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CONODONTS OF THE JUPITER AND CHICOTTE FORMATIONS (LOWER SILURIAN), ANTICOSTI ISLAND, QUÉBEC

T.T. UYENO
C.R. BARNES

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PREFACE

Conodonts are plate- or tooth-like microfossils that are known to be prime indicators for dating and correlating rocks of Cambrian to Triassic age. In this report the conodont faunas from the Jupiter and Chicotte formations of Anticosti Island are described. These strata are of Early Silurian age, and comprise the youngest part of a sequence that starts with rocks of Late Ordovician age, and which is apparently continuous across the Ordovician-Silurian boundary. Relatively abundant, well-preserved conodonts occur throughout most of the highest interval of this sequence and provide detailed biostratigraphic information.

The results of this study allow more precise correlations to be made with the classic Lower Silurian rocks of the Welsh Borderland in Great Britain, and will also facilitate making closer correlations between strata of this age in other sedimentary basins in Canada and elsewhere. Accurate dating of rocks is of great importance in assessing the hydrocarbon and other mineral potential of sedimentary basins.

OTTAWA, January 1983

R.A. Price
Director General
Geological Survey of Canada

PRÉFACE

Les conodontes sont des microfossiles qui ont l'apparence de plaquettes ou de dents et qui sont reconnus comme des indicateurs de datation et de corrélation de premier ordre des roches du Cambrien et du Trias. Dans la présente étude sont décrits des conodontes qui proviennent des formations de Chicotte et de Jupiter de l'île d'Anticosti. Ces strates sont du Silurien inférieur et renferment la partie la plus récente de la séquence commençant avec des roches de l'Ordovicien supérieur et semblent s'étendre jusqu'à la limite siluro-ordovicienne. Des conodontes relativement abondants et bien conservés se trouvent dans l'intervalle le plus élevé de cette séquence et fournissent, de ce fait, des renseignements biostratigraphiques détaillés.

Les résultats de cette étude permettent une corrélation plus précise des roches classiques du Silurien inférieur du Pays-de-Galles en Grande-Bretagne et apporteront plus de précisions aux corrélations entres des strates du même âge des bassins sédimentaires du Canada et d'ailleurs. La datation précise des roches est de grande importance dans l'évaluation du potentiel en minéraux et en hydrocarbures des bassins sédimentaires.

OTTAWA, janvier 1983

R.A. Price
Directeur général
Commission géologique du Canada

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Abstract

The Jupiter and Chicotte formations, respectively 145 m and 23-33 m thick (Bolton, 1972), represent the youngest Silurian units on Anticosti Island. With the exception of informal member 2 (Bolton, 1972) of the Jupiter, they were sampled at 2-m intervals along their main sections. Sixty samples, averaging 2.0 kg in weight, yielded 5100 disjunct conodont elements. The Anticosti conodonts can be confidently assigned to the zonation established by Aldridge (1972) based on strata in the Welsh Borderland. Thus, the sample from about 10 m above the base of member 1 of the Jupiter Formation is in the highest part of the *Icriodella discreta-I. deflecta* Zone (C_2, Fronian age). The remainder of the Jupiter, up to 2 m below the top of the formation, is assignable to the *Distomodus staurognathoides* Zone (C_2 to C_4, Fronian to early Telychian). In the Anticosti Island succession, this zone can be further subdivided into two informal units: the lower *staurognathoides* fauna (C_2, mid-Fronian) and the higher *aldridgei* fauna (C_{3-4}, late Fronian-early Telychian), with the separation occurring about 17 m above the base of member 4. The interval including the uppermost 2 m of the Jupiter and up to 24 m above the base of the Chicotte Formation, belongs to the *Icriodella inconstans* Zone (C_5, Telychian). The *Pterospathodus celloni* Zone of Walliser (1964) probably represents an upper part of this zone. The *Pterospathodus amorphognathoides* Zone (C_6, late Telychian-early Wenlock) is present in the sample 24 m above the base of the Chicotte. Although the zone straddles the Llandovery-Wenlock boundary, the stratigraphic position of this sample suggests that it is probably still of late Telychian age. Two of Cooper's (1980) Datum Planes are represented: the *Distomodus staurognathoides* Datum in member 1 of the Jupiter Formation, and the *Pterospathodus amorphognathoides* Datum in the Chicotte Formation.

Four new species are introduced: *Ozarkodina aldridgei*, *O. clavula*, *O. pirata*, and *Pterospathodus posteritenuis*.

Résumé

Les formations de Jupiter et Chicotte, qui ont respectivement 145 m et 23 à 33 m d'épaisseur (Bolton, 1972) représentent les plus récentes unités siluriennes de l'île d'Anticosti. A l'exception du membre informel 2 (Bolton, 1972) de la formation de Jupiter, on a effectué des échantillonnages à des intervalles de 2 m le long des principales sections. Soixante échantillons, d'un poids moyen de 2,0 kg, ont fourni 5100 éléments disjoints de conodontes. On peut en toute confiance parler des conodontes d'Anticosti suivant la zonation établie par Aldridge (1972) d'après l'étude des strates de la zone limitrophe du Pays de Galles. Ainsi, l'échantillon recueilli à environ 10 m au-dessus de la base du membre 1 de la formation de Jupiter se situe dans la portion la plus élevée de la zone à *Icriodella discreta - I. deflecta* (C_2, Fronien). Le reste de la formation de Jupiter, jusqu'à 2 m au-dessous du sommet de la formation, est attribué à la zone à *Distomodus staurognathoides* (C_2 à C_4, Fronien à Télychien inférieur). Dans la succession d'Anticosti, cette zone se laisse subdiviser à son tour en deux unités informelles: la faune inférieure à *D. staurognathoides* (C_2, Fronien moyen) et la faune plus récente à *D. aldridgei* (C_{3-4}, Fronien supérieur-Télychien inférieur), la séparation entre les deux se situant à environ 17 m au-dessus de la base du membre 4. L'intervalle comprenant les 2 m supérieurs de la formation de Jupiter et jusqu'à 24 m des strates surmontant la base de la formation de Chicotte, appartient à la zone à *Icriodella inconstans* (C_5, Télychien). La zone à *Pterospathodus celloni* de Walliser (1964) représente probablement l'un des niveaux supérieurs de cette zone. La zone à *Pterospathodus amorphognathoides* (C_6, Télychien supérieur – Wenlock inférieur) apparaît dans les 24 m échantillonnés au-dessus de la base de la formation de Chicotte. Bien que cette zone chevauche la frontière entre le Llandovery et le Wenlock, la position stratigraphique de cet échantillon suggère qu'il appartient encore au Télychien supérieur. Deux des niveaux de référence de Cooper (1980) y sont représentés: celui à *Distomodus staurognathoides* dans le membre 1 de la formation de Jupiter, et celui à *Pterospathodus amorphognathoides* dans la formation de Chicotte.

Quatre nouvelles espèces ont été mises en évidence: *Ozarkodina aldridgei*, *O. clavula*, *O. pirata* et *Pterospathodus posteritenuis*.

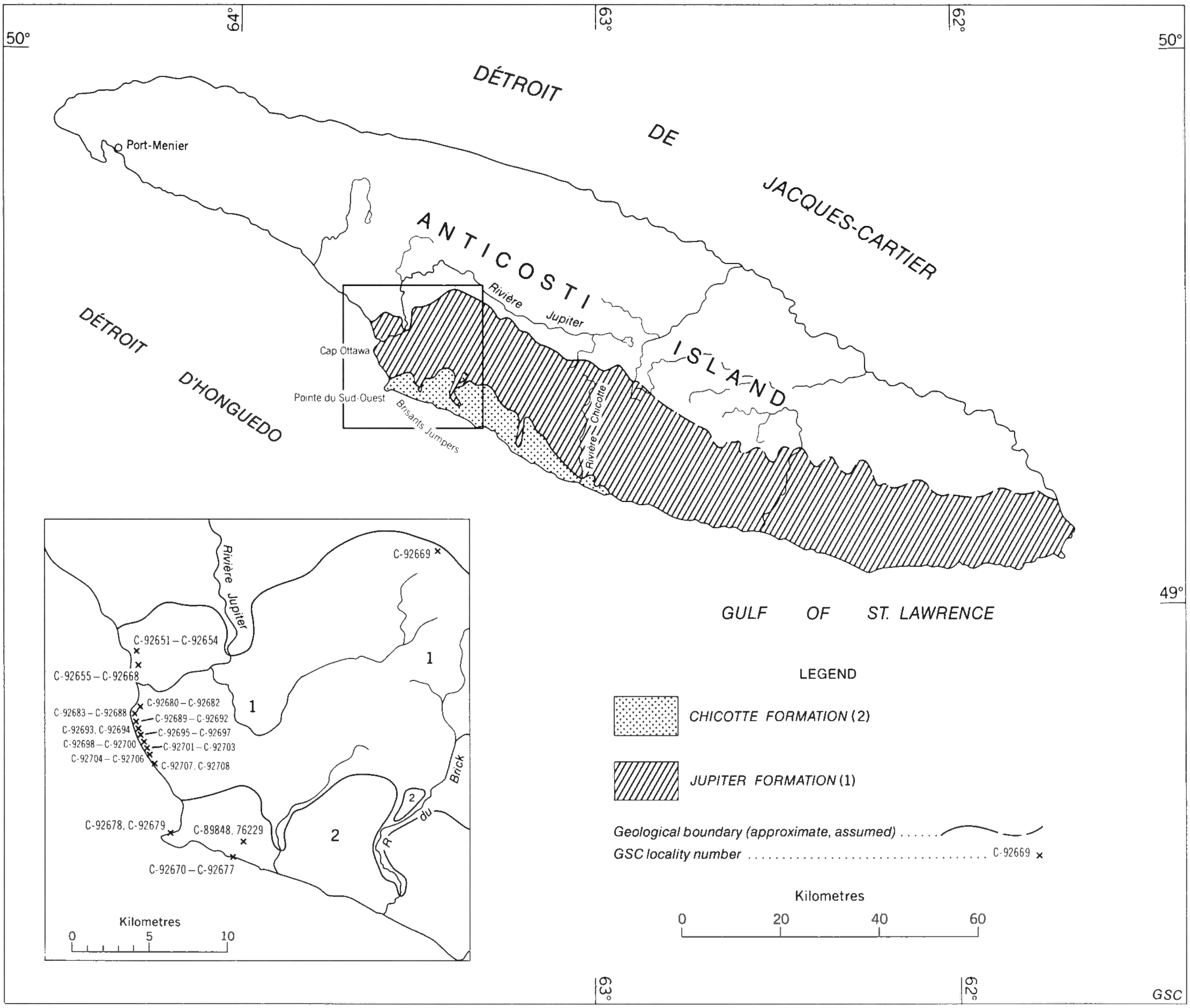

FIGURE 1. Index map of Anticosti Island, Quebec, with outcrop belt of the Jupiter and Chicotte formations (after Bolton, 1972). The enlarged inset map shows the location of the conodont samples

CONODONTS OF THE JUPITER AND CHICOTTE FORMATIONS (LOWER SILURIAN), ANTICOSTI ISLAND, QUÉBEC

INTRODUCTION

Anticosti Island (Fig. 1), located in the Gulf of St. Lawrence, is underlain by limestone and minor shale in an apparently continuous succession extending from Richmondian (Late Ordovician) to late Llandovery (Early Silurian) in age. The total thickness of strata outcropping on the island is about 1100 m (Petryk, 1979) with a total subsurface thickness of Paleozoic strata varying from 900 m to 3300 m from north to south across the island (Roliff, 1968). The strata are well exposed around the coast and inland along the major rivers, and to a lesser extent along the few roads; access to the eastern third of the island is difficult. The strata are structurally undeformed with a regional dip to the southwest of less than two degrees.

Previous studies of the paleontology and stratigraphy of Anticosti Island have been reviewed by Bolton (1972), Petryk (1979), and Nowlan and Barnes (1981). The major studies that involved the Jupiter and Chicotte formations are considered below; no previous study has been made of conodonts from these formations, except for a brief summary by Uyeno and Barnes (1981).

In 1975, a program was initiated by CRB to study all the conodont faunas from Anticosti Island and all formations were sampled at 2-m intervals along the main sections. Taxonomic studies of the Ordovician and basal Silurian conodonts have now been completed (McCracken, Nowlan and Barnes, 1980; Nowlan and Barnes, 1981; McCracken and Barnes, 1981). This present study is based on 53 samples from the Jupiter Formation and seven from the Chicotte Formation. The samples averaged 2.0 kg in weight and yielded 5100 disjunct conodont elements (see Appendix). The specimens are generally well preserved, although some have corroded surfaces, thus masking surface ornamentation. A few have pyrite crystals adhered to them. All specimens have a colour alteration index (CAI) of 1 which indicates burial temperatures of below 50 to 80°C (see Epstein et al., 1977). Additional conodont sampling of these formations was undertaken in 1979 by S.L. Duffield and CRB for more detailed paleoecological studies along with sampling for biostratigraphic studies of acritarchs (Duffield) and chitinozoans (material sent to A. Achab). In this report, TTU is responsible for the identification and systematics of the conodonts and their biostratigraphic conclusions; CRB collected the samples in 1975 and wrote the parts on stratigraphy and depositional environments. We assume joint responsibility for the remainder.

We initiated the study while TTU was on leave from the Geological Survey of Canada and visiting CRB at the University of Waterloo during 1978-79. Fruitful and lively discussions were held with B.J. Cooper, E.C. Druce, and E. Landing.

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R.J. Aldridge, University of Nottingham, England, and G.S. Nowlan and T.E. Bolton, Geological Survey of Canada, have kindly offered constructive reviews of the manuscript.

STRATIGRAPHY

The first detailed studies of the stratigraphy and paleontology of Anticosti Island were by Richardson (1857) and Billings (1857), respectively. The stratigraphic succession was divided into six letter units each with numbered subdivisions. These units were given formational names by Schuchert and Twenhofel (1910) and a monographic study of the stratigraphy and paleontology was undertaken by Twenhofel (1928). A later comprehensive study, which included detailed mapping of the island's interior, was published by Bolton (1961, 1972). Petryk (1979, 1981) has recently remapped the entire island.

The Jupiter Formation, originally called the Jupiter River Formation (Schuchert and Twenhofel, 1910; Twenhofel, 1921), and the Chicotte Formation outcrop in a wide belt occupying the southern third of the island. The type section for the Jupiter Formation is along the south coast, on both sides of the mouth of the Rivière Jupiter (Fig. 1); excellent exposures also occur along the Rivière Jupiter and also on the eastern end of the island. The latter area is only accessible by boat and was not covered by this study. The Chicotte Formation is named for strata well exposed near the mouth of the Rivière Chicotte but this area is inaccessible by road and the reference sections used herein, and by earlier workers, are those between Pointe du Sud-Ouest and Brisants Jumpers, about 40 km farther to the west along the the south coast (Fig. 1).

