Conodonts of the Middle Ordovician Table Head Formation, western Newfoundland

Svend Sandbergh Stouge

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Conodonts of the Middle Ordovician Table Head Formation, western Newfoundland

SVEND SANDBERGH STOUGE

The transgressive Table Head Formation has been described and sampled from eight localities on Great Northern Peninsula, western Newfoundland. The Table Head sediments all along the westcoast of Newfoundland are comparable, but the thickness of the different units varies considerably. The detailed investigation of the rocks revealed that carbonate accumulation was interrupted by 'catastrophic' downwarps of the shelf. These may be related to the emplacement of the allochthons. Two Phylozones and four local assemblage-zones are defined. The phylozones are based on phylogenetically related species of *Histiodella*. The species from the basal lower Table Head belong to Midcontinent Fauna 4. The North Atlantic Province conodonts from the middle Table Head correlate with *Eoplacognathus suecicus* Zone and *E. suecicus–P. sulcatus* Subzone of Scandinavia. The Table Head strata accumulated in lagoonal, shelf (inner–outer) and slope environments. The lateral distribution of conodonts has been directly related to these depositional environments, and a sequence of three biofacies and three subbiofacies is introduced. The conodont fauna is described in multielement taxonomy, and a suprageneric classification is applied. Thirty-five genera and 70 species are described of which two genera and 20 species are new. The Superfamily Panderodontacea Lindström is subdivided into the families Acanthodontidae, Panderodontidae, and the new family Cornuodontidae.

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Contents

Introduction

The Table Head Formation of the Great Northern Peninsula, western Newfoundland, is composed in ascending order of marine carbonates, interstratified carbonates and shales, and black shales. These sediments were deposited during the marine transgression in the early part of the Champlainian Epoch of the Ordovician Period. Table Head strata can be traced from Noddy Bay in the north to Cape Cormorant on Port au Port Peninsula in the south, a distance of over 400 km. Table Head strata are exposed from Cape Cormorant in the west to Hare Bay in the east, which is a distance of over 200 km. The area of study is within the central part of Great Northern Peninsula (Fig. 1).

Geological Setting

The Great Northern Peninsula forms part of the westernmost geologic–tectonic division of Newfoundland (Williams 1964; Williams *et al.* 1974; Williams 1978a, b; Fig. 1. herein). The geology of the western Humber zone consists of a Precambrian (Grenvillian) crystalline basement overlain by autochthonous lower Paleozoic sediments that occur in a broad north-trending belt. The lower Paleozoic is represented by autochthonous platform carbonates and clastics, including a basal Lower Cambrian shallow water sandstone unit. The sediments of this unit are derived from the west. The lower part of the carbonates and sandstones is the Labrador Group (Lower Cambrian). The overlying
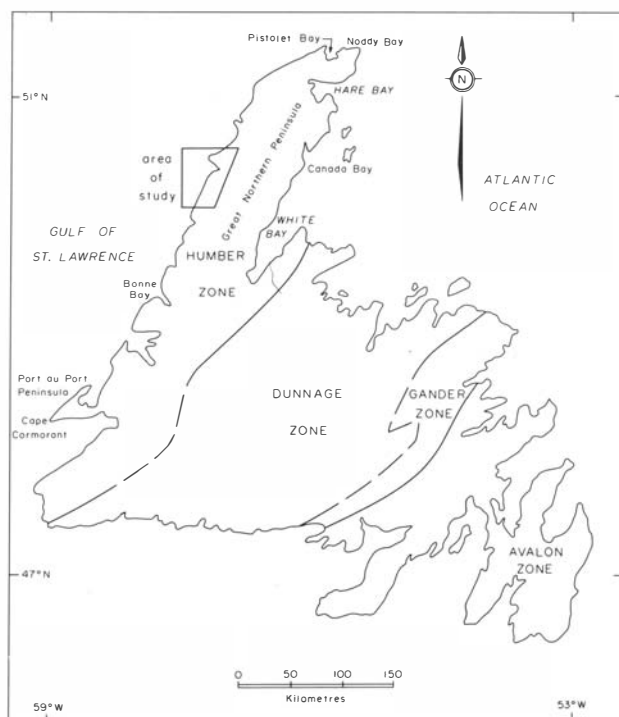
Fig. 1. The geologic–tectonic divisions of Newfoundland (after Williams 1964; Williams *et al.*, 1974; Williams 1978a, b) and location of the area investigated in this study.

Unnamed Group (Upper Cambrian) and the St. George Group (Lower/Middle Ordovician) represent a stable shallow-water carbonate bank that covered all of west Newfoundland by Late Cambrian time (Knight 1977a, b; 1978; Knight & Saltman 1980; Levesque 1977). The Table Head Formation rests on the St. George Group (Schuchert & Dunbar 1934). Table Head strata include rubbly weathering, poorly bedded limestones, limestones and black to brown shales. Due to the transgressive nature of the sedimentation the formation is diachronous and forms a westward migrating series of bank edge, slope to basinal deposits (Stevens 1970). The upper autochthonous succession comprises a sequence of flysch deposits, which were derived from the east in contrast to the lower units.

Allochthonous sequences as recognized in western Newfoundland are (1) the Cow Head Group, consisting of a condensed succession of carbonate breccias with intercalated thin beds of limestone and shale; (2) the Humber Arm Group, which include clastic sequences and carbonate breccias, limestone beds and shales (these are interpreted as distal facies equivalents to the Cow Head Group; Stevens 1970); and (3) an ophiolite sequence, which forms the uppermost allochthonous slices (Stevens 1970).

The strata are succeeded by neoautochthonous marine upper Middle Ordovician carbonates (Long Point Group) and continental red, clastic sediments of (?Late Ordovician to) Silurian age.

Previous work and development of ideas

Richardson (in Logan 1863) designated stratigraphic units by letters of the alphabet. Some of the units in this older classification were never clearly defined and in some cases a type section was not specified. Moreover, Richardson's descriptions, correlations and stratigraphic successions did not correspond to the stratigraphy of the actual rocks (Schuchert & Dunbar 1934). Therefore, the concepts of the stratigraphy of certain divisions have changed considerably from author to author (Schuchert & Dunbar 1934; Whittington & Kindle 1963; Woodard 1957; Cumming 1967a, b; Table 1).

The lithostratigraphic nomenclature used within the study area is derived from the work of Schuchert & Twenhofel in 1910 and Schuchert & Dunbar in 1918, which was the first great step forward in the understanding of the geology of the west coast of Newfoundland.

Schuchert & Dunbar (1934) divided the Table Head Formation into three units which they informally labelled lower, middle, and upper Table Head. They also noted that the Table Head Formation rests on the St. George Group with a disconformity and that the upper boundary of Table Head Formation possibly is conformable, though they noted that the uppermost beds are disrupted and disturbed. They reported the thickness of upper Table Head to be 300 feet (100 metres).

Schuchert & Dunbar (1934) based the boundary between the St. George and Table Head divisions on the presence of a regional disconformity between the two. This boundary also coincided with the boundary between the Lower and Middle Ordovician. The boundary was later described as a

surface with karst topography and associated Pb–Zn mineralization (Collins & Smith 1972, 1975). The time gap should correspond to 10–15 million years (Collins & Smith 1972, 1975). Fåhræus (1977b), Knight (1977b), and Levesque (1977) described the contact as conformable, because the karst topography is not evident in coastal exposures. The breccia-filled fractures penetrating vertically into the upper strata of St. George are interpreted to represent a stratum-bound collapse breccia related to solution of evaporites (Knight 1977b; Beales & Hardy 1980; see James 1979). This led to the conclusion that earlier definitions of lithostratigraphic units such as the St. George and Table Head Group/Formation were not definitive, because rock units to which these names have been commonly applied, are actually stratigraphically recurrent and laterally diverse facies (Woodard 1957; Stevens 1970; Knight 1977a, b; Levesque 1977).

Recent biostratigraphical data show that a faunal hiatus (Flower 1978; Fåhræus 1977a, b; Fortey 1979, 1980; Stouge 1978a, b, in press) is present, and this could support the presence of a disconformity. Because the uppermost St. George is developed as non-fossiliferous dolostones, the stratigraphic interpretation of this succession is equivocal. It could represent either a depositional hiatus or continuing deposition of non-fossiliferous strata. In general, however, it is agreed upon that the disconformity is present to the south, on Port au Port Peninsula, whereas the boundary is conformable to the north in the Hare Bay area (e.g., Flower 1978; Fåhræus 1977b; Stouge 1981, in press).

Whittington & Kindle (1963) described the stratigraphic succession and the ranges of trilobites of the Table Head Formation at Table Point. They corrected the thickness of upper Table Head from the 300 feet of Schuchert & Dunbar (1934) to 30 feet (10 m). They also noted that the middle Table Head strata are predominantly slumped at Table Point. They found Table Head trilobites in the 'Isolated Blocks' of Schuchert & Dunbar (1934). Rather than changing the name Table Head, Whittington & Kindle (1963) recommended continued application of the name Table Head for the formation, so well established in the literature for the rocks at Table Point; a practice that has been followed since.

Recent work is concentrated on detailed investigations and reclassifications of Lower and Middle Ordovician rock successions on Port au Choix Peninsula (Kluyver 1975), Hawkes Bay to Cape Norman (Knight 1977a, b; 1978, 1980), Hare Bay (Stouge 1981), Canada Bay (Knight & Saltman 1980) and Port au Port to Eddies Cove West (Levesque 1977; Pratt 1979; Nelson 1955; Woodard 1957, Klappa *et al.* 1980).

The use of fossils for correlation of Ordovician rock units including Table Head strata in western Newfoundland dates back over one hundred years (i.e., to Logan 1863).

Taxonomic descriptions of faunas from the Table Head Formation were published by Billings (1865) and Raymond (1925). Cooper (1956, 1976) dated the formation as Whiterock (lower Middle Ordovician); he indicated that the Whiterockian genera *Orthidiella, Anomalorthis,* and *Rhysostrophia* are present in the Table Head Formation. The exact ranges of the brachiopod species occurring in the Table Head Formation are unknown. Flower (1978) recently

Table 1. History of stratigraphic nomenclature.

RICHARDSON IN LOGAN (1863)				SCHUCHERT & DUNBAR 1934		NELSON 1955	WOODARD 1957	WHITTINGTON & KINDLE 1963	KNIGHT 1977 a, b		THIS STUDY	
1861 Div.	1861 Loc.	1862 Div.	1862 Sub-Div.	Div.	Sub-Div.							
POINTE RICHE LIMESTONES	TABLE HEAD POINTE RICHE	N	3	TABLE HEAD SERIES — UPPER	20	TABLE HEAD GROUP — UPPER	TABLE HEAD GROUP — UPPER	TABLE HEAD FORMATION — UPPER	NEW GROUP	TABLE HEAD FORMATION — UPPER	TABLE HEAD FORMATION — UPPER	
			2	MIDDLE	19	MIDDLE	MIDDLE	MIDDLE		MIDDLE	MIDDLE	B4 / B3 / B2 / B1
			1		9							
12		M	2	LOWER	8	LOWER	LOWER	LOWER	ST. GEORGE GROUP	LOWER	LOWER	A3 / A2 / A1
11		L	4 / 1									
10		K	1		1							
9		I		ST. GEORGE SERIES		ST. GEORGE GROUP	ST. GEORGE GROUP	ST. GEORGE GROUP	SILICEOUS DOLOMITE FM & DIAGENETIC CARBONATE		ST. GEORGE GROUP	
8		H										
7		G										
6		F										

reported Whiterockian cephalopods from the Table Head. However, their distributions and ranges within the formation are unknown.

Detailed biostratigraphical analyses of Table Head strata have appeared in relatively recent years based on trilobites, graptolites and conodonts.

The trilobite faunas of the Table Head Formation were listed, and their range shown by Whittington & Kindle (1963), and monographed by Whittington (1965). Extensive collections from Table Point and Bellburns implied correlation with much of the Antelope Valley Limestone in Ikes Canyon, Nevada, and with trilobite Zones M and N of the Utah sections (Hintze 1953; Whittington & Kindle 1963). This fauna is of latest Arenig to early Llanvirn in age (Whittington 1968; Fortey 1979, 1980). Whittington (1968) furthermore considered the Table Head fauna at Table Point to correlate with the trilobite fauna in Bed 12 of the Cow Head Group.

Graptolites from the middle and upper Table Head belong to the *Paraglossograptus 'etheridgei'* Zone (Erdtmann 1971; Morris & Kay 1966). This is Zone 9 of Berry's (1960) graptolite zonation established in Texas. In terms of the Australian graptolite zonation (Thomas 1960), the Table Head fauna correlates with the *Diplograptus decoratus* Zone (or Da 3 Zone) of the Darriwil Stage (Finney & Skevington 1979). This is near or above the *Didymograptus 'bifidus'/ Didymograptus murchisoni* zonal boundary (Llanvirn; Finney & Skevington 1979). Erdtmann (1971) indicated that the fauna at Table Point was transitional between faunas 9 and 10 of Berry (1960), and was slightly younger than that of Black Cove in the south (Morris & Kay 1966).

Fåhræus (1970) reported on the conodonts from Table Point and Hare Bay to the north. He concluded that the faunas were mainly of early Llanvirn age, ranging from the top of *Didymograptus hirundo* Zone through the *D. bifidus* graptolite Zone. He also indicated that the middle Table Head conodont fauna to the north (Hare Bay) was as old as the fauna from the lower Table Head at Table Point. Subsequent work on conodonts (Fåhræus 1977a, b; Stouge 1977) has settled the age of the Table Head Formation as mainly Lower Llanvirn, or Midcontinent Fauna 4 of Sweet et al. (1971). Bergström et al. (1972) and Fåhræus (1977a, b) also showed that correlation of the middle Table Head with Bed 12 of the Cow Head Group, as Whittington (1968) suggested based on trilobites, could not be correct. Bed 12 is early middle Arenig age (Fåhræus & Nowlan 1978) or *Prioniodus (Oepikodus) evae* Zone of the Scandinavian conodont succession, and the middle Table Head is of early Llanvirn age.

Purpose of this study

The purpose of this study is to describe the lower Middle Ordovician (Whiterockian) conodont fauna and its succession at Table Point on the Great Northern Peninsula, Newfoundland, and to propose some tentative correlations on the basis of conodonts previously described from Europe and North America.

The distribution of conodonts relative to the rock type is also taken into consideration, and this is compared with present knowledge of the distribution of other fossil groups, in particular the trilobites.

Technique

Fieldwork for this study commenced in June, 1976, at Table Point, where the major part of the month was spent, mapping, measuring, and collecting samples from the sequence. From July onwards, detailed mapping and sample collection were continued in the Pistolet Bay area (Fig. 1). Late July fieldwork continued in the Hare Bay area in the northeast. In August section measuring and sample collection in the Port au Choix area commenced, and by the end of August reconnaissance in the Port au Port area was completed. In 1977 field work was concentrated at Table Point, with additional visits to Hare Bay and Canada Bay.

Eight sections were measured and studied. The sections are Table Point, Bellburns, Pointe Riche, Gargamelle Cove East and West, Back Arm, Port Saunders and St. John Island. The sections are readily accessible, though access to St. John Island is difficult at times of strong winds and heavy seas (i.e. throughout the field season). Most of the sections are generally well-exposed and structurally uncomplicated, though a combination of poor exposure and dolomitization confuse the interpretations at Back Arm. At Gargamelle Cove West structures are not well understood, and some questions still remain to be clarified. Collectively, the sections provide a reasonably comprehensive representation of rock units within the study area. Minor road sections and coastal exposures have added further information.

The sections were collected at regular intervals for conodont research and lithological study. The intervals were usually 5 to 10 metres within uniform lithologies. With a varied lithology and at lithologic boundaries, the collecting intervals were smaller or bed by bed. All rock types were collected and processed for content of conodonts.

Altogether 252 4–15 kg samples were collected of which 201 were processed.

Gross lithological characteristic were studied in the field. For detailed sediment investigation 88 thin sections and 42 acetate peels were studied, mainly to aid in classification of the sediments and the study of depositional environments involved. This investigation was concentrated on three of the sections, namely Table Point, Point Riche, and Back Arm East of Port au Choix.

The limestones were classified according to Folk's (1962) classification, and a combination of field observations and the results of laboratory research allowed an informal lithostratigraphic subdivision.

Processing of limestone samples for conodont studies followed standard procedure (Lindström 1964). The residues were washed through a sieve with the size of 63 μm (230 mesh) sieve. After heavy-liquid separation the residues were completely picked. Black shales of the upper Table Head were broken down with H_2O_2.

Stratigraphy

The study area

In the central part of the Great Northern Peninsula the Table Head Formation is exposed between Spudgels Cove in the south and St. John Island in the north. The study area includes the coastal exposures from Cliffy Point in the south to St. John Island in the north (Fig. 2).

This particular area has been important in previous work on Lower to Middle Ordovician stratigraphy and paleontology of western Newfoundland, and, indeed, North America as a whole. The section at Table Point has been chosen as the stratotype for the Tableheadian Substage of the Whiterockian Stage (Kay 1962; Fåhræus 1977b). Stratigraphy of the Pointe Riche Peninsula, St. John Island and Port au Choix areas has been the topic of controversy in separation of Table Head carbonates from St. George carbonates (Logan 1863; Schuchert & Dunbar 1934; Cumming 1967a, b, 1968; Woodard 1957). Port au Choix Peninsula has been used as the type area for subdivision of the St. George Group (Kluyver 1975), and part of the area has been subjected to detailed lithologic and paleo-environmental studies (Knight 1977a, b, 1978; Levesque 1977; Levesque *et al.* 1977; Pratt 1979; Klappa 1980; Klappa & James 1980).

Stratigraphical succession

The divisions of the lower Paleozoic succession in the study area are: (1) Lower – Middle Ordovician St. George Group; (2) the Middle Ordovician Table Head Formation and Table Cove sandstone and shale; and (3) the Middle Ordovician Cow Head Group and the overlying green sandstones (Schubert & Dunbar 1934).

The Lower – Middle Ordovician St. George Group, the Middle Ordovician Table Cove sandstone and shale, and Middle Ordovician Cow Head Group are not the topic of this study. They are only briefly discussed below.

St. George Group (Lower – Middle Ordovician)

The St. George Group was first named by Schuchert & Dunbar (1934) as the St. George Series. Later workers changed the rank to Group (Kluyver 1975; Knight 1977a, b) and to Formation (Whittington & Kindle 1963; Collins & Smith 1972; Levesque 1977; Levesque *et al.* 1977).

The St. George Group was divided by Kluyver (1975) and Knight (1977a, b; 1978) into several formations, whereas Levesque (1977), because of uncertainty of the precise meaning of older formation names, assigned St.
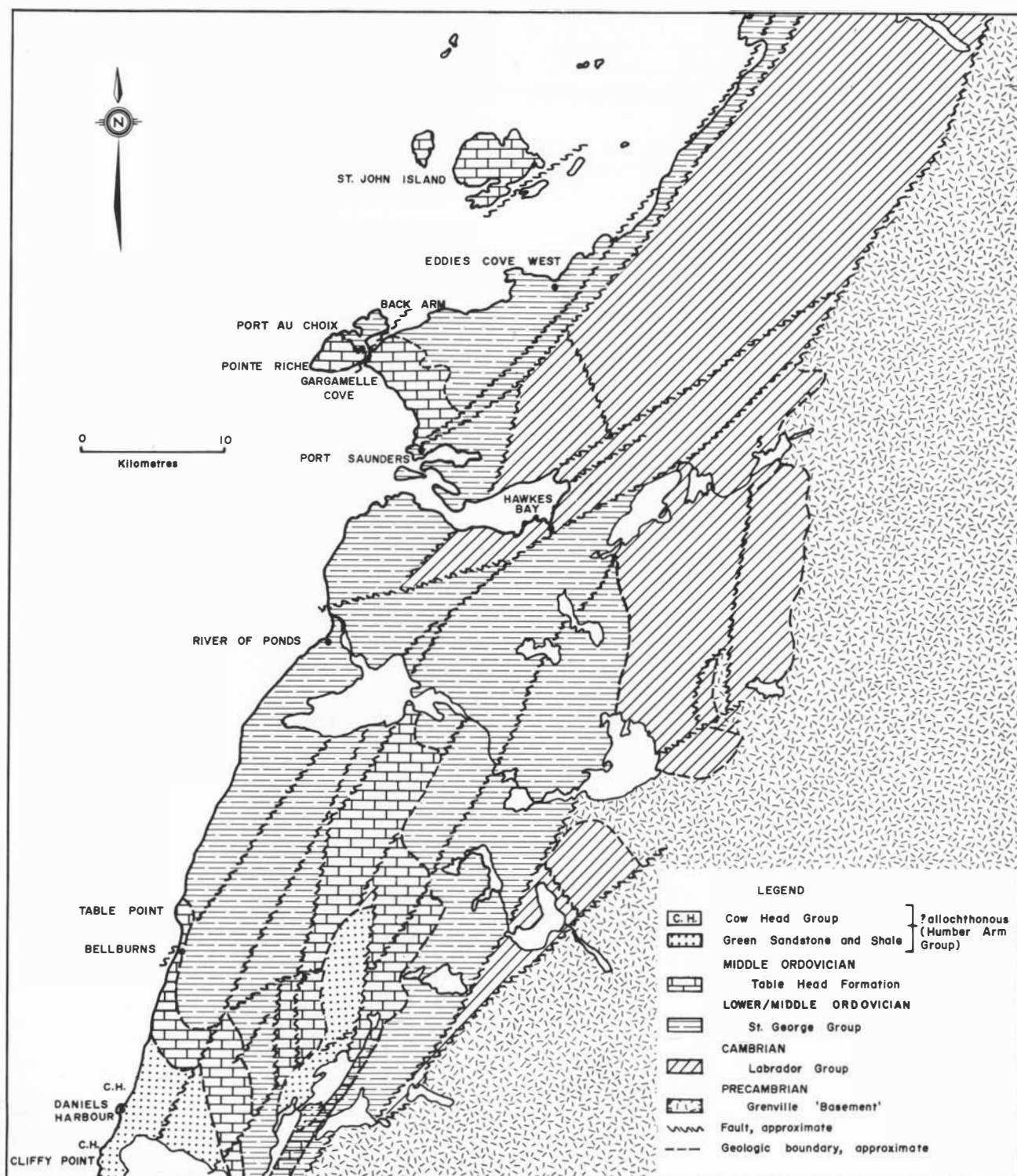
Fig. 2. Generalized geological and location map of the study area (modified after DeGrace 1974; Knight, personal communication 1976–1980; and this study).

George sediments to informal members designated by the word 'cyclic'. The ascending order of the formations are Watts Bight Formation, Boat Harbour formation, Catoche Formation, and 'Siliceous Dolomite' formation.

The St. George Group is mainly composed of carbonates, which vary considerably in composition and color. They are predominantly of supratidal to shallow-water subtidal origin. Cyclic stromatolite units at the base (Watts Bight Formation and Boat Harbour formation) alternate with primarily subtidal biomicrites and biosparites (Boat Har-

bour formation, and the Catoche Formation). The succession is followed by a cyclic dolomitic sequence of 'Siliceous Dolomite' formation of intertidal to supratidal environments.

The total range of the age of the St. George Group is not completely known at present. Flower (1978) reported on the succession of cephalopod faunas. He found the Canadian (Lower Ordovician) to be completely represented in the St. George. Whittington & Kindle (1969) reported upper Canadian shelly faunas from Port au Choix Peninsula.

Fortey (1979) described the trilobite fauna from the Catoche Formation, which is late Canadian age (Zone G–H of Ross and Hintze). Boyce (1978, 1979) reviewed the trilobite zones present in the St. George Group. According to him (Boyce 1978, 1979) the Zones B through G of Ross (1951) and Hintze (1953) are represented in the St. George. A faunal break corresponding to the Subzone G_l is present in the Boat Harbour formation. Cumming (1967c) and Collins & Smith (1972, 1975) recovered graptolites in the upper dolomitic part of the St. George, and they are of middle to late Arenig age. The St. George conodont faunal succession ranges from early Canadian (Midcontinent Fauna B of Ethington and Clark 1971) to late Canadian (Barnes & Tuke 1970). The top of St. George Group is of Whiterockian age (Midcontinent Fauna 2–4 of Sweet *et al.* 1971; Stouge, in press; this study).

Table Cove sandstones and shales (Middle Ordovician)

This informal name refers to the unnamed green sandstones and shales (Kindle & Whittington 1958), which overlie the Table Head Formation south of Table Point (Schuchert & Dunbar 1934; Hubert *et al.* 1977).

The sequence consists of graded-bedded, green to grey sandstones interbedded with grey micaceous siltstones. Load casts and flute casts are common sedimentary structures. The exposed thickness is about 42 m. The sequence is exposed along the shore in the tidal zone between Table Point and Table Cove. The upper boundary has not been observed and is probably not exposed in the study area.

Graptolites from this sequence are Zone 9–10 of Berry (1960), (D. Skevington, personal communication). This is equivalent to the upper Table Head (Erdtmann 1971; Finney & Skevington 1979).

Cow Head Group (Middle Ordovician)

In the southern part of the study area two localities are referred to the Cow Head Group. At Cliffy Point clasts of dominantly lower Table Head lithologic affinity are present. The clasts vary from walnut-size to 25 m in the maximum dimension. The matrix is grey micrite to sparite. Clasts of a white mottled dolomite of unknown affinity are also common. Daniel's Harbour Peninsula is composed of a calcareous breccia, with boulders of lower Table Head, middle Table Head and Table Cove lithologies. Graptolites indicate a Zone 9 age (Whittington & Richards 1969; Finney & Skevington 1979), which correlates with middle Table Head (Erdtmann 1971; Finney & Skevington 1979). The western part of the peninsula is dominated by clasts of a light-grey to white mottled dolomitized micrite with clear sparry calcite filled vugs; these clasts are of unknown or of St. George affinity.

Structure

The strata within the study area are generally gently warped, but locally they are more severely disrupted by faulting and folding. The major structural features are the Hawkes Bay Fault, the Sandy Fault at Port Saunders, and the Gargamelle Cove Fault; the Table Point – Bellburns syn- and anticlines (Fig. 3), and the fault on St. John Island, possibly an overthrust.

The major NNE-trending Hawkes Bay Fault extends inland and can be traced to Hawkes Bay east of the Study area. The fault is marked by spectacular dolomitized fault breccia zones. At Port Saunders, the Sandy Fault trends NNE and brings St. George Group in structural contact with the Table Head Formation, but the fault itself is not exposed. It is marked by a gravel beach that separates the outcrops of the two units.

The faults appear to be a combination of lateral and vertical displacement, as the Table Head Formation is exposed on both sides of the fault zone at Bellburns, but farther north strata of the St. George Group are juxtaposed against the Table Head Formation to the west. Similarly along the Back Arm – Gargamelle Cove Fault, strata of Table Head Formation are exposed on both sides of the fault in Gargamelle Cove, but Table Head strata on St. John Island to the west are juxtaposed against strata of St. George Group to the east on Hare Island.

Minor faults and joints within the Table Head Formation and the St. George Group are abundant. Displacement along these faults is not always directly measureable within the Table Head Formation, mainly due to the lack of marker beds. The faults are associated with white calcite veins and sometimes with pronounced slickensides. Most are vertical to steeply dipping although bedding plane faults are common. The importance and effect of the faults cannot be estimated, but it is believed that the thickness of the formation has been affected, as at Bellburns, where some beds are thrust over each other.

At Pointe Riche a fault breccia occurs trending NNE across the peninsula. A similar breccia is exposed at Gargamelle Cove East, but no direct evidence of a presence of a fault was observed.

St. John Island is a gentle dome. Point Riche is almost flat-lying but in detail it is very gently folded. Strata at Table Point, Table Cove and Bellburns are folded, and close to the fault zone in Table Cove the western limb of an anticline becomes very steep.

At Table Point and Bellburns strata at the hinges of the folds are completely recrystallized to large calcite crystals, surrounded by dolomitic aureoles of former limestone. Furthermore, the dolomitization is associated with calcite veins and dolomite dikes along joints or open fractures. On Point Riche Peninsula and St. John Island vuggy white dolomite cuts vertically through the section and also extends along mainly slumped layers i.e. the St. George/Table Head disconformity according to Cumming (1968). This dolomitization is associated with mineralization on St. John Island and has been described as 'pseudobreccia' (Cumming 1968).

The Cow Head facies at Daniel's Harbour and Cliffy Point is considered either to be transported (Stevens 1970; Hubert *et al.* 1977) or autochthonous (James *et al.* 1979; Finney & Skevington 1979). The outcrops are separated by gravel beaches, and no fault plane is exposed.

Table Head Formation and boundaries of the study area

The Table Head sequence is considered to have the rank of formation in this study.

Table 2. Lithostratigraphic units of the Table Head Formation. See Table 1 for comparison with other subdivisions.

FORMATION	MEMBER	SUBUNIT	PREDOMINANT LITHOLOGY
TABLE HEAD	upper		*Black shale with claystone and siltstone.*
	middle	B_4	*Black micrite, in places laminated, brown to black shale.*
		B_3	*Dark-grey, unsorted biosparite inter-bedded with brown shale.*
		B_2	*Black micrite interbedded with brown to black shale.*
		B_1	*Dark-grey, argillaceous biomicrite and biosparite.*
	lower	A_3	*Grey biomicrite and biosparite.*
		A_2	*Grey biomicrite and fine grained dolo-stone.*
		A_1	*Light-grey dolostone, micrite.*

The lowest occurrence of dark-grey argillaceous biomicrite, which is characterized by ostracodes, trilobites and cephalopods, unlike the St. George Group, which is almost free of fossils in its uppermost part, is chosen as a base for the formation in this study (Fig. 4). The top is the upper boundary of the upper Table Head.

The Table Head Formation is 340 m (1020 feet) in total thickness at Table Point (Formerly Table Head – the type section). The cliffs along the shore provide continuous exposure for about two kilometres from immediately north of Table Point to Table Cove (Fig. 3). Less continuous and shorter ranging sections are exposed on Pointe Riche Peninsula, St. John Island, Gargamelle Cove East to Port Saunders, and along the coast at Bellburns (Fig. 2). The upper Table Head is now known to be much thinner (Whittington & Kindle 1963), and the lower Table Head to be somewhat thinner (this study) than reported by Schuchert & Dunbar (1934).

For the purpose of this study the Table Head Formation is divided into lettered units (Table 2). The divisions are broadly similar to those of Schuchert & Dunbar (1934).

Lithological characteristics of the Table Head Formation

Rubbly-weathering micrites and mottled dolostone are the most characteristic and abundant rock types in the main part of the Table Head. They are associated with a variety of other limestone types (bioclastic, pelletoidal and arenaceous). Rocks that are predominantly detrital (silty limestones and shales), occur mainly in the upper part of the sequence. Because most of the rock types conform to Folk's

standard definitions and descriptions, they will not be described in detail.

The rubbly, argillaceous micrite, so characteristic of the formation, will, however, be described in some detail. This lithology consists of hard, irregular lumps of micrite (dismicrite) in an argillaceous matrix. The lumps are rarely larger than 2 cm (maximum diameter) and appear to be randomly oriented. Locally, the lumps are in contact with each other, but more commonly they are separated by zones of argillaceous material. The combination of resistant limestone lumps with a softer argillaceous matrix is responsible for the distinctive rubbly weathering of the rock in outcrop; commonly stratification is poorly defined in these units.

The limestone lumps consist of micritic calcite and microspar. The argillaceous material consists of clay- to silt-sized quartz, clay minerals, and dolomite. In some varieties of this rock type the dolomite is in the forms of rhombs (longest axis up to 0.03 mm), which partly replace calcite shell fragments.

This rock type commonly contains large numbers of brachiopods, cephalopods, trilobites, and ostracodes.

Lithostratigraphic successions

The Table Point section is used as a reference section. Lithological units identified in other sections are whenever possible referred to this standard section.

Details of lithologies and lithostratigraphic relationships of the eight stratigraphic sections studied are depicted in Fig. 16. The evidence to support these correlations is described below and in Appendices A to H.

Fig. 4. Boundary between the dolostones of the upper St. George Group and the limestones at the base (Unit A_1) of the Table Head Formation, Table Point. The prominent dolostone bed in the middle of the picture is 0.65 m thick.

Table Point Section
Figs. 3, 16; Section I

Location. – The Table Point Section is exposed along the shore north and south of Table Point. Measuring of the section was started south of the river in Freshwater Cove (new name – see Levesque 1977:111; Fig. 3), and was continued southwest along the coast for about 2 km.

The rocks dip SSW ($142°/7°-154°/8°$) to SE ($58°/16°$), thus forming a southwest plunging syncline. The strata are cut by numerous joints and faults, marked by white calcite veins. Secondary dolomitization along these structures is common.

The sediments comprise the uppermost part of the St. George Group, the entire Table Head, and part of the Table Cove sandstone and shale. About 80 m of dolostones of the 'Siliceous Dolomite' formation were measured from the river to the upper boundary of the St. George Group (Fig. 4). Graptolites occur in grey, yellow weathering fine-grained dolostone about 65 m below the base of the Table Head Formation (Fig. 3).

The section forms the type of the Table Head Series of Schuchert & Dunbar (1934). Logan (1863) described the divisions M and N from Table Head (now Table Point).

Stratigraphic succession. – The section has been divided into three parts: lower, middle and upper Table Head, which again can be subdivided into smaller units. Herein the lower Table Head comprises the units A_1, A_2, and A_3 (Table 2).

A_1 is 8 m thick. It is predominantly mottled dolostone, dolostone, and bird's-eye dolostone associated with minor argillaceous micrite. Dolomitic pelmicrite is secondarily present. Unit A_1 has a restricted fauna of gastropods (*Hormotoma* sp.) and predominantly leperditiid ostracodes. Cephalopods and trilobites were rarely found. Bird's-eye structures are associated with mudcracks and minor laminated beds.

A_2 is about 48 m thick. It consists of argillaceous micrite, rubbly argillaceous micrite, dolomitic micrite and minor quantities of biomicrite, silty dolostone and breccias (Fig. 5). Grey micrite has distinctive red iron oxide coating (yellow weathering). Compared to unit A_1, the fauna is more abundant and more diverse. It includes gastropods (*Hormotoma* sp., *Maclurites* sp.), straight and coiled cephalopods, ostracodes and brachiopods. Trilobites are rarely present.

In the central part of unit A_2 and at the top of unit A_2 two pronounced slumped layers are present. The lower is characterized by chert nodules, and the upper by breccias. Mudcracks, ripple marks and burrows are very common in the upper part of unit A_2. The top of unit A_2 grades into unit A_3 (Fig. 6).

A_3 is 186 m thick. It is predominantly micrite, biomicrite, and rubbly argillaceous micrite with lenses of biosparite (Fig. 7). The color varies from dark-grey to grey. Bedding is thin to massive. The upper middle part of unit A_3 is more thinly bedded than the rest of the unit.

Chert is common throughout the sequence (Fig. 16). Slumped beds of biomicrite and biosparite are present. Secondary dolomitization and calcification associated with dolomite dikes are common in the upper part of unit A_3.

The top of unit A_3 consists of rubbly argillaceous micrite and biosparite with funnel-shaped biogenic structures (e.g. sponges).

The lower and middle parts of unit A_3 contain
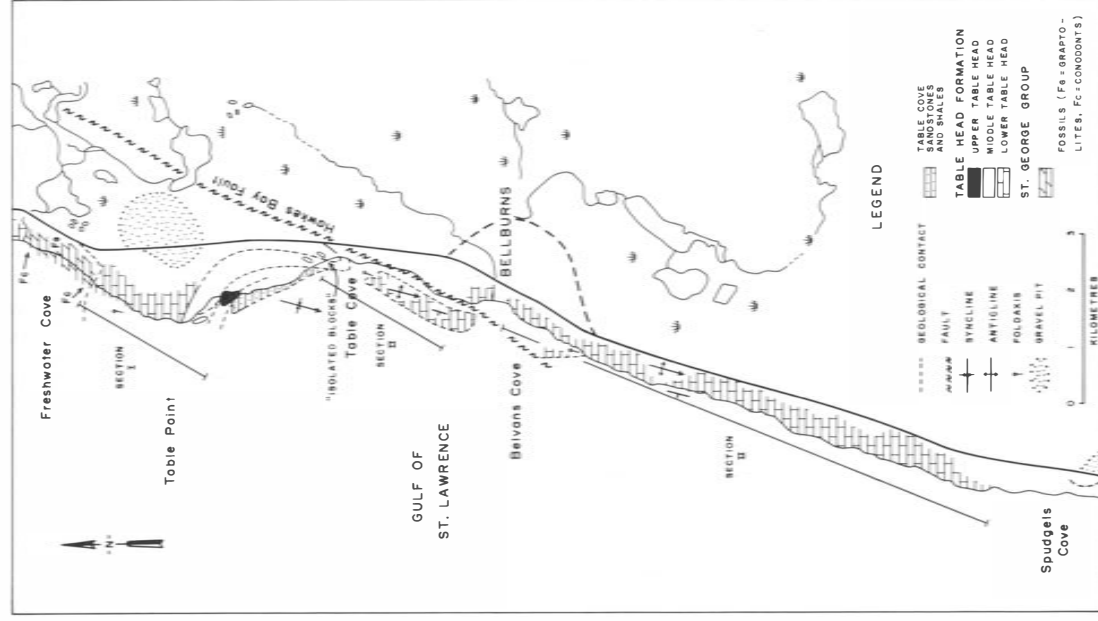
Fig. 3. Location map of the Table Point and Bellburns areas.
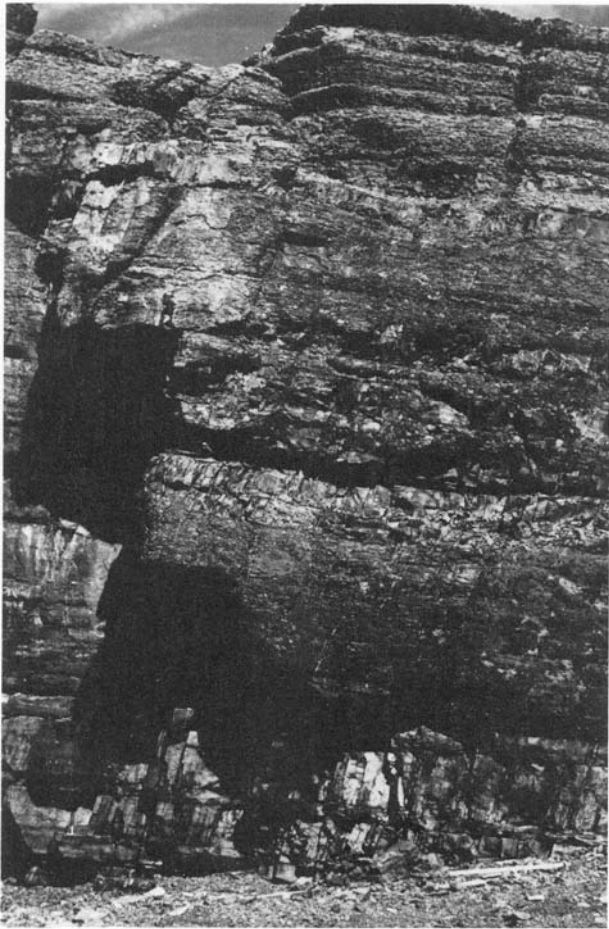
Fig. 5. Unit A$_2$. Interbedded massive and rubbly micrite and dolostone. The cliff is 15 m high.
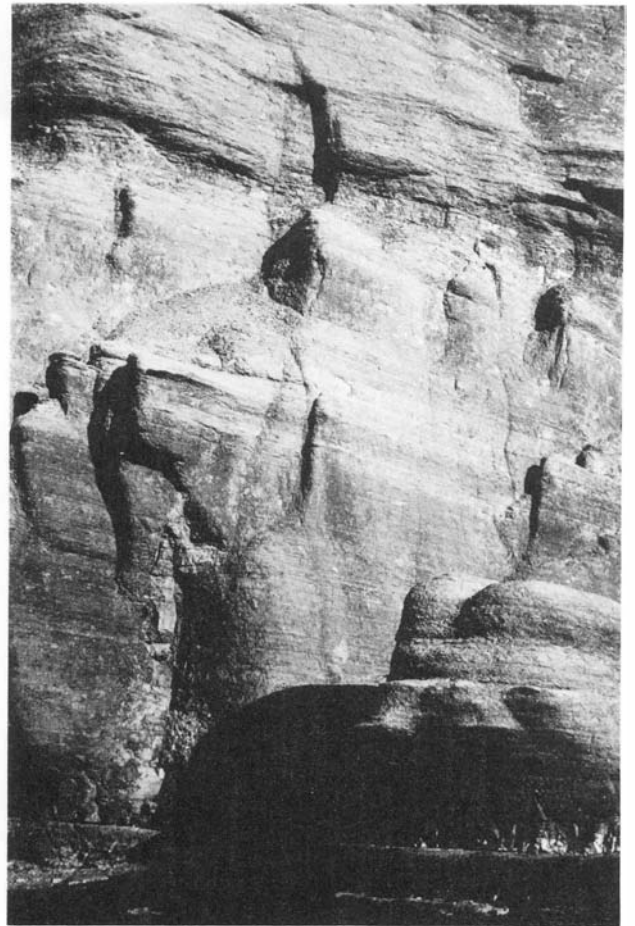
Fig. 7. Unit A$_3$. Massive bedded micrite with lenses of biosparite. The cliff is 30 m high.

cephalopods, trilobites, and a few crinoids. The lower part is characterized by sponge bioherms (Klappa & James 1980). The upper part of the unit, particularly the sponge bed, contains an abundant bryozoan fauna (Klappa 1980), along with large cephalopods, gastropods (*Maclurites* sp.), trilobites and crinoids.

Middle Table Head is characterized by an increasing amount of clastic material (Figs. 8, 9, 10, 11); it forms a transition from a predominantly carbonate regime to a predominantly clastic regime. In the Table Point Section the

beds form open folds or are clearly slumped. This prohibits bed-to-bed measuring. There is also prominent lateral variation. Middle Table Head is subdivided into four units: B$_1$, B$_2$, B$_3$, and B$_4$ (Table 2).

B$_1$ is 21 m thick. It consists of nodular to irregularly bedded, dark-grey, argillaceous biomicrite and biosparite (Fig. 9). The beds are 2 cm thick in average. Brachiopods and trilobites are common, but gastropods, cephalopods and ostracodes are missing.

B$_2$ is 16 m thick. It consists of black micrite interbedded
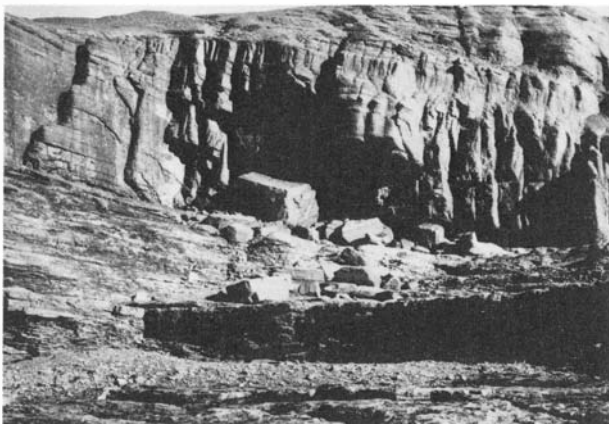
Fig. 6. Top of Unit A$_2$ and base of Unit A$_3$. The base of A$_3$ is at the prominent surface in the centre of the picture. The cliff is 35 m high.

Fig. 8. Middle Table Head. Slumped and brecciated hemipelagic limestones.
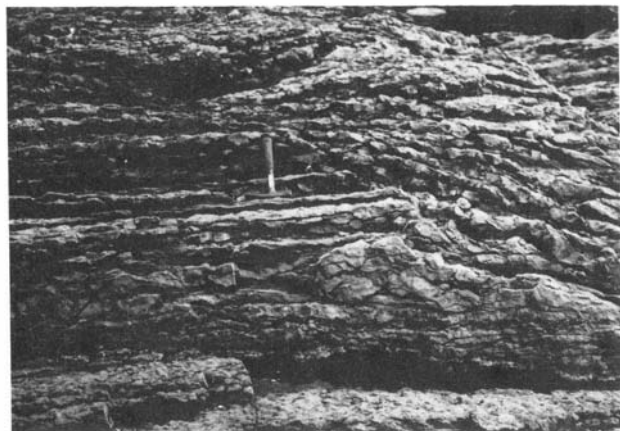
Fig 9. Nodular bedded micrite and biosparite (unit B₁) of the Middle Table Head. The unit is slumped.

Fig. 11. Interbedded silty limestone and shale (Unit B₄) cut by monomictic limestonebreccia (at the top of the picture), middle Table Head.

with dark-brown calcareous shales. The micrite beds are 3–5 cm thick (Fig. 10). The limestones contain trilobites and phosphatic brachiopods.

Graptolites are common in the shales.

B₃ is 6 m thick. It consists predominantly of argillaceous biosparite interbedded with dark-brown to black shale. The unit contains an abundant trilobite fauna. The fossils display random orientation, and were probably transported by slumping.

B₄ is 43 m thick. It comprises the top of the Middle Table Head Section. Unit B₄ is predominantly dark-grey to black micrite interbedded with dark-brown to black calcareous and noncalcareous shales. The micrite is hard and may have fine laminae of bituminous layers or, rarely, silty material. The amount of shale increases toward the top of the section. Limestone breccias are present within this unit (Fig. 11). The limestone contains trilobites and phosphatic brachiopods. Graptolites are common in the shales but occur in the limestones too.

The upper Table Head is 14 m thick. It is a black, noncalcareous, graptolitiferous shale. The graptolites are associated with phosphatic brachiopods.

Upper Table Head is overlain by about 42 m of the Table Cove sandstones and shales. Hubert *et al.* (1977), however, reported a total of 100 m for this unit.

Fig. 10. Interbedded limestone (micrite) and brown shale (Unit B₂), middle Table Head.

Bellburns Section
Figs. 3, 16; Section II

Location. – The Bellburns Section is exposed from about 0.5 km north of Bellburns community and along the coast south of Bellburns to Spudgels Cove.

The section is interrupted by the Hawkes Bay Fault, and is part of a major anticline associated with the fault. The section has undergone secondary dolomitization particularly in the centre of the anticline and in the fault zone.

The Bellburns Section has not been studied in detail, but field indentifications are adequate for a general description of the succession. The structure of this area permits inspection of only incomplete sections and a composite section has been compiled.

Measuring of this section began close to the Hawkes Bay Fault, and was continued south for about 3 km, with several offsets along strike. Toward the north, information was obtained from several outcrops which are isolated from the remainder of the strata ('Isolated Blocks' of Whittington & Kindle 1963; Fig. 12 herein).

Stratigraphic succession. – The general sequence at this locality is very similar to that of Section 1 at Table Point, and this easily permits confident lithological correlations (Fig. 16).

The lower boundary with the St. George Group has not been observed with certainty. Dolomitization, which affects the Table Head Formation at the Hawkes Bay Fault, prohibits a safe separation between lithologies of the two sequences.

The Bellburns Section includes lower and middle Table Head, and the lithological units A₂ (in part), A₃, B₁ and B₂ are exposed (Fig. 12). Units A₁, A₂ (in part), B₃, B₄ and the upper Table Head are not exposed or have not been observed with certainty at this locality.

A₃ is possibly 120 m thick. It consists of massive, bedded, rubbly grey biomicrite and minor biosparite. The fauna includes trilobites, cephalopods, brachiopods, gastropods and occasional crinoids. The unit is exposed along the coast south of Bellburns. The boundary with the middle Table Head is exposed at the 'Isolated Blocks' (Fig. 3). This upper part of A₃ consists of grey micrite with sponges.

B₁ is 10 m thick. It consists of rubbly argillaceous micrite

Fig. 12. The northern part of the Bellburns section. Table Point can be seen in the upper left part of the picture. The rocks are the top of lower Table Head and part of middle Table Head. The top of the 'Isolated Blocks' is to the middle right (compare Fig. 3).

with nodular bedding. Trilobites are common in this unit. B_1 is exposed at the 'Isolated Blocks' and in the tidal zone north of Bellburns (Fig. 12).

B_2 is approximately 7 m thick. It consists of black micrites interbedded with brown to black shale. The fauna includes graptolites and some trilobites. This unit is exposed in the tidal zone in Table Cove. It is overlain by Table Cove sandstones and shales.

The Table Cove sandstones and shales consist of about 22 m of green, massive-bedded sandstones and siltstones. The top of this unit was not observed.

Port Saunders Section
Figs. 13, 16; Section III

Location. – The Port Saunders Section is exposed along the coast 0.5 km west of Port Saunders.

This section was started at the cove were the Sandy Fault (N 38° E) separates the St. George Group from the Table Head Formation.

The section generally dips west (35°/23°W) and is gently folded into a broad westward plunging syncline. The section is internally disrupted by faults and joints; bedding is often difficult to observe.

Stratigraphic succession. – The lower 23 m consist of micrites, biosparites and breccias. Fossils are trilobites, brachiopods and cephalopods.

The upper part of the section is 24 m thick. It consists of grey to dark-grey biomicrite, interbedded with argillaceous micrite. Sponges and large cephalopods at the top are similar to those found on St. John Island and at Table Point.

This section was referred to division L in Logan (1863) and to the lower Table Head in Schuchert & Dunbar (1934:56).

Gargamelle Cove East Section
Figs. 13, 16; Section IV

Location. – The Gargamelle Cove East Section is exposed in the coastal cliffs along the east side of Gargamelle Cove, southeast of Port au Choix.

Measuring of the Gargamelle Cove East Section was started south of the inner part of the cove, and was continued south-southeast to the head of the cove.

The beds of this section are gently dipping (69°/9°E) to subhorizontal. The beds are cut by joints and small faults.

Stratigraphic succession. – The section can be divided into two parts, IVa and IVb (Fig. 16).

IVa consists of about 5 m of massive, bedded, grey micrite.

IVb is 30.5 m thick. The lower 25 m consist predominantly of grey, rubbly weathering micrite and minor biosparites. Cephalopods are common, and sponges are sparingly present at the top.

The upper 5.5 m are distrupted by folding and faulting. This unit consists of micrite lumps (25× 10 cm) in an argillaceous matrix. Lack of distinct bedding makes this unit unique. Also the lithostratigraphic classification of the breccias must remain unsettled. They occupy the same stratigraphic position as in unit A_3 of the Table Point Section, but are not typical unit A_3 lithology. Because of uncertain derivation of these rocks, they are here informally termed 'breccia' beds. A similar unit is exposed at Point Riche Peninsula.

Gargamelle Cove West Section (Pointe Riche Peninsula)
Figs. 13, 16; Section V

Location. – The Gargamelle Cove West Section is exposed along the sea cliffs of the east coast of Pointe Riche Peninsula. This section was started close to the Port au Choix community.

The beds are sub-horizontal to westerly dipping (7°/2°W). At the base of this section grey to reddish, massive- to
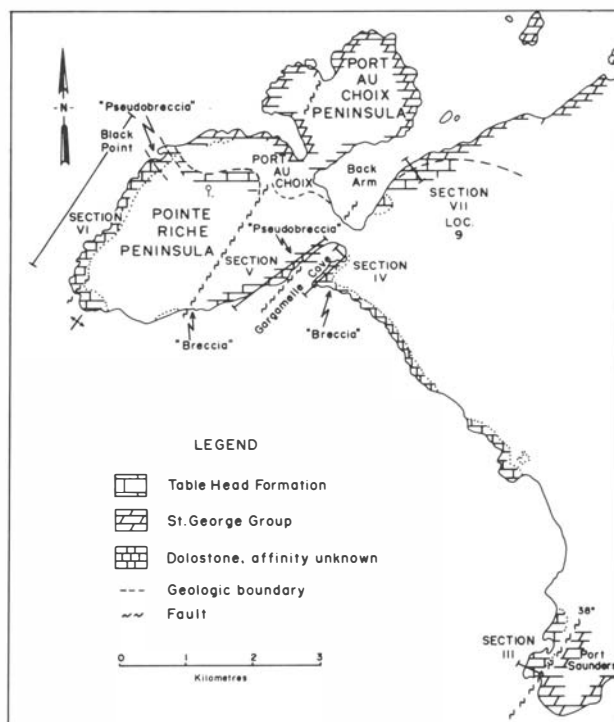
Fig. 13. Location map of the Pointe Riche, Port au Choix and Port Saunders areas.
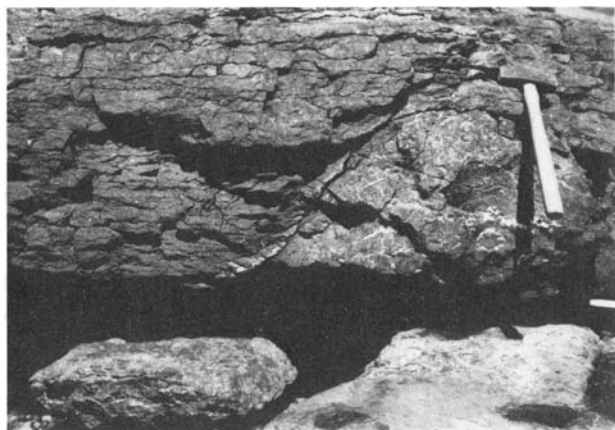
Fig. 14. Secondary dolomitized lower Table Head limestone. This feature has been interpreted to represent a disconformity. See text for details. From Gargamelle Cove W Section.

thin-bedded micrites are exposed. These beds have been referred to the St. George Group by several authors (Schuchert & Dunbar 1934; Cumming 1968; Whittington 1968; Kluyver 1975). The upper part was referred to division K, i.e. Table Head Formation of Logan (1863) and the lower part of division I of Logan (1863) by Schuchert & Dunbar (1934), i.e. the St. George Group. Part of the section is heavily dolomitized. The dolomite/limestone boundary is sharp (Fig. 14) and cuts vertically through the section. A prominent horizontal layer is dolomitized and filled with white vuggy dolomite, but can be traced inland as a non-dolomitized slumped bed. This particular layer was described as the disconformity between the St. George Group and the Table Head Formation by Cumming (1968). The section is separated from the Pointe Riche Section to the west by a fault, trending NNE across the Pointe Riche Peninsula (Fig. 13).

Stratigraphic succession. – The lower 13 m are micrite, grey to moderate orange-pink with some argillaceous stringers. Small stromatolite mounds are present.

The upper 36 m consist of fine- to massive-bedded micrite with minor biosparite beds. Some beds are slumped. Fossils are common and include trilobites, cephalopods, brachiopods and gastropods (*Maclurites* sp.).

Pointe Riche Section
Figs. 13, 16; Section VI

Location. – The Pointe Riche Section is exposed along the seacliffs from Black Point in the northeast to the lighthouse in the southwest of the peninsula.

The section was measured from as close to the St. George Group as possible to the north and towards the south to the lighthouse. Four incomplete sections were measured of which the composite section is shown (Fig. 16).

The strata of Pointe Riche, though generally flat-lying, are folded into gentle synclines and anticlines. Dolomitization occurs in the cones of the structures both along bedding planes and vertical fractures. Vuggy white dolomite and dolostone is present in the Table Head Formation. To the north of Black Point dolostones of the St. George Group

underlie the Table Head Formation. The actual boundary is not exposed (Schuchert & Dunbar 1934), and a covered interval of 40 m of strata is present (Levesque 1977). The lowest exposures of the Table Head strata form an irregular dolomitized layer, which was described as the St. George/Table Head disconformity by Cumming (1968) and Kluyver (1975). Herein it is interpreted as dolomitized Table Head strata, rather than a disconformity. The irregular boundary is either a slumped layer, which is dolomitized, or represents the dolomitic 'front' at this locality (N.P. James, pers. comm. 1978). The dolomitization is not restricted to the irregular layer, but occurs independent of the bed. To the south of the lighthouse folding and minor overthrusting of beds occur.

Stratigraphic succession. – The lower 27 m consist of grey massive-bedded micrite with minor biosparite lenses. Occasional minor chert layers are present. Several small slumped biosparite beds are present. The base of the section is the dolomitized wavy-bedded micrite.

The upper 12 m consist of argillaceous, hard, grey, yellow-weathering micrite. One prominent slumped bed separates the lower lithologies from the upper lithologies. This bed thins out to the north and becomes dolomitized distally.

Remarks. – The Pointe Riche Section was the basis for Richardson's divisions K and L (*in* Logan 1863). Schuchert & Dunbar (1934) reported that 200 feet (66 m) of lower Table Head limestones are present, which is about 25 m more than measured in this study.

Back Arm East Section
Figs. 13, 16; Section VII

Location. – The Back Arm East Section is exposed in the cliffs along the east shore of Back Arm (Fig. 13). The cliffs are within the dump area of the Port au Choix community. Because of the amount of garbage the exposure varies from moderate to covered – a situation that changes from season to season.

The beds in the section are subhorizontal to slightly dipping southward.

At the base and to the north the St. George Group dolostones and dolomitic micrites conformably underlie the section.

Stratigraphic succession. – The lower 5 m consist of fossiliferous micrite, dolomitic micrite, calcareous dolostone, and dolostone. Dolostone predominates in the lower part, in places associated with fine laminations. These beds contain a restricted fauna (principally ostracodes).

The upper 13 m consist of grey, reddish-colored (caused by distinctive red iron oxide coatings), rubbly-weathering micrite.

St. John Island Section
Figs. 15, 16; Section VIII

Location. – The St. John Island Section is exposed from Photographic Point to the cliffs on the south side of the St. John Island Harbour (Fig. 15).
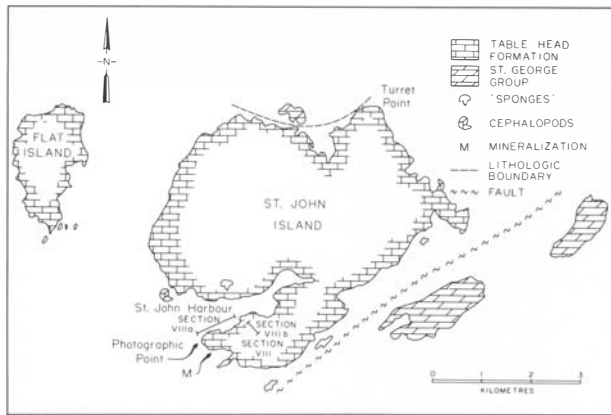
Fig. 15. Location map of the St. John Island.

St. John Island is a large dome. The strata of the St. John Island Section form part of the structure, the other flank is the northern side of the St. John Harbour. At Photographic Point and along the south coast predominantly dolomitized and mineralized Table Head strata are exposed. A thrust is present along the dolomitized layers (Levesque 1977).

The St. George Group/Table Head Formation Boundary as described by Woodard (1957) on the eastern coast of the island is related to a setting similar to Pointe Riche Peninsula (Section VIII), i.e. within the dolomitized Table Head strata. Flower (1978) recorded a typical Table Head fauna from these dolostones.

Stratigraphic succession. – The St. John Section was started close to the dolomitized beds at Photographic Point. The top of the section is exposed on the crest of the hill to the east of Photographic Point. Two incomplete sections, VIIIa and VIIIb, were measured. The exact relative positions were difficult to determine, and a minor gap in the composite section exists between the western part (Section VIIIa) and the eastern part (Section VIIIb), because debris covered bedding planes. The top of Section VIIIb is marked by rubbly debris. The composite section comprises only part of the total Table Head strata exposed on St. John Island.

Section VIIIa. – This section is 15 m thick. The predominant rock types are grey, argillaceous micrite with yellow (?iron-stained) bedding planes are common. Fossils are cephalopods and small sponges. At the top large sponges become common.

Section VIIIb. – The section is 9 m thick. It consists of grey micrite and minor, argillaceous micrite. Trilobites are present.

Remarks. – Woodard (1957) proposed the name Well Cove Formation for these Table Head Limestones. He also included the strata at Eddies Cove West in his formation. Whittington & Kindle (1969:59) found the Eddies Cove West strata to be of St. George age, and they are now correlated with the Boat Harbour Formation and the Catoche Formation of the St. George Group (Knight 1977a, b).

Small outcrops within the study area

Between Port Saunders and Gargamelle Cove East. – Table Head strata crop out as sub-horizontal to undulating beds along the beach. Similar beds are exposed along the road connecting Port au Choix and Port Saunders. A small section of about 12 m of argillaceous, massive – bedded micrite was measured. Cephalopods are common.

Central part of Gargamelle Cove. – A small outcrop, only exposed at low tide, consists of 5 m of grey massive micrite with gastropods. These 5 m are included in the Gargamelle Cove East Section on Fig. 16.

Lithostratigraphic correlations

Lithostratigraphic correlations are summarized in Fig. 16. The correlations suggested are hampered by structural complications combined with local dolomitization. Thus the lower boundary of the Table Head Formation has been observed only at Table Point. In the Back Arm East Section this boundary is interpreted to be present based on the stratigraphic succession.

In general lithostratigraphic criteria are, however, good enough to permit precise correlations. Lateral variations are minor, and the rock units identified at Table Point can be traced over most of the study area. Only the basal units (i.e. A_1 and A_2) of the Table Point Section show variation in the presence of dolostones versus limestones.

Unit A_3 of the Table Point Section is almost complete along the coast of Bellburns and from Pointe Riche to Port Saunders. In the Gargamelle Cove East Section has brecci-ated micrite ('breccia') occupies about one fifth of the stratigraphic thickness. Table Head beds of St. John Harbour on St. John Island have the same lithological characteristics as those of Port Saunders, Table Point and Bellburns but contain a higher number of sponges and fewer large cephalopods.

Middle Table Head of Table Point is incompletely exposed at Bellburns but the presence of units B_1 and B_2 could be recognized.

Upper Table Head strata have no lateral equivalents exposed within the study area.

Table Cove sandstones and shales overlie Table Head strata at stratigraphically different locations. They succeed the upper Table Head black shales at Table Point, but overlie unit B_2 (middle Table Head) at Bellburns. This difference can be explained as (1) a major disconformity separating the Table Cove sandstones and shales from the Table Head Formation, or as (2) different response (competence) of the units to the regional deformation.

Some implications follow:

(1) Regional structural movements have influenced the rocks. Dolomitization and calcification occur in the centre of synclines and anticlines, along faults, joints and bedding planes.

(2) The disconformable contact between the St. George and Table Head has not been observed in the field. The boundary is only exposed with certainty at Table Point and perhaps Back Arm East. At these places it is conformable.
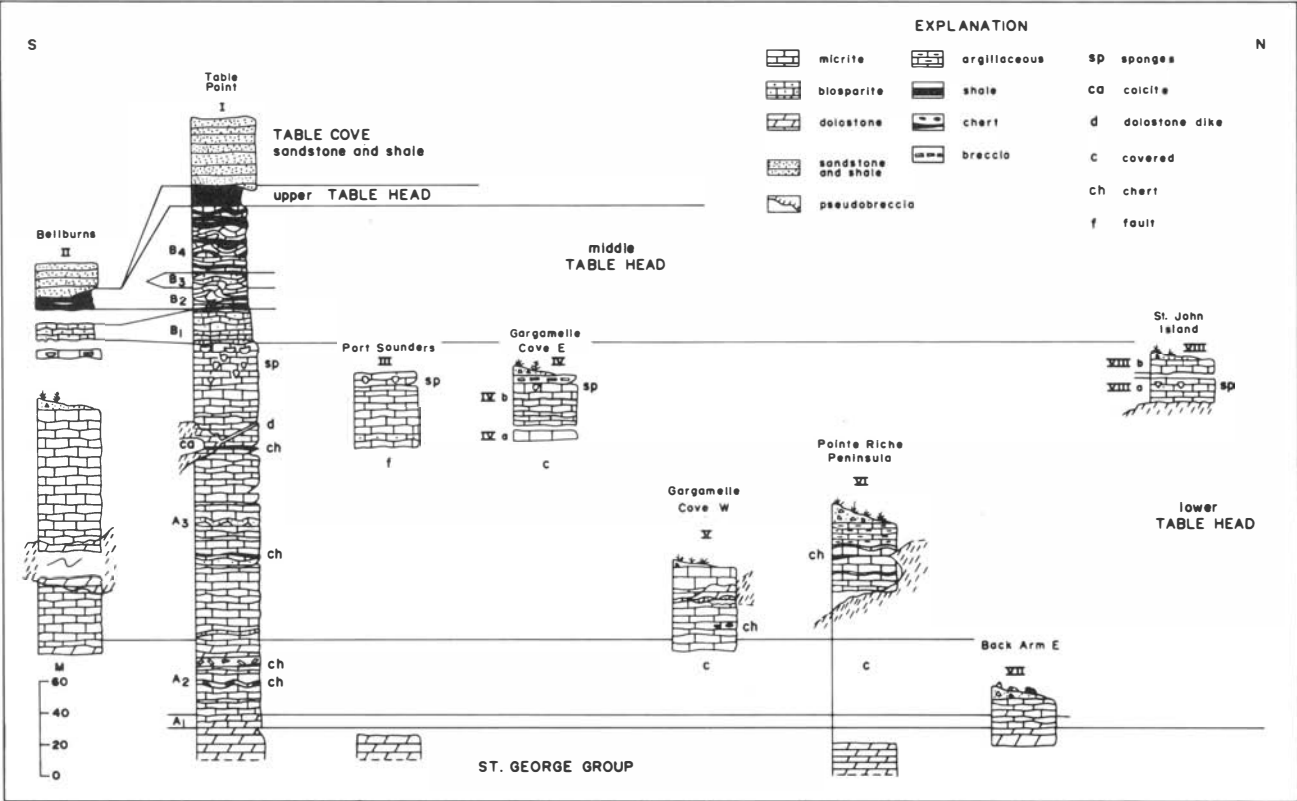
Fig. 16. Sections at Bellburns, Table Point, Port Saunders, Gargamelle Cove, Pointe Riche, Back Arm, St. John Island and lithological correlation.

In other areas where the boundary has been reported to occur it is the result of dolomitization of Table Head limestones (i.e., Pointe Riche Peninsula and perhaps St. John Island). At Pointe Riche the St. George – Table Head boundary is not exposed, and there is possibly a fault at this locality.

Biostratigraphy

Conodont provincialism

Ordovician conodont faunal provinces, the North American Midcontinent Province and the North Atlantic Province, have been reviewed by Barnes *et al.* (1973a); Bergström (1971a, 1973c, 1977a); Barnes & Fåhræus (1975) and Sweet & Bergström (1974).

According to the above authors conodont faunal provincialism was initiated in the Tremadocian. It prevailed to the end of the Ordovician Period, though it apparently was modified as to areal extent and distinctiveness during this time by the closing of the Protoatlantic Ocean (Fåhræus 1976; Bergström 1977a).

The two main faunal provinces are characterized by two distinctly different conodont faunas, and two zonal schemes have been established (Ethington & Clark 1971; Sweet *et al.* 1971; Bergström 1971a, b; Lindström 1971). Correlation between these two schemes is difficult resulting in considerable uncertainty regarding precise relations between them. Correlation of the provincial conodont zonations with other faunal successions has been more successful, and the

conodont successions are tied into standard graptolite zonations (Lindström 1971; Bergström 1971a, 1973c; Sweet & Bergström 1976; Barnes *et al.* 1976).

In the Table Head Formation representatives of both faunal provinces occur. The lower part of the lower Table Head include conodonts of Midcontinent Province affinity. *Trigonodus carinatus* n.sp. is found in greatest abundance. Other important species of the Table Head collections belonging to the midcontinent Province are *Plectodina*? n.sp. A, *Eoneoprioniodus*? spp. and *Leptochirognatus* spp. In its upper two-thirds the middle Table Head contains a fauna of North Atlantic Province affinity. Notable are the genera *Periodon, Cordylodus?, Oistodus?, Polonodus, Protopanderodus* and *Walliserodus.* The main sequence of the lower Table Head includes genera that may be present in one or both provinces. There are also genera which to a large degree are restricted to areas transitional between the two faunal provinces. Previous reports of their distribution indicate that they are not restricted to the centre of the Midcontinent or North Atlantic faunal provinces. *Belodella,* for example, is represented in the lower and middle Table Head and in

northern Sweden (Löfgren 1978) and southern Norway (Fåhræus 1970). Some genera cannot be definitely included in either of the presently recognized provinces. *?Erraticodon*, for example, has elements with long delicate denticles carried on two or three processes, and can be easily distinguished from the bulk of the hyaline Midcontinent forms.

Conodont collections

A collection of amber to dark brown conodont elements has been obtained by means of acetic acid dissolution (15%) of limestones. The color is within the range 1.5–2 of the CAI (Color Alteration Index) of Epstein *et al.* (1977), indicating a heating of the strata from 50°C to 140°C. Conodonts recovered from dolomites dissolved by formic acid are white in color, probably resulting from leaching and/or bleaching of organic materials by dolomitizing solutions and/or formic acid laboratory treatment.

The preservation of the conodonts varies from fragmentary to almost complete elements. Broken specimens are most common in the lower Table Head. Many of these elements show a sucrose surface. Secondary dolomitization probably influences the preservation; thus generally broken specimens are obtained from dolostones and dolomitic micrite in contrast to generally well preserved conodonts recovered from the biomicrite.

The lower part of the lower Table Head yielded few conodonts: 40% of the samples were barren, and another 40% yielded fragmentary conodonts. The remaining 20% yielded conodonts which could be identified to the species level. The yield ranged from 1 to 110 specimens per kilogram of rock. In the higher part of the lower Table Head, conodonts were found in 90% of all samples examined. The yield was affected by secondary dolomitization. The St. John Island, Port Saunders and Gargamelle Cove West sections yielded a maximum of 15 specimens per kilogram, whereas the Gargamelle Cove East Section yielded many well preserved specimens (85 specimens per kilogram).

Unit B_1 of the middle Table Head produced the highest number of specimens per kilogram and accounts for 60% of the total fauna. All samples yielded conodonts with a range from 100 to more than 200 conodonts per kilogram. Unit B_3 produced a similar number of conodonts, whereas Unit B_2 and Unit B_4 yielded conodonts in lower abundances, i.e. 30–60 specimens per kilogram. No conodonts were recovered from the shales of the upper and middle Table Head, though a few specimens have been observed on bedding planes with a hand lens. Generally, the Table Head fauna is composed of normal size specimens, but a few genera are composed of quite large elements (1 to 5 mm). This is typical for species of *Protopanderodus, Eoneoprioniodus?*, and *Polonodus.*

Stratigraphical distribution

Distribution of conodonts recovered from the Table Head Formation is summarized in Table 5 and Figure 18.

Acodus is represented in modest numbers; it occurs in both lower and middle Table Head.

Belodella is a common component, and occurs with two well defined species. *Belodella sinuosa* n.sp. and *Belodella jemtlandica* are present; and the latter seems to succeed the former stratigraphically. The phylogeny of *B. sinuosa* n.sp. is discussed below. Other *Belodella* species, unnamed, sporadically occur through the strata.

Trigonodus is a hyaline multi-element genus and is present with two species, *T. carinatus* n.sp. and *T. rectus* n.sp. This genus is restricted to the lowermost part of the Table Head.

Eoneoprioniodus? is a hyaline multi-element genus. Two species are present in the lower part of the Table Head Formation.

?Erraticodon balticus is a fairly common component in the lower Table Head and lower part of middle Table Head.

Histiodella occurs as three species which allow a detailed zonation. The phylogenic relationship of these species is summarized in Fig. 17.

Parapaltodus is a new simple-cone genus. It occurs in modest numbers, but is represented by several species all with restricted ranges. The species are separated stratigraphically, and they are not closely related. *Parapaltodus angulatus* is restricted to the lower part of lower Table Head; *P. simplicissimus* n.sp. occurs in the higher part of lower Table Head and in the lower middle Table Head, and *P. flexuosus* occurs mainly in the middle Table Head.

