ft) thick based on comparisons with the sequences of Waterways beds present in the Athabasca-Clearwater Rivers area and in the nearest wells south of Birch River. The upper contact of the Waterways beds along Birch River is an erosion surface unconformably overlain by Quaternary and Recent deposits of silt, clay and soil. In Birch Mountains 5.1 km (3.2 miles) south of the Birch River, the eroded upper surface of the Waterways Formation is unconformably overlain by crossbedded quartzose sandstone and siltstone of the Lower Cretaceous McMurray Formation (see Green, 1970).

Most if not all of the megafossils from the seven rock units represented on Birch River are disarticulated, fragmentary or show signs of transport and abrasion suggesting deposition under high energy or turbulent conditions. This is particularly evident in the fossils from the more calcarenitic parts of the succession. Some thin limestone beds within the succession are coquinas consisting largely of closely packed abraded skeletal material. The more highly argillaceous parts of the succession are generally only sparsely fossiliferous.

The age and correlation of these beds are discussed in a succeeding part of this report.

BIOSTRATIGRAPHY

Age and correlation of megafaunas

Slave Point Formation

Fossils in Slave Point beds at Pointe de Roche are exceedingly sparse and poorly preserved. A collection from the upper 0.3 m (1 foot) of the section yielded Desquamatia sp. and other indeterminable atrypid fragments. Fossils derived from the outcrop, but collected loose, comprise bulbous stromatoporoids, Desquamatia sp., and Tentaculites sp. This sparse fauna suggests that the beds at Pointe de Roche are in part equivalent to the upper part of the Slave Point Formation exposed at Gypsum Cliffs on Peace River where megafossils are also scarce (Norris and Uyeno, in press). At the latter locality, the Slave Point Formation contains Desquamatia (Independatrypa) sp. cf. D. (I.) independensis (Webster) associated with a few bulbous stromatoporoids in the upper part, and Emanuella vernilis Crickmay in lower beds. The stratigraphic position of this fauna is above the highest occurrence of Stringocephalus sp. and immediately below the distinctive megafauna characterized by Tecnocyrtina billingsi (Meek) that marks the lower Waterways Formation and equivalent beds throughout a large area of western Canada. At Gypsum Cliffs the Slave Point Formation is immediately underlain by the evaporitic Fort Vermilion Formation which is unfossiliferous (see Table 2).

The sparse megafauna of the Slave Point Formation at Gypsum Cliffs is associated with conodonts of low diversity, suggestive of a polygnathid-icriodid biofacies that Uyeno (in Norris and Uyeno, in press) interpreted as the representative of a biofacies of the Schmidtognathus hermanni-Polygnathus cristatus Zone. Conodonts associated with the overlying Tecnocyrtina billingsi Fauna at Gypsum Cliffs are characteristic of the Pandorinellina insita Fauna that were assigned by Uyeno (in Norris and Uyeno, in press) to the Lowermost Polygnathus asymmetricus Zone (see Table 2).

Emanuella vernilis Crickmay of the lower Slave Point Formation at Gypsum Cliffs is regarded by Pedder (1975, p. 574) as one of the co-markers of the widely distributed Grypophyllum mackenziense Zone. At Powell Creek, Uyeno (1979, p. 239) indicated that both the Leiorhynchus

hippocastanea Zone of Crickmay (1960, p. 3) and the succeeding G. mackenziense Zone of Pedder (in Lenz and Pedder, 1972, p. 36, 37) are associated with conodonts that he assigned to the Upper hermanni-cristatus Zone. At this locality the G. mackenziense Zone is succeeded by the Tecnocyrtina billingsi Zone of Pedder (in Lenz and Pedder, 1972, p. 37). Associated conodonts of the latter zone comprise elements of the Pandorinellina insita Fauna which were assigned by Uyeno (1979, p. 239) to the Lowermost asymmetricus Zone.

Although two megafaunal zones, the G. mackenziense and L. hippocastanea Zones, can be differentiated in the lower Mackenzie area, in other areas, as between Great Slave Lake and the central Mackenzie regions, these two zones have been shown to be facies equivalents of one another (G.O. Raasch, pers. com., January 14, 1980).

In a recent revision of some of the conodont zones by Klapper (in Klapper and Johnson, 1980) the conodonts at Powell Creek associated with both the L. hippocastanea and G. mackenziense Zones were removed from the Upper hermanni-cristatus Zone and placed in a newly named Lower Polygnathus dengleri Subzone. Conodonts associated with the succeeding brachiopod T. billingsi Zone were assigned to the Upper P. dengleri Subzone. The new P. dengleri Zone for North America is aligned with the Lowermost asymmetricus Zone of western Europe. This new revision of the conodont zonal scheme creates a problem for Canadian biostratigraphers in that the hermanni-cristatus Zone does not appear to be unequivocally represented anywhere in Canada. At Powell Creek, the Stringocephalus aleskanus Zone of Crickmay (1963) and Pedder (1975) underlies the L. hippocastanea Zone and is associated with conodonts assigned by Uyeno (1979, p. 238) to an undifferentiated Polygnathus varcus Zone. One wonders if further work will demonstrate that conodonts indicative of the hermanni-cristatus Zone are absent because of unfavourable facies, as in the Lake Claire-Gypsum Cliffs area, or for some other reason.

At a meeting of the Subcommission on Devonian Stratigraphy held in Spain in September, 1979, the majority of members favoured the entry of Polygnathus disparilis, or slightly lower (undecided) level, as the eventual base of the Upper Devonian. The entry of this form marks the base of the Lower dengleri Subzone. Accordingly, by inference, the Slave Point beds exposed at Gypsum Cliffs and on the southwest side of Lake Claire, would correlate approximately with the G. mackenziense Zone which is within the Lower dengleri Subzone and would be placed in the lowermost Upper Devonian (see Table 2).

Waterways Formation

Megafossils other than brachiopods from beds of the Waterways Formation exposed on Birch River comprise sparse algal fragments, very sparse coral fragments one of which is a cup coral, numerous scattered fragments of bryozoa representing a single species, very sparse pelecypods of one or possibly two species, common gastropods represented by two species, a few scattered Tentaculites sp., abundant Spirorbis sp. attached to brachiopod shells, rare ostracode fragments, and exceedingly abundant echinoderm ossicles of four different forms occurring more or less throughout the succession (see Fig. 3).

Corals in the Waterways Formation are exceedingly scarce, and the only known cup coral previously recorded from this formation is Tabulophyllum athabascensis (Whiteaves, 1891, p. 248) which was collected from beds of the Calumet Member outcropping on the west bank of Athabasca River 93 km (58 miles) north of Fort McMurray. The cup coral from Birch River is possibly a juvenile form of this species.

Brachiopods are by far the most abundant group represented in the Waterways beds on Birch River and these are listed below. The better preserved and more diagnostic forms in this list that are illustrated in this report are marked by an asterisk. For ease of comparison of the Birch River brachiopods, the accompanying list shows the distribution and relative abundance of some of the more diagnostic forms in the Waterways Formation of northeastern Alberta as well as some other occurrences.

		1	2	3	4	5	6	7	8
1.	*Petrocrania sp.		r	?	r				
2.	*Schizophoria sp. cf. S. lata Stainbrook	a	a	r		x			
3.	Schizophoria sp.								
4.	*Strophodonta (Strophodonta) sp. A		a						
5.	*Nervostrophia sp.		r	r					
6.	*Eostrophalosia sp. cf. E. pedderi Crickmay				c				
7.	Eostrophalosia sp.								
8.	*Devonoproductus sp. cf. D. tertius Crickmay		c						
9.	productellid fragments								
10.	*Ladogioides asmenista (Crickmay)		r						x
11.	*Variatrypa (Radiatrypa) clarkei (Warren)	a	a	r	a				
12.	Desquamatia sp.								
13.	*Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook)						x		
14.	*Pseudoatrypa sp. cf. P. gigantea (Webster)		a	?	r	x			x
15.	Pseudoatrypa sp.								
16.	*Spinatrypina (Exatrypa) sp. A		a	?	r				x
17.	*Nucleospira? sp.							x	
18.	*Athyris parvula Whiteaves	r	r						x
19.	*Tecnocyrtina sp. A		c	r	r				x
20.	*Eleutherokomma sp. cf. E. impennis Crickmay	c	r	r					x
21.	*Eleutherokomma sp. cf. E. jasperensis (Warren)			r	c				x
22.	Eleutherokomma sp.								
23.	*Allanella minutilla Crickmay		?	c					x
24.	*Cranaena sp.				r	x		?	

Explanation of symbols:

x Occurrence recorded in literature

? Uncertain affinity and abundance

Explanation of symbols (cont'd)

r	Rare	Relative abundance
c	Common	
a	Abundant	
1.	Firebag Member	Waterways Formation
2.	Calumet (Calmut) Member	
3.	Christina Member	
4.	Moberly Member	

5. In beds of post hermanni-cristatus Zone and pre insita Fauna of Iowa
6. In beds of insita Fauna of Iowa
7. In beds of insita Fauna of Manitoba
8. Closely similar but generally not identical to forms in Assemblage 4, upper Flume Formation, British Columbia, illustrated by Raasch in Maurin and Raasch (1972).

Three of the forms from Birch River comprising Strophodonta (Strophodonta) sp. A, Devonoproductus sp. cf. D. tertius Crickmay and Ladogioides asmenista(Crickmay)are known elsewhere to be restricted to the Calumet Member of the Waterways Formation and equivalent beds of northeastern Alberta. One of the forms, Athyris parvula Whiteaves, appears to be restricted to beds of the Firebag and Calumet Members of the Waterways Formation, but is more abundant in the latter member. Two of the forms, Schizophoria sp. cf. S. lata Stainbrook and Eleutherokomma sp. cf. E. impennis Crickmay, range from the Firebag through the Calumet into the Christina Members of the Waterways Formation. Five of the forms comprising Petrocrania sp., Nervostrophia sp., Pseudoatrypa sp. cf. P. gigantea (Webster), Spinatrypina (Exatrypa) sp. A, and Tecnocyrtina sp. A first appear in the Calumet Member and range up into higher beds of the Waterways Formation. With the exception of Nervostrophia sp., all of these forms occur most abundantly in the Calumet Member. Two of the Birch River forms comprising Eleutherokomma sp. cf. E. jasperensis (Warren) and Allanella minutilla Crickmay first appear in the Christina Member and range up into the middle part of the Moberly Member where they are most abundant. Representatives of the genus Cranaena were previously recorded by Norris (1963, Fig. 8) in the Waterways Formation only from the Moberly Member where it is associated with the colour spotted terebratulid Maclarenella maculosa Stehli. Eostrophalosia pedderi Crickmay (1963, p. 18) occurs typically in the Allanella allani Zone in the upper part of the Moberly Member of the Waterways Formation from localities along the Athabasca and Steepbank Rivers. However, the form here designated as Eostrophalosia sp. cf. E. pedderi Crickmay from Birch River differs from the Athabasca River form in having more closely spaced and finer spines and finer spine bases on the pedicle valve. It appears to be a new species. The presence of Nucleospira? sp. in the Waterways beds on Birch River is the first record of this genus in the Waterways Formation of northeastern Alberta, although it has been recorded by McCammon (1960) in approximately equivalent beds in Manitoba. The latter occurrence is now more precisely known to be in the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation (Norris et al., in press).

It has long been known that the Flume Formation of eastern British Columbia and the Alberta central Rockies contains many faunal elements in common with the Waterways Formation of northeastern Alberta. This study shows that eight or more of the brachiopods from the Waterways beds on Birch River (see accompanying list) are closely similar but generally not identical to forms illustrated by Raasch (Maurin and Raasch, 1972) from their Assemblage 4 referred to as the "Atrypa" gregeri Zone in unit DFR4 of the upper Flume Formation of east central British Columbia. The gregeri Zone is referred to as a biozone and is approximately equivalent to the combined Eleutherokomma jasperensis, Allanella allani and Eleutherokomma killeri Zones of Crickmay (1966). The latter are interpreted by Raasch (Maurin and Raasch, 1972) as local teilzones that are consistent only in the Athabasca-Clearwater Rivers area of northeastern Alberta. The faunal distribution chart of Raasch (Maurin and Raasch, 1972, Pl. 3) shows that some of the more diagnostic brachiopods including Cyrtina cf. triquetra Hall, Ladogioides sp. nov., Eleutherokomma jasperensis (Warren) and Athyris randalia Stainbrook, that are closely similar to Birch River forms, appear to be restricted to roughly the lower half of the gregeri Zone in east central British Columbia. This latter interval appears to be roughly equivalent to Crickmay's (1966) Eleutherokomma jasperensis Zone of northeastern Alberta.

From the above summary of brachiopod occurrences it is apparent that the strongest affinities of the elements in the Birch River beds are with those in the Calumet and Christina Members of the Waterways Formation of northeastern Alberta. Although the affinities are with the Calumet and Christina Members the overlapping distribution of the various forms in the Birch River beds (see Fig. 3) fails

TABLE 1

Conodont zones and brachiopod faunas represented in the Lake Claire-Birch River area

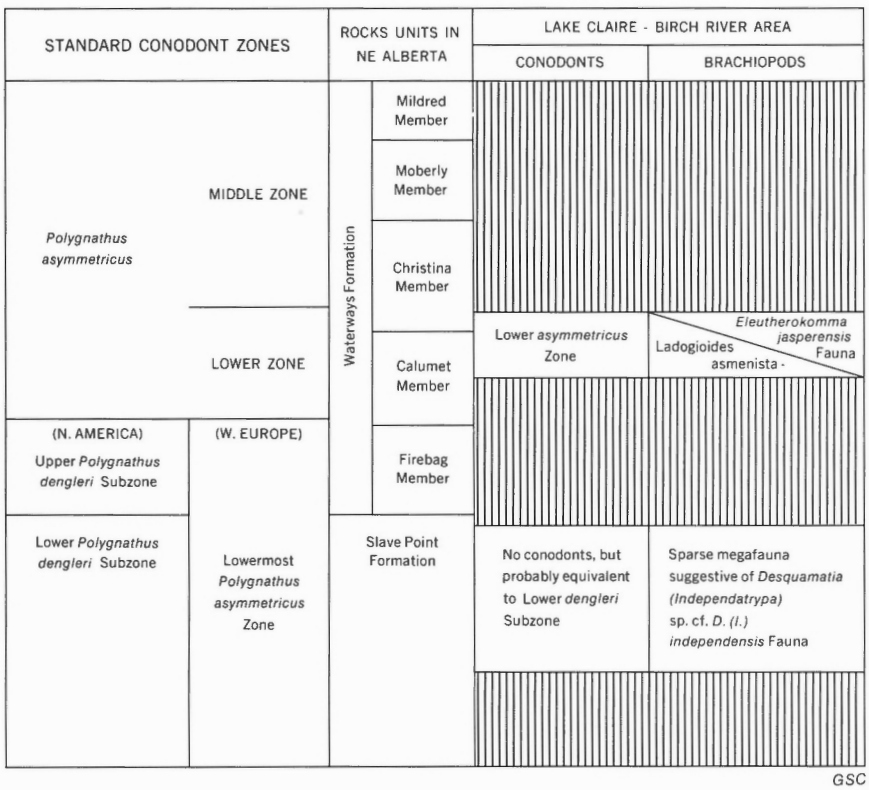

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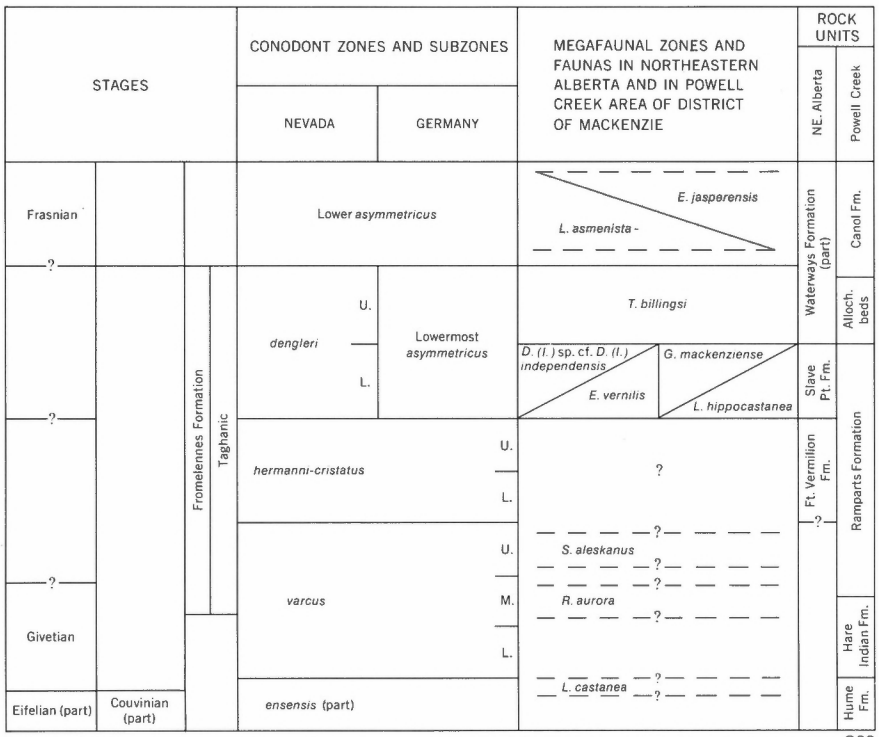
TABLE 2

Relationship of conodont zones and subzones, megafaunal zones and faunas, and rock units represented in the Birch River-Lake Claire-Gypsum Cliffs area of northeastern Alberta and in the Powell Creek area of the southern District of Mackenzie.



to show any clear cut distinction between the faunas of these two members. From the evidence at hand one would conclude that a single assemblage is represented in the Birch River composite section.

The distinctive fauna characterizing the Calumet Member in northeastern Alberta has been designated by Crickmay (1966, p. 20) as the "Stropheodonta costata" Zone, and that of the succeeding Christina Member and lower part of the Moberly Member was referred to by Crickmay (1966, p. 19-20) as the Eleutherokomma jasperensis Zone. The fauna characterizing the upper part of the Moberly Member has been referred to as the Allanella allani Zone (Crickmay, 1966, p. 19, 24, 37) or as the Eleutherokomma hamiltoni/Allanella allani Zone (Crickmay, 1967, p. 2). The zone name "Stropheodonta costata" is unfortunate because the form suggestive of this species in the Waterways Formation is distinct from S. costata Owen which according to Stainbrook (1938, p. 244-245) occurs typically in the "Atrypa" independensis Zone in the Solon Member of the Cedar Valley Formation of Iowa. Furthermore, its occurrence in Iowa is at a much lower stratigraphic level as indicated by independensis Zone brachiopods associated with conodonts assigned to the undifferentiated Polygnathus varcus Zone (Klapper, in Klapper et al., 1971, Fig. 3). More recent precise data on the Iowa section by Ziegler et al. (1976, p. 116, Fig. 3) suggests that the independensis Zone beds may be assignable to the upper Middle and lower Upper varcus Subzones. It is here suggested that until the stropheodontids and other brachiopods of the Waterways Formation are more thoroughly studied, a preferable term to apply to the Calumet megafauna would be the Ladogioides asmenista Fauna.

In terms of conodont zonation of the Waterways Formation in northeastern Alberta, Uyeno (1974, p. 5, Table 1; see Table 1) indicated that the Firebag and lowest part of the Calumet Members are collated with the Pandorinellina insita Fauna, most of the Calumet and lowermost part of the Christina Member are assigned to the Lower Polygnathus asymmetricus Zone, and most of the succeeding Christina and all of the Moberly and Mildred Members are assigned to the Middle P. asymmetricus Zone.

Judging by the thin sequence of Waterways beds exposed on Birch River and brachiopods strongly suggestive of both the Calumet and Christina Members, it is concluded that the Birch River section straddles the upper part of the Calumet and lower part of the Christina Members. If this assumption is correct, the interval would be probably mainly within the Lower Polygnathus asymmetricus Zone. However, there is a slight possibility that the lowermost part of the succeeding Middle Polygnathus asymmetricus Zone is also present.

In conclusion, the brachiopods from the Waterways beds on Birch River represent a single assemblage containing elements indicative of both the Calumet and Christina Members. For convenience this assemblage is here referred to as the Ladogioides asmenista-Eleutherokomma jasperensis Fauna. It is dated as early Late Devonian (early Frasnian) in age.

Age and correlation of conodont faunas

General remarks on the conodont faunas

The conodonts from the Birch River Waterways Formation generally are moderately to well preserved, of light amber colour (conodont colour alteration index, CAI, of 1 to 1.5; Epstein et al., 1977). The fauna is dominated by Icriodus subterminus Youngquist, Polygnathus spp., and Pandorinellina insita (Stauffer), with relatively abundant specimens of Ancyrodella rotundiloba rotundiloba (Bryant). Considering the platform elements only, these taxa comprise about 97 per cent of the entire fauna. The distribution of conodonts in the Birch River beds is given on Figure 4. Generally speaking, the abundant, large robust specimens were derived mainly from biocalcarenite and biocalcirudite, whereas shale and argillaceous calcilutite (GSC locs. C-74173, C-74177, C-74180 and C-74199, from lithologic units III and VI) yielded fewer and smaller-sized specimens. The latter samples lacked the more robust elements such as Polygnathus spp. and A. rotundiloba subspp. The cause of such segregation is open to some speculation and may be the result, at least in part, of post-mortem sorting. The Birch River conodont fauna, like the relatively diversified associated brachiopods, were inhabitants of shallow water, and belonged to the Pandorinellina insita biofacies proposed by Sandberg and Poole (1977, Fig. 2, p. 149).

The locational notation of the elements of conodont apparatuses are after Klapper and Philip (1971, 1972) for icriodontid elements, and Cooper (1975, 1976, 1977) for others. The latter usage is a slight modification of that of Sweet and Schönlaub (1975).

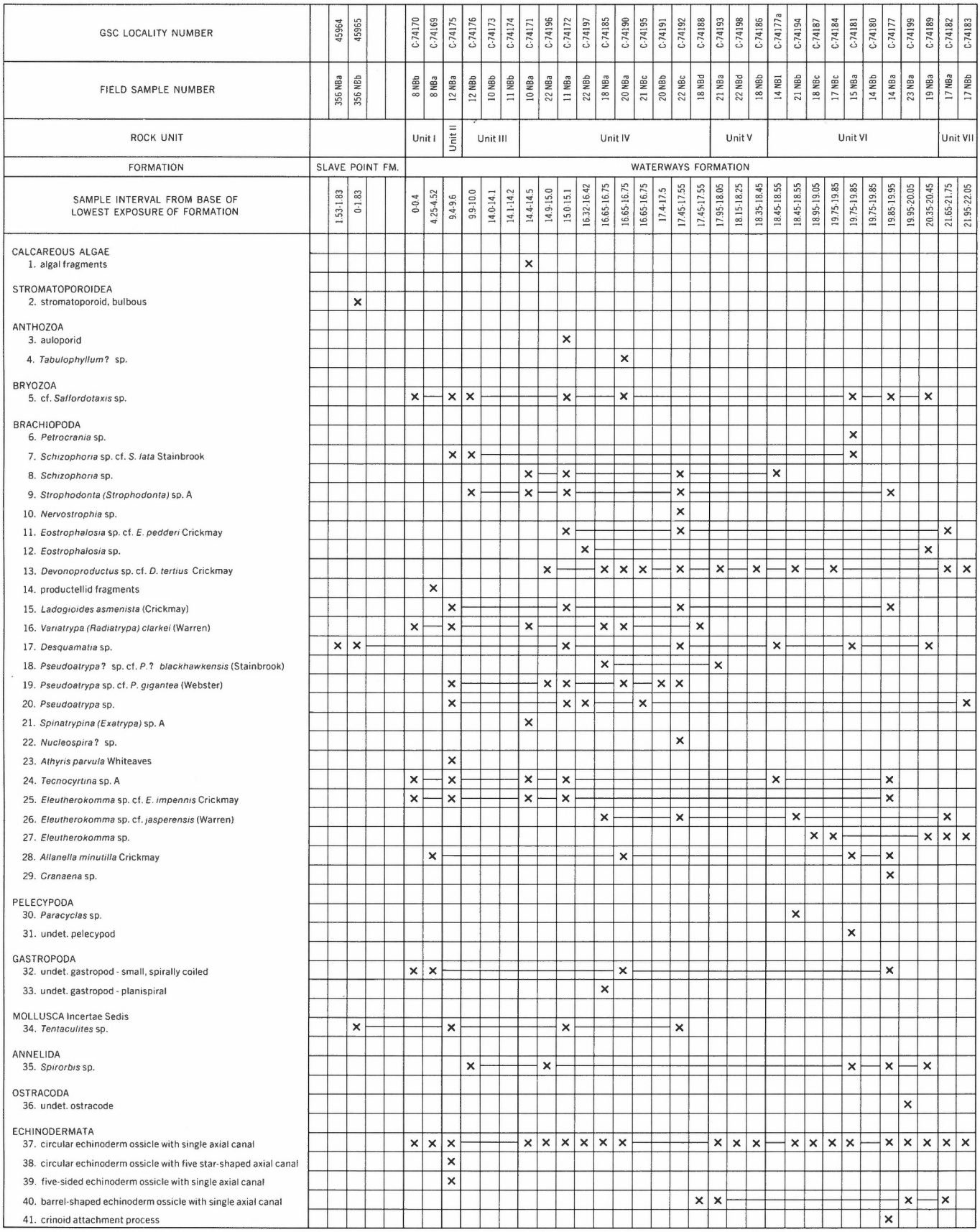


FIGURE 3. *Chart showing distribution of brachiopods and other megafossils in beds of the Slave Point Formation on Lake Claire and in the Waterways Formation on Birch River.*