Only minor changes have been made to the original definitions of the Jupiter and Chicotte formations by subsequent workers (see Petryk, 1979, Table 2). However, estimates of formational thickness have varied, partly due to the difficulty of accurate measurements with the low, slightly undulating dip and the extent to which strata exposed on the wave-cut platform were included in the estimates. For the Jupiter Formation, the thicknesses reported have been 200 m, 145 m, and 171 m, by Twenhofel (1928), Bolton (1972), and Petryk (1979, 1981), respectively. These same three authors considered the thickness of the Chicotte Formation to be 22 m, 23-33 m, and less than 75 m, respectively. The thicknesses of the two formations estimated in the present study (Fig. 2) from the south-central part of the island conform closely to those of Bolton (1972); his formational definitions are adopted herein. Twenhofel (1928) and Bolton (1972) drew the lower contact at the same level and included locally developed bioherms in the lowest unit of the Jupiter Formation. Petryk (1979, 1981) preferred to include these bioherms in the uppermost Gun River Formation.

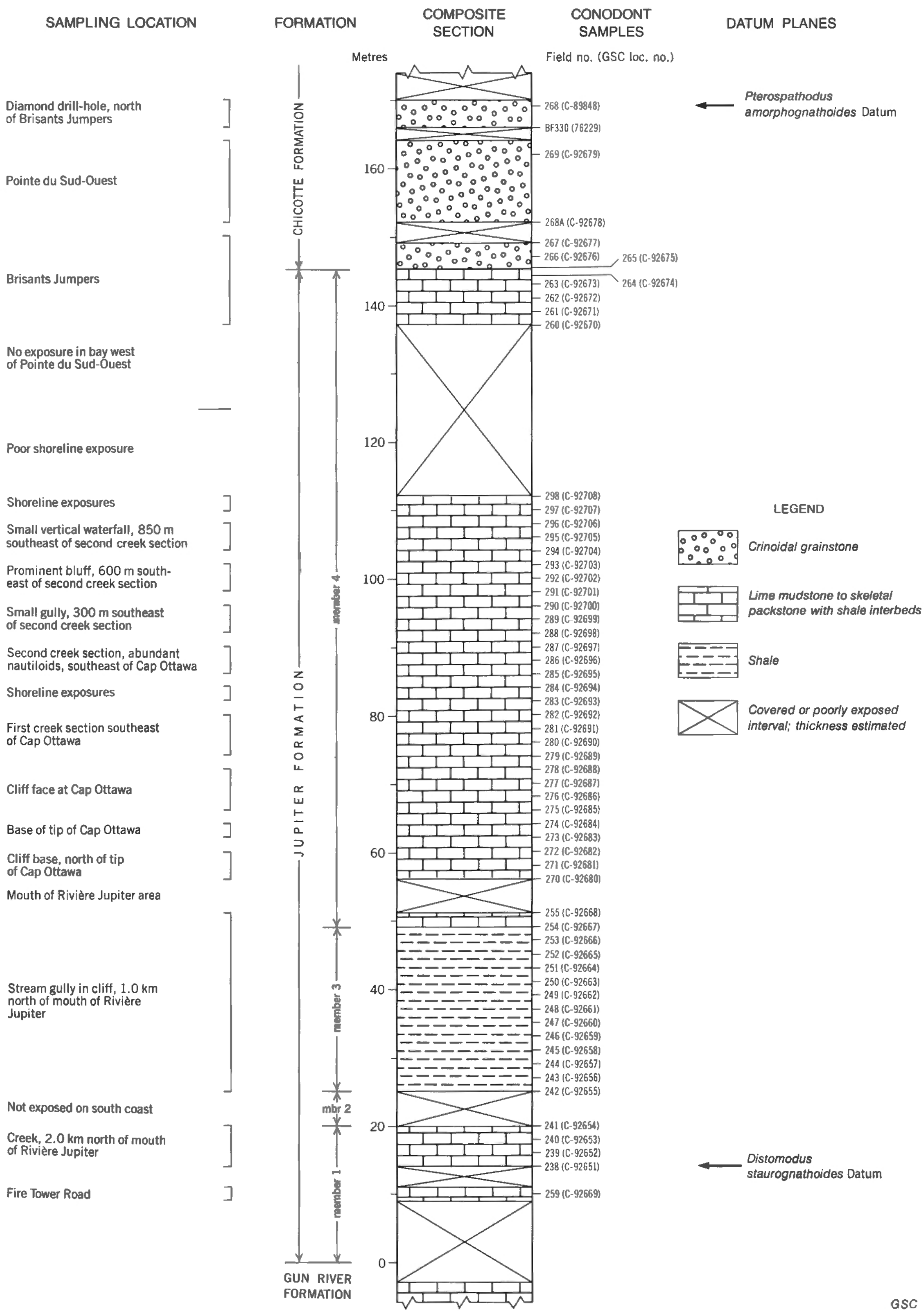

FIGURE 2. *Composite stratigraphic column for the Jupiter and Chicotte formations showing positions of the conodont samples and conodont datum planes, the informal lithostratigraphic units (members) of the Jupiter Formation, and the geographic location of the samples (see also Fig. 1 and text). The sample positions are identified by field and GSC locality numbers.*

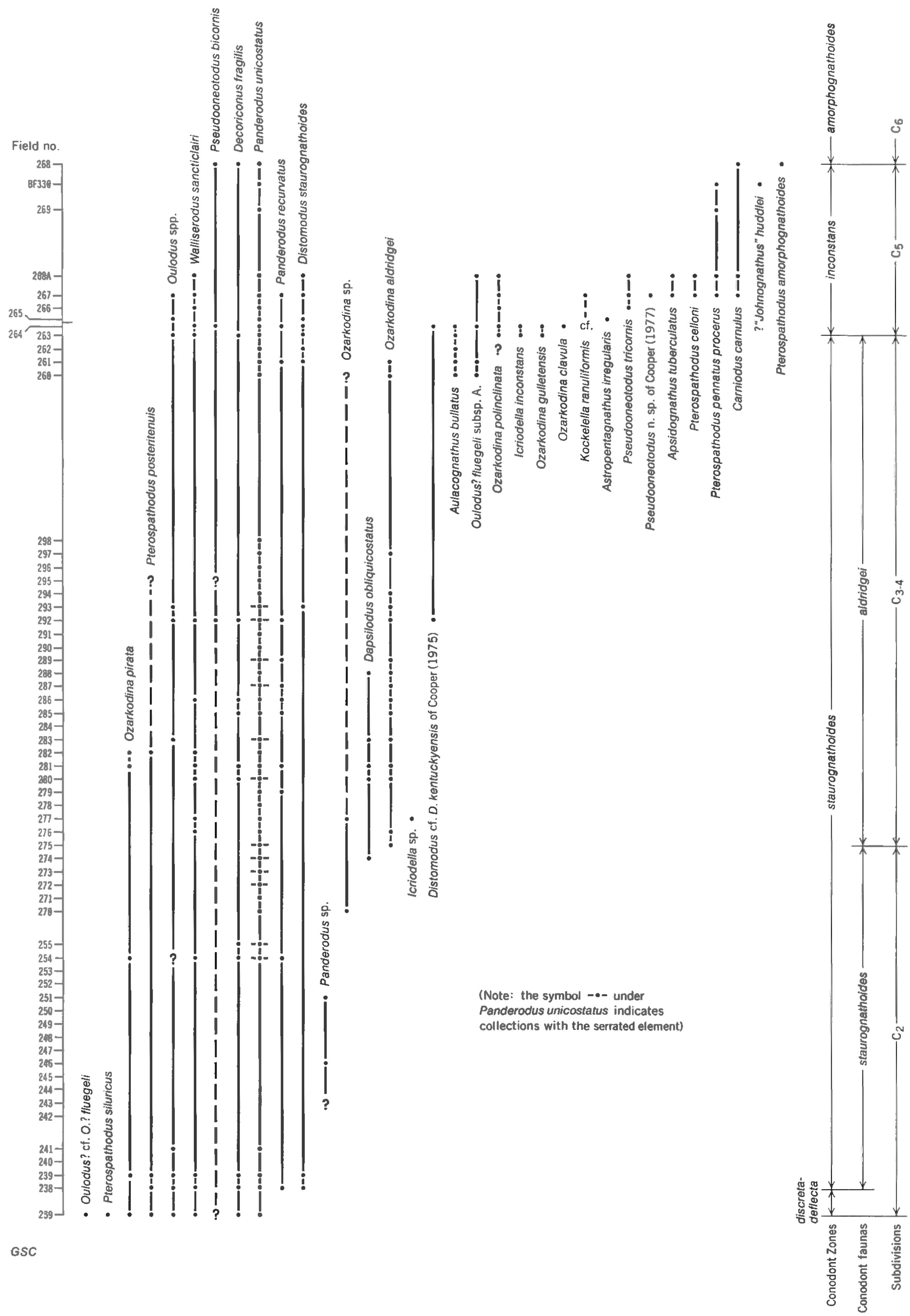

FIGURE 3. Conodont distribution and zonation of the Jupiter and Chicotte formations. Subdivisions shown are those established for the Llandovery Series by Jones (1925)

The internal subdivision of the Jupiter and Chicotte formations has been based partly on lithological and partly on paleontological criteria. Twenhofel (1928) and Bolton (1972) recognized local faunal subdivisions, essentially peak, or acme, zones. Thus, Bolton listed in ascending order, the divisions of *Triplesia anticostiensis*, *Dalmanites*, *Monograptus*, *Amphicyrtoceras futile*, and *Zygobolba decora*. He also referred to four informal lithologic members for the formation; these are adopted herein. The recent stratigraphic studies of Petryk have yet to be published in detail but four lower units are recognized together with two questionable higher units (Petryk, 1979, Table 2). The two divisions of the Chicotte Formation of Twenhofel (1928) have not been adopted by later workers.

For the present study, the type or reference sections of the Jupiter and Chicotte formations were sampled for conodonts. Excellent exposures allowed good stratigraphic control of sample locations although several intervals were partly covered. The stratigraphic sections were measured and described with conodont samples being taken, where possible, at 2-m intervals. Figure 2 documents the sample locations with respect to the informal members. Details of the sections are also provided by Barnes et al. (1981). Twenhofel (1928) and Bolton (1972) listed the dominant fossils found in the formations and Copeland (1974) provided an ostracode zonation for the Anticosti Island Silurian section with two zones and four subzones within the two formations. Several papers reviewing the Anticosti macro- and microfaunas are present in the recent volume edited by Lespérance (1981).

The informal members for the Jupiter Formation used by Bolton (1972) are not recognizable inland, but represent a convenient subdivision of the coastal exposures until a new subdivision is defined by Petryk. Member 1 [Bolton, 1972, Fig. 14 (=photo shown as Fig. 13)] consists of about 20 m of thin to medium bedded, grey-blue, lime mudstone and skeletal wackestone with rare crinoidal packstone; limestone beds are separated by distinct thin green-grey shale beds which comprise about 40 per cent of the unit; some upper bedding surfaces have concentrations of megafossils and others are extensively burrowed horizontally; the megafauna is dominated by brachiopods (e.g., *Triplesia anticostiensis* Twenhofel) with some horizons rich in corals or trilobites. The base of the Jupiter Formation is not well exposed on the south coast or along the Rivière Jupiter. Strata close to the base were collected along the Fire Tower road (13.6 km by road from Jupiter 24 camp). The sample [GSC (=Geological Survey of Canada) loc. C-92669; Fig. 2] was taken approximately 10 m above the base of the formation. Member 1 was sampled (GSC locs. C-92651 to C-92654) in the creek about 2.0 km north from the mouth of the Rivière Jupiter (Bolton, 1972, Fig. 14). Member 2 is not exposed along the coast except partially at low tide and was not sampled; it is an interval of green-grey shale and limestone approximately 5 m thick.

Member 3 is a distinctive unit exposed along the south coast (Bolton, 1972, Fig. 15) but with apparently limited extent eastwards or inland. It comprises about 30 m of green-grey shale, locally sandy, which was sampled (GSC locs. C-92655 to C-92666; Fig. 2) in a waterfall gully 1.0 km west of the mouth of Rivière Jupiter.

The remainder of the formation (about 90 m) is assigned to member 4 but may merit subdivision. The lower part of the member is exposed west of the mouth of the Rivière Jupiter with the remainder exposed to the east, starting at Cap Ottawa and continuing along the Côte Verte to the bay immediately west of Pointe de Sud-Ouest. The highest strata are not exposed in the bay but the uppermost 8 m outcrop at Brisants Jumpers (Copeland, 1974, Text-fig. 6). The lower 4 m (GSC locs. C-92667 and C-92668) of member 4 consist of thin to medium bedded, brown-grey lime mudstone, weathering yellow-grey, with shale interbeds near the base; specimens of *Monograptus sedgwickii* (Portlock) [=*M. clintonensis* (Hall)] are common. The overlying 56 m (GSC locs. C-92680 to C-92708; Fig. 2) are predominantly thin bedded, locally medium bedded, medium grey to brown-grey, lime mudstone with rare skeletal wackestone and packstone; partings and beds of shale up to 5 cm thick separate the limestones, locally burrowed, which have irregular upper and lower surfaces. As recorded by Twenhofel (1928) and Bolton (1972, 1981), these higher beds of the Jupiter Formation have a diverse fauna in which nautiloids [*Amphicyrtoceras futile* (Billings)], trilobites, and pentamerid and stricklandid brachiopods are each locally dominant. A stratigraphic interval, between about 35 to 8 m below the top of the formation, is not well exposed on the south coast. The upper 8 m (GSC locs. C-92670 to C-92674) comprise thin bedded, medium to dark grey lime mudstone to skeletal wackestone interbedded with thin shales, and also thin bedded crinoidal grainstone which thickens towards the top. These uppermost beds are abundantly fossiliferous particularly in brachiopods, trilobites, bryozoans, and crinoid debris.

According to Bolton (1972), brachiopods from the Jupiter Formation indicate an age of Late Llandovery; Berry and Boucot (1970, p. 168-169) likewise favoured a C_3-C_6 Llandovery age; Copper (1981) preferred a C_1-C_4 age. Based on ostracodes, Copeland (1974) correlated the formation with the Lower Clinton Group and the Ontarian Stage, Niagaran Series, of the North American midcontinent.