Periodon is represented by a single species, *Periodon aculeatus*. The phylogenetic relationships with older and younger species have been described by Serpagli (1974), Dzik (1976) and Löfgren (1978).

Polonodus is a rare component of the Table Head fauna and occurs mainly in the lower middle Table Head. It is represented by two species, and provides some of the largest specimens in the fauna. Phylogenetic relationships of this genus are not clear (Dzik 1976; Löfgren 1978).

Protopanderodus is well represented with several species, all of which have previously been described from the North Atlantic Province.

Scalpellodus is a common component in the lower Table Head. It is represented by two species, *S. biconvexus* and *S. pointensis* n.sp.; the latter succeeds the former stratigraphically.

Walliserodus is represented in samples from mainly the upper part of the sequence by *W. ethingtoni.*

Phylogeny of forms in Table Head Formation

The distribution of *Histiodella* is important, because evolutionary changes allow a detailed zonation. The ancestor of *Histiodella* so far is unknown. Fåhræus (1970) indicated that *Histiodella* evolved from a simple cone, but the multi-element apparatus suggests an intermediate ancestor with a ramiform construction. The inferred evolution is expressed mainly in the spathognathodontiforms (Fig. 17), whereas the other elements changed very little.

Phylogenetic relationships are also clearly evident between *Semiacontiodus preasymmetricus* n.sp. and *S. asymmetricus*, the latter being the direct descendant of the former. During evolution the posterior carina becomes prominent and distinct.

Phylogenetic relationship between *Belodella sinuosa* n.sp.

Histiodella
bellburnensis n. sp.

Histiodella
kristinae n. sp.

Histiodella
tableheadensis n. sp.
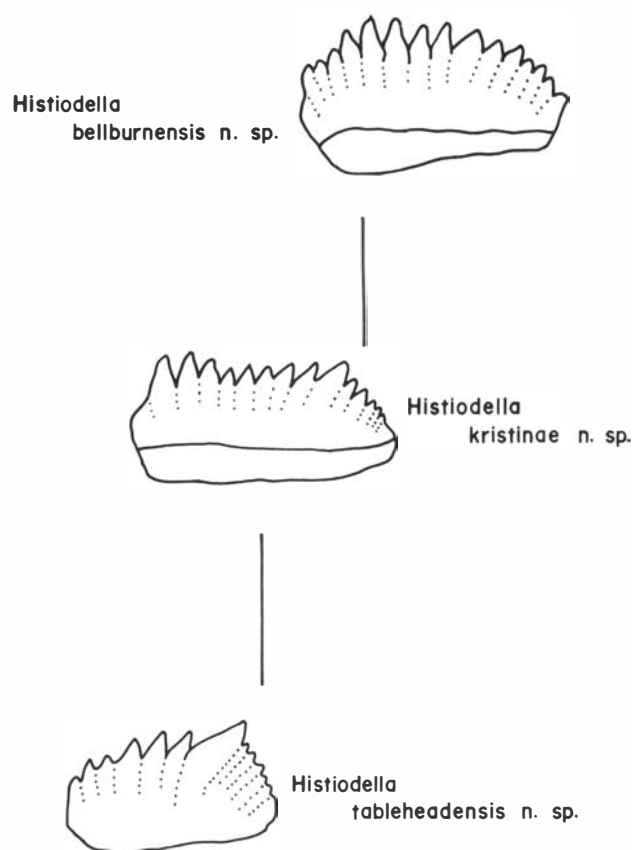
Fig. 17. Phylogeny of *Histiodella* species in the Table Head Formation.

and *B. jemtlandica* is not obvious. The first may be the ancestor to the younger *B. nevadensis,* and *B. jemtlandica* is a closely related species. These forms may have developed as lateral stems from a common ancestor.

Scalpellodus biconvexus and *Scalpellodus pointensis* n.sp. are two closely related species. The second evolved directly from the first.

Conodont zones

Two phylozones based on the evolution of *Histiodella* have been established for the Table Head Formation. These zones are considered valid for regional correlations.

Some genera and species have a relatively short range (Fig. 18) and singly or in combination with others, they characterize four local assemblage zones.

The zones recognized in the study area are defined and discussed below. Fig. 18 illustrates the distribution of conodonts and the zones within the Table Head Formation.

Histiodella tableheadensis *Phylozone*

Definition. – The phylozone coincides with much of the stratigraphic range of the species *Histiodella tableheadensis*. In the Table Point section its base is marked by the first appearance of *Histiodella tableheadensis*. *Histiodella tableheadensis* first appears 5 m above the base of the lower Table Head in the Table Point section. The top of the zone is marked by the first occurrence of *Histiodella kristinae* in the Table Point section.

Reference section. – The Table Point coastal cliffs, Great Northern Peninsula, western Newfoundland (Fig. 3). The top of the phylozone is 215 m above the base of the sequence exposed along the coast.

Characteristic conodont species. – The phylozone contains a varied fauna of Midcontinent Faunal Province affinity, and a fauna transitional between the major provinces. Only a small number of elements belong to the North Atlantic Faunal Province.

Histiodella tableheadensis is common through the whole zonal inverval. Several stratigraphically important hyaline multi-element taxa are restricted to this zone in the study area. These are *Eoneoprioniodus?* sp. 1, *Eoneoprioniodus?* sp. 2, *Leptochirognathus* cf. *quadrata, Erismodus?* sp. A and *E.?* sp. B s.f., *Belodella* spp. and *?Erraticodon balticus* are common in this zone. *Periodon aculeatus* and *Polonodus* spp. are occasionally present.

Conodonts from *Histiodella tableheadensis* Phylozone have been described by Mound (1965a), Uyeno & Barnes (1970), Barnes & Poplawski (1973), Dzik (1978) and Löfgren (1978); additional information has been given by Sweet *et al.* (1971) Fåhræus (1970), Bergström (1979a) and Harris *et al.* (1970).

Remarks. – The lower boundary of this zone has not been established, because the immediate ancestor of *Histiodella tableheadensis* has not been recovered. The full range of this zone is therefore not present at this locality.

The *Histiodella tableheadensis* Phylozone is easily recognized within the study area (Fig. 19) and at other localities on the Great Northern Peninsula (Stouge 1981, unpublished). It is considered valid over a wide area in much of North America and possibly Australia. The evolutionary transition from *Histiodella tableheadensis* to *Histiodella kristinae,* which is manifested by the development of higher anterior denticles than the cusp of the spathognathodontiform is well documented at the reference section, where it occurs in an interval of 30 m.

Trigonodus carinatus – Eoneoprioniodus? *sp. 1 Assemblage Zone*

Definition. – The base of the assemblage zone coincides with the first appearance of *Trigonodus carinatus* n.sp. and *Eoneoprioniodus?* sp. 1. The top is marked by the disappearance of *Trigonodus carinatus.*

Reference section. – The same as for the *Histiodella tableheadensis* Phylozone. The top of the assemblage zone is 40 m above the base of the Table Head Formation. Its base is 3 m below the base of the Table Head Formation at Table Point. Thus the zone is about 43 m thick at Table Point.

Fig. 18. Ranges of selected Table Head conodonts from Table Point. Note that reworked specimens are not included in the range chart (compare with Table 5). (1) Barren interval. (2) A single occurrence of conodonts typical of the *Acodus combsi – Oistodus? tablepointensis* Assemblage Zone. This assemblage does not occur until sample TP 62 (see text).
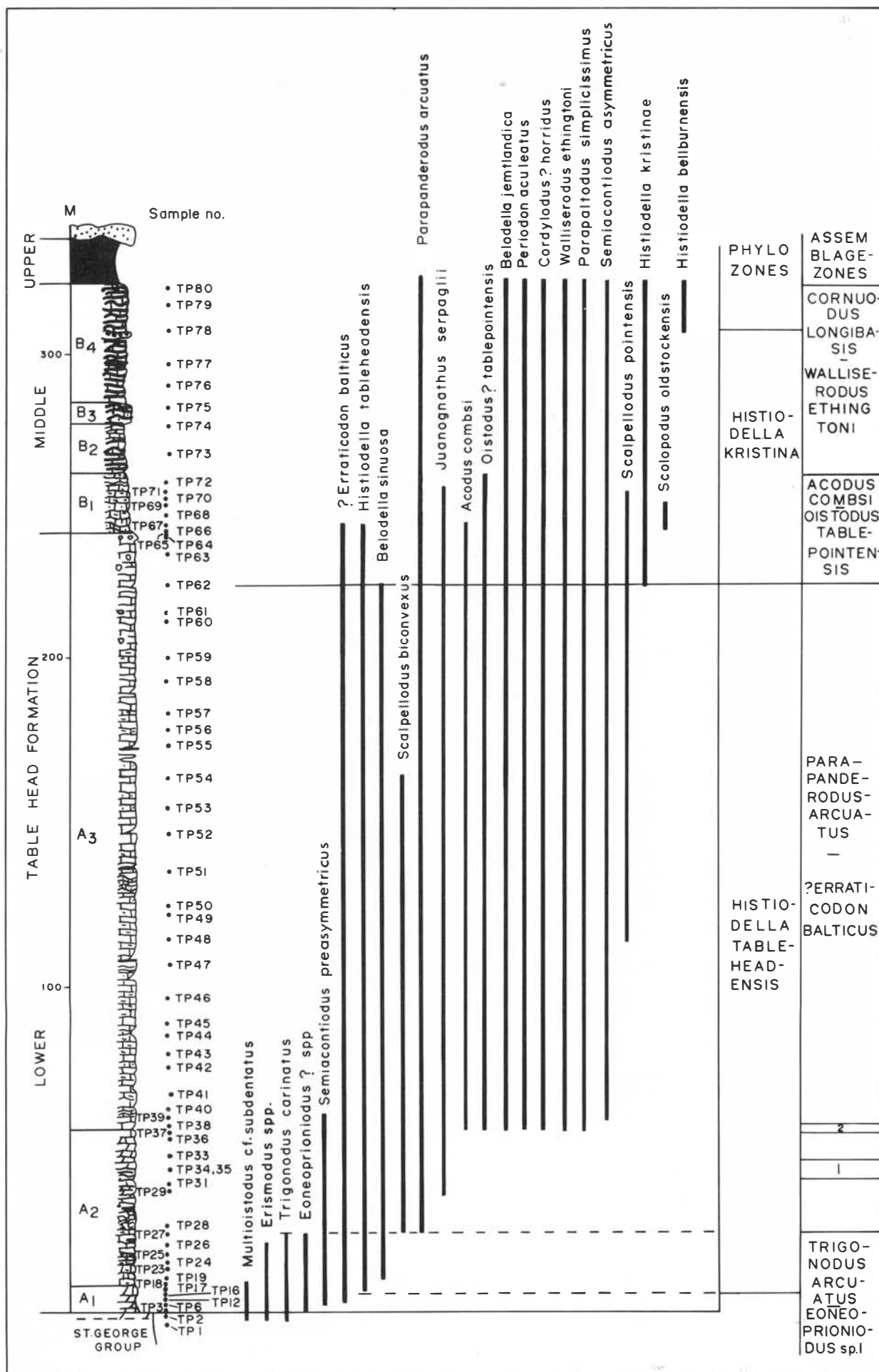
Characteristic conodont species. – The nominate species are restricted to the zone in the study area. Associated species which are also restricted to this zone include *Erismodus?* spp., *Lepthochirognathus* spp., *Plectodina?* n.sp. A, and *Parapaltodus angulatus*. *Drepanodus?* cf. *gracilis* and *Semiacontiodus preasymmetricus* occur in the upper third of the zone. *?Erraticodon balticus* occurs within this zone.

Remarks. – The assemblage zone comprises the lowermost beds of lower Table Head (unit A_1 and part of unit A_2). The conodont fauna is unique, differing markedly from faunas above it, and includes a variety of hyaline species in abundance. The immediately underlying dolostones, of the St. George Group, have so far yielded *Trigonodus carinatus*, *Erismodus?* spp., *Oepikodus* sp. and *Multioistodus* sp. at Table Point, and *Eoneoprioniodus?* sp. 1, *Trigonodus rectus* and *Leptochirognathus prima* at Back Arm.

Elements of this zone have been illustrated by Sweet *et al.* (1971), Mound (1965a), Uyeno & Barnes (1970), Barnes (1974), Tipnis *et al.* (1978), and Harris *et al.* (1979). Sweet *et al.* (1971) assigned a Midcontinent Fauna 4 age for these elements.

Parapanderodus arcuatus – *?Erraticodon balticus* Assemblage Zone

Definition. – The base of this assemblage zone in the study area is marked by the first co-occurrence of *Parapanderodus arcuatus* and *?Erraticodon balticus*. This is about the same level at which *Trigonodus carinatus* disappears in the study area. The top is taken at the level at which *Histiodella tableheadensis* evolves into *Histiodella kristinae*.

Reference section. – The same as for the *Histiodella tableheadensis* Phylozone. The base of the assemblage zone is about 50 m above the base of lower Table Head exposed at Table Point. A barren interval is present within and next to the base of the *Parapanderodus arcuatus* – *?Erraticodon balticus* Assemblage Zone (Fig. 18). The top is 220 m above the base of the lower Table Head. The thickness of the zone is approximately 180 m at the reference section.

Characteristic conodont species. – Several species are known to be restricted to this zone. At the reference section the index species associated with *Scalpellodus* spp. characterize the fauna. In this zone the following species occur: *Scalpellodus biconvexus*, *S. pointensis*, *Loxodus?* *curvatus*, *Semiacontiodus preasymmetricus*, *Semiacontiodus asymmetricus* and *Juanognathus serpaglii*. *Belodella* spp. are common throughout this zone. Locally *Acodus combsi*, *Periodon aculeatus*, *Cordylodus? horridus*, *Paroistodus?* sp. and *Polonodus* sp. are present. Many of the species of this zone were described by Barnes & Poplawski (1973), Dzik (1978) and Löfgren (1978).

Remarks. – The index species are not restricted to the zonal interval, but occurs also above and below it. Consistent differences between associated faunal elements from the *Histiodella tableheadensis* and *H. kristinae* Zones make it possible to date material of *Parapanderodus arcuatus* – *?Erraticodon balticus* Assemblage Zone even in the absence of *Histiodella tableheadensis*. Within the zone local biostratigraphic

ranges and co-occurrences of taxa make a refined local correlation possible.

Scalpellodus biconvexus associated with *Protopanderodus strigatus*, *Parapanderodus striatus,* and *Belodella sinuosa* characterize the lower part of this zone. This level is also characterized by *Semiacontiodus preasymmetricus*, which is limited to the lower 40 m of the zone. Above it is followed by its successor *S. asymmetricus*. *Drepanodus?* cf. *gracilis* and *Parapanderodus* cf. *consimilis* also are common associates within this part of the zone. In the middle part of the zone *Scalpellodus pointensis* and *Belodella sinuosa* are characteristic species, whereas *Juanognathus serpaglii* and *Belodella jemtlandica* characterize the upper part.

The zone has been identified in the main part of the lower Table Head at many localities on the Great Northern Peninsula (Stouge, in preparation).

Histiodella kristinae Phylozone

Definition. – The lower boundary of this zone is marked by the first appearance of *Histiodella kristinae* n.sp. The top of this zone is marked by the first appearance of *Histiodella bellburnensis* n.sp. in the study area.

Reference section. – The section at Table Point, Great Northern Peninsula, western Newfoundland (Fig. 3). The base of the zone is about 16 m below the top of lower Table Head, and the top of the zone is about 70 m above the base of the middle Table Head. The total thickness of the zone is 86 m at Table Point.

Characteristic conodont species. – The *Histiodella kristinae* Phylozone is rich in conodont taxa. The fauna is predominantly of North Atlantic Faunal affinity. But many species are new. In addition to the zonal index fossil, the species *Belodella jemtlandica*, *Cordylodus? horridus*, *Periodon aculeatus*, *Oistodus? tablepointensis* n.sp., *Juanognathus serpaglii* n.sp., *?Erraticodon balticus*, *Scolopodus oldstockensis* n.sp., *Acodus combsi*, *Walliserodus ethingtoni*, and several species of *Protopanderodus* are important.

Conodont faunas from this zone have been described by Barnes & Poplawski (1973), Uyeno & Barnes (1970), Viira (1974), and Löfgren (1978).

Remarks. – *Histiodella kristinae* ranges throughout the middle Table Head. The evolution of *H. kristinae* into its successor occurs in the uppermost beds. It is marked by a reduction in size of the cusp, which obtains a more median position. There is also an increase in height of the anterior denticles (Fig. 17).

The faunal elements of the *Histiodella kristinae* Phylozone display distinct distributions, and justify a division into two local assemblage zones.

Acodus combsi – *Oistodus? tablepointensis* Assemblage Zone

Definition. – The lower boundary of this zone in the study area is marked by the appearance of *Acodus combsi* and *Parapaltodus simplicissimus* n.sp. in abundance. The top of the zone is taken at the upper limit of the local range of *Oistodus? tablepointensis* n.sp.

Reference section. – Same as for the *Histiodella kristinae* Phylozone. *Acodus combsi* appears in abundance close to the top of lower Table Head. The base of the zone is about 16 m below the lithological boundary between the lower and middle Table Head. The top of the zone coincides with the lithological boundary between unit B_1 and unit B_2 of the middle Table Head. The thickness of the zone is approximately 37 m at Table Point.

Characteristic conodont species. – Several species are restricted to this zone and many species from the *Histiodella tableheadensis* Phylozone below, range through but not above this zone. *Acodus combsi* and *Parapaltodus simplicissimus*, dominate the lower third of the zone; *Scolopodus oldstockensis* and *Spinodus* cf. *spinatus* characterize the middle third, and the top is characterized by *Oistodus? tablepointensis* n.sp. All these species are restricted to this zone. Other typical associates are *Juanognathus serpaglii* and *?Erraticodon balticus* in the lower third of the zone. *Loxodus? curvatus, Drepanoistodus?* cf. *venustus, Cordylodus? horridus, Periodon aculeatus,* and *Walliserodus ethingtoni* are also important species in this interval.

Remarks. – The zone contains the most varied and abundant fauna within the Table Head Formation. Only a few genera and species range into the next zone. The faunal assemblage has also been recorded at the base of unit A_3 in the lower Table Head (Fig. 18:2). Reworked specimens of *Oistodus? tablepointensis* have been recorded above unit B_1 (in unit B_2 and unit B_3). These are excluded from the range of the species in Fig. 18.

CORNUODUS LONGIBASIS – WALLISERODUS ETHINGTONI Assemblage Zone

Definition. – The base is at the top of the *Acodous combsi – Oistodus? tablepointensis* Assemblage Zone. The top is the top of the middle Table Head at Table Point.

Reference section. – The same as for the *Histiodella kristinae* Phylozone. The base is 21 m above the base of the middle Table Head; thus the zone is 64 m thick at Table Point.

Characteristic conodont species. – No species is restricted to this zone. Aside from the nominate species *Periodon aculeatus, Cordylodus? horridus,* and *Belodella jemtlandica* are common through the zone. *Histiodella bellburnensis* n.sp. and *Strachanognathus parvus* first appear at the top of the zone.

Remarks. – The zone can best be distinguished from the underlying *Acodus combsi – Oistodus? tablepointensis* Assemblage Zone by the absence of the key fossils of that zone. The fauna is less varied and usually occurs in low frequencies.

At Table Point this zone is clearly connected to the lithology of unit B_2 and unit B_4 of the middle Table Head.

Correlation of zones

Fåhræus (1970, 1977a) has already discussed the conodont fauna from the Table Head Formation and concluded that the main part of the succession at Table Point is of Llanvirn age. Since then conodont taxonomy has drastically changed, and also extensive information on conodont biostratigraphy has appeared. Despite this no major revisions of previous correlations are proposed here, though some comments and some changes in detail are suggested.

Correlation will be made (1) within the study area; (2) with other Newfoundland localities; and (3) with North America, western Europe and Australia.

Table Point and other localities

The distribution within the study area of the above defined phylozones and assemblage zones is outlined in Fig. 19.

Elements of *Histiodella tableheadensis* are present in every section studied. The lower boundary between this species and its immediate ancestor has not been recorded in any sections, thus the total range of the *H. tableheadensis* Phylozone is unknown.

The lowest zone, the *Trigonodus carinatus – Eoneoprioniodus?* sp. 1 Assemblage Zone includes unit A_1 and part of unit A_2 at Table Point, at Back Arm East and at Gargamelle Cove W. It also extends down into the top beds of the St. George Group at Table Point. The thickness at Table Point is 43 m, and 15 m at Back Arm where the top of the zone is not exposed.

The *Parapanderodus arcuatus – ?Erraticodon balticus* Assemblage Zone includes the upper part of unit A_2 and most of unit A_3 at Table Point. At Gargamelle Cove East and West the complete sections are within this zone. The same is true of the Pointe Riche Section, the St. John Island, Port Saunders and Bellburns sections.

The *Histiodella kristinae* Phylozone and the *Acodus combsi – Oistodus? tablepointensis* Assemblage Zone are present at Bellburns. However, their complete distributions within the section were not established in this investigation.

Correlation with Newfoundland examples

Fåhræus (1970) reported and illustrated conodonts from Little Spring Inlet, Hare Bay. Species in common with Table Point include *Polonodus? clivosus* and *Periodon aculeatus*. Fåhræus (1970) indicated that this fauna could be latest Arenig or earliest Llanvirn in age. Additional samples have been collected from Little Spring Inlet and other localities in Hare Bay, and more information has been obtained (Stouge 1981). Species in common with the Table Point Section include: *Histiodella tableheadensis, Belodella sinuosa, Belodella semtlandica,* and *Periodon aculeatus.* This fauna correlates with the *H. tableheadensis* Phylozone.

Conodonts from the top of Bed 14 of the Cow Head Group (Fåhræus, 1970; Fåhræus & Nowlan 1978; Stouge, unpubl.) are present in the lower Table Head. They are: *Histiodella tableheadensis, Parapanderodus arcuatus, Periodon aculeatus* and *Belodella* sp. Bed 14 may be contemporaneous with the lower part of the Table Point Section or slightly older (*Orthidiella* Zone).

Bergström (1979b) listed Table Head conodonts from the Port au Port Peninsula. The fauna was obtained from middle Table Head and probably correlates with the *Histiodella tableheadensis* Phylozone.
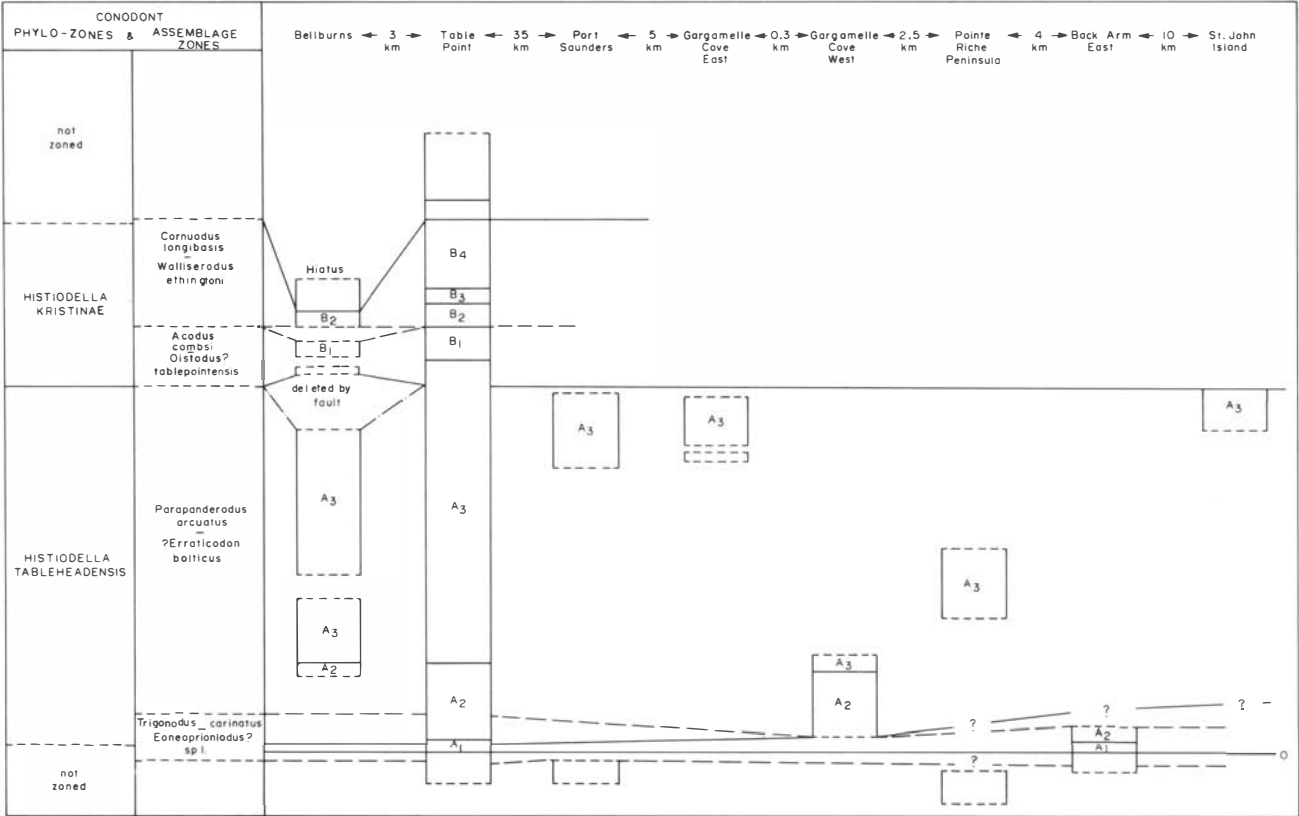
Fig. 19. Distribution of phylozones and assemblage zones within the study area. Full lines are limits of phylozones and the dashed lines are assemblage zones. See text for further explanation. The letters in the columns are the lithological units of Fig. 16. 0 marks the base of the section at Table Point; it is included as reference.

International correlation

Two, possibly three, standard zonations are available for reference when assigning an age to the Table Head strata on the basis of contained conodonts: the Midcontinent Faunal succession (Sweet *et al.* 1971; Sweet & Bergström 1976), the Scandinavian conodont succession (Lindström 1971; Bergström 1971a, b, 1973a; Löfgren 1978), and the preliminary Australian conodont succession (McTavish & Legg 1976).

Midcontinent faunas. – The North American Whiterockian Stage comprises conodont Faunas 1 to 4 (Sweet *et al.* 1971; Sweet & Bergström 1976). The species *Histiodella sinuosa* is considered a key species of Midcontinent Fauna 3 (Sweet & Bergström 1976). *Histiodella tableheadensis* associated with *Eoneoprioniodus?* sp. 1 characterize Midcontinent Fauna 4. *Histiodella kristinae* has not yet been described from the Midcontinent Province.

The Table Head Formation has the following species in common with the Midcontinent Faunas, the number of brackets refers to the fauna in which the genera and species have been reported to be characteristic (Sweet *et al.* 1971); *Semiacontiodus preasymmetricus* (1), *Histiodella tableheadensis* (4), *Leptochirognathus* sp. (4 and higher), *Eoneoprioniodus?* sp. 1 (4), *Multioistodus* (2 through 5) and *Erismodus?* sp. (5).

Histiodella tableheadensis and *Eoneoprioniodus?* sp. 1 occur at the base of the Table Point Section, and Fauna 4 is represented by the *Trigonodus carinatus – Eoneoprioniodus?* sp. 1 Assemblage Zone of this study. Hence, the Table Head Formation is not older than Fauna 4. The range of the

additional species listed above are consequently extended to include Fauna 4.

Conodonts of Fauna 4 in the USA have been reported from the Everton Formation, Missouri and Arkansas; Oil Creek Formation, south-central Oklahoma; Lehman Formation and lower Swan Peak Quartzite in western Utah, and the Antelope Valley Formation of Nevada (Sweet *et al.* 1971; Sweet & Bergström 1976; Ethington 1977; Harris *et al.* 1979). The Joins Formation, south-central Oklahoma (Mound 1965a) and the Fort Peña Formation, Marathon, Texas, are mainly of Midcontinent Fauna 3 age (Bergström 1978; Bradshaw 1969; Sweet & Bergström 1976).

In Canada Midcontinent Fauna 4 is recorded from the Ship Point and Bay Fiord Formations of Arctic Canada (Barnes 1974) and from the Sunblood Formation of the Mackenzie Mountains (Tipnis *et al.* 1978).

A small fauna from Scotland (Higgins 1967) includes *Oistodus multicorrugatus,* but lacks *Histiodella* species, and cannot be evaluated precisely in terms of Table Head zonations. The fauna is probably of Midcontinent Fauna 2 to 4 in age, and it is considered to be older than the Table Head fauna.

Correlation with the North Atlantic Faunal Province. – The Baltoscandian conodont sequence was summarized by Lindström (1971) and Bergström (1971a) for the Lower and Middle Ordovician (for a discussion of chronostratigraphic classification of Ordovician of the Baltic; see Jaanusson 1960). Viira (1974) and Dzik (1978) summarized the conodont successions from the East Baltic area. Refinement

Table 3. Correlation and summary of stratigraphic units referred to in the text. Data for conodont faunas of North America from Ethington & Clark (1971); Sweet *et al.* (1971) and Sweet & Bergström (1976). Data for Scandinavian conodont zones from Lindström (1971); Bergström (1971, 1973a) and Löfgren (1978).

SYSTEM	SERIES (N.A.M.)	Stages Substages (N. America)	Series (British)	Series Stages Substages (Baltic)	British Graptolite Zones	Formation Group (This Study)	Conodont Phylo-zones and Assemblage-zone (This Study)	Conodont (N. Am.)	Faunas (Australia)	Conodont Zones and Subzones (Scandinavia)
ORDOVICIAN	CHAMPLAINIAN	CHAZYAN	LLANVIRN	LASNA MAGI	DIDYMOGRAPTUS MURCHISONI	UNNAMED	NOT ZONED	5		Pygodus serra — Eoplacognathus foliaceus
		WHITEROCKIAN / TABLEHEADIAN		ASERI C_I	DIDYMOGRAPTUS	TABLE HEAD FORMATION M	HISTIODELLA / KRISTINAE — Cornuodus longibasis, Walliserodus ethingtoni		OCH	Eoplacognathus suecicus — E. suecicus – P. sulcatus
				KUNDA B_{III} — Aluoja $B_{III}\gamma$			Acodus combsi, Oistodus tablepointensis		OCG	Eoplacognathus suecicus – S. gracilis
				Valaste $B_{III}\beta$	"BIFIDUS"	TABLE HEAD FORMATION L	HISTIODELLA / TABLEHEADENSIS — Parapanderodus arcuatus ?Erraticodon balticus	4	OCF	Eoplacognathus? variabilis — Eoplacognathus? variabilis, Microzarkodina ozarkodella
							Trigonodus corinatus, Eoneoprioniodus? sp. l	2-3		
	CANADIAN	VALHALLAN / UNNAMED	ARENIG	Hunderum $B_{III}\alpha$	DIDYMOGRAPTUS HIRUNDO	ST. GEORGE GROUP	NOT ZONED or WANTING	E – 1	OCE	E.? variabilis – M. flabellum parva; Microzarkodina flabellum parva; Paroistodus originalis; Baltoniodus novis B. triangularis — NOT SUBZONED
		Langevoja $B_{II}\gamma$								
		Limbata $B_{II}\beta$								
		beds $B_{II}\alpha$								
		CASSINIAN	LATORP B_I — Billingen $B_I\beta$		DIDYMOGRAPTUS EXTENSUS			E	OCD	Oepikodus evae

of the zonation for the Middle and Upper Ordovician was made by Bergström (1971b, 1973b) and Löfgren (1978). Kohut (1972), Stouge (1975) and Löfgren (1978) commented upon and suggested minor revisions of the upper part of the Lower Ordovician zonation of Lindström (1971). These zonations are now considered standard references for the North Atlantic Province and have been correlated with the standard graptolite zonation (Table 4).

In the Table Head fauna no zonal fossils of the Scandinavian zonations have been recorded, but the distributions of *Periodon aculeatus, Walliserodus ethingtoni,* and *Histiodella kristinae* allow a confident correlation.

According to Lindström (1971) and Löfgren (1978) *Microzarkodina flabellum* evolves into *M. ozarkodella* and *Periodon flabellum* evolves into *P. aculeatus* at the same time, i.e. at the base of B_{III} β. Skevington (1965) has shown that the oldest *Didymograptus 'bifidus'* Zone fauna is present at this level, and the boundary between the *D. hirundo* and *D. 'bifidus'* graptolite Zones is close to the base of $B_{III}\beta$ (Jaanusson 1960; Skevington 1965).

Based on the above information the Table Head fauna cannot be older than the base of the *E.? variabilis – M. ozarkodella* Subzone of Löfgren (1978) because *P. aculeatus* ranges through most of the sequence at Table Point. This

correlation is furthermore supported by *Walliserodus ethingtoni,* which first appears in the upper part of the *E.? variabilis – M. ozarkodella* Subzone (Löfgren 1978). In the Table Head the lowermost occurrence of *W. ethingtoni* is close to the base of the *Parapanderodus arcuatus – ?Erraticodon balticus* Assemblage Zone or within the *Histiodella tableheadensis* Phylozone.

Histiodella kristinae has been recorded from the *Platyurus* Limestone on Öland, south-eastern Sweden (Lindström 1960); from Estonia (Viira 1974); and from Poland (Dzik 1976, 1978), where it ranges through the *E. pseudoplanus* Zone or the Aluoja Substage ($B_{III}\gamma$).

The upper limit of the Table Head fauna in terms of conodonts is not clear. *Walliserodus ethingtoni, Belodella jemtlandica* and *Periodon aculeatus* occur together through *E. suecicus* Zone of Löfgren (1978), and they are also present in the succeeding Zone, i.e. the *Pygodus serra* Zone. The lack of *P. serra,* and possible presence of *Pygodus* sp. C Löfgren in the Table Head fauna indicates a correlation with the *E. suecicus – P. sulcatus* Subzone (Aseri, $C_I\alpha$).

Correlation with North Atlantic Faunal Provinces outside the Baltoscandian area. – The faunal association *Periodon, Cordylodus?, Histiodella, Belodella, Protopanderodus* and *Oistodus?,* typical of the middle Table Head, is widespread in North

America and with an occurrence in Norway. The faunas are of much the same age as the Table Head fauna though with minor differences when studied in detail.

These faunas are reported from Ikes Canyon, Toquima Range, Nevada, and Meiklejohn Peak, Nevada (Ethington 1977; Harris *et al.* 1979); the Lévis and Mystic Formations, Quebec (Uyeno & Barnes 1970; Barnes & Poplawski 1973), which also includes slightly older faunal elements; Deep Kill and Mount Merino section of the Taconic Allochthon, New York (Landing 1976), which correlates with the *Histiodella tableheadensis* Phylozone, and the Marathon Basin, Texas (Graves & Ellison 1941; Bergström 1978; Bergström & Cooper 1973). In the Marathon Basin the Fort Peña Formation is older than the Table Head fauna (Bergström 1978). The total range in age of the Fort Peña Formation still needs to be clarified, as Bergström & Cooper (1973) reported the presence of *P. serra* in the upper part of this formation.

In Europe the Hølonda Limestone of western Norway contains a fauna (Bergström 1971a, 1977b, 1979a, 1980) which correlates with *Histiodella tableheadensis* Phylozone.

Correlation with the Australian succession. – A preliminary conodont zonation in association with graptolites and trilobites has been presented by McTavish & Legg (1976). The faunal elements were not illustrated, and the correlation below is solely based on the identifications of McTavish & Legg (1976). The Australian zonation is based on informal zones designated by letters from the alphabet.

The *Histiodella tableheadensis* Phylozone correlates with the upper part of the OCF zone. The following OCG zone is included in the *H. kristinae* Phylozone. The OCH zone yielded *Phragmodus* cf. *flexuosus*, which is a key fossil for Midcontinent Fauna 5 (Sweet *et al.* 1971). This suggests that the OCH zone is younger than the *Histiodella kristinae* Phylozone in the study area.

Summary. – A summary of the correlations given above is described in Table 3.

The Table Head Formation correlates with the *E.? variabilis – M. ozarkodella* Subzone and the *E. suecicus* Zone of the Scandinavian conodont zonation. The *Histiodella kristinae* Phylozone probably correlates with the *Eoplacognathus suecicus* Zone, and the *H. tableheadensis* Phylozone with the *E.? variabilis – M. ozarkodella* Subzone. The Table Head conodont succession is included in the range of Midcontinent Fauna 4.

In terms of the graptolite zonal succession the Table Head fauna at Table Point comprises the whole of *Didymograptus 'bifidus'* Zone and ranges into the lower part of the *D. murchisoni* Zone. Upper Table Head graptolites have been correlated with the *D. murchisoni* Zone (Erdtmann 1971; Finney & Skevington 1979). In the North American graptolite zonation the Table Head succession correlates with Zone 9 of Berry (1960). Upper Table Head graptolites are transitional from Zone 9 to Zone 10 (Erdtmann 1971).

Paleoenvironmental models

Introduction

This section includes an interpretation of the succession of paleoenvironments recognized in the study area. The subsequent integration of this information into a sequential paleogeographic interpretation will be dealt with but briefly, as the Table Head stratigraphy is more complex than this investigation would suggest. A detailed reconstruction must await a three-dimensional knowledge of facies distribution and paleogeography, particularly in terms of sea level fluctuations. The environmental patterns will be illustrated applying Walther's law (Blatt, Middleton and Murray 1972; Middleton 1973) to the depositional environments represented in the vertical succession at Table Point.

Criteria of environmental importance

The interpretation of ancient sedimentary environments depends largely on comparison with modern analogues (e.g., Bathurst 1975; Milliman 1974), and on consideration of fossil faunas as well as lithological criteria and sedimentary structures (e.g., Heckel 1972; Laporte 1967, 1969). The following principal criteria are used to distinguish subtidal rocks from intertidal sediments.

Intertidal environments are characterized by unstable energy levels (Laporte 1967:80) and variable salinity, which creates numerous local microenvironments (Friedman & Sanders 1978). Sediments which accumulate in intertidal environments reflect the complex system of physical parameters. There are frequent lateral and successional facies changes (Logan *et al.* 1974). The formation of dolomite and evaporite minerals is commonly associated with these environments (Bathurst 1975; Friedman & Sanders 1978). The variety of sedimentary structures, including desiccation cracks, fenestral pores and ripple marks, can also be indicative of an intertidal setting (Logan *et al.* 1974; Ginsburg 1975; Grover & Read 1978). Associated faunas *in situ* can be sparse or abundant but characteristically are of low diversity (Heckel 1972).

In contrast, subtidal environments tend to be more stable and sediments deposited there tend to be more extensive vertically and laterally. Limestones of subtidal origin are best distinguished by their autochthonous faunas which may have high individual abundance in addition to diversities distinctly greater than in intertidal strata (Heckel 1972).

Sessile, colonial faunal elements associated with abundant large macrofaunas represent a structure of biohermal or biostromal type (e.g., Friedman & Sanders 1978).

Paleozoic deeper-water subtidal environments of open-water temperature and salinity were characterized by prolific trilobite faunas and predominantly inarticulate brachiopods, which at further depth are associated with the epiplanktic graptolites and radiolarians. The latter association indicates an open oceanic environment.

Lithology, when used in conjunction with other factors, can provide other useful clues about the origin of the rocks (Laporte 1969; Wilson 1975; Friedman & Sanders 1978). The proportion of siliciclastic material may increase shorewards (Milliman 1974) although the reverse has been described (Bathurst 1975). The ratio of lime mud/lime spar is a measure of energy, and may indicate distance from a shore-line or depth of the water (Laporte 1969).

In subtidal rocks slumped layers, chaotic contorted beds, and transported fossils are indications of rapid and early transport along a gradient. This submarine transport may be initiated by a storm or earthquake, or a slope.

Depositional environments of the lower Table Head

Table 4

Unit A_1. – The basal unit A_1 (7–8 m) of the lower Table Head at Table Point consists predominantly of medium-bedded light-grey, dolomitic, pelletal micrite. The unit is characterized by a sparse biota dominated by high-spired gastropods (*Hormotoma* sp.), and smooth ostracodes (leperditiids). Trilobite (*Bathyurus* sp.), cephalopod and brachiopod fragments are scarce or absent. Unit A_1 also is characterized by fenestral pores and desiccation cracks, but laminated beds are rare. Evaporites are not present.

Based on the criteria outlined above, these strata are interpreted to have been deposited in a tidal flat complex of the transgressing early Middle Ordovician sea. The water that periodically covered the flat, evaporated and supplied magnesium-rich brines to the underlying aragonite mud, penecontemporaneously replacing it to form dolomite mud. The depositional fabric remained essentially intact after the replacement with no apparent increase in crystal size.

Carbonate tidal flat fabrics without layering and supratidal facies have recently been discussed by Grover & Read (1978), who suggested that a combination of browsing (gastropods), thin inactive algal mats and high bioturbation rates relative to sedimentation prevailed in these environments. Except for an occasional gastropod, the fossils are scarce and possibly the second factor was important during the Table Head time. Also the paucity of evaporites indicates that the prevailing paleoclimate was humid – a Bahamian type of climate as opposed to a Persian Gulf type – which inhibited the formation of elevated salinities in a humid climate, as features of the arid zone tidal deposits are lacking.

Unit A_2. – This unit consits of argillaceous micrite and biosparite, and minor dolostone with silty dolomitic stringers and argillaceous material. The unit is mainly thick- or massive-bedded (Fig. 5) and medium- to dark-grey. Yellow weathering, red, silty, dolomitic stringers form the matrix of hard, irregular shaped lumps of micrite. Chert bands and nodules are present; stylolites are common.

This unit includes a characteristic slumped layer with finely-laminated angular clasts that is overlain by conchoidally fractured cross-bedded dolomitic siltstone. The next beds include massive-bedded well sorted siliceous or dolomitic siltstones with ripple marks. The beds have vertical and horizontal burrows associated with desiccation cracks. Whole, rolled, high-spired gastropods preserved in pockets are characteristic.

The fauna becomes more diverse within unit A_2, but gastropods (*Hormotoma* sp., *Maclurites* sp.) and ostracodes dominate; cephalopods, trilobites and brachiopods occur in low abundance.

The sequence is interpreted to reflect intertidal to shallow subtidal environments of a lagoon. At the top of the unit, a shallowing of water depth is inferred. It propably represents a spit. The beds, interpreted to represent a spit, are only exposed in vertical section at Table Point (Fig. 6), so any geometry cannot be demonstrated. However, lateral continuity is indicated by the preservation of the top of unit A_2 at Bellburns. The lagoons were elongated, and they were bounded on one side by the intertidal environment and on the other side by the spit and the carbonate bank.

Sorting resulted in a trend toward concentration of the finer grains in the centre of the lagoon and the argillaceous rubbly limestone with silty red-colored stringers may represent the deepest part of this environment. The sediments are generally non-laminated probably because of reworking by organisms. The slumping of argillaceous micrite with chert nodules was initiated by periodic storm activity or by periods of high wind activity, when loosely packed sediments slumped into the lagoon (e.g. Dickinson, Berryhill, & Holmes 1972). Presumably, the slumps travelled to the deeper parts of the lagoon.

The depths listed here as shallow to deep were in fact intertidal to barely subtidal. The centre of the lagoon is not considered to be more than 1–2 m deep.

Unit A_3. – Unit A_3 can be divided into three subunits. The lower subunit is hemicyclic (ABCABC), formed by argillaceous biomicrite (A), massive micrite (B) and biosparites (C) in thinner beds and lenses (Fig. 7). Each sequence varies from 10 to 35 m in thickness. The two local prominent chert bands at Table Point separate two mega-sequences each about 55 m thick. At the Pointe Riche Section a well developed sequence is present, where a coarsening-upward sequence is obvious. Small bioherms, dominated by sponges, were found within the sequences (Klappa & James 1980).

The fauna is diverse. The gastropod *Maclurites* sp. dominates the fauna of the massive-bedded micrite; leperditiids are predominant in the sparite beds, whereas trilobites, cephalopods, and brachiopods preferred sediments forming the medium-bedded argillaceous micrite.

The lower subunit of unit A_3 is interpreted as a shallow marine, nearshore deposit, as indicated by the high amount of sand-sized detritus (shell debris) in lenses. At the base, the environments of unit A_2 grade into those of unit A_3 (Fig. 6) and represent a lower intertidal environment. In this environmental zone the carbonate sediments and cements were not affected by penecontemporaneous dolomitization.

The lithological variations reflect variations in the local

Table 4. Summary of characteristics of the Table Head Formation.

SEDIMENTARY STRATIGRAPHIC UNITS	TABLE HEAD FORMATION								
	LOWER			MIDDLE				UPPER	
	A₁	A₂	A₃	B₁	B₂	B₃	B₄		

The table (Table 4) is a chart with the following row categories along the left side: LITHOLOGY, PALEONTOLOGY, STRUCTURES, ENVIRONMENT.

LITHOLOGY — range bars for: PELLETS, SKELETAL DEBRIS, CARBONATE MUD, TERRIGENOUS MUD, SPARITE, EARLY DOLOMITE.

PALEONTOLOGY — range bars for: ALGAL STRUCTURES, ARTICULATE BRACHIOPODS, INARTICULATE BRACHIOPODS, HORMOTOMA, MACLURITES, TRILOBITES, CEPHALOPODS, OSTRACODES, SPONGES, BRYOZOANS, CRINOIDS, GRAPTOLITES, RADIOLARIANS.

STRUCTURES — range bars for: MUDCRACKS, CROSS STRATIFICATION, VERTICAL BURROWS, HORIZONTAL BURROWS, BIOSTROME, SLUMPS, BIRD'S EYES, STYLOLITES, FINELY LAMINATED.

ENVIRONMENT

	TIDAL FLAT	LAGOON	SHALLOW SHELF	DEEPER SHELF	BIOSTROME	UPPER SLOPE	LOWER SLOPE	LOWER SLOPE TO BASIN
	RESTRICTED		SLIGHTLY RESTRICTED	OPEN MARINE			OCEANIC	
	VARIABLE ENVIRONMENT		STABLE ENVIRONMENT	HIGHLY STABLE ENVIRONMENT		VARIATIONS CAUSED BY PERIODIC TERRIGENOUS INFLUX	STABLE ENVIRONMENT	HIGHLY STABLE ENVIRONMENT
	CIRCULATION POOR		CIRCULATION GOOD			CIRCULATION GOOD (UPWELLING)	CIRCULATION POOR	CIRCULATION VERY POOR
	TEMPERATURE ABOVE NORMAL		TEMPERATURE SLIGHTLY ABOVE NORMAL	NORMAL			OCEANIC	
	SALINITY ABOVE NORMAL		SALINITY SLIGHTLY ABOVE NORMAL	NORMAL			OCEANIC	

environments such as mudbanks, with channels between them, and protected, slightly deeper areas of lime mud deposition and small bioherms.

An alternative explanation for the sequences is the variation of subsidence and progradation caused by the carbonate sedimentation. The subsidence was abrupt rather than being a gradual submergence. Once the typical shelf was flooded regressive carbonate outbuilding occurred until it almost reached the surface and came into the high energy zone (biosparite).

The two explanations in combination are favoured by this author. Thus the abrupt subsidence was initiated possibly by natural castrophic events and the rapid carbonate sedimentation returned the environment to the shallow water deposits. It is proposed that each mega-sequence was initiated by such an event, and progradation prevailed within a mega-sequence until the second abrupt process disturbed the quiet period. Possibly, the formation of the 'breccia bed' at Gargamelle Cove East is related to such a disturbance.

The chert layers probably filled smaller depressions of the bottom of the shallow higher-energy zone, as they are not laterally persistent as seen at Pointe Riche Section. The origin of the chert is not known – it could be of pure diagenetic origin – or the result of remobilization of siliceous sponge spicules.

The middle subunit of unit A_3 consists predominantly of medium-bedded micrite with local (packed) biomicrite beds. This middle part also becomes more thin-bedded, and argillaceous material increases. The biota becomes dominated by cephalopods, brachiopods and trilobites. These occur generally as disarticulated skeletons and occasionally as complete specimens. *Maclurites* sp. and ostracodes disappear or become less dominant. The bioclasts of the (packed) biomicrite are derived from the surrounding sediments.

The relatively abundant brachiopod–trilobite–cephalopod biota represents progressive deepening of the water and establishment of widespread subtidal conditions that continued through the deposition of the rocks of unit A_3 of the study area. This part may have been deposited in a marine offshore environment of moderate depth (outer shelf).

The upper subunit of unit A_3 changes in lithology to a grey- to light-grey micrite and biomicrite with dark-grey argillaceous material. This lithology is not always easy to separate in the field from the middle subunit of unit A_3, though the beds tend to be more massive and have an increasing amount of skeletal debris.

A wide variety of invertebrates colonized the sea floor. Relatively abundant brachiopod, trilobite and crinoid faunas developed periodically, but the most conspicuous were the faunas of sponges and bryozoans (Table 4). The fauna changes gradually with the appearance of sponges and is succeeded by massive or flattened bryozoans. The latter become the most conspicuous up-section and cover whole bedding planes. They are associated with the largest cephalopods recorded in the Table Head Formation.

The upper subunit of unit A_3 in total was deposited in a subtidal environment. A depth cannot be determined with certainty. High sedimentation rates in quiet water environments and/or changes in salinities/temperatures probably prevailed. This is supported by the flattened colonial forms

of the bryozoans. A wide surface area is the best adaption for maximum exposure to water and light in quiet water. Also, the lack of features such as cross-bedding and coarse crinoidal biosparites suggest that the bryozoans grew in a quieter and (?) deeper subtidal environment. Possibly the fauna formed only a minor elevation on the sea bottom.

The upper subunit A_3 may represent a low biostromal structure at the shelf edge.

The construction of large algal bioherms so characteristic for the Lower Ordovician St. George Group (Stevens & James 1975; Knight & Saltman 1980) was probably prohibited by the fast Table Head transgression and steady deepening. This resulted in unstable conditions and high stress on the sessile fauna in contrast to the stable conditions of the St. George Group platform rocks. Based on field experience from various localities of the Table Head Formation, the bioherm, formed mainly by sponges and bryozoans, was developed only within the study area, and the unit is relatively insignificant compared with the bulk of lower Table Head limestones.

In summary, unit A_3 was deposited on the shelf and represents a cycle of three distinguishable subenvironments, namely shallow subtidal nearshore, deeper subtidal, offshore and deep subtidal offshore respectively.

The shelf was submerged abruptly and without reef growth, which may be due to changes in the climate (?), rate of submergence, rate of sedimentation, or influx of terrigenous sediments (or combination of the four). The factors created conditions that exceeded the tolerance limits of hermatypic organisms.

Depositional environments of the middle Table Head

Table 4

The middle Table Head was divided into the four units B_1, B_2, B_3, and B_4 (Table 2).

Unit B_1. – Unit A_3 is overlain conformably by nodular bedded, dark-grey biosparites and micrites with thin shaly partings of unit B_1 (Fig. 9). These nearly black limestones with an increasing amount of argillaceous material contain abundant trilobites and articulate and phosphatic brachiopods. The profuse fauna of large cephalopods at the top of unit A_3 disappears.

The undulose beds grade into nodular beds with limestone or shale matrix. This change of bedding style indicates steepening of the bottom gradient and subsequent water deepening. The fluctuations of micrite to biosparite also indicate unstable energy levels. This environment is interpreted to occupy a high position in the upper slope environment.

Unit B_2. – The lithological unit B_2 consists mainly of uniformly interbedded black micrite, and dark-brown calcareous to black fissile shales (Fig. 10). The dense micrite does not show any features in thin section other than neomorphism where the original lime mud has become recrystallized. The sparse fauna includes trilobites and

brachiopods predominantly in the limestones, and grapto-lites in both lithologies.

Interbeds of fine-grained limestone (micrite) and dark shale occur worldwide in rocks of different ages and show little variation from place to place (Wilson 1969, 1975). These beds are often referred to as hemipelagic, because they are a combination of terrigenous sediment and pure pelagic sediment. Wilson (1969) and Keith & Friedman (1977) suggested that the lime mud was formed on the shallow shelf and transported into deeper water. Schlager & James (1978) introduced the term 'periplatform ooze' for these shelf derived sediments. The basinward transporta-tion processes could either be nepheloid layers or dilute turbidity currents (Walker & Mutti 1973; Keith & Fried-man 1977). The sediments could later have been reworked by contour currents (Heezen *et al.* 1966). Stevens (1970) considered middle Table Head strata to be a carbonate flysch deposit, and in general hemipelagic carbonate beds are commonly associated with turbidite sequences (Walker & Mutti 1973; Wilson 1975). As discussed by Keith & Friedman (1977) the rhythmic succession of micrite and shale beds of very constant and even thickness cannot be explained solely by the processes mentioned above. As yet, however, no acceptable depositional processes have been proposed.

Unit B_2 is interpreted to represent the upper slope environment.

Unit B_3. – An interval of sparry black biosparite and interbedded shales is very rich in trilobites within the limestones. The random orientation of the trilobites, disar-ticulated organisms, and the mixed faunal composition indicate transportation from the environments above, i.e. the outer shelf, shelf edge and uppermost slope into the lower environment of unit B_4.

Unit B_4. – The upper unit of B_4 consists of evenly bedded, dark, mostly non-calcareous shales of the same lithology as the overlying Table Head, interbedded with evenly lami-nated micrite and monomictic breccias (Fig. 11). The dark laminae of the micrite are the result of concentration of organic matter, of iron sulfides, or of argillaceous material. The fauna in the limestone is sparse, consisting of trilobites, inarticulate brachiopods and a few radiolarians. The shales, however, produce an abundant graptolite fauna.

Unit B_4 probably represents the lower slope, or a transition from the upper slope into the lower slope environments. The sea bottom was probably stagnant and reducing in this environment, and bottom-scavenging organisms were not present, because bioturbation did not take place and the original laminae were not disturbed. The sporadic occurrence of radiolarians indicates a relatively increased pelagic faunal influence within this unit.

The strata at Table Point show evidence of slumping after deposition (Figs. 9, 20) and probably represent the initial state of the formation of submarine carbonate breccias as a result of submarine slumping and sliding, in turn probably due to storms or other natural catastrophes (Cook *et al.* 1972) or local overloading (Crevello & Schlager 1980). The body of sediment could move downslope along a curved surface of displacement or fault (slump scar of Walker

Fig. 20. Imbricated limestone bed suggesting the beginning of slumping. From middle Table Head at Table Point.

1966). Such a feature has been observed at Table Point and possibly at Bellburns. The toe of the slump became incoherent and possibly formed a debris flow. Stratification was destroyed and the sediments moved downslope as gravity flows, forming a chaotic mixture of various sizes of particles (Fig. 8).

The slope needs not to be steep, because slumping may take place anywhere on the continental slope. The gradient necessary for initiation may be less than one degree (Johnson 1970), and only a slight tremor is needed to initiate the slump, especially in metastable sediments (mic-rites interbedded with soft shales). A recent example of slumping was described by Crevello & Schlager (1980) from Exuma Sound, Bahamas.

To summarize, unit B_4 is partly deposited by contour currents, nepheloid layers, or dilute turbidity currents. The sedimentary mechanism of the rhythmic succession of even-bedded micrite and shales remains unsolved. After deposi-tion, the sediments slumped, were subsequently transported by submarine debris flows and were then deposited as chaotic masses of plastically deformed clasts.

The middle Table Head strata at Table Point are unique. The prominent slumped nature of the strata has been seen only at this locality. Unit B is much thicker at this locality than its lithologic equivalents in other areas, probably due to sediment accumulation, but also to the slumping.

Depositional environment of the upper Table Head

Table 4

The upper Table Head is a black bituminous shale. The beds were formed in a quiet euxinic environment. Grapto-lites are the dominant fauna. The shale probably was deposited in a basin or lower slope environment. Stevens (1970) suggested that the upper Table Head was a pelagic sediment representing a quiet period before clastic influx from the east of orogenic sandstones and shales.

Environmental reconstruction

The rocks of the Table Head sequence are clearly products of sequential deposition on a shoreline, a shelf and in a slope
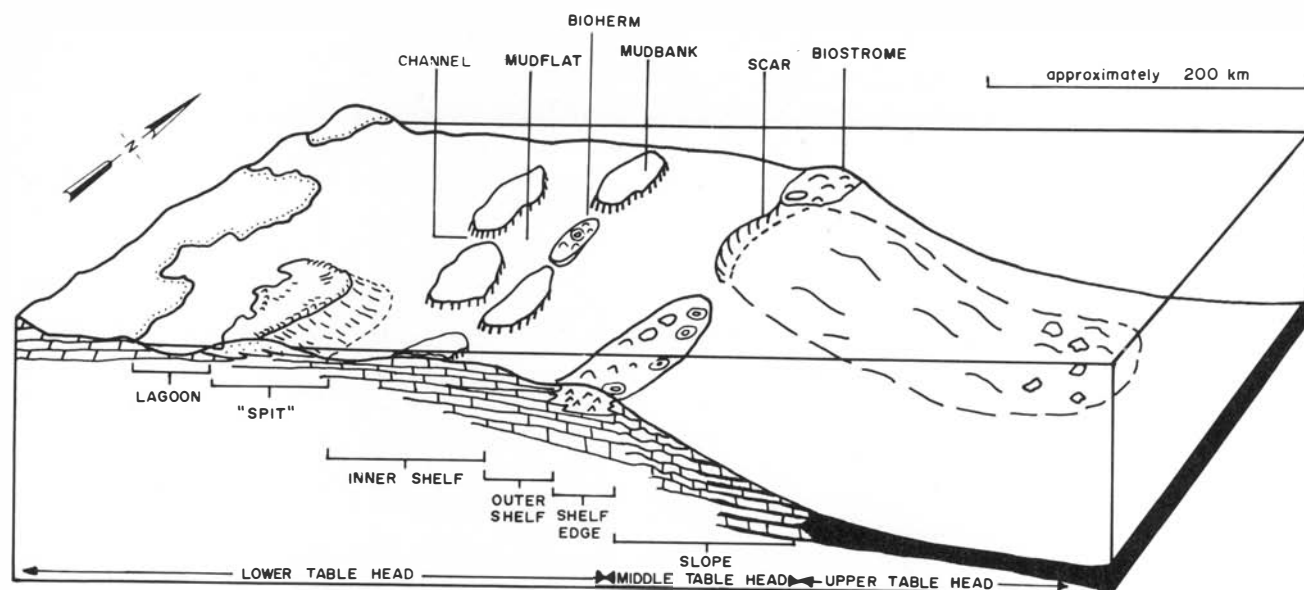
Fig. 21. Sedimentary environments of the Table Head Formation during *Histiodella kristinae* time.

environment. The depositional mechanisms that were active include sediment accumulation *in situ* (carbonate, hemi-pelagic(?) and pelagic sedimentation) and gravity flows (slumping, debris flows and turbidity currents).

There are problems associated with the reconstruction of the environments of the Table Head sequence. Foremost is the lack of specific modern analogues to be compared with the transgressive Table Head. However, the formation can be compared with generalized modern analogues. The modern example that best fits with Table Head lithofacies is the shelf-slope–(?) basin system. In western Newfoundland, the shelf was 200 km or so in width, as represented by present extent to shelf lithofacies. The shelf comprised a variety of chiefly shallow-water sub-environments. It was fringed by a tidal flat on its landward side, and was separated from the slope by an unimpressive biostromal structure to the oceanward side. The slope that prevailed in Table Head time was generally gentle, and decreased basinward to a flat basin floor. This correspond to 'Depositional Margin Slope' of McIllreath & James (1978). Sediments of the gently inclined slope were characterized mainly by hemipelagic carbonates, except where they were subsequently destroyed by current activity. The slope to basin is represented by the black shales. Subaqueous slumping occurred along the slope, and the sediments were transported out to the deeper semi-flat bottom by sediment gravity flows (Middleton & Hampton 1976; Crevello & Schlager 1980). Deposits and features which could be related to submarine canyons were not observed and possibly the Table Point represents a scar along the gently inclined slope. Fig. 21 presents a diagramatic summary of this model.

Paleogeography

In general the Table Head Formation has been interpreted to be transgressive in nature, and therefore markedly diachronous (Stevens 1970). The transgression was toward the west along a north–south trending coastline. The basal Table Head in the Hare Bay area is the oldest, the Table Point strata are intermediate in age and the Port au Port area displays the youngest strata (Stevens 1970). The biostratigraphical data gained from the study of conodonts (Fåhræus 1970; Stouge 1977, 1980b, and in press) suggest some modifications to the previously published models with regard to the regional lateral arrangement of environments during particular time intervals.

During the Upper Canadian – Lower Whiterockian, intertidal sabkha-like conditions prevailed in the study area (Levesque 1977; Levesque *et al.* 1977; Knight 1977b), forming the dolomitic and ?evaporitic 'Siliceous Dolomite' formation. Further east peritidal conditions in the Hare Bay area prevailed (Stouge 1981). To the south in the Port au Port area the St. George surface was locally subaerially exposed. The spatial distribution of these environments suggests that a shoreline or shoal area lay generally to the southwest of the study area, and the shoreline probably fluctuated during this period.

By early late Whiterockian time – *Histiodella tableheadensis* time – the predominantly tidal flat environments in the Hare Bay area were succeeded by subtidal environments of the lower Table Head. These environments graded westward into the generally shallow water lagoon (unit A_2) of lower Table Head in the study area and extended further southwest to the shallow subtidal deposits of the lower Table Head in the Port au Port area. Marine invertebrate life flourished in many of the subtidal areas in waters shallow enough to periodically affect the bottom by water turbulence.

During *H. tableheadensis* time, the shelf began to founder in the Hare Bay area, where the slope to basinal deposits of the middle and upper Table Head were deposited. These depositional facies then spread to the Port au Port area as foundering continued. In the study area carbonate sedimentation continued.

By late *H. tableheadensis* to early *H. kristinae* time the upper Table Head basinal facies was replaced by Goose Tickle

turbidite deposits in the north. In the south, the middle and upper Table Head slope to basinal facies were formed.

During *H. kristinae* time all Table Head deposition had disappeared from the Hare Bay area. To the south the basinal upper Table Head sediments were deposited. In the study area slope and basinal facies prevailed.

Conclusions

One conclusion of this study is that the lowest part of the Table Head Formation is not much older in the Hare Bay area to the north than it is in the Port au Port area to the south. In contrast the uppermost beds of the St. George Group are older in the Port au Port area than they are at the study area and in the Hare Bay area (Flower 1978). Based on the *Histiodella* lineage and the general conodont successions so far known (Ethington & Clark 1971; Ethington 1978, 1979; Sweet *et al.* 1971; Sweet & Bergström 1976) it appears – in contrast to most earlier workers referring to the Table Head transgression – that the initial Table Head transgression in the Port au Port area is not represented by younger strata than that deposited in the north. Resolution of current conodont biostratigraphy, however, is not sufficient to trace the gradual enchroachment of the Middle Ordovician sea over the shelf towards the craton to the west by dating the oldest preserved dateable Middle Ordovician Table Head strata.

In this context it should be mentioned that the strata defined as the St. George Group straddles the Lower – Middle Ordovician boundary. Any well-defined boundary between the upper Lower Ordovician and Lower Middle Ordovician cannot easily be found in the rock record on the shelf due to the fact that the time is represented by mainly non-fossiliferous regressive dolostones. Fossils of latest Canadian age and lowermost Middle Ordovician (Whiterockian) beds (Fåhræus 1977a) are present throughout the Great Northern Peninsula (Flower 1978; Stouge in press). Further study in the areas mentioned may clarify the age ranges of the faunas recorded, and possibly define a boundary in the rock sequence. Until then, the exact age difference between the upper strata of the St. George Group in the Port au Port area to the south, in the study area and in the Hare Bay area to the north likewise cannot be determined. The age difference covers the early Whiterockian or the *Didymograptus hirundo* Zone (see also Fortey 1980).

Until recently, basic assumptions were that limestone was generally Table Head Formation or early Middle Ordovician age whereas dolostone was from the St. George Group of Early Ordovician age. Mapping and study of the stratigraphy of the lower Paleozoic of the Northern Peninsula, western Newfoundland (e.g., Knight 1977, 1978; Knight & Saltman 1980; Stouge 1980b, 1981, in press), has revealed that several megacycles related to major regional transgressive and regressive events occurred during the Middle Cambrian through Lower Ordovician. Each megacycle consists of (1) a basal limestone of subtidal shelf deposition, and (2) a dolostone sequence of restricted shallow water conditions. Variable salinity conditions prevailed during this sedimentation. These regressive strata

contain some major and many minor breaks in sedimentation (disconformities). In Newfoundland the Table Head transgression commenced in the early Middle Ordovician, but the cycle was prevented from being completed by the inception of the Taconic event.

The lack of prominent shelf-edge reef facies in the Table Head Formation in contrast to the St. George Group is probably related to the inception of the Taconic event. Furthermore, variation in the morphology of the ancient margin along western Newfoundland and the style of deposition can be related to this difference. The St. George Group represents a prograding carbonate bank in a stable environment with a reefal shelf-edge and an associated steep slope (Knight & Saltman 1980; Rodgers 1968). This is the 'by-pass margin' of McIllreath & James (1978). The Table Head was deposited during rapid submergence and fast transgression of the early Middle Ordovician sea. Consequently, the Table Head formed on the gentle slope of the 'depositional margin' of McIllreath & James (1978).

Also the biostratigraphic data gained from this study suggest modifications to earlier ideas concerning the lateral distribution of the middle Table Head. One important feature, which was also suggested as a possibility by Fåhræus (1970), Stevens (1970) and Erdtmann (1971), is that Middle Table Head strata are older in the Hare Bay area than they are at Table Point. However, in contrast to previous suggestions (see, however, Erdtmann 1971), middle Table Head strata of the Port au Port are slightly older than at Table Point. The age difference is not great, but corresponds to one conodont zone.

Another of the notable paleogeographic features indicated by the sequence is the non-linearity of the shelf-edge. The shelf-edge was probably sinuous in outline, being convex to the west of the Bonne Bay and the Hare Bay areas.

The explanations for these differences are several. The Lower–Middle Ordovician regressive–transgressive event marks not only a lithological change but also coincides with a regional change. This change has commonly been referred to as the beginning of the destruction of the carbonate bank (e.g., Dewey 1969; Stevens 1970; Williams & Stevens 1974; Fåhræus 1976; Williams 1978b) of the Appalachians and the progression of the west moving thrust slices. The present author will not question this interpretation, but suggests caution, because a similar transgressive–regressive event occurs in other areas outside of the Appalachian–Caledonian system. These areas, such as the North Greenland fold belt (Dawes 1976), had an unrelated structural history. It is probable that more than one factor was responsible for the sea level variations (Vail *et al.* 1977).

The transgression in Newfoundland could be a combination of several factors. For example, an eustatic sea level rise may have been combined with the downwarping process created by the allochthonous slices moving onto the former carbonate bank. The result could have been a very rapid transgression across western Newfoundland.

From this study the diachronous character of the regression was much more pronounced than that of the transgression. The conodont data indicate that the regression was strongly diachronous. It began in late Canadian time and lasted into early Whiterockian time. The surface of the St. George Group did not develop considerable topographic

George surface. This transgression was not strongly diachronous.

The statement that the St. George Group did not develop a prominent topography is in contrast to Flower (1978). Flower (1978) found the top of the St. George Group represented the Lower Cassinian Zone in Port au Port, but the upper zones were preserved at Port au Choix. He interpreted this as the depth of karstification or depth of weathering. If so, the thickness of the basal shoal water facies of the Table Head Formation could be strongly controlled by relief on the disconformity surface of the St. George Group. For example, the lower Table Head at the Table Point Section is thicker than elsewhere and could be interpreted as having been deposited in a topographic low, whereas sections that are relatively thin (e.g., Hare Bay, Stouge 1981; and Port au Port, Klappa *et al.* 1980) could have been deposited on a regional topographic high on the disconformity surface. As a result, relief of tens of metres should be apparent.

This author prefers the first explanation. The early Middle Ordovician marine strata, which were deposited in the topographically lower areas are not very thick. The relief of only ten metres at the most has been noted in the Aguathuna quarry (Port au Port area, Klappa *et al.* 1980). Conodont data support a low relief, a slow regression, and a subsequent fast transgression. Also the time of exposure is short – at most a graptolite zone, but probably much less (Fåhræus 1977a; Stouge in press).

The sinuous outline of the transgressive shelf-edge could possibly by caused by the allochthohonous depression of the platform, or the sinuous outline could simply be original. If so, then the deposits in the embayments would be thicker. Whatever the reasons for the depressions may be, the sinuous outline is supported by the CAI (conodont alteration index of Epstein *et al.* 1977) from the various areas of Great Northern Peninsula. CAI is a measure of the temperature or thermal maturity of the host rock, mainly imposed by the amounts of overburden. Therefore, it indicates differences in depth of burial and/or geothermal gradient. Fig. 22 shows the distribution of the CAI on the Great Northern Peninsula. The isograds reflect a curvilinear outline, which is similar to the interpreted outline from the shelf edge. It is also in accordance with the regional geology of Newfoundland (Williams 1978a, b). CAI 5 or above are within areas which are close to the allochthon ophiolite complexes. The ophiolite complexes may be exposed only at Bonne Bay and Hare Bay areas because there were deepenings in which gravity sliding sould take place.

Fig. 22. The distribution of CAI in western Newfoundland. CAI 5 or above is only present within areas with transported mainly ophiolitic rocks. The data are from the autochthonous St. George Group (Stouge in press) and Table Head Formation (this study); from the allochthonous (?) Cow Head Group at Cow Head, western Newfoundland (Stouge in press). CAI 5 or above were recorded from autochthonous and parautochthonous St. George Group and Table Head Formation in the Hare Bay area (Stouge 1981, in press) and the Bonne Bay area (Stouge, in press). The information from central Newfoundland is from Bergström *et al.* (1974); Hunter (1978) and Stouge (1980a).

relief, as a prominent basal conglomerate indicating high topography is not present in basal beds of the Table Head Formation, and karst features have not been observed. During the regression a relatively planar surface or a very low-angle surface due to progradation of outbuilding of carbonate–evaporite facies was formed. Possibly, the sediments were cemented to form a hard crust of carbonates before the Table Head transgression (see Crevello & Schlager 1980). The subsequent early Middle Ordovician transgression rapidly flooded the entire sub-planar St.

Paleoecology

Introduction

It has become increasingly apparent over the last ten years or so that environmental factors influenced conodont distribution, particularly in the Devonian (Druce 1970) and

the Carboniferous (Merrill 1962; von Bitter 1972). Detailed work on facies dependence of conodonts in the Ordovician has lagged behind that of the Carboniferous, but an attempt

to describe a facies pattern was outlined by Barnes *et al.* (1973a), and in a general way by Barnes & Fåhræus (1975). In Barnes (1976) several authors presented detailed analyses of smaller areas within the Midcontinent and the North Atlantic Provinces, demonstrating that particular generic suites of conodonts were confined to particular environments (biofacies).

The main problem is the enigma of the zoological affinity of the conodontophorid (the conodont-bearing animal). Hence, some paleontologists have queried the validity of biofacies analysis (Klapper & Barrick 1977), because the distributional patterns of conodonts cannot alone reflect the mode of life of the conodontophorid. Several paleontologists have concluded that conodont taxa are not confined to a particular sedimentary facies and that the conodont animal was pelagic. Present-day distribution of pelagic taxa is not simple (e.g., Zeitschel 1978). Thus clustering of taxa is typical across the ocean due to temperature differences and to the access to light and oxygen, but is mainly dependent on the directions of the major ocean currents. Such features have been considered adequate to explain certain abnormalities in the otherwise worldwide distribution of the conodonts (e.g., Müller 1962, Seddon & Sweet 1971; Dzik 1978).