GSC LOCALITY NUMBER	45964	45965	C-74170	C-74169	C-74175	C-74176	C-74173	C-74174	C-74171	C-74196	C-74172	C-74197	C-74185	C-74190	C-74195	C-74191	C-74192	C-74188	C-74193	C-74198	C-74186	C-74177a	C-74194	C-74187	C-74184	C-74181	C-74180	C-74177	C-74199	C-74189	C-74182	C-74183	
FIELD SAMPLE NUMBER	356 NBa	356 NBb	8 NBb	8 NBa	12 NBa	12 NBb	10 NBb	11 NBb	10 NBa	22 NBa	11 NBa	22 NBb	18 NBa	20 NBa	21 NBc	20 NBb	22 NBc	18 NBd	21 NBa	22 NBd	18 NBb	14 NB1	21 NBb	18 NBc	17 NBc	15 NBa	14 NBb	14 NBa	23 NBa	19 NBa	17 NBa	17 NBb	TOTAL
CONODONTA	SLAVE PT. FM.		WATERWAYS FORMATION																														
			Unit I		II	Unit III			Unit IV									Unit V				Unit VI										Unit VII		
Ancyrodella rotundiloba rotundiloba (Bryant) (Pa)				3						1	1	2	1	7	5			1		4	3		3		6				4	2	4	47
A. rotundiloba binodosa Uyeno (Pa)									2																								2
Elsonella rhenana Lindström and Ziegler (falcodontan)														1											2								3
Elsonella rhenana Lindström and Ziegler (lippertiform)																									1								1
"Enantiognathus" lipperti (Bischoff)																							1										1
Icriodus subterminus Youngquist (I)				6	15				25	4	86	1		1	6	1			2	14	5		5	7	6			2		4	4	5	199
Icriodus subterminus Youngquist (S_{2a})					2															2				1				2					7
Icriodus subterminus Youngquist (S_{2b})					5		1		2											4				2							3	2	19
Icriodus subterminus Youngquist (S_{2c})					6			1			2									1				1			2	2			2		17
I. cf. *I. subterminus* Youngquist (I)				1	3				3		3													1							1	2	14
? *Mesotaxis asymmetrica* (Bischoff and Ziegler) (Pa)																									2								2
Oulodus spp. (Pa)											5				2						1		1	1						1		1	12
Oulodus spp. (Pb)											6				1										1								8
Oulodus spp. (M)											6																						6
Oulodus spp. (Sc)									1	1	11		2		1				1					1	1					2			21
Oulodus spp. (Sb)				2					1	1	6		1						1						1					1		1	15
Oulodus spp. (Sa)				2	1				1		10				2								1		1					1			19
Ozarkodina brevis (Bischoff and Ziegler) (Pa)														1		1				3				4						1	2		12
Ozarkodina brevis (Bischoff and Ziegler) (Pb)																							1										1
Ozarkodina brevis (Bischoff and Ziegler) (M)																		1	1										1			1	4
Ozarkodina brevis (Bischoff and Ziegler) (Sc)																									1								1
Ozarkodina brevis (Bischoff and Ziegler) (Sb)																									1								1
Ozarkodina brevis (Bischoff and Ziegler) (Sa)																				1										1			2
Pandorinellina insita (Stauffer) (Pa)				14	31		1		21	1	39	2	3	7	5	4		3	1	6	2		2	4	4		5	4	2	13	2	4	181
Pandorinellina insita (Stauffer) (Sa)				1					1		5		1	1		1			1										1		4	1	17
P. cf. *P. insita* (Stauffer) (Pa with one lateral denticle)					1						1																						2
Polygnathus cf. *P. decorosus* (Stauffer) (Pa)					2					1	1	3	1	3	1			6	2						2					10			32
P. aff. *P. incompletus* (Uyeno) (Pa)				3	1				1	6	4	1			3				2											1			22
P. webbi (Stauffer) (Pa)					1				2	3	6		1		2	1			3					1					1	2			23
P. cf. *P. webbi* (Stauffer) (Pa with acicular free blade)				1							2													1						1			5
P. sp. indet. (Pa juvenile and/or fragmentary)				2	7				1	2	3	1	1	3				1	3						1					2			27
Unassigned elements:																																	
Pb (ozarkodinan)				10	3		2		2	1	6	4	1	4	2	2		2	1	3	8			6	4				4	3	4	4	76
M (neoprioniodontan)				2					2		1			2		1			1	2				2	1		1			5			20
M (synprioniodinan)				2	7						2	2		2	1	1		1		2	1			3	5			1	1	5	2	4	42
Sc (hindeodellan)				2	2		1				6			4		1		2			1			2	2				3			2	28
Sb (angulodontan)				2	1					1			1	1	2						1		1	1	2				2			3	18
No conodont recovery	0																																
Indeterminate fragments only		X																															
Weight of sample (kg)	0.6	0.8		2.0	0.6		0.9	0.6	1.1	0.3	2.0	0.7	0.7	0.8	1.1	1.2		1.0	0.3	1.0	0.6		1.0	0.9	1.1		0.7	0.8	1.0	0.8	0.6	0.8	

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FIGURE 4. *Chart showing distribution of conodonts in beds of the Slave Point Formation on Lake Claire and in the Waterways Formation on Birch River.*

In this and following discussions, the name(s) of author(s) of taxa are given only in their first mention. The zonal name-givers are quoted by their trivial names only, following the recommendation made by Klapper (1977, p. 37).

Slave Point Formation

Except for indeterminate fragments in one of two samples from the Slave Point Formation on Lake Claire, the beds appear to be barren of conodonts. However, the sparse megafauna in these beds suggests that they are in part equivalent to the upper part of the Slave Point Formation at Gypsum Cliffs on Peace River where the associated conodonts are suggestive of the Lower dengleri Subzone. Because of the absence of conodonts in Slave Point beds on Lake Claire, the limited conodont evidence having a bearing on the age of the Slave Point Formation at Gypsum Cliffs is more fully discussed in a preceding part of this report under 'age and correlation of megafaunas'.

Waterways Formation

The Birch River conodont fauna is, in general, very similar to that of the Waterways Formation, exposed along the Athabasca and Clearwater Rivers, some 125 km (75 miles) to the southeast (Uyeno, 1967, 1974). In terms of Ziegler's (1962, 1971) conodont zonation, the Birch River fauna is assignable to the Lower Polygnathus asymmetricus Zone. Conodonts of this zone were previously found in the upper part of the Calumet and the lowermost part of the Christina Members of the Waterways Formation (Uyeno, 1974, Table 1).

As stated under general discussion, three of the more numerous taxa in the fauna comprise Icriodus subterminus, Pandorinellina insita, and Ancyrodella rotundiloba rotundiloba. Although their stratigraphic ranges are longer than some of those discussed below, they are nevertheless restricted to the lower part of the Upper Devonian. Of these, the last-mentioned has the shortest span, from the base of the Lower asymmetricus Zone to the top of the Middle Polygnathus asymmetricus Zone (Ziegler in Ziegler, 1973, p. 30).

The most significant taxon in the collection in terms of biostratigraphy, is Ancyrodella rotundiloba binodosa Uyeno. In northeastern and central Alberta, it was found to have a relatively narrow stratigraphic range mentioned above, i.e., upper Calumet to lowermost Christina. The only possible anomaly to this range is the reported occurrence in the Moberly Member by Pollock (1968, p. 440-441). Conodonts of this member were assigned to the Middle asymmetricus Zone (Uyeno, 1974, Table 1). The two illustrated specimens (Pollock, 1968, Pl. 63, figs. 1-7), however, were both derived from the Calumet Member (see Uyeno, 1974, p. 25).

Ancyrodella rotundiloba binodosa is similarly restricted to the Lower asymmetricus Zone in western Europe (see Ziegler in Klapper and Ziegler, 1979, Text-fig. 5). In the Dinant Basin of Belgium, the subspecies occurs in the "zone des Monstres, F2a" of the "Frasnes" Group, within m.g.m. ("micro-paleontological guiding-mark") 18 and the lowest part of 19 (Coen and Coen-Aubert, 1971, p. 16; Mouravieff, 1974; Bultynck, 1975, Figs. 3-5; see also Tsien, 1977, Table 1). Mouravieff (1974, Pl. 1, fig. 2) illustrated a transitional form between A. rotundiloba binodosa and the nominate subspecies, also from the F2a beds. Similar forms were recovered from the Birch River material, and a transitional form was also reported from the base of the "Schistes" de Beaulieu (level K) in the Boulonnais region of France (Bultynck in Brice et al., 1976, Table 4). In Spain and Nevada, A. rotundiloba binodosa also occurs in the Lower asymmetricus Zone (Garcia-Lopez, 1976, Fig. 2; Klapper and Johnson, 1980, Table 13).

The Pa element of Polygnathus aff. P. incompletus Uyeno is close to, but not identical with, the polygnathan in the Calumet and Christina Members of the Waterways Formation (Uyeno, 1974, Table 1). It is also similar to that reported from southern Poland in beds assigned to the Lowermost asymmetricus Zone by Baliński (1979, Table 3).

The peculiar Pa element of Ozarkodina brevis (Bischoff and Ziegler), with minute denticle(s) posterior of the main cusp, and present in the Birch River collections, was previously reported from the Moberly Member (Uyeno, 1974, Table 1). Also present in the materials, both from Birch River and northeastern Alberta, are the more "typical" spathognathodontan elements which are more characteristic of the older varcus Zone (undivided) and the Lowermost asymmetricus Zone (Ziegler et al., 1976).

The occurrence of probable Mesotaxis asymmetrica (Bischoff and Ziegler) is significant as it verifies the assignment to one of the asymmetricus Zones. In northeastern and central Alberta, it was reported from the Christina to Moberly Members of the Waterways Formation, and a probable fragmentary specimen from the Firebag Member.

Summary statement

Parts of the Slave Point and Waterways Formations are exposed in the Lake Claire-Birch River area of northeastern Alberta. The nearest comparative outcrop sections for the Slave Point Formation are those at Gypsum Cliffs on Peace River located about 90 km (54 miles) along strike to the north described by Norris (1963) and Norris and Uyeno (in press). For the Waterways beds on Birch River comparison is made with the Waterways succession outcropping along strike at between 125 to 220 km (75 to 132 miles) to the south in the Athabasca-Clearwater Rivers area described by Norris (1963, 1973), Uyeno (1967, 1974), and others.

Megafossils in the Slave Point beds at Pointe de Roche on Lake Claire are sparse, poorly preserved, and comprise Desquamatia sp., Tentaculites sp. and bulbous stromatoporoids. These, by comparison with the Gypsum Cliffs succession, are assigned to the Desquamatia (Independatrypa) sp. cf. D. (I.) independensis Fauna which occurs in the upper part of the Slave Point Formation (see Table 1). Unfortunately, except for unidentifiable fragments, conodonts appear to be absent from the Slave Point beds at Point de Roche. At Gypsum Cliffs the independensis Fauna is associated with a sparse conodont fauna suggestive of the Lower dengleri Subzone of Klapper and Johnson (1980) that is dated as early Late Devonian (early Frasnian). This is based on the assumption that the Middle/Upper Devonian boundary will be defined on the entry of Palmatolepis disparilis which marks the base of the Lower dengleri Subzone.

The thin succession of part of the Waterways Formation on Birch River contains a moderately diverse but sparse megafauna. Most of the megafossils show signs of abrasion or disarticulation suggesting deposition under high energy, shallow water turbulent conditions. Megafossil groups represented comprise sparse algal fragments, sparse corals, abundant bryozoan fragments, sparse pelecypods, common gastropods, few tentaculitids, abundant Spirorbis sp., rare ostracode fragments, abundant echinoderm ossicle fragments, and brachiopods which far exceed the other groups in diversity and abundance. The better preserved and more diagnostic Waterways brachiopods from Birch River

illustrated in this report comprise: Petrocrania sp., Schizophoria sp. cf. S. lata Stainbrook, Strophodonta (Strophodonta) sp. A, Nervostrophia sp., Eostrophalosia sp. cf. E. pedderi Crickmay, Devonoproductus sp. cf. D. tertius Crickmay, Ladogioides asmenista (Crickmay), Variatrypa (Radiatrypa) clarkei (Warren), Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook), Pseudoatrypa sp. cf. P. gigantea (Webster), Spinatrypina (Exatrypa) sp. A, Nucleospira? sp., Athyris parvula Whiteaves, Tecnocyrtina sp. A, Eleutherokomma sp. cf. E. impennis Crickmay, Eleutherokomma sp. cf. E. jasperensis (Warren), Allanella minutilla Crickmay, and Cranaena sp. This brachiopod fauna has its strongest affinities with forms in the Calumet and Christina Members of the Waterways Formation of northeastern Alberta. The overlapping distribution of the brachiopods in the Birch River succession suggests that a single assemblage is represented which is designated in this report as the Ladogioides asmenista-Eleutherokomma jasperensis Fauna. This fauna in the Waterways Formation of northeastern Alberta succeeds the Tecnocyrtina billingsi Fauna [≈Eleutherokomma impennis Zone of Crickmay (1966)] and precedes the Eleutherokomma hamiltoni/Allanella allani Zone of Crickmay (1967, p. 2).

The conodont fauna from the Birch River Waterways beds consist largely of Icriodus spp., Polygnathus spp., Pandorinellina insita (Stauffer) and Ancyrodella rotundiloba rotundiloba (Byrant). They are moderately to well preserved and are of light amber colour, the latter suggesting low sediment temperatures under conditions of relatively shallow burial. These conodonts, like the associated brachiopods, are typical inhabitants of a shallow water environment referred to as the Pandorinellina insita biofacies by Sandberg and Poole (1977, Fig. 2, p. 149).

One of the most diagnostic conodont elements in the Waterways beds on Birch River is Ancyrodella rotundiloba binodosa Uyeno. This form in the Waterways Formation of northeastern Alberta is restricted to the upper Calumet, and lower Christina Members, an interval assigned to the Lower asymmetricus Zone (see accompanying Table 1). A similar restricted range within the Lower asymmetricus Zone is recorded for this subspecies in western Europe and Nevada.

The Ladogioides asmenista-Eleutherokomma jasperensis Fauna and associated conodonts assigned to the Lower asymmetricus Zone are dated as early Late Devonian (early Frasnian).

SYSTEMATIC PALEONTOLOGY

All specimens comprising brachiopods and conodonts illustrated in this report have been assigned type GSC numbers (e.g., GSC 63037) and will be placed in the national type collection curated by the Geological Survey of Canada in Ottawa.

BRACHIOPODA

Suborder CRANIIDINA Waagen, 1885

Superfamily CRANIACEA Menke, 1828

Family CRANIIDAE Menke, 1823

Genus Petrocrania Raymond, 1911

[nom. subst. pro Craniella Oehlert, 1888, p. 101 (non von Schlotheim, 1820)]

Type species. Craniella meduanensis Oehlert, 1888, p. 102; OD [+Punctopatella Brubbs, 1939, p. 559 (type, P. corallifera)].

Petrocrania sp.

Plate 8, figure 42

Material. Represented by a single specimen attached by pedicle valve to a specimen of Schizophoria sp. cf. S. lata Stainbrook.

Dimensions (in mm).

Specimen	A
GSC No.	63053
GSC locality	C-74181
Length of bv (Lbv)	12.0
Width (W)	12.7
Ratio: W/Lbv	1.06

Remarks. Although the genus Petrocrania is long ranging and regarded as being of little stratigraphic value (Cooper, in Shimer and Shrock, 1944, p. 291) the form from Birch River is here illustrated for the sake of completeness. It somewhat resembles "Crania" famelica Hall and Whitfield as described and illustrated by Branson (1922, p. 72, Pl. 11, figs. 1, 2) from the Snyder Creek Shale of Callaway County, Missouri.

Occurrence. On Birch River, Petrocrania sp. occurs in unit VI of the Waterways Formation at station 15NB.

In northeastern Alberta, forms designated by Norris (1963, Figs. 6 and 8) as "Crania" sp. A and "Crania" sp. B were recorded from the Calumet and Moberly Members of the Waterways Formation in the Athabasca-Clearwater Rivers outcrop belt.

In Missouri, "Crania" famelica is reported by Branson (1922, p. 72) to be common in the Snyder Creek Shale and is present also in the underlying Callaway Formation. The upper part of the Callaway Formation contains conodonts of the Pandorinellina insita Fauna and the lower part of the Snyder Creek Shale is assigned to the Middle Polygnathus asymmetricus Zone (D. Schumacher, in Klapper et al., 1971, Fig. 3, column 3).

Figured specimen. GSC 63053 is from GSC locality C-74181.

Order ORTHIDA Schuchert and Cooper, 1932

Suborder ORTHIDINA Schuchert and Cooper, 1932

Family ENTELETIDAE Waagen, 1884

Subfamily SCHIZOPHORIINAE Schuchert and LeVene, 1929

Genus Schizophoria King, 1850

Type species. Conchyliolithus (Anomites) resupinatus Martin, 1809, Pl. 49, fig. 13, 14; OD.

Schizophoria sp. cf. S. lata Stainbrook

Plate 6, figures 1-10

1940 Schizophoria lata STAINBROOK, p. 488, Pl. 2, figs. 1-7, 15-16.

1944 Schizophoria lata Stainbrook, WARREN, p. 109, Pl. 1, fig. 1.

1956 Schizophoria sp., WARREN and STELCK, Pl. 10, figs. 14-16.

1956 Schizophoria lata Stainbrook, WARREN and STELCK, Pl. 11, figs. 8-10.

in press Schizophoria lata Stainbrook, NORRIS in NORRIS and UYENO, Pl. 2, figs. 1-22.

Material. Represented by about 25 specimens about half of which are incomplete.

Dimensions (in mm).

Specimen	A	B	C
GSC No.	63018	63019	63020
GSC locality	C-74172	C-74172	C-74181
Length of pv (Lpv)	21.1	35.3	38.3
Length of bv (Lbv)	21.2	36.6	36.5
Width (W)	29.2	41.1	44.8
Depth of shell (D)	12.9	15.6	16.7
Width of interarea	14.7	15.7	24.7
Depth of sulcus at anterior margin	2.9	5.6	7.5
Ratio: W/Lpv	1.38	1.16	1.17
Ratio: D/Lpv	0.61	0.44	0.44

Remarks. Most of the specimens of this form from the Birch River area show signs of abrasion, crushing and disarticulation which make precise comparisons with other forms difficult. The form from Birch River attains a slightly larger size at maturity than the Iowa form and exhibits a more variable shape outline. Some Birch River specimens are slightly thicker and show a slightly stronger V-shaped development of the sulcus on the pedicle valve.

Occurrence. The type specimens of Schizophoria lata Stainbrook (1940, p. 489) are recorded from the waterlooensis Zone in the upper part of the Rapid Member of the Cedar Valley Limestone in southeastern Iowa. In the Gypsum Cliffs area on Peace River in northeastern Alberta it is relatively abundant in beds of the Peace Point Member of the Waterways Formation (Norris, in Norris and Uyeno, in press). In beds of the Waterways Formation in the Clearwater-Athabasca Rivers area, Schizophoria lata and closely related forms have been recorded from the Firebag, Calumet and Christina Members (Crickmay, 1966, p. 20-21). It is particularly abundant in some beds of the Firebag and Calumet Members of the Waterways Formation of this area.

Figured specimens. GSC 63018 and 63019 from GSC locality C-74172, and GSC 63020 from GSC locality C-74181.

Superfamily STROPHOMENACEA King, 1846

Family STROPHEODONTIDAE Caster, 1939

Subfamily STROPHEODONTINAE Caster, 1939

Genus Strophodonta Hall, 1850

Type species. Leptaena demissa Conrad, 1842, p. 258 [=Stropheodonta Hall, 1852, p. 63 (nom. van.)].

Subgenus Strophodonta (Strophodonta) Hall, 1852 emended.

Type species. Leptaena demissa Conrad, 1842.

Strophodonta (Strophodonta) sp. A

Plate 6, figures 11-13

Material. Represented by 11 specimens, about half of which are fragmentary, from beds of the Waterways Formation exposed on Birch River.

Dimensions (in mm).

Specimen	A	B
GSC No.	63021	63022
GSC locality	C-74172	C-74177
Length of pv (Lpv)	21.5	-
Length of bv (Lbv)	-	ca. 28.4
Width (W)	26.5	ca. 30.8
Depth of shell (D)	-	-

Remarks. This form appears to be identical to a new species described by Norris (in manuscript) from beds of the Calumet Member of the Waterways Formation outcropping in the Clearwater-Athabasca Rivers area. It bears some resemblance to Stropheodonta demissa (Conrad) as described by Branson (1922, p. 77-79, Pl. 11, figs. 3, 8, Pl. 14, figs. 1-8) from the Snyder Creek Shale of Missouri.

Occurrence. On Birch River this form has been recorded from rock units II, IV and VI of the Waterways Formation. This form is abundantly represented in beds of the Calumet Member of the Waterways Formation outcropping along the upper Clearwater River and at one locality on the lower Athabasca River.

Figured specimens. GSC 63021 from GSC locality C-74172, and GSC 63022 from GSC locality C-74177.

Subfamily LEPTOSTROPHIINAE Caster, 1939

Genus Nervostrophia Caster, 1939

Type species. Strophomena nervosa Hall, 1843, p. 266.

[=Sulcatostrophia Caster, 1939, p. 81 (type, Leptostrophia camerata Fenton and Fenton, 1924, p. 96); Pseudodouvillina Stainbrook, 1945, p. 26 (type, P. euglyphea)].

Nervostrophia sp.

Plate 6, figures 14-15

Material. Seven incomplete specimens from one locality on Birch River.

Dimensions (in mm).

Specimen	A	B
GSC No.	63023	63024
GSC locality	C-74192	C-74192
Length of pv (Lpv)	ca. 13.9	ca. 19.0
Length of bv (Lbv)	-	-
Width (W)	18.8	25.6
Depth of shell (D)	-	-
Ratio: (W/Lpv)	1.35	1.35

Remarks. A relatively flat form attaining medium size that is ornamented with two sizes of costellae, with the coarser costellae being variably nervate. The fragmentary nature of the specimens precludes a close comparison with described species.

Occurrences. This form was collected from the upper part of unit IV at station 22NB on Birch River. In the Clearwater-Athabasca Rivers area of northeastern Alberta this form occurs sparingly in the Calumet and Christina Members of the Waterways Formation. A Nervostrophia sp. is recorded by Crickmay (1966, p. 13) from the Strophodonta (Strophodonta) costata Zone in beds referred to the Simpson Shale (=lower part of Hay River Formation penetrated by a group of Frobisher boreholes located 16 km (10 miles) from the mouth of Hay River.

Figured specimens. GSC 63023 and 63024 from GSC locality C-74192.

Suborder PRODUCTIDINA Waagen, 1883

Superfamily STROPHALOSIACEA Schuchert, 1913

Family STROPHALOSIIDAE Schuchert, 1913

Subfamily STROPHALOSIINAE Schuchert, 1913

Genus Eostrophalosia Stainbrook, 1943a, p. 58

Type species. Strophalosia rockfordensis Hall and Clarke, 1893, p. 316.

Eostrophalosia sp. cf. E. pedderi Crickmay

Plate 6, figures 16-22

1956 Productella cf. belanskii Stainbrook, WARREN and STELCK, Pl. 11, figs. 4-7.

1963 Eostrophalosia pedderi CRICKMAY, p. 17-18, Pl. 5, figs. 10-15, Pl. 12, figs. 6-12.

Material. Represented by five specimens, only one of which is complete.

Dimensions (in mm).

Specimen	A
GSC No.	63025
GSC locality	C-74192
Length of pv (Lpv)	18.2
Length of bv (Lbv)	16.4
Width (W)	21.4
Depth (D)	8.4
Ratio: W/Lpv	1.18

Remarks. The specimen here illustrated compared with the types of Eostrophalosia pedderi Crickmay (1963, Pl. 12, figs. 6-12) appears to have slightly finer and shorter spines and smaller and more closely spaced spine bases on the pedicle valve.

Occurrences. Crickmay (1963, p. 18) recorded Eostrophalosia pedderi from beds of the Moberly Member of the Waterways Formation outcropping on the east bank of Athabasca River, 41.6 km (26 miles) downstream from Fort McMurray, and from 3.2 km (2 miles) up the Steepbank River. These occurrences are within the Allanella allani Zone of Crickmay (1966) which was later interpreted by Crickmay (1967, p. 2) as the uppermost zone within the Moberly Member.

On Birch River this form has been recovered from rock unit IV of the Waterways Formation at stations 11NB and 22NB, and from rock unit VII of the Waterways Formation at station 17NB (see Fig. 2). The occurrences on Birch River are from beds older than the Moberly Member of the Waterways Formation.

Figured specimens. GSC 63025 is from GSC locality C-74192.

Superfamily PRODUCTACEA Gray, 1840

Family LEIOPRODUCTIDAE
Muir-Wood and Cooper, 1960

Subfamily DEVONOPRODUCTINAE
Muir-Wood and Cooper, 1960

Genus Devonoproductus Stainbrook, 1943, p. 55

Type species. Productella walcotti Fenton and Fenton, 1924, p. 119 [(=Productus dissimilis Hall, 1858, p. 497, non DeKoninck, 1847, p. 255) (=P. (Productella) hallana Walcott, 1884, p. 130, partim)] [=Striatoproductus Nalivkin, 1947, p. 75 (type, Orthis sericea von Buch, 1838, p. 68)].

Devonoproductus sp. cf. D. tertius Crickmay

Plate 6, figures 23-26

1963 Devonoproductus tertius CRICKMAY, p. 26-27, Pl. 5, figs. 25-30, Pl. 14, figs. 23-26.

Material. Represented by approximately 20 specimens most of which are incomplete.

Dimensions (in mm).

Specimen	A	B	C	D	Devonoproductus tertius Crickmay (1963, p. 27)
GSC No.	63026	63027	63028	63029	
GSC locality	C-74182	C-74182	C-74190	C-74193	
Length of pv (Lpv)	3.9	-	-	4.7	5.5
Length of bv (Lbv)	-	6.0	5.0	-	-
Width (W)	4.9	5.7	5.6	5.6	7.0
Depth (D)	-	-	-	-	2.0
Ratio: W/Lpv	1.26	-	-	1.19	-
Ratio: W/Lbv	-	0.95	1.12	-	1.27

Remarks. None of the Birch River specimens show the long, delicate erect spines, but a few irregularly spaced spine bases are evident on some specimens.

Occurrences. The type specimens of Devonoproductus tertius are recorded from the lower part of the Beaverhill Lake Formation in the Imperial Morse River No. 14-31-63-8W5 well at a depth of 2353.1 m (7720 ft). In this well the species ranges from 2338.5 to 2356.1 m (7672 to 7730 ft) depths, and occurs within the Strophodonta (Strophodonta) costata Zone (Crickmay, 1963, p. 27).

On Birch River this form is represented in rock units IV, V, VI and VII of the Waterways Formation various parts of which are represented at stations 17NB, 18NB, 20NB, 21NB and 22NB (see Fig. 2). The interval of the Waterways Formation represented on Birch River is judged to be approximately equivalent to that containing Devonoproductus tertius in the Imperial Morse River No. 14-31-63-8W5 well.

Figured specimens. GSC 63026 and 63027 from GSC locality C-74182, GSC 63028 from GSC locality C-74190, and GSC 63029 from GSC locality C-74193.

Order RHYNCHONELLIDA Kuhn, 1849

Superfamily RHYNCHONELLACEA Gray, 1848

Family Uncertain (?aff. PUGNACIDAE)

Genus Ladogioides McLaren, 1961

[=Athabaschia Crickmay 1963, p. 10]

Type species. Ladogioides pax McLaren, 1961, p. 4, Pl. 1, figs. 6, 7, Pl. 2, fig. C.