The base of the Chicotte Formation was sampled (GSC locs. C-92675 to C-92677; Fig. 2) at Brisants Jumpers and also at the slightly higher exposures at Pointe du Sud-Ouest (GSC locs. C-92678 and C-92679) and at the diamond drill-hole location immediately north of Brisants Jumpers (GSC loc. C-89848). In addition to these, a sample taken in 1966 by Copeland (1974, p. 10; GSC loc. 76229) on Pointe du Sud-Ouest road, 1.2 km from the south end of road and south shore of Anticosti Island, is included in this study. This sample of friable crinoidal limestone is estimated to be about 21 m above the base of the Chicotte Formation (Bolton, pers. comm., 1981). In this region, the lower two-thirds of the formation are exposed. The Chicotte is comprised predominantly of massive to thick bedded, white to pink and brown, coarse crinoidal grainstone with locally developed biostromes and small bioherms (coral-stromatoporoid boundstone). The formation is poorly cemented and weathers to a crinoidal rubble. The basal 1 m is a fine crinoidal grainstone with interbeds of grey shale. From the latter, Copeland (1974) recovered a rich ostracode fauna which is similar to that from the upper Jupiter Formation. Berry and Boucot (1970, p. 135) considered the brachiopods of the Chicotte to be of late C_6 of the Llandovery and early Wenlock age, an assignment also favoured by Bolton (1972, 1981); Copper (1981) preferred a C_5 age.

DEPOSITIONAL ENVIRONMENTS

Until the regional stratigraphic and sedimentologic studies of A.A. Petryk are completed, it is only possible to provide some generalized comments on the depositional environments of the Jupiter and Chicotte formations. Petryk (1979, Fig. 6; 1981, Fig. 24) has presented a general model for the Llandovery sequence of overall transgression with periodic regressive phases. He considered that the development of bioherms marked the peak of each regressive phase and that this occurred in the upper part of most of his redefined stratigraphic units (Petryk, 1979, Table 2).

The limestone-shale succession of the Jupiter and Chicotte formations represents a shallow, open, carbonate platform environment. If Petryk's model is accepted, members 1 and 2 of the Jupiter probably represent the initial phase of a transgressive pulse and a deeper subtidal environment. If the brachiopod community patterns established for the Llandovery (e.g., Ziegler et al., 1968; Ziegler and Boucot in Berry and Boucot, 1970) are applied to the Anticosti Island succession, the dominance of *Triplesia* in member 1 may suggest the presence of the *Microcardinalia* Community or its equivalent in proximity offshore, the *Stricklandia* Community (Ziegler and Boucot in Berry and Boucot, 1970, p. 100). The shale of member 3 is of limited geographic extent, and may represent a local clastic influx from the Canadian Shield to the north and probably a brief period of shallowing. The abundance of non-vascular plant spores in member 3 may also reflect shallowing (Duffield and Legault, 1981). The limestone-shale sequence and the diverse fauna of member 4 suggests a low energy environment with open circulation, only periodically disturbed by storms to produce concentrated skeletal wackestone and grainstone. The local dominance of pentamerid and stricklandid brachiopods may also favour a moderately deep subtidal environment. Ziegler and Boucot (in Berry and Boucot, 1970, p. 102) noted that the *Stricklandia* Community is present in the Jupiter Formation.

The crinoidal grainstone of the uppermost Jupiter Formation is possibly an initial indication of a shallowing phase. This lithology characterizes the Chicotte Formation with coral-stromatoporoid biostromes and bioherms particularly evident in the lower part of the formation. The lithology, cross-stratification, and the almost total disarticulation of the crinoid skeletons all suggest a high energy, shoal environment of migrating crinoidal sands and localized bioherms. Although the higher energy regime and biohermal development may be an indication of regional shallowing, following Petryk's (1979) model, the brachiopod fauna, with *Costistricklandia*, indicates the presence of the *Costistricklandia* Community (Ziegler and Boucot in Berry and Boucot, 1970, p. 104). This evolutionary successor to the *Stricklandia* Community is found in the Jupiter Formation and is regarded by those authors as having the same offshore position. The sudden appearance of crinoidal grainstone deposits in the late Llandovery and Wenlock is widespread in eastern and central North America and its development appears to be influenced by ecologic factors other than relative water depth. However, the higher energy and limited influx of clastic material are indicative of a different environmental regime for the Chicotte than that of the Jupiter Formation. In summary, the depositional environments of the Jupiter and Chicotte formations correspond to open carbonate platform and platform-edge carbonate sands, respectively; that is, to Facies 7 and 6, respectively, in the idealized sequence of Standard Facies Belts of Wilson (1970, 1974).

A recent attempt by Johnson et al. (1981) to determine and correlate Ordovician-Silurian sea-level fluctuations on eastern Anticosti Island is "beset with problems" as admitted elsewhere by one of the authors (Copper, 1981, p. 141). Communities are recognized at relatively few localities in the thick succession and the data presented are insufficient to be fully convincing, especially because "brachiopod-rich beds appear and disappear numerous times within the same section, making identification of a particular community very difficult or arbitrary" (Copper, 1981, p. 141). Specifically, the member 3 shale unit which, as suggested above, may reflect a shallow local clastic influx is regarded by Johnson et al. (1981, p. 77) as a deep-water (*Lissatrypa*-graptolite community) deposit yet absent to the east. If the shales of member 3 do represent deeper water events and yet are not preserved over a few tens of kilometres across eastern Anticosti Island, it must surely caution against correlations of sea-level fluctuations to New York, Michigan and Iowa (Johnson et al., 1981, Fig. 4).

THE CONODONT FAUNA

Member 1 of the Jupiter Formation is moderately productive of conodonts, particularly the lowermost sample (GSC loc. C-92669) which yielded over 400 specimens from a sample weighing 1.7 kg. This sample also produced some agglutinated foraminifers. The fauna is moderately diverse, represented by at least 11 taxa. Member 2 is not exposed on the south coast and was not sampled. The shale of member 3 is virtually devoid of conodonts; only 3 of 12 samples from this unit were productive, each bearing one specimen of *Panderodus*. The conodontophorid obviously avoided the turbid and possibly brackish waters, except for rare *Panderodus* which is generally believed to have been a pelagic and eurytopic animal (Seddon and Sweet, 1971; Druce, 1973; Barnes and Fåhraeus, 1975). Member 4 signals the return of a more hospitable environment. Excluding the uppermost part of the unit, the fauna is comparable to that of member 1, both in terms of abundance and diversity. One exceptionally abundant sample within this interval is from GSC locality C-92702, which yielded over 200 specimens from 2.0 kg; the diversity of this sample is approximately the same as for others of member 4. It is notable that this sample consists of a skeletal packstone in contrast to most of member 4 which comprises mainly dense lime mudstone. The uppermost 8 m or so (GSC locs. C-92670 to C-92674), consisting mainly of coarse skeletal packstone and grainstone and crinoidal grainstone, yielded an abundant and diverse conodont fauna. Five samples from this interval yielded some 2400 conodonts assigned to 17 taxa, at an average of 240 specimens per kg.

The change of environment suggested by the lithology of the Chicotte Formation, significantly reduced the abundance of conodonts compared to the uppermost Jupiter interval. The Chicotte Formation yielded some 1300 specimens at an average of 60 specimens per kg. One notable exception to this is GSC locality C-92677 which yielded some 900 specimens in a 2-kg sample, representing at least 13, and perhaps as many as 17, taxa.

Barrick (1981) proposed three intergrading conodont biofacies for the Wenlock part of the Wayne Formation of central Tennessee: (1) the *Panderodus unicostatus* Biofacies which is dominated by the nominal species and is largely the result of postmortem processes; it is characteristic of shallow water, high energy environments, in which the destruction of elements was greatest; (2) the Mixed Biofacies which is more abundant and diverse than the first, and not dominated by any one species; and (3) the *Dapsilodus obliquicostatus* Biofacies which shows a marked increase in the abundance of the nominal species compared to (2) but which, otherwise, is similar to it; it reflects the most offshore environments.

It is difficult to apply Barrick's concepts of biofacies to the Llandovery faunas of Anticosti Island. *Panderodus unicostatus* ranges throughout the studied interval (Fig. 3), but is only sporadically abundant (in member 1 of the Jupiter Formation, GSC loc. C-92669; in member 4, GSC locs. C-92702, C-92670, C-92671, C-92673, and C-92674; and in the Chicotte Formation GSC locs. C-92677 and C-92678). The faunas in these few samples are well preserved and moderately to extremely diverse, which indicate that they existed in an environment quite unlike that described for the *P. unicostatus* Biofacies of the Wayne Formation. *Distacodus obliquicostatus* is only sparsely present in thin intervals within member 4 of the Jupiter Formation, at approximately 15 m, 27 to 33 m, and 43 m above the base (Fig. 3). The faunas from these intervals may possibly be referable to the Mixed Biofacies. The variation in depositional environments within the limestone-shale sequence of member 4, is suggested by the local dominance of pentamerid and stricklandid brachiopods. At present, however, we see no obvious correlation between brachiopod and conodont biofacies. A similar conclusion was reached by Amsden et al. (1980) in a paleoenvironmental study of the Fitzhugh Member of the Clarita Formation of southern Oklahoma.

Biostratigraphy

Within the last two decades, conodonts have emerged as one of the prime index fossils for the Paleozoic, rivalling, and at times surpassing, the so-called orthochronologic fossils such as graptolites and ammonoids in their usefulness. The Silurian System is no exception to this, and zonations based on conodonts have been reported from various parts of the world. Among the earliest, and considered by many to be the cornerstone of such Silurian zonations, is that proposed by Walliser (1964), based principally on the succession at Cellon in the Carnic Alps of Austria. Unfortunately a greater part of the Llandovery is missing in that section (Schönlaub, 1971). As succinctly summarized recently by Cooper (1980), there is no single zonation at present that could be used as a suitable standard reference by all Silurian stratigraphers.

In view of this somewhat tenuous state of zonation, Cooper (1980) proposed the use of appearance and extinction "Datum Planes" for correlation between distant areas. The former is based on the first appearance of an index taxon whose phylogenetic lineage is known, and established at some reference sections.

Only the Chicotte Formation and the uppermost part of the Jupiter Formation can be correlated with Walliser's zonation. However, the conodonts from the entire Jupiter and Chicotte formations can be assigned with confidence to the zonation established by Aldridge (1972), based on strata in the Welsh Borderland.

Icriodella discreta-I. deflecta Zone

The lowest sample from member 1 of the Jupiter Formation (GSC loc. C-92669), from about 10 m above the base of the formation, contains *Pterospathodus siluricus* (Pollock, Rexroad and Nicoll), and is about 4 m below the first occurrence of *Distomodus staurognathoides* (Walliser). This sample may represent the uppermost part of the *Icriodella discreta-I. deflecta* Assemblage Zone of Aldridge (1972, p. 151), since conodonts from the underlying Becscie and Gun River formations have also been assigned to this zone (Fåhraeus and Barnes, 1981). In the Welsh Borderland, this zone extends into the C_2 interval of the Fronian Stage. For present purposes, this and other zones proposed by Aldridge are abbreviated after their first mention. Hereafter, the *Icriodella discreta-I. deflecta* Assemblage Zone will read as the *discreta-deflecta* Zone. The reader is referred to Figure 3 and tables 2-4 for the distribution of conodonts in the Jupiter and Chicotte formations, and the taxa are illustrated on plates 1-9.

Distomodus staurognathoides Zone

The remainder of member 1, presumably member 2, member 3, and a greater part of member 4, of the Jupiter Formation belong to the *Hadrognathus* [=*Distomodus*] *staurognathoides* Assemblage Zone of Aldridge (1972, p. 151). The upper limit of the zone is marked by the first occurrence of either *Icriodella inconstans* Aldridge or *I. malvernensis* Aldridge. According to Aldridge (*ibid.*), "This zone spans an interval from within the upper Fronian (C_{2-3}) to approximately the top of the C_4 division of the Telychian." In the Anticosti Island succession, the division between C_2 and C_{3-4} is suggested to occur between GSC localities C-92684 and C-92685, that is about 17 m above the base of member 4 (Fig. 3), with the first occurrence of *Ozarkodina* n. sp. B of Aldridge (1972) (=*O. aldridgei* n. sp., herein). This species was reported to range from C_{3-4} to within C_5 in the Welsh Borderland. The *staurognathoides* Zone may be subdivided into two informal units at this level: the lower *staurognathoides* fauna (C_2, mid-Fronian) and the higher *aldridgei* fauna (C_{3-4}, late Fronian-early Telychian).

Icriodella inconstans Zone

The uppermost part of the Jupiter Formation (GSC locs. C-92673 and C-92674) correlates with the *Icriodella inconstans* Assemblage Zone, which is confined to the C_5 subdivision of the Telychian (Aldridge, 1972, p. 153). The base of the zone was defined by the first occurrence of *Icriodella inconstans* or *I. malvernensis*. The upper limit was defined by the first occurrence of the zonal species of the succeeding zone, *Pterospathodus amorphognathoides* Walliser. Within the Anticosti Island sequence, the base of the *inconstans* Zone may eventually be lowered to the level of GSC locality C-92670 as suggested by the first occurrence there of *Aulacognathus bullatus* (Nicoll and Rexroad). This species is restricted to the C_5 subdivision in Britain, and to the *Pterospathodus celloni* Zone in the Carnic Alps. The zone extends as high as GSC locality C-92679 in the Chicotte Formation, approximately 17 m above the base of the formation. Other species characteristic of C_5 that are present include *Apsidognathus tuberculatus* Walliser, *Astropentagnathus irregularis* Mostler, and *Ozarkodina polinclinata* (Nicoll and Rexroad).

In the Carnic Alps, the base of the *celloni* Zone was defined by the first occurrence of the index species, *Pterospathodus celloni* [Walliser, 1964, p. 96, Table 2(I)]. In the Anticosti Island sequence, *P. celloni* first occurs at GSC locality C-92677, about 6 m above the first occurrence of *Icriodella inconstans* at GSC locality C-92673. A similar succession was observed in the Welsh Borderland (Aldridge, 1972, Tables II and III; 1975, Text-fig. 1). Consequently, some indications exist to suggest that the *celloni* Zone may correlate with an upper part of the *inconstans* Zone. The precise relationship of these zones has remained unclear, although suggestions have been made that they are exact equivalents (e.g., Klapper and Murphy, 1975, p. 7; Uyeno in Mayr et al., 1978, p. 393) or part equivalents (e.g., Aldridge, 1972, Text-fig. 12; 1979, p. 10; Cooper, 1975, Text-fig. 3; 1980, Fig. 5). One of the factors contributing to the obscurity of this relationship is the probable ecological preference of *Icriodella* for shallower waters (e.g., Seddon and Sweet, 1971).