A corollary to this model is that the conodont animal was influenced appreciably by environmental factors in its distribution. Alternatively, arguments for a largely nekto-benthic mode of life have been advocated by Barnes and Fåhræus (1975). The restricted occurrences of conodont taxa, which could be related to laterally limited habitats were shown by Fåhræus & Barnes (1975). In addition, Barnes & Fåhræus (1975) proposed that the conodontophorid could have had a pelagic larval stage similar to other marine invertebrates (Thorsen 1957).

In this study, conodonts are broadly accepted to be pelagic and benthic in their mode of life, based on their interpreted lateral distribution.

Conodont associations

The conodont distribution within the Table Head Formation (Figs. 23, 24, 25) is very distinct. Certain genera and species have a limited lateral distribution as indicated in Fig. 23. The distribution is closely related to the lithology, thus suggesting that the faunas are somehow restricted to certain environments.

Three distinct associations (biofacies) of conodont taxa occur in the *H. tableheadensis* and *H. kristinae* Zones. These can be recognized by the percentage compositions of the genera *Trigonodus*, *Eoneoprioniodus?*, *Scalpellodus*, *Belodella*, *Parapanderodus*, *Periodon*, *Cordylodus?*, and *Walliserodus*. Sub-biofacies denoting specialized depositional environments within some of the biofacies have been recognized; these include the genera *Acodus*, *Scolopodus*, and *Oistodus?*.

One biofacies may overlap with a neighbouring biofacies. Species that are distinctive of the *Trigonodus–Eoneoprioniodus?* biofacies are absent in the *Parapanderodus–Scalpellodus* biofacies. Greater overlap occurs between the *Parapanderodus–Scalpellodus* and *Periodon–Cordylodus?* biofacies.

Trigonodus–Eoneoprioniodus? biofacies

This biofacies is dominated by *Trigonodus carinatus* and *Eoneoprioniodus?* sp. 1 and contains *Plectodina?* n.sp. A and *Histiodella tableheadensis;* these species represent more than 80% of the fauna. The hyaline forms, *Parapanderodus* sp., *Drepanodus?* cf. gracilis and *?Erraticodon balticus* occur as minor constituents. This biofacies is of the Midcontinent Province affinity.

Stratigraphically, this biofacies is entirely restricted to the lithologic unit A_1 and to part of unit A_2.

Conodonts from this biofacies are relatively wide-spread and are present at several localities, i.e. Table Point and Back Arm East sections and the Port au Port area, (Stouge, unpublished) and Hare Bay area (Stouge 1981).

The fauna occurred in the shallow, quiet water, intertidal to subtidal environments of higher temperature and salinities.

Parapanderodus–Scalpellodus biofacies

This biofacies is usually dominated by *Parapanderodus arcuatus* and species of *Scalpellodus*. Typical North Atlantic Province elements such as *Walliserodus*, *Periodon*, *Drepanoistodus* and *Cordylodus?* are sporadic within the biofacies, and appear to represent occasional invaders from the adjacent open sea. Their abrupt appearance in this biofacies probably is related to the fast transgressive events related to the irregular submergence of the shelf. Their equally abrupt disappearance is probably a consequence of the relatively fast rate of stabilization of habitats on the shallow shelf.

It appears that maxima of *Scalpellodus* correspond to minima of *Belodella*, and species of *Belodella* may dominate over *Scalpellodus* within the biofacies. *Belodella* also occurs in the *Periodon–Cordylodus?* biofacies, where it has its greatest abundance. Species of *Parapanderodus* occur in other biofacies, but it has its greatest abundance in the *Parapanderodus–Scalpellodus* biofacies. Species of *Semiacontiodus*, *Drepanodus?*, *Histiodella*, *?Erraticodon* and *Protopanderodus* occur in moderate numbers. *Acodus* and *Parapaltodus* are locally common, and *Loxodus?* is present as an exotic. This fauna cannot be included in the presently defined provinces.

The *Parapanderodus–Scalpellodus* biofacies occupies the top of lithologic unit A_2 and the whole of unit A_3. The fauna of this biofacies is widespread. It is represented at most localities in the study area, in the Hare Bay (Stouge 1981) and Port au Port areas (Stouge, unpublished).

The deposits representing the shelf are referred to the inner shelf, outer shelf and shelf-edge. The shelf as a whole was inhabited by varied species associations though the inner shelf had a relatively impoverished fauna.

The inner shelf deposits include the genera *?Erraticodon*, *Scalpellodus*, *Semiacontiodus*, *Drepanodus?* and *Protopanderodus*. The outer shelf is dominated by representatives of *Scalpellodus pointensis*, *Belodella*, *Juanognathus*, *Semiacontiodus asymmetricus* and *Parapanderodus*. The fauna is typical of the offshore, relatively deeper and muddier low energy environment (below wave base). This trend may allow a further subdivision of the *Parapanderodus–Scalpellodus* biofacies into two sub-
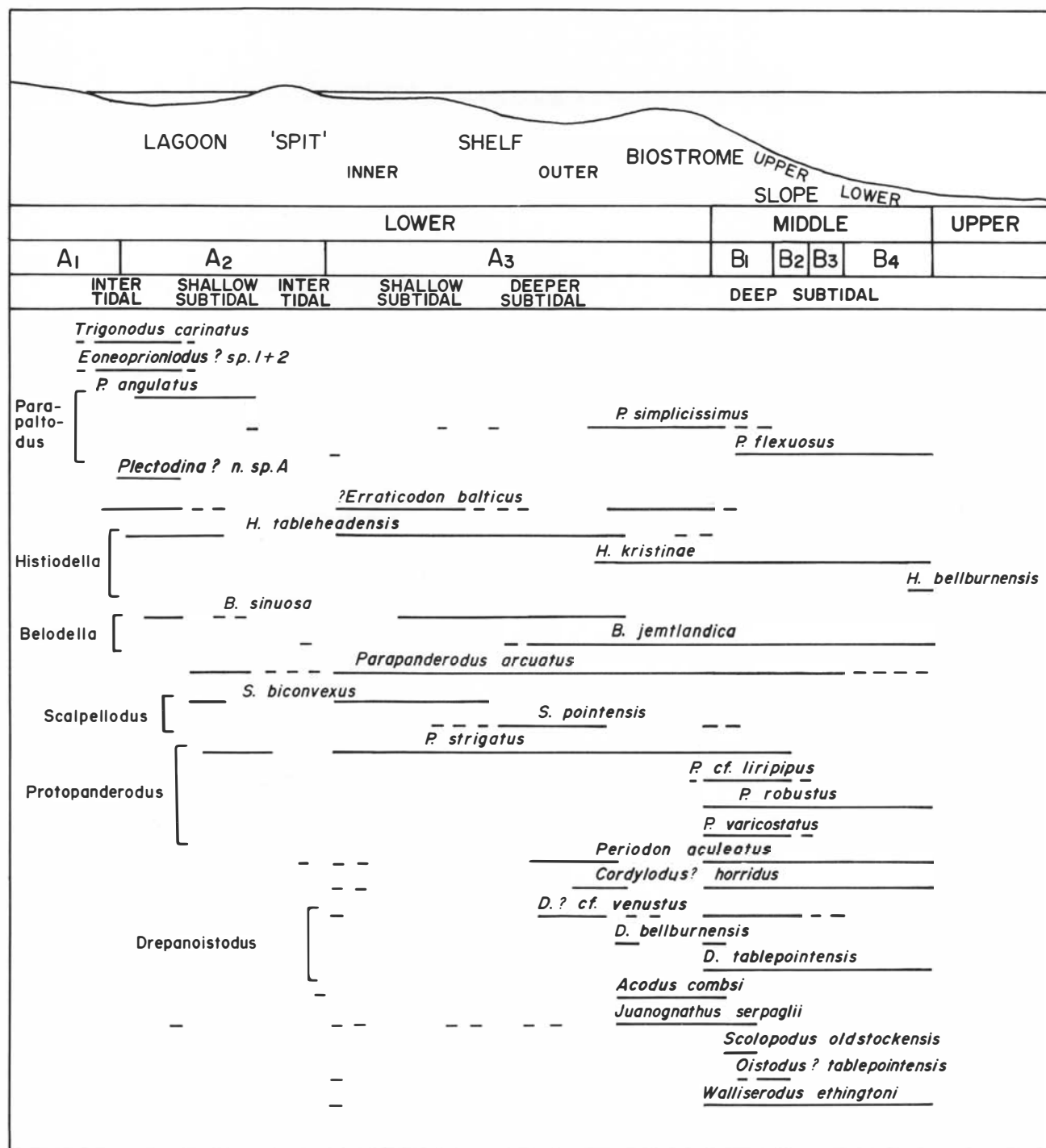
Fig. 23. Distribution of conodonts and paleoenvironments in the Table Head Formation.

biofacies, one dominated by *?Erraticodon* (inner shelf) and one outer shelf biofacies. Better material, however, than the Table Head fauna is necessary to do so.

Acodus sub-biofacies

The conodonts from the bank environment represent an association which may be unique. *Juanognathus serpaglii*, *Acodus combsi* and *Parapaltodus simplicissimus* are common associates in or near to this environment. The fauna is relatively diverse, but the yield as a rule is low, and most of the elements are small. For this fauna the *Acodus* sub-biofacies is introduced.

Periodon–Cordylodus? biofacies

This biofacies is characteristically dominated by *Periodon aculeatus*, *Cordylodus? horridus*, *Belodella jemtlandica* and *Histiodella kristinae*. *Walliserodus*, *Protopanderodus*, *Paroistodus?* and *Drepanoistodus* are common associates. *Oistodus?* and *Scolopodus* are present in a transitional zone from the *Parapanderodus–Scalpellodus* biofacies to the *Periodon–Cordylodus?* biofacies. All these genera belong to the North Atlantic Province.

The fauna is typical for the middle Table Head. Conodonts are abundant in unit B_1. This biofacies has been recorded from the Table Point and Bellburns sections. It is

Table 5. Distribution of conodont elements in samples from the sections studied.

Table 5, cont.

No.	Taxon		
38	*P.* cf. *consimilis*		
39	*P. elegans* n.sp.		
40	*P. striatus*		
41	*P.* aff. *triangularis*		
42	*Semiacontiodus asymmetricus*	sym	asym
43	*S.* cf. *bulbosus*		
44	*S. preasymmetricus* n.sp.	sym	asym
45	*S.* cf. *cordis*	sym	asym
46	*Erismodus? sp. A*		
47	*E.? sp. B. sf.*		
48	*Leptochirognathus* cf. *quadrata*		
49	*L. prima*		
50	*Multioistodus* cf. *subdentatus*		
51	*Amorphognathus? sp. A*		
52	*Polonodus tablepointensis* n.sp.	pol	am
53	*Polonodus? clivosus*	pol	am
54	*P.? newfoundlandensis* n. sp.		
55	*Pygodus? sp. A*		
56	*Oistodus? tablepointensis* n.sp.	pr	rami / ol
57	*Acodus combsi*	ac	rami / ol
58	*Acodus ? n. sp. A*	ac	rami / ol
59	*Baltoniodus? prevariabilis medius*	rami	ol
60	*Eoneoprioniodus ? sp. I*	pr	rami
61	*E.? sp. 2*		
62	*Periodon aculeatus*	pr / ou / cor / loxogn / period / trich / ol	
63	*Phragmodus ? sp. A*		
64	*Plectodina ? n. sp. A*	spath / dich / rami	
65	*? Erraticodon balticus*	hinde / ozark / neopr / rami / pr	
66	*Histiodella bellburnensis*	spath	
67	*H. kristina*	spath / rami / ol	
68	*H. tableheadensis*	spath / rami / ol	
69	*Laxodus? curvatus*		
70	*Spinodus* cf. *spinatus*		
71	*Gen. et sp. indet. A*		
72	*Gen. et sp. indet. B*		
73	*Gen. et sp. indet. C*		
74	*Prioniodus simplex*		
	SAMPLE TOTAL		

Table 5, cont.

	BELLBURNS									TOTAL BELL-BURNS	PORT SAUNDERS		TOTAL PORT SAUNDERS	GARGAMELLE COVE EAST			TOTAL GARGA-MELLE COVE E.	GARGAMELLE COVE WEST						TOTAL GARGA-MELLE COVE W.	POINTE RICHE PENINSULA WEST						TOTAL POINT RICHE	BACK ARM							TOTAL BACK ARM	ST. JOHN ISLAND					TOTAL ST. JOHN ISLAND
	A_3	B_1	B_2	A_2		A_3					A_3			A_3				A_2					A_3		A_3							ST.G	A_1					A_2		A_3					

also present in the Hare Bay (Stouge 1981) and Port au Port (Bergström 1979b) areas.

Scolopodus–Oistodus? sub-biofacies

From a paleoecological point of view, the fauna of unit B_1 is of interest because its distribution exhibits a close correla-

tion between types of conodont faunal associations and sedimentary environment reconstruced on lithic and megafossil criteria. The beds representing the upper slope of a deepening environment yield a distinct fauna, with a restricted occurrence. Scolopodus occurs next to the bank environment and Oistodus? at lower depth. The two genera form a sub-biofacies of their own and the Scolopodus–Oistodus?
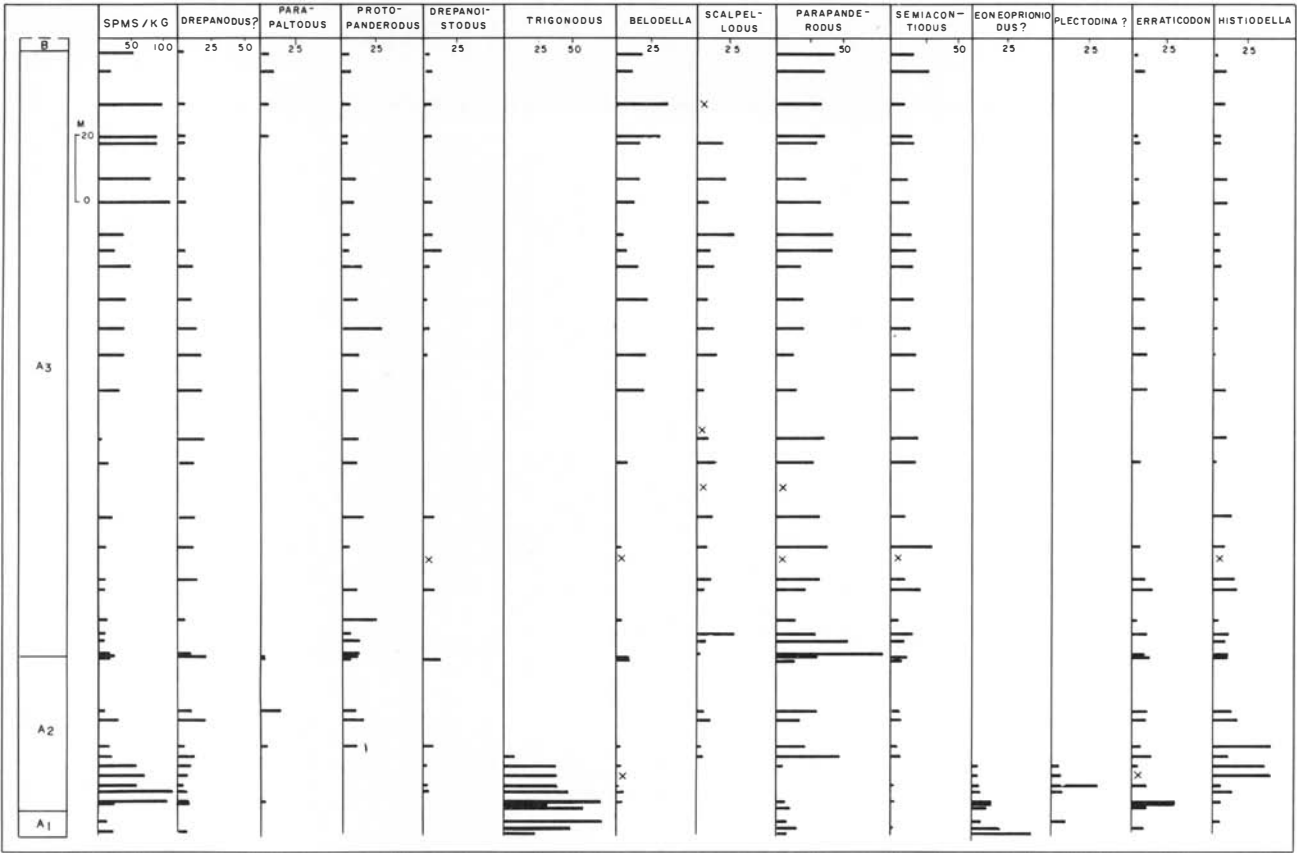
Fig. 24. Relative abundance of the dominant conodont genera in the Lower Table Head at Table Point, western Newfoundland. × marks the presence of a genus.

sub-biofacies is introduced for this faunal association. *Spinodus* and *Polonodus* are characteristic but rare members of this sub-biofacies.

Walliserodus sub-biofacies

Except for unit B_1 and unit B_3 the average frequency of conodonts in samples from the *Periodon–Cordylodus?* biofacies is low (25 specimens or less per kilogram). This probably is due to the high mud content in many samples, which makes complete digestion in acetic acid difficult, but also, to an original low frequency of specimens in the rock. The conodonts are, as a rule, small and the diversity is low. The genera *Cordylodus?*, *Periodon*, *Histiodella*, *Belodella* and with secondary associates as *Walliserodus*, *Parapaltodus*, *Paroistodus?*, *Protopanderodus* and *Drepaniostodus*, form over 80% of the total fauna. For this fauna the term *Walliserodus* sub-biofacies is introduced. *Cordylodus?* increases in relative numbers at the expense of *Periodon* and *Belodella*, and the fauna is associated with the upper slope environment, transitional to the lower slope.

In the upper-slope environment many specimens are considered to have been transported from the shelf edge biofacies. These elements are fragmental and often silty material is attached to the specimens. This is in particular true for elements of *?Erraticodon* and *Oistodus?*. This is directly connected with the lithic unit B_3.

The suggested relationships between biofacies and their environment are summarized in Figure 26.

Mode of life

From the descriptions above the following modes of life may be concluded:

The shallower portions of the *Trigonodus–Eoneoprioniodus?* biofacies are dominated by *Trigonodus* and *Eoneoprioniodus?*. These genera inhabited environments with the highest temperatures and salinities. It is possible that they were adapted to a burrowing mode of life either for protection or camouflage. If this is correct the conodonts may have been benthic and possibly infaunal. A further speculation could be that hyaline material may be related to such a mode of life, and epifaunal elements, floaters and swimmers, are chiefly conodonts with white matter.

Plectodina? inhabited the deeper, though not very deep, subtidal waters of the lagoon.

Parapanderodus, as a genus, would be interpreted to be pelagic, because it is represented in all biofacies. The species, however, indicate different adaptations, that may have been controlled by the substratum or the source of food. *P. arcuatus* was probably an active swimmer accepting difference in temperatures, salinities, and energy, but with a preference for the shelf environment. *P. striatus* inhabited shallow water, probably with slightly elevated temperatures and salinity. It is mainly restricted to the Midcontinent Province. *P.* cf. *consimilis* inhabited the shallow waters of the inner shelf. It may have been a benthic and an infaunal species. *P. elegans* inhabited the shelf and the open ocean and was mainly restricted to the North Atlantic Province. It was probably a pelagic species.
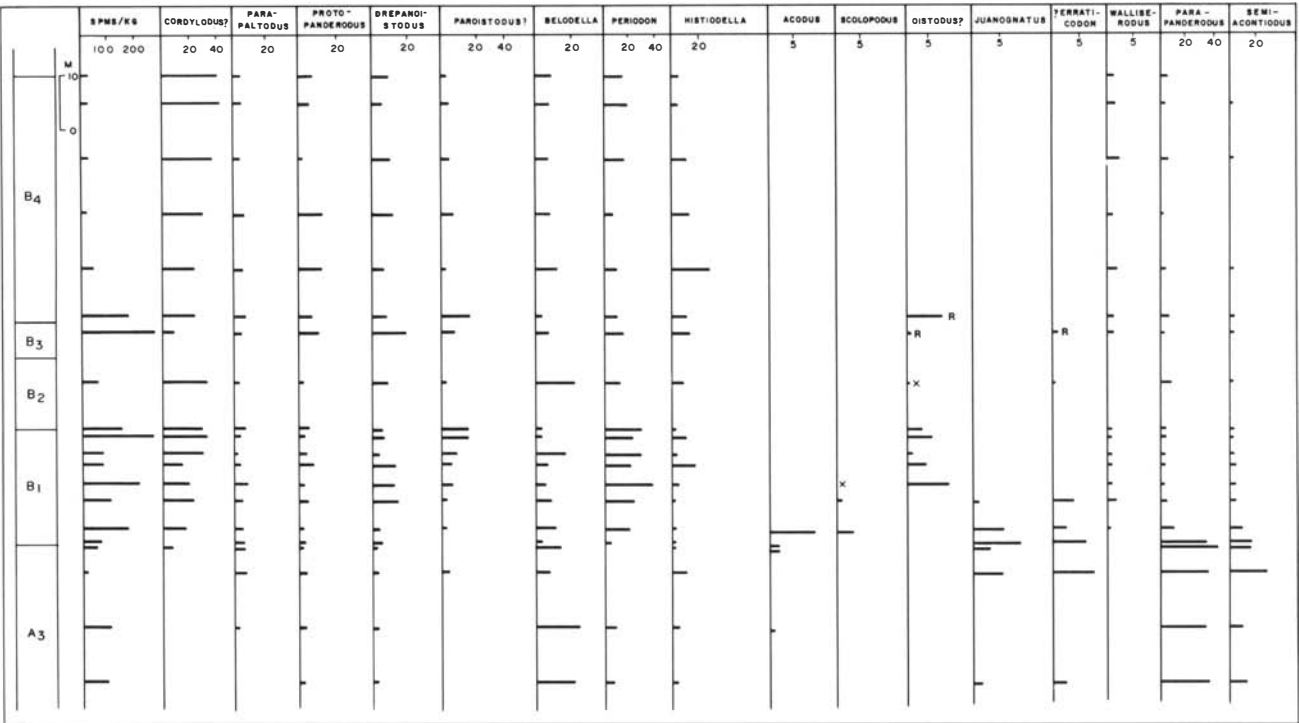
Fig. 25. Relative abundance of the dominant conodont genera in the middle Table Head at Table Point, western Newfoundland. R marks reworked specimens. × marks presence of specimens.

Parapaltodus is similar to *Parapanderodus* with respect to species distribution, and similar conclusions using the same arguments may be applicable. *P. angulatus* was restricted to the lagoonal environments. *P. simplicissimus* mainly inhabited the open shelf, but never appeared out in the ocean. These species were probably nekto-benthic.

Drepanoistodus and *Protopanderodus* also show differences in their preferences in habitat. Most species were oceanic and only a few appeared on the shelf. *Protopanderodus* was more indifferent to environments, as *P. strigatus* was present on the open shelf and the ocean. It was probably a pelagic species. *P. robustus* was oceanic and a free-swimming species (nekto-benthic). *Drepanoistodus*? cf. *venustus* was restricted to the upper slope mainly of the *Scolopodus–Oistodus*? sub-biofacies. *Drepanoistodus bellburnensis* inhabited the bank environs and was probably nekto-benthic.

Belodella is represented by two species each with their own preference as to habitat. *Belodella sinuosa* was a shallow-shelf species, whereas *B. jemtlandica* inhabited the open ocean. This difference was probably due to difference in temperature and salinity. The species were probably nekto-benthic.

Scalpellodus inhabited the relatively shallow waters on the shelf with slightly raised to normal temperatures and salinities. It was probably nekto-benthic. As noted above *Scalpellodus* and *Belodella* have an inversely proportional relative abundance. The difference is probably related to differences in the substrate or temperature. At present, their specific differences in the preference of the habitat have not been detected.

Acodus, *Scolopodus* and *Oistodus*? were probably specialized to a restricted environment at or near to the bank. Their distinct distribution probably was governed by their different preference in water depth, due to differences of light and/or temperature. These genera may have been benthic
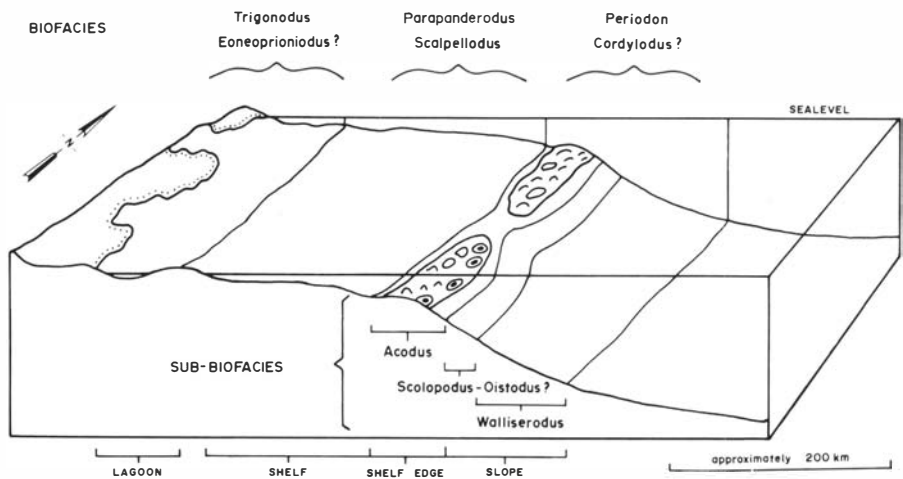
Fig. 26. Upper Whiterockian conodont biofacies and their relations to paleo-tectonic regimes. Note the break that separates shelf from lagoon biofacies (Midcontinent Province) and platform from slope biofacies (North Atlantic Province).

and/or nekto-benthic. Thus *Acodus* lived associated with the biostrome and probably was nekto-benthic, but epifaunal element; *Scolopodus* and *Oistodus*? were infaunal and benthic species.

Periodon was mainly oceanic and only appeared sporadically on the shelf. The genus was probably free-swimming (nekto-benthic). *Cordylodus*? preferred a habitat similar to *Periodon,* and it was possibly a free swimming species (nekto-benthic).

Histiodella species do not have a distinct distribution. *H. tableheadensis* was indifferent to environment because it occurred on shelf and the slope; *H. kristinae* and *H. bellburnensis* were oceanic. The species were probably pelagic and/or nekto-benthic.

Relationship to conodont biofacies in other areas

Distribution of the Table Head conodonts can be compared with the ecological model of Barnes & Fåhræus (1975), which was generally related to depth and distance from a shoreline. Some changes or additions can be applied to the distributions of Barnes & Fåhræus (1975).

Midcontinent Province

The *Trigonodus–Eoneoprioniodus*? biofacies is similar to *Histiodella*–hyaline prioniodontids–*Multioistodus* 'community'. *Multioistodus* is a rare associate in the Table Head fauna, and *Histiodella* is more common in the deeper subtidal lagoon and open shelf of the *Parapanderodus–Scalpellodus* biofacies, and occurs also in the open ocean. *Histiodella* may be the fourth most common genus of the North Atlantic Province

(Fig. 25). It should be noted that the Table Head lagoon was probably not very extensive laterally, and cannot be considered as a pure epeiric sea. Also mixing of faunas of the next biofacies disturb this comparison.

The *Parapanderodus–Scalpellodus* biofacies is new and occupies the shallow–deeper open shelf. Thus, it cannot be compared to the 'communities' of Barnes & Fåhræus (1975).

North Atlantic Province

The *Belodella–Cordylodus* 'community' (Barnes & Fåhræus 1975) probably corresponds to the *Periodon–Cordylodus*? biofacies in this study, as it was stated to be 'well-developed' in the middle Table Formation (Barnes & Fåhræus 1975:142). The deeper position of the *Amorphognathus* (?=*Polonodus*)–*Oistodus–Periodon* 'community' cannot be substantiated by this study. *Amorphognathus* (?=*Polonodus*) is a rare associate present in both the *Scolopodus–Oistodus*? subbiofacies and in the *Parapanderodus–Scalpellodus* biofacies. Based on this study, the *Belodella–Cordylodus* 'community' and *Amorphognathus–Oistodus–Periodon* 'community' occupy the same habitat. The deeper position is occupied by the restricted *Walliserodus* sub-biofacies.

Comparison of Ordovician biofacies in North America

A few works deal with environmental controls over the distribution of conodonts in the Ordovician Period. These include: one on Early to Middle Ordovician platform to slope conodont 'communities' from Spitsbergen (Fortey & Barnes 1977), one on the upper Middle Ordovician platform to slope conodont biofacies from Tennessee (Bergström & Carnes 1976), one on the Upper Ordovician to Lower

	Lagoon	Shelf		Bank	Slope	
		Inner	Outer		Upper	Lower
MIDDLE ORDOVICIAN Late *Pygodus anserinus* Zone (Bergström & Carnes 1976)	*Leptochirognathus* RSA	*Belodella Phragmodus Polyplacognathus* RSA	*Periodon Pygodus* RSA	*Belodella Phragmodus Prioniodus* RSA	*Periodon Pygodus* RSA	
Pygodus serra (Bergström & Carnes 1976)	*Leptochirognathus* RSA	*Belodella Phragmodus Polyplacognathus* RSA		——	*Periodon Pygodus* RSA	
Upper Whiterockian This Study	*Trigonodus Eoneoprioniodus* Biofacies	*Parapanderodus Scalpellodus* Biofacies		*Acodus* Sub-biofacies	*Periodon-Cordylodus* ? Biofacies	
					Scolopodus Oistodus Sub-biofacies	*Walliserodus* Sub-biofacies
Lower Whiterockian (Bradshaw 1969; Barnes & Poplawski 1973)	*Eoneoprioniodus Multioistodus*	——		——	*Periodon Protopanderodus Oistodus*	*Spinodus Eoplacognathus Prioniodus*
LOWER ORDOVICIAN (Fortey & Barnes 1977)	'*Scolopodus*' *Acodus*	'*Oepikodus*' *communis*		*Bergstroemognathus*	*Periodon*	*Oepikodus* (evae)

Fig. 27. Comparison of conodont 'communities' or biofacies from Lower to Middle Ordovician. The Lower Ordovician 'communities' are those of Fortey & Barnes (1977). The Lower Whiterockian 'communities' are from Barnes & Poplawski (1973) and Bradshaw (1969).

Silurian platform conodont 'communities' from Hudson Bay (Le Fèvre *et al.* 1976) and one on Middle Ordovician platform conodont 'communities' from Kentucky (Fåhræus & Barnes 1975).

Fortey & Barnes (1977) distinguished four, possibly five, conodont communities: a shallow-water assemblage occurring in pure white limestone and consisting of genera of the Midcontinent Province (*Scolopodus* 'community'), a further offshore assemblage consisting of *Walliserodus, Bergstroemognathus* and *Prioniodus* (*Oepikodus*); a deeper-water assemblage occurring in impure dark platy limestones and consisting largely of *Periodon* and *Prioniodus* (*Oepikodus*) (*Periodon* 'community'); a deep-water assemblage in finely laminated and black graptolitic limestones and shales and consisting of *Prioniodus* (*Oepikodus*) (*Prioniodus* 'community'), and a pelagic assemblage consisting of simple-cone genera (*Drepanodus, Drepanoistodus* and *Paroistodus*), and occurring in all of the above 'communities' (pelagic 'community'). An early Middle Ordovician (Whiterockian) off-shore 'community' included *Protopanderodus, Oistodus, Periodon* and *?Belodella.* Of the Lower Ordovician 'communities', only the *Periodon* 'community' is similar to any of the three conodont biofacies defined in this study. That is the *Periodon–Cordylodus?* biofacies. One genus only (*Periodon*) is shared.

The Whiterockian assemblage, despite the sparse description, has a reasonably clear correspondence to the *Periodon–Cordylodus?* biofacies. All the genera mentioned are shared and may be equivalent to the *Scolopodus–Oistodus?* sub-biofacies of this study. The principal difference is the lack of *Cordylodus?*.

Other Spitsbergen 'communities' are unrepresented or unrecognized. The *Prioniodus* (*Oepikodus*) 'community' may be represented by the exclusively graptolitic facies seaward of the *Periodon–Cordylodus?* biofacies. The pelagic 'community' has not been recognized or the genera are mainly present in the *Scolopodus–Oistodus?* sub-biofacies. The *Scolopodus* 'community' may correlate with the *Trigonodus–Eoneoprioniodus?* biofacies, and the *Walliserodus, Bergstroemognathus* and *Oepikodus* 'community' may correlate with the *Parapanderodus–Scalpellodus* biofacies.

Bergström & Carnes (1976) defined four conodont biofacies (RSA's – recurrent species associations of these authors) – a shallow-water association (*Leptochirognathus* RSA) occurring in rocks of supra-, inter- and high subtidal environments and consisting of a restricted Midcontinent Province fauna (*Panderodus, Leptochirognathus, Phragmodus, Belodella, Belodina* and hyaline conodonts); a deeper, subtidal relatively nearshore association (*Belodella–Phragmodus–Polyplacognathus* RSA) and consisting of a Midcontinent Province fauna (*Plectodina, Phragmodus* and *Belodina*) and a carbonate-bank association (*Belodella–Phragmodus–Prioniodus* RSA) of mainly Midcontinent Province affinity, but mixed with the North Atlantic Province (*Prioniodus, Eoplacognathus* – possibly specialized genera). A deeper water and muddier more offshore fauna (*Periodon–Pygodus* RSA) is dominated by North Atlantic Province genera (*Pygodus, Periodon, Protopanderodus* and *Walliserodus*). Of these, the *Periodon–Pygodus* RSA compares with the *Periodon–Cordylodus?* biofacies. A number of genera are shared (*Periodon, Protopanderodus* and *Walliserodus*). *Cordylodus?* is the only significant *Periodon–Cordylodus?* biofacies element, which is missing in the *Periodon–*

Pygodus RSA. At that time, *Cordylodus?* was possibly extinct or confined to another unrepresented biofacies.

Some of the Tennessee RSA's are present in considerably altered forms. The *Leptochirognathus* RSA is similar to the *Trigonodus–Eoneoprioniodus?* biofacies of this study in that it contains *Leptochirognathus,* hyaline conodonts and panderodontids. *Belodella–Phragmodus–Polyplacognathus* RSA and *Belodella–Phragmodus–Prioniodus* RSA cannot be recognized in the study area. *Belodella,* the only genus in common, is also represented in the seaward *Periodon–Cordylodus?* biofacies. The two RSA's from Tennessee are, on the family level, similar to the *Parapanderodus–Scalpellodus* biofacies and *Acodus* sub-biofacies in that they contain panderodontids, prioniodinids (*?Erraticodon–'Phragmodus' flexuosus*), balagnathids (*Polonodus–Polyplacognathus*) and prioniodontids (*Acodus–Prioniodus*).

An environmental correlation with *Parapanderodus–Scalpellodus* biofacies, *Acodus* sub-biofacies and the *Periodon–Pygodus* biofacies cannot be made directly during late *Pygodus anserinus* time. This is indicated by the occurrence of the *Belodella–Phragmodus–Polyplacognathus* RSA of the shallow shelf, the *Belodella–Phragmodus–Prioniodus* RSA of the carbonate bank and the *Periodon–Pygodus* RSA of the deeper shelf. The principal difference is that the *Periodon–Pygodus* RSA is typical of the deeper shelf, whereas the deeper shelf is occupied by the *Parapanderodus–Scalpellodus* biofacies of this study.

Biofacies and environmental correlations cannot be made with the sequence of faunal 'communities' established across very broad epicontinental seas (Fåhræus & Barnes 1975; le Fèvre *et al.* 1976). Only a few genera and families are shared.

In Fig. 27 the disposition of the biofacies and sub-biofacies in the study area are related to the Early Ordovician and Middle Ordovician environmentally controlled associations of Fortey & Barnes (1977) and Bergström & Carnes (1976).

Comparison with other nearly contemporaneous faunas

The biofacies introduced in this study can be recognized from other areas of closely similar faunal composition. The faunas from the Fort Peña (Bradshaw 1969), Lévis (Uyeno & Barnes 1970) and Mystic Conglomerate (Barnes & Poplawski 1973), Deep Kill Shale and Styvesant Falls Formations of the Taconic Allochthon (Landing 1976), Hølonda Limestone of the Trondheim Region, Norway (Bergström 1971a, b, 1977b, 1979a, 1980); Cow Head Group, western Newfoundland (Fåhræus & Nowlan 1978) and Lush's Bight, central Newfoundland (Stouge 1980 b) are distributed within oceanic conditions associated with a high influx of clastic material, and adjacent to a slope. This slope may either be the continental slope or slopes near volcanic environments. In most cases these faunas are obtained from conglomeratic units. This indicates transport of the faunas into another environment, often into the lower slope or rise. Due to the conglomeratic nature these faunas are probably older than the surrounding faunas.

Fort Peña Formation, Texas

The Fort Peña fauna is dominated by *Periodon, Protopanderodus* and *Drepanoistodus* (Bradshaw 1969). The association

of *Periodon aculeatus* and *Protopanderodus* cf. *varicostatus* is characteristic. This association may well be the same as the *Periodon–Cordylodus*? biofacies of this study. The high numbers of *Protopanderodus*, and the lack of *Belodella* and *Cordylodus*? (only sporadic occurrences) could be explained in several ways: the biofacies associations represent slightly different ages in the two areas (this is possible, see p. 24); the species may be separated paleogeographically, or the environments may have been different in some character that is not obvious to the writer.

The presence of *Oistodus?*, *Histiodella*, *Scalpellodus*, *Parapanderodus* and *Acodus combsi* indicates that faunal associations similar to *Parapanderodus–Scalpellodus*, *Acodus* and *Scolopodus–Oistodus*? biofacies and sub-biofacies are represented in the Fort Peña fauna.

Lévis Formation, Quebec

The Lévis Formation is dominated by *Periodon*, *Protopanderodus* and *Paroistodus*? (Uyeno & Barnes 1970). The lack of *Cordylodus*? and *Belodella* is characteristic, which in turn is similar to *Parapanderodus–Scalpellodus*, *Acodus* and *Scolopodus–* in the same way. The fauna indicates affinity to the *Periodon–Cordylodus*? biofacies.

Eoneoprioniodus? and *Parapanderodus* cf. *striatus* are exclusively known from the *Trigonodus–Eoneoprioniodus*? biofacies in the study area.

Faunas including *Oistodus*? and *Scolopodus* from boulders in third and fourth conglomeratic unist of the Lévis indicate affinity to the *Scolopodus–Oistodus*? biofacies. Other Table Head biofacies may not be represented in the Lévis.

Mystic Conglomerate, Quebec

The Mystic fauna shows the closest affinity to the middle Table Head fauna together with Lush's Bight and Hølonda Limestone, and the different biofacies of this study can be recognized.

The fauna is dominated by *Periodon*, *Paroistodus*? and *Protopanderodus* (Barnes & Poplawski 1973). Additional forms are *Belodella*, *Oistodus*? and *Parapaltodus*. *Cordylodus*? *horridus* appears in two samples only (GSC 84521, 84533), the latter of which yielded a fairly high number. These two samples can be included in the *Periodon–Cordylodus*? biofacies. The lack of *Cordylodus*? is otherwise similar to the faunas from the Fort Peña and Lévis Formations. The presence of *Oistodus*? indicates an affinity to the *Scolopodus–Oistodus*? sub-biofacies. Hyaline forms., ?*Erraticodon*, *Scalpellodus*, *Juanognathus*, *Semiacontiodus*, *Acodus*? and *Parapanderodus* are known from the shelf biofacies, i.e. *Parapanderodus–Scalpellodus* biofacies.

Taconic Allochthon, New York

In the Deep Kill Shale and Styvesant Falls Formation several genera (Landing 1976) are represented common to the biofacies of this study. The sediments represent the upper and lower slope, and some of the conodont faunas were recovered from conglomeratic beds. The genera include *Periodon*, *Protopanderodus*, *Histiodella* and *Cordylodus?*,

and the fauna indicates an affinity to the *Periodon–Cordylodus*? biofacies. The distribution of each genus being present in separate samples at different levels, however, indicates a situation similar to that of the Fort Peña and Lévis Formations. Also the presence of *Scolopodus giganteus* s.f., a rare but typical element of the Mystic Conglomerate and the Fort Peña Formation could indicate affinity to another biofacies (or age).

Hølonda Limestone, Norway

Bergström (1977b, 1979a, 1980) listed a fauna, which is present mainly in the *Parapanderodus–Scalpellodus* and *Periodon–Cordylodus*? biofacies. The fauna includes *Scalpellodus*, *Semiacontiodus*, *Parapanderodus*, *Histiodella tableheadensis*, *Cordylodus?*, *Belodella*, *Periodon* and *Plectodina*? sp. The presence of *Plectodina*? indicates correspondence with the *Trigonodus–Eoneoprioniodus*? biofacies. The Hølonda Limestone is in a geological setting with sediments dominated by clastics and with volcanics (Neuman & Bruton 1974; Bruton & Bockelie 1980). This sequence probably occupies a position similar to the central volcanic belt of Newfoundland.

Cow Head Group, Newfoundland

Beds 13 and 14 of the Cow Head Group yield an almost pure *Periodon* fauna associated with a few simple cone genera (Fåhræus & Nowlan 1978). This fauna may belong to the *Periodon–Cordylodus*? biofacies, but the lack of *Cordylodus*? is against such a correlation. This author has recorded *Oepikodus*, *Semiacontiodus*, *Parapanderodus*, *Histiodella tableheadensis*, *Belodella*, and *Scalpellodus* from Bed 14. This fauna is present mainly in the *Parapanderodus–Scalpellodus* biofacies.

Lush's Bight, Central Newfoundland

Limestone conglomerates deposited in a volcanic arc complex produced a large fauna in which many genera are shared with the Table Head fauna (Stouge 1980 b, c). The most common genera are *Polonodus?*, *Oistodus?*, *Periodon*, *Cordylodus?*, *Belodella*, *Walliserodus* and *Protopanderodus*. Minor components are *Histiodella* and *Acodus?*. This fauna is typical of the *Periodon–Cordylodus*? biofacies of this study.

Conodonts compared with trilobites

One study combining the information from trilobites and conodonts has been published from Spitsbergen of late Canadian–early Whiterockian age (Fortey & Barnes 1977). The major conclusion of that work was that the conodonts and trilobites seem to occupy the same habitats and have the same modes of life.

The distribution of the Table Head trilobite fauna (Whittington & Kindle 1963; Whittington 1965) allows a similar investigation.

The lower Table Head trilobites were included in an (outer) shelf fauna (Shaw & Fortey 1977), and collected in the *Illaenid–Cheirurid* 'community' of Fortey (1975). Originally Fortey (1975) suggested an environmental correlation

of the *Illaenid–Cheirurid* 'community' with organic reef facies. That an environmental correlation with the trilobites from lower Table Head cannot be made is obvious from the interpretation of this study (pp. 25–27). the *Illaenid–Cheirurid* 'community' of Fortey is, on the family level, similar to the shelf trilobites in that it contains cheirurids, illaenids, dimeropygids, bathyurids and harpids. Whittington (1965) noted that the fauna was relatively impoverished in the lower Table Head. This is understandable, because according to the ranges (Whittington & Kindle 1963) the major part of the taxa was obtained from the lower sub-unit of the lithic unit A_3, which represents a nearshore shallow water environment with a restricted conodont fauna.

Most of the trilobite species from the lower Table Head are considered to be benthic (Fortey 1975; Fåhræus 1977b). Among the conodontophorids, *Scalpellodus, Semiacontiodus* and *?Erraticodon* were best adapted to the restricted *Illaenid–Cheirurid* 'community'.

The middle Table Head trilobites were referred to the upper slope (Shaw & Fortey 1977), which is mainly the Nileid community of Fortey (1975). The Nileid community corresponds directly to the *Periodon–Cordylodus?* biofacies of this study. The majority of the trilobites from the Nileid community are interpreted as benthic (Fortey 1975). Most genera of the *Periodon–Cordylodus?* biofacies were considered to be active swimmers (nekto-benthic). Fortey & Barnes (1977) concluded that the majority of the conodontophorids were nekto-benthic.

The distribution of the middle Table Head trilobites (Whittington & Kindle 1963) also indicates that there is an overlap between two benthic communities (Fortey 1975). A transitional zone suggests that the lower slope environment or olenid community may be present (Fortey 1975; Fåhræus 1977b; Shaw & Fortey 1977). This can be compared to the conodonts, and the restricted *Walliserodus* sub-biofacies is possibly a representative of the lower slope environment. Trilobites from the olenid community are interpreted as benthic (Fortey 1975), or pelagic (Bergström 1973). The conodonts are interpreted to be active swimmers and a nekto-benthic mode of life is indicated for this environment.

Concluding remarks

Based on this study the geographical boundaries of the conodont biofacies correspond approximately to the recognized paleoenvironments (e.g. lagoon, shelf and slope). The sub-biofacies may be related to local variations of the environments and perhaps to the depth. The marked composition and diversity break between the shelf biofacies and slope biofacies is a boundary separating warm water conodonts from cold water conodonts on the slope.

Ordovician conodont provinces have already been dealt with by many authors (e.g., Bergström 1971a, 1973c; Barnes *et al.* 1973c; Serpagli 1974; Sweet & Bergström 1974; Barnes & Fåhræus 1975; Fåhræus 1976; and Lindström 1976). According to those authors temperature was the prime environmental factor controlling Ordovician conodont geography. In addition, Barnes & Fåhræus (1975) defined conodont provinces by their communities (following

Valentine 1968). Therefore, biofacies analysis should provide new information about geography in the Ordovician.

The Midcontinent Province was adapted to a high temperature (and salinity). It was mainly restricted to epicontinental seas on the craton in tropical areas. The North Atlantic Province was cosmopolitan cold water fauna, with occurs in a deeper position at low paleolatitudes and it is found in relatively shallower water at higher latitudes. The presence of the North Atlantic Province colder fauna along the North American craton was possibly due to upwelling of cold currents associated with high organic productivity (Fortey & Barnes 1977).

Based on this study the *Trigonodus–Eoneoprioniodus?* biofacies appears to be largely limited to North America and possibly Australia. The shelf biofacies includes a number of geographically widespread genera and is restricted to the carbonate shelf areas around the Ordovician equator. The slope biofacies (*Periodon–Cordylodus?*) is also geographically widespread, but stenohaline and related to the more argillaceous limestones and graptolite bearing beds of the open ocean.

One conclusion of this study is that the various biofacies gradually change from being dominated by largely infaunal taxa to be dominated by large epifaunal taxa. The lagoonal biofacies (*Trigonodus–Eoneoprioniodus?*) is occupied by relatively more infaunal taxa than the shelf biofacies (*Parapanderodus–Scalpellodus*). The shelf biofacies is occupied by taxa, which are nekto-benthic. The slope biofacies is largely dominated by free swimmers (nekto-benthic). The upper slope sub-biofacies (*Acodus* and *Scolopodus–Oistodus?*) are occupied by relatively more infaunal taxa than the lower slope sub-biofacies (*Walliserodus*).

This conclusion is paralleled by decreasing endemicity with depth previously proposed for the trilobites (Fortey & Barnes 1977; Shaw & Fortey 1977; Ludvigsen 1978). Also it is paralleled at the present time, where infauna is generally restricted to very shallow water, whereas the epifauna has a much wider bathymetric range (Thorsen 1957; Menzies *et al.* 1973).

Furthermore, it appears that the type of apparatus could be related to the mode of life. Barnes & Fåhræus (1975) and Barnes *et al.* (1979) indicated that the pelagic genera were mainly simple cones. From this study is seems that simple-cone apparatuses are restricted to the different biofacies on family level, and a sequence as follows seems to prevail: acanthodontids (*Trigonodus*) for the lagoon to panderodontids for the shelf (*Parapanderodus, Scalpellodus, Semiacontiodus*) to distacodontids (*Drepanoistodus, Protopanderodus*) for the slope environments. A similar trend can be indicated for the apparatus with ramiform elements such as prioniodontids (*Eoneoprioniodus?*), prioniodinidids (*?Erraticodon*) to periodontidids (*Periodon*).

Barnes *et al.* (1979) stressed the influence of provincialism on the apparatus types. According to those authors the apparatus type evolved independently within each of the two main provinces. If so, then the apparent similarity in the style of the apparatus of the species from the *Trigonodus–Eoneoprioniodus?* biofacies (Midcontinent Province), from the *Parapanderodus–Scalpellodus* (province affinity uncertain) and from the *Periodon–Cordylodus?* biofacies (North Atlantic Province) is superficial. The explanation for the presence of the

apparently similar, but genetically separated, apparatuses within each province could be a question of functional adaption. The various apparatus types had distinct functions within each biofacies, but similar function in all biofacies. For example *Trigonodus* and ?*Erraticodon* seem to imitate the apparatus of *Semiacontiodus* and *Periodon*, respectively.

The described examples cited earlier suggested a series of shallow to deep water biofacies coinciding with infaunal to epifaunal trends. During eustatic changes the habitats of the shelf area would decrease (regression) or increase (transgression). During major periods of regression the fauna of the epicontinental seas will be forced onto a constricted and now overpopulated shallow shelf. As a consequence, animals were forced to live in deeper zones, and they were lost from the fossil record. The nearshore, highly adapted species would not be able to respond to rapid environmental alterations and an extinction could occur (Fåhræus 1976). During a transgression the shelf and slope biofacies would migrate onto the platform into the newly created habitats. This would result in a reduction of the number of benthic species. Furthermore, the introduction of shelf fauna onto the platform destroys the habitat for the nearshore infaunal species (in our case the hyaline conodonts of the *Trigonodus–Eoneoprioniodus?* biofacies).

Also the transgression would promote the invasion of species that prior to the transgression were present in other geographical separate (offshore) areas. These areas may not necessarily have been located on other plates because different faunal provinces are present on the same plate (Barnes & Fåhræus, 1975; Fortey & Barnes 1977). The conodonts could also have lived around islands isolated from the craton or volcanic islands (Stouge 1980a, b, c, d), as is the case of some Ordovician brachiopods (Neuman 1972) and trilobites (Shaw & Fortey 1977; Ludvigsen 1978; Bruton & Bockelie 1980).

The Whiterockian transgression is a major transgression at the eastern and northern edges of the North American plate. The migration of North Atlantic Province elements onto the North American craton can be explained as an effect of this transgression.

The rapid faunal replacement during the Whiterockian was accentuated by the collapse of the carbonate bank related to movements of the Taconic Orogeny (Stevens 1970; Barnes & Fåhræus 1975; Fåhræus 1976). The main effect of plate movements on the distribution of provinces is that routes of major currents and paleoclimatic regimes are changed. Major transgressive/regressive events, which can be traced beyond the limits of the Appalachians/Caledonians, for example, may not necessarily have to be related to structural events (Vail *et al.* 1977). The change from a steep carbonate bank with little or no lateral segregation of facies to an open shelf and a gentle slope with lateral segregation can be traced and related to the eustatic changes.

The comparison of closely related *Periodon* faunas reveals some differences. The principial difference is the general lack of *Cordylodus?* in many *Periodon–Protopanderodus* dominated biofacies. If a combination of the following factors are considered: (a) the slight age difference of the faunas; (b) the relative geographical position; (c) the configuration of the margins (steep versus gently inclined); (d) the application of a similar principle as Fåhræus & Barnes (1975) and James *et al.* (1979) did for the Cow Head Group (i.e. transgressions–regressions related to faunal changes); and (e) the proposed transgressive model above, the following sequence of events may apply and explain these differences.

The slight age differences are displayed in the degree of evaluation of certain species. Overall, the Lush's Bight fauna is similar to much of the Mystic Conglomerate, the geologic setting (Stouge 1980b, c) may be similar, both are overlain by Carodocian or interbedded with Llandeilian black shales, and their conodont faunas are about a conodont zone older (i.e. the *H. tableheadensis* Zone) than the fauna at Table Point (*H. kristinae* Zone). The Lévis fauna, the fauna of the Taconic allochthon, the Fort Peña fauna, the Cow Head fauna and fauna from Spitsbergen are in part or generally older than the Table Point fauna.

The Lush's Bight, the Hølonda, and probably the Mystic Conglomerate occupy a position in the open ocean off the craton. The first two are associated with a volcanic arc sequence (Bergström 1979a; Stouge 1980b, c) and the Mystic Conglomerate was interpreted to be a horst isolated from the craton by Barnes & Poplawski (1973). These areas were inhabited by the *Periodon–Cordylodus?* biofacies faunal elements. The margin at these areas included a ?lagoon, shelf, shelf-edge, and upper slope as the faunal elements of these environments were found.

Some of the faunal elements were apparently restricted to these areas. *Cordylodus?*, Polonodus and *Walliserodus* inhabited the environments close to the volcanic sediments (Lush's Bight), but were not able to occupy the habitats along the margins of the craton.

The areas next to the craton, i.e. Cow Head, Lévis Formation, Fort Peña Formation and the Taconic conodont faunas were characterized by a *Periodon–Protopanderodus* biofacies of the slope. It was noted that the biofacies on the shelf (*Parapanderodus–Scalpellodus* biofacies) was missing in some of the areas along the craton. For example, the Lévis Formation was dominated by *Periodon, Protopanderodus* and *Eoneoprioniodus?* in its lower half (Uyeno & Barnes 1970). *Eoneoprioniodus?* is one component of the *Trigonodus–Eoneoprioniodus?* biofacies. This indicates that the slope was steep during that time. This period of time may well be partly contemporaneous with the Late Canadian–Early Whiterockian regression.

Toward the top of the Lévis Formation, Fort Peña and the Taconic conodont-bearing strata, a change in the faunas occurs characterized by the introducing of members of the shelf and shelf-edge biofacies. This change probably represents the initial Table Head transgression and formation of the shelf and gently inclined slope facies of the Hare Bay area and equivalents.

The transgression, however, also created a dilution and mixing of the biofacies due to the migration of faunal elements in two directions. *Cordylodus?* horridus, Belodella, Polonodus and *Walliserodus* migrated landward from the island arc complex and inhabited the slope with *Periodon* and *Protopanderodus* (Taconic sporadic, Fort Peña sporadic, Table Head typical). The shelf facies faunal elements migrated into the area possibly either from other places on the craton with an already developed shelf facies or from the shelfs at the island arc complexes (Stouge 1980c). Accordingly,

faunal elements of the shelf facies migrated seawards (*Histiodella*, *?Erraticodon*, and *Parapanderodus*), and later reached the facies framing the Balto-Scandinavian platforms (outer shelf) together with *Belodella*, *Polonodus* and *Walliserodus* (Dzik 1976, 1978; Löfgren 1978). *Histiodella* was represented by *H. kristinae* and *?Erraticodon* by *Erraticodon balticus* in Europe.

Taxonomy

Introduction

The introduction of the multi-element concept has drastically changed the taxonomy of Early Middle Ordovician conodonts in recent years. This concept implies that individual conodont elements are arranged into supposed natural groupings, which represent a single (i.e. multi-element) species. It is now widely used by conodont workers and the approach in this study is fully committed to multi-element taxonomy.

The reconstruction of multi-element species is based on the combination of some or all of the following criteria (see Jeppsson 1971):

(a) Similarity of stratigraphic ranges of the elements.

(b) Consistent co-occurrence in the same sample.

(c) Similarities in color and the occurrence and distribution of white matter.

(d) Similarity of one or more morphologic features of different elements.

(e) Elemental composition of already described apparatuses.

The general philosophy of having an objective nomenclature for the conodont apparatuses and their elements appears to be followed by most modern conodont workers. The independent evolution of several kinds of nomenclatural schemes in widely different systems (e.g., Jeppsson 1971 for the Silurian System; Klapper & Phillip 1971 for the Devonian System; Sweet *et al.* 1975; Sweet & Schönlaub 1975; and Barnes *et al.* 1979 for the Ordovician System) strongly suggests that the basic philosophic concept is indeed a valid one.

The principal differences within these systems are matters such as where to draw the boundary lines between apparatuses, nomenclature for the several types, and how to label the single elements within the apparatus.

These arguments are interesting, though somewhat immaterial, for what matters is how well the apparatus and the conodont element is described. Nomenclature is simply a convenient handle, and if everyone would describe conodont apparatuses in a systematic and uniform way, each worker with his own cherished scheme could give it whatever pet name he likes.

Hence in this study, single elements within an apparatus are designated as traditional form-element genera with the suffix 'form', for instance, drepanodontiform (stem: *drepanodont*-; connecting vowel *-i*-) derived from the form genus *Drepanodus*, and should be referred to as drepanodontiform elements. This practice is now used by most conodont workers when dealing with taxa of Ordovician age. Fåhræus & Nowlan (1978) proposed to apply the combined word as a noun rather than an adjective, i.e. drepanodontiform(-s), which is a shorter terminology. Their suggestion is followed in this study. For single elements, where symmetry transition is gradual, such as in *Drepanoistodus* and other similar cone genera, this practice is not applied. When possible the suffix '-id' is used for this apparatus, for instance, curvatid or erectid, pending an objective nomenclature in the future.

Complete or incomplete apparatuses, which have been well established elsewhere are assigned to their respective genera and species. Incomplete apparatuses or single elements, which cannot safely be included in established genera or species are referred to in open nomenclature, or with the designation s.f. (*sensu formae*) as done by Barnes & Poplawski (1973) and Fåhræus & Nowlan (1978).

The morphologic terminology is adopted from Lindström (1955a, 1964) and Löfgren (1978:43). One additional term, procurved, is introduced to distinguish single cones with a curved proclined cusp from single cones with straight proclined cusp. The aboral outline refers to the outline of the aboral margin when seen in lateral view.

A genus is considered to consist of a stable apparatus, where every element of the apparatus should be present at all evolutionary stages. Several contemporaneous species may be included in a genus. Species are determined by morphological variation within the apparatus of the genus.

The synonyms of multi-element species are listed and new genera and species are named according to the rules of the I.C.Z.N.

Depository. – The collection of types and all the illustrated specimens are deposited with the Royal Ontario Museum, Toronto, Canada (ROM).

Hyaline versus white matter

The importance of the presence or absence of white matter in suprageneric taxonomy has been discussed by Lindström (1964, 1970), who chose the rank of Superfamily (Chirognathacea) to separate apparatuses with white matter from apparatuses without white matter. Ethington (1972), van Wamel (1974) and Dzik (1976) did not accept the concept hyaline versus white matter to be useful in taxonomy. These

authors included both hyaline elements and elements with white matter in the same species or genus and included those within other superfamilies. Müller & Nogami (1971) concluded that the presence or lack of white matter was of ecological rather than taxonomical importance.

In the Table Head material the problem of hyaline versus white matter is simple, as the multi-element genera include species in which all elements are either hyaline or filled with white matter. The rank of species seems to be applicable and this practice is followed in this study pending a better understanding of this subject.

Classification of the order Conodontophorida

The history of the classification of conodonts has been summarized by Lindström (1964) and Huddle (1972), who showed that two main classifications of conodonts, i.e., form-element or utilitarian taxonomy and multi-element or natural taxonomy, exist.

The most elaborate and comprehensive form-element classification of the Order Conodontophorida (Eichenberg 1930) to date is that by Hass in the *Treatise on Invertebrate Paleontology* (Moore 1962). Present knowledge has advanced far beyond the proposals of that work, and Lindström (1970) introduced a suprageneric classification which was based on multi-element criteria and evolutionary lineages. Dzik (1976, 1978) and Sweet & Bergström (1972) modified the classification of Lindström (1970) for Ordovician genera. The author will follow Lindström's classification (1970) together with the proposals of Dzik (1976, 1978). Increasing knowledge of conodont taxonomy requires new subdivisions of higher categories and some suggestions are made.

There may be protests to these revisions, probably on the basis that the proposed advancement or classification has not provided the final answer. It is, however, unthinkable that any 'final answer' could arise in the next few years, when so much fundamental study remains to be done. Incremental adjustments provide a way of keeping the classification, at least to some degree, relevant to recent advances.

Superfamily Distacodontacea (Bassler 1925)

Diagnosis. – Apparatus of mostly simple conodonts with or without one row of denticles. No clearly discernible fine surface ornamentation (Lindström 1970). The elements of the apparatus form a curvature transition series.

Family Proconodontidae Lindström 1970

Subfamily Cordylodontinae Lindström 1970

Discussion. – Species of Cordylodontinae have apparatuses consisting of elements with a denticulated posterior process. The elements of the apparatus show slight difference in the basal part, curvature and denticulation (van Wamel 1974).

Until now only Upper Cambrian/Lower Ordovician species of *Cordylodus* have been established in multi-element taxonomy, (Miller 1980; Landing *et al.* 1980). The Upper Cambrian/Lower Ordovician *Cordylodus* apparatus consists of two elements, i.e. compressed and rounded elements (*sensu* Miller 1980).

Cordylodus spinatus Hadding s.f. and *C. ramosus* Hadding s.f. exhibit a different symmetry transition series (Lindström 1964), and they are included in Ozarkodinina and referred to the genus *Spinodus* Dzik.

To judge from the literature, *Paracordylodus* may have a similar transition series as *Cordylodus,* but Fåhræus & Nowlan (1978) reported that the apparatus may be more complicated.

Genus *Cordylodus* Pander 1856

Type species. – *Cordylodus angulatus* Pander 1856.

Cordylodus? horridus Barnes & Poplawski
Pl.1:1–11.

Synonymy. – ☐1969 Gen. et species indet. – Bradshaw, pp. 1164–1165, Pl. 137:20–23. ☐1973 *Cordylodus horridus* n.sp. – Barnes & Poplawski, p. 771, Pl. 2:16–18. ☐*Cordylodus horridus* Barnes & Poplawski – Landing, p. 631, Pl. 1:11. ☐1979a *'Cordylodus' horridus* Barnes & Poplawski – Bergström, p. 305, Fig. 4J.

Discussion. – The Table Head fauna includes forms which have previously been described as *Cordylodus horridus* by Barnes & Poplawski (1973). The elements exhibit a characteristic curvature transition series. This feature, together with the lack of obvious descendants of *Cordylodus* described from the Arenig, has led this author to query the generic identification. The morphological similarity also could be attributed to homeomorphy. Possibly, the elements represent a genus of their own.

Diagnosis. – A *Cordylodus?* with a posterior process that varies from almost straight to highly arched. The anterior keel of the cusp continues onto the base as an enlarged anterior basal keel. The basal cavity tends to become inverted anteriorly and posteriorly.

Description. – The elements have an anterior, recurved cusp and a denticulated posterior process. They form a curvature transition series superposed by a sinuous outline of the elements. The denticles vary from vertical to reclined at the posterior end of the process. Elements with vertical denticles have a more arcuate posterior process than elements with reclined denticles. The process may be deflected outward. The denticles may increase in height at the middle of the process, usually above the point of sharpest curvature. Large specimens have abundant small auxiliary denticles proximal to the cusp. The denticles are basally fused, and white matter outlines the continuation of the denticles known to the basal cavity. White matter is otherwise confined to the cusp and denticles.

No surface ornamentation, such as microstriations, has been observed. The basal cavity is inverted both anteriorly and posteriorly on many specimens.

Three morphologically different elements are distinguished.

The first element is straight with an arched posterior process. The cusp is suberect to recurved, keeled and with convex faces. The denticles are free and vertical on the process. Characteristically they have an alternating tilt.

The second element has a recurved and keeled cusp with an inner lateral carina on gerontic forms. The outer face is flat. The anterior keel of the cusp continues as a convex ridge. The anterior keel of the base may be deflected outwards. The aboral outline is sinuous extending from the anterior basal junction to the posterior process. The basal cavity is shallow and located underneath the first two denticles. It continues as a small groove underneath the process. The fully denticulate process carries up to eight denticles. These are laterally compressed, free and keeled.

The third type of element is characterized by a keeled cusp, an inner flare of the base, and an upwardly curved and outwardly deflected process. The denticles are reclined. The element may carry up to three free denticles. The anterior edge of the base and the aboral margin form an angle of about 90 degrees. The basal cavity is initially wide, but becomes a narrow groove beneath the posterior denticle.

Remarks. – The Table Head forms are similar to the Mystic fauna, which also are included in synonymy. Some difference exist, however, which are similar to separate species of *Periodon* and *Baltioniodus*.

The difference include (1) Mystic forms have a conspicuous gap between the cusp and the first denticle. The successive denticles are generally free. Table Head forms do not possess this open space and the successive denticles are basally fused. (2) The aboral margin of specimens of the Mystic fauna is weakly sinuous in lateral view whereas the Table Head specimens have a prominently sinuous aboral margin. The difference is due to the Mystic forms having a higher basal sheath than the Table Head elements. And (3) the Mystic elements are not characterized by the prominent inverted basal cavity as are the Table Head specimens.

These differences may be indicative of two different species, but for the time being, they are all placed in one multi-element species.

Occurrence. – Sporadic in lower Table Head, common in middle Table Head at Table Point.

C.? horridus has been recovered from the Mystic Conglomerate, southern Quebec (Barnes & Poplawski 1973); from the Marathon basin, Fort Peña Formation, Texas (Bradshaw 1969); from the Taconic allochthon, New York (Landing 1976); from the Hølonda Limestone, Norway (Bergström 1977a, 1979); and from the Antelope Valley Formation, Nevada (Ethington 1977; Harris *et al.* 1979).

Material. – Element 1: 777; element 2: 596; element 3: 102.

Family Distacodontidae Bassler 1925 (emend. Lindström 1970)

Discussion. – Distacodontid apparatuses exclusively comprise drepanodontiforms and oistodontiforms (Lindström

1970). The elements of the apparatus may be acostate and costate. Most of the apparatuses are characterized by a curvature transition series, which includes homocurvatids, erectids and oistodontiforms (i.e. *Drepanoistodus*) or homocurvatids and oistodontiforms only (e.g. *Paroistodus*).

Different development of the transition series is the basis for a twofold subdivision of Distacodontidae. Fåhræus & Nowlan (1978) subdivided Distacodontidae into the subfamily Drepanodontinae for species with a *Drepanodus*-type apparatus and the subfamily Drepanoistodinae (correctly Drepanoistodontinae) for species of *Drepanoistodus*, *Paltodus* and *Paroistodus*.

Originally, Lindström (1970) included *Drepanodus* in Distacodontidae. Dzik (1976) transferred *Drepanodus* to Panderodontacea, mainly due to the similarity of *Drepanodus* and *Protopanderodus*, and his belief that both genera envolved from *Semiacontiodus*.

Panderodontacea includes genera, which may have elements highly striated longitudinally. *Protopanderodus* includes species with elements which show inconspicuous striations (Lindström 1971; Ziegler & Lindström 1971). *Protopanderodus* sensu Löfgren (1987:90) is very similar to *Drepanodus*. Thus, in contrast to Dzik (1976) and Lindström (1970), *Protopanderodus* is allocated to Distacodontacea in this study. The result of this procedure is that Drepanodontinae Fåhræus & Nowlan (1978) becomes a junior synonym of Protopanderodontinae Lindström (1970).

Subfamily Protopanderodontinae Lindström 1970

Synonymy. – 1978 Drepanodontinae Fåhræus & Nowlan.

Diagnosis. – Conodont-apparatus consisting of symmetrical to asymmetrical costate and/or non-costate drepanodontiforms and oistodontiforms with a twisted cusp (scandodontiforms). The asymmetry of the drepanodontiforms is due to the variable presence of lateral costae.

Remarks. – Protopanderodontinae consists of the genera *Drepanodus*, *Parapaltodus* n.gen. and *Protopanderodus*. The genera of Protopanderodontinae predominantly are of the North Atlantic Province affinity.

Genus *Drepanodus* Pander 1856

Type species. – *Drepanodus arcuatus* Pander 1856

Remarks. – *Drepanodus* includes drepanodontiforms and oistodontiforms. The apparatus has a curvature transition series and a symmetry transition series, the latter of which includes an oistodontiform with a twisted cusp (scandodontiform; Lindström 1971).

Drepanodus? cf. *gracilis* (Branson & Mehl)
Pl. 1:12–18.

Synonymy. – ☐cf. 1933 *Oistodus gracilis* n.sp. – Branson & Mehl, p. 60, Pl. 4:20. ☐cf. 1933 *Oistodus concavus* n.sp. –

Branson & Mehl, p. 59, Pl. 4:6. □cf. 1944 *Oistodus pandus n.sp.* – Branson & Mehl, p. 61, Pl. 4:21, 22. □1973 *Drepanoistodus basiovalis* (Sergeeva) – Barnes & Poplawski, p. 775, Pl. 4:3, 4, ?7. □1977 *Drepanoistodus basiovalis* (Sergeeva) – Barnes, p. 101, Pl. 1:4–6. □cf. *Drepanodus concavus* (Branson & Mehl) – Kennedy, pp. 55–57, Pl. 1:26–34.

Discussion. – The elements of the apparatus included in *Drepanodus* in this study resemble *Drepanodus* Pander in their morphology, usually being fairly large. The oistodontiform, however, is not a typical 'pipaform', but symmetrical (i.e., oistodontiform). Also the drepanodontiforms are similar to *Drepanoistodus*, being curvatid, but the typical erectid element is not present. The data are considered to be in the favour of a generic assignment to *Drepanodus* (see Kennedy 1980), but it is queried herein, because of the symmetrical oistodontiform.

Diagnosis. – Oistodontiforms have a small quadratic base, which forms an angle of 80 to 110 degrees with the anterior edge of the cusp. The drepanodontiforms have a recurved cusp.

Description. – Drepanodontiforms have laterally compressed cusp and base, which may flare. The basal cavity occupies the whole base and the tip is situated at the centre of the cusp. Only homocurvatid drepanodontiforms are present in this species. The cusp is recurved to 'sub'-erect, but is never straight. The cusp is keeled. The anterior keel continues to the aboral margin and may be flexed to one side. The aboral margin is convex in lateral view. The outline of the basal cavity is convex in lateral view from the oral edge to the tip. From the tip to the anterior junction of base and aboral margin, it is sinuous.

The oistodontiform is strongly reclined. The cusp has well developed keels and an inner carina. The anterior edge of the base meets the aboral margin in an angle, which varies from 80 to 110 degrees. The outline of the aboral margin is first straight and continues as a convex curve to the oral edge. The oral edge is short, straight and keeled. It meets the cusp in an angle of 30 degrees. The basal cavity occupies the whole base. The base is flared, giving a very open basal cavity.

Remarks. – The elements are usually large.

Lower Ordovician elements are similar in morphology to the Table Head specimens. For example *Oistodus gracilis* Branson & Mehl s.f. and *Oistodus pandus* Branson & Mehl s.f. form a similar apparatus in the St. George Group, Newfoundland (Barnes & Tuke 1970; Stouge in press) and in the Jefferson City Formation (Kennedy 1980), which, however, differs in that the basal cavity is more triangular in outline in the drepanodontiforms, and that the aboral margin of the oistodontiforms forms an angle of about 50 to 70 degrees with the anterior edge of the base. The Table Head specimens probably represent a new, but closely related species.

The forms from the Mystic Conglomerate (Barnes & Poplawski 1973) have the open basal cavity, which is typical of the Table Head specimens. The oistodontiforms differ from *Oistodus basiovalis* Sergeeva s.f. by their short oral edge,

more square basal outline and the relatively more wide open basal cavity.

Occurrence. – Lower Table Head and lower middle Table Head.

Material. – 404 drepanodontiforms, 134 oistodontiforms.

Genus *Parapaltodus* n.gen.