Ladogioides asmenista (Crickmay)

Plate 6, figures 27-32; Plate 7, figures 1-12

1962 "Pugnoides" sp. E, McLAREN, NORRIS and McGREGOR, p. 22, Pl. 10, figs. 24-26.

1963 Athabaschia asmenista CRICKMAY, Pl. 3, figs. 1-4, Pl. 9, figs. 14-19.

Material. Represented by approximately 24 specimens, some of which are fragmentary.

Dimensions (in mm).

Specimen	A	B	C	Athabaschia asmenista Crickmay (1963, p. 10)
GSC No.	63030	63031	63032	
GSC locality	C-74192	C-74192	C-74192	
Length of pv (Lpv)	8.6	9.3	10.1	11.0
Length of bv (Lbv)	7.5	8.2	8.8	-
Width (W)	8.5	9.6	11.4	12.5
Depth of shell (D)	4.4	4.9	5.5	7.0
Width of interarea at cardinal margin	4.6	3.7	6.4	-
Depth of sulcus at anterior margin	2.5	1.9	3.2	-
Ratio: W/Lpv	0.99	1.03	1.13	1.14
Ratio: D/Lpv	0.29	0.53	0.54	-
Hinge angle (in degrees)	87	81	77	-

Remarks. The genus Athabaschia was erected by Crickmay (1963, p. 9) to accommodate the species Athabaschia asmenista which McLaren (in Moore, 1965, p. 577) placed in synonymy with the genus Ladogioides McLaren (1961). In the original description of this species Crickmay (1963, p. 10) indicated that a radial micro-ornament was absent. A radial micro-ornament similar to that present on Ladogioides pax McLaren (1961, Pl. 1, figs. 7c, 7d) can be seen on a few specimens in depressed protected areas of the shell (see Pl. 6, fig. 27).

The form of Ladogioides asmenista (Crickmay) of intermediate width here illustrated on Plate 7, figures 1-6, bears some resemblance to the form designated as Ladogioides sp. nov. by Raasch in Maurin and Raasch (1972, Pl. 10, figs. 1-4) from their Assemblage 4 at Kakwa Lake, British Columbia. Ladogioides asmenista is distinguished from the Kakwa Lake form by attaining a much smaller size at maturity, in being less rotund, having a less inflated umbo and more pointed pedicle beak, and in having a median sulcus on the pedicle valve that is confined to the anterior quarter rather than the anterior half of the valve.

Occurrences. The type specimens of Ladogioides asmenista (Crickmay, 1963, p. 10) are recorded from the west bank of Athabasca River in township 97 where beds of the Calumet Member of the Waterways Formation are exposed. From this same locality this species was recorded as Pugnoides sp. E of Norris (1963, p. 29, fig. 8).

On Birch River L. asmenista has been collected from units II, IV and VI of the Waterways Formation at stations 12NB, 11NB, 22NB and 14NB (see Fig. 2), but occurs most abundantly in the upper part of unit IV at station 22NB.

Ladogioides sp. nov. is recorded by Maurin and Raasch (1972, Pl. 3 and explanation of Pl. 10) from about the middle of their Assemblage 4 in their DFR4 unit in the upper part of the Flume Formation at Kakwa Lake, British Columbia.

Figured specimens. GSC 63030, 63031 and 63032 from GSC locality C-74192.

Order ATRYPIDA Rzhonsnitskaya, 1960

Family ATRYPIDAE Gill, 1871

Subfamily VARIATRYPINAE Copper, 1979

Genus Variatrypa Copper, 1979, p. 292

Subgenus Variatrypa (Radiatrypa) Copper, 1979, p. 293

Type species. Atrypa gregeri Rowley, 1900, p. 264, Pl. 5, figs. 9-11.

Variatrypa (Radiatrypa) clarkei (Warren)

Plate 7, figures 13-20

1944 Atrypa clarkei WARREN, p. 122, Pl. 3, figs. 10-12.

1956 Atrypa clarkei Warren, WARREN and STELCK, Pl. 12, figs. 5-7.

1979 Variatrypa (Radiatrypa) clarkei (Warren), COPPER, p. 293, Pl. 5, figs. 7-11.

in press Desquamatia (Variatrypa) clarkei (Warren), NORRIS in NORRIS and UYENO, p. 000, Pl. 5, figs. 34-48, Pl. 6, figs. 10-12.

Material. Represented by about 14 specimens most of which are incomplete.

Dimensions (in mm).

Specimen	A	B	"Atrypa" clarkei Warren (1944, p. 123) Dv880	Dv881	Dv882	"Atrypa" gregeri Rowley (largest of 9 topotypic specimens)
GSC No.	63033	63034				
GSC locality	C-74171	C-74171				
Length of pv (Lpv)	14.4	27.5	25.0	22.0	19.0	19.4
Length of bv (Lbv)	13.8	26.7				
Width (W)	13.6	23.4	27.0	24.0	22.0	19.8
Depth of shell (D)	6.9	15.4				11.9
Hinge line length	10.0	19.8				15.2
Hinge angle (in degrees)	150	142				137
Depth of sulcus at anterior margin	1.3	3.6				nil
Ratio: W/Lpv	0.94	0.85	1.08	1.09	1.16	1.02
Ratio: D/Lpv	0.48	0.56	0.48	0.55	0.58	0.61

Remarks. Copper (1979, p. 293) erected a new subgenus, Variatrypa (Radiatrypa), and designated Atrypa gregeri Rowley (1900, p. 264, Pl. 5, figs. 9-11) as the type species. This species has been well described and illustrated by Branson (1922, p. 97, Pl. 18, figs. 7-9) who indicated that it is a rare form in the Snyder Creek Shale of Callaway County, Missouri. Amongst the species assigned to the subgenus Variatrypa (Radiatrypa), Copper (1979, p. 293) included Atrypa clarkei Warren (1944, p. 122-123, Pl. 3, figs. 10-12) from the Waterways Formation of northeastern Alberta. The morphological differences between the species "Atrypa" gregeri and "Atrypa" clarkei as seen in topotypic material from Missouri and large collections from the Waterways Formation of northeastern Alberta casts doubt on Copper's (1979) classification scheme as it pertains to these two species. Although both are very finely costate, the shape, particularly the almost equally biconvex lateral profile of "Atrypa" gregeri is analogous to that of the genus Pseudogruenewaldtia as described by Rzhonsnitskaya (1960b) whereas, the lateral profile of "Atrypa" clarkei is very unequally biconvex and is more similar to that of a typical Atrypa. However, as the Waterway's brachiopods are in the process of being systematically studied by Norris, further detailed comment will be provided at a later date. A form that does closely resemble "Atrypa" gregeri Rowley from Missouri, that occurs in the Moberly Member of the Waterways Formation on Athabasca River, has been illustrated by Warren and Stelck (1956, Pl. 13, figs. 13-15), as a variety of Atrypa clarkei Warren. The form they (Warren and Stelck, 1956, Pl. 13, figs. 1-3) designated as Atrypa gregeri Rowley is possibly a young form of "Atrypa" clarkei.

Occurrences. Warren (1944, p. 123) indicated that the syntypes Dv. 880-882 of "Atrypa" clarkei were from the Waterways Formation on the Clearwater and Athabasca Rivers. In a later publication, Warren and Stelck (1956, explanation of Pl. 12) indicated that syntype Dv. 880 of "Atrypa" clarkei was collected from the Waterways Formation on Athabasca River, near Fort McMurray, Alberta, which would place it within the Moberly Member of the Waterways Formation. Norris (1963, Figs. 6, 8) showed that Variatrypa (Radiatrypa) clarkei (Warren) ranges throughout the Firebag, Calumet, Christina and Moberly Members of the Waterways Formation, but is probably most abundant in the Moberly Member.

On Birch River this species and closely related variants occur in units I, II and IV of the Waterways Formation represented at stations 8NB, 12NB, 10NB, 18NB and 20NB.

Figured specimens. GSC 63033 and 63034 from GSC locality C-74171.

Genus Pseudoatrypa Copper 1973, p. 492

Type species. Atrypa devoniana Webster, 1921, p. 19 [due to a printing error, the illustrations for this paper were omitted; see Fenton and Fenton, 1935].

Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook)

Plate 7, figures 21-27

1938 Atrypa blackhawkensis STAINBROOK, p. 239, Pl. 30, figs. 2, 3, 6, 7.

Material. Represented by six specimens almost all of which are incomplete.

Dimensions (in mm).

Specimen	A	B	"Atrypa" blackhawkensis Stainbrook, 1938, p. 239 Holotype	Paratype	Paratype
GSC No.	63035	63036			
GSC locality	C-74193	C-74185			
Length of pv (Lpv)	16.9	ca. 18.2	20.1	19.6	26.7
Length of bv (Lbv)	15.8	ca. 17.8	-	-	-
Width (W)	16.4	21.3	23.8	20.4	28.4
Depth of shell (D)	8.2	11.5	9.5	11.3	16.4
Hinge line length	12.1	ca. 14.9	-	-	-
Hinge angle (in degrees)	155	-	-	-	-
Depth of sulcus at anterior margin	0.8	-	-	-	-
Ratio: W/Lpv	0.97	1.17	1.18	1.04	1.06
Ratio: D/Lpv	0.49	0.63	0.47	0.59	0.61

Remarks. The generic assignment of this relatively small medium costate atrypid form is uncertain. Species from North America assigned by Copper (1973, p. 492) to the genus Pseudoatrypa include Atrypa devoniana Webster (1921), A. hackberryensis Fenton and Fenton (1924), A. bremerensis Stainbrook (1938), and ?A. missouriensis Miller (1894).

Occurrences. Pseudoatrypa? blackhawkensis is recorded by Stainbrook (1938, p. 239) from the topmost beds of the section at Waterloo, within the Coralville Member of the Cedar Valley Formation of Iowa. Klapper (in Klapper et al., 1971, p. 298, fig. 3) has indicated that the upper Coralville Member of the Cedar Valley Formation of southeastern Iowa contains the conodont Pandorinellina insita Fauna.

On Birch River this form occurs in units IV and V of the Waterways Formation at stations 18NB and 21NB.

Figured specimens. GSC 63035 from GSC locality C-74193, and GSC 63036 from GSC locality C-74185.

Genus Pseudoatrypa Copper, 1973

Type species. Atrypa devoniana Webster, 1921, p. 19 [due to a printing error illustrations for this paper were omitted; see Fenton and Fenton, 1935].

Pseudoatrypa sp. cf. P. gigantea (Webster)

Plate 7, figures 28-38

1921 Atrypa gigantea WEBSTER, p. 16

1935 Atrypa gigantea Webster, FENTON and FENTON, p. 376.

1938 Atrypa gigantea Webster, STAINBROOK, p. 233, Pl. 30, figs. 5, 13, 17.

1956 Atrypa cf. gigantea Webster, WARREN and STELCK, Pl. 11, figs. 16-18.

Material. Represented by about 10 fragmentary specimens.

Dimensions (in mm).

Specimen	A	B	C	Atrypa gigantea Webster, Stainbrook (1938, p. 234) Hypotype	Hypotype
GSC No.	63037	63038	63039		
GSC Locality	C-74172	C-81282	C-81282		
Length of pv (Lpv)	46.9	19.9	38.5	50.0	39.0
Length of bv (Lbv)	43.4	19.1	38.7	-	-
Width (W)	42.6	20.4	39.4	58.7	45.5
Depth of shell (D)	22.6	8.8	22.9	27.6	21.8
Hinge line length	25.9	14.5	ca. 29.0	-	-
Hinge angle (in degrees)	159	154	152	-	-
Depth of sulcus at anterior margin	5.8	nil	3.2	-	-
Ratio: W/Lpv	0.91	1.03	1.02	1.17	1.16
Ratio: D/Lpv	0.48	0.44	0.59	0.55	0.55

Remarks. On such features as large size, shape of shell, relatively flat pedicle valve and highly inflated brachial valve this form closely resembles Atrypa gigantea Webster as described and illustrated by Stainbrook (1938, p. 233-234, Pl. 30, figs. 5, 15, 17) from the Cedar Valley Formation of Iowa. The form from Birch River is slightly more finely costate than the Iowa form, but is identical to the form indicated as Atrypa cf. gigantea Webster by Warren and Stelck (1956, Pl. 11, figs. 16-18) that occurs abundantly in beds of the Calumet Member of the Waterways Formation outcropping on lower Athabasca River and upper Clearwater River. Two well preserved specimens from the lower Athabasca River locality are here illustrated for comparison.

In shape, large size and costation, the form designated as Atrypa scutiformis Stainbrook by Raasch in Maurin and Raasch (1972, Pl. 6, figs. 1-4) from the top of their Assemblage 3 at Kakwa Lake, British Columbia, somewhat resembles the form from Birch River. The latter form appears to attain a much larger size at maturity, as well as having a more inflated brachial valve and a more pronounced planoconvex lateral profile.

Occurrences. Pseudoatrypa gigantea (Webster) is recorded by Stainbrook (1938, p. 234) from the Neatrypa waterlooensis Zone of the upper Rapid Member of the Cedar Valley Formation of Iowa. This interval is undated by conodonts but is between beds assigned to the Schmidtognathus hermanni-Polygnathus cristatus Zone and the Pandorinellina insita Fauna (Klapper, in Klapper et al., 1971, p. 298, fig. 3).

The "Atrypa" cf. gigantea Webster illustrated by Warren and Stelck (1956, Pl. 11, figs. 16-18) is recorded from the Waterways Formation at McMurray, Alberta. Norris (1963,

Figs. 6, 8) noted this form as occurring abundantly in the Calumet Member and less abundantly in the Moberly Member of the Waterways Formation of the Clearwater-Athabasca Rivers outcrop belt.

Atrypa scutiformis Stainbrook is recorded by Raasch in Maurin and Raasch (1972, explanation of Pl. 6) from the top of Assemblage 3 of their DFR3 unit (sample 497), about the middle of the Flume Formation at Kakwa Lake, British Columbia.

On Birch River, Pseudoatrypa sp. cf. P. gigantea (Webster) has been recovered from units IV and VII of the Waterways Formation at stations 11NB, 22NB and 14NB.

Figured specimens. GSC 63037 from GSC locality C-74172; and GSC 63038 and 63039 from GSC locality C-81282. The latter two illustrated specimens are from unit 1 of the Calumet Member of the Waterways Formation measured at the west end of outcrop, west bank of Athabasca River 0.24 km (0.15 mile) below the mouth of Pierre Creek, or 93 km (58 miles) below Fort McMurray.

Family ATRYPIDAE Gill, 1971

Subfamily SPINATRYPINAE Copper, 1979, p. 297

Genus Spinatrypina Rzhonsnitskaya, 1964

Type species. Spinatrypina margaritoides Rzhonsnitskaya, 1964, p. 101-103, figs. 1-8.

Subgenus Spinatrypina (Exatrypa) Copper, 1967b, p. 123

Type species. Terebratulites explanatus Schlotheim, 1820, p. 263.

Spinatrypina (Exatrypa) sp. A

Plate 8, figures 1-6

Material. One incomplete specimen.

Dimensions (in mm).

Specimen			"Atrypa" albertensis Warren (1944, p. 118) Syntype	Syntype	Syntype
GSC No.	63040	63041	-	-	-
GSC locality	C-74171	C-81277	-	-	-
Length of pv (Lpv)	15.0	20.7	20.0	18.0	17.0
Length of bv (Lbv)	12.8	19.3	-	-	-
Width (W)	18.3	20.8	21.0	19.0	18.0
Depth of shell (D)	-	10.2	10.0	11.0	9.0
Hinge line length	-	14.9	-	-	-
Hinge angle (in degrees)	-	153	-	-	-
Ratio: W/Lpv	1.22	1.00	1.05	1.05	1.06
Ratio: D/Lpv	-	0.49	0.5	0.61	0.53

Remarks. Spinatrypina (Exatrypa) sp. A is distinguished from the closely related species, S. (E.) albertensis (Warren, 1944, p. 118-119, Pl. 3, figs. 13-15; Warren and Stelck, 1956, Pl. 12, figs. 26-28), by its broader outline, much thinner lateral profile, a less sloping hinge line, and a less incurved pedicle beak. This new species will be formally described by A.W. Norris in a forthcoming paper on the brachiopods of the Waterways Formation of northeastern Alberta.

Spinatrypina (Exatrypa) sp. A is very closely similar to a form designated as Spinatrypa albertensis (Warren) by Raasch in Maurin and Raasch (1972, Pl. 8, figs. 20-23) from near the top of the Flume Formation at Kakwa Lake, British Columbia. It appears to differ from the Kakwa Lake form by attaining a larger size at maturity, having a smaller and lesser inflated pedicle umbo, and by having a more weakly developed sulcus at the anterior median margin of the pedicle valve.

Occurrences. The closely related species, Spinatrypina (Exatrypa) albertensis, is recorded by Warren (1944, p. 119) and Warren and Stelck (1956, explanation of Pl. 12) from the Waterways Formation on Athabasca River near Fort McMurray which would place it within the Moberly Member. Norris (1963, Figs. 6, 8) noted that S. (E.) albertensis occurs most abundantly in the Calumet Member and sparingly in the Moberly Member of the Waterways Formation in the Athabasca-Clearwater Rivers outcrop belt.

The form designated as Spinatrypa albertensis (Warren) by Raasch in Maurin and Raasch, (1972, Pl. 8, figs. 20-23) is recorded from the top of Assemblage 4 near the top of the Flume Formation (sample 504) at Kakwa Lake, British Columbia.

Spinatrypina (Exatrypa) sp. A occurs in unit III of the Waterways Formation at station 10NB on Birch River. A much better preserved comparative specimen here illustrated of this new species is from the Calumet Member of the Waterways Formation at station 103NB-79 at the west end of the outcrop on the west bank of Athabasca River 0.56 km (0.35 mile) below the mouth of Pierre River, or 93 km (58 miles) below Fort McMurray (see Plate 5).

Figured specimens. GSC 63040 from GSC locality C-74171, and GSC 63041 from GSC locality C-81277.

Family ATHYRIDIDAE M'Coy, 1844

Subfamily ATHYRIDINAE M'Coy, 1844

Genus Athyris M'Coy, 1844, p. 146

Type species. Terebratula concentrica von Buch, 1834, p. 123; SD King, 1850, p. 136 [=Cliothyris Aggassiz, 1846, p. 90; Spirithyris Quenstedt, 1868, p. 30; Euthyris Quenstedt, 1869, p. 442 (type, T. concentrica); Cleidothyris Paetel, 1875, p. 45].

Athyris parvula Whiteaves

Plate 8, figures 7-12

1891 Athyris parvula WHITEAVES, p. 228-229, Pl. 32, figs. 4, 5 and 5a.

Material. Represented by a single complete specimen.

Dimensions (in mm).

Specimen	A	Athyris parvula Whiteaves (1891, p. 228) No. 1 (Pl. 32, fig. 4)	No. 2 (Pl. 32, figs. 5, 5a)
GSC No.	63042	–	–
GSC locality	C-74175	-	-
Length of pv (Lpv)	10.2	9.0	8.25
Length of bv (Lbv)	9.5	-	-
Width (W)	9.6	9.5	8.0
Depth of shell (D)	6.3	6.0	5.0
Hinge angle (in degrees)	113	-	-
Ratio: W/Lpv	0.94	1.05	0.97
Ratio: D/Lpv	0.62	0.67	0.61

Remarks. Specimen at hand from Birch River is closely similar in shape and size to Athyris parvula as figured by Whiteaves (1891, Pl. 32, figs. 5, 5a) as specimen no. 2. Specimen No. 1 of Whiteaves (1891, Pl. 32, fig. 4) is slightly larger, broader, and has a weak fold on the brachial valve.

Athyris parvula appears to be closely comparable to Athyris simplex Stainbrook and Ladd (1926, p. 359, Pl. 1, figs. 12-14) from the State Quarry Limestone of Iowa. Judging from the illustrations by Stainbrook and Ladd (1926, Pl. 1, figs. 12, 13), Athyris simplex encompasses relatively narrow and broad forms.

Athyris parvula is easily distinguished from Athyris occidentalis Whiteaves (1891, p. 227-228, Pl. 32, figs. 3, 3a, 3b) from younger beds of the Waterways Formation by its smaller size and almost smooth shell. Athyris occidentalis is a distinctly coarsely plicate form.

Some of the forms designated as Athyris vittata Hall by McCammon (1960, p. 62-63, Pl. 11, figs. 1a-c; not 2a-c, and 3) from the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation outcropping on Rose (Bush) Island in Swan Lake, Manitoba, resemble Athyris parvula from Birch River in lacking a fold and sulcus, but differ in attaining a larger size at maturity.

From the closely comparable Athyris randalia Stainbrook as illustrated by Raasch in Maurin and Raasch (1972, Pl. 10, figs. 5-7) from the upper Flume Formation at Kakwa Lake, British Columbia, Athyris parvula differs in having a more slender umbo and pointed pedicle beak, a less inflated pedicle valve, and lacks the shallow median sulcus on the pedicle valve. In contrast, also, Athyris parvula appears to have a very weakly developed median sulcus on the brachial valve.

Occurrences. The type specimens of Athyris parvula are recorded by Whiteaves (1891, p. 228) from 5.8 km (3 miles) below the Calumet, and 48 km (30 miles) below Red River (=MacKay River). The first locality clearly refers to the outcrop of the Calumet Member of the Waterways Formation on the west bank of Athabasca River immediately below the mouth of Pierre River. The second locality, judging by the associated fauna listed by Whiteaves (1891, p. 248), probably refers to the outcrop of the Firebag Member of the Waterways Formation on the east bank of Athabasca 2.4 km (1.5 miles) below Eymundson Creek.

The single specimen of Athyris parvula from the Birch River was recovered from unit II of the Waterways Formation at station 12NB.

The closely comparable Athyris simplex Stainbrook and Ladd (1926, p. 359) occurs in the upper part of the State Quarry Limestone of Iowa associated with the conodont Pandorinellina insita Fauna (Klapper, in Klapper et al., 1971, fig. 3).

In Manitoba, the Athyris vittata Hall occurring in the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation is associated with the conodont Pandorinellina insita Fauna (Uyeno, in Norris et al., in press).

Athyris randalia Stainbrook is recorded by Raasch (Maurin and Raasch, 1972, explanation of Pl. 10) from their unit DFR4 (Assemblage 4) in sample 500B from the lower part of the upper Flume Formation at Kakwa Lake North, British Columbia.

Figured specimen. GSC 63042 from GSC locality C-74175.

Family NUCLEOSPIRIDAE Davidson

Genus Nucleospira Hall, 1859, p. 24

Type species. Spirifer ventricosus Hall, 1857, p. 57.

Nucleospira? sp.

Plate 8, figures 13-17

Material. Represented by a single abraded specimen.

Dimensions (in mm).

Specimen	A
GSC No.	63045
GSC locality	C-74192
Length of pv (Lpv)	13.9
Length of bv (Lbv)	13.5
Width (W)	14.0
Depth of shell (D)	7.5
Hinge angle (in degrees)	132
Ratio: W/Lpv	1.01
Ratio: D/Lpv	0.56

Remarks. Features such as small size, almost circular outline, small incurved pedicle beak, low pedicle interarea, concentric growth lines, a long thin medium septum present in each valve, are all suggestive of the genus Nucleospira.

The present form appears to be closely similar in shape and size to the Nucleospira sp. described and illustrated by

McCammon (1960, p. 61-62, Pl. 10, fig. 10) from beds of the Souris River Formation at locality 9 along the Camperville Road, Manitoba.

Occurrence. The single specimen of Nucleospira? sp. is from unit IV of the Waterways Formation at station 22NB on Birch River.

Figured specimen. GSC 63045 from GSC locality C-74192.

Superfamily CYRTINACEA Frederiks, 1912

[nom. transl. Johnson, 1966, (ex CYRTINAE Frederiks, 1912)]

Family CYRTINIDAE Frederiks, 1912

Genus Tecnocyrtina Johnson and Norris, 1972, p. 566

Type species. Cyrtina billingsi Meek, 1868.

Tecnocyrtina sp. A

Plate 8, figures 18-24

Material. Represented by approximately 10 specimens most of which are incomplete.

Dimensions (in mm).

Specimen	A	B
GSC No.	63043	63044
GSC locality	C-74177	C-74172
Length of pv (Lpv)	10.7	10.1
Length of bv (Lbv)	8.8	8.3
Width (W)	11.3	10.2
Depth of shell (D)	9.7	7.4
Hinge line length	10.5	9.0
Depth of sulcus at anterior margin	2.0	2.3
Ratio: W/Lpv	1.06	1.01
Ratio: D/Lpv	0.91	0.73

Remarks. The form from Birch River has four costae, two of which are very weak, on the sulcus of the pedicle valve, and three on the fold of the brachial valve. In the weak development of costae on the fold and sulcus this form is somewhat similar to Tecnocyrtina missouriensis (Swallow) from the Callaway Formation of Missouri (Branson, 1922, p. 108, Pl. 19, figs. 1-4; Johnson and Norris, 1972, Pl. 1, figs. 5-18), and from the Cedar Valley Formation of Iowa (Stainbrook, 1943b, p. 447, Pl. 70, figs. 6-11).

The bordering furrows on each side of the fold on the brachial valve of the Birch River form are conspicuously wider than they are on Tecnocyrtina missouriensis. Tecnocyrtina sp. A has slightly indented lateral margins and pointed, slightly extended cardinal extremities, a feature which is present also on Tecnocyrtina billingsi (Meek) and Tecnocyrtina missouriensis (Swallow) (see Johnson and Norris, 1972, Pl. 1, fig. 14, Pl. 2, fig. 9).

Like Cyrtina umbonata Hall, as described and illustrated by Stainbrook (1943b, p. 446, Pl. 70, figs. 12-21) from the Cedar Valley Formation of Iowa, the Birch River form has a pronounced median furrow in the sulcus of the pedicle valve.

A pronounced irregular median furrow in the sulcus of the pedicle valve is evident also on Cyrtina cf. triquetra Hall as illustrated by Raasch in Maurin and Raasch (1972, Pl. 9, figs. 5-7) from the base of their DFR4 unit (Assemblage 4) in the upper Flume Formation (sample 498) at Kakwa Lake, British Columbia.

Occurrences. Tecnocyrtina sp. A was collected from units II, IV and VI of the Waterways Formation at stations 12NB, 11NB, 10NB and 14NB on Birch River.

Figured specimens. GSC 63043 from GSC locality C-74177, and GSC 63044 from GSC locality C-74172.