At the Cellon section, the *celloni* Zone is underlain by an interval containing a fauna of Bereich I (Walliser, 1962, p. 282; 1964, p. 95-96). The exact age of this fauna is uncertain although Serpagli (1967, p. 4) and Schönlaub (1971, p. 38) have indicated it as Late Ordovician. Schönlaub (1980, p. 22) later considered the Ordovician-Silurian boundary to occur within sample 5 of Walliser [1964, Pl. 1, Table 2(I)], based principally on correlation of facies changes with a section at Feistritzgraben. The conodonts in the interval of samples 6 to 8, however, cannot be definitely assigned to the Silurian and appear to have closer affinity to the fauna in the underlying beds. Conodonts similar to the fragments referred to *Icriodina irregularis* Branson and Branson by Walliser (1964, p. 37, Pl. 4, fig. 3, Pl. 11, figs. 10-12) have been observed on either side of the boundary (e.g., Orchard, 1980, Pl. 1, figs. 22, 27). Furthermore, an abrupt large-scale change occurs in the conodont fauna beginning at sample 10. This, together with some evidence that the *celloni* Zone is a part equivalent of the *inconstans* Zone, suggests that an unconformity is present in the interval between samples 8 and 10 in the Cellon section.

***Pterospathodus amorphognathoides* Zone**

The uppermost Chicotte sample (GSC loc. C-89848), from approximately 24 m above the base of the formation, contains the first and only occurrence of *Pterospathodus amorphognathoides*. It marks the base of the *Pterospathodus amorphognathoides* Assemblage Zone of Aldridge (1972, p. 153), which occurs in the C_6 subdivision of the Telychian, and extends into the lower part of the Wenlock. The base of Walliser's (1964) *amorphognathoides* Zone is exactly equivalent to Aldridge's zone. The upper limit of the zone in the Welsh Borderland is unknown (Aldridge, *ibid.*; Aldridge, 1974, p. 300). In the Carnic Alps, the top is defined by the first occurrence of *Kockelella patula*, the index species of the superjacent zone [Walliser, 1964, p. 96, Table 2(II)]. In the Clarita sequence of Oklahoma, it is defined by the first occurrence of *Pseudooneotodus bicornis* Drygant, which marks the base of the overlying *ranuliformis* Zone (Barrick and Klapper, 1976, p. 64, Text-fig. 3).

Since GSC locality C-89848 represents the base of the *amorphognathoides* Zone, immediately overlying the *inconstans* Zone, it is highly probable that it is of late Telychian, rather than early Wenlock, age. The higher, unsampled parts of the Chicotte, of course, remain undated by conodonts. It is possible that the C_6 subdivision may start as low as GSC locality 76229, 21 m above the base of the Chicotte Formation, which includes a single fragmentary specimen, illustrated and questionably identified herein as ?"*Johnognathus*" *huddlei* Mashkova. This species is restricted to the *amorphognathoides* Zone in Podolia (Mashkova, 1977) and in Britain (Aldridge in Aldridge et al., 1979).

Apart from the Carnic Alps and the Welsh Borderland, where the main discussion above has centred, conodonts of the interval represented by the Jupiter and Chicotte formations have been reported from various parts of the world. Some of these have been summarized previously by Cooper (1980), Rexroad (1980), and Mashkova (1979 a, b). In the following, then, the more recent literature is included, and the North American occurrences are dealt with in more detail (Table 1).

In the Percé district of the Gaspé Peninsula, *Aulacognathus bullatus* was recovered from the highest unit, 9, of the White Head Formation (Nowlan, 1981, p. 267). As noted earlier, this species occurs in the uppermost beds of the Jupiter Formation on Anticosti Island, associated with *Icriodella inconstans* in the upper reaches of its range (Fig. 3). The tops of the Jupiter and White Head formations thus appear to be correlative. In the Chaleurs Bay district in the Gaspé area, *Icriodella inconstans* was recovered from about the middle part of the Anse Cascon Formation. Conodonts referable to the *inconstans* and *amorphognathoides* zones were reported from the Anse à Pierre-Loiselle Formation. *Pterospathodus amorphognathoides* itself was reported from the La Vieille Formation. Correlation between the Anticosti Island and Gaspé Peninsula sequences has been summarized by Nowlan (1981, Fig. 6) and consequently is not shown on Table 1 herein.

In the eastern United States, the *Icriodina irregularis* Assemblage Zone of Nicoll and Rexroad (1969, p. 6, 7) (=*Distomodus kentuckyensis* Zone of Cooper, 1975) was recorded from the Brassfield Limestone, below the Lee Creek Member, of southeastern Indiana, adjacent parts of Kentucky, and southern Ohio. The first occurrence of *Distomodus staurognathoides* is within this interval. The Lee Creek Member contains the *Neospathognathodus celloni* Assemblage Zone, which also includes the first occurrence of *Pterospathodus amorphognathoides*. The conodonts of the overlying Osgood Member of the Salamonie Dolomite were assigned to the *Pterospathodus amorphognathoides-Spathognathodus ranuliformis* (=*Kockelella ranuliformis* in multielement taxonomy) Assemblage Zone (Nicoll and Rexroad, 1969). The occurrences of these zones elsewhere in the neighbouring areas were summarized by Rexroad (1980). The relationship of these zones with the zonal scheme used on Anticosti Island is shown on Table 1.

Pollock et al. (1970, p. 746) introduced the *Panderodus simplex* (=*P. unicostatus* in multielement taxonomy) Assemblage Zone to fit in the interval between the Ordovician strata below and the *kentuckyensis* Zone above, based on conodont collections from Manitoulin Island, Ontario and the Midwest United States. Cooper (1975, p. 988) expressed his belief that this zone probably represents specific environmental conditions, and excluded it from his zonal scheme.

According to Rexroad and Rickard (1965; modified by Pollock et al., 1970, p. 746) and Telford (1978, p. 33, Fig. 7), at the well-known Niagara Gorge section of Ontario (Bolton, 1957), the *amorphognathoides* Zone occurs in the Rockway Dolomite Member of the Irondequoit Limestone (=upper part of the Reynales Limestone, according to Bolton, pers. comm., 1965; revision noted by Telford, *ibid.*), and the *celloni* Zone in the Hickory Corners Limestone Member of the Reynales Limestone (=lower part of the Reynales Limestone). The fauna in the underlying Neahga Shale was interpreted to belong to the *Icriodina irregularis* Zone. On the basis of presently available literature, it is difficult to determine where the remainder of the *staurognathoides* Zone may occur, if at all, within the Niagara succession.

At the Rocky Bay section of northern Bruce Peninsula, Ontario, the *kentuckyensis* and *amorphognathoides* zones are present in the Dyer Bay and St. Edmund members, respectively, of the Cabot Head Formation (Telford, 1978, Fig. 12; in Barnes et al., 1978, p. 68-69). Unfortunately, the intervening Wingfield Member yielded only *Panderodus*, but eventually may prove to belong to the *staurognathoides* and/or *inconstans* Zone(s).

Uyeno (in Bolton and Copeland, 1972, p. 18, Fig. 2, Table 1, Pl. 1, figs. 5-8) illustrated *Icriodella* n. sp. of Pollock et al. (1970) (=*I. deflecta* Aldridge) from about the middle of the Wabi Formation in the Lake Timiskaming region of Ontario and Quebec. The fauna is referable to the *discreta-deflecta* Zone. This is the only reported conodont fauna from the Wabi or the overlying Thornloe Formation.

TABLE 1

Conodont zonation and correlation of the Jupiter and Chicotte formations

CARNIC ALPS, AUSTRIA (Walliser, 1964; Schönlaub, 1971)	WELSH BORDERLAND, U.K. (Aldridge, 1972)			ANTICOSTI ISLAND (this study)		NIAGARA GORGE, ONTARIO (Rexroad and Rickard, 1965; Pollock et al., 1970; Telford, 1978)	LAKE TIMISKAMING REGION, ONTARIO, QUEBEC (Uyeno in Bolton and Copeland, 1972)	HUDSON BAY BASIN, ONTARIO, MANITOBA (Le Fèvre et al., 1976)	CINCINNATI ARCH OUTCROP AREA, INDIANA, KENTUCKY, OHIO (Rexroad and Nicoll, 1969; Cooper, 1975; Rexroad, 1980)		DATUM PLANES (Cooper, 1980)
ZONE	ASSEMBLAGE ZONE	DIVISION	SERIES AND STAGE	ZONE AND FAUNA	FORMATION						
amorphognathoides	*Pterospathodus amorphognathoides*	C6	Lower Wenlock	*amorphognathoides*		Reynales Ls, upper part			*Pterospathodus amorphognathoides-Kockelella ranuliformis*	Osgood Mbr, Salamonie Dolomite	
celloni	*Icriodella inconstans*	C5	Llandovery (part): Telychian	*inconstans*	CHICOTTE FM	Reynales Ls, lower part		Ecozones 7 (part), 8 ATTAWAPISKAT FM EKWAN FM SEVERN RIVER FM (uppermost part)	*Ozarkodina celloni*	Lee Creek Mbr, Brassfield Limestone	*Pterospathodus amorphognathoides* Datum
	Hadrognathus staurognathoides	C3-4	Llandovery (part): Fronian	*staurognathoides*: *aldridgei* fauna	JUPITER FM: mbr 4			?Ecozone 7 (part) ?SEVERN RIVER FM (mid and upper parts)	?	?	
underlying beds: Bereich I (Upper Ordovician)		C1-2	Llandovery (part): Fronian	*staurognathoides*: *staurognathoides* fauna	JUPITER FM: mbrs 1, 3						
	Icriodella discreta – I. deflecta	B1-3	Llandovery (part): Idwian	*discreta-deflecta*		Neahga Shale	WABI FM (part)	Ecozones 5, 6 SEVERN RIVER FM (lower part)	*Distomodus kentuckyensis*	Brassfield Limestone	*Distomodus staurognathoides* Datum

GSC

TABLE 2

Distribution of conodonts in members 1 and 3, Jupiter Formation

CONODONTS / GSC LOCALITY NUMBER	C-92669	C-92651	C-92652	C-92653	C-92654	C-92655	C-92656	C-92657	C-92658	C-92659	C-92660	C-92661	C-92662	C-92663	C-92664	C-92665	C-92666	Total
	←member 1				→	← member 3											→	
NUMBER OF SPECIMENS	463	89	23	0	23	0	1	0	0	1	0	0	0	0	1	0	0	601
WEIGHT (kg)	1.7	1.6	1.7	2.0	1.9	1.2	1.1	1.9	1.2	1.1	1.6	1.3	1.3	1.5	1.6	1.3	1.8	
FIELD NUMBER	259	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	
Decoriconus fragilis			×															×
Decoriconus fragilis (Sc)	×																	×
Decoriconus fragilis (Sb)	×																	×
Decoriconus fragilis (Sa)	×																	×
Distomodus staurognathoides (Pa)		1																1
Distomodus staurognathoides (Sb)			1															1
Distomodus staurognathoides (Sa)		1																1
Oulodus? cf. *O.? fluegeli* (Pa)	5																	5
Oulodus? cf. *O.? fluegeli* (Pb)	1																	1
Oulodus? cf. *O.? fluegeli* (Sc)	1																	1
Oulodus? cf. *O.? fluegeli* (Sb)	3																	3
Oulodus? cf. *O.? fluegeli* (Sa)	3																	3
Oulodus sp. A (M)	2		1															3
Oulodus sp. A (Sc)	2		1															3
Oulodus sp. A (Sa)	1																	1
Oulodus spp. (Pa)		1			1													2
Oulodus spp. (Sb)		?1			1													2
Ozarkodina pirata (Pa)	20		1															21
Ozarkodina pirata (Pb)	5		1															6
Ozarkodina pirata (M)*	13		3															16
Ozarkodina pirata (Sc)	2		1															3
Ozarkodina pirata (Sb)	5																	5
Ozarkodina pirata (Sb-Sa)	2																	2
Ozarkodina pirata (Sa)	3		1															4
Panderodus recurvatus		×																×
Panderodus unicostatus	×	×	×		×													×
Panderodus sp.							?1			1					1			3
Pseudooneotodus bicornis? (single denticle squat)	3																	3
Pterospathodus posteritenuis (Pa)	7																	7
Pterospathodus posteritenuis (Pb)	4																	4
Pterospathodus posteritenuis (M)	5																	5
Pterospathodus posteritenuis (Sc)	6	1	1															8
Pterospathodus posteritenuis (Sc-Sb)	2																	2
Pterospathodus posteritenuis (Sb)	7		1															8
Pterospathodus posteritenuis (Sb-Sa)	1																	1
Pterospathodus posteritenuis (Sa)	11		?1															12
Pterospathodus siluricus (Pa)	8																	8
Pterospathodus siluricus (Pb)	8																	8
Pterospathodus siluricus (M)	5																	5
Walliserodus sancticlairi	×	×	×															×
Unassigned elements:																		
Pb (ozarkodiniform)		1																1