Type species. – *Parapaltodus simplicissimus* n.sp.

Derivation of name. – Para (Greek) = akin to, referring to the similarity to *Paltodus*.

Diagnosis. – A distacodontacean genus with an apparatus consisting of erect to proclined drepanodontiforms and twisted oistodontiforms (scandodontiforms). The elements have a large laterally compressed cusp with sharp anterior and posterior keels and a triangular base. The basal cavity is triangular.

Remarks. – *Parapaltodus* n.gen. has an oistodontiform with a twisted cusp and is thus consequently included in *Protopanderodontinae*.

This genus could be confused with *Paroistodus* or *Paltodus*, as two types of elements form the apparatus. The apparatus of *Paroistodus* consists of drepanodontiforms and oistodontiforms, the latter of which has a rectangular base and strong reclined cusp. *Paltodus* consists of drepanodontiforms and oistodontiforms, the latter of which has a triangular base and a reclined cusp. In *Parapaltodus* the homologous element is a scandodontiform and it is not strongly reclined.

Parapaltodus angulatus (Bradshaw)
Pl. 2:1–2.

Synonymy. – □1969 *Oistodus angulatus* n.sp. – Bradshaw, p. 1156, Pl. 134:8, 9. □1969 *Drepanodus* sp. – Bradshaw, p. 1150, Pl. 131:1, 2. □1965a *Oistodus abundans* Branson & Mehl – Mound, p. 26–27, Pl. 3:22, 23. □cf. 1964 *Drepanodus toomeyi* n.sp. – Ethington & Clark, p. 690, Pl. 113:17; Pl. 114:11; Fig. 2H. □cf. *Oistodus* sp. A – Ethington & Clark 1965, p. 196, Pl. 2:18.

Description. – The scandodontiform of *Parapaltodus angulatus* has been described by Bradshaw (1969), it has a straight to convex aboral outline. The angle between cusp and oral edge is nearly 90°.

The drepanodontiform is symmetrical, laterally compressed with procurved to recurved cusp. It has a small base with a short oral edge. The anterior edge of the base forms an angle with aboral margin of about 70° to 90°. The aboral outline is convex to straight. The basal cavity is triangular with convex faces. Its tip is in the centre of the cusp.

Remarks. – This species is not abundantly represented, and the material is too small to evaluate the complete variation of this species.

Drepanodus toomeyi Ethington & Clark s.f. has a higher base and a longer oral edge than the Table Head specimens. The anterior basal angle is broken in *Oistodus* sp. A

Ethington & Clark s.f. from the Ice Fields fauna. The angle between cusp and oral edge is smaller for their specimen. Possibly *Drepanodus toomeyi* s.f. and *Oistodus* sp. A s.f. represent another species of *Parapaltodus*.

Occurrence. – Unit A$_2$, lower Table Head.

Material. – 18 drepanodontiforms; 16 oistodontiforms.

Parapaltodus flexuosus (Barnes & Poplawski)
Pl. 1:19, 22–25.

Synonymy. – □1973 *Scandodus flexuosus* n.sp. – Barnes & Poplawski, p. 785–786, Pl. 2:1, 4; Fig. 2L. □1973 *Scandodus mysticus* n.sp. – Barnes & Poplawski, p. 786, Pl. 4:1, 2; Fig. 2K. □1962 *Drepanodus* sp. – Sweet & Bergström, p. 1226, Pl. 168:17. □1970 *Nordiodus* n.sp. A – Fåhræus, Fig. 3N. □?1960 *Scandodus* n.sp. 2 Lindström, Fig. 5:16; Fig. 6:12; Fig. 7:11. □cf. 1978 *Paltodus?* cf. *mysticus* (Barnes & Poplawski) – Löfgren, p. 64–65, Pl. 4:4, 5, 11.

Diagnosis. – Elements with a wide cusp and a deep conical cavity. The base is plano-convex or is flexed to the inner side.

Description. – *P. flexuosus* has been fully described by Barnes & Poplawski (1973) as the form species *Scandodus flexuosus* s.f. and *Scandodus mysticus* s.f.. *S. mysticus* s.f. is the drepanodontiform with a plano-convex base and *S. flexuosus* is the scandodontiform with strongly flexed base.

Remarks. – Swedish specimens from Jämtland differ from those of *P. flexuosus* at Table Point in having an antero-posterior extended base (Löfgren 1978:65).
   Löfgren (1978:47) proposed that *Nordiodus* n.sp. A Fåhræus is a possible adenticulate *Belodella* element, whereas *N.* sp. A Fåhræus was considered to be the drepanodontiform by Barnes & Poplawski (1973). The present material supports the interpretation by the latter authors.
   Barnes & Poplawski (1973) noted the general similarity of *Scandodus* sp. 2 of Lindström (1960) with *P. flexuosus*. Fåhræus (1966) described the form species *Scandodus formosus* s.f., which is synonymous with *Scandodus* sp. 2 of Lindström (1960). Löfgren (1978) included *S. formosus* s.f. in *Protopanderodus robustus*, but not *Scandodus* sp. 2 s.f.
   P. flexuosus differs from *P. angulatus* by the plano-convex base of the first.
   As mentioned in the discussion of *Walliserodus ethingtoni* these elements could be included in *W. ethingtoni*. The elements of *P. flexuosus* have much the same range in the Table Head fauna as *W. ethingtoni*. *P. flexuosus* elements have typically laterally compressed cusps, in contrast to the rounded cross-sections of *W. ethingtoni* elements. *P. flexuosus*, therefore, is considered to be a separate species.

Occurrence. – Rarely found in lower Table Head, common in middle Table Head.

Material. – 87 drepanodontiforms; 50 oistodontiforms.

Parapaltodus simplicissimus n.sp.
Pl. 1:20, 21, 26, 27, 28A, B.

Synonymy. – □1973 *Drepanodus toomeyi* Ethington & Clark – Barnes & Poplawski, p. 773, Pl. 2:10. □1973 *Drepanodus* n.sp. C s.f. – Barnes & Poplawski, p. 773, Pl. 2:11, 11A, 13; Fig. 2J. □cf. 1973 *Scandodus* sp. – Barnes & Poplawski, p. 786, Pl. 2:14. □1976 *Scalpellodus* sp. – Dzik, Fig. 14I. □1978 *Drepanodus?* sp. A – Löfgren, p. 53, Pl. 1:36–37.

Derivation of name. – *Simplicissimus* latin = most or very simple; refers to the simple cones of the skeletal apparatus.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – 11 m above the base of middle Table Head, sample TP 68, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39641 (Pl.1:28), a drepanodontiform.

Diagnosis. – A species with elements having a laterally compressed, large cusp and a small base with a constricted basal cavity. The elements form a weakly developed symmetry transition series.

Description. – The drepanodontiforms are laterally compressed with a wide and keeled procurved cusp and a very small base. The outer face of the cusp has a broad anterior carina, which becomes median in position toward the apex of the cusp. Anteriorly a lateral furrow runs the length of the cusp from the apex to the aboral margin. The anterior keel may be laterally deflexed inwards at the base. The posterior keel continues into the oral edge. The basal cavity is shallow and triangular with concave sides. The tip is close to the anterior keel of the cusp and directed upwards. The inner side of the base is slightly flared. The aboral outline forms a gently concave curve.
   The scandodontiforms are similar to the drepanodontiforms, but the asymmetry is formed by a slight torsion of the cusp and the flare of the inner side of the base.
   A basal filling is present in many elements. It is black in color and forms a compressed hollow cone. White matter is present in the cusp.
   Inconspicuous longitudinal striations may be present. These are restricted to the anterior keel of cusp and form an acute angle with the keel.

Remarks. – *Scandodus* sp. Barnes & Poplawski is similar to the Table Head fauna. The cusp (although broken) seemingly does not taper as fast as in *P. simplicissimus* n.sp.
   P. simplicissimus n.sp. differs from *P. flexuosus* by its small base, from *Drepanodus toomeyi* s.f., which has a high triangular base, and from *P. angulatus* by its rounded antero-basal junction.

Occurrence. – Lower Table Head; common in the lower part of the middle Table Head.

Material. – 214 drepanodontiforms; 89 oistodontiforms.

Genus *Protopanderodus* Lindström 1971

Type species. – Acontiodus rectus Lindström 1955a

Emended diagnosis. – Protopanderodus comprises laterally compressed elements with a cusp that is higher than the base. The longitudinal striations of the cusp are inconspicuous. The cross-section of the cusp may be comma-shaped, lanceolate, or bicostate. Most species include symmetrical as well as asymmetrical drepandontiforms and scandodontiforms. Most elements are costate and/or sulcate.

Discussion. – In the original definition of *Protopanderodus* given by Lindström (1971) the cross section of the cusp could be subcircular, comma-shaped, lanceolate, or *Acontiodus*-like. This led van Wamel (1974) to include elements with surface striations in *Protopanderodus*. Löfgren (1978), however, restricted *Protopanderodus* to include elements where striations were inconspicuous only. Furthermore, she (Löfgren 1978) excluded apparatuses with elements which were anteriorly/posteriorly compressed or had a subcircular cross section of the cusp from *Protopanderodus*.

Highly striated elements with a rounded cross section of the cusp and the base and with slightly thickened rim toward the posterior edge of the base were included in *Semiacontiodus* (Panderodontacea) by Dzik (1976).

Protopanderodus probably evolved from early species of *Drepanodus* by the development of costae during the early Arenig. Transitional forms between *Protopanderodus* and *Drepanodus* exist (see discussion in Fåhræus & Nowlan 1978:458).

Several species of *Protopanderodus* have been recovered from the Table Head Formation, most of which have been fully described from Scandinavia (Löfgren 1978), from along the continental margin of North America, and from volcanic islands (Barnes & Poplawski 1973; Landing 1976; Bradshaw 1969; Kennedy *et al.* 1979).

Some of the species in the Table Head fauna are considered to be more closely related than to other species of *Protopanderodus*. Therefore, it is likely that several contemporaneous species of *Protopanderodus* existed during the Ordovician period. These include the *P. rectus–robustus* lineage, the *P. varicostatus* lineage, the *P. liripipus–P. insculptus* lineage and the *P. gradatus–P. strigatus* lineage. To judge from the present knowledge of the distribution of the species *P. rectus* was mainly a Scandinavian species (Lindström 1955a, 1971; van Wamel 1974; Löfgren 1978); *P. varicostatus* was most common at island arc complexes (Sweet & Bergström 1962; Hunter 1978) whereas *P. strigatus* (this study) preferred the open shelf.

Protopanderodus robustus (Hadding)
Pl. 2:3–8.

Synonymy. – □1913 *Drepanodus robustus* n.sp. – Hadding, p. 31, Pl. 1:5. □cf. 1973 *Protopanderodus cooperi* (Sweet & Bergström) – Barnes & Poplawski, p. 782 (*pars*), Pl. 3:4, 5 only. □1978 *Protopanderodus robustus* (Hadding) – Löfgren, pp. 94–95, Pl. 3:32–35; Fig. 3i G–J (synonymy through 1978).

Description. – Protopanderodus robustus includes symmetrical and asymmetrical acontiodontiforms and scandodontiforms.

The symmetrical acontiodontiform has an erect to recurved cusp with an anterior and a posterior keel. The base varies in length and the short base types may have an antero-basal notch. The long-base types included in this species have a straight aboral outline. The keels and the two postero-lateral costae extend the full length of the unit. A black basal filling may be preserved in some specimens.

The asymmetrical acontiodontiforms are similar to the symmetrical ones, but have a slightly twisted cusp and the inner posterior lateral costa disappears above about the mid-length of the cusp.

The scandodontiform has a twisted keeled cusp and a base which is much shorter than the cusp. The unit is non costate. The margins of the base are keeled, and the inner face is flared. The element may have an inner median carina.

Remarks. – The collection at hand is small, but Löfgren (1978) fully described *Protopanderodus robustus* from a large collection.

The long-base forms may have an anterior flare of the basal sheath, which is similar to the Swedish material. The scandodontiform may have a slightly shorter base than illustrated by Löfgren (1978), and in this way resembles *P. rectus*. As discussed by Löfgren (1978) *P. rectus* and *P. robustus* are very closely related species, and some of the elements of the two species cannot always be distinguished.

The scandodontiform is also similar to the scandodontiform figured by Barnes & Poplawski (1973) and included in *P. cooperi*. The base of the Mystic element is, however, smaller than any of the Table Head specimens.

Löfgren (1978) tentatively included *Scandodus dubius* Bradshaw s.f. in synonymy with *P. robustus*. *S. dubius* is here assigned to *Scalpellodus biconvexus* (Bradshaw).

Occurrence. – Sporadic in lower Table Head; common in middle Table Head.

Material. – 43 symmetrical acontiodontiforms; 99 asymmetrical acontiodontiforms; 24 scandodontiforms.

Protopanderodus cf. *liripipus* Kennedy, Barnes & Uyeno
Pl. 2:9–14, 17.

Synonymy. – □?1978 *Protopanderodus* cf. *varicostatus* (Sweet & Bergström) – Löfgren, pp. 91–93 (*pars*), Pl. 3:30 only. □cf. 1979 *Protopanderodus liripipus* n.sp. – Kennedy, Barnes & Uyeno, pp. 546–550, Pl. 1:9–19.

Diagnosis. – A *Protopanderodus* species with a scandodontiform and a transition series of acontiodontiforms. The scandodontiform has an inner groove and the asymmetrical acontiodontiforms have one costa on one side and one costa and one groove on the other side.

Description. – The symmetrical acontiodontiform has only been recovered as fragments, and therefore cannot be described completely. The unit has a keeled cusp with two postero-lateral costae. The posterior part of the base is broken.

The asymmetrical units are of two types. One type with a long base and another with a short base.

The long base type has a recurved cusp and a relatively long posteriorly extended base. The cusp has sharp keels, which continue onto the oral and anterior margins of the base. The cusp has one postero-lateral costa, which extends to the aboral margin just beneath the oral edge/cusp junction. The other side of the unit has a posterior lateral costa and a median groove, which extend the whole length of the unit. The costa reaches the aboral margin at about midlength.

The asymmetrical element with a short base has an erect cusp and one costa on each side of the cusp. The base is keeled. The posterior keel of the cusp meets the oral keeled edge in an abrupt angle of 110 degrees. The aboral outline is convex. This unit is transitional to the scandodontiform.

The scandodontiform has a small base and a recurved keeled cusp. The outer face is smooth and convex. The inner face has a median broad carina and a groove between the carina and the anterior keel. The aboral outline is convex.

Characteristically, all the elements of this species have an extended antero-basal keel.

Remarks. – The scandodontiform resembles *Scandodus unistriatus* s.f. in that is carries one anterior, inner lateral groove. The element is, however, more laterally compressed, and the groove is more median in its position than *Scandodus unistriatus* s.f. The differences are subtle and the elements are commonly indistinguishable. The *S. unistriatus* elements included in *P.* cf. *varicostatus* in this study differ by the 'fluted' keel and a more flexed cusp of the latter species.

The scandodontiform of Löfgren (1978) is similar to *P.* cf. *liripipus* of this study. The Swedish form has a posteriorly extended oral edge. Löfgren (1978) included the elements in *P.* cf. *varicostatus*, but she mentioned that more than one species might be represented in her material.

The apparatus and the elements of *P.* cf. *liripipus* resemble both *Protopanderodus parvibasis* Löfgren and *P. liripipus* Kennedy *et al.*. Characteristically, the elements of these three species are laterally compressed and with well developed keels. *P.* cf. *liripipus* differs from *P. liripipus* in its smaller posterior extended base of all elements and from *P. parvibasis* by the lateral groove of the drepanodontiforms and the prominent inner groove of the scandodontiforms.

The three species are probably closely related and form a phyletic lineage. Löfgren (1978) noted that the ancestor to *P. parvibasis* probably was *P. rectus*. According to Kennedy *et al.* (1979) *P. liripipus* is the ancestor to *P. insculptus*.

P. cf. *liripipus* is also closely related to *P.* cf. *varicostatus*, and probably the two species evolved from *P. parvibasis* via forms described as *P.* cf. *varicostatus* by Löfgren (1978).

Occurrence. – Rare in lower Table Head; sporadic in middle Table Head.

Material. – 9 symmetrical acontiodontiforms; 31 asymmetrical acontiodontiforms; 16 scandodontiforms.

Protopanderodus strigatus Barnes & Poplawski
Pl. 2:15–16, 18–24.

Synonymy. – ☐1973 *Protopanderodus strigatus* n.sp. – Barnes & Poplawski, p. 784, Pl. 3:14, 17; Fig. 2E. ☐cf. 1974 *Protopan-*

derodus gradatus n.sp. – Serpagli, pp. 59–61, Pl. 15:5 a–8b; Pl. 26:11–15, Pl. 30:1a, b; Fig. 17. ☐cf. 1976 *Protopanderodus gradatus* Serpagli – Landing, p. 639, Pl. 4:8, 9, 11, 12.

Description. – This species has an apparatus consisting of four morphotypes of acontiodontiforms being unicostate to multicostate, and with acostate scandodontiforms. All the elements form a simple curvature transition series, and the length and depth of the basal cavity is related to the degree of curvature. Proclined forms have a slender cone and base, which is almost as long as the cusp, and a deep basal cavity. Erect forms have a shorter base than the cusp and a smaller basal cavity. Proclined forms have a reduced base and basal cavity and a tall cusp.

The number of costae on the acontiodontiforms is variable. Based on the numbers of costae the following types are present: the subsymmetrical elements have one or two costae on one side, or one costa on each side; and one costa on one side and two costae on the other side; all the elements have anterior and posterior keels on the cusp.

The subsymmetrical element has a median to lateral groove framed by two costae. The groove widens on the base and disappears close to the aboral margin. It narrows on the cusp towards the apex. The anterior keel runs from the apex of the cusp to the maximum curvature of cusp. The anterior margin of the base is convex. The posterior keel continues from the cusp onto the oral edge. On each lateral face there are two additional posterior costae between the groove and the posterior keel. The lateral costae disappear a little up on the cusp. The aboral outline is convex on proclined elements, convex to straight or slightly sinuous on elements with an erect to reclined cusp.

The asymmetrical elements are slightly twisted and have unequal numbers of costae associated with grooves on each side. The units vary from being a nontwisted cone with antero-posterior keels with one lateral costa on one side and two lateral costae on the other side separated by a groove to similar forms with a twisted cusp. The torsion of the cusp is both sinistral and dextral. Thus elements with an inner groove and two inner costae and one outer costa occur together with forms with one inner costa and two outer costae and a groove. With increasing torsion the outer side becomes acostate and convex.

The scandodontiforms have a long, robust and keeled cusp. The faces are convex and may carry an inner lateral carina.

Remarks. – Barnes & Poplawski (1973) did not include a scandodontiform in this apparatus.

Protopanderodus gradatus Serpagli is very similar to *P. strigatus,* and the two species are considered to be closely related. Also both species occupy the same habitat. It is likely that *P. strigatus* evolved from *P. gradatus.*

P. strigatus differs from *P.* cf. *varicostatus* by its convex outline of the aboral margin of all elements and the symmetrical element has two costae on both faces. The scandodontiform has an inner convex face, which may be carinated, but no groove is present.

Many specimens have large black cones of basal filling similar to those figured by Sweet & Bergström (1962,

Pl. 168:2, 9). These cones are also preserved separately and resemble elements of the Cambrian genus *Hertzina* or the Ordovician *Coelerodontus*.

Occurrence. – Lower and lower middle Table Head.

Material. – 109 symmetrical acontiodontiforms; 414 asymmetrical acontiodontiforms; 82 scandodontiforms.

Protopanderodus cf. *reclinatus* (Lindström)
Pl. 3:6–10.

Synonymy. – □cf. 1955a *Acontiodus reclinatus* n.sp. – Lindström, p. 548, Pl. 2:5, 6; Fig. 3C. □?1969 *Panderodus* sp. – Bradshaw, p. 1159, Pl. 135:1, 2. □?1969 *Scandodus* cf. *S. pipa* Lindström – Bradshaw, p. 1161, Pl. 135:3, 4. □1970 *Scandodus pipa* Lindström – Uyeno & Barnes, pp. 115–116, Pl. 22:6, 7; Fig. 7C. □1973 *Oistodus* aff. *O. parallelus* Pander sf. – Barnes & Poplawski, p. 777, Pl. 5:1–3. □1973 *Protopanderodus cooperi* (Sweet & Bergström) – Barnes & Poplawski, p. 782 (*pars*), Pl. 3:1. □1973 *Protpanderodus reclinatus* (Lindström) – Barnes & Poplawski, pp. 782, 784, Pl. 3:2, 3. □1976 *Drepanodus arcuatus* Pander – Landing, p. 632 (*pars*), Pl. 1:17–19, 21–23, *non* 16. □1976 *Protopanderodus cooperi* (Sweet & Bergström) – Landing, pp. 638–639 (*pars*), Pl. 4:7, *non* 6.

Description. – The apparatus includes costate acontiodontiforms and acostate scandodontiforms with a long posteriorly extended base.

The acontiodontiform includes symmetrical posteriorly bicostate units with a posteriorly extended base and a recurved cusp. The anterior keel of the base may flare inwards in some elements. These elements tend to be unicostate with a convex outer face. The aboral outline is convex and it meets the keeled oral edge in an angle of 30 degrees.

The scandodontiforms have a twisted recurved cusp and an inner posterior carina. The basal opening varies from a small rounded to a larger oval opening. The aboral outline is convex. The aboral margin meets the oral edge in angles varying from 30 to 80 degrees.

Remarks. – The costae vary from being prominent to inconspicuous. The latter forms could be referred to the form genus *Drepanodus* Pander. Also the apparatus could be referred to the multi-element genus *Drepanodus* Pander (emend. Lindström 1971) as Landing (1976) did. However, as the apparatus includes elements, which are *Acontiodus*-like, the present author prefers to assign the elements to *Protopanderodus*.

Acontiodus reclinatus Lindström s.f. broadly resembles the scandodontiforms of the Table Head. The base is shorter in the Lower Ordovician specimens. *Acontiodus reclinatus* s.f. has not yet found its place in a multi-element taxon. Whereas the Table Head specimens are similar to *Acontiodus reclinatus* s.f., the generic affinity of the elements may suggest that they belong to a new species within the natural genus *Protopanderodus*.

Occurrence. – Sporadic in lower Table Head; present in middle Table Head.

Material. – 4 symmetrical acontiodontiforms; 22 asymmetrical acontiodontiforms; 11 scandodontiforms.

Protopanderodus sp. A
Pl. 3:1–5.

Description. – The species comprises asymmetrical acontiodontiforms with one inner median costa on the cusp and an outer lateral groove and scandodontiforms.

The acontiodontiforms are erect to recurved. The unit has a rounded cusp with a small base. The aboral outline is convex to straight. The groove and costae extend the whole length of the unit.

The scandodontiform has a procurved cusp with convex faces and anterior and posterior keels. The inner face may bear a broad carina. The base is small. The cross-section of the basal opening is almost circular. The aboral outline is convex.

Remarks. – The elements are smaller than other elements of *Protopanderodus*. They resemble *P. strigatus* in that they have an outer groove, and possibly the elements are juveniles of *P. strigatus*. The apparatus, however, does not include symmetrical units, and the lack of intermediate forms as well as the non consistent appearance lead the author to refer the elements to a species of their own.

Occurrence. – Lower and middle Table Head.

Material. – 43 asymmetrical acontiodontiforms; 14 scandodontiforms.

Protopanderodus cf. *varicostatus* (Sweet & Bergström)
Pl. 3:11–17

Synonymy. – □cf. 1962 *Scolopodus varicostatus* n.sp. – Sweet & Bergström, pp. 1247–1248, Pl. 168:4–9; Fig. 1A, C, K. □cf. 1962 *Acontiodus cooperi* n.sp. – Sweet & Bergström, pp. 1221–1222, Pl. 168:2, 3; Fig. 1. □cf. 1962 *Scandodus unistriatus* n.sp. – Sweet & Bergström, p. 1245, Pl. 168:12; Fig. 1E. □?1964 *Acontiodus cooperi* Sweet & Bergström – Hamar, p. 247. □cf. 1964 *Scolopodus varicostatus* Sweet & Bergström – Hamar, p. 284, Pl. 1:1, 2. □1969 *Scandodus unistriatus* Sweet & Bergström – Bradshaw, p. 1161, Pl. 135:5, 6. □1969 *Scolopodus varicostatus* Sweet & Bergström – Bradshaw, p. 1163, Pl. 132:10; Pl. 134:12, 13. □1970 *Scolopodus* n.sp. 2 – Uyeno & Barnes, pp. 116–117, Pl. 22:3–5; Fig. 7A. □1973 *Protopanderodus cooperi* (Sweet & Bergström) – Barnes & Poplawski, p. 782 (*pars*), Pl. 4:8, 15 only. □1974 *Scandodus* cf. *unistriatus* Sweet & Bergström – Viira, p. 119, Pl. 5:30; Fig. 151b only. □1974 *Scolopodus varicostatus* Sweet & Bergström – Viira, p. 123 (*pars*), Fig. 160a, b, Pl. 5:23, 24. □1976 *Protopanderodus rectus* (Lindström) – Dzik, p. 429, Fig. 16, b, c, d. □1978 *Protopanderodus* cf. *varicostatus* (Sweet & Bergström) – Löfgren, pp. 91–93, Pl. 3:26–29, ?31 (*non* fig. 30). □1979 *Protopanderodus* sp. – Bergström, p. 302, Fig. 4A. □*non* 1973 *Protpanderodus cooperi* (Sweet & Bergström) – Barnes & Poplawski, p. 782 (*pars*), Pl. 3:1, 4, 5. □*non* 1976 *Protopanderodus cooperi* (Sweet & Bergström) – Landing, pp. 638–639 (*pars*), Pl. 4:7 only.

Discussion. – *P. varicostatus* has not been formally described as a multi-element taxon, but the elements are without doubt a valid species of *Protopanderodus.*

Elements identified with *Scolopodus varicostatus* Sweet & Bergström s.f. are present in the Table Head material. Some of the elements do not possess the deep anterior notch of *S. varicostatus,* but the size, and the cross-section of the cusp is similar. Associated with *Scolopodus* cf. *varicostatus* s.f. is *Scandodus unistriatus* s.f., and elements morphologically similar to *Acontiodus cooperi* Sweet & Bergström s.f. are tentatively included in the apparatus, until the nature of *P. cooperi* is known. As noted by Sweet & Bergström (1962) *Acontiodus cooperi* s.f. only differs from *Scolopodus varicostatus* s.f. in having one pair of lateral costae.

The Table Head material is far from complete and can only indicate the composition of the apparatus. The present apparatus, however, is considered closely related to *P. varicostatus* (Sweet & Bergström).

The apparatus of *P. varicostatus* and its closely related species consists of a series of symmetrical and asymmetrical variously costate acontiodontiforms and a scandodontiform with an inner lateral groove. In the apparatus *Acontiodus cooperi* s.f. is included as the symmetrical acontiodontiform. Due to priority the species should be named *P. cooperi.* The name *P. varicostatus* is preserved, because the holotype of the apparatus still needs to verify the apparatus, and because of differences in opinion of the composition of *P. cooperi.*

Barnes & Poplawski (1973) suggested that *Protopanderodus cooperi* formed an apparatus with a non-grooved scandodontiform (cf. *Scandodus rectus* s.f.). Landing (1976) followed that procedure, and Kennedy *et al.* (1979) briefly discussed the apparatus of *P. varicostatus* as being different from *P. liripipus.* Löfgren (1978) found an apparatus similar to *P. varicostatus* and included a scandodontiform with an inner groove (i.e., *Scandodus unistriatus* s.f.).

The present author shares the opinion of Löfgren (1978) in that the closely related species of *Protopanderodus* are conservative in the elemental composition of the apparatus, and only minor differences in the morphologies of the elements are present. Therefore, the scandodontiform included in *P. cooperi* by Barnes & Poplawski (1973) is considered to be related to the *P. rectus–robustus* lineage rather than to the *P. varicostatus* lineage (with *S. unistriatus* s.f.). Such an approach is not contradictory to the Mystic collections, as *Acontiodus robustus* s.f. also was recovered (*P. robustus*).

Barnes & Poplawski (1973, Pl. 3:1) also included a scandodontiform with a relatively large and open base in *P. cooperi.* Landing (1976) went a step further and included *Protopanderodus reclinatus* of Barnes & Poplawski (1973) in the apparatus. The elements of this type are included in *Protopanderodus* cf. *reclinatus* (Lindström) in this study, and they are not considered closely related to *P. cooperi.*

The apparatus and the elements of *P.* cf. *varicostatus* of Löfgren are quite similar to *Protopanderodus parvibasis* Löfgren. The scandodontiform of *P. parvibasis* has a weak inner lateral groove and a base of similar height as *P.* cf. *varicostatus.* Possibly *P. parvibasis* is the ancestor to the *P. varicostatus* lineage (and to *P.* cf. *liripipus*).

Description. – *P.* cf. *varicostatus* exhibits a simple symmetry

transition series overprinted by a curvature transition series. The elements are variously costate asymmetrical and symmetrical acontiodontiforms and scandodontiforms with an inner furrow.

The acontiodontiforms are variable in length of the base and development of the anterior basal angle. This may be rounded or sinuous forming an anterior notch. Most elements vary from symmetrical to slightly asymmetrical due to a twist of the cusp. Other elements may evolve a second outer lateral carina.

Symmetrical elements carry two posterior costae separated by a furrow. The posterior edge is 'fluted' and the element is similar to *Acontiodus cooperi* s.f.

The scandodontiform is similar to *S. unistriatus* s.f. as described by Sweet & Bergström (1962). It has a large twisted cusp with sharp keels. The anterior edge of the cusp is convex. The inner face is convex with tendency to develop a median carina. The median carina and the anterior keel are separated by a well-defined furrow, which extends the full length of the unit. The median carina is weakly 'fluted'. The cusp is highly twisted and the antero-posterior keels are almost vertical in position to the original antero-posterior direction. The base is small with a slightly sinuous aboral outline.

Remarks. – The specimens are variable, and only large specimens are 'fluted'. Most of the elements included in synonymy share the characteristics of *P.* cf. *varicostatus,* but it is possible that the specimens represent more than one species. For example, in *P.* cf. *varicostatus* of Löfgren (1978) the furrows of the elements are wider than the Table Head specimens. Also the base of the scandodontiform is higher than the Table Head forms. Landing (1976) illustrated a costate and grooved specimen, which broadly is similar to the *P.* cf. *varicostatus.* The costae seemingly are finer than the Table Head specimens.

P. cf. *varicostatus* differs from *P. strigatus* by having a sinuous aboral outline and a scandodontiform with a postero-lateral furrow.

Löfgren (1978) discussed the relationship of *P.* cf. *varicostatus* with *P. gradatus* Serpagli, and she concluded that the former might be an ancestor of the latter. The relationship of *P. strigatus* and *P. gradatus* is discussed under *P. strigatus.*

Occurrence. – Middle Table Head.

Material. – 5 symmetrical antiodontiforms; 47 asymmetrical acontiodontiforms; 19 scandodontiforms.

Subfamily Drepanoistodontinae Fåhræus & Nowlan 1978

Remarks. – Fåhræus & Nowlan (1978) established Drepanoistodontinae (i.e. Drepanoistodinae; name corrected herein) for apparatuses formed by non-, uni- and bilaterally costate drepanodontiforms and symmetrical oistodontiforms. In many of the elements included in *Drepanoistodus* in this study, the oistodontiforms have well-developed lateral costae and the drepanodontiforms are multicostate. Drepanoistodontinae comprises the genera *Drepanoistodus,* *Paltodus,* and *Paroistodus.*

Genus *Drepanoistodus* Lindström 1971

Type species. – *Oistodus forceps* Lindström 1955a.

Remarks. – The *Drepanoistodus* apparatus comprises drepanodontiforms and oistodontiforms (Lindström 1971), which form a curvature transition series. The drepanodontiforms are distinguished as curvatid and erectid. Van Wamel (1974) separated two additional elements one of which was costate. It is not always possible to differentiate the morphotypes within the species due to the gradual morphologic transition of the elements.

It is considered difficult, if not impossible to separate species on the basis of the drepanodontiforms alone, in particular for closely related species (van Wamel 1974; Dzik 1976). One difference, however, which may appear to be of taxonomic importance is the presence or absence of units with costae in the apparatus. So far, all the species from the North Atlantic Province (*D. forceps–D. basiovalis*) do have costate drepanodontiforms in the apparatus. Species of the Midcontinent Province have not yet been formally described or have been identified with species of the North Atlantic Province.

At present, two different approaches in separating species of *Drepanoistodus* exist. The first focuses on the differences in the morphology of the base of the oistodontiforms (Lindström 1971; Löfgren 1978). Thus, according to these authors two distinct species exist, namely *D. forceps* and *D. basiovalis*.

In contrast, van Wamel (1974) and Dzik (1976) did not recognize the species *D. forceps* and *D. basiovalis* of Lindström (1971) and Löfgren (1978). They found that intraspecific variation both during growth and within the curvature transition series, that otherwise might be interpreted as species indicative, occurred, and only numerical measures were considered valid for separation of species (van Wamel 1974; Dzik 1976).

Several species have been identified from the Table Head mainly following the practice of Löfgren (1978). With the above comments in mind, statistically more reliable material may reduce the number of species separated on the basis of the present material.

Drepanoistodus basiovalis (Sergeeva)
Pl. 3:18–20.

Synonymy. – □1963 *Oistodus basiovalis* sp.nov. – Sergeeva, p. 96, Pl. 7:6, 7; Fig. 3. □1971 *Drepanoistodus basiovalis* (Sergeeva) – Lindström, . 43; Figs. 6, 8. □1973 *Drepanoistodus basiovalis* (Sergeeva) – Lindström (*in* Ziegler), p. 73, Pl. 1:3–4. □1974 *Oistodus basiovalis* Sergeeva – Viira, Pl. 5:9, 10. □1976 *Drepanoistodus suberectus forceps* (Lindström) – Dzik, Fig. 19a, b, c, d, f, ?k; *non* e, g. □1978 *Drepanoistodus basiovalis* (Sergeeva) – Löfgren, pp. 55–56, Pl. 1:11–17; Fig. 26B–C. □*non* 1973 *Drepanoistodus basiovalis* (Sergeeva) – Barnes & Poplawski, p. 775, Pl. 4:3, 4, 7. □*non* 1976 *Drepanoistodus basiovalis* (Sergeeva) – Barnes (*in* Workum *et al.*), p. 171, 173, Pl. 4:1, 2. □*non* 1977 *Drepanoistodus basiovalis* (Sergeeva) – Barnes, p. 101, Pl. 4:4–6.

Remarks. – A small collection of oistodontiforms with a small base and large reclined acostate cusp is identified with *D.*

basiovalis. The size of the base and the convex aboral outline is typical of *Oistodus basiovalis* Sergeeva s.f.

A similar small collection of drepanodontiforms can be associated with the oistodontiforms.

This species has been fully described by Löfgren (1978).

The elements named *Drepanoistodus basiovalis* by Barnes & Poplawski (1973), Barnes (*in* Workum *et al.* 1976), and Barnes (1977) are considered to represent the species *Drepanodus?* cf. *gracilis.* The oistodontiform of the Bad Cache Rapids Formation (Barnes 1977) has an angular (90°) base/aboral margin junction. In *D. basiovalis* this is rounded.

Occurrence. – Lower and middle Table Head.

Material. – 17 drepanodontiforms; 23 oistodontiforms.

Drepanoistodus cf. *basiovalis* (Sergeeva)
Pl. 3:21–23.

Synonymy. – □1969 *Oistodus* sp. – Bradshaw, p. 1158, Pl. 134:10, 11.

Diagnosis. – A *Drepanoistodus* with drepanodontiforms having a small base, a convex to straight aboral outline and a convex basal cavity, and oistodontiforms with a base that varies from rectangular to an anteriorly pointed base. All specimens are noncostate.

Description. – The drepanodontiforms have a long slender, laterally compressed cusp and a small base. The base may be flattened or more widely open. Generally asymmetrical elements have an inner flaring base and symmetrical elements have an open base. The faces of the cusp are convex. The oral edge is straight and short, but increases relatively in length in large specimens. The basal cavity is small. In lateral view the outline of the basal cavity is a gently convex curve with no characteristic tip. All the elements are curvatid in outline.

The oistodontiforms have a compressed, pointed and keeled cusp that is almost parallel to the posterior part of the aboral margin.

Occurrence. – Lower Table Head.

Material. – 29 drepanodontiforms; 22 oistodontiforms.

Drepanoistodus forceps (Lindström)
Pl. 3:24–25.

Synonymy. – □1955a *Oistodus forceps* n.sp. – Lindström, p. 574, Pl. 4:9–13; Fig. 3M. □1955a *Acodus gratus* n.sp. – Lindström, p. 545, Pl. 2:27–29. □1955a *Drepanodus homocurvatus* n.sp. – Lindström, p. 563, Pl. 2:23–24; Fig. 4D. □1955a *Drepanodus planus* n.sp. – Lindström, p. 565, Pl. 2:35–37; Fig. 4A. □1955a *Drepanodus suberectus* (Branson & Mehl) – Lindström, p. 568, Pl. 2:21, 22. □1971 *Drepanoistodus forceps* (Lindström) – Lindström, pp. 43–43; Fig. 5, 8. □1978 *Drepanoistodus forceps* (Lindström) – Löfgren, pp. 53–55, Pl. 1:1–6; Fig. 26A (includes synonymy through 1978).

Remarks. – A small collection of drepanodontiforms and oistodontiforms have been identified with *D. forceps*. The

material differs from *D.* cf. *basiovalis* both in their lighter color, being more translucent and brighter, and their different stratigraphic position. The inner flare of oistodontiforms typical of *D. forceps* also separates *D. forceps* from *D.* cf. *basiovalis*. The drepanodontiforms are sparsely represented, but include erectids. White matter is present in the cusp.

Löfgren (1978) fully described this species from Scandinavia, where it is constricted to Early Arenig.

Occurrence. – Lower Table Head.

Material. – 9 drepanodontiforms; 7 oistodontiforms.

Drepanoistodus bellburnensis n.sp.
Pl. 4:1–8.

Synonymy. – □1973 *Drepanodus* sp. B s.f. – Barnes & Poplawski, p. 774, Pl. 5:4. □1976 *Drepanoistodus* sp. – Landing, p. 632, Pl. 2:12. □1979a *Drepanoistodus* sp. – Bergström, p. 306; Fig. 4N.

Derivation of name. – Bellburns, a small village south of Table Point.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower middle Table Head, sample TP 67, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirn).

Holotype. – ROM 39652 (Pl. 4:4), an oistodontiform.

Diagnosis. – A species of *Drepanoistodus* with an oistodontiform which has a base that is short anteriorly and extended posteriorly. The cusp has an inner costa.

Description. – This species consists of drepanodontiforms and oistodontiforms. The elements form a curvature transition series from procurved to reclined (oistodontiform). An erectid element can be separated, but is very rare. All the drepanodontiforms are referred to as curvatid elements.

Drepanodontiforms have a large keeled cusp filled with white matter. The cusp may be slightly twisted. The faces are smooth or may carry a broad carina. The anterior edge continues onto the base. It meets the aboral margin in a curve for the procurved elements or an angle in recurved elements. The posterior keel continues on the oral edge on procurved elements or forms a sharp angle with the oral edge in erect and recurved elements. The aboral outline is convex in most specimens, but may be sinuous. The oral edge is keeled.

The oistodontiforms have a straight reclined cusp and a long keeled oral edge. The angle between cusp and oral edge is about 45 degrees. The aboral margin is convex and flares slightly to the inner side. It meets the anterior edge with an angle of almost 90 degrees.

Remarks. – Barnes & Poplawski (1973) suggested that this species could belong to *Paroistodus,* whereas Landing (1976)

included it in *Drepanoistodus*. The present material suggests that the elements should be included in the latter genus.

The species resembles *D. basiovalis,* but the oistodontiform has a longer posterior extended base.

The drepanodontiforms differ from other drepanodontiforms of *Drepanoistodus* in their higher base and angular junction of the cusp and the oral edge.

Occurrence. – Very rare in most of lower Table Head; common in uppermost part of lower Table Head and lower part of middle Table Head.

Material. – 101 drepanodontiforms; 59 oistodontiforms.

Drepanoistodus tablepointensis n.sp.
Pl. 4:9–17.

Synonymy. – □cf. 1962 *Oistodus forceps* Lindström – Sweet & Bergström, pp. 1231–1232, Pl. 168:14–15; Fig. 2E. □1978 *Drepanoistodus basiovalis* m.s. (Sergeeva) – Tipnis *et al.,* Pl. IX:21.

Derivation of name. – Table Point, Great Northern Peninsula, Newfoundland.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland

Type stratum. – Lower middle Table Head, sample TP 68, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39654 (Pl.4:10), an oistodontiform.

Diagnosis. – A species of *Drepanoistodus* with an oistodontiform on which the angle of the antero-basal corner varies from 50 to 80 degrees.

Description. – The drepanodontiforms have a long and slender proclined to recurved cusp, which is laterally compressed and keeled. The faces are convex. The base is short and slightly excavated. The anterior part of the base may be flexed outward. The aboral outline is convex.

Oistodontiforms have a compressed pointed and keeled cusp. The antero-basal corner is relatively pointed to rounded. The angle of the antero-basal corner varies between 50 and 80 degrees. The base variably flares inward. The oral edge is keeled and extends posteriorly one-third of the length of the cusp. The angle between cusp and oral edge varies from 20 to 40 degrees for forms with a weak inner flare to forms with a large flare, respectively. A weak inner carina on the cusp envolves with the angle as well.

Remarks. – This species has a ratio of drepanodontiforms: oistodontiforms of 3:1. The species differs from its common associate *D.?* cf. *venustus* by its shorter posteriorly extended base and the constant lack of a typical inner costa on the cusp of the oistodontiforms. Also the angle between the oral edge and the cusp is smaller in this species. The drepanodontiforms differ from the drepanodontiforms of *D.?* cf. *venustus* by the lack of costae. The drepanodontiforms cannot

easily be separated from other species of *Drepanoistodus* of the North Atlantic Faunal Province.

The oistodontiforms are similar to *?Oistodus forceps* s.f. sensu Sweet & Bergström (1962). The inner sinuous aboral margin of the Pratt Ferry forms is more pronounced than it is in the Table Head forms.

Occurrence. – Sporadic in lower Table Head; common through middle Table Head.

Material. – 167 drepanodontiforms; 56 oistodontiforms.

Drepanoistodus? cf. venustus (Stauffer)
Pl. 4:18–25.

Synonymy. – □cf. 1935a *Oistodus venustus* n.sp. – Stauffer, p. 146, 159, Pl. 12:12. □1976 *Drepanoistodus suberectus forceps* (Lindström) – Dzik, Fig. 19, e, g. □1978 *Drepanoistodus? cf. venustus* (Stauffer) – Löfgren, pp. 56–57, Pl. 1:7–8. □1978 *Drepanoistodus? venustus* (Stauffer) – Löfgren, p. 57, Pl. 1:9–10. □*non* 1969 *Oistodus venustus* Stauffer – Bradshaw, p. 1158, Pl. 134:4–7. □*non* 1970 *Oistodus venustus* Stauffer – Uyeno & Barnes, p. 110, Pl. 21:6–7. □?1981 *Drepanoistodus pitjanti* sp.nov. – Cooper, pp. 162–164, Pl. 26:3–5, 7, 8.

Diagnosis. – An apparatus with costate, short to long base oistodontiforms, and costate drepanodontiforms.

Remarks. – *Oistodus venustus* Stauffer (1935a) s.f. is a very characteristic oistodontiform with sharp keels, well developed costae on the cusp and a long base. It has commonly been reported, but has yet to find its place in multi-element taxonomy.

Bergström & Sweet (1966) and Sweet & Bergström (1972) were not able to connect the *venustus* element to any multi-element genera. Barnes & Poplawski (1973) proposed that the *venustus* element was part of *Acodus? mutatus*. Lindström (1971:43) suggested that *Oistodus venustus* s.f. was coupled with drepanodontiforms and formed a *Drepanoistodus* apparatus. Similar approach was tried by Löfgren (1978), but she was not convinced, and she concluded that *Oistodus venustus* s.f. could be the only type of element in the skeletal apparatus of the species.

One major problem with the *venustus* apparatus is that it may have included drepanodontiforms, but if so they are indistinguishable from those of other species of *Drepanoistodus*, with which *O. venustus* s.f. is commonly associated. For example, specimens of *D. suberectus* (Branson & Mehl) s.f. are present with *O. venustus* s.f. (Bergström & Sweet 1966; Webers 1966) or with *D. basiovalis* (Löfgren 1978.)

In the material at hand, both costate and weakly costate oistodontiforms are present with intermediate forms. This is similar to Webers (1966:34–35), who also referred both costate and acostate elements to *Oistodus venustus* s.f. In addition, uni-costate to multi-costate drepanodontiforms occur with *O. venustus* s.f. throughout the sequence, and they are interpreted as part of the *Drepanoistodus? venustus* apparatus.

Description. – The drepanodontiforms are uni-costate to multi-costate with intermediate elements as common associates. Curvatid elements may have an antero-basal pointed flange which may be flexed inwards. Some elements are very strongly flexed and have an outer convex face of the cusp, which may be expressed as a carina or one or two costae. The inner face may carry one or two costae.

The erectid element is easy to distinguish. It has a large cusp which may carry a carina on each side of the cusp or one or two costae on each side. The base is variously extended anteriorly and posteriorly. The base is often wide and the basal cavity is underneath the whole base. The drepanodontiforms form a gradual and complete curvature transition series.

The oistodontiform – or *venustus* element – has a pronounced costa on one side or both sides of the cusp and a rounded basal margin. The upper part of the cusp bends characteristically upwards or in an anterior direction. The antero-basal corners vary from sharply pointed to rounded and may reach over half the length of the cusp. The angle between the cusp and the oral edge varies from 20 to 30 degrees.

Remarks. – The apparatus proposed herein is unusual for *Drepanoistodus* in the sense that the drepanodontiforms can be multi-costate. Earlier species, however, do include uni-costate elements, for example, van Wamel (1974) described *Drepanoistodus forceps* with an apparatus including an acodontiform (*Acodus gratus* s.f.) and Cooper (1981) described *Drepanoistodus pitjanti* with an apparatus including multi-costate drepanodontiforms. Development of more costae is considered possible during growth or as a response to changes in the environments. Thus, increases in energy may support the creation of many costae, which may serve as muscle attachment areas similar to the ones described by Lindström & Ziegler (1971).

The costate elements could be confused with those of *Walliserodus*, but in *Walliserodus* they form a symmetry transition series, which includes a symmetrical element with anterior rounded face. The drepanodontiforms described above form a curvature transition series typical for *Drepanoistodus*. Thus, the main reason for grouping these elements together in the same apparatus is their generally similar morphologies. Except for the costae the elements would with no doubt be identified as drepanodontiforms of *Drepanoistodus*.

Drepanoistodus pitjanti Cooper differs from *D.? cf. venustus* by being hyaline and the oistodontiform has a shorter posterior extension of the base than the *venustus* element has. Also the oistodontiform is multi-costate in *D. pitjanti*.

Occurrence. – Present in lower Table Head, common in middle Table Head.

Material. – 547 drepanodontiforms; 256 oistodontiforms.

Genus *Paltodus* Pander 1856

Type species. – *Paltodus subaequalis* Pander 1856

Remarks. – According to Lindström (1971) *Paltodus* includes drepanodontiforms with a 'triangular base and a suberect to moderately recurved cusp'. Costae may be present. The

oistodontiforms have a base, which extends 'about as far anteriorly as it does posteriorly'.

Van Wamel (1974) allocated *Paltodus* to *Drepanoistodus*. Both Dzik (1976) and Löfgren (1978) considered *Paltodus* valid as a genus of its own. This is accepted here.

Paltodus? cf. *jemtlandicus* Löfgren
Pl. 4:26–33

Synonymy. – ☐1976 ?*Paltodus* (?) sp. – Dzik, Fig. 18a. ☐1978 *Paltodus? jemtlandicus* n.sp. – Löfgren, pp. 65–66, Pl. 4:1–3, 6–10. ☐?1978 Gen. et sp. indet. A – Löfgren, p. 118, Pl. 4:12

Description. – This apparatus consists of noncostate drepanodontiforms with a plano-convex base and oistodontiforms with a slight inner flare of the base.

The drepanodontiform is laterally compressed, and in side view it has a triangular base. The cusp is keeled and curves smoothly onto the straight and keeled oral edge. The aboral outline is straight and meets the anterior margin of the base at an angle of 90 degrees. The anterior part of the base may have an inner flare. The cross-section of the base varies from oval to plano-convex.

The oistodontiform has an anterior extension of the base of about similar length as its posterior extension. It is slightly asymmetrical due to an inner flare of the base. The cusp is large and keeled. The sides of the cusp are smooth.

Remarks. – The number of elements is small in each sample. The basal outline of the oistodontiform varies, thus some are quite similar to the oistodontiform described by Löfgren (1978) as gen. et sp. indet. A, which is tentatively included in the synonymy.

The base of the drepanodontiform varies and may sometimes by indistinguishable from that of the drepanodontiform of *Parapaltodus flexuosus* as noted by Löfgren (1978). In the Table Head material the color of *Paltodus? jemtlandicus* elements is always dark-brown with a black colored base. Drepanodontiforms of *Parapaltodus flexuosus* have a light-brown colored base.

Occurrence. – Lower and middle Table Head.

Material. – 32 drepanodontiforms; 29 oistodontiforms.

Genus *Paroistodus* Lindström 1971

Type species. – *Oistodus parallelus* Pander 1856.

Discussion. – Lindström (1971) defined this genus to consist of drepanodontiforms and oistodontiforms only. Van Wamel (1974) revised this definition to include scandodontiforms, but these are in fact slightly asymmetrical drepanodontiforms, and the term drepanodontiform is preferred in this study.

In the present collection, oistodontiforms with an outline similar to *O. originalis* Sergeeva s.f. are present. These could be interpreted as part of a *Paroistodus* apparatus. The problem, however, is that the oistodontiforms are not only abundant, sometimes dominating in the collection, but also

no drepandontiforms are represented. A similar dominance of oistodontiforms is found in the Mystic Conglomerate and there no drepandodontiforms were found either (Barnes & Poplawski 1973; Table 1).

It is therefore considered likely that this species only has one kind of element in the apparatus. If so, the present apparatus represents a genus of its own. The elements are, however, tentatively included in *Paroistodus* in this study.

Paroistodus? cf. *originalis* (Sergeeva)
Pl. 5:1–4.

Synonymy. – ☐1969 *Oistodus venustus* Stauffer – Bradshaw, p. 1150, Pl. 134:4–7. ☐1970 *Oistodus venustus* Stauffer – Uyeno & Barnes, Pl. 21:?6, 7. ☐1973 *Paroistodus* aff. *P. originalis* (Sergeeva) – Barnes & Poplawski, pp. 779–780 (*pars*), Pl. 4:12 only.

Diagnosis. – The oistodontiform has an extended posterior base. The species apparently lacks drepanodontiforms.

Description. – The oistodontiform has a large, straight cusp and a posteriorly extended base. The base may extend up to two-thirds the length of the cusp. The aboral outline is concave in large specimens but straight in small specimens. Large forms have a short anterior base which meets the anterior keeled edge of the cusp at an angle of 90 degrees. The anterior part of the base may be inverted. The cusp is strongly reclined and parallel to the aboral margin. A broad carina is present on the inner side of the cusp. The basal cavity occupies the full length of the base.

Remarks. – The oistodontiform is similar to that of *P. originalis*. It differs from the older species by its concave outline of the aboral margin, and the longer base.

Löfgren (1978:70) found that a younger (early Llanvirn) possibly new species of *Paroistodus* sporadically occurred in her material. This species may be conspecific with the Table Head species. Her figured elements (Löfgren 1978, Pl.1:22–24, ?25), however, belong to *Paroistodus originalis*. In contrast to the Table Head material the Scandinavian species is associated with drepanodontiforms.

Barnes & Poplawski (1973) interpreted *Paroistodus?* cf. *originalis* as the ancestor of *Oistodus venustus* s.f. The elements depicted by Barnes & Poplawski (1973), however, do not resemble *Oistodus venustus* Stauffer s.f., and are probably misidentified (see also discussion in Löfgren 1978:70). *Oistodus venustus* s.f. is included in a *Drepanoistodus* apparatus by Lindström (1971) and in this study.

The species is at present interpreted to form a single element apparatus. The morphological similarity to oistodontiform of *Paroistodus* indicates a close relationship with *Paroistodus originalis*. If so, the drepanodontiforms may either have been lost during evolution or if present be of another morphology.

Occurrence. – Sporadic in lower Table Head, common to dominating in middle Table Head.

Material. – 834 specimens.

Paroistodus? sp. A
Pl. 5:5–6

Synonymy. – □?1978 *Paroistodus originalis* (Sergeeva) – Löfgren, pp. 69–71 (*pars*), Pl. 1:25 only.

Description. – Oistodontiforms with a strongly reclined cusp. The cusp is keeled and the faces are convex, it is slightly twisted inward. The base is large; it has a keeled oral edge and a straight aboral outline, which is parallel to the cusp. It meets the cusp at an angle of 90 degrees. One or two radial costae may be present between the cusp and the base. The basal cavity is large and occupies the whole base.

No associated drepanodontiforms were recovered.

Remarks. – The oistodontiform resembles oistodontiforms of *Paroistodus,* and is tentatively included in that genus. The element is unlike other hitherto described species of *Paroistodus.* The oistodontiform of *P. originalis* in Löfgren (1978) has a similar appearance as the Table Head species but it lacks costae on the base.

Occurrence. – Upper lower Table Head.

Material. – 4 specimens.

Paroistodus? sp. B
Pl. 5:7–8.

Synonymy. – □?1965a *Oistodus pseudomulticorrugatus* n.sp. – Mound, p. 29, Pl. 4:?3, ?4, ?5, 8, 9;? Fig. 1H.

Description. – Oistodontiforms with a small base and a large cusp. The cusp is straight to slightly bent outward with an anteriorly placed rounded carina and a sharp posterior keel. The anterior margin is weakly keeled. The apex of the cusp is rounded rather than pointed.

The oral edge is keeled, short and straight. The aboral outline is straight or convex. The aboral margin meets the anterior edge in an angle of about 80 degrees. The lower inner side of the base may be flared.

Remarks. – These elements are tentatively placed in *Paroistodus,* but no additional drepanodontiforms were recovered. The elements morphologically resemble the oistodontiforms described by Mound (1965a) as *Oistodus pseudomulticorrugatus* s.f. The larger specimens as depicted by Mound have not been recorded, but the present material is far too sparse to evaluate the species.

Occurrence. – Upper part of lower Table Head.

Material. – 3 specimens.

Family uncertain

Genus *Strachanognathus* Rhodes 1955

Remarks. – The variation of the *Strachanognathus* apparatus was described by Bergström (1961) and Sweet & Bergström (1962). No additional elements have been found, which could be included in the apparatus (Sweet & Bergström 1972). The elements of the apparatus form a curvature transition series combined with a symmetry transition series. This is similar to Distacodontidae. The additional anterior denticles and the lack of oistodontiforms separates *Strachanognathus* from Distacodontidae.

Strachanognathus parvus Rhodes
Pl. 5:9.

Synonymy. – □1955 *Strachanognathus parvus* gen. etsp. nov. – Rhodes, p. 132, Pl. 7:16, Pl. 8:1–4. □1978 *Strachanognathus parvus* Rhodes – Löfgren, pp. 112–113, Pl. 1:29 (synonymy). □1979 *Strachanognathus parvus* Rhodes – Kennedy, Barnes & Uyeno, p. 550, Pl. 1:24 (synonymy).

Description. – Elements of *Strachanognathus parvus* with an inward flexed cusp and with a small base. The unit has a proclined to suberect cusp. The anterior denticle is about two-thirds the height of the main cusp. The aboral outline is convex.

Occurrence. – Top of middle Table Head.

Material. – 4 specimens.

Superfamily Panderodontacea Lindström 1970

Diagnosis. – Apparatus of most simple conodonts, commonly with longitudinal striations along the cusp. Some elements may have a row of denticles posteriorly. The apparatus usually forms a symmetry transition series.

Discussion. – Lindström (1970) divided Panderodontacea into the two families Acanthodontidae and Panderodontidae. The first was subdivided into Acanthodontinae and Protopanderodontinae. Lindström & Ziegler later (1971) referred Protopanderodontinae to its own family. Protopanderodontinae has been included in Distacodontacea in this study because *Protopanderodus* is considered to be closely related to *Drepanodus.*

By definition, the presence of longitudinal striations on the cusp is important in the Panderodontacea. Lindström & Ziegler (1971), Barnes *et al.* (1973c) and Barnes & Slack (1975) described the ultrastructure of panderodontacean elements. Species of Acanthodontidae have moderate longitudinal striations, whereas Panderodontidae carry abundant longitudinal striae and may display a 'radial lamellar' structure (Barnes & Slack 1975). The genera *Cornuodus, Scalpellodus* and *Belodella* carry fine to well-defined striations. *Scolopodus* (*sensu* Lindström 1971) and *Walliserodus* apparently do not show any surface ornamentation in the Ordovician (Löfgren 1978), but are present on elements of *Walliserodus* in the Silurian (Cooper 1975). *Semiacontiodus* carries visible fine striations on the base and along the cusp.

The Acanthodontidae are of Midcontinent Faunal Province affinity. According to Barnes & Slack (1975) most genera have an apparatus which forms a symmetry transi-

tion series including an antero-posteriorly compressed element, whereas *Acanthodus* apparently forms an apparatus of rounded to laterally compressed posterior keeled elements with a deep base (Moskalenko 1972).

Panderodontidae include elements with a very deep conical basal cavity and a relatively small cusp, which is conspicuously ornamented with longitudinal striations. Genera of Panderodontidae appear in the two major provinces.

A group of genera such as *Scalpellodus, Belodella, Cornuodus, Scolopodus* and *Walliserodus* cannot conclusively be placed in Panderodontidae due to the lack of the distinctive furrows diagnostic of *Parapanderodus* n.gen., *Panderodus* and some species of *Semiacontiodus*. *Scalpellodus, Belodella* and *Parapanderodus* appear in marginal zones of the two major provinces.

These facts in combination constitute the basis for a subdivision of Panderodontacea into three families. A further subdivision at the suprageneric level is possible, however, more information is necessary and must await a detailed study of large collections.

Panderodontacea probably evolved from *Semiacontiodus*.

Family Acanthodontidae Lindström 1970

Discussion. – Lindström (1970) defined the Acanthodontidae as follows: 'Species with a relatively long and slender suberect cusp, and the basal cavity not much wider than the cusp. The longitudinal striations, if present, are inconspicuous. Some forms have a couple of lateral longitudinal costae or grooves'. Lindström (1970) listed *Acanthodus* Furnish as the only genus.

Other genera that belong within the Acanthodontidae are *Juanognathus* Serpagli, *Staufferella* Sweet, Thomson & Satterfield, and *Ulrichodina* Furnish.

Many elements of Acanthodontidae have been described as form species of the form genera *Acodus, Acontiodus, Paltodus* and *Scolopodus*. *Acodus, Paltodus* and *Scolopodus* have been redefined in multi-element taxonomy (Lindström 1971; McTavish 1973), and are not considered related to Acanthodontidae.

The status of *Acanthodus* is unsettled, as the nature of the apparatus of the type species is so far unknown. Moskalenko (1972), however, described a series of denticulate elements forming a symmetry transition series. The elements are laterally compressed and have deep basal cavities.

Two groups of undoubted suprageneric significance, therefore, can be recognized among the acanthodids. The first group includes *Juanognathus, Staufferella* and *Ulrichodina* with elements which are erect and may be twisted, have shallow basal cavities and a convex anterior margin. This group probably evolved from *Semiacontiodus*. *Ulrichodina* may belong within an early stage of the evolution. This group is included in *Juanognathinae* n.subfam.

The second group includes *Acanthodus*. If the compound conodonts described by Moskalenko (1972) are true acanthodontids an evolution from simple conodonts with a subelliptical cross-section of the cusp and base to laterally compressed denticulate conodonts with deep basal cavities can be compared with the evolution within *Cornuodontidae* n.fam. This second group comprises the subfamily *Acanthodontinae* Lindström 1970.

Subfamily Juanognathinae n.subfam.

Diagnosis. – Conodont apparatuses of simple cones with mostly subelliptical cross-section of the cusp and base. The conodonts may be antero-posteriorly compressed with a convex anterior surface. The elements have a shallow basal cavity. The apparatus forms a symmetry transition series. Some of the skeletal elements are characteristically twisted.

Remarks. – The subfamily probably also includes the Silurian genus *Decoriconus* Cooper.

Genus *Juanognathus* Serpagli 1974

Type species. – *Juanognathus variabilis* Serpagli 1974.

Diagnosis. – *Juanognathus* includes paired antero-posteriorly compressed simple cones with alate lateral sides forming a symmetry transition series. Elements do not show conspicuous striations.

Remarks. – *Juanognathus* has an apparatus similar to *Staufferella*. The elements in *Staufferella* are, however, more rounded than those of *Juanognathus*.

Juanognathus serpaglii n.sp.
Pl. 5:10–20.

Synonymy. – ☐1979 *Juanognathus* aff. *J. variabilis* Serpagli – Harris *et al.*, Pl. 1:3–5. ☐cf. 1975 Gen. nov. B – Cooper & Druce, p. 579, Fig. 30. ☐cf. 1973 *Protopanderodus? tricarinatus* – Barnes & Poplawski, p. 784, Pl. 1:5; Fig. 2B. ☐?1973 *Protopanderodus?* sp. – Barnes & Poplawski, p. 785, Pl. 1:15.

Derivation of name. – In honor of Dr. E. Serpagli, Professor at Modena University, Modena, Italy.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower middle Table Head, sample TP 66, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39662 (Pl. 5:17), a symmetrical element.

Diagnosis. – A *Juanognathus* with lateral, alate, horizontal keels on the symmetrical element.

Description. – The apparatus includes a symmetrical element and a prograding series of asymmetrical elements. The elements have a large recurved cusp and a short base.

Symmetrical element. – The symmetrical element has a laterally keeled cusp. The keels project as short alate undenticulated processes. The anterior face is convex whereas the posterior face is posteriorly concave, it has a median carina that extends from the apex to the aboral margin. The posterior carina is flanked by two deep longitudinal grooves and it may bear a small median furrow that extends the full length of the carina. The basal cavity is narrow and only

developed as a slit beneath the processes. The anterior aboral margin is horizontal and has a median notch. The posterior aboral margin forms a median concave curve.

Asymmetrical element. – The asymmetrical elements are generally similar to the symmetrical element. During increasing asymmetry the outer lateral process becomes longer and projects in a posterior direction. The inner lateral process conversely is reduced in size and ultimately disappears. The anterior notch on the aboral margin, the basal cavity and the central anterior carina are gradually reduced, and may disappear with the increasing asymmetry.

A thickened rim along the aboral margin is well developed. In many elements black basal filling may be preserved in the basal cavity.

Remarks. – No microstructure such as striations has been observed.

Landing (1976) described an antero-posteriorly compressed element which resembles *Juanognathus serpaglii*. His element has conspicuous striations, unlike the Table Head species. It also has a weakly developed median carina.

The Mystic species *Protopanderodus? tricarinatus* Barnes & Poplawski (1973) is more narrow and higher than any of the Table Head specimens. The generic assignment of this element is not certain, but it probably represent a species of *Juanognathus.*

Protopanderodus? sp. differs from *J. serpaglii* n.sp. by its large basal cavity, and also more rounded cross-section of the element.

Gen. nov. B. Cooper & Druce probably is a species of *Juanognathus.* The asymmetrical element has a median groove. Perhaps Gen. nov. B and *Protopanderodus? tricarinatus* Barnes & Poplawski form an apparatus of an older species of *Juanognathus* than that from the Table Head Formation.

Occurrence. – Lower Table Head and lower middle Table Head.

Material. – 51 symmetrical elements; 103 symmetrical elements.

Genus *Ulrichodina* Furnish 1938

Type species. – *Ulrichodina prima* Furnish 1938.

Remarks. – *Ulrichodina* Furnish includes simple conodonts with bilaterally symmetrical cusp with a rounded anterior margin. The genus has not been established in multi-element taxonomy.

Ulrichodina? sp. A s.f.
Pl. 6:8–9.

Diagnosis. – Small cones with an erect cusp and one posterior sharp keel.

Description. – The elements have a small base and a large, proclined cusp. The cusp is pointed. The anterior margin of the cusp is convex. The lateral faces are straight and the posterior margin is keeled. This posterior keel continues

onto the oral edge to the aboral margin. The aboral outline is straight. The aboral margin meets the oral edge with an angle of 90°. The anterior part of the base bends into the cusp and is smooth. The base has a triangular cross-section with rounded corners. The basal cavity is a small funnel and is commonly filled by black basal matter. The cusp is filled by white matter.

The specimens are fully striated on the base and continue onto the cusp along the posterior keel. A rim next to the aboral margin does not show any surface ornamentation.

Remarks. – The cross-section of the cusp is similar to that of *Ulrichodina* but an anteriorly infolded base is not present in the Table Head species. Hence, the generic assignment is queried.

Occurrence. – Lower Table Head.

Material. – 17 specimens.

Family Cornuodontidae n.fam.

Diagnosis. – Simple conodonts with relatively long and/or high bases and deep basal cavities. Longitudinal striations, if present, are inconspicuous in early genera and increase in distinctiveness during evolution. Some forms have longitudinal costa. Some forms have denticles posteriorly on the base.

Remarks. – Cornuodontidae n.fam. includes *Cornuodus, Scalpellodus, Belodella, Walliserodus, Pseudooneotodus* and perhaps *Scolopodus.*

Cornuodus evolved from *Semiacontiodus,* and it is the ancestor to *Scalpellodus, Belodella* and possibly *Walliserodus* (Dzik 1976).

Genus *Belodella* Ethington 1959

Type species. – *Belodus devonicus* Stauffer 1940.

Discussion. – The history of *Belodella* has been reviewed by Serpagli (1967) and Löfgren (1978). Löfgren (1978) proposed an apparatus including adenticulate and denticulate elements, both of which display a symmetry transition series, and an oistodontiform. The abundant material at hand supports the apparatus proposed by Löfgren, and it is considered valid. The choice, however, of the genus name may be debated for the Ordovician apparatus.

The oistodontiform has not been found in Silurian (Cooper 1974, 1976) and Devonian *Belodella* apparatuses (Chatterton 1974). Thus the Silurian and Devonian apparatus is apparently quite different from the Ordovician apparatus. The choice of *B. devonicus* Stauffer 1940 as a type may be correct for the Devonian *Belodella,* but it is far from certain that this is the case of the Ordovician species referred to *Belodella.* The apparent similarity of the denticulate forms may be a question of homeomorphy.

Belodella jemtlandica Löfgren
Pl. 6:13–23; Pl. 7:1–4.

Synonymy. – □1970 *Belodella* sp. A – Fåhræus, p. 2064, Fig. 3(O). □1978 *Belodella jemtlandica* n.sp. – Löfgren, pp. 46–49, Pl. 15:1–8; Fig. 24A–D.

Description. – The elements of *B. jemtlandica* were fully described by Löfgren (1978). Some comments will, however, be made because the apparatus appears to be more variable than surmised by Löfgren.

Four elements types characterize *Belodella*: (1) undenticulate biconvex to plano-convex elements, (2) denticulated plano-convex elements, (3) denticulated triangular elements, and (4) oistodontiforms.

Undenticulated biconvex – plano-convex element. – The element is characterized by a base that is about two-thirds the length of the whole unit. In the Table Head specimens the symmetrical forms (biconvex forms) are less common than the asymmetrical forms with a broad carina on the outer side. The asymmetrical forms have an almost plane inner side. The aboral outline is slightly concave. The anterior keel of the base disappears a little before the aboral margin and a narrow rim of small wrinkles is developed. The upper margin of the basal cavity is straight and the tip is directed anteriorly. The tip is located close to the anterior margin of the base.

The element is highly striated on the anterior keel beneath the anterior carina.

Denticulate plano-convex element. – The denticulation, the length of the base, and the degree of torsion of the cusp varies. The denticulation can be finely hairlike or the denticles can be wider and apically free. The fine hairlike denticles are usually short and the wider ones are higher. The elements may be plano-convex to asymmetrically triangular due to the development of an outer antero-lateral carina/costa. The strongly twisted elements are similar to those described by Löfgren (1978; Pl. 15:4). The less twisted elements have coarser denticles and an outer antero-lateral carina.

The elements are typically striated on forms developing an outer lateral carina-costa. These elements evolve prominent striations between the anterior inner keel and the anterior lateral carina. The remaining elements are nonstriated as noted by Löfgren (1978). All elements are characterized by the 'wrinkles' at the aboral/anterior base junction.

Denticulated triangular element. – In addition to the elements described by Löfgren, elements with coarser denticulation as well as elements with hair-like denticulation are included. The elements vary in the length of the base, and long-base variants often carry the hairlike denticles. All the elements have a procurved cusp.

The elements are prominently striated on the anterior rounded margin of the cusp. The striations continue onto the anterior lateral costae. The concave area of the base separating the costae is non-striated. Inconspicuous striations have been observed on the faces of the base.

The elements have the basal 'wrinkles' similar to undenticulated and plano-convex denticulated elements.

Oistodontiform. – Two morphotypes can be distinguished. One type of oistodontiform has a cusp/oral edge angle of 80 degrees. The second has a sharper cusp/base angle and the cusp becomes parallel with the aboral margin. The latter type has faint striations on the face at the cusp/base junction. The elements are characterized by a straight aboral outline, an anterior basal margin of equal length as the oral edge, giving an equi-lateral triangular outline of the base when seen in lateral view. Also, a small tongue-like posterior extension of the oral edge is characteristic.

Remarks. – The higher degree of variation displayed by Table Head forms than that of Swedish forms is due to the inclusion of elements with a base of varying length. The elements form a symmetry transition series, and they are similar to *Belodella devonica* (Stauffer) s.f. These elements are considered to be variants of the *B. jemtlandica* apparatus.

The relationship to *B. sinuosa* n.sp. and *B. nevadensis* (Ethington & Schumacher) is discussed under *B. sinuosa* n.sp.

Occurrence. – Lower and middle Table Head.

Material. – 373 undenticulated elements; 538 denticulated elements; 273 oistodontiforms.

Belodella sinuosa n.sp.
Pl. 7:5–14.

Synonymy. – □?1973 *Belodella erecta* (Rhodes & Dineley) s.f. – Barnes & Poplawski, p. 769, Pl. 4:19, 20. □1973 *Belodella* n.sp. s.f. – Barnes & Poplawski, p. 769, Pl. 4:5, 9, 10, 18, 18a; Fig. 2F. □1978 *Belodella* sp. A Fåhræus – Fåhræus & Nowlan, p. 461, Pl. 3:21. □1979a *Belodella* sp. A Fåhræus 1970 – Bergström, p. 306, Fig. 4L, 4M. □*non* 1970 *Nordiodus* sp. A – Fåhræus, p. 2064; Fig. 3(N).

Derivation of name. – The outline of the aboral margin of the oistodontiform is sinuous.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 55, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39670 (Pl. 7:10), an oistodontiform.

Diagnosis. – Undenticulate elements with a well-developed antero-lateral costa, and basal cavity, which occupies one-half or less of the length of the unit. Denticulate elements with a procurved to recurved cusp and high denticles. Oistodontiforms have a sinuous aboral outline. The lower margin of the basal cavity is concave and the tip is directed anteriorly in all specimens.