Superfamily SPIRIFERACEA King, 1846

Family DELTHYRIDIDAE Waagen, 1883

Subfamily ACROSPIRIFERINAE Termier and Termier, 1949

Genus Eleutherokomma Crickmay, 1950, p. 219

Type species. Eleutherokomma hamiltoni Crickmay, 1950, p. 219, Pl. 36, figs. 1-3.

Eleutherokomma sp. cf. E. impennis Crickmay

Plate 8, figures 28-31

1953 Eleutherokomma impennis CRICKMAY, p. 3, Pl. 2, figs. 1-8.

1956 Eleutherokomma n. sp., WARREN and STELCK, Pl. 10, figs. 2-4.

1962 Eleutherokomma impennis Crickmay, McLAREN, NORRIS and McGREGOR, Pl. 10, figs. 18-20.

1963 Eleutherokomma aechmophora Crickmay, p. 16, Pl. 3, figs. 14-15, Pl. 11, figs. 9-13.

1971 Eleutherokomma sp. cf. E. impennis Crickmay, HARRINGTON, p. 792, Pl. 4, figs. 12-16 (not Pl. 4, figs. 1-10).

in press Eleutherokomma impennis Crickmay, NORRIS in NORRIS and UYENO, p. 00, Pl. 7, figs. 39-48, Pl. 8, figs. 1-4.

Material. Represented by approximately 10 specimens most of which are incomplete.

Dimensions (in mm).

Specimen	A	B	C	Eleutherokomma impennis Crickmay (1953, p. 3) Holotype bv	Eleutherokomma aechmophora Crickmay (1963, p. 16)
GSC No.	63047	63048	63049		
GSC locality	C-74175	C-74175	C-74175		
Length of pv (Lpv)	8.4	-	4.8 est.	7	12.0
Length of bv (Lbv)	-	6.2	-	-	-
Width (W)	14.8	11.0	8.2	13.0	21.5
Depth of shell (D)	-	-	-	-	8.5
Hinge line length	13.8	9.4	6.5	-	-
Ratio: W/Lpv	1.85	-	1.71	1.86	1.79
Ratio: D/Lpv	-	-	-	-	0.71

Remarks. Eleutherokomma impennis Crickmay (1953, p. 3, Pl. 2, figs. 1-8) and E. aechmophora Crickmay (1963, p. 16, Pl. 3, figs. 14-15, Pl. 11, figs. 9-13) were placed in synonymy under E. impennis by Norris (Norris and Uyeno, in press) because they are indistinguishable from one another and occur in essentially the same stratigraphic interval. Some of the Birch River specimens exhibit features, such as the shape of the lateral margins, that appear to be intermediate between that displayed by E. impennis and that of the succeeding Eleutherokomma jasperensis Crickmay (1953, p. 3-4, Pl. 2, figs. 9-13). However, most of the narrow, non-mucronate forms from Birch River are morphologically closer to E. impennis than they are to E. jasperensis.

A relatively narrow, non-mucronate form included in Eleutherokomma jasperensis (Warren) by Raasch (Maurin and Raasch, 1972, Pl. 9, figs. 8-11; not figs. 12-16) from their Assemblage 4 at Kakwa Lake, British Columbia, somewhat resembles the form here referred to as Eleutherokomma sp. cf. E. impennis Crickmay from Birch River. The latter form has a flaring, trumpet-shaped sulcus on the pedicle valve in contrast to an evenly V-shaped sulcus on the form from Kakwa Lake.

Occurrences. Eleutherokomma impennis Crickmay and its synonym, Eleutherokomma aechmophora Crickmay, occur typically in the Firebag Member and equivalent rocks of the Waterways Formation of northeastern Alberta. Forms recorded as E. sp. cf. E. impennis and E. sp. cf. E. aechmophora range upward through the succeeding Calumet into the Christina Member of the Waterways Formation (Norris, in Norris and Uyeno, in press).

The relatively narrow, non-mucronate form of Eleutherokomma jasperensis is recorded by Raasch (Maurin and Raasch, 1972, explanation of Pl. 9) from their Assemblage 4 (samples 499 and 500) from the lower part of the unit DFR4 in the upper part of the Flume Formation at Kakwa Lake North, British Columbia.

On Birch River Eleutherokomma sp. cf. E. impennis was collected from units II, IV and VI of the Waterways Formation at stations 12NB, 10NB, 11NB and 14NB.

Figured specimens. GSC 63047, 63048 and 63049 from GSC locality C-74175.

Eleutherokomma sp. cf. E. jasperensis (Warren)

Plate 8, figures 32-40

1932 Spirifer jasperensis WARREN, in ALLAN, WARREN and RUTHERFORD, pars, p. 245, Pl. 2, figs. 16-17; not Pl. 2, figs. 18-21.

1953 Eleutherokomma jasperensis (Warren), CRICKMAY, p. 3, Pl. 2, figs. 9-13.

1967 Eleutherokomma jasperensis (Warren), CRICKMAY, p. 11, Pl. 1, figs. 16, 17, Pl. 4, figs. 14, 15.

1972 Eleutherokomma jasperensis (Warren), RAASCH in MAURIN and RAASCH, Pl. 9, figs. 12-17; not Pl. 9, figs. 8-11.

Material. Represented by approximately 10 specimens most of which are incomplete.

Dimensions (in mm).

Specimen	A	B	Eleutherokomma jasperensis Crickmay (1953, p. 4) Lectotype	Eleutherokomma jasperensis Crickmay (1953, p. 4) Syntype	Eleutherokomma scymnus Crickmay (1967, p. 13) pv	Eleutherokomma scymnus Crickmay (1967, p. 13) pv
GSC No.	63050	63051	-	-	-	-
GSC locality	C-74192	C-74192	-	-	-	-
Length of pv (Lpv)	7.8	-	10.0	8.5	7.0	-
Length of bv (Lbv)	6.7	6.8	-	-	-	6.0
Width (W), excluding slender cardinal extensions	14.8 est.	12.2 est.	17.0	19.4	11.0	11.0
Width, including cardinal extensions	23.8 est.	22.8 est.	-	-	-	-
Depth of shell (D)	5.0	-	-	-	-	-
Depth of sulcus at anterior margin	2.3	-	-	-	-	-
Ratio: W/Lpv	1.90	-	1.70	2.28	1.57	1.83
Ratio: D/Lpv	0.64	-	-	-	-	-

Remarks. The form from Birch River is intermediate in size attained at maturity between Eleutherokomma scymnus and E. jasperensis but is otherwise morphologically closely similar to E. jasperensis.

Occurrences. The types of Eleutherokomma jasperensis, according to Crickmay (1953, p. 4), are from the topmost bed of the Flume Formation at the Sulphur Spring just east of the bridge over Athabasca River 9.6 km (6 miles) northeast of Jasper, Alberta. At this locality it is associated with Allanella minutilla Crickmay which Warren (in Allan, Warren and Warren, 1932) originally included in "Spirifer" jasperensis. In the Bear Biltmore No. 1 well (7-11-87-17-W4M) Crickmay (1966, p. 17, 19-20) indicated the range of the Eleutherokomma jasperensis Zone to extend throughout the 27.4 m (90 feet) of the Christina Member into the lower

18.3 m (60 feet) of the overlying Moberly Member of the Waterways Formation. Crickmay (1967, p. 2) in a revision of the zonal scheme for the Moberly Member indicated that Eleutherokomma scymnus occurs in the lower part, E. jasperensis in a middle part, and E. hamiltoni in an upper part of the member. No mention was made of the previously recorded (Crickmay, 1966, p. 20) E. jasperensis and E. cf. aechmophora occurring in the underlying Christina Member.

Eleutherokomma jasperensis (Warren) is recorded by Raasch (Maurin and Raasch, 1972, explanation of Pl. 9) from their DFR4 unit (Assemblage 4) in the upper part of the Flume Formation at Kakwa Lake (samples 499 and 500) and at Wallbridge Mountain (sample 473), British Columbia.

On Birch River, Eleutherokomma sp. cf. E. jasperensis was collected from units IV, VI and VII of the Waterways Formation at stations 18NB, 22NB, 21NB, 19NB and 17NB (see Fig. 2).

Figured specimens. GSC 63050 and 63051 from GSC locality C-74192.

Superfamily SPIRIFERACEA King, 1846

Family SPINOCYRTIIDAE Ivanova, 1959

Genus Allanella Crickmay, 1953, p. 5

[=Allanaria Crickmay, 1953 (obj.)]

Type species. Spirifer allani Warren, 1944, p. 123.

Allanella minutilla Crickmay

Plate 8, figures 25-27

1932 Spirifer jasperensis WARREN, in ALLAN, WARREN and RUTHERFORD, part, p. 245, Pl. 2, figs. 18-21 (not Pl. 2, figs. 16, 17).

1953 Allanella minutilla CRICKMAY, p. 7, Pl. 1, figs. 12-22.

1967 Acutatheca (Minutilla) minutilla (CRICKMAY), p. 10, Pl. 2, figs. 45, 46.

1972 Allanella minutilla Crickmay, RAASCH in MAURIN and RAASCH, Pl. 9, figs. 19-20.

Material. Represented by about 8 specimens all of which are incomplete.

Dimensions (in mm).

Specimen	A	Allanella minutilla Crickmay (1953, p. 7) Holotype	Allanella allani (Warren) Crickmay (1953, p. 6) Lectotype
GSC No.	63046	–	–
GSC locality	C-74177	-	-
Length of pv (Lpv)	9.3	9.5	16.5
Length of bv (Lbv)	-	-	-
Width (W)	10.9	12.0	19.0
Depth of shell (D)	-	7.5	10.5
Hinge line length	9.9	-	-
Ratio: W/Lpv	1.17	1.26	1.15
Ratio: D/Lpv	-	0.79	0.63

Remarks. The lateral slopes of the pedicle valve in the specimen at hand bears seven fairly strong round-topped costae. The form from Birch River differs slightly from the type specimens of Allanella minutilla as described and illustrated by Crickmay (1953, p. 7, Pl. 1, figs. 13-22) in having a less inturned pedicle interarea and a shallower and flatter-bottomed sulcus on the pedicle valve.

The close similarity in shape and micro-ornament of Allanella minutilla Crickmay and Allanella allani (Warren) suggests that they are very closely related and are here considered to be species of the same genus. Crickmay (1967, p. 10, 13) assigned them to different genera, and this seems highly questionable. The latter species, that is Allanella allani, attains a larger size at maturity and occurs in stratigraphically younger beds.

Occurrences. The types of Allanella minutilla are from the topmost beds of the Flume Formation, associated with the primary types of Eleutherokomma jasperensis (Warren), at Sulphur Spring just east of the bridge over Athabasca River 9.6 km (6 miles) northeast of Jasper, Alberta (Crickmay, 1967, p. 11). It is recorded also from the lowest beds of the Moberly Member on Clearwater River, 8 km (5 miles) east of Waterways, Alberta, where it is also associated with Eleutherokomma jasperensis (Warren) (Crickmay, 1967, p. 12).

Raasch (Maurin and Raasch, 1972, Pl. 9, figs. 19-20) recorded this species in sample 537 from about the middle of their unit DFR4 (Assemblage 4) in the upper part of the Flume Formation, Cecilia Lake South, British Columbia.

On Birch River Allanella minutilla was collected from units I, IV and VI of the Waterways Formation at stations 8NB, 20NB, 14NB and 15NB.

Figured specimens. GSC 63046 from GSC locality C-74177.

Suborder TEREBRATULIDINA Waagen, 1883

Superfamily DIELASMATACEA Schuchert, 1913

Family CRANAENIDAE Cloud, 1942

Subfamily CRANAENINAE Cloud, 1942

Genus Cranaena Hall and Clarke, 1893, p. 297

[=Eunella Hall and Clarke, 1893, p. 290; Cranaenella Fenton and Fenton, 1924, p. 129]

Type species. Terebratula romingeri Hall, 1863, p. 48; OD.

Cranaena sp.

Plate 8, figure 41

Material. Represented by a single incomplete pedicle valve.

Dimensions (in mm).

		Cranaena iowensis (Calvin) (Stainbrook, 1941, p. 44-45)				
Specimen	A	Holotype	Hypotype	Hypotype	Hypotype	Large broken specimen
GSC No.	63052	-	-	-	-	-
GSC locality	C-74177	-	-	-	-	-
Length of pv (Lpv)	28.0 est.	24.6	24.8	23.1	22.3	36.0
Width (W)	22.0 est.	21.6	22.3	22.3	21.6	27.0
Ratio: W/Lpv	0.79	0.88	0.90	0.97	0.97	0.75

Remarks. The incomplete specimen from Birch River is comparable in shape and relative large size to Cranaena iowensis (Calvin) as described and illustrated by Stainbrook (1941, p. 44-45, Pl. 7, figs. 1-5, text-fig. 8) from Iowa, and by Branson (1922, p. 95-96, Pl. 20, figs. 20-22) from Missouri.

A similar large form designated as Cranaena cf. iowensis (Calvin) by McCammon (1960, p. 63, Pl. 11, fig. 4) occurs in the Micritic limestone beds of the Point Wilkins Member of the Souris River Formation of Manitoba (Norris et al., in press).

Occurrences. On Birch River this form occurs in one sample from unit VI of the Waterways Formation at station 14NB. It appears to be an exceedingly rare component of the fauna from Birch River.

In Iowa, Cranaena iowensis (Calvin) is recorded by Stainbrook (1941, p. 45) from the Cranaena iowensis Zone of the Coralville Member of the Cedar Valley Formation. This zone is within an interval undated by conodonts, above beds assigned to the lower Schmidtognathus hermanni-Polygnathus cristatus Zone and below beds assigned to the Pandorinellina insita Fauna (Klapper, in Klapper et al., 1971, Fig. 3).

In Missouri, C. iowensis is recorded by Branson (1922, p. 96) from the Callaway Limestone in Callaway County.

In Manitoba, the Cranaena sp. cf. C. iowensis (Calvin) occurring in the Point Wilkins Member of the Souris River Formation is associated with the conodont Pandorinellina insita Fauna (Uyeno, in Norris et al., in press).

Figured specimen. GSC 63052 from GSC locality C-74177.

CONODONTA

Genus Ancyrodella Ulrich and Bassler, 1926

Type species. Ancyrodella nodosa Ulrich and Bassler, 1926.

Ancyrodella rotundiloba rotundiloba (Bryant)

Plate 9, figures 1-5, 8, 9, 16-21, 28, 29

Polygnathus rotundilobus Bryant, 1921, p. 26-27, Pl. 12, figs. 1-6, Text-fig. 7 (Pa).

Ancyrodella rotundiloba rotundiloba (Bryant), Ziegler in Ziegler, ed., 1973, p. 29-31, Ancyro Pl. 1, figs. 1, 2 (Pa); Mouravieff, 1974, Pl. 1, figs. 4, 5, 8 (Pa); Druce, 1975, p. 62-64, Pl. 9, figs. 1, 2, 5-7 only (fig. 4=A. rotundiloba alata? Glenister and Klapper), Pl. 10, figs. 1-3, Pl. 12, fig. 1, Pl. 71, fig. 8 (Pa); Garcia-Lopez, 1976, Pl. 2, figs. 2-4 (Pa); Baliński, 1979, p. 75, Pl. 20, figs. 6, 7 (Pa); Klapper and Johnson, 1980, p. 447, Table 13.

Ancyrodella rotundiloba n. subsp. A Uyeno, 1967, p. 5, Pl. 1, figs. 1, 3, 6 (Pa); Uyeno, 1974, p. 25-26, Pl. 2, figs. 1, 4, 6-9 (Pa).

Ancyrodella rotundiloba alata Glenister and Klapper, Druce, 1975, p. 64-65, Pl. 11, figs. 2, 3 only (fig. 1=A. rotundiloba alata; fig. 4=probably A. rotundiloba alata, but lower surface features not illustrated) (Pa).

Remarks. Uyeno (1967, p. 5; 1974, p. 25-26) assigned the form with extremely coarse nodes on the upper surface of the platform to a new, but unnamed, subspecies. Only those specimens with similar ornamentation were recovered from the Birch River sections. The nodose form differs from those originally described and illustrated from the North Evans Limestone (the "conodont bed") of New York (Bryant, 1921), in exhibiting relatively coarser and fewer nodes on the upper platform surface. Subsequently to Uyeno's (*ibid.*) studies, others have illustrated similar nodose specimens that occur in close association with a more "typical" form (Mouravieff, 1974; Garcia-Lopez, 1976; Baliński, 1979), and the two forms are now considered to fall within the concept of the nominate subspecies. This synonymy was suggested earlier by Druce (1975, p. 63).

Figured specimens. GSC 63054 to 63060.

Ancyrodella rotundiloba binodosa Uyeno

Plate 9, figures 22-24

Ancyrodella rotundiloba binodosa Uyeno, 1967, p. 4-5, Pl. 1, figs. 2, 4, 5 (Pa); Ziegler in Ziegler, ed., 1973, p. 35-36, Ancyro Pl. 1, fig. 4 (Pa); Uyeno, 1974, p. 24-25, Pl. 1, figs. 2, 4-6, Pl. 2, figs. 2, 3, 5 (Pa); Mouravieff, 1974, Pl. 1, figs. 1, 3 (Pa); Bultynck, 1975, p. 17-18, Pl. 1, figs. 1-3 (Pa); Garcia-Lopez, 1976, Pl. 2, fig. 1 (Pa); Ziegler and Klapper in Ziegler, Klapper and Johnson, 1976, Table 13; Klapper and Johnson, 1980, p. 447, Table 13.

Remarks. Only two specimens that are clearly assignable to Ancyrodella rotundiloba binodosa were recovered in this study. Some specimens are morphologically transitional to the nominate subspecies, in exhibiting on the upper platform surface additional and smaller nodes in association with the characterisitc two large, principal nodes. One of these is illustrated on Plate 9, figures 8, 9. Similar specimens were recovered from the Waterways Formation in northeastern and central Alberta (Uyeno, 1974, p. 25). Mouravieff (1974, Pl. 1, fig. 2) illustrated a transitional form which originated in the "zone des Monstres, F2a" of Belgium. The "Frasnes" specimens illustrated by Bultynck (1975, Pl. 1, figs. 1-3) also approach the transitional form. An occurrence of a single transitional specimen was reported from the lower part (level K) of the "Schistes" de Beaulieu at Ferques, Boulannais region, France (Bultynck in Brice et al., 1976, Table 4).

The subspecies was reported for the first time from Australia by Druce (1975, p. 65-66), in the Sadler Formation of the Canning Basin. Unfortunately the single specimen was not illustrated. Druce [1976, p. 66, Fig. 15(2)] considered the derivation of A. rotundiloba binodosa from "Spathognathodus" swanhillensis Pollock. According to Pollock's information (see Uyeno, 1974, p. 25), however, the latter form co-occurs with A. rotundiloba binodosa in the Calumet Member of the Waterways Formation, and may possibly range higher into the Moberly Member. The similarity in morphological features and stratigraphic range suggests that the two taxa are synonymous (see Ziegler in Ziegler, ed., 1973, p. 35; Uyeno, 1974, p. 24).

Bultynck (in Brice et al., 1976, p. 141) considered Ancyrodella binodosa as a separate and autonomous species and not as a subspecies of A. rotundiloba. The occurrence of transitional specimens noted above strongly suggests affinity with A. rotundiloba, however, and the taxon is therefore retained within the concept of the latter, at least for the present.

Figured specimen GSC 63067.

Genus Elsonella Youngquist, 1945

Type species. Elsonella prima Youngquist, 1945.

Elsonella rhenana Lindström and Ziegler

Plate 10, figures 33 and 34

Elsonella rhenana Lindström and Ziegler, 1966, p. 212-216, Pls. 1, 2 (falcodontan, lippertiform, angulodontan, diplododellan); Uyeno, 1979, p. 249, Pl. 2, fig. 7 (falcodontan).

Remarks. The four different morphotypes originally assigned to Elsonella rhenana by Lindström and Ziegler (1966, p. 212-216) all feature a peculiar granular surface, and constitute a part of an apparatus. Three of these morphotypes were recovered from the Ramparts Formation at Powell Creek, western District of Mackenzie (Uyeno, 1979, p. 249).

In the Birch River collection only two morphotypes are present, the lippertiform and falcodontan. The latter is somewhat different from those illustrated by Lindström and Ziegler (1966, Pl. 1, figs. 1-3) and by Uyeno (1979, Pl. 2, fig. 7) in exhibiting a shorter, less prominent posterior process. Both morphotypes exhibit the characteristic granular surface and a ridge parallel to the lower margin.

Figured specimens. GSC 63086 and 63087.

Genus "Enantiognathus" Mosher and Clark, 1965

Type species. "Apatognathus" inversus Sannemann, 1955

"Enantiognathus" lipperti (Bischoff)

Apatognathus lipperti Bischoff, 1956, p. 121-122, Pl. 9, figs. 27, 31.

Enantiognathus lipperti (Bischoff), Uyeno, 1974, p. 27, Pl. 6, fig. 9.

Remarks. "Enantiognathus" lipperti is a form-species and hence the generic term is placed in quotation marks (inverted commas). The apparatus to which it belongs is as yet unknown.

The single Birch River specimen has the alternation in the size of the denticles on the two processes, a feature that is characteristic of the species.

Bischoff and Ziegler (1957, Table 4) and Ziegler (1958, Table 2) recorded the range of the species as Lower asymmetricus Zone to a position within the Upper gigas Zone. In the subsurface of Alberta it was previously recorded from the Mildred Member of the Waterways Formation and the Swan Hills Formation of the Beaverhill Lake Group [Uyeno, 1974, Table 4(b)].

Genus Icriodus Branson and Mehl, 1938

Type species. Icriodus expansus Branson and Mehl, 1938.

Remarks. That simple cone elements were actually a part of the Icriodus apparatus, as initially proposed by Klapper and Philip (1971, p. 438-439; 1972, p. 101), was questioned by Bultynck (1972, p. 72). More recently, van den Boogaard and Kuhry (1979, p. 15) have cast similar doubt for the following reasons: 1) the simple cones cannot be demonstrated to occur in pairs in the apparatus, and 2) the number of samples in which the icriodontan and simple cone elements are mutually exclusive are far greater than those in which they occur together. The latter evidence was cited earlier by Bultynck (*ibid.*) in his argument.

In this study, the icriodontan (I) elements only were recovered from 11 samples, the simple cones (S_2 elements) from only 3, and the two together from 8 samples. The screen used in the washing procedure was 200 mesh (75 microns).

Icriodus subterminus Youngquist

Plate 10, figures 1-13, 23-27

Icriodus subterminus Youngquist, 1947, p. 103, Pl. 25, fig. 14 (I); Klapper in Ziegler, ed., 1975, p. 149-150, Icriodus Pl. 3, fig. 4 (I) (includes synonymy); Weddige, 1977, p. 297-298, Pl. 3, figs. 44, 45 (I); Klapper and Johnson, 1980, Tables 12, 13, Pl. 3, figs. 13, 14 (I) (includes further synonymy); Uyeno in Norris et al., in press, Pl. 36, figs. 16-22, Pl. 37, figs. 15-21 (multielement); Uyeno in Norris and Uyeno, in press, Pl. 1, figs. 9-22, 25-27 (multielement).

Icriodus brevis brevis Stauffer, Uyeno, 1974, p. 29, 30, Pl. 6, figs. 11, 12 (I) (non fig. 3=I. expansus? Branson and Mehl); Druce, 1976, p. 112, Pl. 32, figs. 1, 2 (I).

Icriodus brevis Stauffer, Nicoll, 1977, p. 222, 225, Fig. 7 (multielement).

Remarks. Uyeno (in Norris and Uyeno, in press) assigned a set of three simple cones, designated as S_{2a}, S_{2b}, and S_{2c}, to the apparatus of Icriodus subterminus. Two of these, S_{2b} and S_{2c}, may correspond to the S_2 and M_2 elements, respectively, in an apparatus found by Nicoll (1977). The latter apparatus was recovered from a limestone nodule found in the Gogo Formation of Frasnian age, in the Canning Basin of Western Australia.

The three types of simple cones mentioned above were also recovered from the Birch River collections. All have been assigned to Icriodus subterminus, although conceivably they could belong to I. cf. I. subterminus. Since the former is much more abundant (199 I elements of I. subterminus vs. 14 of I. cf. I. subterminus), it is probable that this assignment is correct.

Figured specimens. GSC 63068 to 63072, 63076 to 63080.

Icriodus cf. I. subterminus Youngquist

Plate 10, figures 14-22

Icriodus expansus Branson and Mehl, Uyeno, 1974, p. 30, Pl. 6, fig. 2 only (I) (figs. 1, 5=I. expansus Branson and Mehl).

Icriodus nodosus (Huddle) sensu lato, Uyeno, 1974, p. 30, Pl. 6, figs. 4, 10 (I); Uyeno in Norris and Uyeno, 1972, p. 219, Pl. 3, fig. 18 (I).

Icriodus cf. I. subterminus Youngquist, Uyeno in Norris et al., in press, Pl. 37, figs. 22-27, Pl. 38, figs. 8-10, 16-21 (I); Uyeno in Norris and Uyeno, in press, Pl. 1, figs. 23, 24, 28-30 (I).

Remarks. The Birch River I elements of Icriodus cf. I. subterminus are similar to those from the Peace Point Member of the Waterways Formation of the Gypsum Cliffs area of northeastern Alberta, and described by Uyeno (in Norris and Uyeno, in press). Features in common include the elongation of lateral row denticles and, in most specimens, a low ridge on the upper surface of the spur.

Figured specimens. GSC 63073 to 63075.

Genus Mesotaxis Klapper and Philip, 1972

Type species. Polygnathus asymmetricus Bischoff and Ziegler, 1957.

?Mesotaxis asymmetrica (Bischoff and Ziegler)

Plate 9, figures 6, 7, 10, 11, 25-27

(?) Polygnathus dubius Hinde, Bischoff and Ziegler, 1957, p. 88 (Pa).

(?) Mesotaxis asymmetrica (Bischoff and Ziegler), Klapper and Philip, 1972, p. 100; Philip and McDonald, 1975, p. 100-101; van den Boogaard and Kuhry, 1979, p. 28-29.

Remarks. Two fragmentary polygnathan specimens were recovered from Unit VI, GSC loc. C-74185. Together, the posterior part of the platform of a larger specimen and the anterior half, including the free blade, of a smaller specimen, suggest an assignment to Mesotaxis asymmetrica, although this is done only questionably owing to their fragmentary nature. A similar fragmentary polygnathan specimen was recovered from the lower part of the Firebag Member of the Waterways Formation in the subsurface, in the Alberta Government Salt Well no. 1 at the interval of 146.3 to 149.4 m (480 to 490 ft) (Uyeno, 1974, p. 37, Table 4(b), GSC loc. 80264). This specimen, which was at the time assigned questionably to Polygnathus asymmetricus, and now reassigned to the multielement genus, Mesotaxis, is illustrated here on Plate 9, figure 27.