*may have been shared with *Oulodus*? cf. *O.? fluegeli*

GSC

TABLE 3

Distribution of conodonts in member 4, Jupiter Formation

GSC LOCALITY NUMBER	FIELD NUMBER	WEIGHT (kg)	NUMBER OF SPECIMENS / CONODONTS	*Aulacognathus bullatus* (Pa)	*Aulacognathus bullatus* (Pb)	*Aulacognathus bullatus* (Sa?)	*Dapsilodus obliquicostatus*	*Dapsilodus obliquicostatus* (S)	*Decoriconus fragilis*	*Decoriconus fragilis* (Sc)	*Decoriconus fragilis* (Sb)	*Distomodus* cf. *D. kentuckyensis* (Pa; fused)	*Distomodus* cf. *D. kentuckyensis* (Pa; single)	*Distomodus staurognathoides* (Pa)	*Distomodus staurognathoides* (M)	*Distomodus staurognathoides* (Sc)	*Distomodus staurognathoides* (Sb)	*Distomodus staurognathoides* (Sa)	*Icriodella inconstans* (I)	*Icriodella inconstans* (M?)	*Icriodella* sp. (I)	*Kockelella* cf. *K. ranuliformis* (Pa)	*Oulodus? fluegeli* subsp. A (Pa)	*Oulodus? fluegeli* subsp. A (Pb)	*Oulodus? fluegeli* subsp. A (M)	*Oulodus? fluegeli* subsp. A (Sc)	*Oulodus? fluegeli* subsp. A (Sb)	*Oulodus? fluegeli* subsp. A (Sb-Sa)	*Oulodus? fluegeli* subsp. A (Sa)	*Oulodus* sp. B (Pa)	*Oulodus* sp. B (Pb)	*Oulodus* sp. B (M)	*Oulodus* sp. B (Sc)	*Oulodus* sp. B (Sb)	*Oulodus* sp. B (Sa)	*Oulodus* spp. (Pa)	*Oulodus* spp. (Pb)	*Oulodus* spp. (Sc)	*Oulodus*? sp. (Sb?)	*Ozarkodina aldridgei* (Pa)	*Ozarkodina aldridgei* (Pb)	*Ozarkodina aldridgei* (M)	*Ozarkodina aldridgei* (Sc)	*Ozarkodina aldridgei* (Sb)	*Ozarkodina aldridgei* (Sa)
C-92667	254	1.6	38						×																														1						
C-92668	255	1.9	21						×																																				
C-92680	270	2.1	9																																										
C-92681	271	1.7	6																																										
C-92682	272	2.0	9																																										
C-92683	273	1.8	8																																										
C-92684	274	1.8	5				×																																						
C-92685	275	2.0	17																																					1				?1	1
C-92686	276	2.0	7																																						1	1			
C-92687	277	1.8	19																		1																								
C-92688	278	2.0	3																																										
C-92689	279	1.9	5																																										
C-92690	280	2.0	55				×	×		×	×																													1	1	1	1		1
C-92691	281	2.0	66				×				×																														1	1			
C-92692	282	1.8	24																																										
C-92693	283	2.0	27				×																													1					1	1		1	
C-92694	284	1.7	0																																										
C-92695	285	2.0	51						×																															1		2			
C-92696	286	2.1	13						×																																2	1			
C-92697	287	2.0	29																																					1	1		1	3	
C-92698	288	2.1	18				×																																		1	1	1		
C-92699	289	2.0	45																																						1			1	
C-92700	290	1.6	4																																										
C-92701	291	1.8	5																																										
C-92702	292	2.0	251						×			1	1																	1	1	2	3	2	4					5	4	10	7	1	5
C-92703	293	1.5	49											1	2																				1						2	2	6	3	1
C-92704	294	2.1	10																																						1			1	
C-92705	295	2.0	11																																										
C-92706	296	1.8	7																																										
C-92707	297	1.8	4																																							1			
C-92708	298	1.8	1																																										
C-92670	260	1.9	812	3																			2	5	5	3	1		1											1	?				
C-92671	261	2.1	181	4	1	2									2	?1	2						1	2	2		1		2											1					
C-92672	262	2.0	32	3										1																															
C-92673	263	1.9	219	5	6				×					1	2	1	2	2	1																		1	1							
C-92674	264	2.0	1166	11	9							1		1	12		7		4	1		1	3	7	7	5	7	3	2																
	Total		3227	26	16	2	×	×	×	×	×	2	1	4	18	2	11	2	5	1	1	1	6	14	14	8	9	3	5	1	1	2	3	2	5	1	1	1	1	11	17	21	16	11	8

In the Hudson Bay Basin, ecozones 5 and 6 of Le Fèvre et al. (1976) in the lower Severn River Formation are probably assignable to the *kentuckyensis* Zone. The upper part of Ecozone 7 and Ecozone 8, which include the uppermost part of the Severn River Formation, and Ekwan and Attawapiskat formations, correlate with the *celloni* Zone. The middle and upper parts of the Severn River Formation may well represent the *staurognathoides* Zone.

In the Canadian Arctic Archipelago, *celloni* Zone conodonts were recovered from the Cape Phillips Formation at depths of 530.4 to 566.9 m in the Panarctic Tenneco et al. CSP Eids M-66 well, and in the Read Bay-Allen Bay carbonate unit at depths of 1767.8 to 1798.3 m, in the Panarctic ARCO et al. Blue Fiord E-46 well (Uyeno in Mayr et al., 1978, p. 393, 396). Both wells are located on southern Bjorne Peninsula in southwestern Ellesmere Island. The *celloni* Zone may also be represented in the Panarctic Deminex Garnier O-21 well, at depths of 664.5 to 670.6 m, located at northeastern Somerset Island (Uyeno in Mayr et al., 1980, p. 211). The *celloni* and *amorphognathoides* zones were recorded from the Cape Phillips Formation in the Canadian Arctic Archipelago (Barnes et al., 1976, p. 38).

A conodont fauna assigned to the *amorphognathoides* Zone was reported from near the base of the Heceta Limestone in southeastern Alaska (Ovenshine and Webster, 1970, p. C-173, C-174).

In southeastern British Columbia, conodonts of the *amorphognathoides* Zone were recovered from the Tegart Formation. There they are associated with a graptolite fauna indicative of the upper part of the *Monograptus spiralis* Zone (Norford, 1976, p. 39). Southwest of this locality, Rexroad (in Boucot et al., 1973, p. 15) noted the presence of *amorphognathoides* Zone conodonts in the eastern Klamath Belt of northern California. Conodonts of both the *celloni* and *amorphognathoides* zones were recorded from the Hidden Valley Dolomite in southeastern California (Miller, 1978).

GSC

Ozarkodina clavula (Pa)	6		6																																		
Ozarkodina clavula (Pb)	1		1																																		
Ozarkodina clavula (Sa)	2		2																																		
Ozarkodina gulletensis (Pa)	13		6	7																																	
Ozarkodina gulletensis (Pb)	7		5	2																																	
Ozarkodina gulletensis (M)	6		3	3																																	
Ozarkodina gulletensis (Sc)*	9		5	4																																	
Ozarkodina gulletensis (Sb)*	4		2	2																																	
Ozarkodina gulletensis (Sa)*	4		2	2																																	
Ozarkodina pirata (Pa)	2																								1													1
Ozarkodina pirata (Pb)	3																							2	1													
Ozarkodina pirata (Sc)	3																							1	1													1
Ozarkodina pirata (Sa)	2																							1	1													
Ozarkodina polinclinata (Pa)	7		5	1	?1																																
Ozarkodina polinclinata (Pb)	5		5																																		
Ozarkodina polinclinata (M)	6		5	1																																	
Ozarkodina polinclinata (Sb)	1			1																																	
Ozarkodina polinclinata (Sa)	1			1																																	
Ozarkodina spp. (Pa)	1																																			1		
Ozarkodina spp. (Pb)	3						?2																													1		
Ozarkodina spp. (M)	3						?3																															
Ozarkodina spp. (Sc)	2						?1																						1									
Ozarkodina spp. (Sb)	2						?1																						1									
Ozarkodina spp. (Sa)	3						?2																						1									
Panderodus recurvatus	x		x			x								x					x		x				x		x											x
Panderodus recurvatus (Sc)	x													x			3																					
Panderodus recurvatus (Sb)	x													x																								
Panderodus unicostatus	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Panderodus unicostatus (M)	x			x																																		
Panderodus unicostatus (Sc)	x			x																																		
Panderodus unicostatus (Sb)	x			x																																		
Panderodus unicostatus (Sa)	x			x																																		
Panderodus unicostatus (serrated element)	x												x	x			x		x				x			x					x	x	x	x			x	x
Pseudooneotodus bicornis (single denticle squat)	11		2								?2			7																								
Pseudooneotodus bicornis (two-denticle squat)	2		1											1																								
Pterospathodus posteritenuis (Sa)	2										?1													1														
Walliserodus sancticlairi	x		x	x																x				x	x	x			x	x								x
Walliserodus sancticlairi (M)	1													1																								
Walliserodus sancticlairi (Sd)	2													2																								
Walliserodus sancticlairi (Sc)	1													1																								
Walliserodus sancticlairi (Sb)	5													5																								
Walliserodus sancticlairi (Sa)	2													2																								
Simple cone elements, group "c" (Sa)	1		1																																			
Unassigned elements:																																						
Pb (ozarkodiniform)	1																										1											
M	1																															1						
Sc	5									1						1																	2	1				
Sb (grellingiform)	1																							1														
Sb	2														1						1																	
Sa	3																1																	2				
simple cone	7								2								2	1						1		1												

*may have been shared with *Ozarkodina polinclinata*

Silurian conodonts of Eureka County, central Nevada, were investigated by Klapper and Murphy (1975) and Murphy et al. (1979). Of the interval under discussion here, the former authors reported *celloni* Zone conodonts from the base of Roberts Mountains Formation at Birch Creek I and Pete Hansen II sections. Murphy et al. (1979) recovered conodonts older than the *celloni* Zone in the Hansen Creek interval below an unconformity, and those of the *celloni* Zone in the Roberts Mountains Formation above it. In addition to *Aulacognathus bullatus* and *Distomodus staurognathoides*, some interesting new forms are present in the Copenhagen Canyon [COP I; UCR (=University of California, Riverside) loc. 7365] section, in an interval bracketed by graptolite zones (of Elles and Wood) 18 below (UCR loc. 7393), and 22 or 23 above (UCR loc. 7366). Zone 18 is the *cyphus* Zone (A_4), 22 combines the *maximus* and *turriculatus* zones (C_{2-3}), and 23 the *crispus* Zone (C_4). Although this interval represents a lengthy span of time, the fauna is probably from the upper part of this range. In the Anticosti Island sequence, *A. bullatus* occurs in the upper part of the *staurognathoides* Zone (C_{3-4}) and the lowest part of the *inconstans* Zone (C_5), below the first occurrence of *Pterospathodus celloni*. A similar succession was recorded at the Birch Creek I section (Klapper and Murphy, 1975, Text-fig. 4) and at the Pete Hansen Creek section IB. Also in the Copenhagen Canyon section, graptolites of zone 18 are in turn bracketed by beds containing *Icriodina irregularis sensu* Rexroad (1967), which suggests that the *kentuckyensis* Zone ranges at least as low as A_4. Since only slightly over 2 m of strata occur between UCR localities 7365 and 7393, this interval is probably highly condensed, if unconformity is discounted.

Silurian conodonts from the Arbuckle Mountains of Oklahoma were studied by Barrick and Klapper (1976). Of the zones of interest in this paper, the *celloni* and *amorphognathoides* zones are represented, with the former occurring in the uppermost exposed part of the Cochrane Formation. The latter zone was identified in the Prices Falls Member, and in the lowest part of the Fitzhugh Member of the Clarita Formation.

TABLE 4

Distribution of conodonts in the Chicotte Formation

GSC LOCALITY NUMBER	C-92675	C-92676	C-92677	C-92678	C-92679	76229	C-89848		Total
FIELD NUMBER	265	266	267	268A	269	BF330	268		
WEIGHT (kg)	2.1	2.0	2.0	1.4	1.1	–	2.2		
NUMBER OF SPECIMENS / CONODONTS	43	66	929	203	11	5	31		1288
Apsidognathus tuberculatus (Pa1)			2	2					4
Apsidognathus tuberculatus (Pa2)			4	3					7
Apsidognathus tuberculatus (Pb)			2	1					3
Apsidognathus tuberculatus (Sa)			5	1					6
Astropentagnathus irregularis (Pa1)	2								2
Astropentagnathus irregularis (Pa2)	2								2
Astropentagnathus irregularis (S?)	1								1
Carniodus carnulus (Pa)			21	2					23
Carniodus carnulus (Pb)			26	4			1		31
Carniodus carnulus (Pb; "abbreviated")			4						4
Carniodus carnulus (M)			5						5
Carniodus carnulus (Sc)			9	1			1		11
Carniodus carnulus (Sb)			6	1			1		8
Carniodus carnulus (Sa)			12	2					14
Decoriconus fragilis (Sa)							4		4
Distomodus staurognathoides (Pa)	1								1
Distomodus staurognathoides (M)	2		4						6
Distomodus staurognathoides (Sc)	5		2	2					9
Distomodus staurognathoides (Sb)	1		1	1					3
Distomodus staurognathoides (Sa)	1		1	1					3
?"*Johnognathus*" *huddlei*						1			1
Kockelella ranuliformis (Pa)			2						2
Kockelella ranuliformis (Sc)			2						2
Kockelella ranuliformis (Sb)			1						1
Kockelella ranuliformis (Sa)			2						2
Oulodus? fluegeli subsp. A (Pa)				1					1
Oulodus? fluegeli subsp. A (Sc)				1					1
Oulodus? fluegeli subsp. A (Sb)				1					1
Oulodus spp. (Pa)	1		1						2
Oulodus spp. (M)	1		1						2
Oulodus spp. (Sc)	2		2						4
Ozarkodina polinclinata (Pa)		1	20	11					32

Conodonts of the *amorphognathoides* Zone have been reported from the basal shaly beds of the Maddox Member of the Wayne Formation in central Tennessee (Barrick, 1981), and from the upper part of the Rose Hill Formation in West Virginia and Maryland (Helfrich, 1980).

Mashkova (1979b p. 200, Table 1) proposed a biozone consisting of five sequential assemblages, based primarily on *Ozarkodina*, for the Silurian strata of the USSR. The oldest of these assemblages was termed "*Polinclinata* (*amorphognathoides*)" with *Ozarkodina polinclinata* and *Kockelella ranuliformis* as its characteristic species. Other species of this assemblage include *Pterospathodus amorphognathoides*, *Apsidognathus tuberculatus*, *Carniodus carnulus*, *Distomodus staurognathoides* and *Johnognathus huddlei*. This assemblage was reported from the Restevo and Demshinsk beds of the Kitaigorod Stage of Podolia. Although these species, with the possible exception of the last, are present in the Jupiter and Chicotte formations, their occurrences are scattered and are not found together at any single locality (see Fig. 3). Mashkova (1979b, p. 204) stressed that these groupings are assemblages and should not be considered as zones without further detailed studies. In terms of established zonal schemes, the *polinclinata* assemblage equates with the *amorphognathoides* Zone. The occurrences of *amorphognathoides* Zone elsewhere in the USSR was summarized by Mashkova (1979b, p. 200-201).

Although the assemblages of the *Ozarkodina* biozone are sequential, they are not in continuous succession, leaving some gaps between these intervals (Mashkova, 1979b, Table 1). The *sagitta* assemblage, for example, which succeeds the *polinclinata* assemblage and which is characterized by *Ozarkodina sagitta rhenana* (Walliser), is about mid-Wenlock age (see Barrick and Klapper, 1976, Fig. 3). In terms of the Clarita conodont sequence, there appears to be one zone missing between these assemblages.