Description. – Löfgren (1978) labelled elements of *Belodella:*

undenticulated biconvex, denticulate plano-convex, denticulate triangular, and oistodontiforms.

Undenticulate biconvex element. – The unit has an erect to procurved cusp. It is laterally compressed with a high base. The aboral outline is straight to concave. The cusp may be larger than the base. In side view the basal cavity is triangular with a concave anterior margin and a straight to concave posterior margin. The element has sharp posterior and anterior edges. The element varies from almost symmetrical to asymmetrical. The unit has an anterior lateral costa on the base which continues onto the cusp as a broad carina. The element has characteristic striations on the surface along the anterior keel. The edge along the aboral margin is characteristically 'wrinkled'.

Denticulated plano-convex element. – This element has an erect to proclined cusp, a denticulated oral edge and deeply excavated base. In lateral view the basal cavity is deep, triangular with an anterior concave margin and a posterior concave to straight margin. The tip is anterior. The oral edge carries up to ten slender, laterally compressed and basally fused proclined denticles. The denticles increase in size toward the cusp. In some forms the denticles extend up along the cusp. Variation of degree of asymmetry is commonly associated with the length of the base. The most asymmetrical units have a shorter base than those with a smaller torsion of the cusp.

Denticulated triangular element. – The cusp is erect to proclined and is provided with two lateral costae, which continue to the anterior margin of the base. The anterior margin of the cusp is convex. The anterior edge of the base is concave between the two costae. The posterior margin of the cusp is sharp and continues onto the oral edge. The oral edge carries basally fused and proclined denticles. The basal cavity is sickle-shaped with an anteriorly directed tip. Due to the outline of the basal cavity the anteriormost denticles are higher than the more posterior ones.

All elements have cusp and denticles filled with white matter. The faces of the base have a characteristically striated pattern on the surface. The convex surface of the cusp and the anterior basal costa are striated.

Oistodontiform. – The base is high with a sinuous aboral outline. The oral edge and the aboral margin meet in a sharp angle. The anterior basal angle is about 90 degrees. The cusp is sharp-edged and more or less flexed to the inner side. It is reclined and filled with white matter. The basal cavity is moderately deep and with the tip pointed anteriorly. The anterior margin of the basal cavity does not reach the anterior basal corner. Two morphotypes can be distinguished due to the degree of reclination of the cusp.

Remarks. – *B. sinuosa* n.sp. differs from *B. jemtlandica* by the basal cavity, the strong costa-like carina and the often smaller base than cusp of the undenticulated element. The oistodontiforms have a sinuous aboral outline and a short rounded anterior basal corner, whereas in *B. jemtlandica* they have an extended antero-basal corner and a straight aboral outline. The denticulated plano-convex element is difficult

to separate from that of *B. jemtlandica,* but the concave anterior margin of the basal cavity is diagnostic.

The denticulate element includes types with a recurved cusp, which has not been recorded for *B. jemtlandica.*

Löfgren (1978:47) indicated that *Nordiodus* sp. A Fåhræus 1970 could be an undenticulated element of a *Belodella* species with a large cusp and a short base. These are *B. sinuosa* characteristics. *Nordiodus* sp. A, however, is herein included in *Parapaltodus flexuosus.*

Belodella nevadensis (Ethington & Schumacher) differs from *B. jemtlandica* by a concave outline of the anterior margin of the basal cavity rather than straight or convex, and by the presence of the strong antero-lateral furrow and carina. Also the oistodontiform has a sinuous aboral outline. These characteristics are similar to those of *B. sinuosa* n.sp. which is considered to be the ancestor of *B. nevadensis.*

Occurrence. – Lower Table Head.

Material. – 129 undenticulated elements; 179 denticulated elements; 91 oistodontiforms.

?*Belodella* sp. A
Pl. 7:15–16

Synonymy. – ☐1973 *Belodina* sp. – Barnes & Poplawski, p. 770, Pl.3:18.

Diagnosis. – Denticulated elements with a small basal cavity and a short cusp forming a symmetry transition series.

Description. – The apparatus consists of denticulated plano-convex units and weakly denticulated biconvex elements.

Denticulated plano-convex element. – The element has an inner flare of the base, a proclined pointed cusp and bears up to twelve small proclined to erect basally fused denticles. The anterior keel of the base may be twisted outwards.

Denticulated biconvex element. – This element was described by Barnes & Poplawski (1973) as *Belodina* sp. The elements has an antero-lateral carina, a proclined cusp and a small base. The basal cavity is small and triangular in outline. The element is rarely represented in the Table Head collections.

Remarks. – The apparatus does not seem to include undenticulate plano-convex elements, oistodontiforms and triangular denticulated elements. This could be a chance coincidence, but the author does not necessarily think so, because although not abundantly represented, the elements occur consistently through the section and cannot at present be associated with other elements. The generic assignment, therefore, is queried.

Occurrence. – Lower and Middle Table Head.

Material. – 66 specimens.

Genus *Cornuodus* Fåhræus 1966

Type species. – *Cornuodus erectus* Fåhræus 1966.

Remarks. – *Cornuodus* has an apparatus of moderately laterally compressed cones forming a symmetry transition series. Dzik (1976) included *Cornuodus* in *Scalpellodus,* but Löfgren (1978) revised *Scalpellodus* and retained *Cornuodus* as a separate genus.

Cornuodus longibasis (Lindström)
Pl. 8:1–8.

Synonymy. – □1955a *Drepanodus longibasis* n.sp. – Lindström, p. 564, Pl. 3:31. □1966 *Cornuodus erectus* n.sp. – Fåhræus, p. 20, Pl. 2:8a, b; Fig. 2B. □1967 *Cornuodus bergstroemi* n.sp. – Serpagli, p. 57, Pl. 12:1a–2c. □1967 *Cornuodus erectus* Fåhræus – Serpagli, p. 57, Pl. 12:5a–8b. □1967 *Scandodus?* *lanzaensis* n.sp. – Serpagli, p. 95, Pl. 26:4a–7d. □1970 *Cornuodus erectus* Fåhræus – Lee, p. 315, Pl. 7:9. □1974 '*Cornuodus' longibasis* (Lindström) – Serpagli, p. 43, Pl. 7:2a, b; Pl. 20:12. □1974 *Protopanderodus longibasis* (Lindström) – van Wamel, p. 92, Pl. 4:4–6. □1976 *Cornuodus longibasis* (Lindström) – Landing, p. 631, Pl. 1:12, 13, 15. □1976 *Scalpellodus (?Cornuodus) laevis* sp.n. – Dzik, p. 421, Pl. 41:1; Fig. 13a–c. □1978 *Cornuodus longibasis* (Lindström) – Löfgren, pp. 49–51, Pl. 4:36, 38–42; Fig. 25a–c. □1978 *Cornuodus bergstroemi* Serpagli – Löfgren, Pl. 2:37; Fig. 25D.

Remarks. – All the elements of *Cornuodus longibasis* have been fully described by Serpagli (1967, 1974) and Löfgren (1978). The current interpretation of *C. longibasis* is broad and probably two species can be distinguished with further taxonomic work.

In contrast to the Swedish material an asymmetrical element intermediate between symmetrical element A and B of Löfgren (1978) is present in the collections.

Single elements formerly referred to as *B. bergstroemi* s.f. are included in the apparatus, as both material at hand and collections from the Baltic of this author (see Stouge 1975) confirm this association (compare Löfgren 1978:50 and follow Fig. 25 from D-B-A).

Occurrence. – Lower and middle Table Head.

Material. – 41 specimens.

Genus *Scalpellodus* Dzik 1976

Type species. – *Protopanderodus latus* van Wamel 1974.

Remarks. – The diagnosis for *Scalpellodus* given by Dzik (1976:421) is as follows: 'Only asymmetrical conodonts with flattened and posteriorly sharpened denticle. A trend to development of denticulation'. Löfgren (1978) based her interpretation of the elemental composition of the apparatus of the type-species, and emended the diagnosis to include twisted scandodontiforms and drepanodontiforms. Furthermore, she added that the elements are finely striated. Elements with a trend to develop denticles were excluded. Thus defined, *Scalpellodus* includes simple cones forming a symmetry transition series due to torsion of cusp overprinted by a curvature transition series.

The *Scalpellodus* species present in the Table Head fauna have three distinct morphologic types of elements: the first

type has a base shorter than the cusp, the second type has a very long base. Both types display a symmetry transition series. The third type of element has a short triangular base due to the development of an additional outer costa.

Scalpellodus biconvexus (Bradshaw)
Pl. 8:9–14.

Synonymy. – □1941 *Paltodus variabilis* Furnish – Graves & Ellison, p. 21, Pl. 2:17. □1969 *Scandodus biconvexus* n.sp. – Bradshaw, p. 1161, Pl. 134:16–18. □1969 *Scandodus dubius* n.sp. – Bradshaw, p. 1161, Pl. 134:19–21. □1969 *Scandodus?* sp. – Bradshaw, p. 1162, Pl. 135:11, 12. □1973 *Paltodus?* sp. B – Barnes & Poplawski, p. 778, Pl. 1:13. □1973 *Drepanodus?* sp. 4 – Barnes & Poplawski, p. 774, Pl. 3:13. □cf. 1965 *Acodus* n.sp. – Ethington & Clark, p. 187, Pl. 2:3, 4. □cf. 1965 *Distacodus* n.sp. – Ethington & Clark, p. 190, Pl. 2:1, 2. □cf. 1979 *Juanognathus variabilis* Serpagli – Bergström, p. 303, Fig. 4H.

Description. – The cusp is twisted in all specimens, and the species comprises two types of scandodontiforms (element 1 and 2) and a three-costate element (element 3).

Element 1. – The element has a long cusp and a triangular base, which is shorter than the cusp. The cusp varies from recurved to suberect in position. It has two sharp anteroposterior keels, which continue onto the base to the aboral margin. The cusp has a convex outer margin, which may evolve into a broad carina. The inner margin is flat. The aboral outline is straight and becomes weakly sinuous to concave in full mature specimens. The element varies in torsion of the cusp. Highly twisted forms have an inner antero-lateral furrow formed by the upward bend of the keel. The base has an inner posterior flare of these forms. The basal cavity is deep with a medially placed tip.

Element 2. – This element has a long, slender base and a long recurved cusp. Cusp and base are of equal lengths. Well defined keels extend along the whole unit. The aboral outline is straight or convex. The basal cavity is deep with the tip anterior of the maximum curvature. The elements form a symmetry transition series similar to element 1. A weakly developed curvature transition series superposes the symmetry transition series.

Element 3. – The element has a recurved cusp and it is strongly twisted. In this way, the outer lateral face of the cusp occupies an anterior position, whereas the anteroposterior margins become inner lateral and outer lateral costae, respectively. The outer lateral face develops a prominent carina, and the base becomes triangular in posterior view.

Element 3 is the ultimate state of the symmetry transition series of Element 1, but it can easily be distinguished as a separate element.

Remarks. – The evolution of this species into *S. pointensis* n.sp. is marked by an initial posterior extension of the anterior keel in some specimens of element 1.

The depth of the basal cavity is related to the degree of

curvature. Those showing marked curvature have shallow broadly flaring conical cavities. In the less sharply bent forms, the basal cavity is a more slender cone, whose tip reaches to midlength near the anterior margin.

Ethington & Clark (1965) noted that their specimens, i.e. *Acodus* sp. s.f. and *Distacodus* sp. s.f., may belong to the same species. Also the elements show variation in the length of the cusp, but their illustrated specimens are all of Element 1 type. When the whole apparatus is reconstructed the elements may belong to *Scalpellodus biconvexus*.

Ethington & Clark (1965) also mentioned that their specimens resembled *Acanthodus* Furnish. If this is case, then the generic assignment of the Table Head specimens may have to be re-evaluated. At present, the general outline of the Albertan elements resemble those of *Scalpellodus*.

Juanognathus variabilis Serpagli (Bergström 1979) probably belongs to *Scalpellodus biconvexus,* but the broken nature of the Hølonda specimen prohibits a definite identification on the species level.

Occurrence. – Lower Table Head

Material. – 87 element 1; 24 element 2; 9 element 3.

Scalpellodus pointensis n.sp.
Pl. 8:15–19, 22–23

Derivation of name. – The elements have a posteriorly extended pointed anterior keel.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 58, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39675 (Pl.8:23), an element type 2.

Diagnosis. – A species of *Scalpellodus* with a well-developed anterior, posteriorly directed extension and a concave aboral outline.

Description. – All the elements have a concave aboral outline. The units are continuously curved throughout their length.

Element 1. – The element has a recurved cusp and slightly higher base than cusp. The element is antero-posteriorly keeled throughout its length. The anterior keel extends beyond the aboral margin to form a small adenticulate process-like extension. The aboral outline is concave.

Element 2. – The element has procurved cusp and base of equal length. The cusp may have sharp or blunt anterior and posterior margins, an inner median carina, which continues onto the base as a broad lateral carina. The anterior keel and the inner median carina are separated by a furrow. The aboral outline is concave and the anterior keel projects posteriorly as an undenticulated short process. The basal cavity is triangular in lateral view with a tip, which is pointed slightly downwards. The tip is placed close to the anterior margin beneath the maximum curvature of the elements.

Element 3. – Element 3, the extreme asymmetrical element, has a short base, which is triangular in posterior view with sharp edges, and a cusp, which is longer than the base.

Remarks. – This species differs from *S. biconvexus* by its concave aboral outline and by its posteriorly projected undenticulated process.

Occurrence. – Upper part of lower Table Head; sporadic in lower part of middle Table Head.

Material. – 153 element 1; 113 element 2; 42 element 3.

?*Scalpellodus* sp. A
Pl. 8:20–21.

Description. – The apparatus is formed by small scandodontiforms. The cusp is antero-posteriorly keeled. The cusp is twisted and its faces are convex. The keels continue onto the base to the aboral margin. The inner face of the cusp continues onto the inner flare of the base via an inner median carina at the maximum curvature. The basal cavity is small.

Occurrence. – Upper part of lower Table Head.

Material. – 31 specimens.

Genus *Scolopodus* Pander 1856

Type species. – *Scolopodus sublaevis* Pander 1856

Remarks. – Lindström (1971) redefined *Scolopodus* in multielement taxonomy: '*Scolopodus* includes hyaline, drepanodontiform elements with rounded cross section and symmetrical as well as asymmetrical elements. The sides of the elements may be finely costate. The base is not greatly expanded'.

Lindström (1971) based the definition on *Scolopodus rex* Lindström, because the nature of the natural association of the holotype *Scolopodus sublaevis* Pander s.f. is unknown. *Scolopodus rex* is hyaline and forms a symmetry transition series. The elements are multi-costate, and without surface striations. Based on the hyaline nature of the elements, Lindström (1970) placed the genus in *Oistodontidae*.

Scolopodus oldstockensis n.sp.
Pl. 8:24–30.

Derivation. – Old Stock, brand name of the author's favourite beer.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 66, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39678 (Pl.8:28), an intermediate element.

Diagnosis. – A *Scolopodus* with a small base and a large cusp. The costae are relatively sparse.

Description. – Depending on the degree of asymmetry, three types of elements may be distinguished: symmetrical, intermediate and asymmetrical. The elements may have cloudy white matter along the growth axis. Basal filling commonly is preserved. No surface striations have been observed.

Symmetrical element. – The symmetrical element is recurved, with a rounded cusp, and with a convex anterior smooth surface. The posterior margin has a median costa. In addition, up to four smaller postero-lateral costae are present. The cross-section of the base is triangular with rounded edges. Slight asymmetry is only due to a little variation in development of the postero-lateral costae.

Intermediate element. – The intermediate element has a laterally compressed proclined to recurved keeled cusp and a small base. It carries two inner central costae, which end close to the apex of the cusp and the aboral margin of the base. The outer rounded face varies from smooth convex to multi-costate with up to four fine costae. These costae begin close to the aboral margin leaving a noncostate rim around the base.

Asymmetrical element. – This unit is recurved with a small twisted base due to torsion of the cusp. An inner sharp median costa continues throughout the length of the cusp to the apex, and gradually changes into a carina close to the apex. It disappears near the aboral margin. Due to the twist of the cusp, this sharp costa rotates toward the anterior side of the cusp, and disappears on the most asymmetrical elements which only have a convex face on the inner side of the cusp. Some elements have two inner sharp costae. The outer surface of the cusp is convex and smooth, or may carry one or two lateral costae.

Remarks. – Only two species of *Scolopodus* as defined above are known. Serpagli (1974), Landing (1976), and Ethington & Clark (1965) identified elements with *S. rex*. These elements are not conspecific with *S. rex,* and should be considered a new species, which is partly contemporaneous with *S. rex. Scolopodus oldstockensis* n.sp. differs from the two species by the presence of the intermediate element. *S. oldstockensis* n.sp. is the youngest known species of *Scolopodus sensu* Lindström (1971).

Occurrence. – Lower middle Table Head.

Material. – 1 symmetrical; 31 intermediate and asymmetrical elements.

Genus *Walliserodus* Serpagli 1967 (emend. Cooper 1975)

Type species. – *Acodus curvatus* Branson & Branson 1947.

Remarks. – Serpagli (1967) was the first to propose *Wal-*

liserodus as a genus of its own. He selected *Paltodus debolti* Rexroad 1967 s.f. as the type species.

Cooper (1975:995) emended the diagnosis of *Walliserodus* to include both *Acodus curvatus* s.f. and *Paltodus debolti* s.f. in the same species. He found that *Acodus curvatus* s.f. had name priority for the type species.

According to Cooper (1975) *Walliserodus* is a multielement genus with an acodontiform and a suite of paltodontiforms forming a symmetry transition series. In the Table Head fauna, a limited number of elements are all included in *Walliserodus ethingtoni,* but no acodontiforms could be included in the apparatus. Löfgren (1978) discussed *Walliserodus* in detail, and she did not include an acodontiform element in the apparatus.

Walliserodus ethingtoni (Fåhræus)
Pl. 9:1–9.

Synonymy. – ☐1966 *Panderodus ethingtoni* n.sp. – Fåhræus, p. 25, Pl. 3:5a–b. ☐1974 *Walliserodus ethingtoni* (Fåhræus) – Bergström, Riva & Kay, Pl. 1:12. ☐1976 *Walliserodus ethingtoni* (Fåhræus) – Dzik, Fig. 14 o,p. ☐1978 *Walliserodus ethingtoni* (Fåhræus) – Löfgren, pp. 114–116, Pl. 4:27–35; Fig. 33. ☐1978 *Walliserodus ethingtoni* s.f. (Fåhræus) – Tipnis *et al.,* Pl. IX:23–24.

Description. A species of *Walliserodus* with unicostate through multicostate cones. The cones form a limited curvature transition series from procurved to slightly recurved elements. This is associated with differences in the length of cusp and base. Procurved elements have a longer base and a shorter cusp than the elements which are recurved. Due to torsion of cusp the cones form a symmetry transition series. All the elements have a deep, broad basal cavity with the tip near the anterior margin at the maximum curvature of the element. The anterior margin of the base is convex. The cusp may be sharp or rounded anteriorly. The posterior edge of the cusp is sharp. The oral edge of the base is keeled. The aboral outline is slightly sinuous.

Symmetrical element. – The symmetrical element is erect to slightly recurved; it has a rounded anterior face on cusp and base, and one posterior sharp keel on the cusp. The keel continues onto the oral edge of the base. There are two antero-lateral costae on the base that extend on the anterior side of the cusp to the point of maximum curvature. Additional (1 to 3) symmetrically placed costae may develop between the lateral and posterior costae. The youngest is closest to the oral margin. They extend to various lengths of the cusp, but usually do not reach the whole length of the cusp.

Asymmetrical element. – The asymmetrical elements are variably costate, from slightly asymmetrical and unicostate, bicostate to multicostate, often with two costae on the outer side and three on the inner side. However, many asymmetrical elements can be derived from the symmetrical cone by a simple rotation of the costae with the cone axis as reference.

No surface ornamentation such as striations was observed.

Remarks. – Löfgren (1978) discussed the variable costate elements of *Walliserodus ethingtoni* in detail. She found that the variability was inconsistent, a conclusion with which the limited material at hand seems to agree.

Löfgren (1978) also discussed the possible association of *Paltodus? jemtlandicus* and *Walliserodus ethingtoni,* and concluded that the two are distinct taxa. In this material, an association could be considered between *Parapaltodus flexuosus* and *Walliserodus.* The elements co-occur, have the same stratigraphic range, and have broadly similar morphology, and *P. flexuosus* could be part of the symmetry transitions series. However, the relatively small number of elements and the lack of possible transitional forms appear to prohibit this.

Walliserodus is close to *Scolopodus,* in that both are multi-costate simple cones and have a curvature transition series superposed by a symmetry transition series. No surface ornamentation are present on the elements of the two genera. The main differences are the presence of white matter, the large deep basal cavity and the more prominent costae in *Walliserodus.*

Occurrence. – Through Middle Table Head, rare in Lower Table Head.

Material. – 6 symmetrical elements; 62 asymmetrical elements.

Genus *Pseudooneotodus* Drygant 1974

Type species. – *Oneotodus* (?) *beckmanni* Bischoff and Sannemann 1958.

Pseudooneotodus mitratus mitratus (Moskalenko)

Synonymy. – □1933 *Oistodus* (?) sp. – Branson & Mehl, Pl. 9:3. □1966 Form I – Webers, p. 73, Pl. 15:7. □1973 *Ambalodus mitratus mitratus* sp. nov. subsp. nov. – Moskalenko, p. 86, Pl. 17: 9–11. □1976 *Oneotodus mitratus* Moskalenko – Dzik, Fig. 12, e,f. □cf. 1967 Gen. et sp. indet B. – Serpagli, p. 107, Pl. 29:1a, b. □cf. 1977 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Cooper, pp. 1068–1069, Pl. 2:14, 17. □1978 *Ambalodus mitratus mitratus* s.f. Moskalenko – Tipnis *et al.,* Pl.VII:18.

Description. – A bonnet-shaped, irregular simple cone with a small cusp and a high, broad flared base. The oral edge is rounded. The basal cavity occupies the whole of the base. The only element in the collection was fragmental and part of the inner base was broken.

Remarks. – Cooper (1977) reported several species of *Pseudooneotodus* of which *P. beckmanni* (Bischoff & Sannemann) is closest to *P. mitratus mitratus.* The Silurian specimens, however, have a higher cusp and a smaller base than the Ordovician forms.

The Table Head specimen was lost during office moving.

Occurrence. – Lower Table Head.

Material. – 1 specimen

Family Panderodontidae Lindström 1970

Diagnosis. – Conodont apparatuses of simple cones that include laterally to antero-posteriorly compressed elements with a posterior or lateral furrow or a posterior carina and some may bear a posterior denticle row. Characteristically, the Panderondontidae have longitudinal striations.

Remarks. – Panderodontidae includes *Panderodus, Neopanderodus, Parapanderodus* n.gen., *Belodina,* and *Semiacontiodus.*

Genus *Parapanderodus* n.gen.

Type species. – *Parapanderodus arcuatus* n.sp.

Derivation of name. – Para- (Greek) = akin to; refers to the similarity of the genus to *Panderodus.*

Diagnosis. – A multi-element genus with a skeletal apparatus of simple, slender slightly rounded to laterally compressed or heart-shaped, costate drepanodontiforms. The base is rounded to symmetrical oval. The units characteristically have a posterior groove, which extends through the whole length of the element. The elements are finely striated, and contain various amounts of white matter in the cusp. The elements may form a weakly developed symmetry transition series.

Remarks. – In all elements of *Parapanderodus* the striations form an angle with the posterior furrow, and in most species the striations begin next to the aboral margin leaving an unornamented rim.

Parapanderodus n.gen. includes elements, which commonly have been referred to *Scolopodus* Lindström, the form-genus *Drepanodus* Pander and *Panderodus* Ethington.

Scolopodus has recently been restricted to an apparatus with hyaline, multi-costate conodonts forming a symmetry transition series (Lindström 1971) pending a better understanding of *S. sublaevis* Pander. The elements of *Scolopodus* are more rounded and they are not striated.

Drepanodus has been redefined in multi-element taxonomy by Lindström (1971). *Drepanodus* includes a scandodontiform in the apparatus.

Semiacontiodus is similar to *Parapanderodus* in that it may have a posterior furrow and is striated. *Semiacontiodus* differs by the well developed symmetry transition series including an antero-posteriorly compressed symmetrical element, and the striations are parallel to the length of the cusp.

Parapanderodus resembles the Devonian *Neopanderodus* Lindström and Ziegler (1971). The principal differences are the coarse surface striations and the postero-lateral position of the groove of *Neopanderodus.*

Parapanderodus arcuatus n.sp.
Pl. 9:10–15.

Synonymy. – □cf. 1969 *Scolopodus* cf. S. *quadraplicatus* Branson & Mehl – Bradshaw, p. 1163, Pl. 132:8–9; Fig. 4, Nos. E. F. □1973 *Scolopodus gracilis* Ethington & Clark – Barnes & Poplawski, pp. 786–787, Pl. 3:8, 8a only; Fig. H.

Derivation of name. – The elements are all gently arched.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 46, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39681 (Pl. 9:10A, B), an element type 1.

Diagnosis. – A *Parapanderodus* with elements carrying few costae on lateral and posterior faces. The cross-section of the cusp is 'acontiodus'-like with elements which are heart-shaped in cross-section. All the elements are procurved.

Description. – The elements are slightly asymmetrical because the lateral and posterior costae are not exactly in a symmetrical position. An antero-lateral broad furrow is often present. Cusp and base form a gently continuous curve. All the elements have an anterior sharp keel.

The elements are fully striated on the faces of the base. From the base and onto the tip of the cusp the striations are solely developed between the two posterior carinas-costae. The striations form an acute angle with the posterior groove.

Two distinct morphologies are recognized in *P. arcuatus*.

The first type (element type 1) has a posterior subsymmetrical, well-developed sharp, outer costa, and two posterior lateral costae. The posterior furrow is situated next to the posterior costa. The sides of the base are either concave or an additional antero-lateral inner carina may be present. The aboral outline is concave. The aboral margin meets the oral edge at an acute angle, which gives a characteristic, short tonguelike elongation of the base. The anterior edge and aboral margin meet at a right to obtuse angle. The keels continue onto the base to the aboral margin. In large specimens a lateral-anterior furrow is developed, and this becomes broader on the base. Small specimens have weakly developed lateral costae. The cusp is about twice as long as the base. The basal cavity is triangular with the tip placed close to the anterior edge and pointed anteriorly. The cusp is filled with white matter.

The second type of element (element type 2) is slender, evenly curved with a posterior groove and one antero-lateral furrow on each side. Two rounded posterior costae surround the central groove. The base is slightly wider than the cusp. The elements are almost symmetrical, and only a slight lateral position of the posterior groove creates asymmetry. The base is excavated by the basal cavity with its tip near the anterior margin. The aboral outline is convex, when seen in lateral view. Basal matter, when preserved, is black. The elements have white matter in the cusp.

Remarks. – The elements are very inhomogenous in the ratios from sample to sample of the two general morphotypes. The feature may be due to variation in the growth, as mainly gerontic forms seem to be costate.

The second morphotype shows variation in the length of the base, and a few short base variants similar to *Scolopodus gracilis* of Barnes & Poplawski (1973) are included in the species.

S. cf. *quadraplicatus* is slightly different than the Table Head forms in that the basal cavity is small and in that the elements apparently are not keeled. The general outline of the Fort Peña specimens, however, are similar to *P. arcuatus* n.sp., and they may be conspecific or closely related.

Occurrence. – Common to dominating in the lower Table Head; present in middle Table Head.

Material. – 954 element 1; 751 element 2.

Parapanderodus cf. *consimilis* (Moskalenko)
Pl. 9:16–19.

Synonymy. □cf. 1973 *Scolopodus consimilis* n.sp. – Moskalenko, p. 44, Pl. 4:1–5.

Diagnosis. – A *Parapanderodus* with two posterior lateral furrows in addition to the posterior median groove. All specimens are hyaline.

Description. – The cone-shaped elements are hyaline and consist of a slender cusp and slightly wider base. Base and cusp are about the same size. The basal cavity is deep and cone-shaped with anteriorly directed tip. The cusp is proclined and has an anterior rounded face. Two posterior lateral furrows on the oral edge continue up to one-third of the length of the cusp. The lateral faces of the cusp and the base are broadly grooved. The oral edge is straight and meets the aboral margin in an angle of 90 degrees. A small tongue-like posterior extension may be present in some specimens. Juvenile forms are thin and long, and gerontic elements have a more compressed base. All specimens have the two lateral furrows.

The surface ornamentation includes striations on the base with a nonstriated area on the posterior part of the base. The striations on the cusp are restricted to the posterior face and along the median furrow. The striations form an acute angle with the median furrow.

Remarks. – *P. consimilis* of Moskalenko (1973) has a median groove and two lateral posterior costae. The species described above lacks the lateral costae.

Occurrence. – Lower Table Head.

Material. – 62 specimens.

Parapanderodus elegans n.sp.
Pl. 9:20–27

Synonymy. – □1978 *Scolopodus* aff. *S. gracilis* Ethington & Clark – Löfgren, p. 110, Pl. 8:10A–B. □1979 *'Scolopodus'* sp. Bergström – p. 302–303, Fig. 4 D.

Derivation of name. – The elements are elegant, i.e. very delicate and slender.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 68, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39684 (Pl. 9:24).

Diagnosis. – A species of *Parapanderodus* with a long slender base and a deep basal cavity. The aboral outline is straight.

Description. – The elements vary in the length of the cusp and the base, but most specimens have a longer base than cusp. The cusp is proclined. The basal cavity may extend through the whole base with the tip beneath the point of maximum curvature of the cusp. Two lateral anterior weakly developed furrows may be present. The aboral outline is straight. The aboral margin meets the oral edge in an angle of 75 to 90 degrees.

A large nonstriated rim on the base next to the aboral margin is typical for this species. The base is otherwise fully striated by coarse parallel striations. These become finer upwards toward the tip of the cusp. They are restricted to near the posterior furrow on the cusp. The striations meet the furrow in an acute angle, typical of *Parapanderodus*.

Remarks. – The transition from laterally flattened elements to rounded is not strong in this material, but it is indicated by a few flattened elements. The flattened forms tend to have a shorter base than the rounded ones. The aboral outline is straight in most specimens, but a small posterior tonguelike extension of the oral edge may occasionally be developed.

Löfgren (1978) did not find forms with a widened base as described by Ethington & Clark (1964) for *S. gracilis* s.f. This is similar to the Table Head material, and the specimens are not associated with other elements, which is in accordance with the Swedish material (Löfgren 1978). On the other hand Löfgren (1978) did not find specimens with a deep basal cavity.

P. elegans differs from *P.* cf. *consimilis* by its lack of posterior lateral grooves. The species resembles *P. striatus*, but the deep basal cavity and the posterior nonstriated base are diagnostic.

Occurrence. – Lower and middle Table Head.

Material. – 305 specimens.

Parapanderodus striatus (Graves & Ellison)
Pl. 10:1–3.

Synonymy. – □1941 *Drepanodus striatus* – Graves & Ellison, p. 11, Pl. 1:3, 12. □cf. 1970 *Scolopodus gracilis* Ethington & Clark – Uyeno & Barnes, p. 116, Pl. 22:9–10. □cf. 1973 *Scolopodus gracilis* E. & C. – Barnes & Poplawski, p. 786, 787, Pl. 3:6, 6a, ?7, ?7a; Fig. 2G. □?1964 *Scolopodus gracilis* – Ethington & Clark, p. 699, Pl. 115:8 only; Fig. 2D.

Discussion. – *Drepanodus striatus* Graves & Ellison s.f. has commonly been identified as *Scolopodus gracilis* Ethington & Clark s.f. Ethington & Clark (1964) indicated that *Scolopodus gracilis* s.f. showed affinities with *Scolopodus quadraplicatus* Branson & Mehl s.f. and with *Scolopodus triplicatus* Ethington & Clark s.f. In multi-element taxonomy such an association would probably form an apparatus of a new genus. Barnes & Poplawski (1973) suggested that *Scolopodus gracilis* s.f. and

S. triangulatus s.f. form an apparatus. They found support for this in the presence of intermediate forms in the Mystic Conglomerate.

Only slight variation of the cross-sections of the cusp and the base and the size of the posterior furrow is represented by the elements of *P. striatus*. Also no additional elements were found, which could be included in an apparatus such as those proposed by the above authors.

It therefore seems likely that two or possibly three genera with closely similar morphological elements will be recognized in the future and *Parapanderodus* is one of them.

Description. – Simple cones with a base that is smaller than the cusp. The elements are procurved to proclined. They have a rounded cusp with anteriorly concave faces and a weakly developed anterior keel. The aboral outline is straight to concave. The posterior furrow is well-developed. The basal cavity is funnel-shaped and small. All the specimens are characterized by a slightly thickened rim of the base next to the aboral margin. All specimens are hyaline.

Remarks. – The Lévis forms (Uyeno & Barnes 1970) are a little more rounded and the posterior furrow is deeper than in the Table Head elements.

The elements depicted by Barnes & Poplawski (1973) share similarities with both *P. striatus* and *P. arcuatus* n.sp. The oval cross-section of the base, the smaller posterior groove and the posterior tongue-like extension of the base are characteristics of *P. arcuatus*. The rounded cross-section of the element and the small base (Barnes & Poplawski 1973; Pl.3:6) are *P. striatus* characteristics that are not displayed by *P. arcuatus*. Possibly *P. striatus* is the ancestor to *P. arcuatus*.

Occurrence. – Lower Table Head.

Material. – 66 specimens.

Parapanderodus? aff. triangularis (Ethington & Clark)
Pl. 10:4.

Synonymy. – □aff. 1964 *Scolopodus triangularis* n.sp. – Ethington & Clark, p. 700, Pl. 115:6, 11, 13, 17; Fig. 21. □?1973 *Coelocerodontus?* sp. s.f. – Barnes & Poplawski, p. 770, Pl. 5:19, 19a.

Description. – Simple cones with an anterior sharp keel, two postero-lateral costae and a constricted basal cavity are tentatively included in *Parapanderodus*. The elements are procurved. They form a symmetry transition series due to the inward twist of the cusp, and associated reduction of the inner costae on the base. The elements have a deep posterior groove between the posterior costae. The base and the cusp are equal in length and the basal cavity occupies the whole of the base and with its tip close to the anterior edge.

Remarks. – The element broadly resembles *S. triangularis* s.f. in the presence of a sharp interior keel and the posterior groove. The present knowledge to the Lower Ordovician species is still limited and a closer determination of the Table Head species is not possible at present.

Coelocerodontus? sp. s.f. Barnes & Poplawski may represent a gerontic element of this species.

Occurrence. – Lower and Middle Table Head.

Material. – 21 specimens.

Genus *Semiacontiodus* Miller 1969 (emended Miller 1980)

Type species. – *Acontiodus* (*Semiacontiodus*) *nogamii* Miller 1969

Diagnosis. – Simple cones having a central posterior costa, carina or a groove, two lateral costae and a convex anterior face. The elements generally have longitudinal striations on the surface. The apparatus forms a symmetry transition series.

Remarks. – Miller (1969) described different 'acontiodontiforms' on the level of subgenus. Lindström (*in* Ziegler 1973), Dzik (1976) and Miller (1980) considered *Semiacontiodus* a genus.

Semiacontiodus has a relatively short base with a thickened rim at the aboral margin. Elements of a different species are variable. For example, some species may have a posterior groove, and others have asymmetrical elements, which may become 'blade-like' e.g., *S. asymmetricus* (Barnes & Poplawski). All the species, however, have a shallow, rounded cone in the symmetrical position of the apparatus.

Striations are well-developed on elements of *Semiacontiodus*. They often extend throughout the entire length of the unit.

Semiacontiodus has an apparatus which is similar to that of the genera *Staufferella*, *Scolopodus*, *Walliserodus* and *Juanognathus*. All these genera include a symmetrical element with a rounded anterior margin. *Staufferella* is distinguished by its sharp margins and the lack of striations on the base. *Walliserodus* and *Scolopodus* are multi-costate and have no surface striations. *Juanognathus* lacks the surface striations on the base.

Semiacontiodus is included in Panderodontidae rather than Acanthodontidae, because it is considered to be closely related to *Parapanderodus* n.gen. The distribution and appearance of striations are similar to *Parapanderodus,* and also the presence of a posterior groove in some species of *Semiacontiodus* are characteristics of *Parapanderodus*. *Semiacontiodus* is probably the direct ancestor of *Parapanderodus*.

Semiacontiodus asymmetricus (Barnes & Poplawski)
Pl. 10:5–10, 15.

Synonymy. – ☐1973 *Protopanderodus asymmetricus* – Barnes & Poplawski, pp. 781–782, Pl. 1:12, 12a, 14, 16; Fig. 2A. ☐1979 a *Juanognathus asymmetricus* (Barnes & Poplawski) – Bergström, p. 303, Fig. ?4C, 4E.

Description. – Barnes & Poplawski (1973) described the asymmetrical elements. The symmetrical element is described herein.

It has a slender recurved cusp, an anterior convex face, two lateral costae and a posterior median keel. The cusp

curves onto the base. The base is short and wider than the cusp, and has an oval aboral margin.

Striations are well displayed on the symmetrical element. It has striations on both faces. The element has very coarse striations on the base, and carries symmetrical parallel fine striations on each side of the median posterior costa. In asymmetrical elements, the coarse striations on the base almost disappear and the finer striations on the cusp decrease in abundance with increasing asymmetry. Highly asymmetric units are almost non-striated.

Remarks. – The 'scolopodontiform' from Hølonda (Bergström 1979a, Fig. 4C) apparently has antero-posterior keels. This is not typical of the Table Head specimens and perhaps the element belongs to a different apparatus.

Occurrence. – Upper and middle Table Head.

Material. – 138 symmetrical elements; 365 asymmetrical elements.

Semiacontiodus cf. *bulbosus* (Löfgren)
Pl. 10:11–14, 20.

Synonymy. – ☐cf. 1978 *Scolopodus bulbosus* n.sp. – Löfgren, pp. 107–108, Pl. 7:7A, B, 8; Pl. 3:3A, B.

Remarks. – Small symmetrical 'cornuoforms' with recurved cusps were recovered, and they are comparable with those of *S. bulbosus* Löfgren. The elements differ in the more prominent recurved cusp and no one of the Table Head elements has an erect cusp as the Swedish species. Löfgren (1978) found two element-types: cornuoforms and scandodontiforms, and the species is a typical *Semiacontiodus*. No scandodontiforms were recovered in the present collection.

The specimens are completely covered by striae.

Occurrence. – Lower and middle Table Head.

Material. – 21 specimens.

Semiacontiodus preasymmetricus n.sp.
Pl. 10:16–19.

Synonymy. – ☐1971 *Paltodus* n.sp. A – Sweet, Ethington & Barnes, Pl. 1:14. ☐?1964 *Acontiodus iowensis* Furnish – Ethington & Clark, p. 687, Pl. 113:3.

Derivation of name. – Pre = before. The species is considered the ancestor of *S. asymmetricus* (Barnes & Poplawski).

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 29, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39690 (Pl.10:18), a symmetrical element.

Diagnosis. The symmetrical element is without a posterior median costa. The median central costa is weakly

developed, but a broad convex carina is present in asymmetrical elements.

Description. – This species comprises elements with a small base and a large cusp, which is proclined to recurved. The cusp is pointed and the anterior face is convex. The elements have one lateral sharp costa on each side, and a posterior median rounded carina. The costae continue onto the aboral margin. The oral edge is rounded, short and curves onto the cusp. The aboral margin is sub-circular to oval.

The asymmetrical elements are antero-posteriorly compressed and have laterally extended faces. These continue toward the base and in most elements narrow towards the basal opening. The cusp is recurved.

The symmetrical elements are slender cones with anteriorly convex faces. They may carry a small weakly developed keel. The elements have two lateral costae. The posterior face is convex. The aboral margin is subcircular.

Remarks. – This species differs from *Semiacontiodus asymmetricus* by the lack of a prominent posterior costa. The symmetrical element has a sub-circular aboral margin. In *S. asymmetricus* it is oval. The asymmetrical element with a wide blade-like cusp is not present in *P. preasymmetricus*. The figured specimen of Ethington & Clark (1964) is possibly a symmetrical, juvenile element.

Occurrence. – Lower part of lower Table Head.

Material. – 38 specimens.

Semiacontiodus cf. *cordis* (Hamar)
Pl. 11:1–6.

Synonymy. – □cf. 1966 *Scolopodus cordis* n.sp. – Hamar, pp. 74–75, Pl. 3:4–6; Fig. 2, No. 5. □?1973 *Oneotodus gracilis* (Furnish) – Barnes & Poplawski, pp. 777–778, Pl. 1:1 only.

Description. – Symmetrical elements have a recurved cusp with a rounded or weakly keeled anterior margin. The posterior margin has a narrow furrow, which runs the whole length of the cusp and onto the base. The lateral faces are convex and carry two postero-lateral carinas. The carinas may be developed as weak costae. The base is short, it has convex faces and a rounded cross-section.

The asymmetrical elements are similar to the symmetrical elements. The asymmetry is due to torsion of the cusp. The cusp is proclined and has a sharp anterior and posterior keel and is laterally compressed. The furrow is present on the base and becomes inconspicuous on the cusp.

All the specimens are finely striated on the surface of the whole unit. Striations are best developed on the base, where they begin a short distance away from the aboral margin.

A basal funnel is commonly preserved; it is black.

The distribution of white matter is characteristic. The base and posterior half of the cusp is hyaline or translucent, and white matter fills the anterior of the cusp from the point of maximum curvature of the unit. Above that, white matter completely fills the cusp.

Remarks. – *S.* cf. *cordis* (Hamar) does not carry costae on the lateral faces of the base. This species is similar to *Parapanderodus* in that is possesses a posterior furrow, but the apparatus is similar to *Semiacontiodus*.

The Mystic fauna element resembles an asymmetrical element of *S.* cf. *cordis*. The long base-type (Barnes & Poplawski 1973, Pl. 1:2) may belong to their species, but it does not fit within the Table Head material.

Occurrence. – Lower and middle Table Head.

Material. – 180 symmetrical elements; 266 asymmetrical elements.

Superfamily Chirognathacea (Branson & Mehl 1944)

Remarks. – Chirognathacea comprise Oistodontidae, Chirognathidae and Rhipodognathidae (Lindström 1970). The Oistodontidae have an apparatus similar to Prioniodontidae (Dzik 1976) and are consequently allocated to the Prioniodontina.

In this way the Chirognathacea comprise apparatuses of asymmetrical and symmetrical elements, mainly hyaline and mainly of Midcontinent Fauna Province affinity.

Dzik (1976) indicated that Chirognathacea could be related to Westergaardodina and belong within Westergaardodinina Lindström (emend. 1970).

Family Chirognathidae Branson & Mehl 1944

Remarks. – Chirognathidae includes *Chirognathus*, *Erismodus*, *Microcoelodus*, *Multioistodus*, and *Leptochirognathus*. Sweet & Schönlaub (1975) discussed the relation of *Microcoelodus* (and *Erismodus*) to *Oulodus*, and they indicated that the ancestor of *Oulodus* should be referred to Prioniodinacea.

Genus *Erismodus* Branson & Mehl 1933

Type species. – *Erismodus typus* Branson & Mehl 1933

Discussion. – Elements of *Erismodus* have an apical cusp, arched denticulate processes, and an excavated base containing a boss extending aborally beneath the cusp (Branson & Mehl 1933:25). Andrews (1967) showed that the form-genera *Erismodus*, *Microcoelodus* and *Ptiloconus* included components of several closely related form transition series, and four species of *Erismodus* were described. He also noted that *Erismodus* formed a *Roundya–Ligonodina* transition series of Lindström (1964). *Erismodus* is presently under revision and a more complex apparatus is to be expected (Sweet & Schönlaub 1975).

The present material includes elements which are erismodid-like, and the form transitions of Andrews can barely be recognized. The elements are tentatively included in *Erismodus*.

Erismodus? sp. A.
Pl. 11:7–9

Synonymy. – □?1978 *Erismodus* sp. A – Tipnis *et al.*, Pl. IV:23–24.

Description. – The most common element consists of a cusp and has a posterior and an anterior denticulated process. The cusp is reclined, slightly twisted to the inner side and has sharp anterior and posterior keels with smoothly convex faces. The anterior process is directed downward. It carries from three to six rounded denticles. The posterior process carries five to six discrete denticles, which are recurved. The aboral margin has a strong inner flare.

A second element has only been recovered as fragments. It consists of a cusp, which is broken, with denticulated, posterior, anterior and lateral processes. The posterior process is nearly straight. It carries from three to five laterally compressed, discrete denticles. The anterior process extends sharply downward and has six small denticles. The lateral process forms a curve. It has six discrete small denticles. The base has a larger inner flare.

Remarks. – *Erismodus* sp. A Tipnis *et al.* (1978) may belong to this species. The anterior process apparently does not extend downwards as in the Table Head species.

Occurrence. – Top of St. George Group and lower Table Head Formation.

Material. – 40 specimens.

Erismodus? sp. B. s.f.
Pl. 12:1.

Synonymy. – □1973 'Fibrous' conodont elements – Barnes & Poplawski, pp. 787–788, Pl. 5:14.

Description. – Single elements with a large cusp and two denticulated processes. An additional anterior small process, directed downward, may evolve as an extension of the anterior keel of the cusp on large specimens. The cusp is recurved, strongly keeled and with a convex outer face. The keels continue as lateral and posterior processes. The basal cavity has an inner flare.

Remarks. – The element differs from prioniodontiforms of *Eoneoprioniodus?* sp. A by the lack or poor development of an anterior process.

Occurrence. – Top of St. George Group and basal Table Head Formation.

Material. – 21 specimens.

Genus *Leptochirognathus* Branson & Mehl 1943

Type species. – *Leptochirognathus quadrata* Branson & Mehl 1943

Remarks. – A few leptochirognathodontiforms were recovered in the collections. The elements are constant in their morphology within each sample. The morphology, however, differs from sample to sample. The elements are described as form species, but may be considered as species of a multi-element genus with one element in the apparatus. Sweet & Bergström (1972), however, suggested that *Leptochirognathus* has an apparatus of elements which form a symmetry transition series.

Leptochirognathus cf. *quadrata* Branson & Mehl s.f.
Pl. 12:2–3.

Synonymy. – □cf. 1943 *Leptochirognathus quadrata* – Branson & Mehl, pp. 378–379, Pl. 63:23–28.

Description. – The specimens are orientated so that the concave side is the inner side. The cusp is directed toward the posterior.

The element consists of a cusp, and denticulated anterior and posterior processes. The cusp is slightly reclined, keeled and has an outer median carina that extends beneath the aboral margin as an apical lip. The inner face carries a well developed carina, which fades at the base. The anterior process carries three denticles; the one next to the cusp is very wide, keeled and much larger than the outer two denticles. The latter are about one-fifth of the width of the first denticle. The denticles are proclined. The posterior process has two denticles, which are reclined and unequal in size. The one next to the cusp is largest and occupies almost the whole length of the process. The second denticle is small and broken in most cases. The elements are deeply excavated by the basal cavity, which is deepest underneath the cusp.

The elements are laterally bent to form an open curve.

The elements have fine striations on the cusp and denticles.

Remarks. – The elements differ from *L. quadrata* by the presence of auxiliary, apical denticles. With larger collections than the Table Head fauna, this possibly is within the variation of *L. quadrata*.

Occurrence. – Lower part of lower Table Head.

Material. – 10 specimens.

Leptochirognathus prima Branson & Mehl s.f.
Pl. 12:6–7.

Synonymy. – □1943 *Leptochirognathus prima* – Branson & Mehl, p. 378, Pl. 63:29–35.

Remarks. – The specimens fit those described by Branson & Mehl (1943). No additional elements were recovered that could be included in the species.

Occurrence. – Top of the St. George Group at Back Arm.

Material. – 5 specimens.

Genus *Multioistodus* Cullison 1938

Type species. – *Multioistodus subdentatus* Cullison 1938.

Multioistodus cf. *subdentatus* Cullison
Pl. 12:4–5.

Synonymy. – □cf. 1938 *Multioistodus subdentatus* – Cullison, p. 226, Pl. 29:13a, b. □cf. 1965a *Multioistodus subdentatus*, Cullison – Mound, p. 25, Pl. 3:?17, 18, 20, 25. □cf. 1971 *Multioistodus subdentatus*, Cullison – Sweet, Ethington & Barnes, Pl. 2:24. □cf. 1965a *Multioistodus tridens* Cullison – Mound, p. 26, Pl. 3:19, 24, 26.

Description. – The apparatus is incompletely preserved. One asymmetrical element has a large recurved cusp which is keeled. The posterior keel continues onto the base in a curve. The oral edge is straight and carries a recurved denticle. The denticle may reach half the length of the cusp. The anterior keel of the cusp continues on the base in a smooth curve. The anterior edge of the base may evolve a thin keel. The anterior keel of the base forms an angle of about 90 degrees with the aboral margin. The aboral outline is straight to convex.

The associated fragmental, asymmetrical elements with one lateral denticle on each side complete the apparatus as described by Lindström (1964).

All the specimens are finely striated.

Remarks. – *M.* cf. *subdentatus* differs from *M. subdentatus* Cullison by its rounded antero-basal junction, whereas *M. subdentatus* Cullison has an extended anterior base on the symmetrical element.

Occurrence. – Top of the St. George Group and lower part of the Table Head Formation.

Material. – 6 specimens.

Suborder Prioniodontina Dzik 1976

Superfamily Prioniodontacea (Bassler 1925)

Remarks. – Lindström (1970) included the Periodontidae in the Prioniodontacea. Dzik (1976) transferred the Periodontidae to the Ozarkodinina Dzik, which is followed in this study.

Prioniodontacea (Bassler 1925) comprise the families Balognathidae, Icriodontidae and Prioniodontidae.

Family Balognathidae Hass 1969

Remarks. – Balognathidae include apparatuses with two platforms, which may be associated with ramiforms (e.g., *Amorphognathus*). The family comprises *Amorphognathus*, *Eoplacognathus*, *Polyplacognathus*, *Pygodus* (Lindström 1970) and *Polonodus. Eoplacognathus, Polonodus* and *Polyplacognathus* have apparatuses with platforms but without ramiforms. It

is likely that all these genera should be referred to more than a single family. The problem is not considered further in this study.

Genus *Amorphognathus* Branson & Mehl 1933

Type species. – *Amorphognathus ordovicicus* Branson & Mehl 1933

Amorphognathus? sp. A.
Pl. 12:8–12, 14.

Remarks. – Dzik (1976:6) recently figured in a schematical way the apparatus of *Amorphognathus variabilis*. Löfgren (1978) included the type specimen (i.e., *Amorphognathus variabilis* Sergeeva s.f.) in *Eoplacognathus? variabilis*. The elements described below form an incomplete apparatus which imitates *Amorphognathus variabilis* Dzik.

Description. – The apparatus is not complete. It consists of amorphognathiform, ambalodontiform and ramiforms.

The amorphognathiform has a small cusp, an anterior denticulated process, an antero-lateral process and a posterior denticulated process. The posterior process carries two rows of denticles in large specimens. The possible postero-lateral process is broken in the material on hand.

The ambalodontiform has antero-posterior denticulated processes. The processes are connected with basal sheath. The base is flared to the inner side.

The ramiforms include tetraprioniodontiforms and trichonodelliforms. The tetraprioniodontiforms have an anterior and posterior denticulate process which are in the same plane as the cusp. Two symmetrically placed lateral processes are posteriorly projected.

The trichonodelliforms have three posteriorly directed denticulated processes. The processes are connected by a basal sheath. The cusp is proclined.

Remarks. – The apparatus was not completely recovered as figured by Dzik (1976), because holodontiforms have not been found.

Occurrence. – Lower and middle Table Head.

Material. – 13 specimens.

Genus *Polonodus* Dzik 1976

Type species. – *Ambalodus clivosus* Viira 1974

Discussion. – Dzik (1976) originally defined *Polonodus* as 'Conical conodonts with 4 lobes covered with concentric and radial rows of tubercles. Very large basal cavity.'

Löfgren (1978) queried the validity of the diagnosis based on the identification of *A. clivosus* Viira s.f. by Dzik (1976). She noted that two types of four-branched elements were represented – one group with a well developed anterior platform and the second group, which Dzik (1976) assigned to *Polonodus*. Löfgren (1978), however, did not change the diagnosis of *Polonodus*, and she preferred to describe the forms as single elements.

The present material confirms that two apparatuses can be distinguished. The first apparatus is composed of paired polyplacognathiforms and ambalodontiforms and could be assigned to the genus *Polyplacognathus* Stauffer 1935 (emend. Bergström & Sweet 1966). The Table Head material is still too sparse to propose a definite transfer to *Polyplacognathus*. In this group the polyplacognathiforms has a large basal cavity, a large outer, blade-like process and typically an inner anterior notch on the anterior process. The ambalodontiform has four lobes of which the anterior may carry slightly larger denticles. The basal cavity is restricted. The group includes *Polonodus clivosus* (Viira) *sensu* Löfgren (1978).

The second group is not as well known. It is considered possible that the group comprises two kinds of elements: polyplacognathiform and ambalodontiform. Both elements have four lobes and deep basal cavities.

The polyplacognathiform basically forms an X, having four processes. The anterior process carries two rows of denticles, which are connected by a platform. The anterior and outer lateral lobes are of equal length and the largest of the element. The posterior and the inner lateral lobe are also of equal length and generally much smaller than the anterior process. Typically, additional processes are formed both anteriorly and posteriorly of the outer lateral process.

The ambalodontiform forms an X with straight to curved processes. In this element the anterior process has one denticle ridge.

The elements of the second group were described as *Polonodus?* sp. A, *Polonodus?* sp. B and *Polonodus clivosus (in pars)* by Löfgren (1978). The elements referred to *Polonodus clivosus* (Viira) by Dzik (1976) have not been recorded in the Table Head material. The general surface ornamentation of the Table Head specimens and the Swedish specimens is similar to that of the Polish forms. Thus, the group is probably taxonomically valid and should be recognized as the genus *Polonodus* Dzik.

The elements of the *Polonodus* group differ from polyplacognathiforms of the first group by having small rounded well separated denticles on the outer lateral process.

Polonodus tablepointensis n.sp.
Pl. 12:13; Pl. 13:1–5.

Synonymy. – □1964 *Amorphognathus* n.sp. – Lindström, pp. 93–94, Fig. 33C. □1970 *Amorphognathus* n.sp. cf. *Amorphognathus* n.sp. Lindström 1964 – Fåhræus, p. 2065, Fig. 3A, B. □1970 *Amorphognathus variabilis* Sergeeva – Fåhræus, p. 2065, Fig. 3E. □1976 *Polonodus clivosus* (Viira) – Dzik, p. 423, Fig. 28C, D (only). □cf. 1976 *Polonodus clivosus* (Viira) – Dzik, p. 423, Fig. 7, Pl. 43:1. □?1976 Nov. gen. 1 n.sp. 1 – Landing, p. 642, Pl. 4:20. □1978 *Polonodus?* sp. A – Löfgren, pp. 76–77, Pl. 16:?9, 11, 14A, B. □1978 *Polonodus?* sp. B – Löfgren, pp. 77–78, Pl. 16:7, 8; Fig. 30. □1978 *Polonodus clivosus* (Viira) – Löfgren, p. 76, Pl. 16:15A, B, C only. □1979 cf. 'Amorphognatus' n.sp. Lindström – Harris *et al.*, Pl. 2:?11, 15.

Derivation of name. – Table Point, Great Northern Peninsula, Newfoundland.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Middle Table Head, sample TP 74, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39699 (Pl. 13:3), a polyplacognathiform.

Diagnosis. – Two types of elements are present: polyplacognathiform and ambalodontiform. The anterior process of the polyplacognathiform carries two denticles rows, which are separated by a wide platform. The anterior process of the ambaladontiform has a median denticle ridge and an outer small notch. All the processes characteristically become wider distally.

Description. – The polyplacognathiform has typically an anterior process which has a well developed wide platform. The anterior process is divided by a deep inner notch or a strongly concave area separating two almost equal size anterior processes. In mature forms the anterior process develops a large anterior process. The main denticle row curves inward with a maximum curvature anterior of the cusp. The denticles are rounded and of equal size. The denticles are connected by a thin ridge. The surface of the platform is covered by blunt contoured ridges. The anterior process develops an additional outer denticulated process. The two processes are connected by a wide platform. The outer lateral process is long and straight. It carries small oval denticles, which are equal size and apically free. One or two additional processes evolve during the growth between the anterior and the outer lateral process. An additional process between the outer lateral process and the posterior process is also present.

The ambalodontiform has four straight to curved processes. The anterior process carries one median to outer denticle ridge. The surface is ornamented by traverse ridges. The main denticle row continues onto the posterior process. The outer lateral process is of the same length as the anterior process. Additional processes are formed on the outer lateral process in mature specimens. The outer lateral process carries a median denticle ridge, which initiates just anterior of the cusp. The inner lateral process carries a median to anterior denticle row. The denticle row runs from just posterior of the cusp to over mid-length of the process. The posterior process is straight. The whole unit has a large basal cavity.

Remarks. – The polyplacognathiform shows variation in the curvature of the anterior, the inner lateral and the posterior processes. The outer lateral process is always straight. Commonly, the outer lateral process is broken.

Polonodus tablepointensis n.sp. represents the largest conodonts in the collection.

Polonodus? sp. A. Löfgren (1978; Pl. 16:9) has a strongly concave area separating two almost equal size anterior processes and it belongs within the variation of the polyplacognathiform.

Polonodus? sp. A. Löfgren (1978; Pl. 16:11, 14A, B) is probably juvenile polyplacognathiform.

Polonodus sp. B. Löfgren (1978; Fig. 30) has a large anterior platformal process, and it is a polyplacognathiform.

Amorphognathus n.sp. Lindström, *Amorphognathus* n. sp. cf. *A.* n.sp. Lindström and *A. variabilis* (Viira) of Fåhræus

(1970) and *Polonodus* sp.? B of Löfgren (1978; Pl. 16:7–8) all have an anterior process without an anterior platformal process. They belong to the ambalodontiform.

Nov. gen. 1 n. sp. 1 of Landing (1976) has a curved anterior process. The element is fragmentary but it possibly belongs within the variation of *Polonodus tablepointensis* n.sp., as it is similar to *Polonodus*? sp. B Löfgren and *A. variabilis* (Viira) of Fåhræus (1970).

Polonodus clivosus (Viira) of Dzik (1976; Fig. 7 and Pl. 43:1) differs from the Table Head species by its larger angle between the posterior and inner lateral process in the element with straight processes. The specimen with curved processes is higher than the Table Head forms. Possibly the elements represent a different species.

Cf. *'Amorphognathus'* n.sp. Lindström depicted by Harris *et al.* (1979; Pl. 2:11, 15) are fragmental, and the anterior process is broken off on both specimens. The appearance (in particular Pl. 2:15) is similar to the polyplacognathiform of *Polonodus tablepointensis* n.sp.

Polonodus clivosus (Viira) of Löfgren (1978, Pl. 16:15) differs from *P. clivosus* by the lack of an inner lateral notch of the anterior process. Instead, the notch has an outer position and the element is identified with *Polonodus*? sp. B Löfgren (1978, Pl. 16:8). Also the denticle pattern is typical of *Polonodus tablepointensis* n.sp. rather than *Polonodus*? *clivosus* (Viira).

Occurrence. – Lower and middle Table Head.

Material. – 13 polyplacognathiforms; 13 ambalodontiforms.

Polonodus? clivosus (Viira)
Pl. 13:6–13.

Synonymy. – □1967 *Ambalodus* n.sp. – Viira, Fig. 3, No. 24a, b. □1970 *Polyplacognathus* n.sp. A. – Fåhræus, p. 2064, Fig. 3F, G. □1970 *Ambalodus* n.sp. A – Fåhræus, p. 2064, Fig. 3J, K. □1974 *Ambalodus clivosus* n.sp. – Viira, pp. 51–52, Pl. 8:1; Fig. 37, 38. □1978 *Polonodus clivosus* (Viira) – Löfgren, p. 76 *(pars)*, Pl. 16:12A, B, 13; *non* 15A, B, C.

Description. – Ambalodontiform. – The unit is X-shaped. The anterior process develops into a straight blade with high apically free, and laterally compressed denticles. The lateral processes are straight with a median row of denticles. The posterior process has a relatively larger platform with a rounded outline. A few denticles continue from the anterior process onto the posterior process. The angle between the anterior and the outer lateral processes is about 90 degrees in juvenile specimens and decreases to almost 45 degrees in adult elements. The inner lateral process forms an angle of 80 degrees or less with the main denticle row. The basal cavity is restricted.

Polyplacognathiform. – Two morphotypes are recognized. The first morphotype has an anterior, platformal process, which carries an outer comb-like row of apically free denticles. The platform is covered by transverse or contoured ridges. A small inner notch is present on the platform. The denticle row is sinuous and continues across the entire unit via a

laterally compressed, pointed cusp and onto the inner side of the posterior platform-like process.

The inner lateral process is curved and carries a median denticle ridge. The posterior process is small and weakly ornamented by transverse ridges.

The outer lateral process is straight, blade-like with confluent large denticles which lean posteriorly. An additional process develops during growth between the anterior process and the inner lateral process.

The basal cavity is deep beneath the anterior and the outer lateral processes, weakly developed beneath the inner lateral process, and absent beneath the posterior process.

The second variant has an additional row of denticles on the inner side of the anterior platformal process. The outer lateral denticle ridge consists of laterally compressed denticles. The unit has a high pointed cusp. The inner lateral process is straight. The outer lateral process is straight, but typically not blade-like and does not develop an additional process between the outer lateral and the anterior processes.

Occurrence. – Lower middle Table Head.

Material. – 18 polyplacognathiforms; 13 ambalodontiforms.

Polonodus? newfoundlandensis n.sp.
Pl. 13:14–16; Fig. 28.

Derivation of name. – Newfoundland.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 59, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39702 (Pl. 13:16, Fig. 28), a polyplacognathiform.

Diagnosis. – A *Polonodus*? with ambalodontiforms having an angle of 60 degrees between the anterior and outer lateral processes. The denticles are small and blunt. The platform of the anterior process of the polyplacognathiform has a deep inner notch.

Description. – All elements are four branched in this species.

Ambalodontiform. – The ambalodontiform has a straight anterior process which carries small, apically free denticles. The cusp is inconspicuous. The outer lateral process is straight and carries a ridge of small rounded denticles which meets the anterior denticle ridge just anterior of the cusp in an angle of 60 degrees. The inner lateral process extends vertically from the unit and carries a low denticle row. The posterior process is platform-like and only a few blunt denticles are present. The posterior denticle ridge forms an angle close to 90 degrees with the anterior denticle row. The basal cavity is restricted and only narrow slits are present.

Polyplacognathiform. – The anterior process forms a wide platform. It has an outer lateral ridge of small free denticles,
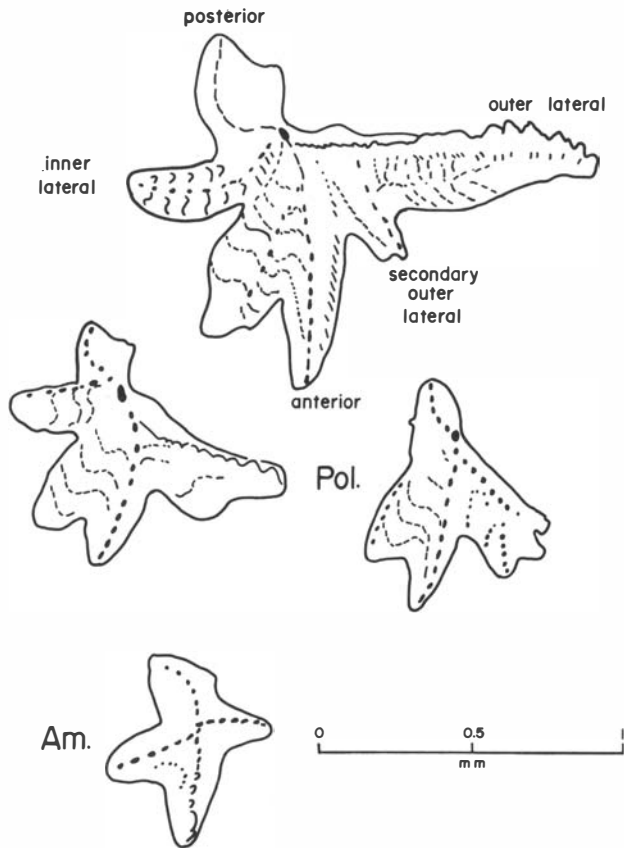
Fig. 28. Polonodus? newfoundlandensis n.sp. (×70). Specimens from sample TP 59. am. = ambalodontiform; pol = polyplacog-nathiform. The anterior process is directed downwards and the outer lateral process is to the right on the illustration.

and the surface is ornamented by transverse or contoured ridges. The process has a deep inner notch on the platform which separates the main process from an additional inner lateral process in mature elements. The additional inner process is ornamented by a small median ridge of rounded denticles.

The outer lateral process is long, straight and laterally compressed. It carries denticles which are high, laterally compressed and apically free. The angle between the outer lateral denticle ridge and the anterior denticle ridge varies from 45 degrees in juvenile specimens to 70 degrees in adult specimens. In adult elements the outer lateral process becomes much longer than the anterior process.

An additional outer lateral process develops between the anterior and the outer lateral processes during growth of the unit. In juvenile specimens this additional process is only present as an inner flare of the outer lateral process. This additional process is ornamented by a row of small rounded denticles. It meets the main denticle row on the lateral process in an angle of 60 degrees.

The posterior process is rounded and develops a small secondary outer lobe. It is covered by small rounded denticles, which have a lateral inner position on the process.

The inner lateral process is posteriorly curved. It has a median to anteriorly placed row of small rounded denticles. The inner lateral and the posterior processes are equal in size and they are much shorter than the anterior process.

The basal cavity is wide and large and has a small

thickened rim along the edge of the element. In some specimens the basal cavity has not been formed underneath the posterior and posterior lateral processes.

Remarks. – The species differs from *P.? clivosus* by the small denticles of the anterior process of the ambalodontiform and by the deep notch on the anterior process of the polyplaco-gnathiform.

Occurrence. – Lower Table Head.

Material. – 8 polyplacognathiforms; 2 ambalodontiforms.

Genus *Pygodus* Lamont & Lindström 1957

Type species. – *Pygodus anserinus* Lamont & Lindström 1957.

Discussion. – Bergström (1971a) included two elements, pygodontiform and haddingodontiform, in *Pygodus*. Further-more, he mentioned that ramiforms probably completed the apparatus.

Löfgren (1978) found early forms of *Pygodus*-like elements. She also included ramiforms in the apparatus. As these early representatives only occurred in small numbers and in fragmental state of preservation the apparatus was not complete, and she tentatively included the elements in *Pygodus?*.

In the collections at hand a few ramiforms similar to the ones depicted by Löfgren (1978) are present. These are tentatively referred to *Pygodus?*

Fåhræus (1970) figured a possible haddingodontiform, this element is tentatively included in the apparatus.

Pygodus? sp. A
Pl. 14:1–2

Synonymy. – □?1970 *Haddingodus serrus* (Hadding) – Fåhræus, Fig. 3:4, 5. □?1978 *Pygodus?* sp. B – Löfgren, p. 97, Pl. 16:2–3; Fig. 32F.

Description. – The ramiforms are asymmetrical with three processes and have a short cusp, which is recurved. The processes are connected by a basal sheath.

Remarks. – The possible haddingodontiform could belong to the multi-element species *Pygodus serra,* but it differs in the angle between the anterior and posterior processes being over 90 degrees.

Occurrence. – Middle Table Head.

Material. – 9 specimens.

Family Oistodontidae Lindström 1970

Remarks. – The original diagnosis for Oistodontidae was based on the hyaline elements of *Oistodus* which form a transition series (Lindström 1964, 1970). Characteristic for Oistondontidae is that the elements have high lateral costae, and that they lack accessory denticles (Dzik 1976). The

architecture of the apparatus is comparable to that of *Acodus* (Prioniodontidae), which also led Dzik (1976) to include *Acodus* in Oistodontidae. *Acodus* is here placed in Prioniodontidae following McTavish (1973).

Lindström (1970) included *Scolopodus* in Oistodontidae, because it is a hyaline genus. The elements of *Scolopodus* do not possess high lateral costae, and in overall morphology they differ from the elements of *Oistodus,* and they are not considered to be closely related. In this study *Scolopodus* is allocated to Panderodontacea.

Genus *Oistodus* Pander 1856

Type species. – *Oistodus lanceolatus* Pander 1856

Discussion. – *Oistodus* comprises three types of elements: cordylodontiforms, cladognathiforms and hibbardelliforms (deltiforms) Lindström (1971). The apparatus of the collection at hand does not include a deltiform, but consists of prioniodontiforms, ramiforms and oistodontiforms.

Oistodus lanceolatus is well known in much older strata than the Table Head Formation, and is constantly associated with a deltiform (van Wamel 1974; Löfgren 1978). Younger species are associated with a trichonodelliform (Serpagli 1974).

McTavish (1973) proposed *Protoprioniodus* for an apparatus of nondenticulate elements of prioniodontiforms, oistodontiforms and ramiforms. Lindström (1973) discussed the phylogenetic relationship between *Protoprioniodus* McTavish, *Oistodus* sensu Lindström and *Acodus*, and he indicated that *Protoprioniodus* might be a junior synonym of *Oistodus.* Dzik (1976), however, suggested that *Protoprioniodus* and *Oistodus* were not identical but closely related. The present author agrees with Dzik and the present apparatus may be considered as a genus of its own. The generic assignment is therefore queried.

Oelandodus van Wamel has an apparatus similar to *Protoprioniodus* and probably is a junior synonym of the latter.

Oistodus? tablepointensis n.sp.
Pl. 14:3–12.

Synonymy. – ☐cf. 1970 *Oistodus lanceolatus* Pander – Uyeno & Barnes, p. 119, Pl. 24:23, 24. ☐1973 *Oistodus lanceolatus* Pander – Barnes & Poplawski, p. 777, Pl. 5:5–7, 10, 11.

Derivation of name. – Table Point. The type locality of Table Head strata.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Middle Table Head, sample TP 72, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39705 (Pl. 14:12), a ramiform.

Diagnosis. – A species of *Oistodus?* in which the ramiforms have a long extended posterior process.

Description. – All specimens have a long laterally compressed weakly recurved to erect cusp with well defined anterior and posterior keels.

Prioniodontiforms. – The units have a wide almost erect, laterally compressed cusp, which may be either non-, uni- or bicostate. The cusp is widest where it merges with the oral edge. The anterior edge continues down to the anterior basal corner. Some elements may have an anteriorly extended base, as illustrated by Barnes & Poplawski (1973, Pl. 5:11), forming a small inconspicuous process. The posteriorly extended base reaches about the length of the cusp. The base is compressed, curved and has a high oral keel. The basal cavity begins beneath the center of the cusp and extends below the entire unit. It is inverted below the cusp.

Ramiforms. – The units have slightly recurved cusps and posteriorly extended bases, which may reach the length of the cusp. Two morphotypes are present. The first has one lateral outer costa and an anterior costa which extend from the apex of the cusp to the aboral margin. The face between these costae is concave. The sides of the cusp are broadly convex, and may develop a small costa in the lower part of the cusp, and extend to slightly above the aboral margin. The cusp is slightly twisted. The base forms a convex curve in lateral view, and has a slightly outward twist. The aboral margin is slightly thickened. The basal cavity extends below the posterior process.