Although the correct multielement taxonomic assignment of the polygnathan element under discussion is Mesotaxis (see, e.g., Klapper, 1977, p. 48; van den Boogaard and Kuhry, 1979, p. 28-29), its reference to Polygnathus persists in the literature (see, e.g., Sandberg and Poole, 1977, p. 150, Fig. 2; Sandberg, 1979, p. 92-93, Figs. 1, 2). This continuing practice is owing to the critical role played by the species in the conodont zonation of the lower part of the Upper Devonian, as established and subsequently modified by Ziegler (1962, p. 16-20; 1971, p. 267), and which consequently has become well-ingrained. In the present study, then, the species is referred to Polygnathus when discussed in its role in biostratigraphy.

Figured specimens. GSC 63061 to 63063.

Genus Ozarkodina Branson and Mehl, 1933

Type species. Ozarkodina confluens (Branson and Mehl, 1933).

Ozarkodina brevis (Bischoff and Ziegler)

Plate 10, figures 28-32

Spathognathodus brevis Bischoff and Ziegler, 1957, p. 116-117, Pl. 19, figs. 24, 27-29 (Pa); Orchard, 1978, p. 951, Pl. 108, figs. 22-24, 27 (Pa).

Spathognathodus cf. S. brevis Bischoff and Ziegler, Uyeno, 1974, p. 42, Pl. 7, figs. 11-13, Pl. 8, figs. 4, 9 (Pa).

Ozarkodina brevis (Bischoff and Ziegler), Klapper in Perry et al., 1974, p. 1086 (no illustration; includes further synonymy); Ziegler and Klapper in Ziegler et al., 1976, Pl. 3, figs. 14-16 (Pa); Klapper in Ziegler, ed., 1977, p. 263-265, Ozarkodina Pl. 3, figs. 9, 11 (Pa); Klapper in Johnson and Klapper, 1978, p. 296, Pl. 1, figs. 11, 13, 15 (Pa, Pb); Requadt and Weddige, 1978, p. 212, Fig. 13e (Pa); Uyeno, 1979, p. 240, Pl. 2, fig. 19 (Pa); Savage and Amundson, 1979, p. 1396, Pl. 1, figs. 3-8 (Pa, Pb); Klapper and Johnson, 1980, p. 449, Tables 9-12); Uyeno in Norris et al., in press, Pl. 32, figs. 23, 24, 29-38 (multielement).

Ozarkodina aff. O. brevis (Bischoff and Ziegler), Chatterton, 1979, p. 188, Pl. 9, fig. 8 (Pa).

Remarks. The Pa element of Ozarkodina brevis has a relatively wide morphological variation, and is perhaps referable to separate morphotypes. A detailed study of this species is being planned, and only a brief treatment is given herein.

The holotype specimen (from Koppen near Rhenegge; Bischoff and Ziegler, 1957, p. 116-117; see also Ziegler et al., 1976, Table 13) exhibits a basal cavity of rectangular ("dumb-bell") outline, which is located at the extreme posterior end but protrudes beyond the posterior margin of the blade. The posteriormost denticle is the largest and is slightly inclined posteriorly. The specimens from central Oregon, illustrated by Johnson and Klapper (1978) and Savage and Amundson (1979), are of this morphotype. The reported range of this morphotype is from the Lower varcus Subzone to the Middle asymmetricus Zone (Bischoff and Ziegler, 1957, Table 4; Ziegler et al., 1976, Table 6), and its lower range may extend into the Eifelian (Uyeno in Norris et al., in press; Orchard, 1978, p. 915; Klapper and Johnson, 1980, p. 424, Table 9).

The second morphotype is the form referred to "Spathognathodus" cf. "S." brevis by Uyeno (1974). If differs from the first in possessing one, and in some specimens, two, minute denticles posteriorly of the large cusp. The basal cavity is located correspondingly farther away from the posterior margin of the blade. The Pb elements of the first and second morphotypes may also be slightly different. Most of the Waterways specimens, both from the Athabasca-Clearwater Rivers area of northeastern Alberta (Uyeno, 1974) and in the present Birch River collections, are of this morphotype. The associated conodonts in these collections are assignable to the Lower and Middle asymmetricus Zones, respectively.

There may be additional morphotypes to the two mentioned above.

Figured specimens. GSC 63081 to 63085.

Genus Pandorinellina Müller and Müller, 1957

Type species. Pandorina insita Stauffer, 1940.

Pandorinellina insita (Stauffer)

Plate 9, figures 14 and 15;
Plate 11, figures 16-18, 32-39

Pandorina insita Stauffer, 1940, p. 429, Pl. 59, figs. 23, 25 (Pa).

Pandorinellina insita (Stauffer), Klapper and Philip, 1972, p. 99 (multielement); Klapper in Ziegler, ed., 1977, p. 439, Pandorinellina Pl. 1, figs. 1-8 (multielement); Sandberg and Ziegler, 1979, p. 191-192, Pl. 7, figs. 11, 13, 14 (Pa); Klapper and Johnson, 1980, p. 450-451, Tables 12, 13; Uyeno in Norris et al., in press, Pl. 37, figs. 2-5, 25-45 (multielement).

Remarks. Sandberg and Ziegler (1979) noted certain similarities between the Pa elements of Pandorinellina insita and P. expansa Uyeno and Mason. Indeed in some specimens, in upper and lateral views, it is difficult to distinguish the two species (compare, e.g., Pl. 11, figs. 26, 27, 33, 38). The anterior one-third of the blade ("fin" of Sandberg and Ziegler, 1979, p. 191) is always offset to the right in P. expansa, whereas this is a variable feature in P. insita (see, e.g., Pl. 11, figs. 18, 33, 39). The major difference is exhibited by the lower surfaces of the two species, and the contrast goes far beyond the relative depth of the basal cavity. In P. expansa (see Pl. 11, fig. 28, the lower surface of a topotype specimen; see also Uyeno in McGregor and Uyeno, 1972, Pl. 5, fig. 20, and Lane and Ormiston, 1979, Pl. 7, fig. 28), the basal cavity occupies the entire lower surface of the posterior two-thirds of the blade, with an extremely narrow extension under the fin. There is no suggestion of inversion. In that of P. insita, on the other hand, the entire cavity is inverted and, in some specimens, there are lateral flares under the posterior two-thirds of the blade, and a generally relatively wide and similarly inverted, extension under the fin. The difference in the nature of the basal cavity of P. insita and P. expansa is somewhat analogous to the difference in this feature of two Polygnathus species, both of Early Devonian age, P. dehiscens Philip and Jackson, and P. inversus Klapper and Johnson (see Klapper and Johnson, 1975, Fig. 3, Pl. 1, figs. 2, 3, 6, 7, 13, Pl. 3, figs. 26, 28).

Five specimens that are questionably assignable to P. insita were recovered from Units II and IV (two of these are illustrated on Pl. 9, figs. 12, 13 and Pl. 11, figs. 22-25). They are identical in most features to P. insita except in the possession of a single small denticle on the left lateral side. Similar specimens, but with denticles on both lateral sides, were found previously in the upper part of the Firebag Member of the Waterways Formation (Uyeno, 1967, p. 11, Pl. 2, figs. 2, 3; 1974, p. 44, Pl. 8, figs. 8, 10), and in the Peace Point Member of the Waterways Formation (Uyeno in Norris and Uyeno, in press, Pl. 1, figs. 31-34).

Figured specimens. Pandorinellina insita, GSC 63065, 63066, 63095 to 63100; Pandorinellina cf. P. insita, Pa element with a small lateral denticle, GSC 63064 and 63103.

Genus Polygnathus Hinde, 1879

Type species. Polygnathus dubius Hinde, 1879.

Polygnathus cf. P. decorosus Stauffer

Plate 11, figures 7-11

(cf.) Polygnathus decorosus Stauffer, 1938, p. 438, Pl. 53, figs. 5, 6, 10, 15, 16 (Pa); Klapper, Philip and Jackson, 1970, p. 652-654, Pl. 3, figs. 1-6 (Pa).

Remarks. The Birch River polygnathan element differs from the Pa element of Polygnathus decorosus in the following features: the platform outline is noticeably asymmetrical, with the outer margin flaring out and somewhat constricted anteriorly; and the upper platform surface is entirely smooth. It differs from those specimens from the Waterways Formation, also compared with P. decorosus by Uyeno (1974, Pl. 4, figs. 2, 7, Pl. 5, fig. 2), in its relatively low, uniform height of the free blade and the smooth platform surface.

Figured specimens. GSC 63092 to 63094.

Polygnathus aff. P. incompletus Uyeno

Plate 11, figures 19-21, 29-31

(aff.) Polygnathus incompleta Uyeno, 1967, p. 7, 10, Pl. 2, figs. 6, 7 (Pa).

(aff.) Polygnathus incompletus Uyeno, Uyeno, 1974, p. 39, Pl. 4, fig. 5, Pl. 5, fig. 1 (Pa); Klapper in Ziegler, ed., 1975, p. 291-292, Polygnathus Pl. 5, fig. 4, (Pa); Baliński, 1979, p. 80, Pl. 23, fig. 11 (Pa).

Remarks. The Birch River specimens differ slightly from those illustrated by Uyeno (1974), both of which originated in the Calumet Member of the Waterways Formation, in that the carina extends relatively farther posteriorly; i.e., to about three-quarters of the platform length, as opposed to one-half. In all other features they are identical.

Baliński (1979) reported P. incompletus from southern Poland, in strata assigned to the Lowermost asymmetricus Zone.

Figured specimens. GSC 63101 and 63102.

Polygnathus webbi Stauffer

Plate 11, figures 1-6, 12-15

Polygnathus webbi Stauffer, 1938, p. 439, Pl. 53, figs. 25, 26, 28, 29 (Pa); Klapper in Ziegler, ed., 1973, p. 393-394, Polygnathus Pl. 2, fig. 7 (Pa) (includes further synonymy); Uyeno, 1974, p. 40, Pl. 5, fig. 7 (Pa); Baliński, 1979, p. 81, Pl. 23, figs. 13-15 (Pa); Klapper and Johnson, 1980, p. 454, Tables 12, 13, Pl. 4, fig. 9; Uyeno in Norris and Uyeno, in press, Pl. 1, figs. 47, 48 (Pa).

Polygnathus n. sp. B, Pollock, 1968, p. 437-438, Pl. 62, fig. 34 (Pa).

(?) Polygnathus webbi Stauffer, Garcia-Lopez, 1976, p. 177, Pl. 1, fig. 5 (=Polygnathus dubius? Hinde) (Pa).

Remarks. The platform of the Pa element of Polygnathus webbi in the Birch River collections features only faint ribbing. This is in contrast to the distinct grooves, with corresponding marginal serration, in the specimen illustrated by Uyeno (1974, Pl. 5, fig. 7) from the Firebag Member of the Waterways Formation.

Some of the smaller specimens are considered as juveniles of P. webbi. They are generally distinct, distinguished by their relatively short free blade and a small pit, although some appear to be transitional to those small specimens that have been previously assigned to Polygnathus xylus Stauffer by Uyeno (1974, Pl. 4, figs. 6 and 8). One such transitional specimen is illustrated on Plate 11, figure 15, and is further characterized by acicular dentition on the posterior half of the free blade. This is probably an aberrant feature and does not represent an early ontogenetic stage. A similar kind of needle-like development on the lower keel of the platform and the upper platform surface was interpreted as a feature of early growth stages of some Upper Devonian polygnathans by Shaffer (1963).

The small specimen originating in the Firebag Member of the Waterways Formation in the subsurface, and illustrated by Pollock (1968), may also represent a juvenile stage of Polygnathus webbi.

Figured specimens. GSC 63088 to 63091.

REFERENCES

Allan, J.A., Warren, P.S., and Rutherford, R.L.
1932: A preliminary study of the eastern ranges of the Rocky Mountains in Jasper Park, Alberta; Royal Society of Canada, Transactions, sect. 4, 1932, p. 225-248, Pls. 1-2, text-figs. 1-2.

Astrova, G.G.
1972: Some Devonian bryozoa from western Canada; Geological Association of Canada, Proceedings, v. 24, no. 2, p. 75-86, Pls. 1-4.

Baliński, A.
1979: Brachiopods and conodonts from the Frasnian of the Dębnik Anticline, southern Poland; Polish Academy of Sciences, Institute of Paleobiology, Palaeontologia Polonica, No. 39, p. 3-95, Pls. 1-23.

Bassett, H.G., and Stout, J.G.
1968: Devonian of western Canada; in Oswald, D.H., editor, International Symposium on the Devonian System, Calgary, Alberta, September, 1967, v. 1, p. 717-752 (1967).

Bayrock, L.A.
1972a: Surficial geology, Fort Chipewyan (NTS 74L); Research Council of Alberta, Map 36.

1972b: Surficial geology, Lake Claire (NTS 84I); Research Council of Alberta, Map 39.

Belyea, H.R., and McLaren, D.J.
1962: Upper Devonian formations, southern part of Northwest Territories, northeastern British Columbia, and northwestern Alberta; Geological Survey of Canada, Paper 61-29 (Reprinted, 1964).

Belyea, H.R., Moyer, G.L., Grey, F.F., and Grayston, L.D.
1964: Upper Devonian (Chapter 6), Committee on Slave Point and Beaverhill Lake Formations (Part I); in McCrossan, R.G., and Glaister, R.P., editors, Geological History of Western Canada, Alberta Society of Petroleum Geologists, p. 60-66.

Belyea, H.R., and Norris, A.W.
1962: Middle Devonian and older Palaeozoic formations of southern District of Mackenzie; Geological Survey of Canada, Paper 62-15.

Beus, S.S.
1965: Devonian faunule from the Jefferson Formation, central Blue Spring Hills, Utah-Idaho; Journal of Paleontology, v. 39, no. 1, p. 21-30, Pls. 9-10, 4 text-figs.

Bischoff, G.
1956: Oberdevonische Conodonten (tolα) aus dem Rheinischen Schiefergebirge; Notizblatt des Hessischen Landesamt für Bodenforschung, v. 84, p. 115-137.

Bischoff, G. and Ziegler, W.
1957: Die Conodontenchronologie des Mitteldevons und tiefsten Oberdevons; Abhandlungen des Hessischen Landesamtes für Bodenforschung, Heft 22.

Branson, E.B.
1922: The Devonian of Missouri; Missouri Bureau of Geology and Mines, v. 17, 2nd series, 279 p., 71 Pls.

1944: The Geology of Missouri; University of Missouri Studies, v. 19, no. 3, 535 p., 49 Pls., 51 text-figs.

Branson, E.B. and Mehl, M.G.
1933: Conodonts from the Bainbridge (Silurian) of Missouri; University of Missouri Studies, v. 8, p. 39-52, 69-70.

1938: The conodont genus Icriodus and its stratigraphic distribution; Journal of Paleontology, v. 12, no. 2, p. 156-166.

Braun, W.K.
1968: Upper Devonian Ostracod faunas of Great Slave Lake and northeastern Alberta, Canada; in Oswald, D.H., editor, International Symposium on the Devonian System, Calgary, Alberta, 1967; Alberta Society of Petroleum Geologists, v. 2, p. 617-652 (1967).

Brice, D., Bultynck, P., Colbeaux, J.P., Lethiers, F., Mistiaen, B., Rohart, J.C., and Bigey, F.
1976: Une nouvelle coupe dans le Dévonien de Ferques (Boulonnais, France); Annales de la Société Géologique du Nord, v. 96, p. 135-155.

Bryant, W.L.
1921: The Genesee conodonts with descriptions of new species; Bulletin of the Buffalo Society of Natural Sciences, v. 13, p. 1-59.

Bultynck, P.
1972: Middle Devonian Icriodus assemblages (Conodonta); Geologica et Palaeontologica, v. 6, p. 71-86.

1975: Conodontes de la Formation de Fromelennes du Givetien de l'Ardenne Franco-Belge; Bulletin Institute Royal des Sciences Naturelles de Belgique, v. 50, no. 10, 30 pp. [imprint 1974].

Carrigy, M.A.
1959: Geology of the McMurray Formation, Part III, General geology of the McMurray area; Research Council of Alberta, Geology Division, Memoir 1, 130 p., map 26, 8 Pls., 11 figs.

Caster, K.E.
1939: A Devonian fauna from Colombia; Bulletin of American Paleontology, v. 24, no. 83, p. 1-218, Pls. 1-14.

Chatterton, B.D.E.
1979: Aspects of late Early and Middle Devonian conodont biostratigraphy of western and northwestern Canada; in Stelck, C.R. and Chatterton, B.D.E., editors, Western and Arctic Canadian Biostratigraphy, Geological Association of Canada, Special Paper 18, p. 161-231 [imprint 1978].

Coen, M. and Coen-Aubert, M.
1971: L'assise de Fromelennes aux bords sud et est du Bassin de Dinant et dans le massif de la Vesdre; Annales de la Société Géologique de Belgique, v. 94, p. 5-20.

Cooper, B.J.
1975: Multielement conodonts from the Brassfield Limestone (Silurian) of southern Ohio; Journal of Paleontology, v. 49, no. 6, p. 984-1008.

1976: Multielement conodonts from the St. Clair Limestone (Silurian) of southern Illinois; Journal of Paleontology, v. 50, no. 2, p. 205-217.

1977: Toward a familial classification of Silurian conodonts; Journal of Paleontology, v. 51, no. 6, p. 1057-1071.

Cooper, G.A.
1944: Phylum Brachiopoda (Chapter IX); in Shimer, H.W., and Shrock, R.R., Index Fossils of North America; The Technology Press, Massachusetts Institute of Technology, John Wiley and Sons, Inc., p. 277-365, Pls. 105-143.

1968: Age and correlation of the Tully and Cedar Valley Formations in the United States; in Oswald, D.H., editor, International Symposium on the Devonian System, September, 1967, Calgary, Alberta, Alberta Society of Petroleum Geologists, v. 2, p. 701-710 (1967).

Copper, P.
1967a: Frasnian Atrypidae (Bergisches Land, Germany); Palaeontographica, Abt. A, v. 126, p. 116-140, Pls. 19-27, 17 text-figs.

1967b: Spinatrypa and Spinatrypina (Devonian Brachiopoda); Palaeontology, v. 10, Pt. 3, p. 489-523, Pls. 76-83.

1973: New Siluro-Devonian Atrypoid Brachiopods; Journal of Paleontology, v. 47, no. 3, p. 484-500, 3 Pls.

1979: Devonian atrypoids from western and northern Canada; in Stelck, C.R. and Chatterton, B.D.E., editors, Western and Arctic Canadian Biostratigraphy; Geological Association of Canada, Special Paper 18, p. 289-331, Pls. 1-7, text-figs. 1-6 (Imprinted 1978).

Crickmay, C.H.
1950: Some Devonian Spiriferidae from Alberta; Journal of Paleontology, v. 24, no. 2, p. 219-225.

1953: New Spiriferidae from the Devonian of western Canada; published by the author, Imperial Oil Limited, Calgary, 13 p., 6 Pls.

1957: Elucidation of some western Canada Devonian formations, published by the author, Imperial Oil Company Limited, Calgary, Alberta.

1960: The older Devonian faunas of the Northwest Territories; published by the author, Evelyn de Mille Books, Calgary, 21 p., 11 Pls.

1963: Significant new Devonian brachiopods from western Canada; published by the author, Evelyn de Mille Books, Calgary, 63 p., 16 Pls.

1966: Devonian time in western Canada; published by the author, Evelyn de Mille Books, Calgary, 38 p.

1967: The method of indivisible aggregates in studies of the Devonian; published by the author, Evelyn de Mille Books, Calgary, 18 p., 4 Pls.

Douglas, R.J.W., Gabrielse, H., Wheeler, J.O., Stott, D.F., and Belyea, H.R.
1970: Geology of western Canada, Chapter VIII; in Douglas, R.J.W., editor, Geological Survey of Canada, Geology and Economic Minerals of Canada, Economic Geology Report No. 1, p. 367-488.

Druce, E.C.
1976: Conodont biostratigraphy of the Upper Devonian reef complexes of the Canning Basin, Western Australia; Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin 158, v. 1, 2.

Epstein, A.G., Epstein, J.B. and Harris, L.D.
1977: Conodont color alteration - an index to organic metamorphism; United States Geological Survey, Professional Paper 995.

Fenton, C.L., and Fenton, M.A.
1924: The stratigraphy and fauna of the Hackberry Stage of the Upper Devonian; Michigan University, Museum of Geology, Contributions, v. 1, p. 1-260, 45 Pls.

1935: Atrypae described by Clement L. Webster and related forms (Devonian, Iowa): Journal of Paleontology, v. 9, no. 5, p. 369-384, Pls. 37-43.

Fong, G.
1959: Type section Swan Hills Member of the Beaverhill Lake Formation; Alberta Society of Petroleum Geologists, Journal, v. 7, no. 5, p. 95-108.

1960: Geology of Devonian Beaverhill Lake Formation, Swan Hills area, Alberta, Canada; American Association of Petroleum Geologists, Bulletin, v. 44, no. 2, p. 195-209.

Furnish, W.M., Glenister, B.F., and Klapper, G.
1969: The Middle Paleozoic paleontology and biostratigraphy of eastern Iowa; North American Paleontological Convention 1969, Guidebook, Field Trip No. 2, 41 p.

Garcia-Lopez, S.
1976: La Caliza de Candas en la zona de Luanco (Asturias) y su contenido en conodontos; Trabajos de Geologia, no. 8, p. 173-185.

Glenister, B.F., and Rexroad, C.B.
1968: Conodont successions, Field Trip No. 6; in Steinhilber, W.L., editor, A field-trip guidebook prepared for the Second Annual Meeting of the North-Central Section of The Geological Society of America, May 8-11, 1968, p. 11-17.

Gray, F.F., and Kassube, J.R.
1963: Geology and stratigraphy of Clarke Lake gas field, northeastern British Columbia; American Association of Petroleum Geology, Bulletin, v. 47, no. 3, p. 467-483.

Grayston, L.D., Sherwin, D.F., and Allan, J.F.
1964: Middle Devonian (Chapter 5); in McCrossan, R.G., and Glaister, R.P., editors, Geological History of Western Canada, Alberta Society of Petroleum Geologists, p. 49-59.

Green, R. (editor)
1970: Bedrock geology of northern Alberta, east and west halves; Research Council of Alberta, maps with legends and descriptive notes, geology by R. Green and G.B. Mellon, 1962, and by M.A. Carrigy and R. Green, 1965.

Green, R.
1972: Geological Map of Alberta; Research Council of Alberta, Map 35, scale: 1 to 1,267,000, 1 inch to 20 miles.

Griffin, D.L.
1965a: The Devonian Slave Point, Beaverhill Lake, and Muskwa Formations of northeastern British Columbia and adjacent areas; British Columbia Department of Mines and Petroleum Resources, Bulletin 50.

1965b: The facies front of the Devonian Slave Point-Elk Point sequence in northeastern British Columbia and the Northwest Territories; Journal of Canadian Petroleum Technology, v. 4, no. 1, p. 13-22.

1968: Devonian of northeastern British Columbia; in Oswald, D.H., editor, International Symposium on the Devonian System, Calgary, Alberta, September, 1967; Alberta Society of Petroleum Geologists, v. 2, p. 802-826 (1967).

Grubbs, D.M.
1939: Fauna of the Niagaran nodules of the Chicago area; Journal of Paleontology, v. 13, no. 6, p. 543-560, Pls. 61-62.

Hall, J.
1843: Natural History of New York; Geology, pt. 4, ix+525p., 19 Pls. (Albany).

1850: On the Brachiopods of the Silurian Period; particularly the Leptaenidae; American Association for the Advancement of Science, v. 2, p. 347-351.

Hall, J.
1852: Containing descriptions of the organic remains of the lower middle division of the New York System (equivalent in part to the Middle Silurian rocks of Europe); New York State Geological Survey, Palaeontology of New York, 353 p., 85 Pls.

1857: Descriptions of Palaeozoic fossils; New York State Cabinet, Natural History, 10th Annual Report, p. 41-186.

1859: Observations on genera of Brachiopoda; 12th Annual Report of the New York State Cabinet, p. 8-110.

Hall, J., in Hall, J. and Whitney, J.D.
1858: Report on the Geological Survey of the State of Iowa; embracing the results of investigations made during portions of the years 1855-1857; Paleontology, v. 1, pt. 2, p. 473-724, 29 Pls. (Albany, New York).

Hall, J.
1863: Descriptions of new species of Brachiopoda from the Upper Helderberg, Hamilton, and Chemung groups; New York State Cabinet, Natural History, Annual Report 16, p. 48, text-fig. 22-23.

Hall, J., and Clarke, J.M.
1892-1895: An introduction to the study of the genera of Palaeozoic Brachiopoda; New York Geological Survey, v. 8, pt. 1, p. 1-367, Pls. 1-20 (1892); pt. 2, p. 1-317 (1893), p. 319-394, Pls. 21-84 (1895).

Hargreaves, G.E., Hunt, A.D., deWitt, R., and Workman, L.E. (Lexicon Committee)
1960: Lexicon of Geologic Names in the Western Canada Sedimentary Basin and Arctic Archipelago; Alberta Society of Petroleum Geologists, 380 p.

Harrington, J.W.
1971: Brachiopods of the Melville Island Group (Upper Devonian) Banks Island, N.W.T.; Bulletin of Canadian Petroleum Geology, v. 19, no. 4, p. 782-798.

Hinde, G.J.
1879: On conodonts from the Chazy and Cincinnati Group of the Cambro-Silurian, and from the Hamilton and Genesee-Shale divisions of the Devonian, in Canada and the United States; Geological Society of London, Quarterly Journal, v. 35, pt. 3, p. 351-369.

Imperial Oil Limited, Western Division, Geological Staff
1950: Devonian nomenclature in Edmonton area, Alberta, Canada; American Association of Petroleum Geologists, Bulletin, v. 34, no. 9, p. 1807-1825.

Jansa, L.F., and Fischbuch, N.R.
1974: Evolution of a Middle and Upper Devonian sequence from a clastic coastal plain-deltaic complex overlying carbonate reef complexes and banks, Sturgeon-Mitsue area, Alberta; Geological Survey of Canada, Bulletin 234, 105 p., 42 figs.

Johnson, J.G. and Klapper, G.
1978: Devonian brachiopods and conodonts from central Oregon; Journal of Paleontology, v. 52, no. 2, p. 295-299.

Johnson, J.G., Klapper, G., and Trojan, W.
in press: Brachiopod and conodont successions in the Devonian of northern Antelope Range, central Nevada; Geologica et Palaeontologica, 14.