Silurian conodonts obtained from a series of drill holes in Estonia were examined by Viira (1977). The key reference well among these was the Ohesaare drill hole located on southwestern Saaremaa Island. In this well the interval of 371.0 to 385.3 m appears to correspond to the lower part of the *inconstans* Zone and the highest part of the *staurognathoides* Zone of the Anticosti Island succession. This interval has yielded "*Lonchodina*" *fluegeli* Walliser, "*Neoprioniodus*" *planus* Walliser, "*Ligonodina*" *egregia* Walliser, and ?"*Roundya*" *trichonodelloides* Walliser, which may represent the elements of the apparatus of *Oulodus*? *fluegeli* (Walliser). The presence of *Aulacognathus* sp. adds further support to this correlation. On Saaremaa Island, this interval occurs in the upper part of the Raikküla (G_3) and the lowest part of the Adavere (H) stages. That part of the Ohesaare well below the level of 385.3 m is difficult to correlate on the basis of currently available information. The *celloni* Zone occurs in the interval of 357.5 to 371.4 m, in the lower half of the Adavere (H) Stage. The overlying *amorphognathoides* Zone has its base at the level of 357.5 m; its upper limit is difficult to place since the markers of the superjacent zone appear to be absent. "*Spathognathodus*" *corpulentus* Viira, which has its first occurrence at 294.0 m, may be conspecific with *Kockelella walliser* (Helfrich) (see Mashkova, 1979b, Table 1; Cooper, 1980, p. 221; Klapper in Ziegler, ed., 1981, p. 167). In Oklahoma, the latter species is confined to the *ranuliformis* and *amsdeni* zones which equate approximately with the *patula* Zone of Walliser (1964) (Barrick and Klapper, 1976, p. 64, Text-fig. 3). In the Rhenish Schiefergebirge this species occurs in the *sagitta* Zone (Walliser, 1964, p. 88). It appears that the *amorphognathoides* Zone occupies at least the upper half of the Adavere Stage, and probably a part of the Jaani (J_1) Stage as well (see also Mashkova, 1979b, p. 201).

Ozarkodina polinclinata (Pb)	5					2	1	2	
Ozarkodina polinclinata (M)	8					2	6		
Ozarkodina polinclinata (Sc)	6					3	3		
Ozarkodina polinclinata (Sb)	3					1	2		
Ozarkodina polinclinata (Sa)	3					1	1	1	
Panderodus recurvatus	X						X		
Panderodus unicostatus	X		X	X	X	X	X	X	X
Pseudooneotodus bicornis (single denticle squat)	9		9						
Pseudooneotodus bicornis (two-denticle squat)	1		1						
Pseudooneotodus tricornis (single denticle squat)	29					2	27		
Pseudooneotodus tricornis (three-denticle squat)	33					7	25	1	
Pseudooneotodus n. sp. of Cooper (1977) (M?)	1						1		
Pseudooneotodus n. sp. of Cooper (1977) (Sc)	1						1		
Pseudooneotodus n. sp. of Cooper (1977) (Sb)	1						1		
Pseudooneotodus n. sp. of Cooper (1977) (Sa)	1						1		
Pterospathodus amorphognathoides (Pa)	1		1						
Pterospathodus celloni (Pa)	16					4	12		
Pterospathodus celloni (Pb)	15					4	11		
Pterospathodus celloni (M)	7						7		
Pterospathodus celloni (S)	6					4	2		
Pterospathodus pennatus procerus (Pa)	10			2	1	3	4		
Pterospathodus pennatus procerus (Pb)	7					?1	6		
Pterospathodus pennatus procerus (M)	1						1		
Walliserodus sancticlairi	X							X	
Walliserodus sancticlairi (M)	2						2		
Walliserodus sancticlairi (Sd)	1						1		
Walliserodus sancticlairi (Sc)	5					2	3		
Walliserodus sancticlairi (Sb)	2						2		
Walliserodus sancticlairi (Sa)	5					1	4		
Simple cone elements, group "a"	4						4		
Simple cone elements, group "b"	2						2		
Simple cone elements, group "c" (Sc)	4						4		
Simple cone elements, group "c" (Sb)	3						3		
Simple cone elements, group "c" (Sb-Sa)	1						1		
Simple cone elements, group "c" (Sa)	3						3		
Simple cone elements, group "d" (Sc)	5					1	4		
Simple cone elements, group "d" (Sb)	12					1	11		
Simple cone elements, group "d" (Sa)	4						4		
Unassigned elements:									
Pb	1		1						
Sc	2		2						
Sb	4			2	1	1			
Sa	2		1		1				
simple cone	2					2			

GSC

As noted at the outset of this discussion, Cooper (1980) introduced several "Datum Planes" in an attempt to interrelate the several published zonal schemes for the Silurian. The concept may be of special aid to the Lower Silurian since these zonal schemes appear largely to be applicable only locally. Two Datum Planes are present in the interval under study; the *Distomodus staurognathoides* Datum in member 1 of the Jupiter Formation (GSC loc. C-92651), and the *Pterospathodus amorphognathoides* Datum in the Chicotte Formation (GSC loc. C-89848).

Pterospathodus siluricus occurs at GSC locality C-92669, the only sample below GSC locality C-92651, and is a species that occurs below the *Distomodus staurognathoides* Datum (Cooper, 1980, p. 218). It is interesting to note the occurrence of *Pterospathodus posteritenuis* in members 1 and 4 of the Jupiter Formation, since it appears to be a phyletically late form of *Amorphognathus tenuis* Aldridge, another species that is restricted to below the Datum.

With the exception of only two species, all of the taxa listed by Cooper (1980, p. 219) to occur between the *Distomodus staurognathoides* Datum and the *Pterospathodus amorphognathoides* Datum, are present in the Anticosti Island succession within this interval. These include *D. staurognathoides*, *Astropentagnathus irregularis*, *Apsidognathus tuberculatus*, *Aulacognathus bullatus*, *Icriodella inconstans*, *Pterospathodus celloni*, *P. pennatus* (Walliser), *Oulodus petilus* (Nicoll and Rexroad) [?=*Oulodus*? *fluegeli* subsp. A herein], *Ozarkodina polinclinata* and *Kockelella ranuliformis* (Walliser).

The *Pterospathodus amorphognathoides* Datum takes on added significance in the Anticosti Island succession since the phylogeny of this species can be well demonstrated. The earliest recognized species of this lineage is *Pterospathodus celloni*, which occurs in GSC localities C-92677 and C-92678, followed by *P. pennatus*, which overlaps with *P. celloni* and ranges up to GSC locality C-92679, and finally *P. amorphognathoides* occurs at GSC locality C-89848. This phylogeny was observed earlier in the Cellon section of Austria by Walliser (1964).

In summary, on the basis of conodonts the Jupiter and Chicotte formations may be assigned to four zones previously established in the Welsh Borderland: (1) the lowest sample in member 1 of the Jupiter Formation (GSC loc. C-92669) represents the uppermost part of the *discreta-deflecta* Zone (C_2, Fronian). (2) The remainder of member 1 through the upper beds of member 4 of the Jupiter Formation are assignable to the *staurognathoides* Zone (C_2 and C_{3-4}, Fronian to early Telychian). This zone in the Anticosti Island sequence may be subdivided into a lower *staurognathoides* fauna (C_2, mid-Fronian) and an upper *aldridgei* fauna (C_{3-4}, late Fronian-early Telychian), the demarcation line occurring between GSC localities C-92684 and C-92685. (3) The highest part of the Jupiter Formation and approximately the lower 24 m of the overlying Chicotte Formation belong to the *inconstans* Zone (C_5, Telychian). The *celloni* Zone is suggested to be equivalent to an upper part of the *inconstans* Zone. (4) The highest available sample from the Chicotte Formation, from approximately 24 m above the base of the unit, is assignable to the *amorphognathoides* Zone (C_6, late Telychian).

SYSTEMATIC PALEONTOLOGY

This section was prepared by T.T. Uyeno, and subsequent references to new species or other parts of this section should be stated as Uyeno in Uyeno and Barnes.

Locational notations are after Klapper and Philip (1971, 1972) for icriodontid elements, and Sweet and Schönlaub (1975), modified by Cooper (1975, 1976, 1977), for others.

The primary type and figured specimens are deposited in the collections of the Geological Survey of Canada, Ottawa.

CONODONTA

Genus *Apsidognathus* Walliser, 1964

Type species. *Apsidognathus tuberculatus* Walliser, 1964.

Apsidognathus tuberculatus Walliser

Plate 6, figures 6-14

Apsidognathus tuberculatus n. sp. WALLISER, 1964, p. 29-30, Pl. 5, fig. 1, Pl. 12, figs. 16-22, Pl. 13, figs. 1-5 (Pa_1); NICOLL and REXROAD, 1969, p. 24, Pl. 3, fig. 8 (Pa_1); WALLISER, 1972, p. 76 (multielement); ALDRIDGE, 1972, p. 165, Pl. 2, figs. 7, 9 (Pa_1); ALDRIDGE, 1975, Pl. 1, figs. 1, 2 (multielement); HELFRICH, 1980, Pl. 1, figs. 25, 29 (multielement); UYENO in Uyeno and Barnes, 1981, Pl. 1, figs. 14-17 (multielement); NOWLAN, 1981, Pl. 7, figs. 7, 12-14, 17 (multielement).

Astrognathus tetractis n. sp. WALLISER, 1964, p. 30, Pl. 5, fig. 4, Pl. 14, figs. 1, 2 (Pb); SCHÖNLAUB, 1971, p. 46, Pl. 2, fig. 15 (Pb); ALDRIDGE, 1972, p. 166, Pl. 3, fig. 1 (Pb).

?*Pygodus lenticularis* n. sp. WALLISER, 1964, p. 67-68, Pl. 4, fig. 17, Pl. 12, fig. 15 (Pa_2); ALDRIDGE, 1975, Pl. 3, figs. 22, 23 (Pa_2).

Pygodus lyra n. sp. WALLISER, 1964, p. 68, Pl. 5, fig. 5, Pl. 12, figs. 8-14 (Sa).

Pygodus lenticularis Walliser, SCHÖNLAUB, 1971, p. 48, Pl. 2, figs. 13, 14 (Pa_2).

Pygodus? *lyra* Walliser, ALDRIDGE, 1972, p. 210, Pl. 3, fig. 2 (Sa).

Diagnosis. A species of *Apsidognathus* in which all known constituent elements show broad, shallow excavation in the lower surface. The two Pa elements display a central, slightly offset carina which, in Pa_1 forms a free blade. The anterior half of the carina is flanked on either side by a converging ridge comprising a series of nodes. In the Pa_2 element, the carina bifurcates near the anterior end, resulting in a similar, but vaguely outlined, V-shaped set of ridges. The Pb element is cruciform, formed by a blade and flanked laterally by two centrally located denticulated processes. In the Pb element, the excavation extends throughout the length of the blade, and under the lateral processes, it is restricted to an area near their junction with the blade.

Description. The Pa_1 element is a highly modified amorphognathiform with six main ridges of varying length that diverge from a point in the centre of the unit. The ridges consist of a series of tubercles, all about equal height so that there is no cusp. One of the ridges extends beyond the platform at the anterior end, forming a short free blade. The area between these ridges may have random tubercles or secondary ridges composed of more subdued tubercles. The under side of the unit is completely excavated.

The Pa_2 element is a modified ambalodiform with three ridges similar in appearance to those in the amorphognathiform. There is no cusp, and the ridges diverge from a point located about one-quarter of unit length from the anterior end. The inter-ridge area may have some subdued tubercles. The lower surface is similarly excavated, and the cavity extends as a narrow slit into a sheath at the anterior end. Both the anterior and posterior ends are bluntly pointed.

The Pb element is cruciform, formed by a blade and flanked laterally by two centrally located denticulated processes. The lower side is excavated under the blade, with the cavity extending only slightly under the lateral processes. (The illustrated Pb element on Plate 6, figure 9, is an aberrant form with an abbreviated anterior part of the blade.)

The bilaterally symmetrical Sa element is pygodiform with a central carina in the posterior half of the unit. The carina extends posteriorly, forming, in some specimens, a short posterior process. V-shaped ridges, consisting of a series of subdued irregular nodes, form the lateral margins. A deep depression is formed in the area surrounded by the central carina and lateral ridges. The lateral ridges converge anteriorly to a blunt end. The lower surface is shallowly and entirely excavated, with the deepest part located near the midlength of the unit.

Remarks. The descriptions above are necessarily brief as most of the elements here assigned to *Apsidognathus tuberculatus* have been described in the literature (see Synonymy). Both the Pa_2 and Sa elements in the Anticosti material are morphologically closer to those either described and/or illustrated from the Welsh Borderland by Aldridge (1972, 1975), than to those illustrated from the Carnic Alps (Walliser, 1964). Aldridge (pers. comm., Oct. 1980) noted a similarly elongated *lenticularis* form in Walliser's (1964) collections from the Cellon section, in sample 10E. This finding is not unexpected since Schönlaub (1971) illustrated an elongated Pa_2 element that is similar to the Anticosti and Welsh specimens from the Seewarte section, also in the Carnic Alps. The Pb element of the apparatus was illustrated previously by Helfrich (1980, Pl. 1, fig. 25).

The Sa element is very similar to the pygodiform element of *Apsidognathus walmsleyi* Aldridge (1974, figs. C, D). Consequently, there appears to be a gradual morphologic gradation in the pygodiform from the form illustrated by Walliser (1964), to that from the Welsh Borderland (Aldridge, 1972), to the present specimens.

The *Apsidognathus tuberculatus* apparatus is reconstructed here on the basis of two samples from the Chicotte Formation; one from Brisants Jumpers (GSC loc. C-92667), and the other from Pointe du Sud-Ouest (GSC loc. C-92678), both from an interval assigned to the *inconstans* Zone. Aldridge (1972, 1975, pers. comm., Oct. 1980) recovered the apparatus from the Wych Formation at

Gullet Quarry in the Malvern Hills, Welsh Borderland (sample Gullet 4). The rather unusual composition of this apparatus suggests that the present reconstruction is probably incomplete.

Apparatuses with two platform elements are not uncommon. Such species include *Polyplacognathus ramosus* Stauffer of Middle Ordovician age, and *Astropentagnathus irregularis* Mostler (also see under Systematics of this paper).

Walliser (1972 p. 76), as first reviser, chose *Apsidognathus tuberculatus* to have nomenclatural priority.

Figured specimens. GSC 64842-64845, 64971-64975.

Genus *Astropentagnathus* Mostler, 1967

Type species. Astropentagnathus irregularis Mostler, 1967.