The second morphotype has two outer lateral costae separated by a deep groove. These extend down to the aboral margin and disappear at the middle height of the cusp.

Oistodontiforms. – These elements have a small posteriorly extended base. The anterior keel may be a little extended and meet the aboral margin is a sharp angle. The elements are asymmetrical having an inner broad carina, and a twisted cusp. The cusp is recurved. The aboral outline is sinuous. The basal cavity fills the whole of the base.

Remarks. – Elements of this species have been described as *Oistodus lanceolatus* Pander from the Mystic Conglomerate (Barnes & Poplawski 1973). The Mystic faunal elements have a slightly different appearance due to a higher base, a wider and more reclined cusp and a shorter posteriorly extended base. Similarly, the prioniodontiform has a higher and wider cusp than any of the Table Head specimens. The Mystic faunal elements probably represent an early evolutionary state of *Oistodus? tablepointensis* n.sp.

The specimen from the Lévis (Uyeno & Barnes 1970) has an appearance similar to the ramiforms with one lateral costa. The remaining elements and the preservation of the Lévis specimens (broken base) prohibit a definite identification with *O.? tableheadensis* n.sp.

Occurrence. – Sporadic in lower Table Head, common in lower middle Table Head.

Material. – 70 prioniodontiforms; 120 ramiforms; 52 oistodontiforms.

Family Prioniodontidae (Bassler 1925)

Discussion. – Lindström (1970) included the genera *Acodus* (*Gothodus* emend. McTavish 1973; Serpagli 1974), *Baltoniodus* and *Prioniodus* in Prioniodontidae. The incorporation of *Acodus* in Prioniodontidae may be debated as *Acodus* has been considered to be similar to Oistodontidae, mainly because of its nondenticulated elements (Dzik 1976). *Oistodus* and *Scandodus* have an apparatus, which includes hyaline conodonts with symmetry transition from simple elements without any lateral costa, through elements with a strongly developed costa on one side, to elements with two anterior lateral costae and no anterior edge.

The apparatus of *Acodus* was established by McTavish (1973) and Serpagli (1974) as a multi-element genus with an apparatus following the prioniodontid plan, and McTavish (1973) considered *Acodus deltatus* to be the ancestor of the *Baltoniodus* lineage. Lindström *et al.* (1972) described longitudinal striations on the cusp of the early prioniodontids similar to those on younger species. *Acodus* was therefore considered to be more closely related to *Prioniodus* and *Baltoniodus* than to *Oistodus* and *Scandodus*. Consequently *Acodus* is allocated in Prioniodontidae.

The Midcontinent Province genera *Trigonodus* Nieper (emend. Cooper 1981) and *Eoneoprioniodus* Mound (emend. Barnes 1977) have apparatuses that imitate the prioniodont plan. The elements are hyaline. The ancestors to *Trigonodus* and *Eoneoprioniodus* are unknown; however, according to Cooper (1981) *Eoneoprioniodus* is the descendant of *Trigonodus*. *Eoneoprioniodus?* described below has an apparatus following the prioniodont plan, but all the elements are denticulated. The three genera are tentatively allocated to Prioniodontidae is this study.

Genus *Acodus* Pander 1856

Type species. – *Acodus erectus* Pander 1856

Remarks. – *Acodus* was first described as a form genus by Pander (1856). Bergström & Sweet (1966) included single form elements *Acodus mutatus* (Branson & Mehl) s.f. as part of a multi-element apparatus of *Acodus*. They did, however, express reservations about the use of the genus name *Acodus*, because the apparatus of the type species (*Acodus erectus* Pander s.f.) had not yet been established. Lindström (1971) introduced the name *Gothodus* for elements forming a prioniodont apparatus, but Sweet & Bergström (1972) showed that *Gothodus* was a junior synonym of *Prioniodus*. Kennedy (1980) considered *Acodus* as a *nomen dubium*, because the apparatus of the type species is unknown. The present author prefers to retain the name *Acodus* until the nature of the apparatus for the type species has been established.

McTavish (1973) and Serpagli (1974) defined *Acodus* as a multi-element genus including acodontiforms (= prioniodontiforms), oistodontiforms and ramiforms (= trichonodelliforms, cordylodontiforms, and tetraprioniodontiforms). *Acodus* includes predominantly undenticulated conodonts.

Acodus combsi Bradshaw
Pl. 14:13–19.

Synonymy. – □1969 *Acodus combsi* n.sp. – Bradshaw, p. 1147, Pl. 132:11, 12. □1969 *Scolopodus alatus* n.sp. – Bradshaw, p. 1162, Pl. 132:1–4. □1969 *Tripodus laevis* n.sp. – Bradshaw, p. 1164, Pl. 135:9, 10. □ 1973 *Distacodus* sp. s.f. – Barnes & Poplawski, p. 772, Pl. 3:11. □1973 *Oistodus* n.sp. s.f. – Barnes & Poplawski, p. 777, Pl. 1:3.

Diagnosis. – An *Acodus* apparatus consisting of undenticulated elements with all processes connected with a basal sheath, and the ramiforms with secondary costae on the inner lateral surface of the specimens.

Description. – *Acodus combsi* Bradshaw s.f. is the prioniodontiform. *Scolopodus alatus* Bradshaw s.f. is the trichonodelliform and *Tripodus laevis* Bradshaw s.f. is the tetraprioniodontiform. *Distacodus* n.sp. s.f. and *Oistodus* n.sp. s.f. Barnes & Poplawski are the cordylodontiforms. These units were fully described by the respective authors. The ramiforms are unique in the presence of secondary inner lateral costae on many elements.

The oistodontiforms are new, they have a large reclined cusp, which is laterally compressed, keeled and provided with an inner carina. The posterior keel meets the oral edge in an angle of about 80 degrees. The oral edge is short and keeled. The aboral outline is straight with a small inner notch next to the anterior keel. The base is almost plano-convex with an inwards flaring aboral margin and may resemble the acodontiform. The base is triangular with a flexed outward keel. The anterior keel of the base extends downward to form a small incipient process. The basal cavity is triangular with an anteriorly directed tip.

White matter is confined to the cusp in all specimens.

Occurrence. – Lower and lower middle Table Head.

Material. – 17 acodontiforms; 50 ramiforms, 20 oistodontiforms.

Acodus? n.sp. A
Pl. 14:20–28

Synonymy. – □cf. 1973 *Protopanderodus* n.sp. 5 – Barnes & Poplawski, pp. 784–785, Pl. 2:12 only; Fig. 2D.

Discussion. – A series of undenticulated ramiforms can be associated with acodontiforms and oistodontiforms (scandodontiforms). The ramiforms all include tall, slender, erect, quadricostate units, which form a symmetry transition series. The costae are extended downward slightly beyond the thinly sheathed basal cavity to form short undenticulated processes and the element therefore is to be considered a tetraprioniodontiform.

The apparatus differs from *Acodus* in the lack of trichonodelliforms, but instead has symmetrical tetraprioniodontiforms. The apparatus is probably closely related to *Acodus*, but it is also similar to *Scandodus* and *Triangulodus* van Wamel (sensu Dzik 1976). The lack of trichonodelliforms led the author to query the generic assigment.

Diagnosis. – An apparatus of undenticulated acodontiforms, cordylodontiforms, scandodontiforms (oistodontiforms) and tetraprionodontiforms.

Description. – The acodontiforms have a wide laterally compressed cusp which is keeled, reclined and has one lateral carina.

The carina continues onto the aboral margin as an apical lip. The aboral outline is straight. The posterior keel of the cusp meets the oral edge in a sharp angle. The base is small, and the basal cavity is a narrow groove, which expands to a small cavity beneath the cusp and the lateral carina.

The ramiforms have a long, slender, erect to slightly reclined cusp which is keeled and has one sharp costa on each lateral face. The costae extend below the aboral margin as undenticulated alate processes. The posterior keel meets the oral edge in a rounded angle. The anterior keel continues onto the base and extends downwards as a small process. The oral edge or posterior process is straight, sharply keeled, and longer than the alate processes. The basal cavity is small, thinly sheathed and cone-shaped. The elements form a tetraprioniodont plant. The position of the lateral and anterior processes changes forming a symmetry transition series, whereas the posterior process remains stable in its position. The symmetrical element is cross-shaped in aboral view, thus having a sharp anterior keel in the place of a rounded face present in trichonodelliforms.

The oistodontiforms have a reclined, keeled, and relatively wide cusp. The base is flared to the inner side. The oral edge is short and meets the cusp in a sharp angle. The basal cavity is small with a centrally placed tip and extends beneath the whole unit. Juvenile forms are simple triangular laterally compressed cones with a straight aboral outline. During growth the angular junction between the cusp and the oral edge becomes prominent.

Cordylodontiforms are laterally compressed cones with a cusp and triangular base. The cusp forms an angle of about 90 degrees with the oral edge. The oral edge is keeled. The basal cavity extends beneath the whole base as narrow slit.

Remarks. – Juvenile specimens of oistodontiforms resemble *Histiodella minutiserrata* Mound s.f. or *H. altifrons* Harris s.f. The principal differences are the lack of flaring lips and the lack of denticulation of the oistodontiform in *Acodus?* n.sp. A.

Protopanderodus sp. 5 of Barnes & Poplawski (1973) is similar in that it is a tetraprionodontiform. To judge from the description of Barnes & Poplawski (1973) the element is part of a *Triangulodus* apparatus, and the similarity may be due to homeomorphy.

Occurrence. – Lower Table Head and lower middle Table Head.

Material. – 32 acodontiforms; 36 ramiforms; 19 oistodontiforms.

Genus *Baltoniodus* Lindström 1971

Type species. – *Prioniodus navis* Lindström 1955a.

Remarks. – Fåhræus & Nowlan (1978) reviewed the history of the genera *Prioniodus, Oepikodus, Gothodus* and *Acodus.* Dzik (1976) and Löfgren (1978) found that *Baltoniodus* was a subgenus of *Prioniodus,* but Lindström *et al.* (1974) provided arguments for the rank of genus for *Baltoniodus.* The present author agrees with Lindström *et al.* (1974) and is of the opinion that the apparatus of *Baltoniodus* is well established and easily can be regarded as a separate genus.

Baltoniodus comprises *B. triangularis, B. navis* and *B. prevariabilis* as the best known species. Additional species were not described from large collections. *Baltoniodus prevariabilis* is a transitional form between *B. navis* and elements described as *Prioniodus variabilis* (Bergström 1971a).

Baltoniodus prevariabilis has been separated into three subspecies based on differences in the ramiforms, in particular the tetraprioniodontiform (Dzik 1976; Löfgren 1978).

A series of ramiforms including 'paracordylodontiforms', 'gothodontiforms', trichonodelliforms, tetraprioniodontiforms and falodontiforms was recovered in the Table Head fauna. No amorphognathodontiforms and ambalodontiforms were found, and a certain assignment to *Baltoniodus,* therefore, is not possible. Two possibilities for the affinity of the elements exist.

The first is to assign the elements to *Baltoniodus* and consider the lack of the remaining elements of the apparatus as a chance coincidence. The general morphology of the elements are in favour of this approach.

The position of the processes of the tetraprioniodontiform is similar to and identified with the *medius* variant of *B. prevariabilis.* The falodontiform (Löfgren 1978, Pl. 12:34) is identical to the Table Head specimens. Presence of 'gothodontiforms' and 'paracordylodontiforms' characterize the stratigraphically older elements of this subspecies (?middle Kundan into Aserian).

The second possibility would be that the elements could be ramiforms in an apparatus including *Polonodus?* clivosus (Viira). The apparatus then would be similar to *Amorphognathus.* At present this possibility is not considered likely, because the collection at hand is sporadic and far from conclusive.

Baltoniodus? prevariabilis medius (Dzik)
Pl. 15:1–6.

Synonymy. – □?1973 *Baltoniodus prevariabilis?* (Fåhræus) – Barnes & Poplawski, p. 769, Pl. 1:20. □1976 *Prioniodus alatus medius* ssp. n. – Dzik, p. 423, Pl. 42:1; Fig. 23A-1 (*in pars*). □1978 *Prioniodus (Baltoniodus) prevariabilis medius* Dzik – Löfgren, pp. 86–87, Pl. 12:27–36, Pl. 13:1A-B, 3, 6A-D.

Description. – The collection includes 'paracordylodontiforms', trichonodelliforms, tetraprioniodontiforms, 'gothodontiforms' and falodontiforms.

'Paracordylodontiform'. – The unit has a recurved, twisted and keeled cusp with an inner median carina and an outer convex face. The keels continue onto the denticulated processes.

'Gothodontiform'. – The gothodontiform has a cusp and three denticulated processes. The cusp is erect and carries three costae. The costae continue onto the processes. The unit has

an anterior, a posterior and antero-lateral outer process. All the processes are denticulated. Black basal matter is often attached to the unit.

Trichonodelliform. – The trichonodelliform has an erect cusp with three costae. The anterior margin is convex. The lateral and posterior costae continue onto the three denticulated processes.

Tetraprioniodontiform. – The unit has two lateral processes, an anterior and a posterior process. The anterior process is almost in a plane with the posterior process, but has a small lateral deflection. The lateral processes are not completely symmetrical in position. All processes are denticulated.

Falodontiform. – The falodontiform has a large reclined cusp with well developed keels and a small base. The aboral outline is sinuous. The anterior process is thin and long. It carries up to seven pointed denticles. The posterior basal extension is short, but may be broken. The outline from the cusp to the anterior process is sinuous.

Remarks. – The 'paracordylodontiform' and 'gothodontiform' are similar to *P. (B.) prevariabilis norrlandicus* Löfgren in that the anterior process is denticulated. The angle with the posterior process is about 55 degrees or less. According to Löfgren (1978) these characteristics are also present within early forms of *Baltoniodus prevariabilis medius*. The nearly symmetrical tetraprioniodontiform is characteristic of *B. prevariabilis medius*. The lack of a posteriorly extended base on the falodontiform is typical of the Table Head specimens.

The single prioniodontiform element illustrated by Barnes & Poplawski (1973) from the Mystic Conglomerate may complete the apparatus, and it is tentatively included in the synonymy.

Occurrence. – Lower and middle Table Head.

Material. – 30 ramiforms; 18 falodontiforms.

Genus *Eoneoprioniodus* Mound 1965 (emend. Barnes 1977)

Type species. – *Oistodus bilongatus* Harris 1962

Discussion. – Barnes (1977) redefined *Eoneoprioniodus* Mound as a multi-element genus consisting of hyaline elements with an apparatus following the prioniodontid plan. The elements of *Eoneoprioniodus* are mainly adenticulate or weakly denticulated. The apparatus includes oistodontiforms.

The present material is close to the definition of *Eoneoprioniodus* Mound. Hyaline elements form a prioniodus-like skeletal apparatus, but differs by the possible presence of cyrtoniodontiform instead of an oistodontiform. The presence of the cyrtoniodontiform in the apparatus is, however, not certain, as the present material is sparse. Possibly an oistodontiform will be found in larger collections. One other principal difference is that all the elements are denticulated. However, it seems best to tentatively include the elements in

Eoneoprioniodus pending more information on the nature of the Table Head elements.

The similarity of *Eoneoprioniodus* with *Acodus,* and the forms found herein with *Prioniodus* is striking.

Eoneoprioniodus? sp. 1
Pl. 15:7–13, 15–16.

Synonymy. – □cf. 1965a *Cordylodus delicatus* Branson & Mehl – Mound, p. 14, Pl. 1:25, 28, 30. □1965a *Dichognathus extensa* Branson & Mehl – Mound, p. 15, Pl. 1:27. □1965a *Dichognathus typica* Branson & Mehl – Mound, p. 15–16, Pl. 1:28. □cf. 1965a *Ozarkodina delecta* Stauffer – Mound, pp. 30–31, Pl. 4:15. □cf. 1965a *Prioniodus evae* Lindström – Mound, p. 34–35, Pl. 4:17, 18. □cf. 1965a *Tetraprioniodus costatus* – Mound, p. 34–35, Pl. 4:19, 25, 31; Fig. 1K. □1970 *Prioniodus* aff. *P. evae* Lindström – Uyeno & Barnes, p. 109, Pl. 22:21, 22. □1971 *Prioniodina*? sp. A – Sweet, Ethington & Barnes, p. 170, Pl. 1:37. □1971 *Tetraprioniodus* sp. A – Sweet, Ethington & Barnes, p. 170, Pl. 1:30. □cf. 1971 *Prioniodus* sp. A – Sweet, Ethington & Barnes, p. 170, Pl. 1:26. □cf. 1971 *Prioniodus* sp. B – Sweet, Ethington & Barnes, p. 170, Pl. 1:28. □cf. 1977 Hyaline prioniodontiform element – Barnes, p. 236, Pl. 1:14. □1978 *Prioniodus* sp. B. s.f. Sweet *et al.* – Tipnis *et al.,* Pl. IV:11. □1978 *Tetraprioniodus* sp. A. s.f. Swet *et al.* – Tipnis *et al.,* Pl. IV:21. □1979 '*Prioniodus*' n.sp. – Harris *et al.,* Pl. 1:13–15.

Description. – *Eoneoprioniodus*? sp. 1 has an apparatus of prioniodontiforms, paracordylodontiforms, trichonodelliforms, and tetraprioniodontiforms.

Prioniodontiform. – The unit has a large straight keeled cusp and three denticulated processes. The keels continue onto the outer anterior process and the postero-lateral process. The outer face of the cusp is convex. An inner antero-lateral costa extends the full length of the cusp and continues onto the inner anterior lateral process. The face between the costa and the posterior keel is convex, whereas the face between the anterior keel and the antero-lateral costa is concave. The outer lateral process is curved. It carries 5–6 free, laterally compressed and pointed denticles. The anterior process is directed downwards and it carries three, free, laterally compressed denticles. The angle between the anterior and posterior lateral process is about 100 degrees to 110 degrees. The antero-lateral inner process carries 5 to 7 free, laterally compressed denticles. The angle between the cusp and the antero-lateral process varies between 30° and 45°. The two lateral processes may be twisted outwards and they are in the same horizontal plane. All the denticles have white matter whereas the processes and the cusp are hyaline. The basal cavity is a small cone beneath the cusp and disappears beneath the processes. A basal sheath may be present between the anterior and the posterior processes.

Paracordylodontiform. – The unit consists of a costate cusp with a denticulated posterior process and an anterior process. The anterior process is a short, thin extension which may carry denticles. In large specimens the anterior process is well developed and denticulated. The cusp is recurved and more or less twisted. Sharp anterior and

posterior keels extend from the apex of the cusp to the base, where they continue onto the anterior and posterior processes. The cross section of the cusp is oval. The posterior process is extended with an outward flexing. It has 3 to 9 laterally compressed, discrete and sharply pointed denticles. The basal cavity has thin walls and is only slightly wider than the cusp. Asymmetrical forms always have denticulated processes.

Trichonodelliform. – The unit has a large recurved cusp, two antero-lateral denticulated processes and a short posterior denticulated process. The cusp has three costae from the tip to the base and continuing onto the processes. The anterior face of the cusp is convex. The two lateral processes extend downwards and carry from 4 to 7 free denticles. The lateral processes are always longer than the posterior process. The posterior process is convex in lateral view. The basal cavity is shallow and is covered by a thin basal sheath.

Tetraprioniodontiform. – The unit consists of a costate cusp with two denticulated posterior processes, one denticulated anterior lateral process and one adenticulate anterior process. The element has a recurved cusp. The outer lateral process is flexed outwards and carries from 4 to 6 laterally compressed denticles. The posterior process is directed straight backwards, and it forms an open arch when seen in lateral view. It carries from 4 to 7 free, laterally compressed denticles which are increasingly tilted toward the posterior. The anterior lateral process, when preserved, carries four free denticles. The process is almost vertical relative to the posterior process. The anterior process is short and directed downwards. All the denticles have white matter whereas the remainder of the unit is hyaline. The basal cavity is a small cone. A basal sheath connects the processes.

Cyrtoniodontiform. – The cyrtoniodontiform has a recurved cusp, and a denticulated posterior process. The denticles are free and laterally compressed. The basal cavity is shallow.

Remarks. – The paracordylodontiforms of the Joins Formation (Mound 1965a) differ from the Table Head fauna in their curvature of the cusp and that the denticles are fused. The prioniodontiform has an anterior lateral downwards projected process. The tetraprioniodontiform (*T. costatus* Mound s.f.) differs in having five costae, whereas the Table Head species have four. Some of the Joins specimens may form an apparatus similar to the Table Head species (e.g. *Dichognathus extensa* s.f., *T. costatus* s.f.), but others may belong to a different genus (e.g. *Cordylodus delicatulus* s.f.).

Prioniodus sp. A and *Prioniodus* sp. B. of Sweet *et al.* (1971) have a different orientation of the anterior lateral and the anterior processes. The first seemingly is directed downwards on *P. sp.* A, and the second is directed outwards on *P.* sp. B. In the Table Head specimens the anterior lateral process is horizontal and the anterior process has a downward direction.

The hyaline prioniodontid element from the Bay Fiord Formation (Barnes 1977) differs by possessing short lateral processes and an anterior keel.

Occurrence. – Lower Table Head.

Material. – 42 prioniodontiforms; 116 ramiforms

Eoneoprioniodus? sp. 2
Pl. 15:14, 17–20.

Synonymy. – □1971 *Cyrtoniodus* sp. A – Sweet, Ethington & Barnes, p. 170, Pl. 2:22.

Description. – The collection includes hyaline specimens all with an anteriorly keeled base. The elements form a *Cordylodus–Roundya* transition series of Lindström (1964).

Cyrtoniodontiform. – The element has a large, laterally compressed, keeled and recurved cusp and a denticulated posterior process. The cusp is twisted inwards and the anterior keel continues onto the base to the aboral margin. The denticles are laterally compressed and fused. The basal cavity is initially wide but becomes a narrow furrow beneath the process. The aboral outline is sinuous and the base has an inner flare.

Ramiforms. – The ramiforms have one inner lateral denticulated process. The lateral process carries from two to three denticles. The basal cavity is small and extends as a furrow beneath the processes.

Trichonodelliform. – The unit has a recurved cusp, two lateral costae, and a posterior costa. All costae continue onto the processes. The anterior face of the cusp is convex. The two lateral processes are short and carry up to two free denticles. The posterior process is long and almost straight.

Remarks. – Additional elements to this apparatus have not been found. The elements of this possible species differ from *Eoneoprioniodus?* sp. 1 by the short lateral processes; the laterally compressed and fused denticles of the cyrtoniodontiform; the prominent anterior keel on the base, and the basal furrow beneath the processes of the elements.

Occurrence. – Lower Table Head.

Material. – 50 specimens.

Genus *Trigonodus* Nieper 1969 (emend. Cooper 1981)

Type species. – *Trigonodus larapintinensis* (Crespin 1943) (= *Trigonodus triangularius* Nieper 1969).

Discussion. – *Trigonodus* Nieper was defined (*in* Hill *et al.* 1969) as follows: '*Trigonodus* gen. nov. simple symmetrical conodonts with deep, conical basal cavity and triangular basal cross section. Anterior margin smooth, flattened or broadly convex; posterior margin sharp or keeled. Prominent keeled anterio-lateral costa on each lateral face.' As type species *T. triangularius* Nieper sp. nov. (Pl. 0 VII:22 *in* Hill *et al.* 1969) s.f. was selected. Cooper (1981) emended the diagnosis of *Trigonodus* and brought *Trigonodus triangularius* in synonymy with *T. larapintinensis* (Crespin). Hence, the latter name has priority for the former as the type species. The diagnosis of *Trigonodus* is emended to:

The multi-element genus *Trigonodus* Nieper has an apparatus of simple costate cones with a rounded base forming a simply symmetry transition series, which includes acontiodontiform (*Trigonodus* s.f.), acodontiforms, distacodontiforms and scandodontiforms. All elements are hyaline.

The genus also includes the form species described as *Acodus campanula* s.f., *Acontiodus curvatus* s.f., *Scandodus sinuosus* s.f. and *Scolopodus quadraplicatus* s.f. from the Joins Formation (Mound 1965a).

Cooper (1981) presented an extensive discussion of *Trigonodus*. He (Cooper 1981:179) brought *Triangulodus* van Wamel in synonymy based on his identification of the Baltic genus. The apparatuses of the Baltic multi-element species which have been assigned to *Triangulodus* are the subject of conflicting interpretation or are still poorly known (e.g., *Triangulodus brevibasis* (Lindström 1971 *vs* van Wamel 1974 *vs* Löfgren 1978) and *Scandodus furnishi* (Lindström 1971 *vs* van Wamel 1974 *vs* Löfgren 1978)).

Trigonodus carinatus n.sp.
Pl. 6:1–7.

Synonymy. – □1969 *Trigonodus* sp. nov. – Hill, Playford & Woods, p. 0.14, Pl. OVII:23. □cf. 1965a *Acodus campanula* n.sp. – Mound, pp. 8–9, Pl. 1:4–6; Fig. 1A. □cf. 1965a *Acontiodus curvatus* n.sp. – Mound, pp. 11–12, Pl. 1:19–21; Fig. 1D. □cf. 1965a *Drepanodus subarcuatus* Furnish – Mound, p. 19, Pl. 2:14, 18, 19. □cf. 1965a *Scandodus sinuosus* n.sp. – Mound, pp. 33–34, Pl. 4:21–22, 24; Fig. 1J. □cf. 1965a *Distacodus symmetricus* n.sp. – Mound p. 16, Pl. 2:1–3; Fig. 1E. □aff. 1971 *Acontiodus? curvatus* Mound – Sweet, Ethington & Barnes, p. 173, Pl. 2:35. □aff. 1971 *Acontiodus coniformis* Fåhræus – Sweet, Ethington & Barnes, p. 173, Pl. 2:20. □aff. 1971 *Distacodus symmetricus* Mound – Sweet, Ethington & Barnes, p. 173, Pl. 2:34.

Derivation of name. – Most of the elements have carinae.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 25, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39664 (Pl. 6:5), an acontiodontiform.

Diagnosis. – The acontiodontiform has three notches on the aboral margin of the base.

Description. – This species has symmetrical bi- and tricostate drepanodontiforms (acontiodontiforms), asymmetrical tri- (acodontiforms) and quadracostate distacodontiforms and a twisted drepanodontiform (scandodontiform) in its apparatus. The elements form a simple curvature transition series.

Acontiodontiform. – The symmetrical acontiodontiform is proclined to recurved with two lateral costae on the cusp and one posterior median costa. The lateral costae continue onto the base and may reach the aboral margin. The anterior margin of the cusp is convex, and the posterior faces are flat or slightly convex. The posterior keeled costa continues from the cusp to the basal margin. The cross-section of the base is triangular with rounded sides. The aboral margin has a convex outline. It has three pronounced slits at the junction of the coast and the aboral margin. The basal cavity has an anteriorly directed tip. Some specimens may have additional costae on each side of the posterior median costa.

Distacodontiform. – The distacodontiform is proclined to recurved and with twisted cusp and rounded to oval base. The costae extend down to the aboral margin. The outer side of the cusp is convex. The inner side is convex, with a broad carina or costa.

Transitional forms between tri-, and quadra-costae elements are present, i.e. having broad carina at the place where the new costae evolves. Elements with five costae are also present.

Scandodontiform. – The scandodontiform is proclined to recurved. The cross-section of the base is circular to oval. The faces of the cusp are convex. The cusp is sharply keeled. Transitional forms between distacodontiforms and scandodontiforms are present, i.e. an inner carina appears where the new costa of the distacodontiform is present.

Remarks. – The species from the Joins Formation described by Mound (1965a) differs in the shape of the base, and it does not have a slit. The Joins fauna is considered to contain an older related species. Although the posterior and anterolateral costae are sharp-edged in the Table Head material, they do not develop into incipient processes as in the Joins and Kanosh faunas (see Sweet *et al.* 1971, Pl. 1:20, 34, 35).

Occurrence. – Lower part of lower Table Head.

Material. – 146 acontiodontiforms; 657 distacodontiforms; 793 scandodontiforms.

Trigonodus rectus n.sp.
Pl. 6:10–12

Synonymy. – □?1970 *Acontiodus* sp. 2 – Uyeno & Barnes, p. 104, Pl. 21:4–5; Fig. 7I.

Derivation of name. – The cusp is erect in all specimens.

Type locality. – Back Arm East, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, from Gargamelle Cove West, sample CCW 1, *Trigonodus carinatus – Eoneoprioniodus?* sp. 1 Asssemblage zone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39666 (Pl. 6:12A, B) an acontiodontiform.

Diagnosis. – The species forms a symmetry transition series due to progressive twisting of the cusp.

Acontiodontiform. – The acontiodontiform has an erect to slightly proclined cusp with an anterior convex face. The cusp has two lateral median grooves and one posterior median groove. The grooves are framed by well-developed carinas. The base is wide with an open shallow basal cavity. The unit is slightly asymmetrical due to lateral bend of the upper part of the cusp near the apex, and due to the slight difference in the flaring of the base. The asymmetrical units are transitional to the distacodontiform.

Distacodontiform. – The distacodontiform is similar to the acontiodontiform, but is asymmetrical. The asymmetry is formed by the rotation of the cusp and a corresponding moving of the posterior lateral costa toward the lateral side of unit.

Scandodontiform. – A scandodontiform has not been recorded, possibly due to the small collection at hand. A transitional element with one inner lateral groove is included as a scandodontiform. The specimen has one inner carina and two antero-posterior carinas.

Remarks. – All the elements are prominently striated on the surface. *Trigonodus rectus* n.sp. resembles *Scolopodus quadraplicatus* Branson & Mehl s.f. The Table Head specimens differ by the lateral bend of the upper part of the cusp and by the wide open base.

Scolopodus quadraplicatus has been established in multi-element taxonomy (= *Glyptoconus quadraplicatus* (Branson & Mehl)) (Kennedy 1980). Its apparatus appears to be identical with *Trigonodus rectus* n.sp. and possibly the generic assignment has to be re-evaluated for *Trigonodus rectus*. At present the Table Head specimens fit within the definition of *Trigonodus*.

In form-taxonomy the *Acontiodus* sp. 2 of Uyeno & Barnes (1970) could be identified with the distacodontiform of the Table Head material. It mainly differs by its sharp costae, whereas the Table Head elements carry carinas.

Occurrence. – Top of the St. George Group and basal Table Head Formation.

Material. – 6 acontiodontiforms; 16 distacodontiforms; 2 scandodontiforms.

Suborder Ozarkodinina Dzik 1976

Diagnosis. – Dzik (1976) defined Ozarkodinina as: 'Asymmetric two-branched (ozarkodiniform and hindeodelliform) elements predominant functionally in the apparatus.'

Remarks. – Dzik (1976) erected this suborder to comprise apparatuses consisting of ozarkodiniforms, asymmetrical to symmetrical elements (*Cordylodus–Roundya* transition series of Lindström 1964) and an element with one process reduced in size (i.e. oistodontiforms, neoprioniodontiforms). The apparatus mainly consists of six types of elements, which can be reduced in number or an extra element may be added.

The Ozarkodinina apparently originated from simple apparatuses and presumably evolved from *Drepanoistodus* in the Early Ordovician (Dzik 1976). During evolution the oistodontiforms are replaced by neoprioniodontiforms (Dzik 1976, 1978).

Superfamily Prioniodinacea (Bassler 1925)
Family Periodontidae Lindström 1970

Diagnosis. – Apparatus having oistodontiforms without posterior denticles. Anterior denticles may be present on oistodontiforms.

Remarks. – Apparatuses with posteriorly denticulated oistodontiforms are included in Prioniodinidae (Dzik 1978). Periodontidae comprises the genera *Microzarkodina, Phragmodus* and *Periodon. Microzarkodina* includes trichonodelliforms with or without a short posterior process and oistodontiforms without anterior denticles. *Phragmodus* has an apparatus with an adenticulate oistodontiform (Bergström & Sweet 1966; Moskalenko 1972). According to Dzik (1978) *Phragmodus* includes a trichonodelliform with a short posterior process. Younger species of *Phragmodus* have trichonodelliforms with a posterior process (Sweet & Bergström 1972; Moskalenko 1972; Uyeno 1974). *Periodon* comprises trichonodelliforms with a long denticulated, posterior process and oistodontiforms with or without anterior denticles.

Genus *Periodon* Hadding 1913

Type species. – *Periodon aculeatus* Hadding 1913

Discussion. – Bergström & Sweet (1966) redefined *Periodon* as a multi-element genus with six elements in its apparatus: 'Cordylodus-, ligonodina-, cladognathus-, roundya-, prioniodina-, and falodus-like conodont elements.' The *Cordylodus-, Ligonodina-, Cladognathodus-* and *Roundya*-like elements characterize the *Cordylodus-Roundya* transition series (Lindström 1964).

Lindström (1971) suggested that *Periodon flabellum* did not include a falodontiform (or oistodontiform) in its apparatus. The element should be added to the apparatus during evolution. Subsequent workers (van Wamel 1974; Serpagli 1974; Landing 1976; Fåhræus & Nowlan 1978; Löfgren 1978), however, all found an oistodontiform which completed the apparatus.

Hunter (1978, unpubl. M.Sc. thesis) carefully described two distinct morphotypes: loxognathiform and periodontiform within the *Cordylodus–Roundya* transition series in *Periodon aculeatus*. The elements were recovered from the Cobbs Arm Limestone, central Newfoundland, of Middle Ordovician age (*Pygodus serra* and *Pygodus anserinus* Zones).

By comparing elements of *P. flabellum* (Swedish material available in the author's own collection from Tomten: middle to upper Billingian, Lower Ordovician) and *P. aculeatus* (this study) it appears that a similar structural pattern can be reconstructed in this material as well and it is therefore considered to be characteristic of *Periodon*.

The definition of *Periodon* is: *Periodon* is a multi-element

genus with an apparatus consisting of cordylodontiforms, loxognathiforms, periodontiforms, trichonodelliforms, ozarkodiniforms and oistodontiforms. The ozarkodiniforms are developed as two morphotypes, i.e., prioniodiniform and oulodontiform.

Periodon aculeatus zgierzensis Dzik
Pl. 16:1–15.

Synonymy. – □cf. 1941 *Loxognathus flabellata* n.sp. – Graves & Ellison, p. 12, Pl. 2:29, 31, 32. □1941 *Oistodus prodentatus* n.sp. – Graves & Ellison, pp. 13–14, Pl. 2:6, 22, 23, 28. □1941 *Ozarkodina macrodentata* n.sp. – Graves & Ellison, p. 14, Pl. 2:33, 35, 36. □cf. 1965 *Prioniodina? inflata* Lindström – Ethington & Clark, p. 199, Pl. 1:8. □cf. 1965 *Trichonodella flabellum* Lindström – Ethington & Clark, p. 199, Pl. 2:8. □1965 *Falodus prodentatus* (Graves & Ellison) – Ethington & Clark, pp. 192–193, Pl. 1:16. □cf. 1965 *Periodon aculeatus* Hadding – Ethington & Clark, p. 198, Pl. 2:10. □1969 *Periodon aculeatus* Hadding – Bradshaw, pp. 1159–1160, Pl. 137:1, 2, 3, ?4, ?5, 6. □1969 *Falodus prodentatus* (Graves & Ellison) – Bradshaw, p. 1151, Pl. 135:16, ?17. □1969 *Ligonodina tortilis* Sweet & Bergström – Bradshaw, pp. 1152–1153, Pl. 137:18. □1969 *Prioniodina macrodentata* (Graves & Ellison) – Bradshaw, p. 1160, Pl. 137:19. □1970 *Falodus prodentatus* (Graves & Ellison) – Uyeno & Barnes, p. 108, Pl. 22:8, 14, 18. □1970 *Falodus* sp. – Uyeno & Barnes, p. 108, Pl. 22:15. □1970 *Periodon aculeatus* Hadding – Uyeno & Barnes, p. 112, Pl. 23:1, 2, 3, 4, ?5, 6, 7. □cf. 1970 *Periodon flabellum* (Lindström) – Uyeno & Barnes, p. 112, Pl. 23:10, 15. □1973 *Periodon aculeatus* Hadding – Barnes & Poplawski, pp. 780–781, Pl. 5:15, 15a, 16–18, 18 a. □1976 *Periodon aculeatus zgierzensis* ssp. n. – Dzik, p. 424, Pl. 44:5, 6; Fig. 34E–K. □cf. 1976 *Periodon aculeatus aculeatus* Hadding – Dzik, Fig. 34I-r. □1976 *Periodon aculeatus* Hadding – Landing, p. 636, Pl. 3:3–6, 14. □1978 *Periodon aculeatus* Hadding – Fåhræus & Nowlan, p. 462 *(pars)*, Pl. 3:1, 7, 8, ?10, 11, 12; Fig. 5A, ?H, J, K. L. □cf. 1978 *Periodon flabellum* Lindström – Fåhræus & Nowlan, pp. 462–463, Pl. 3:2–6; Fig. 5B–F. □1978 *Periodon aculeatus* Hadding – Löfgren, pp. 74–75 *(pars)*, Pl. 10:1A, B; Pl. 11:12–18 only. □1978 *Periodon* cf. *P. aculeatus* Hadding – Tipnis *et al.*, Pl. VIII:13–15.

Description. – Löfgren (1978) and Hunter (1978) fully described *P. aculeatus*. The Table Head material fits with the early form of *P. aculeatus (sensu* Löfgren 1978) and corresponds to *P. aculeatus zgierzensis* Dzik (1976). A few remarks are needed because the Table Head specimens are less advanced than *P. aculeatus* typical of the upper Llanvirn.

The prioniodiniform has processes of equal length. It carries 3 to 5 denticles on the anterior process and 3 to 6, normally 4, denticles on the posterior process. The anterior process is directed downwards and inwards. It forms an inner angle with the posterior process that varies from 90 to 180 degrees, normally at about 140 degrees.

The oulodontiform has the anterior process deflected outwards. The anterior process forms an angle of 100 to 130 degrees with the posterior process. It normally carries three denticles, and the number varies from 2 to 5. The posterior process carries from 5 to 7 denticles.

The oistodontiform constantly carries anterior denticles. The number of denticles varies from two to five, normally it has three denticles. The unit is asymmetrical due to an inner flare of the base and the cusp may be inward flexed. The oistodontiform varies in morphology and the extremes can be distinguished as two morphotypes. The first type has a strongly reclined cusp, which forms an angle of about 45 degrees with a gently sinuous oral edge. The anterior basal edge meets the aboral margin in an angle of 45 degrees. The second morphotype has a reclined cusp, which meets the straight distal part of the oral edge in an angle of 60 degrees. The cusp and the oral edge forms an angle of 5 to 10 degrees. The aboral margin is strongly sinuous in outline. This morphotype is finely striated at the point of maximum curvature of the cusp. The two morphotypes were illustrated by Löfgren (1978, Pl. 11:17, 18).

The cordylodontiforms carry one to three, in juveniles incipient, anterior denticles. The unit is slightly laterally bent. Some elements have an outer lateral carina on the cusp. The number of denticles between the cusp and the large denticle on the posterior process varies from 4 to 5.

The loxognathiform is characterized by the presence of an outer lateral process and an inner antero-lateral process. The posterior process is distally flexed inward. The inner antero-lateral process carries 3 to 4 denticles. It forms an angle of 130 degrees with the posterior process. The outer lateral process is directed posteriorly. It forms an acute angle with the posterior process. It carries from 2 to 4 denticles. The number of denticles between the cusp and the large denticle on the posterior process varies from 4 to 5.

The periodontiform has an outer carina or costa, which may extend downwards as a nondenticulated process, an inner antero-lateral process, and a posterior process which is distally flexed outward (*Oulodus*-like). The number of denticles between the cusp and the largest denticle on the posterior process varies from 4 to 5.

The trichonodelliform carries 2 to 4 denticles on the lateral processes. The number of smaller denticles between the cusp and the large denticle of the posterior process varies from 4 to 5. The large denticle is posteriorly inclined from 45 degrees in juvenile specimens to 80 degrees in mature units.

Remarks. – The variation of the elements in *Periodon* is gradual and this makes it difficult to separate closely related species (Löfgren 1978). In general, the oistodontiform is considered to be diagnostic (Serpagli 1974; Löfgren 1978) and an increase in the number of denticles from older to younger species is characteristic. *P. flabellum* has been distinguished from *P. aculeatus zgierzensis* by the absence of anterior denticles of its oistodontiform, whereas the oistodontiform of *P. aculeatus* always carries denticles (i.e. falodontiform). According to Löfgren (1978) *P. flabellum* may carry anterior denticles on the oistodontiforms, but the same elements should have a less sinuous aboral outline than early forms of *P. aculeatus.*

The increase in the length of the oral edge relative to the length of the cusp, however, is important in evaluation of *Periodon* species. Thus in *P. flabellum* the ratio of length of oral edge: length of cusp is 1:2, in *P. aculeatus zgierzensis* the similar ratio is 3:4, and in *P. aculeatus aculeatus* the ratio is 1:1.

In the Table Head material, the variation of the oistodontiform corresponds to that of early members of *P. aculeatus* (i.e. *P. aculeatus zgierzensis*).

The remaining elements of *P. flabellum* and *P. aculeatus* were discussed by Dzik (1976) and Löfgren (1978), and a general increase in the number of denticles was noted. The basal sheath becomes narrower in younger forms, and an increase in the lateral bend of the elements is also typical. The angular position of the outward directed anterior process of the oulodiform may appear to be of taxonomical value. Thus in *P. flabellum* the angle varies from 130 to 170 degrees; in *P. aculeatus zgierzensis* from 100 to 130 degrees and in *P. aculeatus aculeatus* the angular position is 90 to 100 degrees.

The late Llanvirnian *Periodon aculeatus* (i.e. Hadding 1913; Lindström 1955b; Sweet & Bergström 1962, 1966; Hamar 1964; Schopf 1966; Webers 1966; Viira 1967, 1974; Bergström, Riva & Kay 1974; Dzik 1976; Bergström 1978; Löfgren 1978 (Pl. 11:19–26) and Tipnis, 1978) represents an evolutionary stage which is beyond the one represented by the Table Head fauna.

Uyeno & Barnes (1970) and Fåhræus & Nowlan (1978) described transitional elements between *P. flabellum* and *P. aculeatus*. Their *Periodon aculeatus* largely fits with the Table Head specimens. *Periodon flabellum*, however, has not been recorded in this study. The Albertan species (Ethington & Clark 1965) may belong within the range of variation of *Periodon aculeatus zgierzensis*, or belong to the late form of *P. flabellum* of the Mystic Conglomerate (Uyeno & Barnes 1970) and the Cow Head Group (Fåhræus & Nowlan 1978). The Albertan specimens are fragmental which prohibits a definite species identification.

Bergström & Sweet (1966); Repetski & Ethington (1977); and Kennedy *et al.* (1979) have discussed the differences between *P. aculeatus* and its successor *P. grandis*.

Occurrence. – Sporadically in lower Table Head; abundant in middle Table Head.

Material. – 1322 specimens (specified in Table 5)

Genus *Phragmodus* Branson & Mehl 1933 (emend. Bergström & Sweet 1966:366)

Type species. – *Phragmodus primus* Branson & Mehl 1933.

Remarks. – Uyeno (1974) and Dzik (1978) most recently discussed *Phragmodus*. The apparatus of *Phragmodus* comprises at least five elements: phragmodontiform, dichognathodiform, oistodontiform and ramiforms forming cordylodontiform gothodontiform and plectodiniform–cyrtoniodontiform transition series.

Dzik (1978) distinguished *Phragmodus* from *Plectodina* and *Oulodus* by the presence of an oistodontiform in the former and neoprioniodontiform (cyrtoniodontiform) in the latter. *Plectodina* and *Oulodus* were included in Prioniodinidae Bassler 1925.

Phragmodus? n.sp. A
Pl. 16:16–20.

Synonymy. – □cf. 1979 *Phragmodus* n.sp. – Harris *et al.*, Pl. 24:13.

Remarks. – A small collection forms an apparatus including ozarkodiniforms, cordylodontiforms, trichonodelliforms, and oistodontiforms. The trichonodelliform has a long posteriorly extended process and short lateral processes. This apparatus is tentatively assigned to *Phragmodus*.

Description. – The ozarkodiniform has a large straight cusp, which is laterally compressed, keeled and carinate. The cusp is variable in length. The anterior keel continues onto the base through a curve. The antero-basal corner is pointed and flexed outward. The aboral outline is concave and the base has an inner flare. The posterior process is flexed outward. It carries four to six laterally compressed, pointed and reclined denticles. The basal cavity is triangular and covered by a thin basal sheath.

The cordylodontiform has an erect to slightly reclined cusp. The cusp is keeled and the keels continue onto the base. The aboral outline is convex. The posterior process is straight and carries erect laterally compressed denticles. The denticles have an increasing tilt posteriorly from the cusp toward the distal end of the process. The basal cavity is triangular with the tip beneath the centre of the cusp. The antero-basal corner is broken in the present material.

The trichonodelliform has a long slender reclined cusp. The two lateral processes are directed posteriorly and each carries from one up to three free denticles. The aboral outline is concave anteriorly and straight posteriorly. The posterior process is curved next to the cusp; beyong that it is straight. The distal part of the posterior process is broken on the Table Head specimens, and the total number of preserved denticles does not exceed five.

The oistodontiform has a strongly reclined cusp with rounded faces. The anterior keel continues onto the base. The antero-basal corner forms an angle of 45 degrees with the aboral margin. The aboral outline is sinuous. The oral edge is keeled and arched. It reaches between 2/3 to 3/4 the length of the cusp. The unit is asymmetrical due to an inward twist of the cusp and the inner flare of the base.

Remarks. – Phragmodontiforms have not been recorded in this small collection.

The oistodontiform is the diagnostic element in evaluation of species of this apparatus (Dr. Anita Harris, GSA, Washington D.C., pers. comm. 1980). *Phragmodus* n.sp. Harris *et al.* has a longer posterior process than the Table Head species. *Phragmodus* n.sp. Harris *et al.* probably represents a younger, closely related species.

Occurrence. – Lower and middle Table Head.

Material. – 30 specimens.

Family Prioniodinidae Bassler 1925

Diagnosis. – Conodonts having two-branched ozarkodiniforms and oistodontiforms with a posteriorly denticulated process (neoprioniodontiforms) (Dzik 1976, 1978).

Remarks. – Prioniodinidae evolved from *Periodon* (Lindström 1970). It differs from Periodontidae by the transformation of

oistodontiforms into neoprioniodontiforms (Dzik 1976, 1978).

Genus *Erraticodon* Dzik 1978

Type species. – Erraticodon balticus Dzik 1978

Discussion. – Dzik (1978) defined *Erraticodon* as: 'Three-branched trichonodelliform and plectospathodiform elements. Neoprioniodiform element with a denticulated posterior branch only ('*Cyrtoniodus*').' The elements are mainly hyaline. The apparatus is comparable to that of *Periodon*, and Dzik (1978) found that *Erraticodon* could be the ancestor of Prioniodinidae.

Dzik (1978) considered *Erraticodon balticus,* the type species of *Erraticodon,* to include six types of elements, i.e. spathognathodontiform, ozarkodiniform, plectospathodiform, hindeodelliform, neoprioniodontiform and trichonodelliform in the apparatus. Dzik (1978) chose the specimen illustrated by Viira (1974, Pl. 11:22) as a spathognathodontiform.

According to the terminology of Dzik (1976) the spathognathodontiform is two-branched, and it does also appear with two branches on the schematic illustration of the apparatus (Dzik 1978, Fig. 6). Similarly, elements with two branches have been illustrated from conodont bearing strata which are older (early Arenig) and (late Llanvirn) younger than those of the Table Head (Lindström 1955b, Pl. 22:13; Lindström 1960; Cooper 1981).

In the Table Head material, however, an element with three processes or prioniodontiforms is always present, and the only two-branched elements present are ozarkodiniforms and hindeodelliforms. The prioniodontiform of the Table Head Formation is identical to the specimen of Viira (1974), when seen in lateral view. Furthermore, it is common that one process is broken and, therefore, it has an appearance of two branches only. A complete prioniodontiform was illustrated by Müller (1978) and Cooper (1981).

It is not obvious from the data of Dzik (1978, Table 1) if the Polish species in fact carried two branches only or if it was based on identification with Viira's (1974) specimen. Thus, alternatively, it is possible that *Erraticodon* carried a two-branched unit in its apparatus (Dzik 1978; Cooper 1981).

Based on the relatively large collection from the Table Head, the positive identification with the 'spathognathodontiform' of Viira (1974), and also the presence of a prioniodontiform elsewhere (i.e. Australia, Müller 1978; Cooper 1981), this author is convinced that *Erraticodon* includes a three-branched element or prioniodontiform in its apparatus.

In addition to the prioniodontiforms, the plectospathodontiforms can be separated into two distinct morphotypes, here labeled sannemannuliform (after Lindström 1964) and zygognathiform. The elements carry three denticulated and variously bent processes.

Erraticodon, therefore, is defined as follows:

Erraticodon has an apparatus which consists of prioniodontiforms, hindeodelliforms, ozarkodiniforms, neoprioniodontiforms (cyrtoniodontiforms) and a transition series of elements with three denticulated processes. The transition series comprises symmetrical (trichonodelliforms) and asymmetrical elements (zygognathiform and sannemannulliform) and prioniodontiform. All elements are hyaline.

?*Erraticodon balticus* Dzik
Pl. 17: 9–19.

Synonymy. – □cf. 1913 *Polygnathus alternans* – Hadding, p. 32, Pl. 1:7. □cf. 1955b *Chirognathus alternans* (Hadding) – Lindström, p. 107, Pl. 22:7, ?13. □?1960 *Chirognathus* sp. – Lindström, Fig. 7:16. □cf. 1960 *Chirognathus*? – Lindström, Fig. 7:9. □cf. 1962 'Fibrous' conodont elements – Sweet & Bergström, pp. 1249–1250, Pl. 169:1, 2, 5, 10, 13, 15, 16. □1966 *Phragmodus*? n.sp. – Fåhræus, p. 28, Pl. 1:12a, b. □cf. 1966 'Fibrous' conodonts – Fåhræus, p. 32, Pl. 4:7, 8, 9a, 9b. □1967 '*Chirognathus*'? – Viira, Fig. 4:9–11. □1970 *Chirognathus* sp. – Fåhræus p. 2064, Fig. 3L, M. □?1970 *Polycaulodus* sp. – Uyeno & Barnes, pp. 112–113, Pl. 21:17. □?1973 'Fibrous' conodont elements – Barnes & Poplawski, pp. 787–788, *(pars)*, Pl. 4:21 only. □1974 '*Chirognathus*' sp. – Viira, p. 63, Pl. 1:15, 21, 22. □1978 Gen. et. sp. indet. B. – Löfgren, p. 118, Pl. 1:41–44. □cf. 1978 Prioniodid conodont element – Müller, p. 276. □?1978 *Erraticodon balticus* sp.n. – Dzik, p. 66, Pl. 15:1–3, 5, 6; Fig. 6A–E. □cf. 1979 *Erraticodon* sp. – Harris *et al.,* Pl. 3:1–5. □cf. 1981 *Erraticodon patu* sp. nov. – Cooper, pp. 166–168, Pl. 32:1–6, 8.

Description. – The *Erraticodon* apparatus includes two transition series, the first of which includes hindeodelliforms, ozarkodiniforms and neoprioniodontiforms. This is a simple transition series characterized by a reduction of the anterior process.

Hindeodelliform. – The hindeodelliform has a tall, recurved and keeled cusp, a posterior process bearing vertically orientated denticles, and an inner lateral process, which is directed posteriorly. The denticles on the posterior process increase in length distally. About midlength of the process a large recurved denticle is present. This denticle is about equal in length or slightly longer than the cusp. The inner lateral process bears denticles, which increase in height at the middle of the process.

The inner lateral process is curved and the posterior process is flexed. The whole unit is sinuous.

The aboral outline is convex. The basal cavity is mainly restricted to the base beneath the cusp. The processes are slightly excavated by a narrow groove in some elements. Black basal filling is often preserved. The basal filling has a large basal funnel.

Ozarkodiniform. – The element consists of a tall recurved cusp and denticulated anterior and posterior processes. The cusp is keeled and has convex faces. The anterior process extends downwards and carries from two to five free denticles. The anterior process has a slight inward twist, and the denticles curve posteriorly. The posterior process is slightly flexed. It carries six to nine, reclined, usually free, denticles. In larger specimens the denticles increase in height about midlength of the process and become basically confluent. The aboral outline is concave. The basal cavity occupies the whole of the base and extends beneath the processes as narrow slits.

Neoprioniodontiform. – The neoprioniodontiforms are asymmetrical laterally compressed compound conodonts with short posterior processes bearing suberect reclined, sharp-edged denticles. The unit is slightly flexed and arched. The erect cusp is longer than the denticles. It has sharp keels and is flexed inward distally. The keels continue onto the base. The posterior process (or extended base) bears up to five flattened denticles, which decrease in size posteriorly. The base is flared inwards and broadly convex to the outer side. The sharp-edged anterior margin of the base may be flexed inward aborally; it meets the aboral margin in a rounded corner. The aboral outline is straight to slightly sinuous. Distally the aboral margin meets the oral edge in an acute angle. The basal cavity is small and distally forms an aboral slit and centrally obtains a moderate width. In general, the morphology resembles the form genus *Cyrtoniodus*.

The second transition series is similar to the *Trichonodella-Oulodus* transition series (Lindström 1964). This transition series includes trichonodelliforms, zygognathiforms and sannemanulliforms.

Trichonodelliform. – The trichonodelliform has a large cusp and a posterior denticulated process. It has one, rarely two, lateral denticles which diverge from the aboral margin of the base.

Zygognathiform. – The zygognathiform has a slender recurved cusp, a long posterior process, one short antero-lateral and one long postero-lateral process. The posterior process is curved aborally and flexed outward. The denticles are laterally compressed, keeled, reclined, and free. The basal cavity extends as a shallow groove beneath the three processes. The short antero-lateral process is inclined anteriorly and carries one to two denticles of various height; the distal denticle being the highest in mature forms. The angle between the antero-lateral and posterior processes is 120 degrees. The outer postero-lateral process is directed posteriorly and forms an acute angle with the posterior process. It carries four to six denticles.

Sannemanulliform. – The unit has a slender cusp, two short lateral processes, and a long posterior process. The posterior process is curved aborally and slightly flexed outwards. The denticles are laterally compressed, keeled and reclined. Commonly the distal part of the posterior process is broken. The posteriorly directed lateral process forms an acute to right angle with the posterior process. The process varies in length. It is longer than the outer lateral process, and of equal length or shorter than the posterior process. The outer lateral process is directed downwards and carries two to three denticles of varying height. The denticle proximal to the cusp is highest and the remaining denticles decrease greatly in size. The outer lateral process forms an angle of 90 degrees with the posterior process.

The element is identical with the plectospathodontiform of Dzik (1978).

Prioniodontiform. – The prioniodontiform has a tall recurved cusp, an anterior, a posterior, and an antero-lateral process. The cusp has three costae, which continue onto the processes. The anterior process is directed downwards, it carries three to seven recurved and laterally flexed denticles. The process is straight to slightly curved. The posterior process is distally flexed with outward tilted denticles. In some specimens the distal part is sub-horizontal. The process carries four to six flexed denticles.

The antero-lateral process is directed anteriorly. It usually becomes the longest of the processes and curves laterally at about midlength, forming an open U. The denticles are highest at about midlength, they are curved inwards. In juvenile specimens the denticles are thin and delicate. The anterior lateral process forms an acute angle (25–35 degrees) with the anterior process.

The narrow basal cavity lies beneath the cusp and a shallow slit occupies the aboral surface of the base.

Characteristically, all the denticles of the three processes curves in the vertical plane. The convex face is regarded as the outer side of the unit in this description. The whole unit has an *Oulodus* outline, and the element may be included in *Oulodus–Trichonodella* transition series as the oulodontiform.

Remarks. – The elements of *Erraticodon* vary greatly from juvenile specimens, which are delicate with laterally compressed denticles, to mature forms with rounded robust denticles.

Commonly, the elements are preserved with one or two broken processes. These fragments of *Erraticodon* can be confused with elements of the form genus *Curthognathus* s.f.. Such elements have been tentatively included in synonymy (e.g., Barnes & Poplawski 1973).

Stratigraphically a gradual increase in height and numbers of denticles, and length of the outer processes of the prioniodontiforms and sannemanulliforms occur. Also, the neoprioniodontiforms change with an increase of the inner basal flare, the size of the denticles and development of an anterior basal keel. The antero-lateral processes of the trichonodelliform are reduced in length and the number of denticles is reduced. It appears that these elements are useful and diagnostic for evaluation of the species. Accordingly, the diagnosis of *Erraticodon* species should concentrate on these elements, since ozarkodiniforms and hindeodelliforms remain conservative.

Based on this information the species from Poland is considered slightly more advanced than the Table Head species. The outer lateral process of the sannemannulliform is shorter, and the cyrtoniodontiform has a higher basal sheath and the base has a smaller flare of the Table Head specimens.

Similarly, the specimens from Sweden (Hadding 1913; Lindström 1955a, 1960; Fåhræus 1966), from Pratt Ferry Formation (Sweet & Bergström 1962) and from Eureka Quartzite (Harris *et al.* 1979) are more advanced and represent a new species of *Erraticodon*. For this species the name *Erraticodon alternans* (Hadding) is available.

Erraticodon patu Cooper differs from the Table Head specimens by the presence of anterior denticles on the neoprioniodontiforms and its higher number of denticles on the antero-lateral processes of the trichonodelliforms. The oulodontiform was not recorded in the Table Head material.

Occurrence. – Lower Table Head and lower Middle Table Head.

Material. – 387 specimens.

Genus *Plectodina* Stauffer 1935a

Type species. – Plectodina aculeata (Stauffer 1935a).

Discussion. – In the Table Head collection an apparatus comprises spathognathodontiforms, dichognathiforms, cordylodontiforms, a symmetry transition series of trichonodelliforms (trichonodelliform, zygognathiform), and oistodontiform. The apparatus may belong to *Plectodina, Oulodus, Aphelognathus* or *Phragmodus* (as defined by Dzik 1978).

Based on the transition series of trichonodelliforms and zygognathiforms associated with spathognathodontiforms the apparatus is allocated to *Plectodina*. The genus assignment, however, is queried because the oistodontiform has not been recorded earlier in *Plectodina* (Moskalenko 1972; Uyeno 1974; Sweet & Bergström 1972).

Plectodina? sp. A
Pl. 17:1–8.

Synonymy. – □1979 *Plectodina?* sp. – Bergström, p. 303, Fig. 4G.

Diagnosis. – The apparatus includes a spathognathodontiform with a high anterior denticulated process with fused denticles, dichognathiform, hindeodelliform (= cordylodontiform), oistodontiform, and a trichonodelliform transition series, which includes zygognathiforms and trichonodelliforms.

Description. – Spathognathodontiform. – Spathognathodontiforms are straight with an anterior denticulated process bearing fused, erect, laterally compressed denticles, an erect cusp and a posterior process with free denticles. The anterior process is higher and with larger denticles than the posterior process. The aboral outline is straight anterior of the cusp and concave posterior of the cusp. The two processes are equal in length. The denticles are compressed, sharp-edged and filled with white matter. The unit is excavated by a basal furrow which flares on the inner side beneath the cusp. This flare continues as a broad carina onto the cusp.

Dichognathiform. – The dichognathiform has a well developed lateral denticulated process, a sharp-edged cusp and a denticulated posterior process. The lateral process forms an acute engle with the cusp.

Hindeodelliform. – The hindeodelliform (= cordylodontiform) has a big keeled, slightly proclined cusp with convex faces. The keels continue onto the base. The anterior sharp edge of the base meets the aboral margin in an acute angle. The anterior basal junction is extended aborally. The aboral outline is concave beneath denticles number 3 to 4 and continues posteriorly subparallel to the oral edge. The posterior process tapers distally. It bears eight to ten free, laterally compressed denticles. The denticles are longest in size about midlength of the process, distally they decrease in size.

Trichonodella transition series. – The zygognathiform has a submedian cusp and two lateral denticulated processes of unequal length. The unit varies in the number of denticles and may bear up to three on each process. Some variation also exists with respect to symmetry. Also the two processes vary from lateral to posterior directions.

The trichonodelliform is similar to the zygognathiform. It has a large median cusp, two lateral processes bearing one or two denticles, and a small posterior extension of the oral margin. A posterior costa runs the full length of the cusp and onto the base.

Oistodontiform. – The oistodontiform has a large, keeled cusp with convex faces. The anterior keel continues onto the base. The anterior margin meets the aboral margin in an angle of about 50 degrees. The aboral margin has a sinuous outline. The base tapers posteriorly. The oral edge is keeled, and meets the cusp in an angle of 80 degrees. The base flares to the inner side.

Occurrence. – Lower part of lower Table Head.

Material. – 184 specimens.

Family uncertain

Diagnosis. – Conodonts forming an apparatus of blade-like ozarkodiniforms, ramiforms forming a *Cordylodus–Roundya*-like transition series, and oistodontiforms.

Remarks. – The apparatus of *Histiodella* is composed of oistodontiforms and two branched ozarkodiniforms. This is typical of Ozarkodinina Dzik. Lindström (1970) tentatively included *Histiodella* in the superfamily Bryantodontacea. As known so far, Bryantodontacea comprises apparatuses with ozarkodiniforms only (Lindström 1970).

The apparatus of *Histiodella,* however, resembles the apparatus of Polygnathidae Bassler (emend. Klapper & Philip 1972; Cooper 1977) or Spathognathidae Hass (emend. Lindström 1970). The principal difference is the presence of oistodontiform in the *Histiodella* apparatus.

The small number of ramiforms in this study prohibits conclusive decisions at the family level.

Genus *Histiodella* Harris 1962

Type species. – Bryantodina sinuosa Graves & Ellison 1941.

Discussion. – *Histiodella* has been defined as individual asymmetrical blade-like conodonts, and differences in denticulation are the basis of different species (Harris 1962; Mound 1965a). Fåhræus (1970), Fåhræus & Nowlan (1978), and Sweet *et al.* (1971) discussed the evolutionary development of *Histiodella.* Thus, increasingly denticulated forms of the genus appear through the North American early Middle Ordovician. In contrast, Sweet (1963) and Landing (1976) argued that different ontogenetic stages were identified as different form species.

The *Histiodella* apparatus was reconstructed by McHargue (1974, unpubl. M.Sc. thesis) from large collections from the Joins Formation, Oklahoma, to comprise bryantodiniforms, ramiforms and an oistodontiform. The present

collection supports the reconstruction of the apparatus, and six morphologically distinct elements can be recognized. An additional slender cone, similar to form species *Histiodella altifrons,* may also be included (see Mound 1965a, Pl. 2:26). The spathognathodontiforms are numerously represented, whereas the ramiforms, usually very small, are only sporadically represented.

The spathognathodontiforms, trichonodelliforms and oistodontiforms are significant in the evaluation of *Histiodella* species. The spathognathodontiforms are undenticulated in juvenile specimens though partly denticulated in mature specimens of early species of *Histiodella* (e.g. *H. altifrons*). *Histiodella minutiserrata* Mound developed small serrations. *Histiodella sinuosa* has a well-defined cusp, distinct anterior denticles and denticles defined by partitioning of the white matter in the blade on the oral edge. McHargue (1974) placed *H. sinuosa* and *H. serrata* in synonymy. The ramiforms become denticulated in *H. sinuosa.*

The Table Head *Histiodella* species represent a continuation of the evolution of *Histiodella* (Fig. 17). *Histiodella tableheadensis* n.sp. bears apically free denticles both on the anterior and posterior margins. The evolution continues in *H. kristinae* n.sp., where the anterior blade increases in height and the cusp decrease in size. The youngest species, *H. bellburnensis* n.sp., has an inconspicuous cusp. The ramiforms are only partly denticulated in *H. tableheadensis* n.sp. but fully denticulated in *H. kristinae.*

Histiodella bellburnensis n.sp.
Pl. 17: 20–21. Fig. 17.

Derivation of name. – Bellburns, a small community on the Great Northern Peninsula.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Middle Table Head, sample TP 80, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39716 (Pl. 17:20).

Diagnosis. – The spathognathodontiform is fully denticulated with an inconspicuous cusp.

Description. – The spathognathodontiform has an inconspicuous cusp in a sub-median position and a large convex denticulated oral edge. The cusp is of equal thickness as the remaining denticles.

Remarks. – The cusp cannot always be distinguished from the denticles. The basal excavation marks the position of the cusp.

Occurrence. – Top of middle Table Head.

Material. – 6 spathognathodontiforms.

Histiodella kristinae n.sp.
Pl. 18: 1–7, 9–11. Fig. 17.

Synonymy. – □1960 *Spathognathus* n.sp. – Lindström, Fig. 5:3. □1967 *Spathognathus* sp. – Viira, Fig. 4:8. □1970 *Spatho-*

gnathus n.sp. Lindström – Fåhræus, Fig. 3I. □1973 *Histiodella sinuosa* (Graves & Ellison) – Barnes & Poplawski, p. 776, Pl. 1:18. □1974 *Spathognathodus* sp. – Viira, p. 125, Pl. 5:39. □1976 *Histiodella serrata* Harris – Dzik, Fig. 12D. □cf. 1978 *Histiodella serrata* Harris – Dzik, Pl. 14:7.

Derivation of name. – Kristine, a girl's name.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Middle Table Head, sample TP 68, *Histiodella kristinae* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39718 (Pl. 18:3), a spathognathodontiform.

Diagnosis. – Spathognathodontiforms with anterior denticles which are taller than the cusp.

Description. – The spathognathodontiform has a well-developed denticulated blade. The cusp is as high as or lower than the anterior denticles. Juvenile specimens always have anterior denticles as high as a line through the apex and parallel to the aboral margin. The cusp is normally 1.5 as wide or less the width of anterior denticles. The oral edge is straight to convex. Cusp is within the distal third of the whole unit.

The ozarkodiniform is a short denticulated unit. It carries one anterior denticle and three to four small posterior denticles. The trichonodelliform is a denticulated *Histiodella triquetra* Mound s.f.. The hindeodelliform has two to three anterior denticles and six to eight posterior denticles. The oistodontiform has a costate cusp and sharp anterior basal corner. Its aboral outline is straight.

Remarks. – *Histiodella kristinae* n.sp. differs from *Histiodella tableheadensis* n.sp. by the height of the anterior denticles on the spathognathodontiform. The ramiforms are similar to *Histiodella tableheadensis,* but all the elements are denticulated in *H. kristinae.*

The anterior part of the blade is broken on *Histiodella serrata* Harris (Dzik 1978). Thus, it cannot safely be included in *H. kristinae.* The cusp, however, is identical to *H. kristinae,* and the Polish specimen is probably *H. kristinae.*

Occurrence. – Sporadic in uppermost lower Table Head, common in middle Table Head.

Material. – 515 spathognathodontiforms; 74 ramiforms; 28 oistodontiforms.

Histiodella tableheadensis n.sp.
Pl. 18:8, 12–14. Fig. 17.

Synonymy. – □1970 *Spathognathodus* sp. – Uyeno & Barnes, p. 117, Pl. 24:12, 13. □1971 *Histiodella* sp. A – Sweet, Ethington & Barnes, Pl. 1:16. □aff. 1971 *Histiodella serrata* Harris – Sweet, Ethington & Barnes, Pl. 1:19. □1973 *Histiodella sinuosa* (Graves & Ellison) – Barnes & Poplawski, p. 778, Pl. 1:17 only. □1976 *Histiodella serrata* Harris – Landing, pp.

633–634, Pl. 1:20. □1979 *Histiodella* n.sp. 1 – Harris *et al.*, Pl. 1:9. □1979 *Histiodella* sp. cf. *Histiodella serrata* Harris – Bergström, pp. 303–305, Fig. 4 I.

Derivation of name. – After Table Head Formation.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 43, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39720 (Pl. 18:14), a spathognathodontiform.

Diagnosis. – A *Histiodella* with fully denticulated spathognathodontiforms. The spathognathodontiform always has a cusp which is higher and is 1.5 to 2 times wider than the anterior denticles.

Description. – The spathognathodontiform has an anteriorly and posteriorly denticulated blade. The anterior blade bears up to nine compressed, apically free denticles. The two to three distal denticles are smaller than the others. The next three to four denticles become the highest. The fused denticles are defined by white matter in the blade. The white matter continues down to the thickened rim above the aboral margin. In juvenile specimens the angle from the apex of the cusp to the anterior highest denticle is always below a horizontal line parallel to the aboral margin. In mature specimens this angle is sub-horizontal. The cusp is wide, tilted posteriorly and in juvenile forms the apex reaches beyond the distal part of the posterior blade. The cusp is posterior in position to the midpoint of the blade. The oral edge is straight in small units and becomes convex in large specimens. It is serrated by small equal-sized denticles which are apically free, but basally fused. The denticles are progressively inclined toward the posterior.

The basal margin is straight in lateral view. The basal cavity is constructed below the basal rim and it is a small slit below the entire unit. It is slightly excavated beneath the cusp. Variation from straight, laterally bent to sinuous forms are common. The anterior part of the blade has a typical translucent area just above the thickened rim along the aboral margin.

The ramiforms are partly to fully denticulated. The hindeodelliform is fully denticulated with apically free slender denticles and a cusp. The denticles are reclined. The ozarkodiniform is fully denticulated. The aboral outline is slightly convex. Trichonodelliforms have developed an anteriorly denticulated blade.

The oistodontiforms have a large cusp, which is widest at the base, and has an inner prominent costa. The cusp forms a sharp acute angle with the oral margin which is keeled and convex. The base is about two-thirds the length of the cusp. The basal cavity is shallow and straight, it extends the full length of the unit.

Remarks. – Adenticulate ramiforms may resemble *Histiodella triquetra* Mound s.f.. They differ by the margins being convex rather than concave as on the Joins specimens. The trichonodelliforms differ from those of *Histiodella serrata* (see Harris *et al.* 1979, Pl. 1:10) by the lack of the short posterior process. Instead *Histiodella tableheadensis* has an anterior process.

H. tableheadensis differs from *H. kristinae* n.sp. by its larger cusp and the small posterior denticles.

Occurrence. – Lower Table Head.

Material. – 607 spathognathodontiforms; 131 ramiforms, 29 oistodontiforms.

Family uncertain

Genus *Loxodus* Furnish 1938

Type species. – *Loxodus bransoni* Furnish 1938.

Discussion. – This genus was defined by Furnish (1938) in form-element taxonomy. Subsequent work has not revealed any additional elements, and *Loxodus* most likely forms an apparatus composed by one type of element only.

In this study, elements with a morphology similar to *Loxodus bransoni* have been included in that genus. Barnes & Poplawski (1973) described these elements as ?*Coleodus* Branson & Mehl. *Coleodus* is a hyaline genus, which consists of a denticulate bar. *Coleodus* differs from *Loxodus* in its denticulation and the basal cavity.

The elements resemble specimens that are included in *Appalachignathus delicatulus* Bergström, Carnes, Ethington Votaw & Wigley. The ozarkodiniforms of *A. delicatulus* differ in having larger denticles, but shares the slit-like basal cavity. The spathognathodontiforms have an enlarged basal cavity distally, unlike *Loxodus*. The species from Table Head is fairly abundantly represented. No other regularly associated elements comparable to the zygognathiforms, trichonodelliforms and eoligonodiniforms of *Appalachignathus* have been found.

Loxodus? *curvatus* n.sp.
Pl. 18:19.