Johnson, J.G., and Norris, A.W.
1972: Tecnocyrtina, a new genus of Devonian brachiopods; Journal of Paleontology, v. 46, no. 4, p. 565-572, 2 Pls., 3 text-figs.

Kindle, E.M.
1928: The occurrence and correlation of a Devonian fauna from Peace River, Alberta; Geological Survey of Canada, Contributions to Canadian Palaeontology, Bulletin 49, p. 14-18.

King, W.
1850: A monograph of the Permian fossils of England; Palaeontographical Society, Monograph 3, xxxvii+258 p., 29 Pls.

Klapper, G.
1968: Preliminary outline of the conodont sequence within the Cedar Valley and State Quarry Limestones (Middle and Upper Devonian) of southeastern Iowa and northwestern Illinois; an Appendix, in Glenister, B.F., and Rexroad, C.B., Conodont successions; Geological Society of America, Northcentral Section Meeting Guidebook, Field Trip No. 6, p. 11-15.

Klapper, G. and Johnson, D.B.
1975: Sequence in conodont genus Polygnathus in Lower Devonian at Lone Mountain, Nevada; Geologica et Palaeontologica, v. 9, p. 65-83.

Klapper, G. (with contributions by D.B. Johnson)
1977: Lower and Middle Devonian conodont sequence in central Nevada; in Murphy, M.A., Berry, W.B.N., and Sandberg, C.A., editors, Western North America: Devonian; California University, Riverside, Campus Museum Contribution no. 4, p. 33-54.

Klapper, G., and Johnson, J.G.
1980: Endemism and dispersal of Devonian conodonts; Journal of Paleontology, v. 54, no. 2, p. 400-455, 4 Pls., 6 text-figs.

Klapper, G. and Philip, G.M.
1971: Devonian conodont apparatuses and their vicarious skeletal elements; Lethaia, v. 4, p. 429-452.

1972: Familial classification of reconstructed Devonian conodont apparatuses; in Lindström, M. and Ziegler, W., editors, Symposium on conodont taxonomy, Geologica et Palaeontologica, v. SB1, p. 97-114.

Klapper, G., Philip, G.M., and Jackson, J.H.
1970: Revision of the Polygnathus varcus Group (Conodonta, Middle Devonian); Neues Jahrbuch für Geologie und Paläontologie Monatshefte, Jahrgang 1970, p. 650-667.

Klapper, G., Sandberg, C.A., Collinson, C., Huddle J.W., Orr, R.W., Rickard, L.V., Schumacher, D., Seddon, G., and Uyeno, T.T.
1971: North American Devonian Conodont Biostratigraphy; in Sweet, W.C., and Bergström, S. M., editors, Symposium on Conodont Biostratigraphy; Geological Society of America, Memoir 127, p. 285-316.

Klapper, G., and Ziegler, W.
1979: Devonian conodont biostratigraphy; in House, M.R., Scrutton, C.T., and Bassett, M.G., editors, The Devonian System, Special Papers in Palaeontology, no. 23, p. 199-224.

Lane, H.R., and Ormiston, A.R.
1979: Siluro-Devonian biostratigraphy of the Salmontrout River area, east-central Alaska; Geologica et Palaeontologica, v. 13, p. 39-96.

Law, J.
1955a: Rock units of northwestern Alberta; Alberta Society of Petroleum Geologists, Journal, v. 3, no. 6, p. 81-83.

1955b: Geology of northwestern Alberta and adjacent areas; American Association of Petroleum Geologists, Bulletin, v. 39, no. 10, p. 1927-1975.

Leavitt, E.M., and Fischbuch, N.R.
1968: Devonian nomenclatural changes, Swan Hills area, Alberta; Bulletin of Canadian Petroleum Geology, v. 16, no. 3, p. 288-297.

Lenz, A.C., and Pedder, A.E.H.
1972: Lower and Middle Paleozoic sediments and paleontology of Royal Creek and Peel River, Yukon, and Powell Creek, N.W.T.; 24th International Geological Congress, Guidebook, Field Excursion A14.

Lindström, M., and Ziegler, W.
1966: Ein Conodontentaxon aus vier morphologisch verschiedenen Typen; Fortschritte in der Geologie von Rheinland und Westfalen, v. 9, p. 209-218 [imprint 1965].

Martin, W.
1809: Petrificata derbiensia; or figures and descriptions of petrifications collected in Derbyshire; Wigan.

Maurin, A.F., and Raasch, G.O.
1972: Early-Frasnian stratigraphy, Kakwa-Cecilia Lakes, British Columbia, Canada; TOTAL, Compagnie Française des Petroles, Notes et Mémoires, no. 10, 80 p., 12 Pls., (Paris).

McCammon, H.
1960: Fauna of the Manitoba Group in Manitoba; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 59-6, 80 p., 13 Pls., 4 tables, 2 text-figs.

McGregor, D.C., and Uyeno, T.T.
1972: Devonian spores and conodonts of Melville and Bathurst Islands, District of Franklin; Geological Survey of Canada, Paper 71-13.

McLaren, D.J.
1961: Three new genera of Givetian and Frasnian (Devonian) rhynchonelloid brachiopods; Institut royal des Sciences naturelles de Belgique, Bulletin 37, no. 23, p. 1-7, Pls. 1, 2.

1962: Middle and early Upper Devonian rhynchonelloid brachiopods from western Canada; Geological Survey of Canada, Bulletin 86, p. 1-222, Pls. 1-18, 29 text-figs.

McLaren, D.J., Norris, A.W., and McGregor, D.C.
1962: Illustrations of Canadian fossils, Devonian of western Canada; Geological Survey of Canada, Paper 62-4, 34 p., 16 Pls.

M'Coy, F.
1844: A synopsis of the characters of the Carboniferous limestone fossils of Ireland; 207 p., 29 Pls., 34 text-figs. (Dublin).

Meek, F.B.
1868: Remarks on the geology of the valley of the Mackenzie River, with figures and descriptions of fossils from that region, in the museum of the Smithsonian Institution, chiefly collected by the late Robert Kennicott, Esq.; Chicago Academy of Sciences, Transactions, v. 1, p. 61-114, Pls. 11-15 (1867).

Miller, S.A.
1894: Palaeontology; Indiana Department of Geology and Natural Resources, Report 18, p. 257-333, Pls. 1-12.

Moore, R.C., editor
1965: Brachiopoda, Part H, Treatise on Invertebrate Paleontology; Geological Society of America and University of Kansas Press, v. 1, p. i+xxxii, 1-522; v. 2, p. 523-927.

Mosher, L.C. and Clark, D.L.
1965: Middle Triassic conodonts from the Prida Formation of northwestern Nevada; Journal of Paleontology, v. 39, no. 4, p. 551-565.

Mouravieff, A.
1974: Guidebook to Excursion F; International Symposium on Belgian Micropaleontological Limits from Emsian to Visean, Namur, Belgium, 1974, Bouckaert, J., and Streel, M., editors, Geological Survey of Belgium.

Muir-Wood, H., and Cooper, G.A.
1960: Morphology, classification and life habits of the Productoidea (Brachiopoda); Geological Society of America, Memoir 81, 447 p., 135 Pls., 8 text-figs.

Müller, K.J., and Müller, E.M.
1957: Early Upper Devonian (Independence) conodonts from Iowa, Part I; Journal of Paleontology, v. 31, no. 6, p. 1069-1108.

Murray, J.W.
1965: Stratigraphy and carbonate petrology of the Waterways Formation, Judy Creek, Alberta, Canada; Bulletin of Canadian Petroleum Geology, v. 13, no. 2, p. 303-326.

1966: An oil producing reef-fringed carbonate bank in the Upper Devonian Swan Hills Member, Judy Creek, Alberta; Bulletin of Canadian Petroleum Geology, v. 14, no. 1, p. 1-103.

Nalivkin, D.V., editor
1947: Atlas Rukovodyashchikh form iskopaemykh faun S.S.S.R.: Devonskaya sistema Moskva-Leningrad; Ves. Nauchno-Issledov. Ministerstvo geologii SSSR. Vses geologicheskii institut, v. 3, p. 1-245, Pls. 1-56 [Atlas of the guide forms of fossil faunas of the USSR: Devonian System Moscow-Leningrad]. (In Russian).

Nicoll, R.S.
1977: Conodont apparatuses in an Upper Devonian palaeoniscoid fish from the Canning Basin, Western Australia; Bureau of Mineral Resources, Journal of Australian Geology and Geophysics, v. 2, p. 217-228.

Norris, A.W.
1963: Devonian stratigraphy of northeastern Alberta and northwestern Saskatchewan; Geological Survey of Canada, Memoir 313, 168 p., 12 figs.

1965: Stratigraphy of Middle Devonian and older Palaeozoic rocks of the Great Slave Lake region, Northwest Territories; Geological Survey of Canada, Memoir 322, 180 p., 9 figs.

1973: Paleozoic (Devonian) Geology of northeastern Alberta and northwestern Saskatchewan; in Carrigy, M.A., and Kramers, J.W., editors, Guide to the Athabasca Oil Sands area, Alberta Research, Information Series 65, p. 15-76, 7 text-figs., and Appendix.

Norris, A.W., and Uyeno, T.T.
1972: Stratigraphy and conodont faunas of Devonian outcrop belts, Manitoba; Geological Association of Canada, Special Paper no. 9, p. 209-223 [imprint 1971].

in press: Biostratigraphy and paleontology of Middle-Upper Devonian boundary beds, Gypsum Cliffs area, northeastern Alberta; Geological Survey of Canada, Bulletin 313.

Norris, A.W., Uyeno, T.T., and McCabe, H.R.
in press: Devonian rocks of the Lake Winnipegosis-Lake Manitoba outcrop belt, southwestern Manitoba; Geological Survey of Canada, Memoir 392, and Manitoba Geological Services Branch, Publication 77-1.

Orchard, M.J.
1978: The conodont biostratigraphy of the Devonian Plymouth Limestone, South Devon; Palaeontology, v. 21, pt. 4, p. 907-955.

Pedder, A.E.H.
1975: Revised megafaunal zonation of Middle and lowest Upper Devonian strata, central Mackenzie Valley; Geological Survey of Canada, Paper 75-1, Part A, p. 571-576.

Perry, D.G., Klapper, G., and Lenz, A.C.
1974: Age of the Ogilvie Formation (Devonian), northern Yukon: based primarily on the occurrence of brachiopods and conodonts; Canadian Journal of Earth Sciences, v. 11, no. 8, p. 1055-1097.

Philip, G.M., and McDonald, L.
1975: A provisional phylogeny for some reconstructed Late Devonian polygnathid conodont apparatuses; Alcheringa, v. 1, p. 97-107.

Pitrat, C.W.
1975: Orthospirifer new genus of Devonian spinocyrtiid brachiopods; Journal of Paleontology, v. 49, no. 2, p. 387-394, 2 Pls., 1 text-fig.

Pollock, C.A.
1968: Lower Upper Devonian conodonts from Alberta, Canada; Journal of Paleontology, v. 42, no. 2, p. 415-443, Pls. 61-64, 2 text-figs.

Raymond, P.E.
1911: The Brachiopoda and Ostracoda of the Chazy; Carnegie Museum, Annals, v. 7, no. 2, p. 215-259.

Requadt, H., and Weddige, K.
1978: Lithostratigraphie und Conodontenfaunen der Wissenbacher Fazies und ihrer Äquivalente in der südwestlichen Lahnmulde (Rheinisches Schiefergebirge); Mainzer Geowissenschaftliche Mitteilungen, v. 7, p. 183-237.

Richmond, W.O.
1965: Paleozoic stratigraphy and sedimentation of the Slave Point Formation, southern Northwest Territories and northern Alberta; unpublished Ph.D. thesis, Stanford University. (Reproduced by University Microfilms, Ann Arbor, Michigan, U.S.A., 1968).

Rowley, R.R.
1900: Descriptions of new species of fossils from the Devonian and subCarboniferous rocks of Missouri; The American Geologist, v. 25, p. 261-273, Pl. 5.

Rzhonsnitskaya, M.A.
1960a: Order Atrypida; in Sarycheva T.G., editor, Osnovy paleontologii, Brachiopoda, Akademy Nauk SSSR, p. 257-264, Pls. 53-56, figs. 310-335, Moscow (In Russian).

1960b: The genus Gruenewaldtia from the Devonian of the SSSR; Sbornik Statie po Paleontologii i Biostratigrafii, NIIGA, no. 20, p. 45-50, Pls. 1-2. (In Russian).

1964: On Devonian atrypids from the Kuznetsk Basin; Transactions of the All-Union Scientific Research Institute for Geology (VSEGEI), Paleontology and Stratigraphy, n. ser., v. 93, p. 91-112, 2 Pls., Leningrad (In Russian).

Sandberg, C.A.
1979: Devonian and Lower Mississippian conodont zonation of the Great Basin and Rocky Mountains; in Sandberg, C.A. and Clark, D.L., editors, Conodont biostratigraphy of the Great Basin and Rocky Mountains, Brigham Young University Geology Studies, v. 26, part 3, p. 87-105.

Sandberg, C.A., and Poole, F.G.
1977: Conodont biostratigraphy and depositional complexes of Upper Devonian cratonic-platform and continental-shelf rocks in the western United States; in Murphy, M.A., Berry, W.B.N, and Sandberg, C.A., editors, Western North America: Devonian, California University, Riverside, Campus Museum Contribution no. 4, p. 144-182.

Sandberg, C.A., and Ziegler, W.
1979: Taxonomy and biofacies of important conodonts of Late Devonian styriacus-Zone, United States and Germany; Geologica et Palaeontologica, v. 13, p. 173-212.

Sannemann, D.
1955: Oberdevonische Conodonten (tolIIα); Senckenbergiana lethaea, v. 36, p. 123-156.

Savage, N.M., and Amundson, C.T.
1979: Middle Devonian (Givetian) conodonts from central Oregon; Journal of Paleontology, v. 53, no. 6, p. 1395-1400.

Schlotheim, E.F.
1820: Die Petrefactenkunde auf ihrem jetzigen Standpunkt durch die Beschreibung einer Sammlung versteinerter und fossiler Überreste des Thier- und Pflanzenreichs der Vorwelt; 1, Das Thierreich, p. i-lxii, 1-378, (Becker) Gotha.

Shaffer, B.
1963: A unique ontogeny in some polygnathid conodonts; The Compass (of Sigma Gamma Epsilon), v. 41, no. 1, p. 14-19.

Skall, H.
1975: The paleoenvironment of the Pine Point Lead-Zinc district; Economic Geology, v. 70, p. 22-45.

Stainbrook, M.A.
1938: Atrypa and Stropheodonta from the Cedar Valley beds of Iowa; Journal of Paleontology, v. 12, no. 3, p. 229-256, Pls. 30-35.

1940: Orthoid brachiopods of the Cedar Valley Limestone of Iowa; American Midland Naturalist, v. 23, no. 2, p. 482-492, 2 Pls.

1941: Terebratulacea of the Cedar Valley beds of Iowa; Journal of Paleontology, v. 15, no. 1, p. 42-55, Pls. 7-8, 10 text-figs.

1943a: Strophomenacea of the Cedar Valley Limestone of Iowa; Journal of Paleontology, v. 17, no. 1, p. 39-59, Pls. 6-7.

1943b: Spiniferacea of the Cedar Valley Limestone of Iowa; Journal of Paleontology, v. 17, no. 5, p. 417-450, Pls. 65-70, figs. 1-14.

1945: Brachiopoda of the Independence Shale of Iowa; Geological Society of America, Memoir 14, 74 p., 6 Pls., 2 text-figs.

Stainbrook, M.A., and Ladd, H.S.
1926: The fauna of the State Quarry beds; Iowa Academy of Science, Proceedings for 1924, v. 31, p. 353-361.

Stauffer, C.R.
1938: Conodonts of the Olentangy Shale; Journal of Paleontology, v. 12, no. 5, p. 411-443.

1940: Conodonts from the Devonian and associated clays of Minnesota; Journal of Paleontology, v. 14, no. 5, p. 417-435.

Sweet, W.C. and Schönlaub, H.P.
1975: Conodonts of the genus Oulodus Branson and Mehl, 1933: Geologica et Palaeontologica, v. 9, p. 41-59.

Tsien, H.H.
1977: The sequence and distribution of Frasnian rugose coral faunas in Belgium; in Second International Symposium on corals and fossil coral reefs, Paris, Sept. 1975, Mémoirs du Bureau de Recherches Géologiques et Minières, p. 203-220.

Ulrich, E.O., and Bassler, R.S.
1926: A classification of the toothlike fossils, conodonts, with descriptions of American Devonian and Mississippian species; Proceedings of the United States National Museum, v. 68, article 12, p. 1-63.

Uyeno, T.T.
1967: Conodont zonation, Waterways Formation (Upper Devonian), northeastern and central Alberta; Geological Survey of Canada, Paper 67-30.

1974: Conodonts of the Waterways Formation (Upper Devonian) of northeastern and central Alberta; Geological Survey of Canada, Bulletin 232.

1979: Devonian conodont biostratigraphy of Powell Creek and adjacent areas, western District of Mackenzie; in Stelck, C.R., and Chatterton, B.D.E., editors, Western and Arctic Canadian Biostratigraphy, Geological Association of Canada, Special Paper 18, p. 233-257 [imprint 1978].

Uyeno, T.T. and Mason, D.
1975: New Lower and Middle Devonian conodonts from northern Canada; Journal of Paleontology, v. 49, no. 4, p. 710-723.

van den Boogaard, M., and Kuhry, B.
1979: Statistical reconstruction of the Palmatolepis apparatus (Late Devonian conodontophorids) at the generic, subgeneric, and specific level; Scripta Geologica, v. 49, p. 1-57.

Walcott, C.D.
1884: Paleontology of the Eureka district, Nevada; United States Geological Survey, Monograph, v. 8, 298 p., 24 Pls.

Warren, P.S.
1933: Age of Devonian limestone at McMurray, Alberta; Canadian Field Naturalist, v. 47, no. 8, p. 148-149.

1942: The Spirifer argentarius fauna in the Canadian Rockies; Royal Society of Canada, Transactions, ser. 3, v. 36, sec. 4, p. 129-136.

1944: Index brachiopods of the Mackenzie River Devonian; Royal Society of Canada, Transactions, ser. 3, v. 38, sec. 4, p. 105-135, 3 Pls.

1957: The Slave Point Formation; Edmonton Geological Society Quarterly, v. 1, no. 1, p. 1, 2 and 5.

Warren, P.S., and Stelck, C.R.
1956: Devonian faunas of western Canada; in Reference Fossils of Canada, Part 1; Geological Association of Canada, Special Paper No. 1, 15 p., 29 Pls.

Webster, C.L.
1921: Notes on the genus Atrypa with descriptions of new species; American Midland Naturalist, v. 7, p. 13-20.

Weddige, K.
1977: Die Conodonten der Eifel-Stufe im Typusgebiet und in benachbarten Faziesgebieten; Senckenbergiana lethaea, v. 58, p. 271-419.

Whitaker, S.H., and Pearson, D.E. (compilers)
1972: Geological map of Saskatchewan; Saskatchewan Department of Mines and Resources and Saskatchewan Research Council.

Whiteaves, J.F.
1891: The fossils of the Devonian rocks of the Mackenzie River Basin; Geological Survey of Canada, Contributions to Canadian Palaeontology, v. 1, pt. 3, no. 5, p. 197-253, Pls. 27-32.

Williams, A.
1953: North American and European Stropheodontids: Their morphology and systematics; Geological Society of America, Memoir 56, 67 p., 13 Pls., 5 text-figs.

Youngquist, W.L.
1945: Upper Devonian conodonts from the Independence Shale(?) of Iowa; Journal of Paleontology, v. 19, no. 4, p. 355-367.

Ziegler, W.
1958: Conodontenfeinstratigraphische Untersuchungen an der Grenze Mitteldevon/Oberdevon und in der Adorfstufe; Notizblatt des Hessischen Landesamtes für Bodenforschung, v. 87, p. 7-77.

1962: Taxionomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung; Abhandlungen des Hessischen Landesamtes für Bodenforschung, v. 38.

1971: Conodont stratigraphy of the European Devonian; in Sweet, W.C., and Bergström, S.M., editors, Symposium on conodont biostratigraphy, Geological Society of America, Memoir 127, p. 227-284.

Ziegler, W. (editor)
1973: Catalogue of Conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, v. 1.

1975: Catalogue of Conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, v. 2.

Ziegler, W., Klapper, G., and Johnson, J.G.
1976: Redefinition and subdivision of the varcus-Zone (Conodonts, Middle-?Upper Devonian) in Europe and North America; Geologica et Palaeontologica, v. 10, p. 109-140.

APPENDIX I

Description of a composite section of part of the Slave Point Formation exposed at station 356NB (58°22'25"N, 112°07'05"W) on the south side of Point de Roche, southwest shore of Lake Claire, and parts of the Waterways Formation discontinuously exposed on Birch River between stations 8NB (58°19'40"N, 113°03'57"W) and 17NB (58°18'20"N, 113°09'00"W), northeastern Alberta.

Section at Pointe de Roche measured by A.W. Norris, 28 August 1961; and sections on Birch River measured by A.W. Norris and R. Schulz, during July 1979.

UPPER DEVONIAN	
Waterways Formation	22.05 m (72.34 ft); incomplete
Slave Point Formation	1.83 m (6.0 ft); incomplete

Unit	Description	Thickness (metres) Unit	From base
	UPPER DEVONIAN		
	Waterways Formation		
VII	Limestone micritic, medium to dark brown, beds up to 0.3 m thick, interbedded with limestone, argillaceous, micritic, light greenish grey, soft, rubbly beds up to about 0.15 m thick; unit as a whole is relatively resistant, weathers a buff brown, contains sparse megafossils.	0.7	22.05
	Unit VII is exposed only in the upper part of the section at station 17NB, at the most westerly of the Waterways outcrops on Birch River. Station 17NB is located on the south bank of Birch River at 58°18'20"N, 113°09'00"W bearing 071T at 3.2 km (2 miles) from the mouth of Alice Creek. Bedding: 050T/7NW.		
	Sample 17NBb (GSC loc. C-74183) from 0.6 to 0.7 m above base of unit VII (21.95 to 22.05 m above base of Waterways outcrops).		
	Sample 17NBa (GSC loc. C-74182) from 0.3 to 0.4 m above base of unit VII (21.65 to 21.75 m above base of Waterways outcrops).		
	Composite megafauna from unit VII:		
	Eostrophalosia sp. cf. E. pedderi Crickmay Devonoproductus sp. cf. D. tertius Crickmay Pseudoatrypa sp. Eleutherokomma sp. cf. E. jasperensis Crickmay circular echinoderm ossicle with single axial canal barrel-shaped echinoderm ossicle with single axial canal		
VI	Limestone, micritic, slightly argillaceous along parting planes, light greenish grey, beds highly irregular and up to 0.2 m thick, unit highly resistant, weathers light brownish grey.	2.9	21.35
	Parts of unit VI are exposed at stations 17NB (upper 1.9 m), 18NB (lower 0.6 m), 19NB (2 m), 21NB (lower 1.2 m), 23NB (1.5 m), 15NB (2.2 m) and 14NB (lower 1.5 m).		
	Station 18NB is located on the east bank of Birch River at 58°18'30"N, 113°08'35"W bearing 069T at 4.3 km (2.7 miles) from the mouth of Alice Creek. Bedding: 140T/2 - 3NE.		
	Station 19NB is located on the north bank of Birch River at 58°19'00"N, 113°08'50"W bearing 053T at 4.3 km (2.7 miles) from the mouth of Alice Creek. Bedding: 037T/17SE.		
	Station 21NB is located on the east bank of Birch River at 58°18'57"N, 113°07'55"W bearing 063T at 4.8 km (3 miles) from the mouth of Alice Creek. Bedding: Flat.		
	Station 23NB is located on the south bank of Birch River at 58°18'29"N, 113°06'03"W bearing 076T at 5.6 km (3.5 miles) from the mouth of Alice Creek. Bedding: Flat.		
	Station 15NB is located on the south bank of Birch River at 58°18'40"N, 113°06'30"W bearing 061T at 5.6 km (3.5 miles) from the mouth of Alice Creek. Bedding: Flat.		
	Station 14NB is located on the east bank of Birch River at 58°19'25"N, 113°05'14"W bearing 073T at 6.4 km (4 miles) from the mouth of Alice Creek. Bedding: Flat.		

Unit	Description	Thickness Unit	(metres) From base

Sample 19NBa (GSC loc. C-74189) from 1.9 to 2.0 m above base of unit VI (20.35 to 20.45 m above base of Waterways outcrops).

Sample 23NBa (GSC loc. C-74199) from 1.5 to 1.6 m above base of unit VI (19.95 to 20.05 m above base of Waterways outcrops).

Sample 14NBa (GSC loc. C-74177) from 1.4 to 1.5 m above base of unit VI (19.85 to 19.95 m above base of Waterways outcrops).

Sample 14NBb (GSC loc. C-74180), sample 15NBa (GSC loc. C-74181), and sample 17NBc (GSC loc. C-74185) from 1.3 to 1.4 m above base of unit VI (19.75 to 19.85 m above base of Waterways outcrops).

Sample 18NBc (GSC loc. C-74187) from 0.5 to 0.6 m above base of unit VI (18.95 to 19.05 m above base of Waterways outcrops).

Sample 21NBb (GSC loc. C-74194) and sample 14NB1 (GSC loc. C-74177) from 0 to 0.1 m above base of unit VI (18.45 to 18.55 m above base of Waterways outcrops).

Composite megafauna from unit VI:

cf. Saffordotaxis sp.
Petrocrania sp.
Schizophoria sp. cf. S. lata Stainbrook
Schizophoria sp.
Strophodonta (Strophodonta) sp. A
Eostrophalosia sp.
Devonoproductus sp. cf. D. tertius Crickmay
Ladogioides asmenista (Crickmay)
Desquamatia sp.
Tecnocyrtina sp. A
Allanaria minutilla Crickmay
Eleutherokomma sp. cf. E. impennis Crickmay
Eleutherokomma sp. cf. E jasperensis Crickmay
Eleutherokomma sp.
Cranaena sp.
Paracyclas sp.
undet. pelecypod
undet. gastropod - small, spirally coiled
Spirorbis sp.
undet. ostracode
circular echinoderm ossicle with single axial canal
barrel-shaped echinoderm ossicle with single axial canal
crinoid attachment process

V Mudstone, highly calcareous, medium greenish grey, with irregular thin interbeds, in part nodular, of limestone, argillaceous, micritic, medium greenish grey; unit mainly poorly exposed, recessive, weathers light greenish grey; macerated megafossils present in argillaceous limestone beds; this unit is one of the more distinctive markers of the Waterways Formation on Birch River. 0.9 18.45

Unit V is exposed at stations 18NB (0.9 m), 21NB (0.9 m) and 22NB (0.7 m).