Astropentagnathus irregularis Mostler

Plate 4, figures 23, 24

Astropentagnathus irregularis n. sp. MOSTLER, 1967, p. 298-300, Pl. 1, figs 1-11 (Pa_1); ALDRIDGE, 1972, p. 166-167, Pl. 2, fig. 5 (Pa_1); ALDRIDGE, 1975, Pl. 3, fig. 14 (Pa_1); KLAPPER and MURPHY, 1975, p. 24-25, Pl. 1, figs. 1, 15-18 (multielement); PICKETT, 1978, Pl. 1, fig. 29 (Pa_1); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 13 (Pa_1).

Spathognathodus tyrolensis n. sp. MOSTLER, 1967, p. 302, Pl. 1, figs. 17, 19, 20, 23 (Pa_2).

Hadrognathus irregularis (Mostler), SCHÖNLAUB, 1971, p. 42-43, Pl. 1, figs. 1-11 (multielement); MILLER, 1978, Pl. 4, figs. 5-7 (multielement).

"*Rhynchognathodus*" n. sp., SCHÖNLAUB, 1971, p. 48-49, Pl. 3, figs. 15-19 (S?).

Remarks. All three elements known to date as constituents of the *Astropentagnathus irregularis* apparatus have been recovered from the Chicotte Formation at Brisants Jumpers (GSC loc. C-92675). The inclusion of "*Rhynchognathodus*" n. sp. of Schönlaub (1971) was suggested earlier by Klapper and Murphy (1975, p. 25). Cooper (1977, p. 1066) disagreed with Schönlaub's (1971) placement of this species in *Hadrognathus*, and suggested its reassignment to *Astropentagnathus*.

Figured specimens. GSC 64841, 64947.

Genus *Aulacognathus* Mostler, 1967

Type species. Aulacognathus kuehni Mostler, 1967.

Aulacognathus bullatus (Nicoll and Rexroad)

Plate 4, figures 18, 20-22

Spathognathodus sp., ex aff. *Sp. celloni* Walliser, WALLISER, 1964, p. 74, Pl. 14, figs. 17, 18, text-fig. 7a (Pa).

Ozarkodina sp., ex aff. *Oz. adiutricis* Walliser, WALLISER, 1964, p. 54, Pl. 27, fig. 11, text-fig. 7n (Pb).

Neospathognathodus bullatus n. sp. NICOLL and REXROAD, 1969, p. 44-45, Pl. 1, figs. 5-7 (Pa); ALDRIDGE, 1972, p. 196, Pl. 3, fig. 15 (Pa); SCHÖNLAUB, 1975, p. 59, Pl. 1, fig. 6 (Pa).

Ozarkodina adiutricis Walliser?, NICOLL and REXROAD, 1969, p. 49, Pl. 2, figs. 6, 7 (Pb); PICKETT, 1978, Pl. 1, fig. 34 (Pb).

Aulacognathus bullatus (Nicoll and Rexroad), KLAPPER and MURPHY, 1975, p. 26, Pl. 2, figs. 15-20 (Pa); MILLER, 1978, Pl. 4, figs. 22-24 (Pa); MURPHY et al., 1979, text-fig. 19-3 (Pa); ALDRIDGE, 1979, p. 11, Pl. 1, figs. 1, 6, 7 (Pa); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 6 (Pa); NOWLAN, 1981, Pl. 5, figs. 20, 23, 24 (multielement).

Neospathognathodus latus Nicoll and Rexroad, PICKETT, 1978, p. 35, Pl. 1, fig. 31 (Pa).

Remarks. The Pa element of *Aulacognathus bullatus* has been well described in the literature. The Pb element is a highly arched ozarkodiniform, and is especially well illustrated in Walliser (1964, text-fig. 7n). The short lateral process on the outer side is a continuation of a ridge developed at or near the cusp, and bears two stubby denticles. The inner side of the blade may be flat (Pl. 4, fig. 22), or may have an offset, slight protuberance of the basal cavity, with an accompanying low lateral ridge (Pl. 4, fig. 18). Klapper and Murphy (1975) were the first to note that Walliser's (1964) form represented a growth stage of *Aulacognathus bullatus*. Similar intermediate forms were recovered from member 4 of the Jupiter Formation at Brisants Jumpers (GSC loc. C-92674).

Both the Pa and Pb elements were previously reported from the *celloni* Zone at the Cellon section (Walliser, 1964), the Lee Creek Member of Brassfield Limestone of southeastern Indiana (Nicoll and Rexroad, 1969), and the Liscombe Pools Limestone of New South Wales, Australia (Pickett, 1978).

Aldridge (1979, p. 11) quite correctly expressed concern in reconstructing *Aulacognathus* apparatuses based on ambiguous material, such as those in which the arched blade element is associated with two or more different morphotypes of the Pa element. The present reconstruction is believed to be correct since (1) the Pa and Pb elements are represented by a single morphotype each, occurring together in three samples, and (2) the same association has been reported from the same sample at four widely separated localities (on three continents).

Figured specimens. GSC 64835, 64944-64946.

Genus *Carniodus* Walliser, 1964

Type species. *Carniodus carnulus* Walliser, 1964.

Carniodus carnulus Walliser

Plate 5, figures 1-10

Carniodus carnulus n. sp. WALLISER, 1964, p. 32-33, Pl. 6, fig. 10, Pl. 10, figs. 20, 21, Pl. 27, figs. 27-38, Pl. 28, fig. 1, text-figs. 4a-f (Pa); ALDRIDGE, 1975, Pl. 1, figs. 3, 4, 8, 9 (multielement); BARRICK and KLAPPER, 1976, p. 68-69, Pl. 1, figs. 1, 2, 6-8, 12-14 (multielement; includes synonymy); LIEBE and REXROAD, 1977, Pl. 1, fig. 3 (Pa); HELFRICH, 1980, Pl. 1, figs. 1-6 (multielement); UYENO in Uyeno and Barnes, 1981, Pl. 1, figs. 18, 19 (multielement); NOWLAN, 1981, Pl. 7, figs. 8-11 (multielement).

Carniodus carnicus Walliser, ALDRIDGE, 1975, Pl. 3, fig. 12 (M); LIEBE and REXROAD, 1977, Pl. 1, fig. 4 (M).

Exochognathus latialatus (Walliser), ALDRIDGE, 1975, Pl. 3, fig. 15 (Sa); LIEBE and REXROAD, 1977, Pl. 1, fig. 16 (Sa).

Carniodus carinthiacus Walliser, LIEBE and REXROAD, 1977, Pl. 1, fig. 2 (Pb).

Neoprioniodus subcarnus Walliser, LIEBE and REXROAD, 1977, Pl. 1, fig. 1 (Sc).

Apparatus "D" of Walliser, MILLER, 1978, Pl. 4, figs. 14-17 (multielement).

Remarks. A complete apparatus of *Carniodus carnulus* was recovered from the Chicotte Formation at Brisants Jumpers (GSC loc. C-92677). The present reconstruction follows that of Barrick and Klapper (1976).

One notable feature about the Anticosti apparatus is that the low, broad ridge that runs parallel to the lower margin ("platform-like widening" of Walliser, 1964, p. 31), so characteristic of the species, is either lacking or subdued. The illustrated M element (Pl. 5, fig. 4) exhibits a denticulated lateral costa off the cusp. A similar costa is displayed by the Pa element in the Clarita apparatus, illustrated by Barrick and Klapper (1976, Pl. 1, fig. 7). In most features the elements are identical with, or very similar to, those described from the Carnic Alps and elsewhere.

In the Anticosti collection there are four specimens of a form which resembles a "normal" Pb element, but differs from it in having only one-half of the blade. The posteriormost denticle is homologous with the apical denticle of the "normal" form. In one of the four specimens there is a small denticle immediately anterior of the apical denticle, and it probably represents a transitional form between the "abbreviated" and "normal" forms. Superficially they appear to be pelekysgnathiform, but only a single crest is present in the basal cavity (as opposed to two or double crests in true *Pelekysgnathus*).

Figured specimens. GSC 64846, 64847, 64948-64955.

Genus *Dapsilodus* Cooper, 1976

Type species. *Distacodus obliquicostatus* Branson and Mehl, 1933.

Dapsilodus obliquicostatus (Branson and Mehl)

Plate 9, figures 11, 12

Distacodus obliquicostatus n. sp. BRANSON and MEHL, 1933, p. 41, Pl. 3, fig. 2 (S); REXROAD et al., 1978, p. 4, Pl. 1, fig. 9 (S).

Dapsilodus obliquicostatus (Branson and Mehl), COOPER, 1976, p. 212, Pl. 2, figs. 10-13, 18-20 (multielement); BARRICK, 1977, p. 50-52, Pl. 2, figs. 6, 10, 13 (multielement).

Remarks. The Anticosti specimens of the S element of *Dapsilodus obliquicostatus* have only faint striae along the basal anterior margin. Barrick (1977, p. 51) noted that a small number of elements of this species from the Clarita Formation of Oklahoma lack the striae altogether.

Figured specimens. GSC 65036, 65037.

Genus *Decoriconus* Cooper, 1975

Type species. *Paltodus costulatus* Rexroad, 1967.

Decoriconus fragilis (Branson and Mehl)

Plate 9, figures 1-10, 13-16

Decoriconus fragilis (Branson and Mehl), COOPER, 1976, p. 212-213, Pl. 2, figs. 5, 8, 14-17 (multielement); BARRICK, 1977, p. 53-54, Pl. 2, figs. 15, 21-23 (multielement; includes synonymy).

Decoriconus? fragilis (Branson and Mehl), REXROAD et al., 1978, p. 4, Pl. 1, fig. 10 (Sc).

Remarks. Cooper (1976, p. 213) and Barrick (1977, p. 53) noted that *Decoriconus costulatus* (Rexroad) differs from *D. fragilis* in the absence of a markedly asymmetrical drepanodiform (Sc) element. McCracken and Barnes (1981, p. 76), however, suggested that one constituent element of *D. costulatus*, as reconstructed by Cooper (1975, p. 992-993), may be considered as drepanodiform, thus removing the principal distinguishing criterion and possibly making the two species synonymous. On Anticosti Island, *D. costulatus* has been reported previously from the Ellis Bay Formation (Fauna 13, Upper Ordovician, to the *Oulodus? nathani* Zone, lower Llandovery; McCracken and Barnes, 1981). It has also been reported from the Brassfield Limestone of southern Ohio in the *kentuckyensis* Zone (Cooper, 1975).

The species of *Decoriconus* from the Jupiter and Chicotte formations may be synonymous with that reported from the Ellis Bay. Until the study of the conodonts from the intervening Becscie and Gun River formations is completed, however, the collections are being referred to *D. fragilis*. The present collections include the entire transition series, Sa, Sb and Sc. One notable feature in the successively younger collections is the increased smoothness of the cones.

The older collections have deep, coarse striae, whereas the younger ones are virtually smooth in most specimens, and faintly striate in others. This is one of the distinguishing features noted by Cooper (1976, p. 213) between *D. costulatus* and *D. fragilis*. In some specimens, the surface ornamentation is obscured by recrystallization, and the original striae may be observed only through "windows" (Pl. 9, figs. 13, 14).

Figured specimens. GSC 65026-65035, 65038-65041.

Genus *Distomodus* Branson and Branson, 1947

Type species. *Distomodus kentuckyensis* Branson and Branson, 1947.

Distomodus cf. *D. kentuckyensis* Branson and Branson of Cooper (1975)

Plate 9, figures 27, 28

Distomodus sp. cf. *D. kentuckyensis* Branson and Branson, COOPER, 1975, p. 1000, 1003, Pl. 2, figs. 5, 9 (multielement).

Remarks. Three specimens of the Pa element of *Distomodus* cf. *D. kentuckyensis* were recovered from member 4 of the Jupiter Formation near Cap Ottawa (GSC loc. C-92702) and at Brisants Jumpers (GSC loc. C-92674). One is a simple cone and the other a set of fused simple cones. Other accompanying elements were not found. Similar Pa elements were previously reported by Rexroad (1967) and Cooper (1975) from the Brassfield Limestone of the Cincinnati Arch area.

The reconstruction suggested by Cooper (1975) could not be duplicated by McCracken and Barnes (1981). Cooper (*ibid.*) believed that fused simple cone elements represent a reduced Pa component of the apparatus. Because the fused element was found in association with the simple cone element, Cooper's (1975) nomenclature is followed herein. Those simple cones that are present without the accompanying fused elements are listed in the abundance list (see Appendix) under "Simple Cone Elements".

Figured specimens. GSC 65052, 65053.

Distomodus staurognathoides (Walliser)

Plate 3, figures 1-15.

Hadrognathus staurognathoides n. sp. WALLISER, 1964, p. 35, Pl. 5, fig. 2, Pl. 13, figs. 6-15 (Pa); ALDRIDGE, 1974, p. 301, fig. 1I (Pa); SCHÖNLAUB, 1975, p. 53-56, Pl. 1, figs. 1-4, 17, 20, 23, Pl. 2, figs. 1-10, 12-21 (multielement); COOPER, 1977, p. 1066-1067, Pl. 1, figs. 1, 5-7, 12, 16 (multielement); MILLER, 1978, Pl. 4, fig. 26 (Pa).

Distomodus staurognathoides (Walliser), BARRICK and KLAPPER, 1976, p. 71-72, Pl. 1, figs. 20-28 (multielement; includes synonymy); ALDRIDGE, 1979, Pl. 1, figs. 16, 17 (multielement); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 3 (Pa); NOWLAN, 1981, Pl. 5, figs. 21, 27, Pl. 6, fig. 21 (multielement).

Remarks. Elements representing an almost complete apparatus of *Distomodus staurognathoides* were recovered from the Chicotte Formation at Brisants Jumpers (GSC loc. C-92675), with only the Pb element missing.

Figured specimens. GSC 64832, 64904-64917.

Genus *Icriodella* Rhodes, 1953

Type species. *Icriodella superba* Rhodes, 1953.

Icriodella inconstans Aldridge

Plate 4, figures 7-10, ?15

Icriodella inconstans n. sp. ALDRIDGE, 1972, p. 184-185, Pl. 1, figs. 13-17 (I); ALDRIDGE, 1975, Pl. 1, fig. 17 (I); UYENO in Uyeno and Barnes, 1981, Pl. 1, figs. 8, 9 (I).

Remarks. The I element herein assigned to *Icriodella inconstans* differs somewhat from Aldridge's (1972) holotype in having a low basal cavity flare with an accompanying subdued lateral flange on the outer side. Another of Aldridge's (1972, Pl. 1, fig. 13) specimens exhibits a less prominent flare and this form more closely matches the Anticosti individuals. Furthermore, the present specimens, like those of the Welsh Borderland, display an upper view outline of the anterior and posterior processes that can either be broadly curving (Pl. 4, fig. 7) or abruptly inturned (Pl. 4, fig. 10). The denticles on the anterior process have circular cross-section in the smaller specimens, but are laterally elongated in the larger ones. This ontogenetic development is also clearly demonstrated in the Welsh material (Aldridge, 1972, Pl. 1, figs 15, 16).