Synonymy. – □1973 ?*Coleodus* sp. – Barnes & Poplawski, p. 771, Pl. 1:19. □?1979 *Coleodus?* sp. – Harris *et al.*, Pl. 1:7. □1979a *Coleodus?* sp. Barnes & Poplawski – Bergström, p. 303. Fig. 4 F.

Derivation of name. – The unit is commonly curved.

Type locality. – Table Point, Great Northern Peninsula, Newfoundland.

Type stratum. – Lower Table Head, sample TP 59, *Histiodella tableheadensis* Phylozone, late Whiterockian (early Llanvirnian).

Holotype. – ROM 39722 (Pl. 18:19).

Diagnosis. – Long, blade-like, bent and bowed denticulated bar with an aboral minor groove. The numerous subequal-sized denticles are fused.

Description. – The element is a long bar. It carries numerous, fused denticles along the full length of the unit. The margin is serrate. Prominent white matter outlines the denticles in the bar. The anteriormost denticles are small and erect; towards the middle of the bar the denticles increase in size and become reclined. The unit tapers posteriorly from the middle of the bar. It has a small slit running beneath the whole bar. No definite basal cavity and cusp are present. The aboral outline is straight to concave. The unit varies in lateral bowing from almost straight to 90 degrees. The maximum curvature is at the middle of the bar. The unit is crescent-shaped.

The surface has characteristic striations, which are proclined i.e., opposite to the orientation of the fused denticles. This gives a typical 'cross-lamellar' ornamentation. This feature is an internal structure, and cannot be observed in SEM. Complete specimens are rarely preserved.

Remarks. – The specimen from the Antelope Valley Limestone (Harris *et al.* 1979) has an anterior basal slit which is not present in the material at hand.

Occurrence. – Lower and middle Table Head.

Material. – 131 specimens.

Family uncertain

Genus *Spinodus* Dzik 1976

Type species. – *Cordylodus spinatus* Hadding 1913.

Diagnosis. – Apparatus that includes elements which carry posteriorly directed processes and bear long, separate denticles. The elements form a *Cordylodus–Roundya* transition series (Lindström 1964).

Remarks. – The affinity of *Spinodus* is not well established. Dzik (1976) suggested that the apparatus should be incorporated in Prioniodontidae, but mentioned that similarity exists between *Multioistodus* (Chirognathidae) and *Spinodus*, because of a similar apparatus.

The apparatus of *Spinodus* is comparable with those of Periodontidae and Prioniodinidae. *Spinodus* exhibits a symmetry transition from trichonodelliform, plectospathodontiform to cordylodontiform. *Spinodus*, therefore, is considered to be more closely related to Ozarkodinina than with Prioniodontina. The apparatus is reduced and at present cannot be included in a family with certainty.

Elements of this genus were described as *Cordylodus* (Hadding 1913; Lindström 1955b; Barnes & Poplawski 1973). As shown by Lindström (1964) elements of *Spinodus* form a transition series. This led Bergström & Sweet (1966) and Barnes & Poplawski (1973) to include elements with

this transition series in the genus *Cordylodus*. Subsequent workers, Lindström (1970) and Sweet & Bergström (1972), hesitated in doing so. Dzik (1976) erected the genus *Spinodus* for these conodonts.

Spinodus cf. *spinatus* (Hadding)
Pl. 18:17–18.

Synonymy. – □cf. 1913 *Cordylodus ramosus* – Hadding, p. 31, Pl. 1:6. □cf. 1913 *Cordylodus spinatus* – Hadding, p. 32, Pl. 1:8. □cf. 1955b *Cordylodus ramosus* Hadding – Lindström, pp. 108–109, Pl. 22:12, 19. □cf. 1964 *Cordylodus spinatus* Hadding – Lindström, pp. 80–81, Fig. 27A-D. □cf. 1976 *Spinodus spinatus* (Hadding) – Dzik, p. 424, Fig. 21C. □cf. 1978 *Cordylodus spinatus* s.f. (Hadding) – Tipnis *et al.*, Pl. VIII:16.

Remarks. – The scarce material available shows similarities to *Spinodus spinatus* (Hadding). The elements do, however, possess some differences. The number of denticles on the posterior process does not exceed more than two; the size of the denticles is much less than for former descriptions (Hadding 1913; Lindström 1955b); the ligonodiforms have a horizontal posteriorly directed lateral denticulated process, the denticle next to the cusp is aligned with the cusp, whereas the second is tilted inwards. The elements do not have inverted basal cavities.

Occurrence. – Middle Table Head.

Material. – 11 specimens.

Gen. et sp. indet. A
Pl. 18:15–16

Diagnosis. – Simple hyaline cones with weakly denticulated oral edges.

Description. – The element consists of a large recurved, keeled and slightly twisted cusp with convex faces. The posterior keel continues onto the oral edge. The anterior keel continues onto the base where it meets the aboral margin in an angle of 75 to 90 degrees. The aboral outline is straight to slightly sinuous. The base is small and the basal cavity is shallow.

Remarks. – This unit is similar to *Trigonodus* elements. The denticles on the oral edge and a stronger keeled cusp are, however, different from *Trigonodus* elements.

Occurrence. – Basal part of lower Table Head.

Material. – 16 specimens.

Gen. et sp. indet. B.
Pl. 18:20.

Description. – The unit is spindle-shaped. It is a platform with one blunt anterior (?) denticle. The element is sub-symmetrical with a median hole. The surface of the platform is unevenly bolbous. A rim runs around the unit next to the aboral margin. The basal cavity occupies at the whole unit.

Occurrence. – Middle Table Head.

Material. – 1 specimen.

Gen. et sp. indet. C.
Pl. 18:21–23.

Remarks. – Elements of an incomplete apparatus consisting of prioniodontiforms and trichonodelliforms are sparsely represented in the Table Head fauna. The apparatus probably could be included in Ozarkodinina.

Description. – The prioniodontiform is incomplete. It carries an anterior outward flexed process, which is broken, an incomplete antero-lateral process with three denticles and a posterior outward flexed posterior process. The cusp is keeled. The basal cavity is shallow.

The trichonodelliform has a high slightly recurved cusp, a long posterior process and two antero-lateral denticles. The cusp is keeled. The keels continue onto the processes. The antero-lateral processes carry one denticle. The posterior process carries 6 to 9 high and free laterally compressed denticles. The basal cavity is shallow. The aboral outline is strongly concave beneath the cusp, otherwise it is straight.

Remarks. – The elements resemble those of ?*Erraticodon,* but they have white matter in the cusp and the denticles, in contrast to ?*Erraticodon.*

Occurrence. – Upper lower Table Head.

Material. – 4 specimens.

Affinity unknown
Genus *Ptiloncodus* Harris 1962

Type species. – Ptiloncodus simplex Harris 1962.

Ptiloncodus simplex Harris
Pl. 18:24.

Synonymy. – ☐1962 *Ptiloncodus simplex* – Harris, p. 207, Pl. 1:5A–C, 6. ☐1965a *Ptiloncodus simplex* Harris – Ethington & Clark, pp. 203–204. Pl. 1:8. ☐1965a *Ptiloncodus simplex* Harris – Mound, p. 33, Pl. 4:20. ☐1973 *Ptiloncodus simplex* Harris – Barnes & Poplawski, p. 785. ☐1979 *Ptiloncodus simplex* Harris – Tipnis, Pl. 8.1:1–7.

Remarks. – Elements of this fish-hook-like fossil are present through the Table Head Formation. The affinity of *Ptiloncodus* has been discussed by Sweet (1963), Lindström (1964), Ethington & Clark (1965), Mound (1965a) and Tipnis (1979). There is a general agreement this is not a conodont, as originally suggested by Harris (1962). The affinity, however, of *Ptiloncodus* is not agreed upon by the above authors.

The elements are black. They vary from units with a long, circular base in cross section and short strongly recurved cusp to elements with a short base and a long recurved cusp. The aboral margin may be flattened with subovate lobes with a central vertical slit, as described by Harris (1962). Other forms do only have a rounded aboral margin and a vertical slit. No basal cavity has been observed.

The stratigaphical value of this fossil is not known yet (Tipnis 1979).

Occurrence. – Lower and middle Table Head.

Material. – 25 specimens.

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Appendix A

Appendix A contains the lithologic descriptions of the section of Table Head Formation at Table Point, Great Northern Peninsula, Newfoundland (Section I of this study; see Figs. 3, 16).

The following description is from the base of the Formation and upwards.

Unit	Sample No.	Description	Thickness (metres)		Height above base (metres)
St. George Group					
	TP1	Dolostone, light-grey, aphanitic to fine-grained, crossbedded, thick-bedded.	0.64	÷	1.00
	TP2	Dolostone, light-grey to grey, aphanitic; vertical burrows at the top filled by clear sparry calcite and quartz; some burrows reach the surface of the lower bed; mudracks at the base of unit.	0.36	÷	0.36
		This is the top of St. George Group			
Table Head Formation					
		Lower Table Head (241 metres ± m)			
Lower Table Head					
Unit A_1					
	TP3	Micrite, grey to dark-grey, mottled weathering, argillaceous. Bioclasts are trilobites (*Bathyurus* sp.), orthocones, brachiopods, ostracodes, gastropods (*Hormotoma* sp.).	0.00–0.10		0.10
	TP4	Micrite, dolomitized mottled weathering, minor argillaceous stringers.	0.10–0.55		0.65
	TP5	Dolostone, grey to light-grey, bluish, aphanitic to fine-grained, pelletoid. *Hormotoma*-bearing at the rop. Minor yellow argillaceous stringers. Surface of bed is rippled.	0.63–0.70		1.35
	TP6	Dolomitic micrite, light-grey to grey.	0.45		1.80
	TP7 TP8 TP9	Dolostone, light-grey, stylolitic; fenestrae common; mudcracks; argillaceous stringers present. High-spired gastropods (*Hormotoma* sp.) common.	0.80		2.60
	TP10 TP11 TP12 TP13	Dolostone interbedded with shale, light-grey; dolostone fine-bedded to medium-bedded; birds-eye (fenestrae) common; mudcracks are present. Top may have thin lenses of dark-grey micrite.	1.25		3.85
	TP14	Micrite, dolomitic, pelletoid, hard, medium- to thick-bedded; fractures vertically. Unit not well exposed, probably the same as below.	0.30 0.70		4.15 4.85
	TP15 TP16	As TP14 with thin shaly parting. Micrite with micro-laminations and micro-burrows. Pelletoid. Bioclasts are *Leperditia* sp., gastropods and non-determinable.	3.00		7.85
Unit A_2					
	TP17 TP18	Micrite, dark-grey, argillaceous, massive-bedded, rubbly weathering. Fossils are *Hormotoma* sp., *Leperditia* sp., and *Maclurites* sp.	2.10		9.95
	TP19 TP20	Micrite, dolomitic; dark-grey, hard, weathers yellow, fractures vertically; argillaceous. Fossils are *Maclurites* sp., *Leperditia* sp., and ?trilobite.	0.60		10.55
	TP21	Micrite, dark-grey, rubbly weathering. Thin shaly layers above and below unit.	0.10		10.65
		Minor fault, displacement possibly 0.35 cm.			
	TP22	Micrite, dolomitic dark-grey, argillaceous, partly vertically fracturing and partly rubbly weatering. At the top a white calcite vein (0.5 cm).	1.45		12.10
	TP23	Micrite, dolomitic dark-grey, argillaceous, partly vertically fractured and partly rubbly weathering. At the top a white calcite vein (0.5 cm) and a layer of light-grey siltstone (4 cm).	2.60		14.70
	TP24 TP25	Micrite, dark-grey, argillaceous, yellow-weathering, red-colored argillaceous matter forms up to 20% of unit; a small chert-band and nodules.	3.90		18.60

Appendix A, continued

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Unit A$_2$ (continued)				
	TP26	Micrite, dark-grey, rubbly weathering, a few argillaceous stringers.	2.70	21.30
	TP27	Micrite, dark-grey, up to 20% of argillaceous material; yellow-weathering, red-colored; small chert-bands; white calcite veins present, associated with small faults.	3.95	25.25
	TP28	Micrite, dark-grey, argillaceous with chert-bands; unit is slumped. Direction of axis about 160°.	1.80	27.05
		Micrite, dark-grey, chert-nodules; probably slumped; direction of axis is 160°. Top is a white calcite vein (1 cm). Slickensides, direction 146°.	3.60	30.65
		Micrite, dark-grey, with three 1- to 10-cm-thick chert-bands; lithology the same as slumped beds below.	1.45	32.10
		Micrite, dark-grey; thin (2 cm) chert layer.	1.00	33.10
		Micrite, light-grey to grey; biosparite (5%) and argillaceous biomicrite (5%) are present. Bioclasts are cephalopods and gastropods (*Maclurites* sp.). Many fossils are filled with white sparry calcite.	1.30	34.40
		Argillaceous biomicrite, grey. The unit forms a prominent slope. *Leperditia* sp. and cephalopods present.	1.50	35.90
	TP29	Micrite, partly dolomitic, grey; minor biosparite (5–10%); bioclasts are gastropods, cephalopods, ostracodes and trilobites. Weathers partly conchoidal; stylolitic.	1.15	37.05
	TP30	Micrite, slightly argillaceous; orthocones.	0.60	37.65
	TP31	Micrite, dolomitic, grey; stylolitic.	1.20	38.85
	TP32	Biosparite, brownish; a medium-grained, sparry dolomitic limestone runs as an irregular 'snake' within and along the bed. Affinity unknown	1.35	40.20
		Micrite, dark-grey, rubbly weathering	0.35	40.55
		Slumped unit, stratum-bound. The unit is a folded and contorted breccia. Sharpedged clasts of flat finelaminated dolostones floating in argillaceous/dolomitic material. Becomes finer upwards, forming fine laminated argillaceous layers and lime/dolomite mud. Direction of slump is approximately 120°. The top is stylolitic.	2.00	42.55
		Dolostone, grey; finelamellar, slightly burrowed.	0.45	43.00
		Dolostone, grey, light-yellow-weathering, finely crystalline; finelaminated and crossbedded with cut-and-fill structures. Stylolitic. Wavey bedded and flow structures. Whole specimens of trilobites on bedding planes; *Hormotoma* sp., partly filled by sparry calcite, in pockets and on bedding planes.	2.15	45.15
		Dolostone, fine-grained; vertical and some horizontal burrows (*Chondrites*). *Hormotoma* sp., sparry calcite-filled in pockets. Chert nodules at the top; mudcracks.	0.90	46.05
	TP33	Micrite, fine-laminated, sandy; minor beds of biosparite, dolomitic; fossiliferous; *Leperditia* sp., *Hormotoma* sp.; *Zoophycos*.	1.00	47.05
	TP34 TP35	Dolostone, light-grey, finely laminated, finegrained; minor dolarenite; minor biosparite, some argillaceous stringers; brecciated; burrows in clasts; clasts may be finely laminated; silty argillaceous (qz) material. Fossils in lenses (1 – 1.5 m long). Gastropods (*Hormotoma* sp.) dominate. Increasing amount of CaCo$_3$ toward the top. Stylolites common in lower part. Horizontal burrows predominate in lower half of unit. Gastropods and cephalopods more common toward the top of unit.	6.45	53.50
	TP36 TP37	Micrite, dolomitic; biosparite at the top. Bioclasts are brachiopods, cephalopods, gastropods, trilobites. The top of the unit is a prominent bedding plane.	2.00	55.50

Appendix A, continued

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Unit A₃ (continued)				
	TP38 TP39 TP40	Micrite, grey, massive-bedded; at 5.70 m a gently folded bed, 20 cm thick of biosparite; bioclasts are trilobites, gastropods (*Maclurites* sp.), cephalopods. Cut-and-fill structures. Surface of bedding plane (?) weathers into a white color. Joints and small faults at this place.	7.00	62.50
	TP41	Micrite as below, various amount of minor argillaceous stringers. At surface a white calcite vein.	6.60	69.10
	TP42 TP43	Micrite, grey, rubbly weathering, massive; argillaceous stringers separate micrite beds of 2 to 25 mm in thickness. Low angle small faults with slickensides.	10.80	79.90
	TP44	Micrite, grey, fine-bedded 5–7 cm thick. Micrite may be gently slumped. Beds show cut-and-fill structures. Argillaceous seams 1–5 mm in thickness. Pressure solution common. Biosparite, grey, forms lenses and thin beds, 2–5 cm thick. Fossils in biosparite; Leperditids, brachiopods, and trilobites. Top of unit is a prominent (?) bedding plane with white calcite.	6.20	86.10
	TP45	Micrite, grey. Beds 15–30 cm thick. Stylolitic. At 1 m above the base of unit a well developed (?) bedding-plane with white calcite. Surface of unit cuts bedding. White calcite veins along fractures.	5.40	91.50
	TP46 TP47	Micrite, grey, massive-bedded in lower 4.90 m; the next 7.10 m are fine bedded with argillaceous seams. The upper 5 m include biosparite lenses up to 20 cm thick and up to 2 m long. Stylolitic. 4.10, 4.80 and 6.00 m above the base of unit are prominent bedding planes. The surface at 11 m above the base of unit forms a large, prominent slope. Gently folded beds are present close to the top of unit. Fossils include gastropods, cephalopods. Some of the fossils are silicified. The surface of unit is the first large chert layer. The chert is black, yellow brownish weathering. The chert layer forms a large prominent slope north of Table Point.	17.00	108.50
	TP48 TP49 TP50	Micrite, fine-bedded, interbedded with micrite with argillaceous seams. Biosparite beds, 5–10 cm thick are present (up to 15%). *Leperditia* sp. predominates in biosparite beds.	19.00	127.50
	TP51	Micrite, medium-bedded. Biosparite beds form up to 20% of unit. Fossils include brachiopods, ostracodes, cephalopods and gastropods (*Maclurites* sp.). Micrite, thin-bedded to medium-bedded; argillaceous. Biosparite beds form 5–10% of unit. Pressure solution surfaces are common. Fossils include: ostracodes, brachiopods, cephalopods, trilobites. Between 127.5–131.5 m a prominent, probably slumped layer of biosparite. At 137.10 m a prominent surface (?bedding plane with white calcite). 147.00 m forms the next prominent slope.	19.50	147.00
	TP52 TP53 TP54 TP55 TP56 TP57	Micrite, grey, massive-bedded; biosparite beds present. Fossils are trilobites, ostracodes, brachiopods, cephalopods. At 171.10 and 173.10 m prominent large slopes. At 173.90 m a characteristic bedding plane covered by brownish chert. Fault activity high. Slickensides covered by white calcite (134°) and have various dip (0°–90°). Between 167.50–190.50 m calcification, dolomitisation and associated calcite veins and dolomite dikes cut the bedded limestone. This is associated with the synclinal structure at this locality. The nuclei is formed by the crystalline calcite (scalenoedre) and surrounded by dolomite aureole and associated with calcite veins and dolomite dikes.	44.50	191.50
	TP58 TP59	Micrite, grey, medium-and nodular-bedded. Pressure solution is common. Faults and joints predominate. Fossils are cephalopods, trilobites, brachiopods, which are evenly distributed in the unit.	15.00	206.50
	TP60 TP61	Micrite, massive-bedded with thinner beds. Rubbly weathering. Fossils are not abundant. Large flat and high (?sponges) organisms appear at 206.5 m.	18.00	224.50

Appendix A, continued

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Unit A₃ (Continued)				
	TP62	Micrite/biomicrite, grey-to light-grey; bioclasts are fairly common (less than 10%) and include cephalopods, trilobites, brachiopods, ?sponges, bryozoans and crinoids. Large funnel-shaped fossil first appears at 230.5 m. Fossils become more abundant up through the unit.	13.00	237.50
	TP63 TP64	Biomicrite, rubbly, massive. Numerous fossils orthocones, trilobites, brachiopods, crinoids and bryozoans. The prominent slope at Table Point is close to the top of the unit. The surface is rich in flattened bryozoans, crinoids, large cephalopods, in particular orthocones and large complete and disarticulate trilobites.	3.50	241.00
Middle Table Head				
Unit B₁	TP65 TP66 TP67	Dark-grey, biomicrite, biosparite, argillaceous matter 5%; bioclasts are trilobites and brachiopods. Thin-to nodular-bedded, average 2 cm thick. Occassional dolomitic mottling.	9.00	250.00
	TP68	Biomicrite, dark-grey, wavy bedded, slightly gently open folding (slumped). Direction about 160°.	2.00	252.00
	TP69 TP70	Flat lying beds alternating with gently folded beds. Similar lithology as TP68.	5.50	257.50
	TP71 TP72	Limestone similar to TP68. Slumped. Wavy bedded.	4.50	262.00
Unit B₂	TP73	Hard black, platy, micrite with shale (Hemipelagic limestone); slumped. Direction about 140°.	10.50	272.50
		Even bedded, dark-grey to black micrite with 10% shale.	1.30	273.80
		Deformed, brecciated bed	1.10	274.90
		Hard black, platy micrite with shale.	0.60	275.50
		Brecciated, micrite and shale.	1.60	277.10
		Hard black, micrite interbedded with shale; unit is slumped.	1.40	278.50
Unit B₃	TP74 TP75	Black, slumped, micrite and biosparite interbedded with shale (30%), dark brown to black. Fossils predominantly trilobites. Random orientation of fossils.	6.50	285.00
Unit B₄	TP76 TP77 TP78	Hard, black micrite interbedded with shale. Amount of shale increases toward the top of the section. Limestone beds vary from 2–20 cm in thickness. Whole unit is slumped. Breccias 1 to 2 m thick form 20% of unit. Direction of slumps about 160°.	33.90	318.90
	TP79 TP80	Hard, black micrite with laminations of black organic stringers interbedded with black shale, mainly noncalcareous. Breccias 1 to 2 m thick occur in the unit.	9.20	328.10
Upper Table Head				
	TP81	Black, bituminous, noncalcareous shale. Graptolites predominate, phospatic brachiopods present. The upper 4–5 metres are disrupted, jointed and cleaved.	12.00	340.10
		This is the top of the Table Head Formation. The Table Head Formation is overlain by Table Cove sandstone and shales (>20 metres).		

Appendix B

Appendix B contains the lithologic descriptions of the part sections of Table Head Formation at Bellburns, Great Northern Peninsula, Newfoundland (Figs. 3, 16). The sections in combination represent Section II of this study.

   The following descriptions are from the basis of the sections and upward.

Section IIa. – Coastal section east of Hawkes Bay Fault. This section is situated close to the Hawkes Bay Fault. Any definite lithologic correlation to the Table Head Formation or to the St. George Group is not possible.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
		Dolostone, light-grey, fine-grained.	4.20	4.20
		Micrite, light-grey, mottled.	0.60	4.80
		Dolostone, bluish-grey.	0.30	5.10
		Dolostone with yellow argillaceous stringers.	0.40	5.50
	BS1	Micrite, light-grey.	1.10	6.60
		Micrite, light-grey.	1.80	8.40
		Dolostone.	0.70	9.10

Section IIb. – The section is in the Table Cove west of Hawkes Bay Fault. It is part of the Bellburns anticline and includes 'Isolated Blocks' of Schuchert & Dunbar (1934). The 'Isolated Blocks' are vertical in position; upwards facing west.

Lower Table Head				
Unit A_3	BS_2	Micrite, grey, massive-bedded, with 'sponges' (Isolated Block East).	5.00	5.00
Middle Table Head				
Unit B_1	BS_3	Biosparite, sparry, nodular-and thin-bedded argillaceous. Trilobites predominate the fauna.	10.00	15.00
		Not exposed.	Not determined.	
Unit B_2	BS_4	Micrite, thin-bedded with shale interbeds. (Hemipelagic limestone).	7.00	22.00
		This is the top of the Table Head Formation in Table Cove.		
Table Cove sandstones and shales				
		Massive-bedded sandstone interbedded with siltstones, overlies Unit B_2.		22.00
		(Hubert *et al.* (1977) report a thickness of 100 meters for this unit).		

Section IIc. – Coastal section south of river measured toward the south to the center of anticline.

Lower Table Head				
Unit A_2		Dolomitic micrite, finelaminated, crossbedded, ripple marks, '*Zoophycos*'. Gastropods.	5.80	5.80
		Micrite, dolomitized finelaminated.	2.30	8.10
	BS_5	Micrite, grey, rubbly, argillaceous, partly dolomitized.	9.10	17.20
Unit A_3		Micrite, grey, argillaceous, yellow weathering.	7.80	25.00
	BS_6	Micrite, grey, finebedded with lenses of biosparite. Bioclasts are trilobites, cephalopods, gastropods and crinoids.	10.40	35.40
		Bed of slumped biosparite.	0.50	35.90
	BS_7	Micrite, grey, massive-bedded, argillaceous stringers common.	19.20	55.10

Appendix B, continued

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)

Section IId. – Coastal section south of anticline and toward the south.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A_3		Micrite, dolomitized, faulted, folded.	20.00	20.00
	BS_8 BS_9 BS_{10}	Micrite, grey to dark-grey, massive-bedded alternating with zones with thin-bedded micrite, argillaceous. Biosparites (unsorted) are thin-bedded individual beds or lenses 5–10 cm thick (10% of unit). The bioclasts include trilobites, cephalopods, brachiopods, and gastropods; the latter diminishes toward the top.	90.00	110.00
		This is the top of the Bellburns Section. A gravel beach separates the strata from the Daniels Harbour lime breccias of Cow Head affinity.		

Appendix C

Appendix C contains the lithologic descriptions of the section at Port Saunders, Great Northern Peninsula, Newfoundland. (Section III of this study; see Figs. 13, 16).

The following description is from the base of the sequence and upward.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A_3	PS_1	Micrite, grey, massive-bedded, stylolitic, argillaceous.	4.00	4.00
		Micrite, grey, stylolitic. The upper 10 cm are biosparite, mottled by white calcite. Bioclasts are cephalopods.	1.00	5.00
		Biosparite, brown-grey beds 5–10 cm thick. 20% are argillaceous micrite. Fault at the top of unit (N76°). Joints with white calcite. Minor thrusting.	4.00	9.00
		Micrite, argillaceous 50%. Biosparite (unsorted) brownish 50% of unit. Thrusted (44°/30°W).	3.00	12.00
		Micrite, grey, rubbly. The top of unit is a fault.	8.00	20.00
		Biomicrite, grey, rubbly. Bioclasts are cephalopods and trilobites. 60 cm above base of unit is a prominent bedding plane.	4.00	24.00
		Biomicrite, grey, argillaceous, Bioclasts are cephalopods and sponges. The top of unit is faulted (N56°).	2.00	26.00
		Biomicrite, rubbly, argillaceous. Small chertbeds. Several prominent bedding-planes. Bioclasts includes cephalopods and sponges.	5.20	34.70
		Micrite (70%) and biosparite (30%). The top of unit is prominently faulted and jointed. Gently folded with a westerly plunging axis.	3.00	37.70
		Micrite, grey, argillaceous with biosparite (20%).	0.80	38.50
	PS_2	Micrite, grey, argillaceous. Several prominent bedding planes. The unit is jointed and faulted. The top of unit is the westernmost prominent slope.	4.50	43.00
		Biomicrite, grey, argillaceous. This unit has large cephalopods and sponges.	5.80	48.80

This is the top of the section.

Appendix D

Appendix D contains the lithologic descriptions of the section at Gargamelle Cove East, Great Northern Peninsula, Newfoundland (Section IV of this study, see Figs. 13, 16).

All the sediments correlate with Unit A_3 of the Lower Table Head at Table Point. The top of the section represent a lithology that is not typical of Unit A_3, and may be related to faults or slumping. The section comprises two local subdivisions: IVa and IVb.

Section IVa. – This is the small outcrop in the centre of Gargamelle Cove (only exposed at high tide).

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A_3	GCI_1	Micrite, grey, massive-bedded. Ostracodes and gastropods (*Maclurites* sp.). Orientation 84°/60°S.	4.70	4.70
		Not exposed.		

Section IVb. – Section of coastal cliffs at Gargamelle Cove East. The base was the tidelevel at the present day (12 August, 1977).

Lower Table Head				
Unit A_3		Micrite, grey, thick-bedded (1 m or more) with argillaceous stringers. Orientation 70°/12°S.	2.60	2.60
	GCI_2	Micrite, rubbly, grey. Bioclasts include cephalopods, trilobites and sponges. The top of unit is a very straight bedding plane.	22.40	25.00
		?Breccia of micrite, coarse inhomogenous, disturbed.	5.60	30.60
		Slumped or faulted.		
		This is the top of the section.		

Appendix E

Appendix E contains the lithologic descriptions of the section of Table Head Formation at Gargamelle Cove West (Pointe Riche Peninsula), Great Northern Peninsula, Newfoundland (Figs. 13, 16).

The following description is from the base of the section and upward.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A_2	GCW_1	Micrite, grey mottled, white dolomite stringers.	1.50	1.50
	GCW_2	Micrite, orange-pink, fine laminated.	0.30	1.80
		Micrite, grey, thick-bedded, fine laminated at the top.	2.40	4.20
		Micrite, grey, mottled with white calcite.	0.20	4.40
		Micrite, grey to light-grey, argillaceous.	2.10	6.50
		Micrite, grey, with "stromatolite"-like fossils.	1.40	7.90
		Micrite, grey, argillaceous, biosparite (unsorted) at the top.	5.00	12.90
		Micrite, grey, argillaceous material up to 10%. Chert nodules at the top.	3.00	15.90
	GCW_3	Zone of disturbance; joints are common. Biomicrite, gray, with cephalopods.	4.00	19.90
	GCW_4	Micrite, grey, dolomitic; argillaceous material relatively prominent (5%).	3.60	23.50
		Micrite, grey-brownish; dolomitic, stylolitic.	3.40	26.90
		Biomicrite, grey; fossils include cephalopods.	3.10	30.00
		Biosparite, grey, slumped. This bed becomes prominently dolomitized with white, vuggy dolomite in brownish-grey, dolomitized micrite out toward the waterfront ('pseudo-breccia'). The surface is wavy with an amplitude up to 30 cm.	0.50	30.50
	GCW_5	Micrite, grey-brown, dolomitized. Fossils are brachiopods, trilobites, cephalopods and ostracodes.	3.70	34.20
		Micrite, grey, in places dolomitic, and with white vuggy dolomite. Minor argillaceous stringers.	3.00	37.20
Unit A_3		Micrite, grey, massive, rubbly weathering. Orientation 7°/2° W.	6.00	43.20
	GCW_6	Biomicrite, grey, rubbly; beds are fossiliferous. Bioclasts include trilobites, brachiopods, cephalopods and ostracodes. Small beds (5–10 cm) of biosparite are present.	6.00	49.20
		This is the top of the section. Along the coast southwest of the section is an exposure of 'lime breccia'.		

Appendix F

Appendix F contains the lithostratigraphic descriptions of the sections along the western sea cliffs of Pointe Riche Peninsula, Great Northern Peninsula, Newfoundland. Three part-sections were measured and they in combination represent Section VI of this study (Figs. 13, 16).

Section VIa. – The section was started southwest of prominent vertical dolomitized fracture at Black Point. According to Klyver (1975) this is a fault, but no displacement was observed, and probably represents the dolomitic 'front' at this locality.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A₃	PRP 9	Micrite, grey, massive; at 8 metres a small slumped bed. Fossiliferous (*Maclurites* sp.).	8.30	8.30
	PRP 1	Micrite, grey, fine-bedded (1–4 cm). Biosparite lenses. Leperditids and *Maclurites* sp.	1.20	9.50
		Micrite, grey, medium-bedded (20–50 cm). Argillaceous stringers common. Fossils as at PRP 1.	2.50	12.00
		Micrite, grey, thinl-bedded, argillaceous. Small beds or lenses of biosparite (5%).	0.80	12.80
		Micrite, grey, massive-bedded.	2.00	14.80
	PRP 2	Micrite, grey medium-bedded (20–50 cm). argillaceous.	2.50	17.30
		Biomicrite and biosparite beds and lenses; bioclasts are leperditids, brachiopods, cephalopods and trilobites.	1.75	19.05
	PRP 3	Lithology as PRP 2 with shaly material and crinoids.	3.25	22.30
		Vuggy dolomite and dolomitic micrite.	0.70	23.00
		Slumped stratum-bound bed of micrite. The upper 25 cm are graded from biosparite (unsorted) at the base to yellow weathering, fine laminated (dis-) micrite.	2.30	25.30
	PRP 4	Micrite, dark-grey, hard, fine-bedded (2–10 cm). Yellow weathering. Argillaceous material about one-third of unit. The lower one metre is transitional from the lithologies below. Bioclasts include trilobites, cephalopods and ostracodes. Sparry brown calcite commonly fills the chambers of cephalopods. Top of unit covered by debris.	12.00	37.30

Section VIb. – At the lighthouse. The section is measured from sea level and toward the east.

Unit	Sample No.	Description	Thickness	Height
Lower Table Head				
Unit A₃		Micrite, grey, mottled by pink dolomite.	1.50	1.50
		Micrite, grey, bedded. Bioclasts are predominantly coiled cephalopods.	5.50	7.00
	PRP 6	Micrite, grey, argillaceous, medium-bedded (20–40 cm).	2.00	9.00
		Micrite, grey, massive-bedded; argillaceous stringers present. The surface of 10.80 is a brown-weathering black chert band. It vanishes laterally to the northeast.	1.80	10.80
		Micrite, grey, medium-bedded, argillaceous.	1.20	12.00
	PRP 7	Micrite, grey, fine-to medium-bedded with argillaceous stringers and lenses of biosparite; bioclasts are trilobites, cephalopods and brachiopods.	3.70	15.70
		Micrite, slumped, fossiliferous. The layer corresponds to slumped unit at 25.30 min Section VIa. The unit increases in thickness toward the south.	3.30	19.00

Appendix F, continued

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)

Section VIc. – This is measured from the dolomitic, undulating micrite with white dolomite ('Pseudobreccia'), and toward the south to Black Point. 4–5 metres is equivalent to the basis of Section VIa.

Lower Table Head				
Unit A$_3$	PRP 8	Micrite, grey medium-bedded (10–40 cm) in places dolomitic. Fossils include cephalopods, trilobites, leperditids and gastropods. Minor biosparite.	11.50	11.50
		Slumped bed of micrite and biosparite (30%). Finer beds (10–20 cm) of argillaceous internally laminated (1 cm) lenses. The unit grades up into the following beds.	1.00	12.50
		Micrite, grey, minor biosparite. Fossils are cephalopods and gastropods.	2.00	14.50
		Micrite, grey, argillaceous material abundant.	1.40	15.90
		Micrite, grey, with decreasing amount of argillaceous matter.	4.60	20.50
		Micrite, grey. Brachiopods and cephalopods.	1.00	21.50
		Micrite, grey, massive-bedded. Biosparite beds and argillaceous stringers present. 'Pseudobreccia' at the base.	3.30	24.80
		Micrite, grey argillaceous (20%). Eroded out of wall.	0.10	24.90
		Grey micrite.	2.00	26.90
		Micrite, grey.	0.40	27.30
		Laterally varied dolomitization.		
		Micrite, grey, argillaceous (5–10%).	1.20	28.50

Appendix G

Appendix G contains lithologic descriptions of the section at Back Arm East (Dump area of Port au Choix community) (Figs. 13, 16.) The section includes the boundary St. George Group/Table Head Formation. The boundary is placed at first dark gray fossiliferous micrite. The section is partly covered by garbage.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
St. George Group				
	BA 1	Micrite, dolomitic; light-grey, yellow weathering. Thick-bedded.	2.60	2.60
		Dolostone, light-grey, fine-grained; thick-bedded.	1.10	3.70
		Micrite, dolomitic, light-grey. The lower 50 cm is a mottled dolostone. The upper part is finely laminated. Yellow weathering.	2.20	5.90
		Not exposed; possibly the same as below.	1.00	6.90
	BA 2	Micrite, dolomitic, grey to dark-grey, hard. Laminated at the top.	1.20	8.10
		Not exposed, possibly yellow weathering dolostone.	0.60	8.70
		Micrite, dolomitic, yellow-brown; minor laminations.	0.70	9.40
		Dolostone, light-grey to brown, fine-grained; homogeneous. The section is partly covered by debris. This is the top of St. George Group.	1.00	10.40
Table Head Formation				
Unit $_1$	BA 3	Micrite, grey, mottled; argillaceous stringers present. Fossils include trilobites and leperditids.	0.60	0.60
	BA 4 BA 5	Micrite, grey. Finelaminated and thin beds (5 cm). Leperditids.	0.70	1.30
		Micrite, grey, rubbly with argillaceous stringers.	0.90	2.20
		Not exposed.	0.60	2.80
		Micrite, light-yellow weathering; light-grey to light-brown. Fine-bedded (2–5 cm). ?Birds-eye structures. *Leperditia* sp.	1.90	4.70
		Micrite, light-grey. Hard. Leperditids.	0.60	5.30
Unit A$_2$		Micrite, in part dolomitic, grey, rubbly. Various amount of argillaceous material. Unit mainly by debris.	5.20	10.50
	BA 6 BA 7	Micrite, grey, rubbly. Argillaceous material abundant and red. This is top of the section.	7.80	18.30

Appendix H

Appendix H contains the lithologic descriptions of the section at the western part of St. John Island (Figs. 15, 16). Two part sections have been measured. These sections form only a part of the total strata exposed on the island.

Section VIIIa. – The part section was initiated from the Photographic Point and measured toward the east.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Lower Table Head				
Unit A_3	SJI 1 SJI 2	Micrite, grey, dolomitic; sparitic. Cephalopods dominate.	5.00	5.00
		Biosparite to biomicrite; cephalopods predominate.	2.50	7.50
	SJI 3	Micrite, grey, argillaceous, with yellow bedding planes. Medium-bedded (40–60 cm). Fossils as below.	3.75	11.25
	SJI 4	Micrite, grey with round (10 cm diameter) sponges.	3.75	15.00
		Top of section VIIIa		

Section VIIIb. – East of Section VIIIa. The base of Section VIIIb is close to the top of Section VIIIa, i.e. bed with sponges but with a minor slip, due to the lack of exposure.

Unit	Sample No.	Description	Thickness (metres)	Height above base (metres)
Unit A_3		Micrite, grey, cephalopods and sponges common.	2.40	2.40
		Not exposed.	1.00	3.40
	SJI 5	Biomicrite, grey, argillaceous. Trilobites are present. Rubbly material on the top of the section.	6.00	9.40

Plate 1

Fig. 1–11. Cordylodus? horridus Barnes & Poplawski. All specimens are from the *Histiodella kristinae* Phylozone. □1. Element 3, outer side. TP 68. ROM 39637. ×100. □2. Element 3, inner side. TP 68. ROM 39637. ×95. □3. Element 3, inner side. TP 67. ROM 39637. ×85. □4. Element 2, outer side. TP 68. ROM 39637. ×65. □5. Element 2, inner side. TP 67. ROM 39637. ×60. □6. Element 2, inner side. TP 67. Rom 39637. ×60. □7. Element 2, outer side. TP 68. Rom 39637. ×60. □8. Element 1. Note the alternating tilt of the denticles. TP 68. ROM 39637. ×65. □9. Element 2, inner side. TP 66. Rom 39637. ×65. □10. Element 1. TP 71. ROM 39637. ×65. □11. Element 1. TP 66. ROM 39637. ×55.

Fig. 12–18. Drepanodus? cf. *gracilis* (Branson & Mehl). All specimens are from the *Histiodella tableheadensis* Phylozone. □12. Homocurvatid drepanodontiform, inner side. TP 52. ROM 39638. ×100. □13. Oistodontiform, inner side. TP 53. ROM 39638. ×90. □14. 'Suberectid' drepanodontiform. TP 52. ROM 39638. ×100. □15. Homocurvatid drepanodontiform, inner side. TP 53. ROM 39638. ×100. □16. Homocurvatid drepanodontiform, inner side. TP 55. ROM 39638. ×100. □17. Homocurvatid drepanodontiform. TP 52. Rom 39638. ×90. □18. Oistodontiform, inner side. TP 25. ROM 39638. ×130.

Fig. 19, 22–25. Parapaltodus flexuosus (Barnes & Poplawski). All specimens are from the *Histiodella kristinae* Phylozone. □19. Drepanodontiform, inner side. TP 72. ROM 39640. ×60. □22. Scandodontiform, inner side. TP 67. ROM 39640. ×115. □23. Drepanodontiform, inner side. TP 74. ROM 39640. ×115. □24. Scandodontiform, inner side. TP 68. ROM 39640. ×120. □25. Scandodontiform, inner side. TP 71. ROM 39640. ×70.

Fig. 20–21, 26–28. Parapaltodus simplicissimus n.sp. All specimens are from the *Histiodella kristinae* Phylozone. □20. Scandodontiform, inner side. TP 67. Rom 39642. ×65. □21. Drepanodontiform. TP 67. ROM 39642. ×65. □26. Drepanodontiform. TP 72. Rom 39642. ×60. □27. Scandodontiform. TP 67. ROM 39642. ×65. □28. Drepanodontiform. Holotype. TP 68. ROM 39641. □28A. Detail of basal anterior part of the cusp. Same specimen as Fig. 28B. ×750. □28B. Drepanodontiform with basal funnel. TP 68. ROM 39641. ×55.
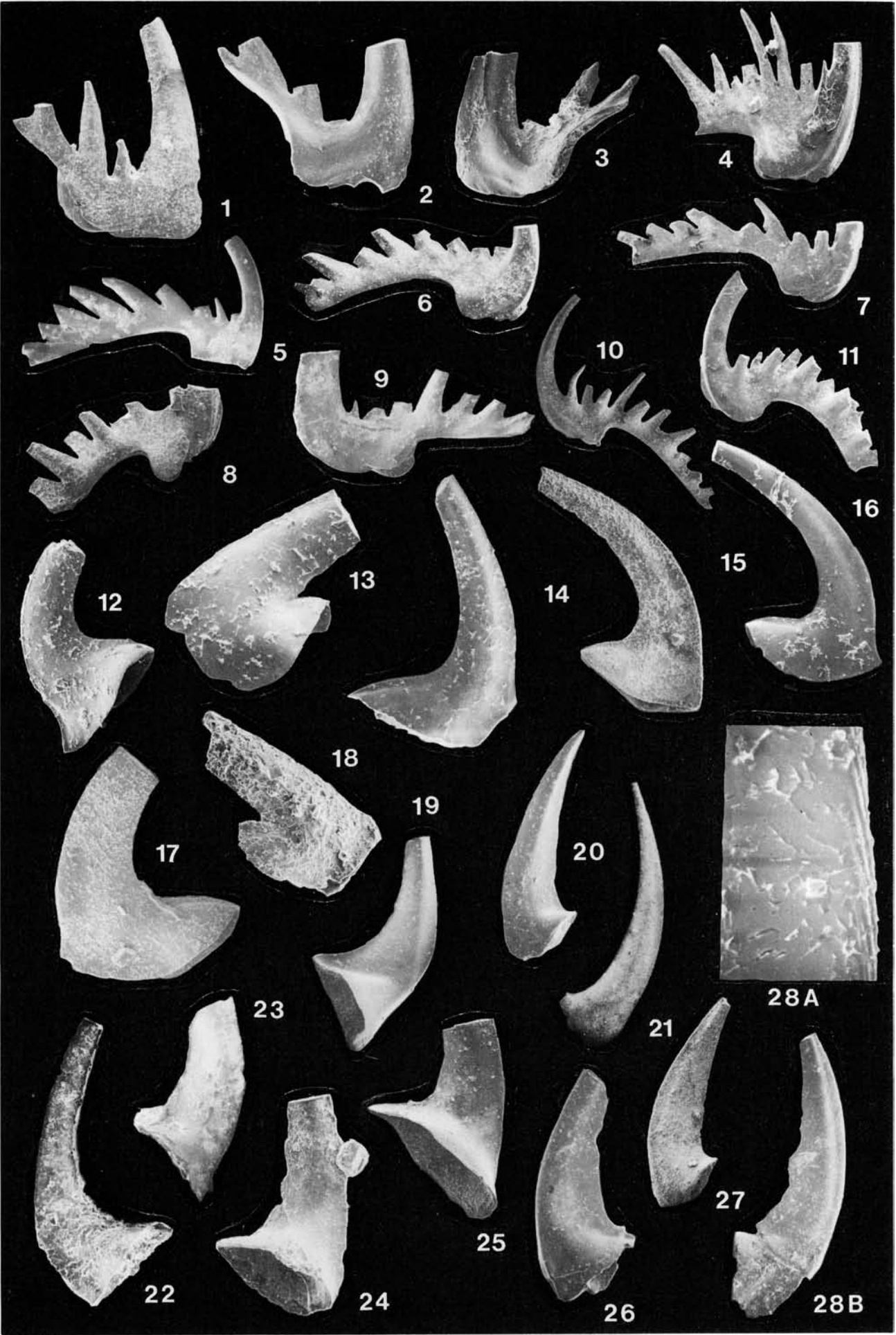
Plate 2

Fig. 1–2. Parapaltodus angulatus (Bradshaw). Specimens from the basal *Histiodella tableheadensis* Phylozone. □1. Drepanodontiform. TP 19. ROM 39639. ×100. □2. Scandodontiform. TP 19. Rom 39639 ×100.

Fig. 3–8. Protopanderodus robustus (Hadding). All specimens are from *Histiodella kristinae* Phylozone. □3. Symmetrical acontiodontiform. TP 76. ROM 39643. ×115.□4. Scandodontiform. TP 67. ROM 39643. ×125.□5. Symmetrical acontiodontiform. TP 70. ROM 39643. ×105.□6. Asymmetrical acontiodontiform. TP 76. ROM 39643. ×100.□7. Symmetrical acontiodontiform. TP 71. ROM 39643. ×50.□8. Scandodontiform. TP 71. ROM 39643. ×100.

Fig. 9–14, 17. Protopanderodus cf. *liripipus* Kennedy, Barnes & Uyeno. All specimens are from the *Histiodella kristinae* Phylozone.□9. Asymmetrical acontiodontiform, outer side. TP 68. ROM 39644. ×90.□10. Asymmetrical acontiodontiform, inner side. TP 71. ROM 39644. ×105. □11. Asymmetrical acontiodontiform, inner side. TP 71. ROM 39644. ×100. □12. Symmetrical acontiodontiform. TP 68. ROM 39644. ×90. □13. Subsymmetrical acontiodontiform. TP 68. ROM 39644. ×100. □14. Asymmetrical acontiodontiform, outer side. TP 71. ROM 39644. ×100. □17A. Scandodontiform, inner side. TP 74. Rom 39644. ×105. □17B. Detail of base. Same specimen as in 17A. ×280.

Fig. 15–16, 18–24. Protopanderodus strigatus Barnes & Poplawski. All specimens are from *Histiodella tableheadensis* Phylozone. □15. Asymmetrical acontiodontiform, bicostate side. TP 53. ROM 39645. ×70. □16. Asymmetrical acontiodontiform, unicostate side. TP 54. ROM 39645. ×65. □18. Symmetrical acontiodontiform. TP 52. ROM 39645. ×70. □19. Asymmetrical acontiodontiform, unicostate side. TP 53. ROM 39645. ×65. □20. Symmetrical acontiodontiform. TP 59. ROM 39645. ×70. □21. Asymmetrical acontiodontiform, bicostate side. TP 52. ROM 39645. ×70. □22. Asymmetrical acontiodontiform, unicostate side. TP 53. ROM 39645. ×70. □23. Scandodontiform, inner side. TP 59. ROM 39645. ×65. □24. Asymmetrical acontiodontiform, unicostate side. TP 53. ROM 39645. ×65.
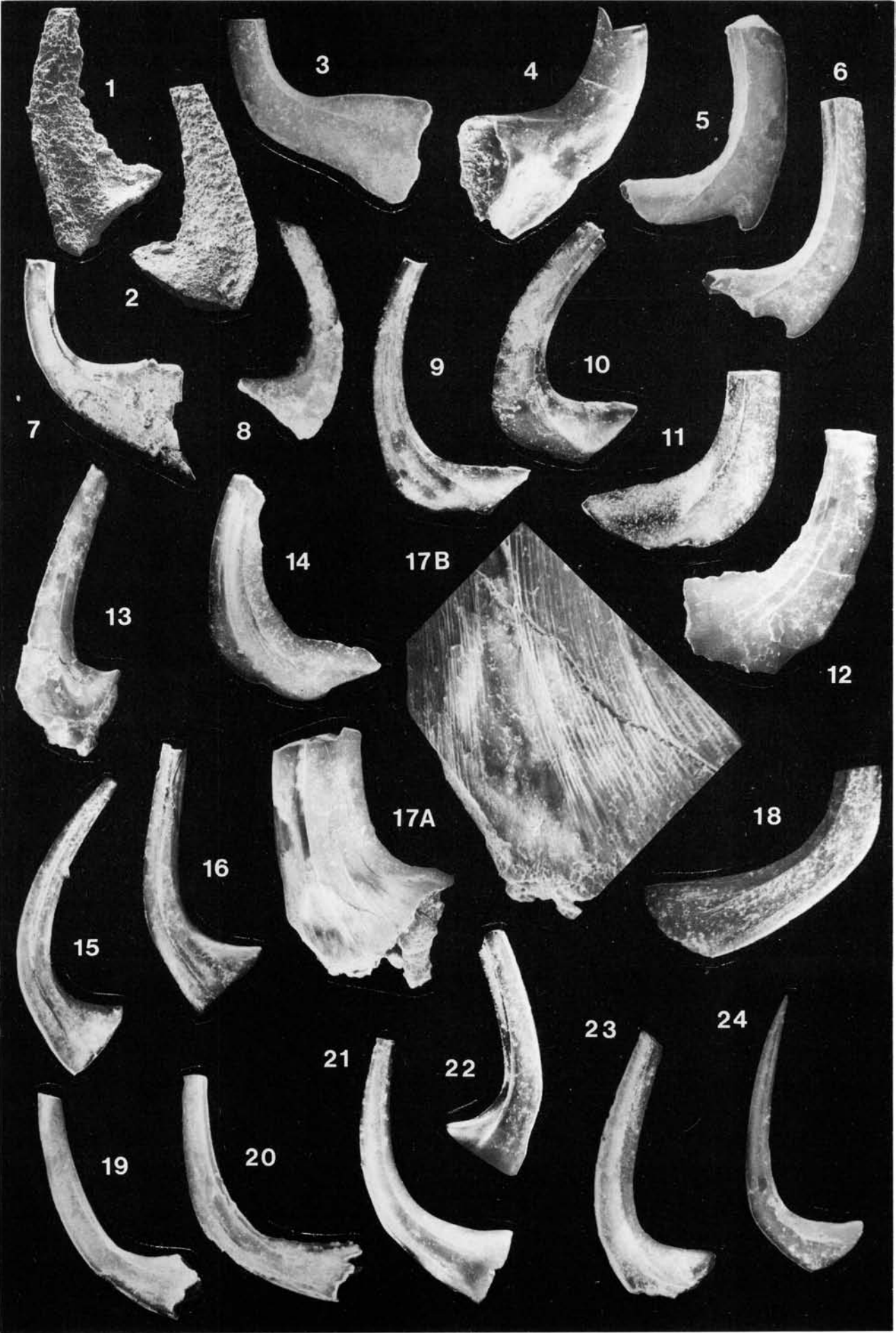
Plate 3

Fig. 1–5. Protopanderodus sp. A. All specimens from the *Histiodella tableheadensis* Phylozone. □1A. Scandodontiform, inner side. TP 59. ROM 39646. ×65. □1B. Detail of basal, posterior part of cusp. Same specimen as in 1A. ×225. □2. Scandodontiform. TP 53. Rom 39646. ×100. □3. Asymmetrical acontiodontiform. TP 54. ROM 39646. ×120. □4. Asymmetrical acontiodontiform. TP 59. ROM 39646. ×70. □5A. Asymmetrical acontiodontiform. TP 61. ROM 39646. ×65. □5B. Detail of cusp. Same specimen as 5A. ×225.

Fig. 6–10. Protopanderodus cf. *reclinatus* (Lindström). All specimens from the *Histiodella kristinae* Phylozone. □6. Scandodontiform. TP 71. ROM 39647. ×120. □7. Acontiodontiform. TP 77. ROM 39647. ×80. □8. Acontiodontiform. TP 74. ROM 39647. ×75. □9. Acontiodontiform. TP 74. ROM 39647. ×80. □10. Scandodontiform. TP 74. ROM 39647. ×80.

Fig. 11–17. Protopanderodus cf. *varicostatus* (Sweet & Bergström). All specimens from the *Histiodella kristinae* Phylozones. □11. Asymmetrical acontiodontiform. TP 71. ROM 39648. ×60. □12. Asymmetrical acontiodontiform. TP 72. ROM 39648. ×65. □13. Scandodontiform. TP 72. ROM 39648. ×70. □14. Asymmetrical acontiodontiform. TP 74. ROM 39648. ×70. □15. Scandodontiform. TP 74 ROM 39648. ×50. □16. Symmetrical acontiodontiform (*'Acontiodus cooperi'*). TP 72. ROM 39648. ×70. □17A. Detail of base. Same specimen as in 17B. ×320. □17B. Asymmetrical acontiodontiform. TP 72. ROM 39648. ×60.

Fig. 18–20. Drepanoistodus basiovalis (Sergeeva). Specimens from the *Histiodella tableheadensis* Phylozone. □18. Drepanodontiform. TP 36. ROM 39649. ×110. □19. Oistodontiform. TP 36. ROM 39649. ×100. □20. Oistodontiform. TP 36. ROM 39649. ×90.

Fig. 21–23. Drepanoistodus cf. *basiovalis* (Sergeeva). Specimens from the *Histiodella tableheadensis* Phylozone. □21. Oistodontiform. TP 23. ROM 39650. ×120. □22. Drepanodontiform. TP 23. ROM 39650. ×110. □23. Drepanodontiform. TP 23. ROM 39650. ×100.

Fig. 24–25. Drepanoistodus forceps (Lindström). Specimens from the *Histiodella tableheadensis* Phylozone. □24. Oistodontiform. TP 53. ROM 39651. ×100. □25. Oistodontiform. TP 46. ROM 39651. ×190.

Fig. 26. Protopanderodus sp. Basal funnel. The specimen is from the *Histiodella kristinae* Phylozone. TP 71. ROM 39648. ×60.
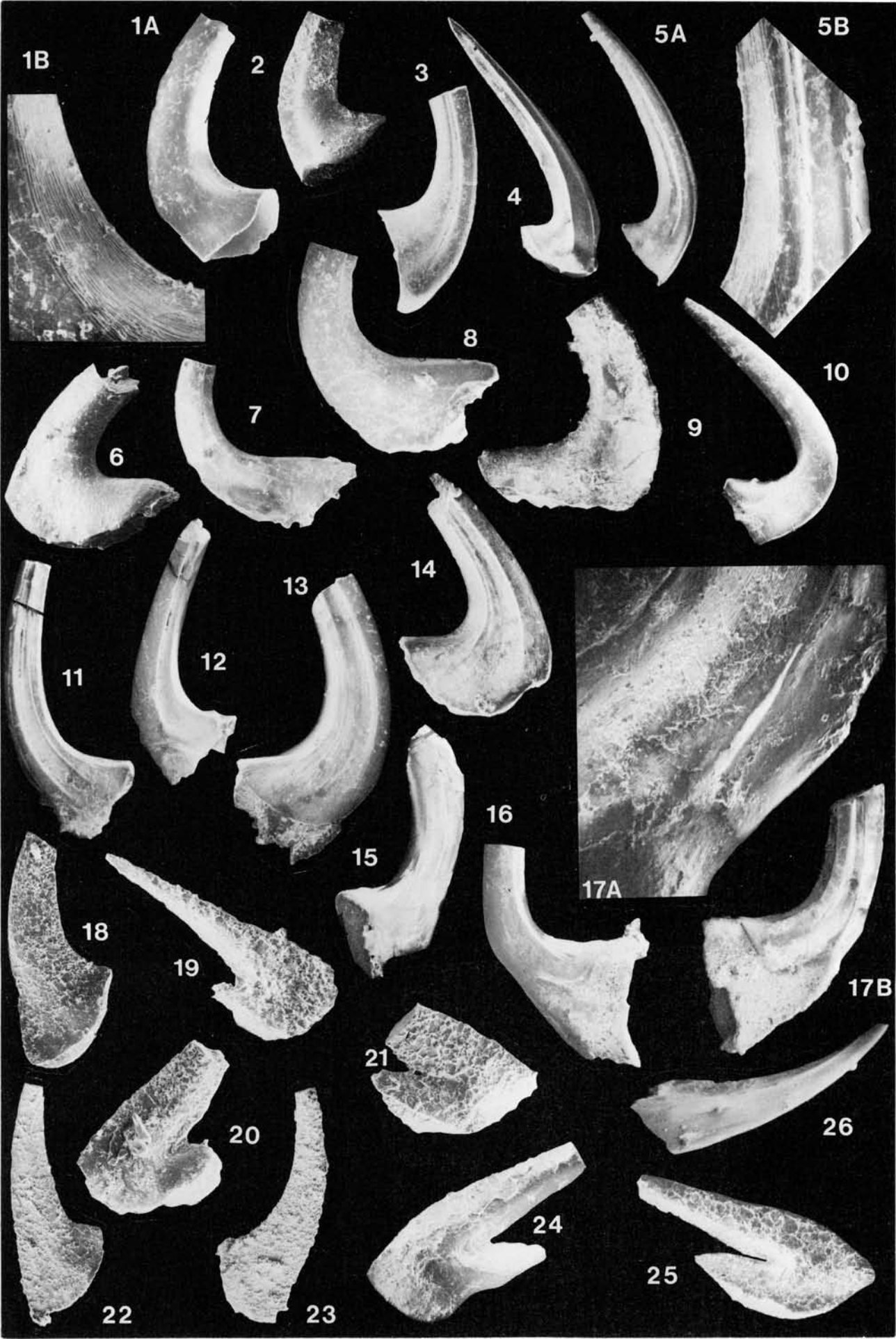
Plate 4

Fig. 1–8. Drepanoistodus bellburnensis n.sp. All specimens are from the *Histiodella kristinae* Phylozone. □1. Erectid drepanodontiform. TP 67. ROM 39653. ×100. □2. Homocurvatid drepanodontiform, recurved. TP 67. ROM 39653. ×100. □3. Oistodontiform. TP 68. ROM 39653. ×75. □4. Oistodontiform. Holotype. TP 67. ROM 39652. ×100. □5. Homocurvatid drepanodontiform, recurved. TP 66. ROM 39653. ×80. □6. Homocurvatid drepanodontiform, procurved. TP 68. ROM 39653. ×80. □7. Homocurvatid drepanodontiform, procurved. TP 66. ROM 39653. ×110. □8. Drepanodontiform, reclined. TP 68. ROM 39653. ×100.

Fig. 9–17. Drepanoistodus tablepointensis n.sp. All specimens from the *Histiodella kristinae* Phylozone. □9. Erectid drepanodontiform. TP 68. ROM 39655. ×75. □10. Oistodontiform. Holotype. TP 68. ROM 39654. ×85. □11. Homocurvatid drepanodontiform. TP 68. ROM 39655. ×75. □12. Homocurvatid drepanodontiform. TP 67. ROM 39655. ×70. □13. Homocurvatid drepanodontiform. TP 67. ROM 39655. ×70. □14. Homocurvatid drepanodontiform. TP 68. ROM 39655. ×65. □15. Oistodontiform. TP 67. ROM 39655. ×85. □16. Oistodontiform. TP 68. ROM 39655. ×90. □17. Oistodontiform. TP 67. ROM 39655. ×90.

Fig. 18–25. Drepanoistodus? cf. *venustus* (Stauffer). All specimens from the *Histiodella kristinae* Phylozone. □18. Oistodontiform ('venustus'-element). TP 71. ROM 39656. ×70. □19. Erectid drepanodontiform. TP 71. ROM 39656. ×85. □20. Homocurvatid drepanodontiform. TP 66. ROM 39656. ×70. □21. Homocurvatid drepanodontiform. TP 66. ROM 39656. ×80. □22. Oistodontiform. TP 67. ROM 39656. ×75. □23. Homocurvatid drepanodontiform. TP 71. ROM 39656. ×80. □24. Homocurvatid drepanodontiform. TP 71. ROM 39656. ×65. □25. Homocurvatid drepanodontiform. TP 67. ROM 39656. ×70.

Fig. 26–33. Paltodus? cf. *jemtlandicus* Löfgren. All specimens from the *Histiodella kristinae* Phylozone. □26. Oistodontiform. TP 71. ROM 39657. ×100. □27. Drepanodontiform. TP 71. ROM 39657. ×105. □28. Drepanodontiform. TP 70. ROM 39657. ×115. □29. Drepanodontiform. TP 71. ROM 39657. ×160. □30. oistodontiform. (specimen lost). TP 68. ROM 39657. ×80. □31. Oistodontiform. TP 71. ROM 39657. ×105. □32. Drepanodontiform. TP 71. ROM 39657. ×110. □33. Oistodontiform. TP 71. ROM 39657. ×110.
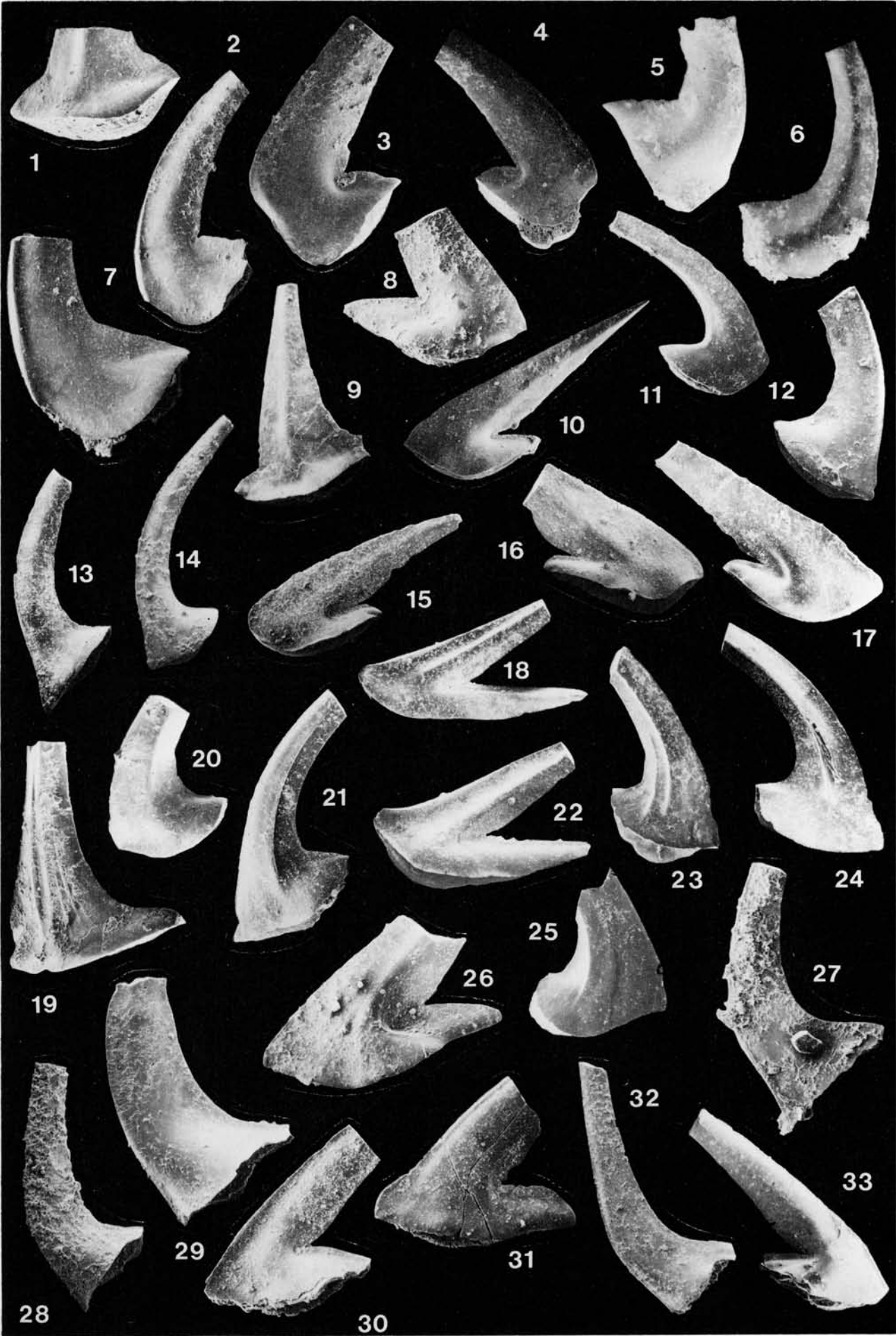
Plate 5

Fig. 1–4. Paroistodus? cf. *originalis* (Sergeeva). From *Histiodella kristinae* Phylozone. □1. Oistodontiform. TP 67. ROM 39658. ×110. □2. Oistodontiform. TP 68. ROM 39658. ×75. □3. Oistodontiform. TP 68. ROM 39658. ×70. □4. Oistodontiform. TP 70. ROM 39658. ×90.

Fig. 5–6. Paroistodus? sp. A. The specimens are from the *Histiodella tableheadensis* Phylozone. □5A. Oistodontiform. TP 60. ROM 39659. ×120. □5B. Detail of posterior keel of cusp near cusp-base junction. Note inconspicuous striations. Same specimens as 5A. ×1175. □6. Oistodontiform. TP 60. ROM 39659. ×130.

Fig. 7–8. Paroistodus? sp. B. The specimens are from the *Histiodella tableheadensis* Phylozone. □7. From TP 60. Rom 39660. ×200. □8. TP 60. ROM 39660. ×240.

Fig. 9. Strachanognathus parvus Rhodes. Specimen from *Cornuodus longibasis – Walliserodus ethingtoni* Assemblage Zone. The anterior cusp is broken. TP 80. ROM 39661. ×215.

Fig. 10–20. Juanognathus serpaglii n.sp. All specimens from *Histiodella kristinae* Phylozone. □10. Symmetrical element, anterior side. TP 65. ROM 39663. ×65. □11. Asymmetrical element, posterior view. TP 65. ROM 39663. ×65. □12. Symmetrical element, anterior view. TP 66. ROM 39663. ×110. □13. Asymmetrical element, posterior view. TP 65. ROM 39663. ×85. □14. Asymmetrical element, anterior view. TP 66. ROM 39663. ×80. □15. Asymmetrical element, posterior view. TP 66. ROM 39663. ×105. □16. Asymmetrical element, posterior view. TP 66. ROM 39663. ×75. □17. Symmetrical element, posterior view. Holotype. TP 66. ROM 39662. □17. Symmetrical element, posterior view. Holotype. TP 66. ROM 39662. ×60. □18. Asymmetrical element, posterior view. TP 66. ROM 39663. ×110. □19. Asymmetrical element, posterior view. TP 66. ROM 39663. ×80.
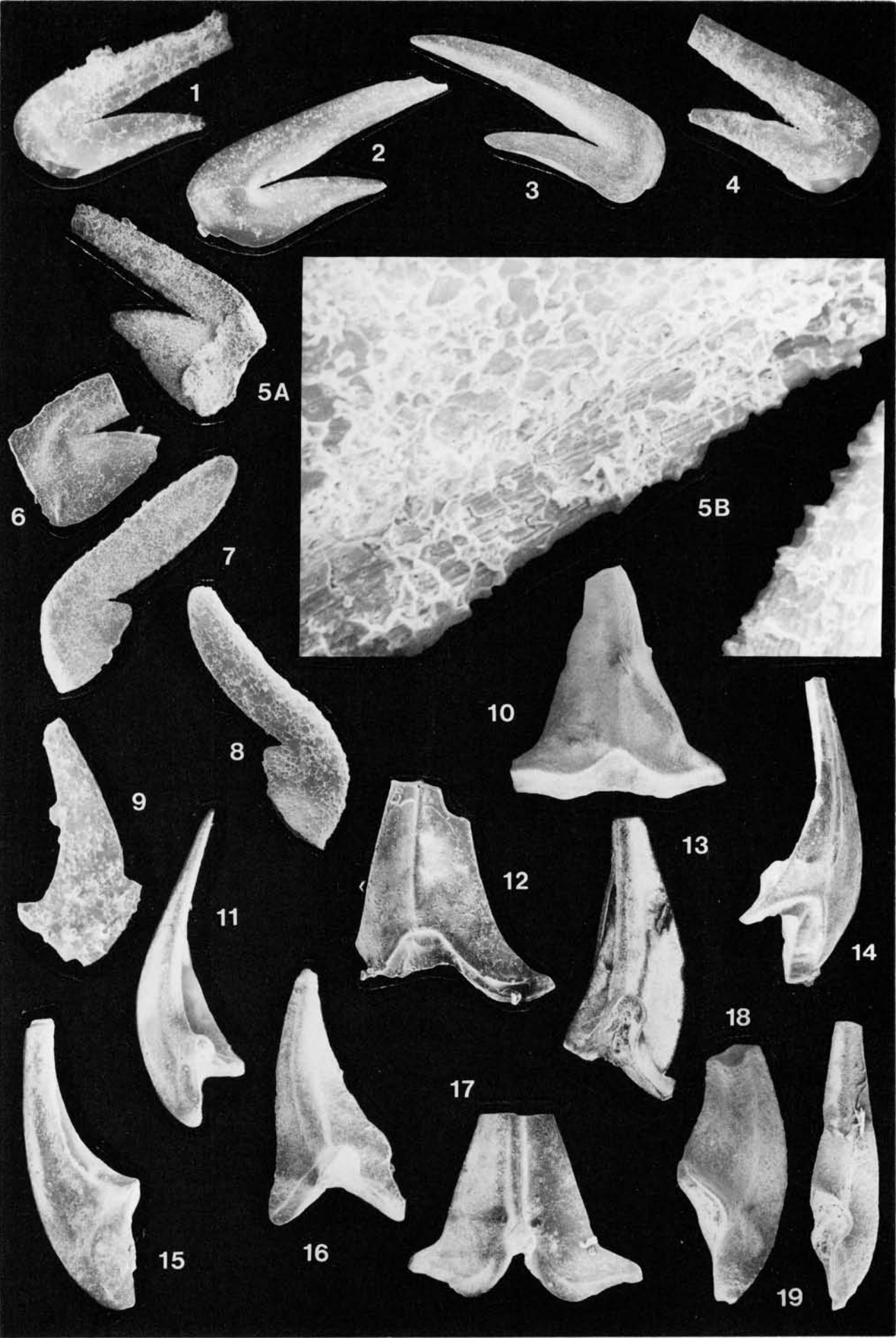
Plate 6

Fig. 1–7. Trigonodus carinatus n.sp. All specimens from *Histiodella tableheadensis* Phylozone. □1. Distacodontiform. TP 25. ROM 39665. ×60. □2. Distacodontiform. TP 24. ROM 39665. ×60. □3. Scandodontiform. TP 25. ROM 39665. ×60. □4. Acondiodontiform, posterior view. TP 25. ROM 39665. ×70. □5. Acontiodontiform, lateral view. Holotype. TP 25. ROM 39664. ×50. □6. Distacodontiform. TP 24. ROM 39665. ×55. □7. Distacodontiform. TP 24. ROM 39665. ×55.

Fig. 8–9. Ulrichodina? sp. A. From the *Histiodella tableheadensis* Phylozone. □8. From TP 60. ROM 39668. ×140. □9. From TP 60. ROM 39668. ×155.

Fig. 10–12. Trigonodus rectus n.sp. From the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1 Assemblage Zone. □10. Distacodontiform. From Back Arm. BA 3. ROM 39667. ×55. □11. Distacodontiform. Note the sinuous outline of the cusp. From TP 6. ROM 39667. ×45. □12A. Acontiodontiform. Holotype. From Gargamelle Cove West. CCW 1. ROM 39666. ×75. □12B. Detail of posterior part of cusp of same specimen as 12A. ×500.