Station 22NB is located on the southwest bank of Birch River at 58°18'40"N, 113°07'35"W bearing 071T at 4.9 km (3.1 miles) from the mouth of Alice Creek. Bedding: Flat.

Sample 18NBb (GSC loc. C-74186) from 0.8 to 0.9 m above base of unit V (18.35 to 18.45 m above base of Waterways outcrops).

Sample 22NBd (GSC loc. C-74198) from 0.6 to 0.7 m above base of unit V (18.15 to 18.25 m above base of Waterways outcrops).

Sample 21NBa (GSC loc. C-74193) from 0.4 to 0.5 m above base of unit V (17.95 to 18.05 m above base of Waterways outcrops).

APPENDIX I (cont'd)

Unit	Description	Thickness Unit	(metres) From base

Composite megafauna from unit V:

Devonoproductus sp. cf. D. tertius Crickmay
Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook)
circular echinoderm ossicle with single axial canal
barrel-shaped echinoderm ossicle with single axial canal

IV Limestone, in part very slightly argillaceous, micritic, light brown to light greenish grey, beds irregular and in part nodular, generally between 4 to 7 cm thick, unit is highly resistant, weathers light greenish grey; scattered beds are richly fossiliferous, megafossils are commonly highly macerated. 3.35 17.55

Unit IV is exposed at stations 18NB (upper 1.7 m), 20NB (1.8 m), 21NB (upper 0.9 m), 22NB (upper 3.1 m), 13NB (loose fragments), 11NB (lower 1.3 m) and 10NB (lower 0.4 m).

Station 20NB is located on the east bank of Birch River at 58°19'12"N, 113°07'55"W bearing 059T at 5.1 km (3.2 miles) from the mouth of Alice Creek. Bedding: 120T/7SW.

Station 13NB is located on the south bank of Birch River at 58°18'33"N, 113°05'15"W bearing 079T at 7.7 km (4.8 miles) from the mouth of Alice Creek. Bedding: undeterminable.

Station 11NB is located on the south bank of Birch River at 58°18'48"N, 113°04'36"W bearing 080T at 8 km (5 miles) from the mouth of Alice Creek. Bedding: 195T/10W.

Station 10NB is located on the east bank of Birch River at 58°18'50"N, 113°04'05"W bearing 076T at 8.9 km (5.6 miles) from the mouth of Alice Creek. Bedding: Flat.

Sample 18NBd (GSC loc. C-74188) and sample 22NBc (GSC loc. C-74192) from 3.25 to 3.35 m above base of unit IV (17.45 to 17.55 m above base of Waterways outcrops).

Sample 20NB (GSC loc. C-74191) from 3.2 to 3.3 m above base of unit IV (17.4 to 17.5 m above base of Waterways outcrops).

Sample 21NBc (GSC loc. C-74195), sample 20NBa (GSC loc. C-74190) and sample 18NBa (GSC loc. C-74185) from 2.45 to 2.55 m above base of unit IV (16.65 to 16.75 m above base of Waterways outcrops).

Sample 22NBb (GSC loc. C-74197) from 2.12 to 2.22 m above base of unit IV (16.32 to 16.42 m above base of Waterways outcrops).

Sample 11NBa (GSC loc. C-74172) from 0.8 to 0.9 m above base of unit IV (15.0 to 15.1 m above base of Waterways outcrops).

Sample 22NBa (GSC loc. C-74196) from, 0.7to 0.8 m above base of unit IV (14.9 to 15.0 m above base of Waterways outcrops).

Sample 10NBa (GSC loc. C-74172) from 0.2 to 0.3 m above base of unit IV (14.4 to 14.5 m above base of Waterways outcrops).

Composite megafauna from unit IV:

algal fragments
auloporid
Tabulophyllum? sp.
cf. Saffordotaxis sp.
Schizophoria sp.
Strophodonta (Strophodonta) sp. A
Nervostrophia sp.
Eostrophalosia sp. cf. E pedderi Crickmay
Eostrophalosia sp.
Devonoproductus sp. cf. D. tertius Crickmay
Ladogioides asmenista (Crickmay)
Variatrypa (Radiatrypa) clarkei (Warren)
Desquamatia sp.
Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook)
Pseudoatrypa sp. cf. P. gigantea (Webster)

APPENDIX I (cont'd)

Unit	Description	Thickness Unit	(metres) From base
	Pseudoatrypa sp. Spinatrypina (Exatrypa) sp. A Tecnocyrtina sp. A Allanella minutilla Crickmay Eleutherokomma sp. cf. E. impennis Crickmay Eleutherokomma sp. cf. E. jasperensis (Warren) undet. gastropod - small, spirally coiled undet. gastropod - planispiral Tentaculites sp. Spirorbis sp. circular echinoderm ossicle with single axial canal barrel-shaped echinoderm ossicle with single axial canal		
III	Mudstone, highly calcareous, greenish grey, soft, recessive, very poorly exposed, weathers light greenish grey, megafossils sparse.	4.5 (est.)	14.2
	Parts of unit III are exposed at stations 12NB (lower 4 m), 11NB (upper 1 m) and 10NB (upper 1 m). Station 12NB is located on the south bank of Birch River at 58°18'32"N, 113°04'40"W bearing 079T at 7.8 km (4.9 miles) from the mouth of Alice Creek.		
	Sample 11NBb (GSC loc. C-74174) from 4.4 to 4.5 m above base of unit III (14.1 to 14.2 m above base of Waterways outcrops).		
	Sample 10NBb (GSC loc. C-74173) from 4.3 to 4.4 m above base of unit III (14.0 to 14.1 m above base of Waterways outcrops).		
	Sample 12NBb (GSC loc. C-74176) from 0.2 to 0.3 m above base of unit III (9.9 to 10 m above base of Waterways outcrops).		
	Composite megafauna from unit III: cf. Saffordotaxis sp. Schizophoria sp. cf. S. lata Stainbrook Strophodonta (Strophodonta) sp. A Spirorbis sp.		
II	Limestone, moderately argillaceous, micritic, greenish grey, irregular thin beds up to 4 cm thick, relatively resistant, weathers light greenish grey, contains abundant macerated skeletal material; richly fossiliferous.	0.7	9.7
	Unit II is exposed only at station 12NB.		
	Sample 12NBa (GSC loc. C-74175) from 0.4 to 0.6 m above base of unit II (9.4 to 9.6 m above base of Waterways outcrops); megafossils comprise: cf. Saffordotaxis sp. Schizophoria sp. cf. S. lata Stainbrook Ladogioides asmenista (Crickmay) Variatrypa (Radiatrypa) clarkei (Warren) Pseudoatrypa sp. cf. P. gigantea (Webster) Pseudoatrypa sp. Athyris parvula Whiteaves Tecnocyrtina sp. A. Eleutherokomma sp. cf. E impennis Crickmay Tentaculites sp. circular echinoderm ossicle with single axial canal circular echinoderm ossicle with five star-shaped axial canal five-sided echinoderm ossicle with single axial canal		
Ib	Limestone, highly argillceous, micritic, greenish grey, irregularly thin bedded, recessive, weathers light greenish grey, interval is mainly covered but is represented by numerous loose fragments at station 12NB; not sampled.	4.5 (est.)	9.0

APPENDIX I (cont'd)

Unit	Description	Thickness Unit	(metres) From base
1a	Covered interval; loose fragments from upper part of interval consist of limestone, micritic, light brown, beds up to 9 cm thick, some layers with considerable sparry calcite, some thin layers appear to be finely brecciated, contains very finely macerated skeletal fragments, weathers light brown with patches of pale orange ocherous staining. Loose fragments from lower part of interval consist of limestone, micritic, moderately argillaceous, medium to light brown, very evenly thin bedded, fissile, weather light tan brown, worm burrowings parallel to bedding noted in one fragment, fossils sparse, fragmentary, and highly abraded.	4.5	4.5

Represented at station 8NB which is located on the west and east banks of Birch River at about 58°19'40"N, 113°03'57"W bearing 072T at 9.4 km (5.9 miles) from the mouth of Alice Creek.

Sample 8NBa (GSC loc. C-74169) collected loose from between 4.2 and 4.5 m above river level and base of Waterways section on the west bank of Birch River.

Sample 8NBb (GSC loc. C-74170) collected loose from between 0 and 0.4 m above river level and base of Waterways section on east bank of Birch River.

Composite megafauna from unit Ia interval:

cf. Saffordotaxis sp.
productellid fragments
Variatrypa (Radiatrypa) clarkei (Warren)
Tecnocyrtina sp. A
Allanella minutilla Crickmay
Eleutherokomma sp. cf. E. impennis Crickmay
undet. gastropod - small, spirally coiled
circular echinoderm ossicle with single axial canal

3	Covered interval unknown between base of lowest outcrops of Waterways Formation on Birch River and base of formation.	55 (est.)	

Slave Point Formation

2	Covered interval unknown to top of Slave Point Formation.	3 (est.)	
1	Limestone, calcarenite, angular light brown lithic fragments in a matrix of darker brown micritic limestone and sparry calcite, beds irregular, up to 5 cm thick, weathering light tan brown, contains sparse megafossils.	1.83 (exposed)	1.83

Unit 1 is exposed immediately above lake level at station 356NB at 58°22'25"N, 112°07'05"W on the south side of Point de Roche on the southwest shore of Lake Claire. Bedding: estimated 130T/2SW.

Sample 356NBa (GSC loc. 45964) sparse fossils collected from the upper 0.3 m of unit 1:

Desquamatia sp.
undet. atrypid fragments

Sample 356NBb (GSC loc. 45965) fossils collected loose in unit 1 interval between 0 and 1.83 m above base of section:

stromatoporoid, bulbous
Desquamatia sp.
Tentaculites sp.

PLATE 1

Beds of units Ib, II and III of the Waterways Formation poorly exposed at station 12NB (58°18'32"N, 113°04'40"W) on the south bank of Birch River bearing 079T at 7.8 km (4.9 miles) from the mouth of Alice Creek. The top of unit II can be seen about one-half way up the slope. (Photograph No. 1390-9, AWN, 1979).

PLATE 2

Beds of unit IV and V of the Waterways Formation exposed at station 22NB (58°18'40"N, 113°07'35"W) on the southwest bank of Birch River bearing 071T at 4.9 km (3.1 miles) from the mouth of Alice Creek. Field assistant is standing on top of unit IV. (Photograph No. 1390-20, AWN, 1979).

PLATE 3

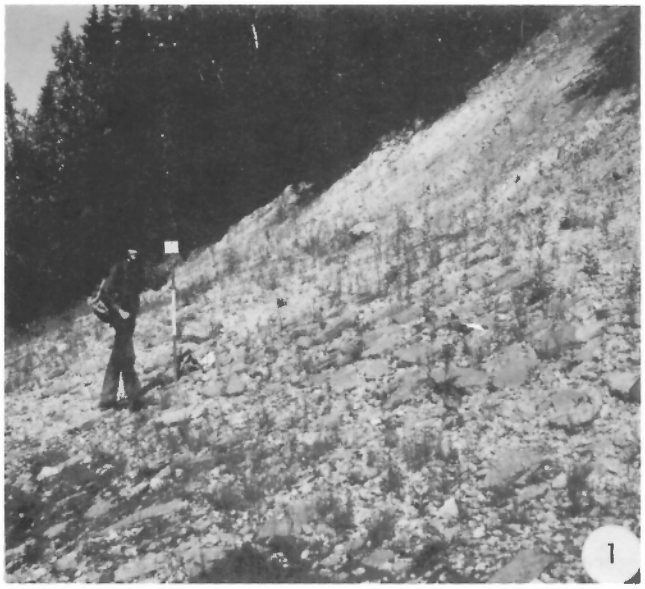
Beds of units IV, V and VI of the Waterways Formation exposed at station 18NB (58°18'30"N, 113°08'35"W) on the east bank of Birch River bearing 069T at 4.3 km (2.7 miles) from the mouth of Alice Creek. The top of unit IV is marked by the field assistant's feet. (Photograph No. 1390-14, AWN, 1979).

PLATE 4

Beds of units VI and VII of the Waterways Formation exposed at station 17NB (58°18'20"N, 113°09'00"W) on the south bank of Birch River bearing 071T at 3.2 km (2 miles) from the mouth of Alice Creek. The right hand of the field assistant is near the eroded top of unit VII. (Photograph No. 1390-11, AWN, 1979).

PLATE 5

Beds of the Calumet (Calmut) Member of the Waterways Formation exposed on the west bank of Athabasca River, 93 km (58 miles) below Fort McMurray. This is the nearest exposure of Calumet beds to those along Birch River containing some closely comparable brachiopods, two of which are illustrated from this locality in this report. (Photograph No. 1390-4, AWN, 1956).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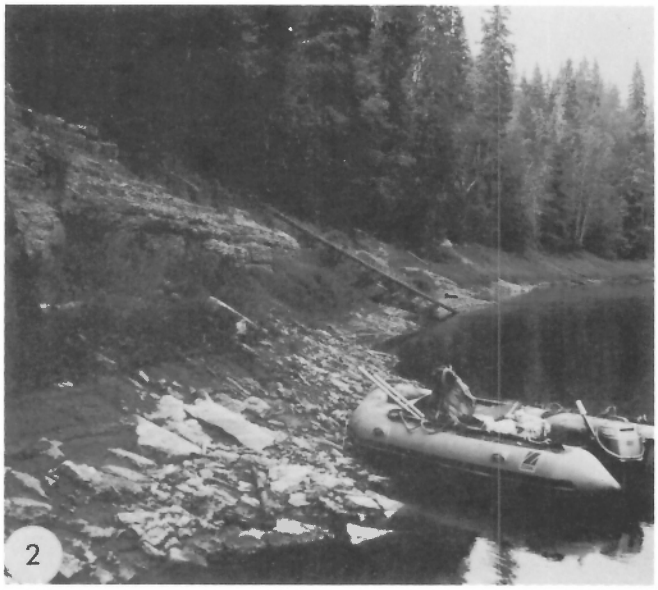
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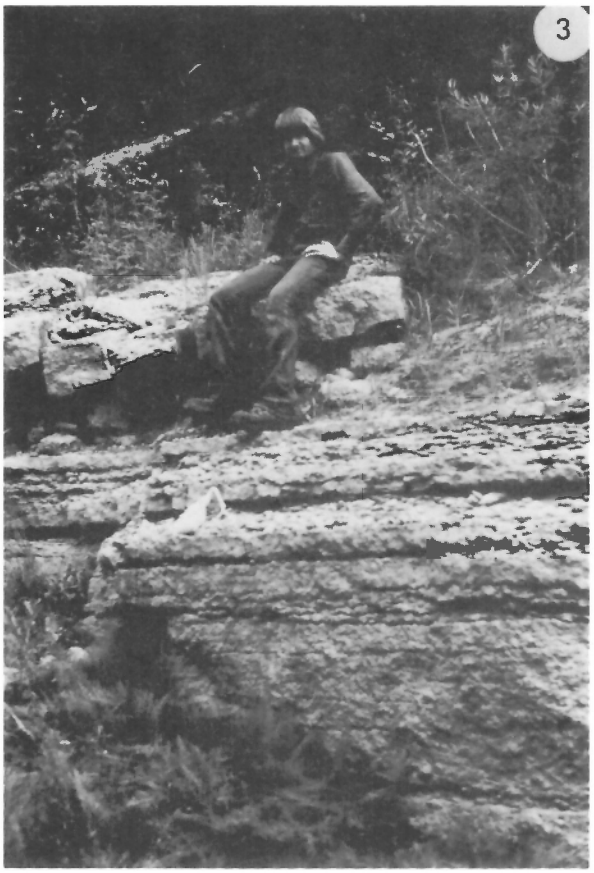
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4


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PLATE 6

All illustrated specimens are from beds of the Waterways Formation exposed along Birch River unless otherwise indicated.

Figures 1-10. Schizophoria sp. cf. S. lata Stainbrook. (page 14)

1-4. Pedicle (1), brachial (2), anterior (3) and lateral (4) views of a young individual, x1, GSC 63018, GSC loc. C-74172.

5-7. Pedicle (5), lateral (6) and anterior (7) views of a thin young adult individual, x1, GSC 63019, GSC loc. C-74172.

8-10. Brachial (8), anterior (9) and lateral (10) views of a thin, wide, mature adult individual, x1, GSC 63020, GSC loc. C-74181.

Figures 11-13. Strophodonta (Strophodonta) sp. A. (Page 14)

11-12. Pedicle (11) and lateral (12) views of an adult individual, x1, GSC 63021, GSC loc. C-74172.

13. View of interior brachial valve of a large individual partly embedded in matrix, x1, GSC 63022, GSC loc. C-74177.

Figures 14-15. Nervostrophia sp. (page 15)

14. View of exterior of pedicle valve of a fragmentary specimen embedded in matrix, x1, GSC 63023, GSC loc. C-74192.

15. View of interior pedicle valve of a specimen embedded in matrix, x1, GSC 63024, GSC loc. C-74192.

Figures 16-22. Eostrophalosia sp. cf. E. pedderi Crickmay (page 15)

16-22. Pedicle views (16-17), x1, x2, brachial views (18-19), x1, x2, posterior (20), x1, lateral and anterior views (21-22), x2, of a mature adult individual, GSC 63025, GSC loc. C-74192.

Figures 23-26. Devonoproductus sp. cf. D. tertius Crickmay (page 15)

23. View of exterior of pedicle valve of a specimen embedded in matrix, x4, GSC 63026, GSC loc. C-74182.

24. View of interior of brachial valve of a specimen embedded in matrix, x4, GSC 63027, GSC loc. C-74182.

25. View of exterior of brachial valve of an abraded specimen embedded in matrix, x4, GSC 63028, GSC loc. C-74190.

26. View of exterior of pedicle valve of a specimen embedded in matrix, x4, GSC 63029, GSC loc. C-74193.

Figures 27-32. Ladogioides asmenista (Crickmay) (page 16)

27-32. Pedicle valve (27-28), x4, x2, the former showing radial micro-ornament, brachial (29), posterior (30), anterior (31), and lateral (32) views of an elongate adult individual, x2, GSC 63030, GSC loc. C-74192.

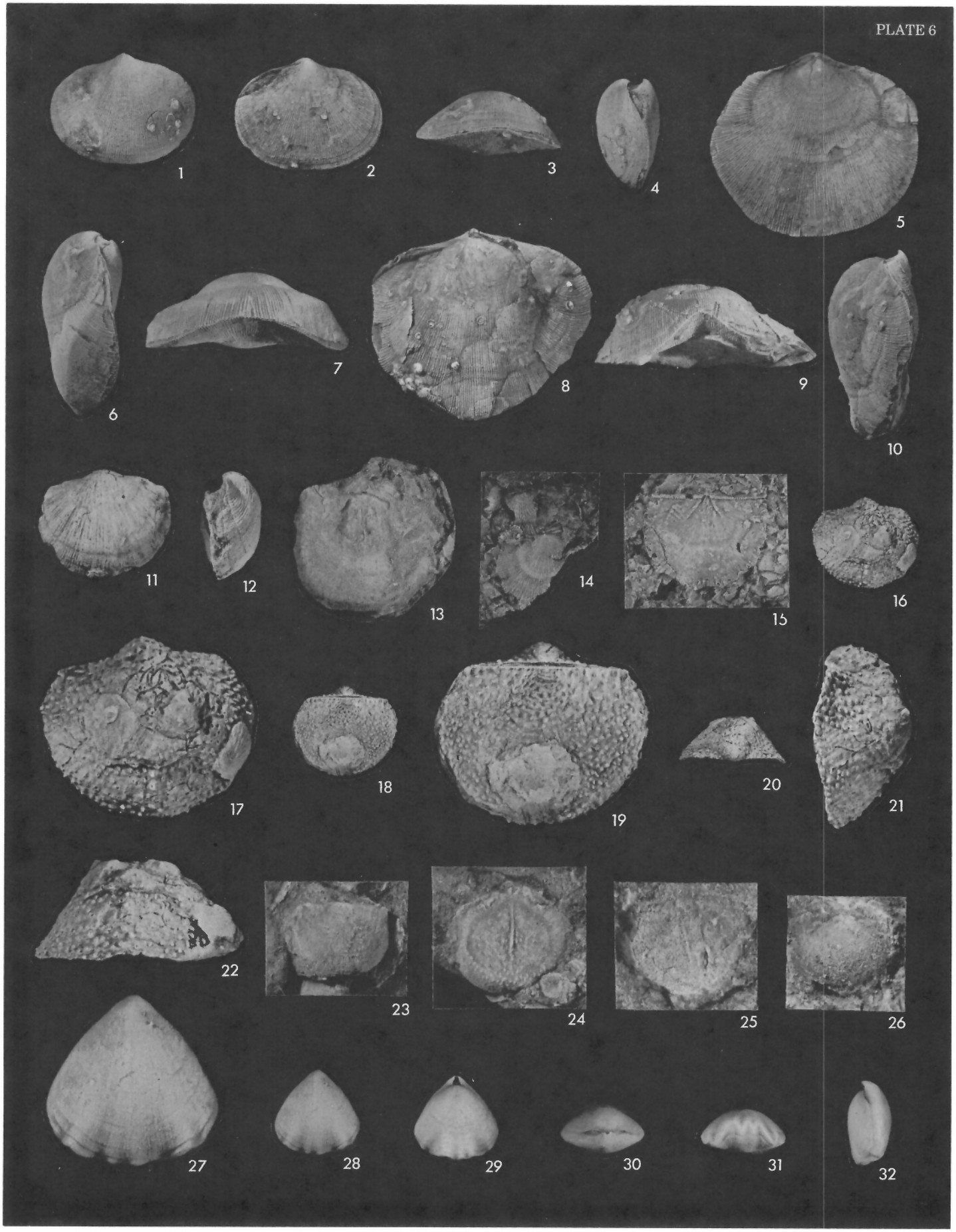
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PLATE 7

All illustrated specimens are from beds of the Waterways Formation exposed along Birch River unless otherwise indicated.

Figures 1-12. Ladogioides asmenista (Crickmay) (page 16)

1-6. Pedicle views (1-2), x2, x1, brachial (3), posterior (4), anterior (5) and lateral (6) views of an adult individual of medium width, x2, GSC 63031, GSC loc. C-74192.

7-12. Pedicle views (7-8), x1, x2, posterior (9), brachial (10), lateral (11) and anterior (12) views of a broad adult individual, x2, GSC 63032, GSC loc. C-74192.

Figures 13-20. Variatrypa (Radiatrypa) clarkei (Warren) (page 17)

13-15. Pedicle (13), x1, brachial (14), x2, and lateral (15) views, x1, of a young, incomplete specimen, GSC 63033, GSC loc. C-74171.

16-20. Pedicle (16), brachial (17), posterior (18), lateral (19), and anterior (20) views of a partly abraded, elongate adult individual, x1, GSC 63034, GSC loc. C-74171.

Figures 21-27. Pseudoatrypa? sp. cf. P.? blackhawkensis (Stainbrook) (page 17)

21-25. Brachial (21), pedicle (22), posterior (23), lateral (24), and anterior (25) views of an adult individual of medium width, x1, GSC 63035, GSC loc. C-74193.

26-27. Brachial (26), and pedicle (27) views of a broad adult individual partly embedded in matrix, x1, GSC 63036, GSC loc. C-74185.

Figures 28-38. Pseudoatrypa sp. cf. P. gigantea (Webster) (page 18)

28. Pedicle view of an adult individual, x1, GSC 63037, GSC loc. C-74172.

29-33. Pedicle (29), brachial (30), lateral (31), posterior (32) and anterior (33) views of a young individual, x1, GSC 63038, GSC loc. C-81282; from beds near base of section of the Calumet Member of the Waterways Formation outcropping on the west bank of Athabasca River 58 miles (93 km) below Fort McMurray.

34-38. Posterior (34), brachial (35), lateral (36), anterior (37), and pedicle (38) views of an adult individual, x1, GSC 63039, GSC loc. C-81282; from beds near base of section of the Calumet Member of the Waterways Formation outcropping on the west bank of Athabasca River 58 miles (93 km) below Fort McMurray.

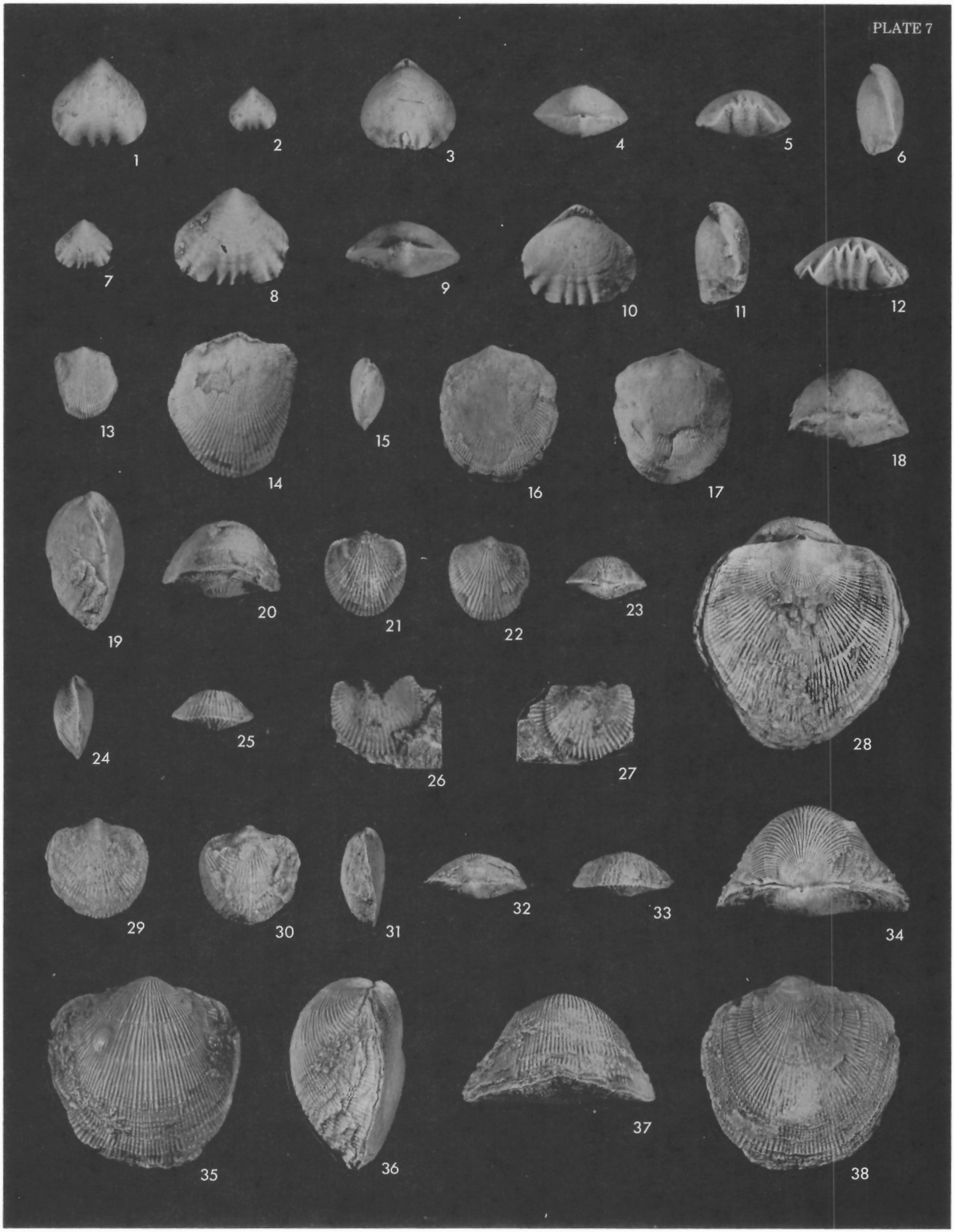
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PLATE 8

All illustrated specimens are from beds of the Waterways Formation exposed along Birch River unless otherwise indicated.