Fig. 13–23. Belodella jemtlandica Löfgren. All specimens from the *Histiodella tableheadensis* Phylozone. □13. Denticulated plano-convex element, outer view. TP 58. ROM 39669. ×80. □14. Denticulated, asymmetrical triangular element, inner view. TP 58. ROM 39669. ×105. □15. Denticulated, asymmetrical triangular element. TP 60. ROM 39669. ×80. □16A. Denticulated, asymmetrical triangular element. TP 60. ROM 39669. ×85. □16B. Detail of posterior part of base. Same specimen as in 16A. ×615. □16C. Detail of anterior part of specimen 16A. Note striations on the inner side of the groove. ×590. □17. Denticulated, asymmetrical triangular element. TP 61. ROM 39669. ×90. □18. Oistodontiform. TP 61. ROM 39669. ×80. □19A. Undenticulated element. TP 59. ROM 39669. ×80. □19B. Detail of base of same specimen as in 19A. ×390. □20. Denticulated plano-convex element. TP 60. ROM 39669. ×110. □21. Undenticulated element. TP 59. ROM 39669. ×75. □22. Denticulated plano-convex element. Note the faint denticulation of the oral margin of this specimen. TP 59. ROM 39669. ×65. □23A. Denticulated, asymmetrical triangular element. TP 60. ROM 39669. ×80. □23B. Detail of the anterior margin of same specimen as in 23A. ×350.
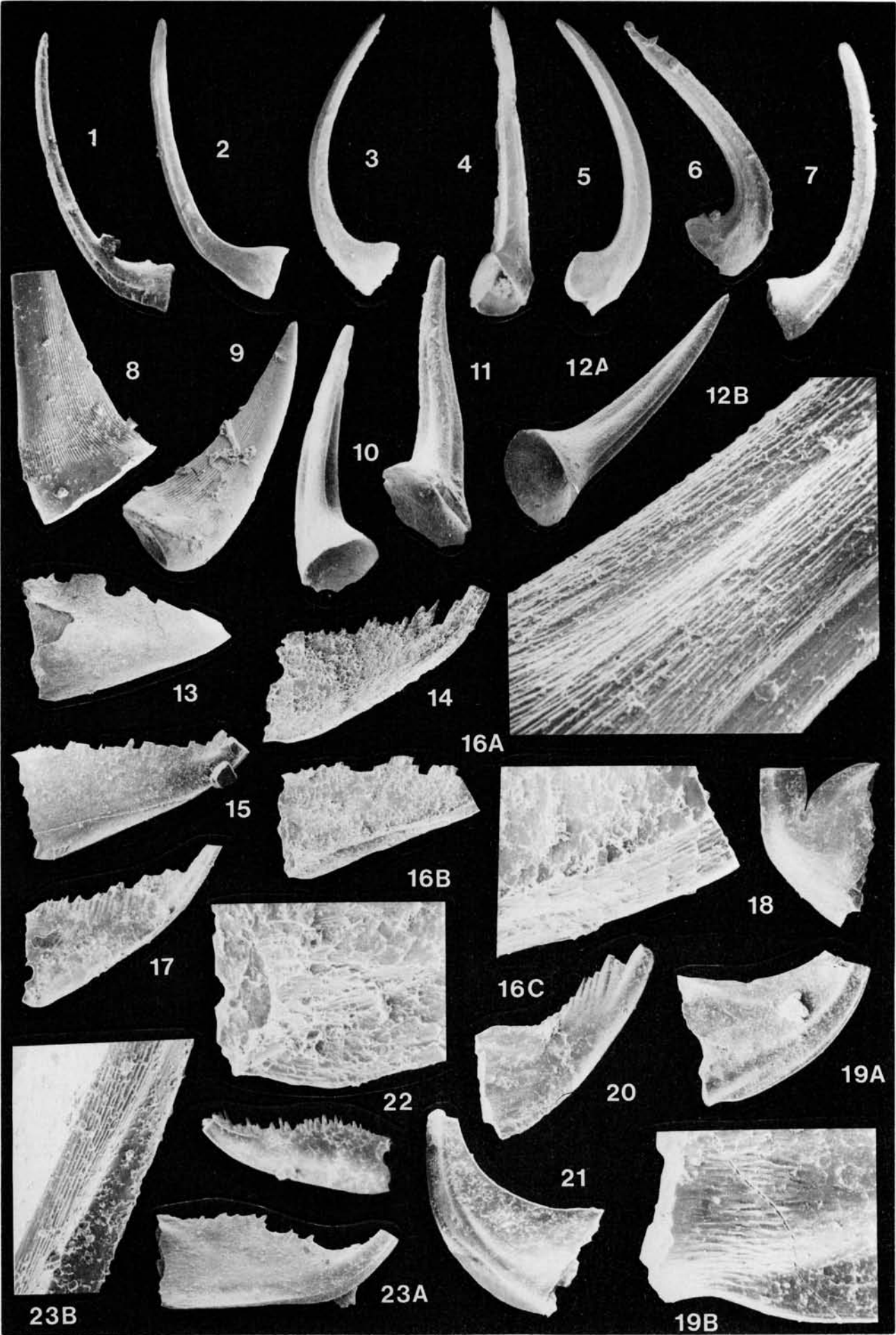
Plate 7

Fig. 1–4. Belodella jemtlandica Löfgren. All specimens from the *Histiodella kristinae* Phylozone. □1A. Denticulated triangular, symmetrical element. TP 70. ROM 39669. ×100. □1B. Detail of anterior base and cusp. Same specimen as in 1A. ×485. □1C. Anterior view of denticulated triangular symmetrical element. Same specimen as in 1A. ×90. □2A. Oistodontiform. Note the sharp angle between oral margin and posterior edge of cusp. TP 70. ROM 39669. ×135. □2B. Detail of junction of oral margin and cusp. Same specimen as in 2A. ×460. □3A. Oistodontiform. TP 70. ROM 39669. ×110. □3B. Detail of base. Same specimen as in 3A. ×600. □4. Undenticulated element. TP 71. ROM 39669. ×85.

Fig. 5–14. Belodella sinuosa n.sp. All specimens from the *Histiodella tableheadensis* Phylozone. □5. Denticulated asymmetrical, plano-convex element. TP 54. ROM 39671. ×90. □6. Undenticulated element. TP 54. ROM 39671. ×105. □7. Undenticulated element. TP 54. ROM 39671. ×125. □8. Denticulated triangular element. TP 55. ROM 39671. ×115. □9. Denticulated triangular element. TP 54. ROM 39671. ×125. □10. Oistodontiform. Holotype. TP 55. ROM 39670. ×125. □11. Oistodontiform. TP 54. ROM 39671. ×120. □12. Denticulated, asymmetrical triangular element. TP 52. ROM 39671. ×110. □13. Denticulated, asymmetrical triangular element. TP 52. ROM 39671. ×110. □14A. Undenticulated element. TP 51. ROM 39671. ×95. □14B. Detail of anterior part of base showing striations. Same specimen as in 14A. ×285.

Fig. 15–16. ?Belodella sp. A. Specimens from the *Histiodella tableheadensis* Phylozone. □15. From TP 61. ROM 39672. ×120. □16. From TP 61. ROM 39672. ×110.
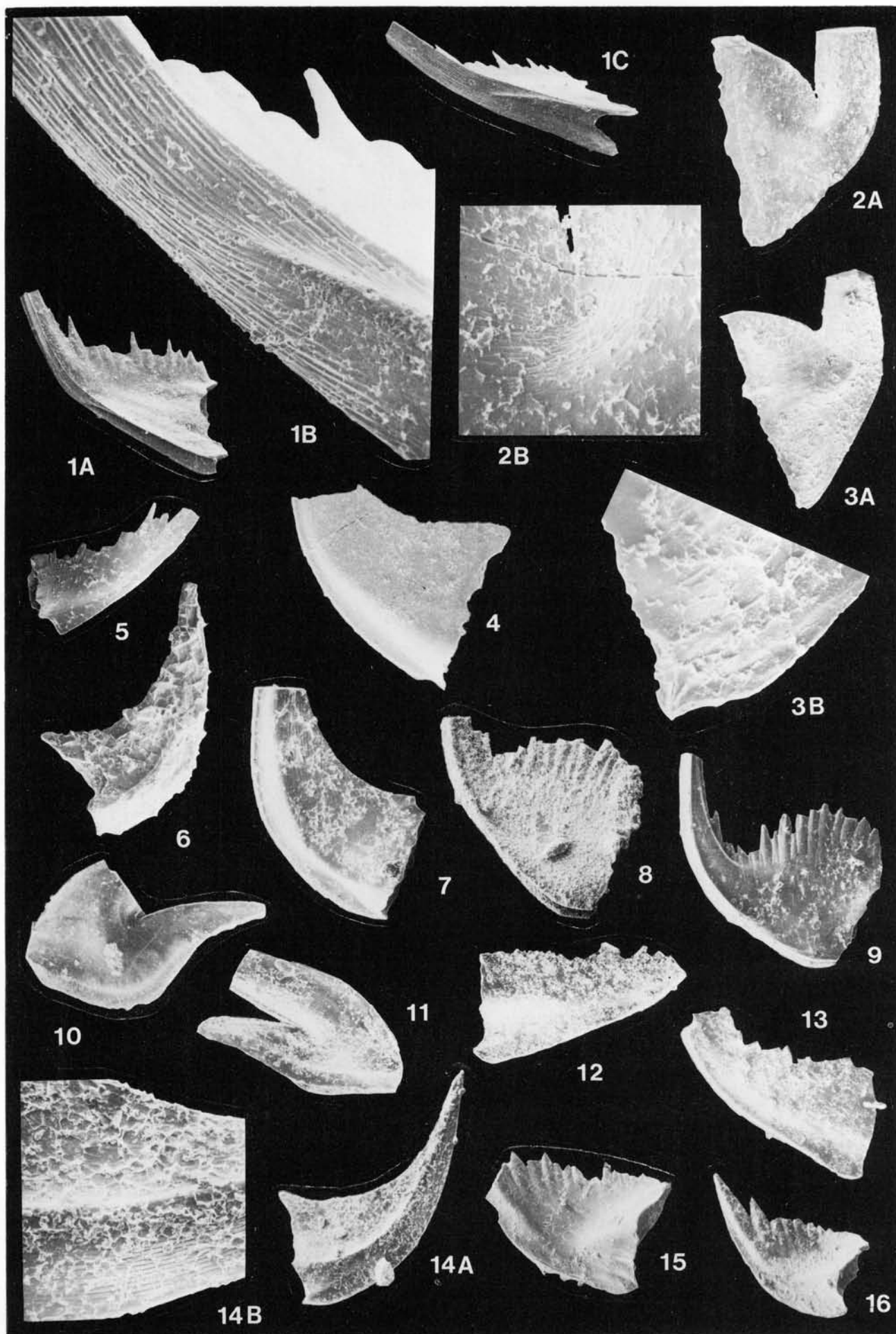
Plate 8

Fig. 1–8. Cornuodus longibasis (Lindström). Figures 2–7 from the *Histiodella kristinae* Phylozone. Figures 1,8 from *Cornuodus longibasis–Walliserodus ethingtoni* Assemblage Zone. □1. From TP 80. ROM 39673. ×125. □2. From TP 70. ROM 39673. ×120. □3A. From TP 74. ROM 39673. ×120. □3B. Detail of posterior part of cusp of same specimen as in 3A. ×490. □4. From TP 71. ROM 39673. ×120. □5. From TP 79. ROM 39673. ×145. □6. From TP 78. ROM 39673. ×110. □7. From TP 78. 39673. ×125. □8. From TP 79. ROM 39673 ('*Cornuodus bergstroemi*'). ×160.

Fig. 9–14. Scalpellodus biconvexus (Bradshaw). All specimens from the *Histiodella tableheadensis* Phylozone. □9. Element type 3. From TP 53. ROM 39674. ×35. □10. Element type 1. From TP 53. ROM 39674. ×45. □11. Element type 1. From T P 53. ROM 39674. ×40. □12. Element type 2. From TP 54. ROM 39674. ×45. □13. Element type 2. From TP 54. ROM 39674. ×40. □14. Element type 3. From TP 53. ROM 30674. ×75.

Fig. 15–19, 22–23. Scalpellodus pointensis n.sp. All specimens from the *Histiodella tableheadensis* Phylozone. □15. Asymmetrical element, type 3. TP 59. ROM 39676. ×45. □16. Element type 2. TP 59. ROM 39676. ×40. □17. Element type 2. TP 59. ROM 39676. ×40. □18. Element type 1. TP 60. ROM 39676. ×45. □19. Element type 1. TP 58. ROM 39676. ×50. □22. Element type 2. TP 58. ROM 39676. ×40. □23. Element type 2. Holotype. TP 58. ROM 39675. ×45.

Fig. 20–21. ?Scalpellodus sp. A. Specimens from the *Histiodella tableheadensis* Phylozone. □20. Subsymmetrical element. TP 59. ROM 39677. ×120. □21. Scandodontiform. TP 59. ROM 39677. ×110.

Fig. 24–30. Scolopodus oldstockensis n.sp. All specimens from the *Histiodella kristinae* Phylozone. □24. Intermediate element. TP 67. ROM 39679. ×65. □25. Asymmetrical element. TP 66. ROM 39679. ×65. □26. Asymmetrical element. TP 66. ROM 39679. ×75. □27. Symmetrical element. TP 66. ROM 39679. ×70. □28. Intermediate element. Holotype. TP 66. ROM 39678. ×60. □29. Asymmetrical element. TP 66. ROM 39679. ×70. □30. Intermediate element. TP 67. ROM 39679. ×65.

Plate 9

Fig. 1–9. Walliserodus ethingtoni (Fåhræus). All specimens from the *Histiodella kristinae* Phylozone. □1. Symmetrical element. TP 68. ROM 39680. ×95. □2. Asymmetrical element. TP 68. ROM 39680. ×90. □3. Asymmetrical element. TP 68. ROM 39680. ×80. □4. Asymmetrical element. TP 74. ROM 39680. ×75. □5. Asymmetrical element. TP 74. ROM 39680. ×60. □6. Asymmetrical element. TP 76. ROM 39680. ×55. □7. Asymmetrical element. TP 77. ROM 39680. ×50. □8. Asymmetrical element. TP 78. ROM 39680. ×75. □9A. Asymmetrical element. TP 78. ROM 39680. ×85. □9B. Detail of base of same specimen as in 9A. ×150.

Fig. 10–15. Parapanderodus arcuatus n.sp. All specimens from the *Histiodella tableheadensis* Phylozone. □10A. Detail of base of same specimen as in 10B. ROM 39681. ×200. □10B. Element type 1 with a median costa. Holotype. TP 46. ROM 39681. ×60. □11. Element type 2 with a median grove. TP 59. ROM 39682. ×60. □12. Element type 2, oral view. TP 59. ROM 39682. ×60. □13. Element type 1. TP 59. ROM 39682. ×60. □14. Element type 1. TP 60. ROM 39682. ×55. □15. Element type 2. TP 60. ROM 39682. ×55.

Fig. 16–19. Parapanderodus cf. *consimilis* (Moskalenko). Specimens from the *Histiodella tableheadensis* Phylozone. □16. From TP 19. ROM 39683. ×70. □17. From TP 19. ROM 39683. ×80. □18. From TP 19. Oral view. ROM 39683. ×70. □19A. From TP 19. ROM 39683. ×70. □19B. Detail of posterior part of base of same specimen as in 19A. ×395.

Fig. 20–27. Parapanderodus elegans n.sp. Fig. 22–23 are from the *Histiodella tableheadensis* Phylozone. Fig. 20–21, 24–27 are from the *Histiodella kristinae* Phylozone. □20. From TP 68. ROM 39685. ×160. □21A. From TP 68. ROM 39685. ×160. □21B. Detail of base of same specimen as in 21A. ×685. □22. From TP 54. ROM 39685. ×160. □23. From TP 54. ROM 39685. ×160. □24. Holotype. From TP 68. ROM 39684. ×160. □25. From TP 78. ROM 39685. ×180. □26. From TP 78. ROM 39685. ×180. Note 22 – 26 form a transition series. □27. From TP 78. ROM 39685. ×160.
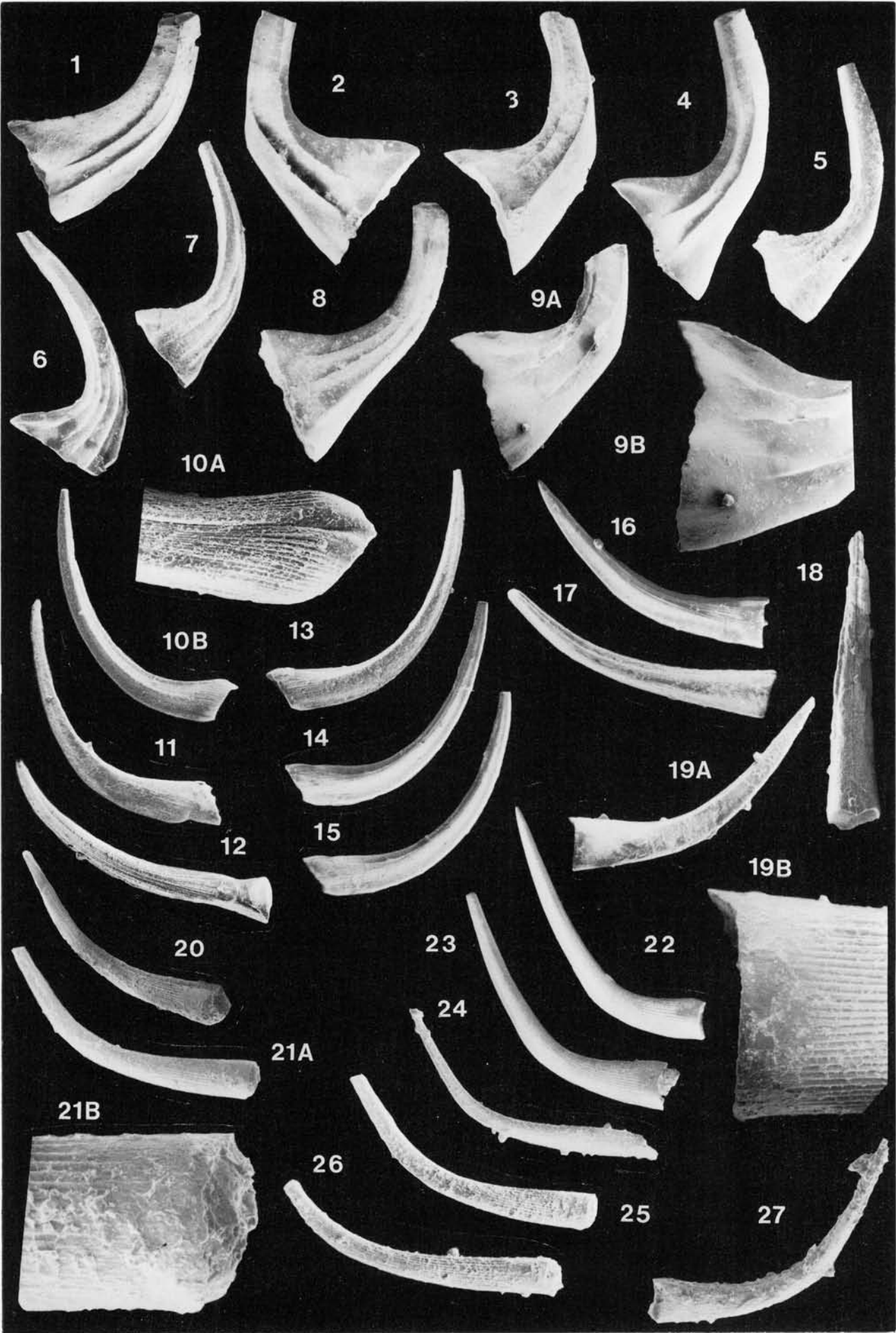
Plate 10

Fig. 1–3. Parapanderodus striatus (Graves & Ellison). Specimens from the basal *Histiodella tableheadensis* Phylozone. □1A. From TP 3. ROM 39686. ×80. □1B. Detail of base of same specimen as in 1A. ×540. □2A. From TP 3. ROM 39686. ×75. □2B. Detail of base of same specimen as in 2A. note the deep furrow of this specimen. ×170. □3A. From TP 25. ROM 39686. ×70. □3B. Detail of base of same specimen as in 3A. ×240.

Fig. 4. Parapanderodus? aff. *triangularis* (Ethington & Clark). From the *Histiodella tableheadensis* Phylozone. From TP 53. ROM 39687. ×180.

Fig. 5–10, 15. Semiacontiodus asymmetricus (Barnes & Poplawski). Specimens from the *Histiodella tableheadensis* Phylozone. □5. Asymmetrical element. Note the 'inverted' basal cavity on the outer side of the specimen. TP 58. ROM 39688. ×100. □6. Asymmetrical element. TP 58. ROM 39688. ×105. □7. Symmetrical element. Note the oval and restricted basal opening. TP 59. ROM 39688. ×160. □8. Asymmetrical element. TP 59. ROM 39688. ×100. □9. Asymmetrical element. TP 60. ROM 39688. ×100. □10A. Symmetrical element. TP 59. ROM 39688. ×80. □10B. Detail of base of same specimen as in 10A. ×270. □15A. Symmetrical element. TP 60. ROM 39688. ×100. □15B. Detail of base and lower posterior part of base. Same specimen as in 15A. ×310.

Fig. 11–14, 20. Semiacontiodus cf. *bulbosus* (Löfgren). All specimens from *Histiodella kristinae* Phylozone. □11. From TP 66. Rom 39689. ×140. □12. From TP 66. ROM 39689. ×140. □13. From TP 66. ROM 39689. ×140. □14. From TP 66. ROM 39689. ×130. □20. From TP 66. Same as 14. ×145.

Fig. 16–19. Semiacontiodus preasymmetricus n.sp. All specimens from the *Histiodella tableheadensis* Phylozone. □16. Asymmetrical element. TP 39. ROM 39691. ×120. □17. Asymmetrical element. TP 29. ROM 39691. ×85. □18. Symmetrical element. Holotype. TP 29. ROM 39690. ×100. □19. Symmetrical element. TP 27. ROM 39691. ×200.
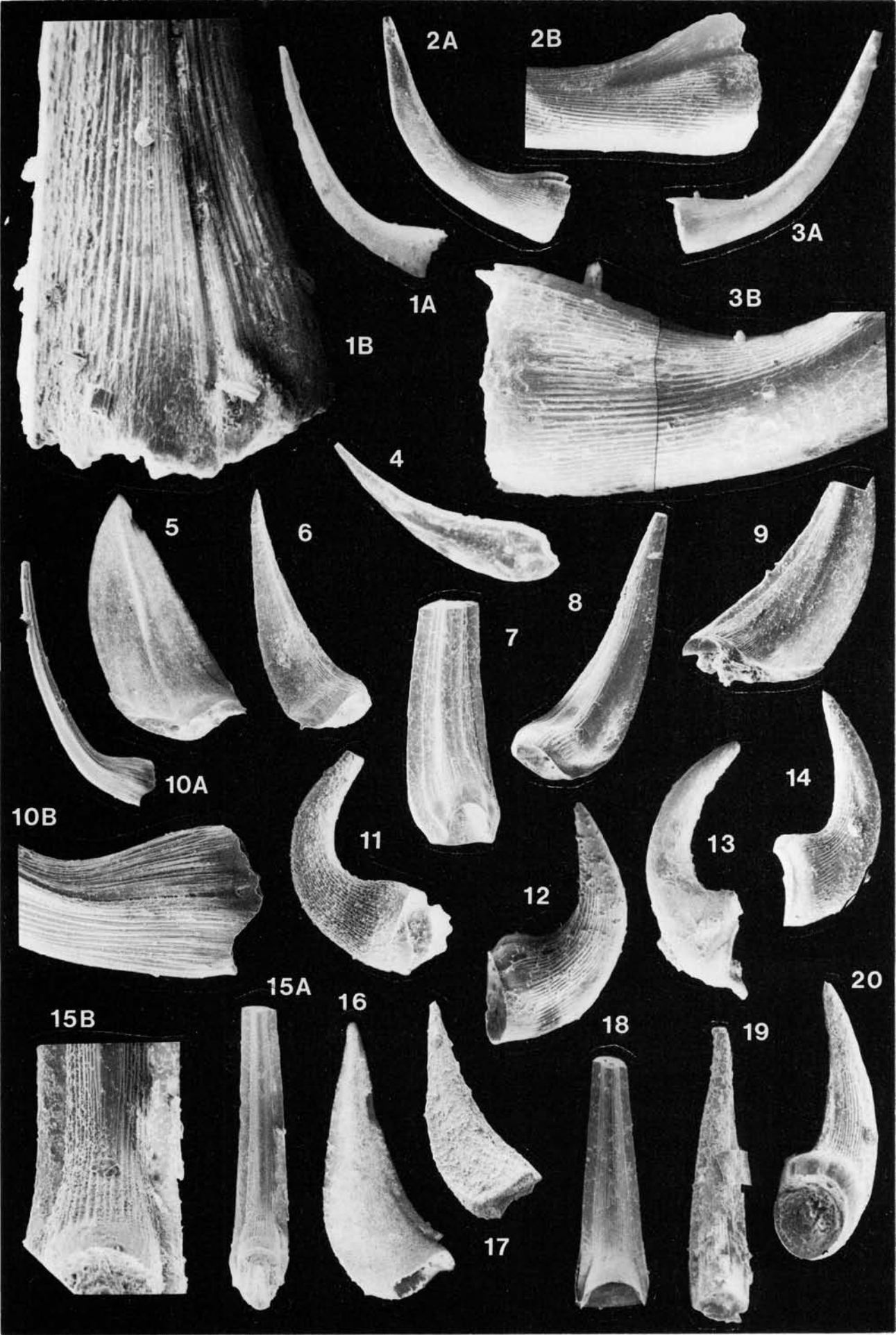
Plate 11

Fig. 1–6. Semiacontiodus cf. *cordis* (Hamar). All specimens from the *Histiodella tableheadensis* Phylozone. □1. Asymmetrical element. TP 55. ROM 39692. ×130. □2. Asymmetrical element. TP 55. ROM 39692. ×100. □3. Asymmetrical element. TP 55. ROM 39692. ×100. □4. Asymmetrical element. TP 55. ROM 39692. ×105. □5A. Symmetrical element. TP 59. ROM 39692. ×60. □5B. Detail of base, oral view. Same specimen as in 5A. ×200. □5C. Detail of base, lateral view. Same specimen as in 5A. ×150. □6A. Asymmetrical element. TP 59. ROM 39692. ×75. □6B. Detail of cusp. Note additional finer grooves next to the median groove. Same specimen as in 6A. ×1050. □6C. Detail of base. Same specimen as in 6A. ×350.

Fig. 7–9. Erismodus? sp. A. Specimens from the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1 Assemblage Zone. □7. From TP 24. ROM 39693. ×45. □8A. From TP 3. ROM 39693. ×45. □8B. Detail of anterior margin of cusp. Same specimen as in 8A. ×230. □8C. Aboral view. Same specimen as in 8A. ×65. □9. From TP 3. ROM 39693. ×45.
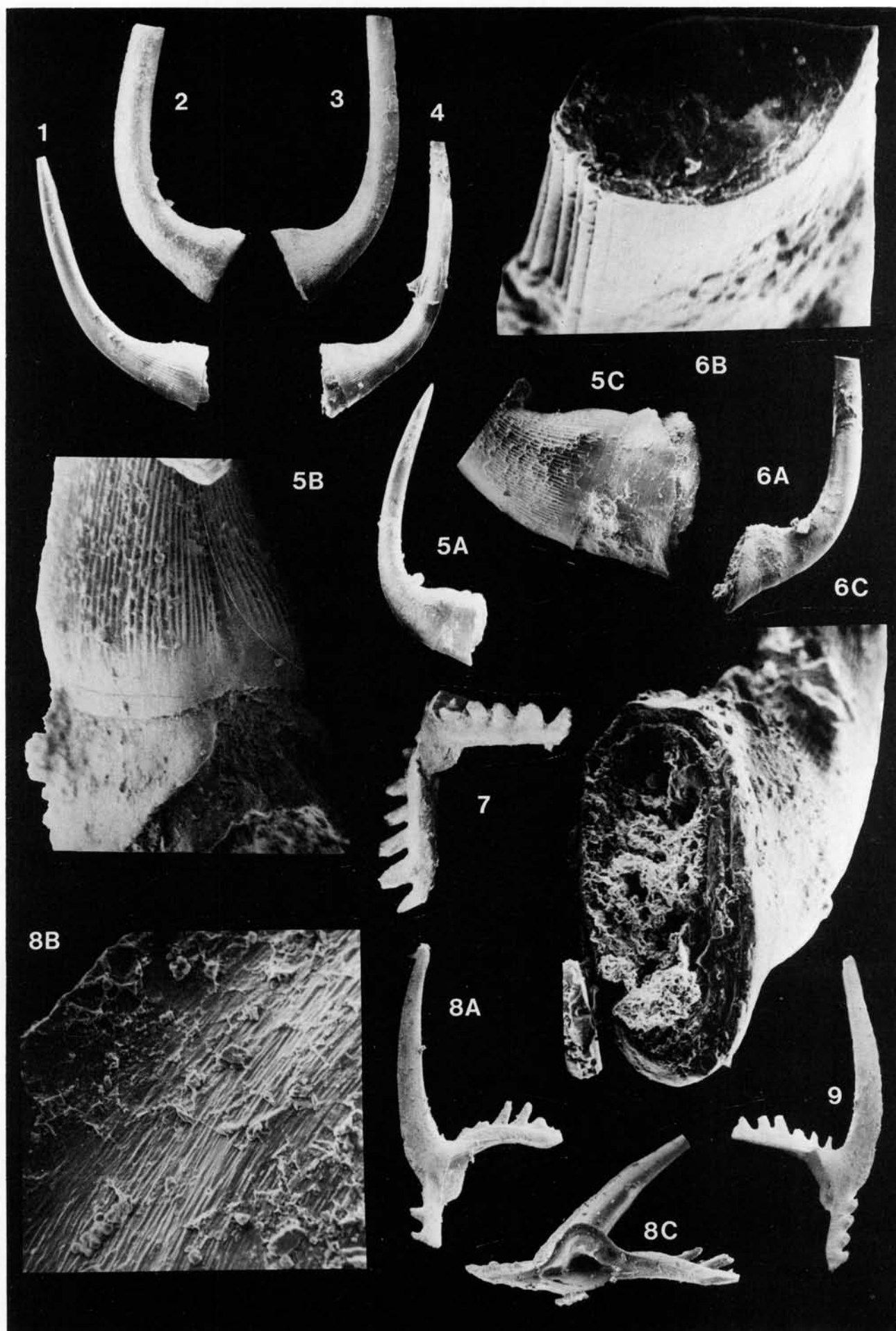
Plate 12

Fig. 1. Erismodus? sp. B. s.f. From the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1 Assemblage Zone. □1A. From TP 3. ROM 39694. ×20. □1B. Detail of cusp. Same specimen as 1A. ×230.

Fig. 2–3. Leptochirognathus cf. *quadrata* Branson & Mehl. From the *Histiodella tableheadensis* Phylozone. □2. Inner view. TP 25. ROM 39695. ×55. □3. Outer view. TP 26. ROM 39695. ×65.

Fig. 4–5. Multioistodus cf. *subdentatus* Cullison. From the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1 Assemblage Zone. □4. From TP 1. (St. George Group at Table Point). ROM 39697. ×145. □5. From TP 3. ROM 39697. ×220.

Fig. 6–7. Leptochirognathus prima Branson & Mehl s.f. From the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1 Assemblage Zone. □6. From Back Arm Sample BA 1. ROM 39696. ×140. □7. From Back Arm Sample BA 1. ROM 39696. ×140.

Fig. 8–12, 14. Amorphognathus? sp. A. From the *Histiodella kristinae* Phylozone. □8. Tetraprioniodontiform. TP 74. ROM 39698. ×155. □9. Ambalodontiform. TP 74. ROM 39698. ×190. □10. Amorphognathiform. ROM 39698. ×95. □11. Ambalodontiform. TP 74. ROM 39698. ×90. □12. Ambalodontiform. TP 74. ROM 39698. ×165. □14A. Trichonodelliform. ROM 39698. ×160. □14B. Detail of inner side of cusp. Same specimen as in 14B. ×895.

Fig. 13. Polonodus tablepointensis n.sp. Specimen from the *Histiodella kristinae* Phylozone. □13A. Polyplacognathiform. TP 66. ROM 39700. ×30. □13B. Aboral view. Same specimen as in 13A. ×40. □13C. Upper view. Same specimen as in 13A. ×30.
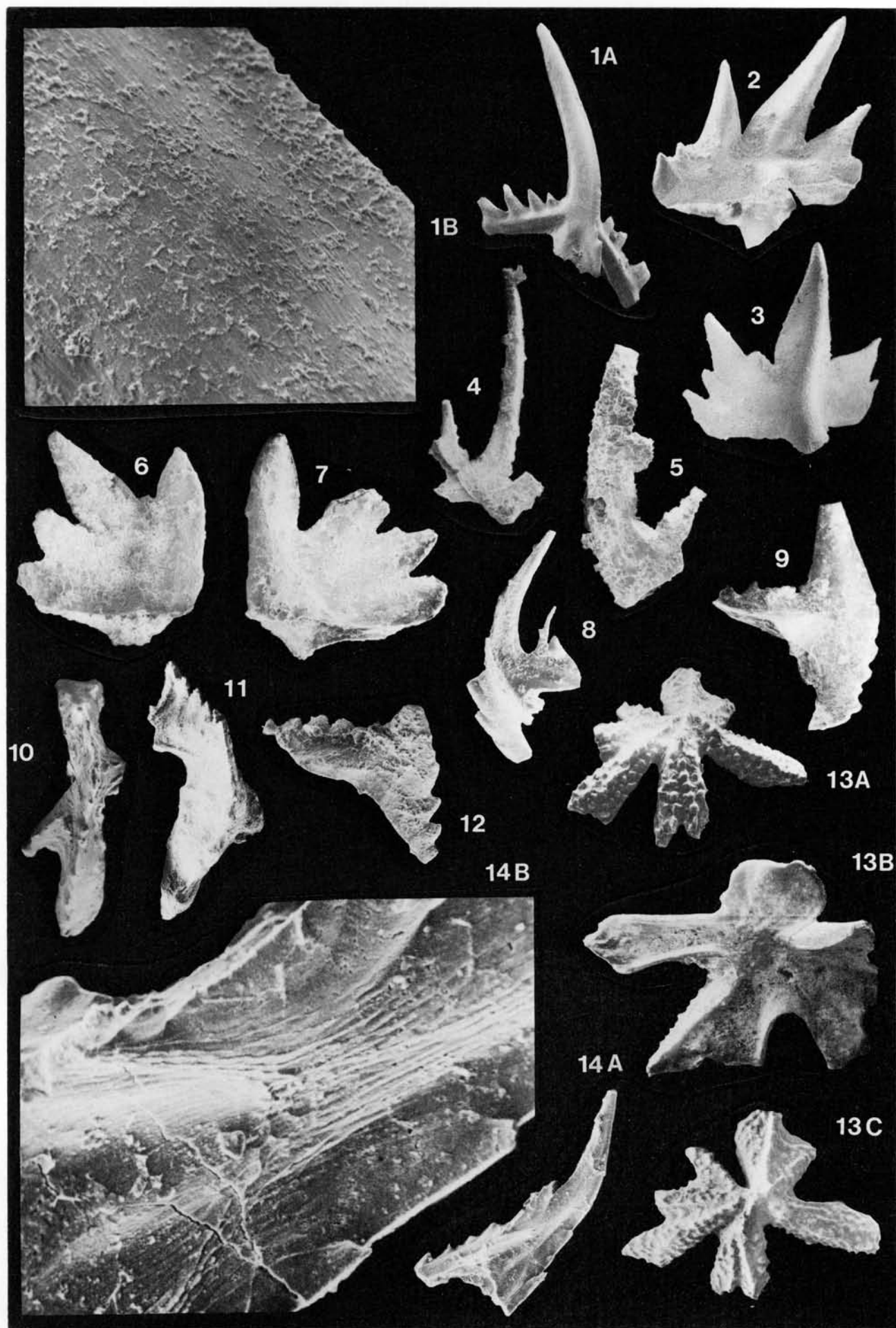
Plate 13

Fig. 1–5. Polonodus tablepointensis n.sp. All specimens from the *Histiodella kristinae* Phylozone. □1A. Ambalodontiform. From TP 74. ROM 39700. ×50. □1B. Detail of anterior process. Same specimen as in 1A. ×165. □2. Polyplacognathiform. From TP 74. ROM 39700. ×55. □3. Polyplacognathiform. Holotype. TP 74. ROM 39699. ×15. □4. Polyplacognathiform. TP 71. ROM 39700. ×20. □5. Ambalodontiform. TP 71. ROM 39700. ×75.

Fig. 6–13. Polonodus? clivosus (Viira). All specimens from the *Histiodella kristinae* Phylozone. □6A. Polyplacognathiform. TP 74. ROM 39701. ×125. □6B. Detail of middle part of inner lateral process. Same specimen as in 6A. ×1170. □7. Ambalodontiform. TP 74. ROM 39701. ×85. □8. Ambalodontiform. TP 74. ROM 39701. ×100. □9. Polyplacognathiform. TP 74. ROM 39701. ×95. □10. Polyplacognathiform. TP 74. ROM 39701. ×90. □11. Ambalodontiform. TP 74. ROM 39701. ×110. □12. Ambalodontiform. TP 68. ROM 39701. ×125. □13. Polyplacognathiform. TP 74. ROM 39701. ×50.

Fig. 14–16. Polonodus? newfoundlandensis n.sp. All specimens from the *Histiodella tableheadensis* Phylozone. □14. Polyplacognathiform. TP 59. ROM 39703. ×65. □15. Ambalodontiform. TP 59. ROM 39703. ×95. □16. Polyplacognathiform. Holotype. Note the deep inner notch in the platform of the anterior process. TP 59. ROM 39702. ×40.
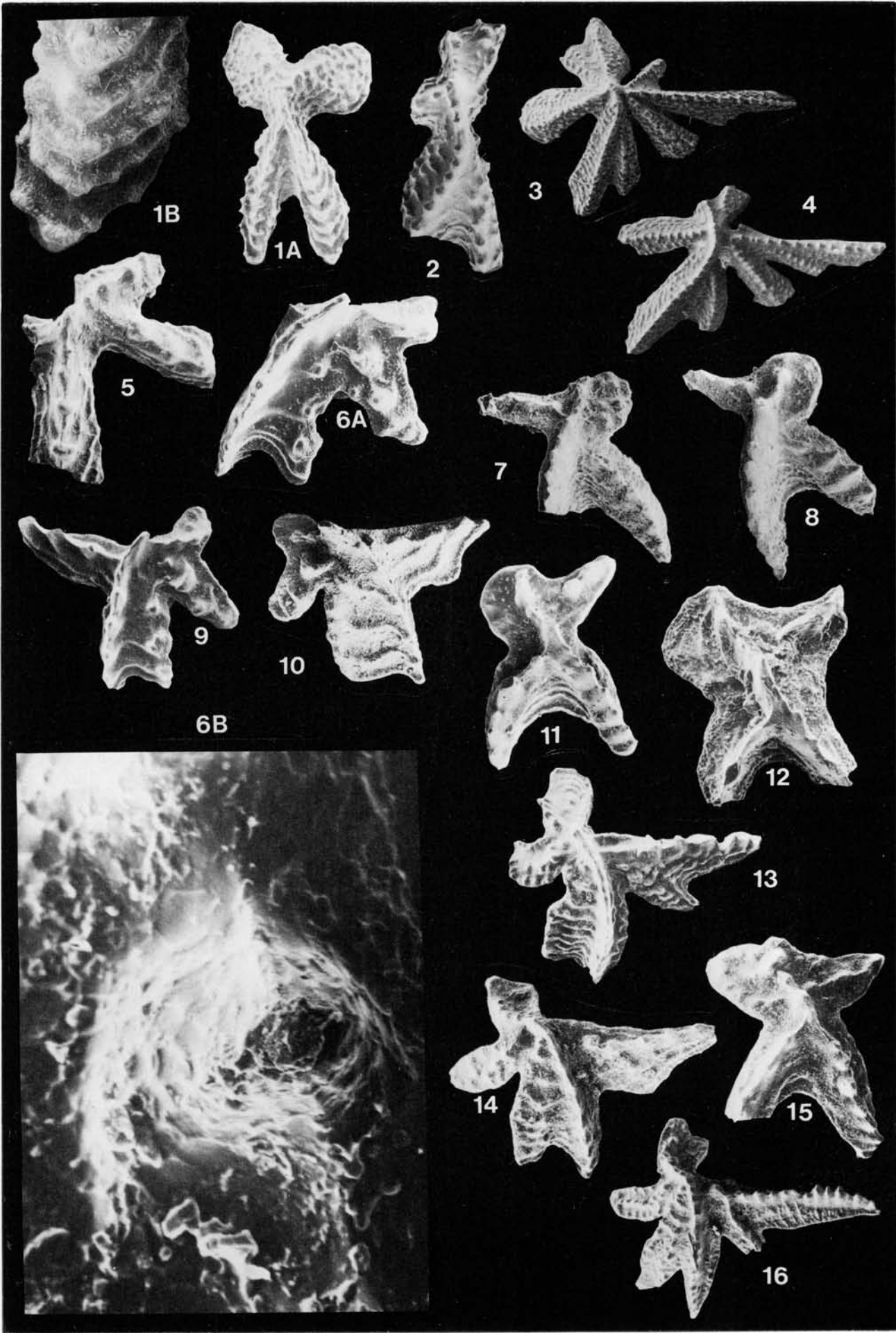
Plate 14

Fig. 1–2. Pygodus? sp. A. Specimens from the *Histiodella kristinae* Phylozone. □1. Ramiform element. TP 67. ROM 39704. ×65. □2. Trichonodelliform. TP 68. ROM 39704. ×75.

Fig. 2–12. Oistodus? tablepointensis n.sp. All specimens from the *Histiodella kristinae* Phylozone. □3. Oistodontiform. TP 68. ROM 39706. ×50. □4. Prioniodontiform. TP 68. ROM 39706. ×50. □5. Prioniodontiform. TP 68. ROM 39706. ×60. □6. Oistodontiform. TP 71. ROM 39706. ×50. □7. Prioniodontiform. TP 72. ROM 39706. ×55. □8. Oistodontiform. TP 71. ROM 39706. ×60. □9. Ramiform. TP 71. ROM 39706. ×50. □10. Ramiform. TP 71. ROM 39706. ×50. □11. Ramiform. TP 71. ROM 39706. ×50. □12. Ramiform. Holotype. TP 72. ROM 39705. ×50.

Fig. 13–19. Acodus combsi Bradshaw. Specimens from the *Histiodella kristinae* Phylozone. □13. Prioniodontiform. TP 66. ROM 39707. ×100. □14. Tetraprioniodontiform, inner side. TP 66. ROM 39707. ×75. □15. Cordylodontiform, inner side. TP 66. ROM 39707. ×80. □16. Tetraprionidontiform, outer side. TP 66. ROM 39707. ×75. □17. Oistodontiform. TP 66. ROM 39707. ×70. □18. Cordylodontiform. TP 66. ROM 39707. ×90. □19. Trichonodelliform. TP 66. ROM 39707. ×70.

Fig. 20–28. Acodus? n.sp. A. Specimens from the *Acodus combsi – Oistodus? tablepointensis* Assemblage Zone. □20. Oistodontiform. TP 66. ROM 39708. ×120. □21. Ramiform, symmetrical. TP 71. ROM 39708. ×160. □22. Acodontiform. TP 66. ROM 39708. ×105. □23. Ramiform, asymmetrical. TP 66. ROM 39708. ×110. □24. Ramiform, asymmetrical. TP 71. ROM 39708. ×110. □25. Ramiform, asymmetrical. TP 68. ROM 39708. ×110. □26. Oistodontiform. TP 71. ROM 39708. ×100. □27. Cordylodontiform. TP 66. ROM 39708. ×110. □28. Oistodontiform. TP 66. ROM 39708. ×70.
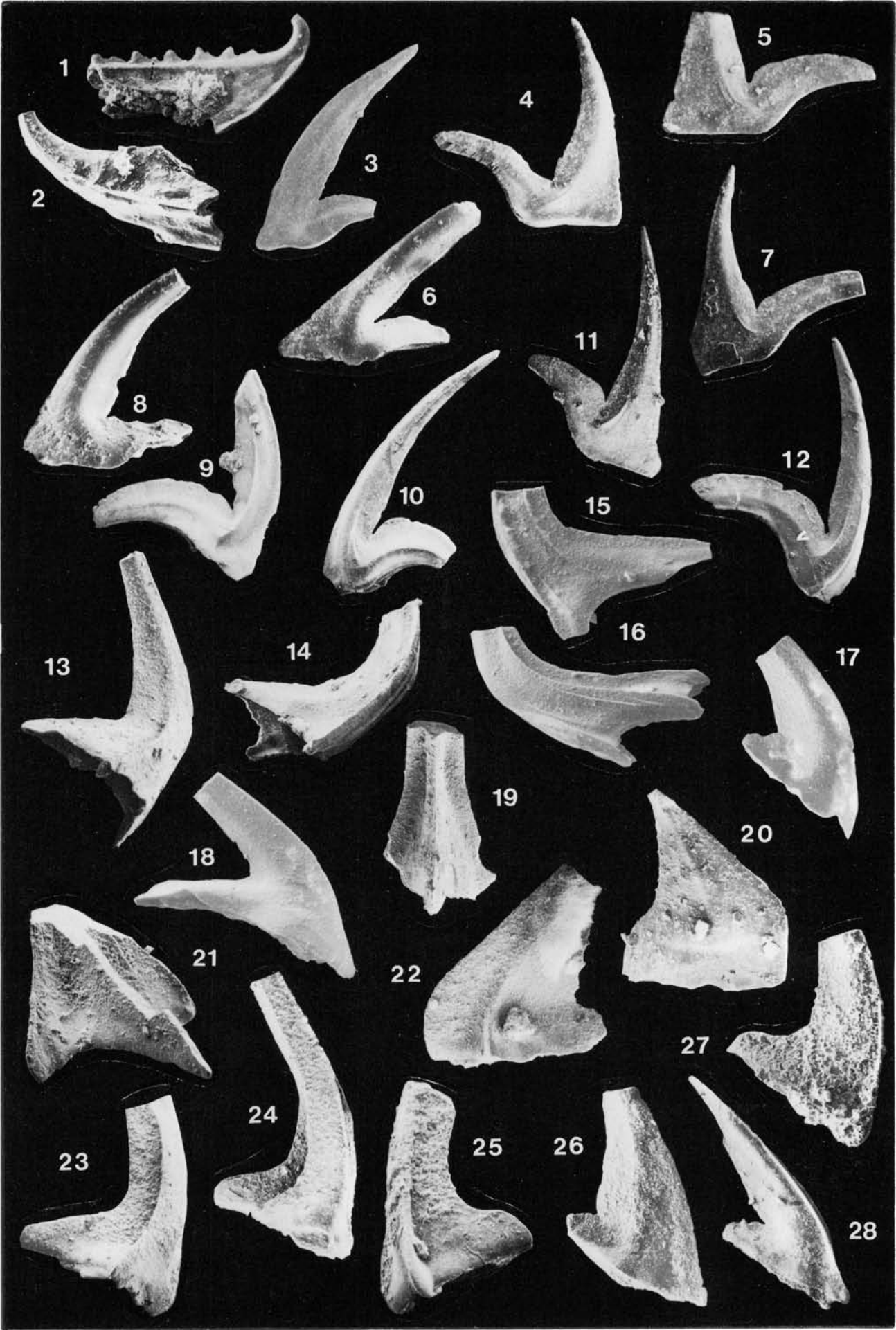
Plate 15

Fig. 1–6. Baltoniodus? prevariabilis medius (Dzik). All specimens from the lower *Histiodella kristinae* Phylozone. □1. Tetraprioniodontiform. TP 67. ROM 39709. ×145. □2. Trichonodelliform. TP 67. ROM 39709. ×145. □3. 'Paracordylodontiform'. TP 67. ROM 39709. ×145. □4. Falodontiform. TP 74. TOM 39709. ×70. □5. Falodontiform. TP 74. ROM 39709. ×100. □6. Tetraprioniodontiform. TP 70. ROM 39709. ×145.

Fig. 7–13, 15–16. Eoneoprioniodus? sp. 1. All specimens from the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1. Assemblage Zone. □7. Prioniodontiform. From Back Arm Sample BA 2. ROM 39710. ×50. □8. Prioniodontiform. From TP 3 at Table Point. Rom 39710. ×50. □9. Tetraprioniodontiform. TP 3. ROM 39710. ×50. □10. Prioniodontiform. Same specimen as 7. ROM 39710. ×50. □11. Cyrtoniodontiform. TP 3. ROM 39710. ×45. □12. Trichonodelliform. From sample BA 2 at Back Arm. ROM 39710. ×50. □13. Tetraprioniodontiform. TP 3. ROM 39710. ×50. □15. Paracordylodontiform. TP 3. ROM 39710. ×45. □16. Paracordylodontiform. Sample BA 2 at Back Arm. ROM 39710. ×60.

Fig. 14, 17–20. *Eoneoprioniodus?* sp. 2. Fig. 17 from the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1. Assemblage Zone. Fig. 14, 18–20 from the basal *Histiodella tableheadensis* Phylozone. □14. Trichonodelliform. TP 19. ROM 39711. ×90. □17. Cyrtoniodontiform. From TP 3. ROM 39711. ×35. □18. Ramiform. TP 19. ROM 39711. ×70. □19. Ramiform. TP 23. ROM 39711. ×90. □20. Ramiform. TP 23. ROM 39711. ×75.
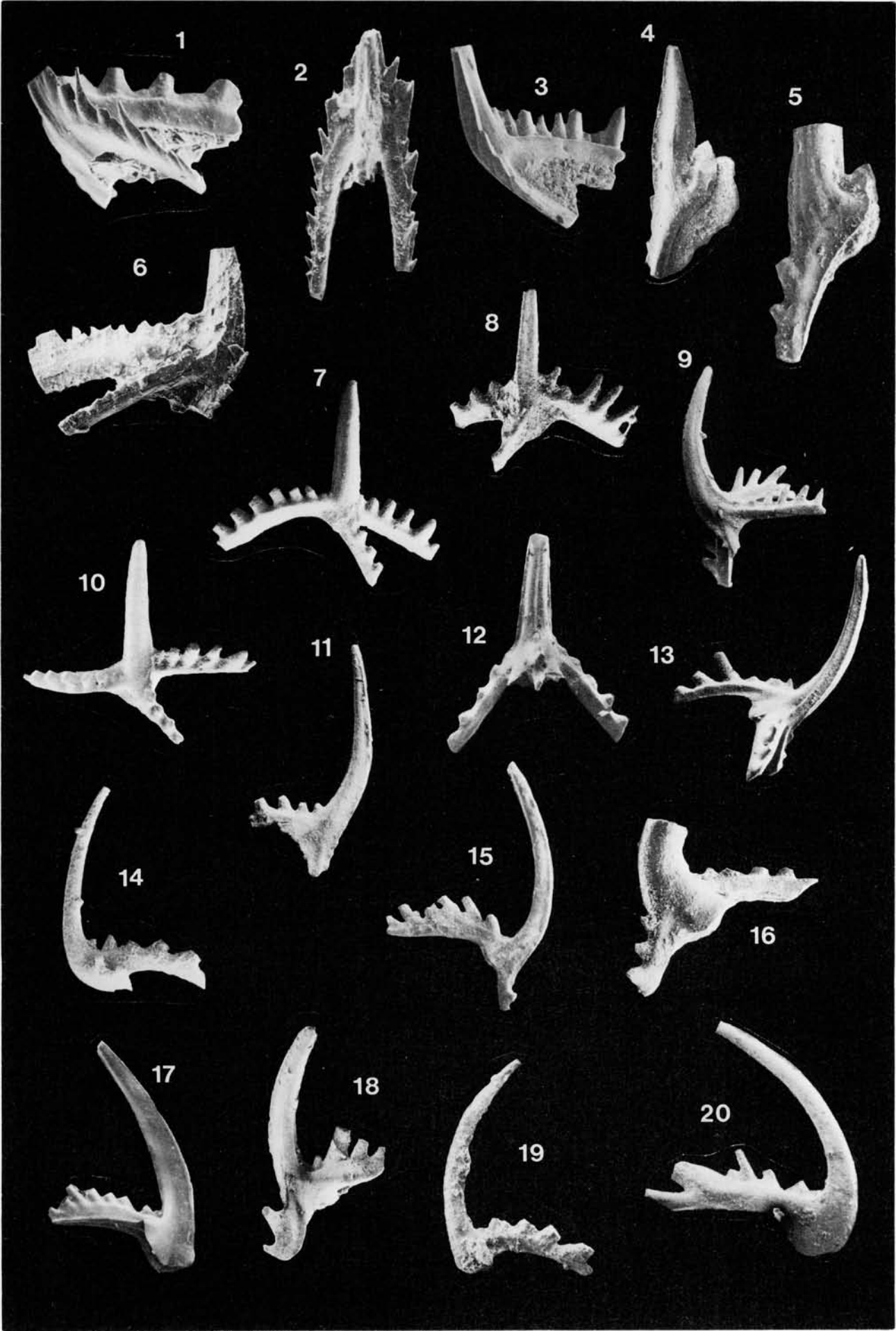
Plate 16

Fig. 1–15. Periodon aculeatus zgierzensis Dzik. All specimens from the *Histiodella kristinae* Phylozone. □1. Prioniodiniform. TP 67. ROM 39712. ×75. □2. Oulodontiform. TP 67. ROM 39712. ×85. □3. Oistodontiform. TP 68. ROM 39712. ×70. □4. Oistodontiform. TP 68. ROM 39712. ×75. □5. Cordylodontiform. TP 68. ROM 39712. ×80. □6. Cordylodontiform. TP 68. ROM 39712. ×75. □7. Oistodontiform. TP 67. ROM 39712. ×60. □8. Prioniodiniform. TP 69. ROM 39712. ×65. □9. Cordylodontiform. TP 69. ROM 39712. ×90. □10. Loxognathiform. TP 67. ROM 39712. ×90. □11. Periodontiform. TP 69. ROM 39712. ×65. □12. Periodontiform. TP 69. ROM 39712. ×70. □13. Loxognathiform. TP 67. ROM 39712. ×80. □14A. Periodontiform. TP 67. ROM 39712. ×60. □14B. Detail of inner side of cusp. Same specimen as in 14A. ×140. □15. Trichonodelliform. TP 69. ROM 39712. ×70.

Fig. 16–20. Phragmodus? sp. A. Specimens from the *Histiodella kristinae* Phylozone. □16. Ozarkodiniform. TP 74. ROM 39713. ×120. □17. Cordylodontiform. TP 77. ROM 39713. ×140. □18. Cordylodontiform. TP 77. ROM 39713. ×145. □19. Oistodontiform. TP 79. ROM 39713. ×120. □20. Trichonodelliform. TP 79. ROM 39713. ×130.
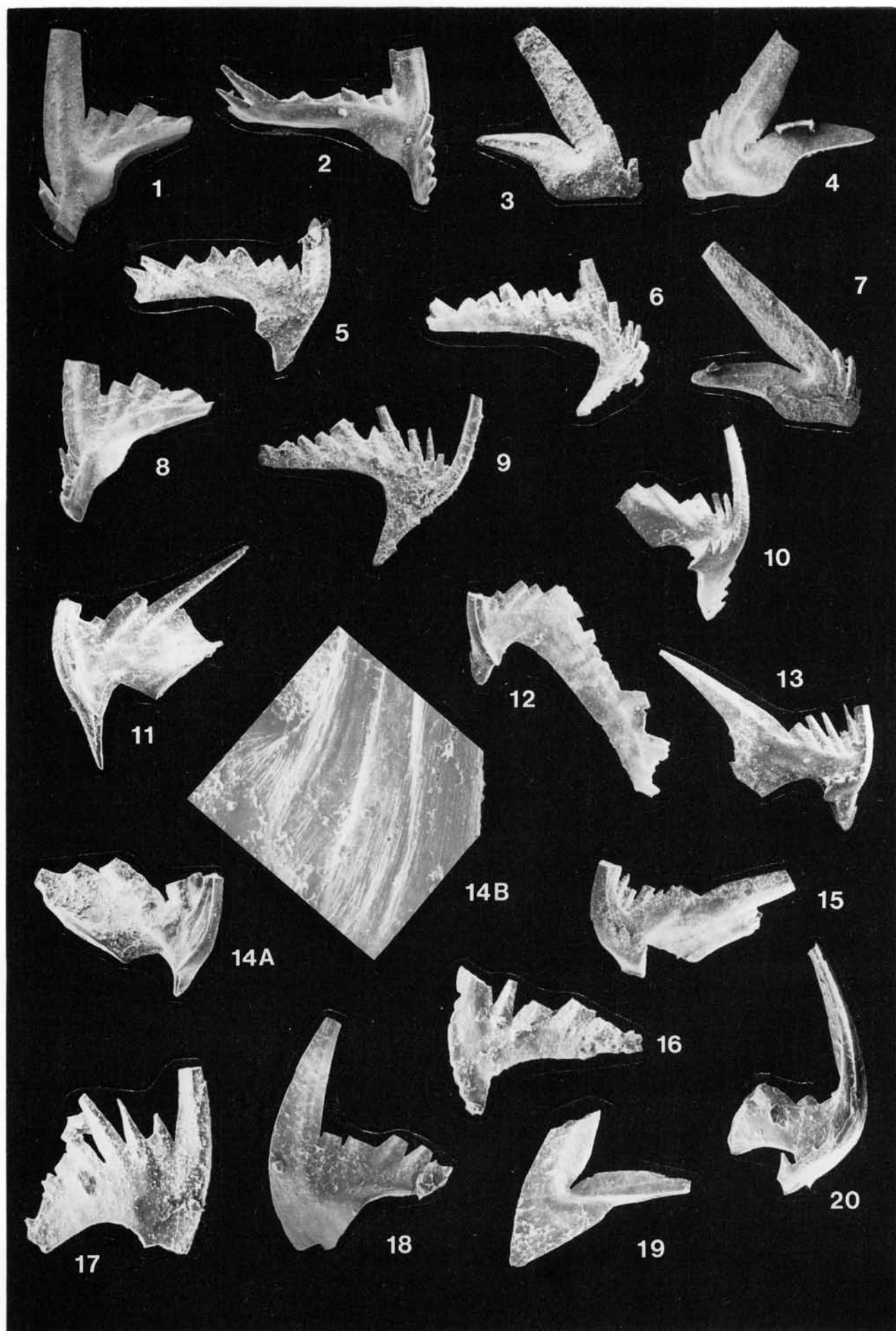
Plate 17

Fig. 1–8. Plectodina? sp. A. Specimens from the *Trigonodus carinatus – Eoneoprioniodus?* sp. 1. Assemblage Zone. □1. Dichognathiform. TP 24. ROM 39714. ×125. □2. Spathognathodontiform. TP 24. ROM 39714. ×100. □3. Dichognathiform. TP 24. ROM 39714. ×100. □4. Hindeodelliform. TP 24. ROM 39714. ×100. □5. Zygognathiform. TP 24. ROM 39714. ×110. □6. Zygognathiform. TP 25. ROM 39714. ×100. □7. Zygognathiform. TP 25. ROM 39714. ×100. □8. Oistodontiform. TP 25. ROM 39714. ×125.

Fig. 9–19. ?Erraticodon balticus Dzik. All specimens from the *Histiodella tableheadensis* Phylozone. □9. Hindeodelliform. TP 29. ROM 39715. ×40. □10. Hindeodelliform. TP 52. ROM 39715. ×85. □11. Neoprioniodontiform. TP 52. ROM 39715. ×85. □12. Prioniodontiform. TP 52. ROM 39715. ×50. □13. Zygognathiform. TP 53. ROM 39715. ×45. □14. Zygognathiform. TP 54. ROM 39715. ×30. □15. Sannemanulliform. TP 58. ROM 39715. ×60. □16. Prioniodontiform. ROM 39715. ×45. □17. Trichonodelliform. TP 58. ROM 39715. ×55. □18. Trichonodelliform. TP 54. ROM 39715. ×60. □19. Ozarkodiniform. TP 55. ROM 39715. ×35.

Fig. 20–21. Histiodella bellburnensis n.sp. Specimens from the top of the *Cornuodus longibasis – Walliserodus ethingtoni* Assemblage Zone. □20. Spathognathodontiform. Holotype. TP 80. ROM 39716. ×130. □21. Spathognathodontiform. TP 80. ROM 39717. ×130.
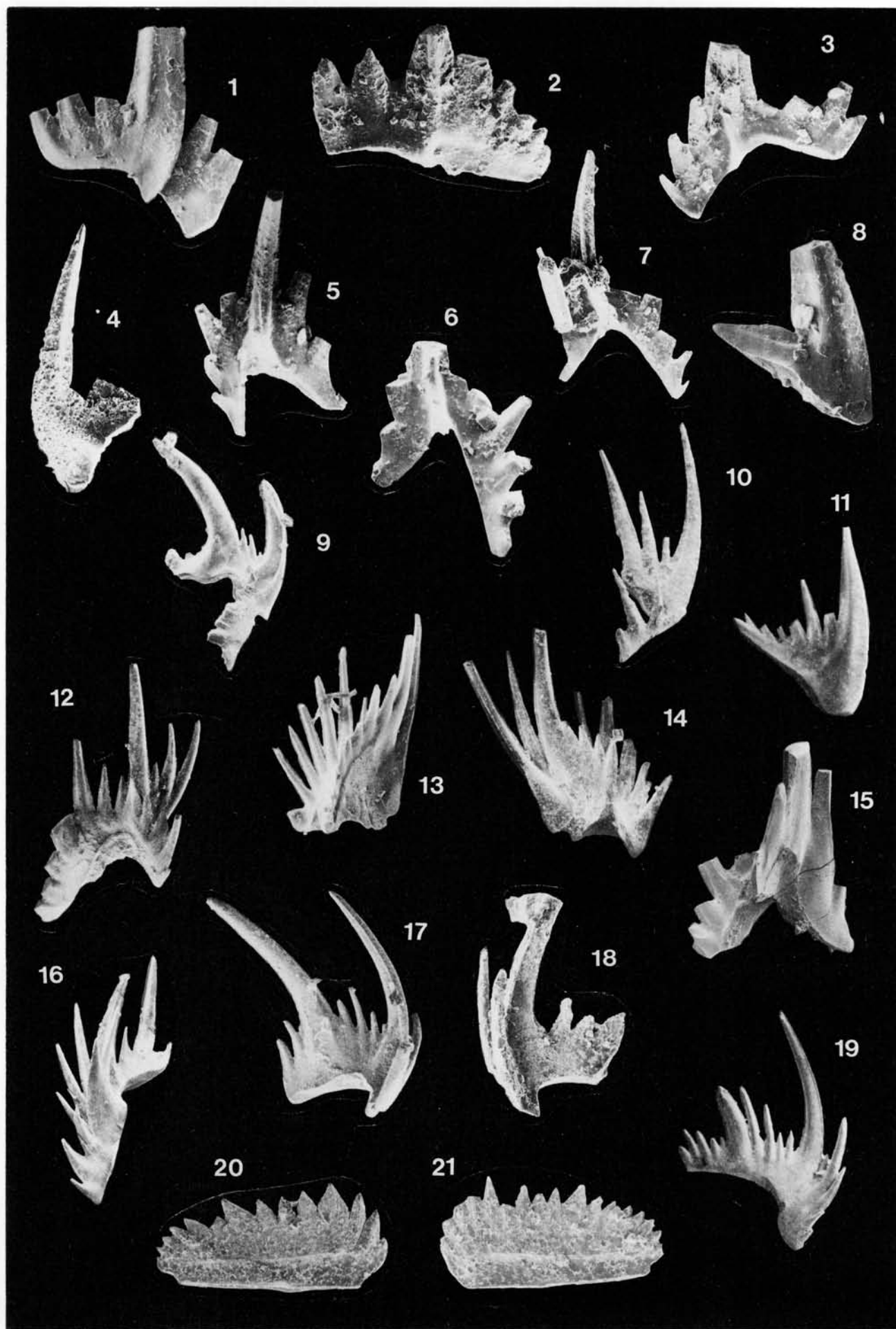
Plate 18

Fig. 1–7, 9–11. Histiodella kristinae n.sp. All specimens from the *Histiodella kristinae* Phylozone. □1. Oistodontiform. TP 67. ROM 39719. ×110. □2. Spathognathodontiform. TP 68. ROM 39719. ×80. □3. Spathognathodontiform. Holotype. TP 68. ROM 39718. ×100. □4. Oistodontiform. TP 71. ROM 39719. ×90. □5. Ramiform. TP 71. ROM 39719. ×90. □6. Spathognathodontiform. TP 71. ROM 39719. ×100. □7. Spathognathodontiform. TP 71. ROM 39719. ×119. □9. Ramiform. TP 71. ROM 39719. ×80. □10. Ramiform. TP 71. ROM 39719. ×150. □11. Trichonodelliform. TP 71. ROM 39719. ×150.

Fig. 8, 12–14. Histiodella tableheadensis n.sp. Specimens from the *Histiodella tableheadensis* Phylozone. □8. Spathognathodontiform. TP 25. ROM 39721. ×65. □12. Spathognathodontiform. Advanced specimen. TP 61. ROM 39721. ×65. □13. Spathognathodontiform. TP 46. ROM 39721. ×115. □14. Spathognathodontiform. Holotype. TP 43. ROM 39720. ×140.

Fig. 15–16. Gen. et sp. indet. A. Specimens from the *Trigonodus carinatus–Eoneoprioniodus?* sp. 1. Assemblage Zone. □15. From TP 3. ROM 39724. ×40. □16. From TP 19. ROM 39724. ×50.

Fig. 17–18. Spinodus cf. *spinatus* (Hadding). Specimens from the *Histiodella kristinae* Phylozone. □17. Cordylodontiform. TP 67. ROM 39723. ×80. □18. Ligonodontiform. TP 74. ROM 39723. ×75.

Fig. 19. Loxodus? curvatus n.sp. From the *Histiodella tableheadensis* Phylozone. TP 59. Holotype. ROM 39722. ×35.

Fig. 20. Gen. et sp. indet. B. From the *Histiodella kristinae* Phylozone. TP 72. ROM 39725. ×95.

Fig. 21–23. Gen. et sp. indet. C. From the *Histiodella tableheadensis* Phylozone. □21. Trichonodelliform. TP 60. ROM 39726. ×95. □22. Prioniodontiform. TP 61. ROM 39726. ×125. □23. Trichonodelliform. TP 63. ROM 39726. ×125.

Fig. 24. Ptiloncodus simplex Harris. Specimen from the *Histiodella kristinae* Phylo-zone. TP 79. ROM 39727. ×100.
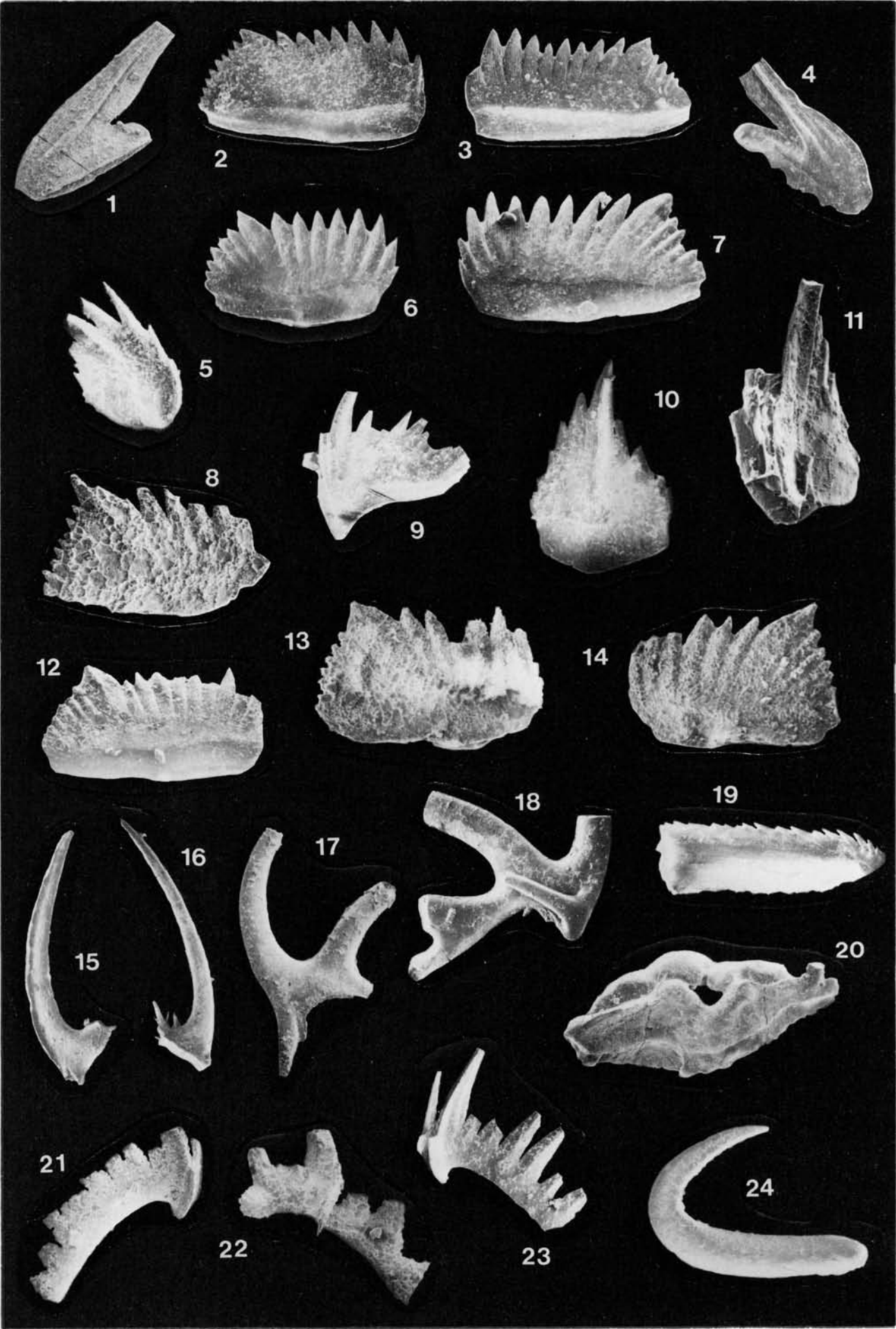
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Henderson, R. A. 1974: Shell adaptation in acrothelid brachiopods to settlement on soft substrata. *Lethaia 7,* 57–61.

Lindström, M. 1971: Lower Ordovician conodonts of Europe. *In* Sweet, W. C. & Bergström, S. M. (eds.): Symposium on conodont biostratigraphy. *Geological Society of America, Memoir 127,* 21–61.

Popov, L. E. (Попов, Л. Е.) 1975: Беззамковые брахиоподы из среднего ордовика хребта Чингиз. [Inarticulate brachiopods from the Middle Ordovician of the Chingiz Range.] *Палеонтологический журнал 1975:4,* 32–41.

Rudwick, M. J. S. 1970: *Living and Fossil Brachiopods.* 199 pp. Hutchinson, London.

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