Figures 1-6. Spinatrypina (Exatrypa) sp. A. (page 19)

1. View of part of brachial valve of an adult individual embedded in matrix, x1, GSC 63040, GSC loc. C-74171.

2-6. Pedicle (2), brachial (3), posterior (4), anterior (5), and lateral (6) views of a young adult individual, x1, GSC 63041, GSC loc. C-81277; from beds of the Calumet Member of the Waterways Formation outcropping on the west bank of Athabasca River 58 miles (93 km) below Fort McMurray.

Figures 7-12. Athyris parvula Whiteaves. (page 19)

7-12. Pedicle (7-8), x1, x2, brachial (9-10), x1, x2, lateral (11), and posterior (12) views, x2, of a young adult individual, GSC 63042, GSC loc. C-74175.

Figures 13-17. Nucleospira? sp. (page 20)

13-17. Brachial (13-14), x1, x2, pedicle (15), lateral (16), x1, posterior (17), x2, views of an abraded adult individual, GSC 63045, GSC loc. C-74192.

Figures 18-24. Tecnocyrtina sp. A. (page 21)

18-22. Pedicle (18-19), x1, x2, brachial (20), posterior (21), and lateral (22) views, x2, of a young adult individual, GSC 63043, GSC loc. C-74177.

23-24. Pedicle (23) and lateral (24) views of an adult individual, x2, GSC 63044, GSC loc. C-74172.

Figures 25-27. Allanella minutilla Crickmay (page 23)

25-27. Pedicle (25-26), x1, x2, and lateral (27), x2, views of an adult individual partly embedded in matrix, GSC 63046, GSC loc. C-74177.

Figures 28-31. Eleutherokomma sp. cf. E. impennis Crickmay (page 21)

28-29. Views of pedicle valve of a relatively narrow individual embedded in matrix, x1, x2, GSC 23047, GSC loc. C-74175.

30. View of brachial valve of a relatively broad individual embedded in matrix, x2, GSC 63048, GSC loc. C-74175.

31. View of pedicle valve of a broad adult individual embedded in matrix, x2, GSC 63049, GSC loc. C-74175.

Figures 32-40. Eleutherokomma sp. cf. E. jasperensis (Warren) (page 22)

32-38. Views of pedicle valve (32-33), x3, x1, the former showing micro-ornament; brachial valve (34-35), x1, x2, lateral (36), anterior (37), and posterior (38) views, x2, GSC 63050, GSC loc. C-74192.

39-40. Views of brachial valve (39, 40), x2, x1, of an individual embedded in matrix showing almost complete preservation of extended mucron, GSC 63051, GSC loc. C-74192.

Figure 41. Cranaena sp. (page 23)

41. View of pedicle valve of an incomplete adult individual embedded in matrix, x1, GSC 63052, GSC loc. C-74177.

Figure 42. Petrocrania sp. (page 13)

42. View of brachial valve of specimen attached to a crushed shell of Schizophoria sp. cf. S. lata Stainbrook, x1, GSC 63053, GSC loc. C-74181.

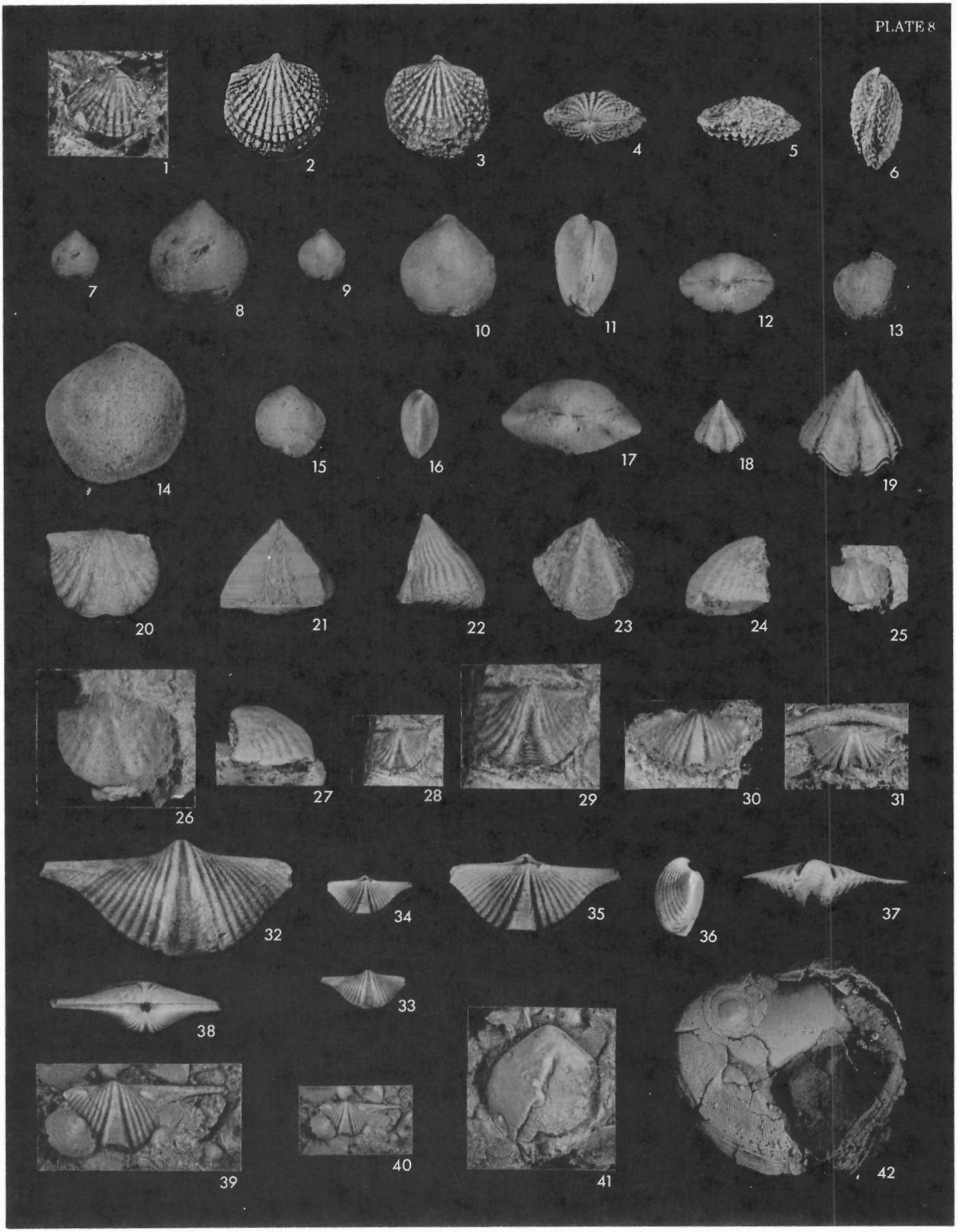
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PLATE 9

All figures x37 unless otherwise noted.

Figures 1-5, 8, 9, 16-21, 28, 29. Ancyrodella rotundiloba rotundiloba (Bryant) (page 24)

1, 2. GSC 63054, upper and lower views of juvenile Pa element, Unit V, GSC loc. C-74198.

3-5. GSC 63055, upper, lateral and lower views of juvenile Pa element, Unit VII, GSC loc. C-74182.

8, 9. GSC 63056, upper and lower views of Pa element, transitional to A. rotundiloba binodosa Uyeno, Unit I, GSC loc. C-74169.

16, 17. GSC 63057, upper and lower views of Pa element, Unit V, GSC loc. C-74198.

18. GSC 63058, upper view of Pa element, Unit VII, GSC loc. C-74182.

19-21. GSC 63059, upper, outer lateral and lower views of Pa element, Unit VII, GSC loc. C-74183.

28, 29. GSC 63060, upper and lower views of Pa element, Unit IV, GSC loc. C-74190.

Figures 6, 7, 10, 11, 25-27. ?Mesotaxis asymmetrica (Bischoff and Ziegler). (page 26)

6, 7, 25. GSC 63061, upper, lower and upper views of Pa element, Unit VI, GSC loc. C-74185; fig. 25 at x80.

10, 11, 26. GSC 63062, upper, lower and upper views of Pa element, Unit VI, GSC loc. C-74185; fig. 26 at x120.

27. GSC 63063, upper view of Pa element, Firebag Member, Waterways Formation, Alberta Government Salt Well No. 1, located at Lot 8, McMurray townsite, tp. 89, rge. 9, W4th mer., Alberta, at depth interval of 146.3 to 149.4 m (480 to 490 ft), GSC loc. 80264; see Uyeno, 1974, p. 62-63, Table 4(b).

Figures 12, 13. Pandorinellina cf. P. insita (Stauffer). (page 27)

12, 13. GSC 63064, right-lateral and left-lateral views of Pa element with a small lateral denticle, Unit IV, GSC loc. C-74172.

Figures 14, 15. Pandorinellina insita (Stauffer). (page 27)

14. GSC 63065, right-lateral view of Pa element, Unit IV, GSC loc. C-74190.

15. GSC 63066, right-lateral view of Pa element, Unit IV, GSC loc. C-74172.

Figures 22-24. Ancyrodella rotundiloba binodosa Uyeno. (page 24)

22-24. GSC 63067, upper, inner lateral and lower views of Pa element, Unit IV, GSC loc. C-74171.

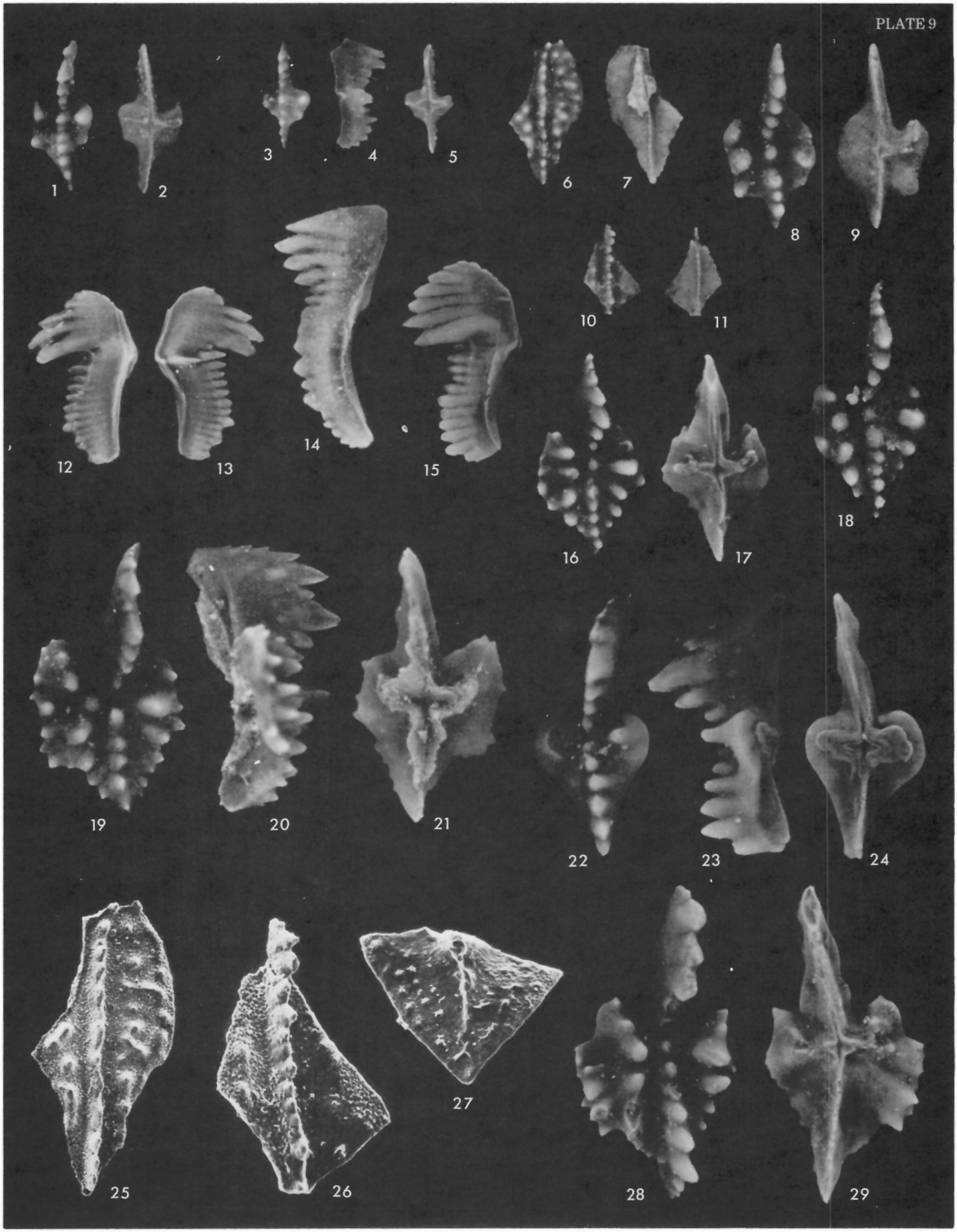
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PLATE 10

All figures x37 unless otherwise noted.

Figures 1-13. Icriodus subterminus Youngquist. (page 25)

1-3. GSC 63068, upper, lateral and lower views of I element, Unit II, GSC loc. C-74175.

4, 5. GSC 63069, upper and lateral views of I element, Unit V, GSC loc. C-74198.

6-8. GSC 63070, upper, inner lateral and lower views of I element, Unit IV, GSC loc. C-74172.

9, 10. GSC 63071, upper and lateral views of I element, Unit V, GSC loc. C-74198.

11-13. GSC 63072, upper, lateral and lower views of I element, Unit IV, GSC loc. C-74172.

Figures 14-22. Icriodus cf. I. subterminus Youngquist. (page 25)

14-16. GSC 63073, upper, inner lateral and lower views of I element, Unit VI, GSC loc. C-74187.

17-19. GSC 63074, upper, inner lateral and lower views of I element, Unit II, GSC loc. C-74175.

20-22. GSC 63075, upper, inner lateral and lower views of I element, Unit IV, GSC loc. C-74172.

Figure 23-27. Icriodus subterminus Youngquist. (page 25)

All from Unit V, GSC loc. C-74198.

23. GSC 63076, upper view of I element; x85.

24. GSC 63077, lateral view of I element; x80.

25. GSC 63078, lateral view of S_{2a} element; x80.

26. GSC 63079, lateral view of S_{2b} element; x95.

27. GSC 63080, lateral view of S_{2c} element; x95.

Figures 28-32. Ozarkodina brevis (Bischoff and Ziegler) (page 26)

28. GSC 63081, lateral view of Pa element, Unit IV, GSC loc. C-74191; x120.

29. GSC 63082, lateral view of Pa element, Unit VI, GSC loc. C-74187; x120.

30. GSC 63083, lateral view of Pa element, Unit VI, GSC loc. C-74187; x75.

31. GSC 63084, upper view of Pa element, Unit VI, GSC loc. C-74187; x75.

32. GSC 63085, lower view of Pa element, Unit VII, GSC loc. C-74182; x80.

Figures 33, 34. Elsonella rhenana Lindström and Ziegler. (page 25)

33. GSC 63086, lateral view of falcodontan element, Unit IV, GSC loc. C-74190; x80.

34. GSC 63087, posterior view of lippertiform element, Unit VI, GSC loc. C-74185; x70.

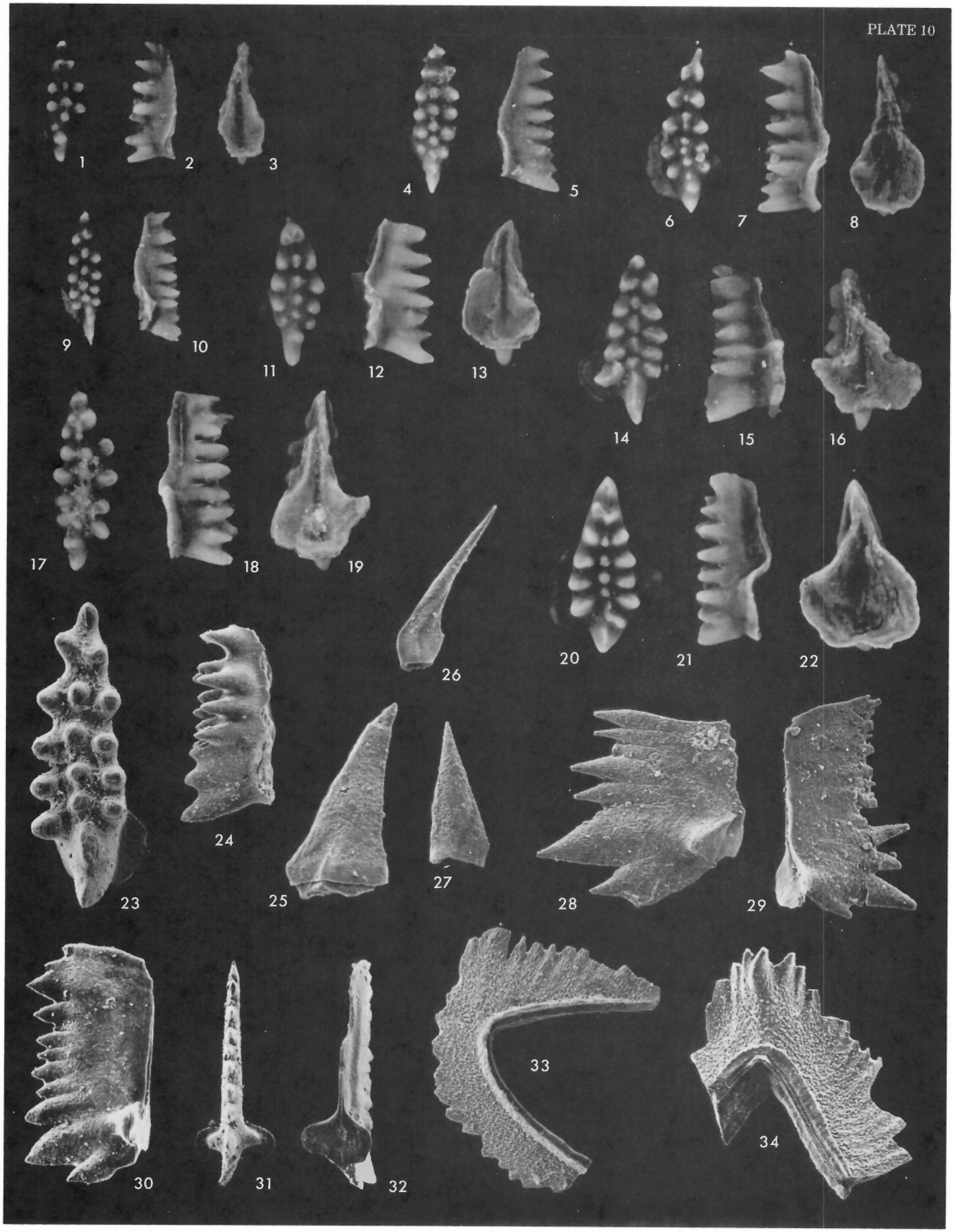
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PLATE 11

All figures x37 unless otherwise noted.

Figures 1-6, 12-15. Polygnathus webbi Stauffer. (page 27)

1-3. GSC 63088, upper, outer lateral and lower views of Pa element, Unit VI, GSC loc. C-74187.

4-6. GSC 63089, upper, inner lateral and lower views of juvenile Pa element, Unit IV, GSC loc. C-74191.

12-14. GSC 63090, upper, inner lateral and lower views of Pa element, Unit IV, GSC loc. C-74172 (pit and basal cavity partly obscured by basal attachment).

15. GSC 63091, inner lateral view of juvenile Pa element with acicular free blade, Unit VI, GSC loc. C-74199; x70 (note basal attachment).

Figures 7-11. Polygnathus cf. P. decorosus Stauffer. (page 27)

7-9. GSC 63092, upper, outer lateral and lower views of Pa element, Unit VI, GSC loc. C-74189.

10. GSC 63093, inner lateral view of juvenile Pa element, Unit IV, GSC loc. C-74196; x70.

11. GSC 63094, inner lateral view of juvenile Pa element, Unit VI, GSC loc. C-74189; x70.

Figures 16-18, 32-39. Pandorinellina insita (Stauffer). (page 27)

16. GSC 63095, lateral view of Sa element, Unit IV, GSC loc. C-74191.

17, 18. GSC 63096, right-lateral and upper views of Pa element, Unit VI, GSC loc. C-74189.

32, 33. GSC 63097, right-lateral and upper views of Pa element, Unit I, GSC loc. C-74169.

34, 35. GSC 63098, right-lateral and lower views of Pa element, Unit V, GSC loc. C-74193.

36, 37. GSC 63099, right-lateral and lower views of Pa element, Unit IV, GSC loc. C-74190.

38, 39. GSC 63100, right-lateral and upper views of Pa element, Unit IV, GSC loc. C-74172.

Figures 19-21, 29-31. Polygnathus aff. P. incompletus Uyeno. (page 27)

19-21. GSC 63101, upper, outer lateral and lower views of Pa element, Unit IV, GSC loc. C-74195.

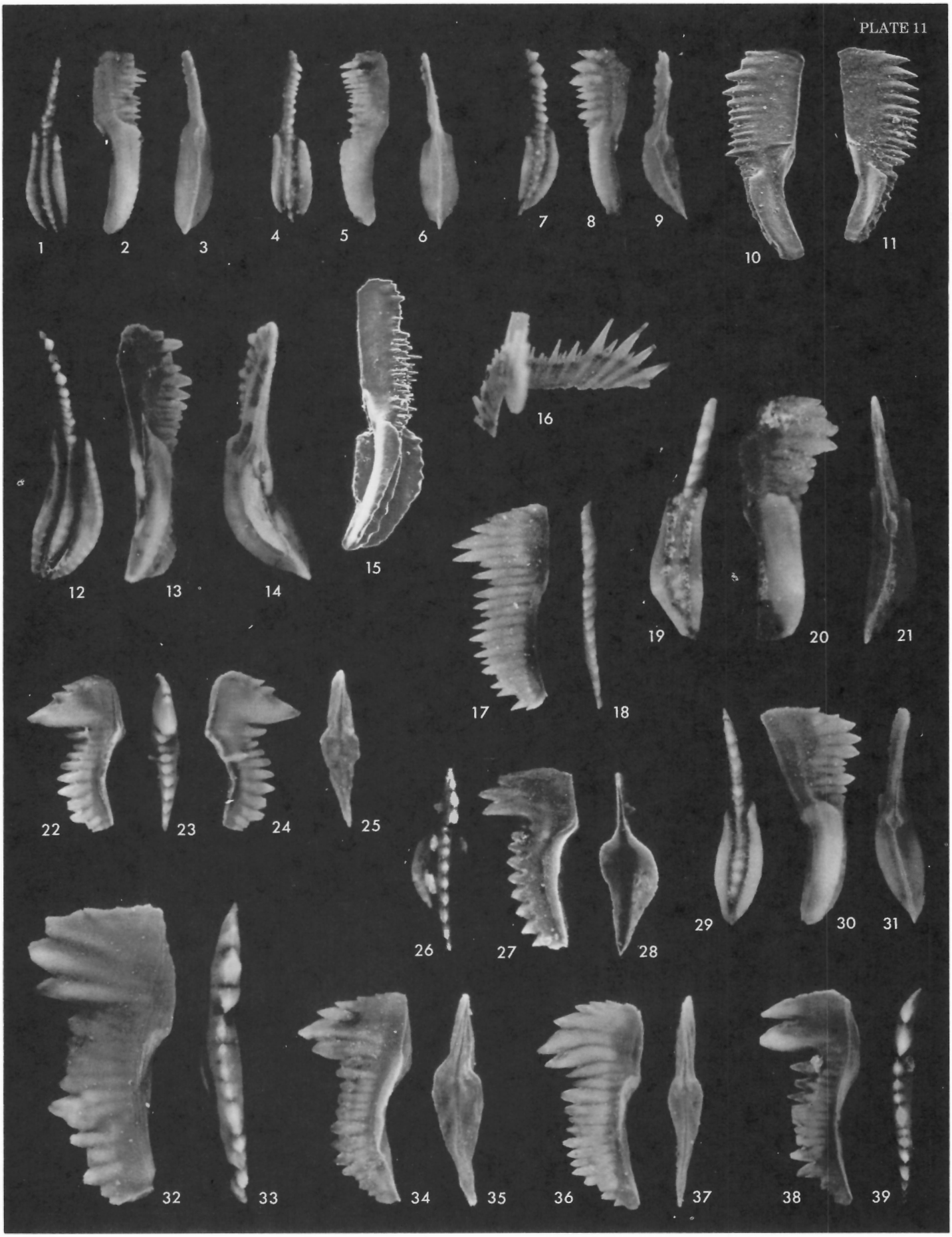
29-31. GSC 63102, upper, inner lateral and lower views of Pa element, Unit IV, GSC loc. C-74197.

Figures 22-25. Pandorinellina cf. P. insita (Stauffer). (page 27)

22-25. GSC 63103, right-lateral, upper, left-lateral and lower views of Pa element with a small lateral denticle, Unit II, GSC loc. C-74175.

Figures 26-28. Pandorinellina expansa Uyeno and Mason (page 27)

26-28. GSC 63104, upper, inner lateral and lower views of topotype Pa element, Eids Formation, 6.1 m (20 ft) above its base, Bathurst Island, Arctic Archipelago (locality 2 of Uyeno and Mason, 1975; GSC loc. 83703).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