A specimen that may possibly be the sagittodontiform element (M?; Pl. 4, fig. 15) of *Icriodella inconstans* was recovered, together with the Pa element, from member 4 of the Jupiter Formation at Brisants Jumpers (GSC loc. C-92674). The blade has a prominent cusp at the posterior tip, with three smaller denticles in front. The anteriormost denticle is almost as large as the cusp. Two lateral processes run at right angles to the blade, and are joined to it at the posterior tip, resulting in a "T" shape in upper view. One of these lateral processes is short, with two stubby denticles, and the other is longer and curved, convex posteriorly, and ornamented with two, posteriorly inclined denticles. The lower margin of the blade is slightly arched, whereas those of the two lateral processes are flat and lie almost in the same plane. No other accompanying elements of *I. inconstans* have been found.

Figured specimens. GSC 64837, 64936, 64937.

Genus *Johnognathus* Mashkova, 1977

Type species. *Johnognathus huddlei* Mashkova, 1977.

?"*Johnognathus*" *huddlei* Mashkova

Plate 8, figure 25

(?) *Johnognathus huddlei* n. sp. MASHKOVA, 1977, p. 129-131, text-figs. 1, 2.

?"*Johnognathus*" *huddlei* Mashkova, UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 25 (Pa?).

Remarks. A single fragmentary specimen may represent the anterior part of the form species "*Johnognathus*" *huddlei*. It was recovered from the Chicotte Formation, about 21 m above its base (GSC loc. 76229). The specimen displays a rectangular outline, with straight anterior end and sides. The margins of all three sides are highly irregular and nodose. The central carina consists of six laterally compressed denticles. Low, thin ridges extend in a radiating manner from the carina at the anterior end of the unit. The Podolian form differs in having tapering sides and a pointed anterior end (Mashkova, 1977). In other respects, the two forms are similar.

"*Johnognathus*" *huddlei* is restricted to the *amorphognathoides* Zone in Podolia (Mashkova, 1977) and in Britain (Aldridge in Aldridge et al., 1979, text-fig. 1). The accompanying elements are as yet unknown. Mashkova (1977, p. 127, 129), however, suggested the possibility that "*Johnognathus*" occupied a medial position, flanked by the apparatuses of *Pterospathodus amorphognathoides*, *Apsidognathus tuberculatus*, *Distomodus staurognathoides*, *Carniodus carnulus*, and *Ozarkodina ranuliformis*, in the skeletal framework of a single animal. All five multielement species are present in the Anticosti collections.

Figured specimen. GSC 64853.

Genus *Kockelella* Walliser, 1957

Type species. *Kockelella variabilis* Walliser, 1957.

Kockelella ranuliformis (Walliser)

Plate 6, figures 1-4

Spathognathodus ranuliformis n. sp. WALLISER, 1964, p. 82, Pl. 6, fig. 9, Pl. 22, figs. 5-7 (Pa); ALDRIDGE, 1972, p. 215, Pl. 4, fig. 14 (Pa); LIEBE and REXROAD, 1977, Pl. 1, fig. 23 (Pa).

Ozarkodina ranuliformis (Walliser), ALDRIDGE, 1975, Pl. 3, fig. 1 (Pa); COOPER, 1976, p. 216, Pl. 1, fig 9 (Pa).

Ozarkodina? *ranuliformis* (Walliser), SCHÖNLAUB, 1975, p. 57, Pl. 1, figs. 5, 7 (multielement).

Kockelella ranuliformis (Walliser), BARRICK and KLAPPER, 1976, p. 76, Pl. 2, figs. 1-11 (multielement; includes synonymy); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 11 (Pa).

Remarks. A partial apparatus, consisting of Pa and the transition series S elements, of *Kockelella ranuliformis* was recovered from the basal Chicotte Formation at Brisants Jumpers (GSC loc. C-92677). The present reconstruction follows that of Barrick and Klapper (1976).

Also at the Brisants Jumpers section, in the uppermost part of member 4 of the Jupiter Formation (GSC loc. C-92674) and about 5 m below the only occurrence of *Kockelella ranuliformis* cited above, a single specimen of Pa element was recovered that differs slightly in having a more strongly sigmoidal outline of the free blade and carina (illustrated on Pl. 6, fig. 5). However, like *K. ranuliformis*, the basal cavity extends posterior of the blade tip. It thus morphologically approaches the form referred to as "*Spathognathodus*" cf. "*S.*" *abruptus* Aldridge from the C_{3-4} strata of the Welsh Borderland, and interpreted by Aldridge (1972, fig. 10, p. 215) to be intermediate between "*S.*" *abruptus* and *K. ranuliformis*. "*Spathognathodus*" *abruptus* is known from B_{1-3} to C_{1-2} strata in the Welsh Borderland, and was reported from Anticosti Island, in the stratigraphically lower Ellis Bay Formation by McCracken and Barnes (1981, Pl. 7, fig. 19; referred to as "*Spathognathodus*" *manitoulinensis* Pollock, Rexroad and Nicoll).

Figured specimens. GSC 64839, 64967-64969.

Genus *Oulodus* Branson and Mehl, 1933

Type species. *Oulodus mediocris* Branson and Mehl, 1933 [=junior synonym of *Oulodus serratus* (Stauffer, 1930)].

Remarks. As many as five different species of *Oulodus* may be represented in the Anticosti collections; of these, two are referred to specific taxa, namely, *Oulodus*? *fluegeli* subsp. A and *O.*? cf. *O.*? *fluegeli* (Walliser). The remaining species are designated only by letters, with attempts made to compare them with published literature. In the distribution tables, they are referred to these letters where possible, but in instances where this could not be done, they are listed as *Oulodus* spp.

The reader is referred to Sweet and Schönlaub (1975) and Sweet (in Ziegler, ed., 1981, p. 193-194) for a thorough review of the genus *Oulodus*.

Oulodus? *fluegeli* (Walliser)

Remarks. Aldridge (1979, p. 14-15) reconstructed the apparatus of *Oulodus*? *fluegeli* based principally on material from the Welsh Borderland (Aldridge, 1972) and the Cellon section (Walliser, 1974), and reinforced by his North Greenland collection. A very similar apparatus was recovered from the highest beds of member 4 of the Jupiter Formation (GSC locs. C-92670, C-92671 and C-92673), and from the lower Chicotte Formation (GSC loc. C-92678). The greatest difference between the Anticosti and Greenland-European reconstructions lies in the Pa element [Pb of Aldridge, 1979]. Aldridge (1979) assigned this species only tentatively to *Oulodus* since its denticulation characteristics differ from the generic diagnosis given by Sweet and Schönlaub (1975, p. 45). In the following discussion, the Anticosti taxon is considered as a subspecies of *O.*? *fluegeli*, and that of Aldridge (1979) as the nominate subspecies. The present subspecies is probably the same as the species listed by Cooper (1980, p. 219) as *Oulodus petila* (Nicoll and Rexroad). Its referral to this species by Uyeno and Barnes (1981, p. 181) was based on this assumption.

Oulodus? *fluegeli* subsp. A

Plate 7, figures 11-22

Diadelognathus n. sp. A, NICOLL and REXROAD, 1969, p. 30, Pl. 6, figs. 9, 10 (Pa).

Ligonodina petila n. sp. NICOLL and REXROAD, 1969, p. 38-39, Pl. 5, figs. 20-22 (Sc).

Neoprioniodus planus Walliser, NICOLL and REXROAD, 1969, p. 41, Pl. 5, figs. 11, 12 (M).

Trichonodella sp., NICOLL and REXROAD, 1969, p. 65, Pl. 4, fig. 15 (Sb).

Diagnosis. A subspecies of *Oulodus*? *fluegeli* with a six-element apparatus, characterized by the Pb element with a laterally twisted posterior process. All constituent elements have a prominent cusp and laterally compressed denticles that are relatively broad on the lateral and posterior processes.

Remarks. The common feature of all the elements of *Oulodus fluegeli* subsp. A is the prominent cusp. The denticles in the lateral and posterior processes are compressed laterally, with noticeably more flattening on the anterior side. The Pa, M, Sb and Sc elements are identical or very similar to those previously described by Nicoll and Rexroad (1969), in collections from the Lee Creek Member of the Brassfield Limestone (Indiana Geological Survey localities 14-A3 and 12-2) of southern Indiana. The M element is "*Neoprioniodus*" *planus* Walliser, a form similar to that of *Ozarkodina pirata* n. sp. and possibly *Oulodus*? cf. *O.*? *fluegeli* both described herein from the Anticosti collections.

As noted under general remarks above, most of the elements in the apparatus of the present subspecies are similar to, if not identical with, those of the nominate subspecies, *O.*? *fluegeli fluegeli*. The principal difference lies in the morphology of the Pa element, which is diadelognathiform with a shallow basal cavity under the cusp and the basal posterior extension of the cusp. Its outer lateral process is longer than the inner one, and may be curved or straight. The Pa element of the nominate subspecies, on the other hand, has lateral processes of about equal length and lacks the basal extension of the cusp.

The Pb element is a modified ozarkodiniform, with the posterior process laterally twisted inward so that it lies in plane about 45 degrees in relation to that of the anterior process. The basal cavity is similar to that of the M element, i.e., it is slightly flared laterally under the cusp with tapering grooves extending to both ends.

The Sb element is zygognathiform with a posterior extension at the base of cusp. The basal cavity extends from under the cusp to the posterior extension, and runs for a short distance as shallow grooves under the lateral processes.

The Sa element is trichonodelliform with a posterior extension at the base of the cusp. The extension and the nature of the basal cavity are similar to those of the Sb element and of the form transitional between Sb and Sa.

The holotype of *Ligonodina petila* Nicoll and Rexroad is included in the synonymy, and thus a name is already available for this taxon. However, this name was previously used by Barrick and Klapper (1975, p. 69-70), for the apparatus reconstructed from the Clarita Formation of Oklahoma, and referred by them to *Delotaxis petila* (Nicoll and Rexroad). The two apparatuses appear to be closely related. The Sc and Pa elements in both are very similar to their respective counterparts, although the latter was interpreted to occupy the Sb position by these authors. The denticles of the Anticosti subspecies are slightly compressed whereas those of the Clarita species are more typical of the genus *Oulodus*, that is, peg-like and round, separated by wide, U-shaped spaces. Further studies may yield evidence that the two taxa are indeed synonymous. Until this doubt is removed, however, the present subspecies is left in open nomenclature.

Figured specimens. GSC 64992-65003.

Oulodus? cf. *O.*? *fluegeli* (Walliser)

Plate 1, figures 1-6

Ozarkodina? sp., UYENO in Uyeno and Barnes, 1981, text-fig. 3.

Remarks. An apparatus that is questionably assigned to *Oulodus* has been reconstructed based on material from member 1 of the Jupiter Formation at Fire Tower road (GSC loc. C-92669). Its compressed denticles have narrow, V-shaped intervening spaces, a feature which is more characteristic of the genus *Ozarkodina*. As in *Oulodus*? *fluegeli*, however, the Pa element assigned to it is oulodontiform, a form usually associated with the genus *Oulodus*.

The present species appears to be morphologically related to *Oulodus*? *fluegeli*, but there are some significant differences between the two. Firstly, its denticles are more compressed, attenuated, and sharply pointed, and secondly, the posterior protuberance of the basal part of the cusp is less pronounced in the Pa and Sb elements. Although this basal posterior protuberance is about the same length in the Sa element, it is relatively narrower. Moreover, there is a low keel developed on the posterior edge of the cusp in the Sa element. The Pb and possibly M elements of these species, on the other hand, are very similar, if not identical. The M element is questioned since it may have been shared with *Ozarkodina pirata*, the apparatus of which was reconstructed from the same locality. The element is provisionally placed with the latter species (see also discussion under *Ozarkodina pirata*).

Figured specimens. GSC 64854-64859.

Oulodus sp. A

Plate 1, figures 14, 15, 18-20

Neoprioniodus cf. *N. excavatus* (Branson and Mehl), POLLOCK et al., 1970, p. 756, Pl. 114, fig. 20 (M).

Remarks. *Oulodus* sp. A is represented by small delicate forms, which are assignable to M, Sc and Sa elements. The M element has been reported from the Niagara Gorge section in Ontario, presumably from the Reynales Limestone of the *celloni* Zone (Rexroad and Rickard, 1965; Pollock et al., 1970, p. 744, 756). It should be noted that this form is not identical to the M element of *Oulodus* sp. B of Cooper (1975, p. 997), an older form from the *kentuckyensis* Zone in the Brassfield Limestone of Ohio. The latter has a straight, erect cusp as opposed to a cusp that is curved and inclined posteriorly. *O.* sp. A is from the *discreta-deflecta* Zone in member 1 of the Jupiter Formation at the Fire Tower Road (GSC loc. C-92669).

Figured specimens. GSC 64866-64870.

Oulodus sp. B

Plate 4, figures 1-6

(?) *Oulodus jeannae* n. sp. SCHÖNLAUB in Sweet and Schönlaub, 1975, p. 49-51, Pl. 1, fig. 22 (only) (Sa).

Remarks. *Oulodus* sp. B is from member 4 of the Jupiter Formation (GSC loc. C-92702). Six elements are present, all with typical oulodontan denticles, that is, round and peg-like with wide, U-shaped intervening spaces. Most specimens have an attachment covering the basal cavity. The lateral processes of the Sa element form a semicircular arch and, in this respect, it is similar to its counterpart in *Oulodus jeannae* Schönlaub. The Sc element of these species may also be similar, but all other constituents of *O. jeannae* appear to differ substantially from those of O. sp. B. The cusp on the Pa element is turned inward whereas the denticles on the processes are inclined posteriorly. The Pb element exhibits short processes and a lateral costa on the cusp and, superficially at least, resembles the Sb element. It can be readily distinguished, however, as the latter has a costa on the posterior side of laterally twisted cusp. The Pb element lacks the platform-like structure present in its counterpart in the *Distomodus staurognathoides* apparatus. However, the M and Sb elements of this apparatus are morphologically similar to their counterparts in the *D. staurognathoides* apparatus. They are at least tentatively assigned to this species owing to the overall morphological similarity with other assigned elements, especially Pb, as well as in their state of preservation. As noted earlier, most specimens, including the illustrated M and Sb elements, possess the basal attachment.

Figured specimens. GSC 64930-64935.

Oulodus sp.

Plate 8, figure 21

Remarks. *Oulodus* sp. is known only by its oulodontiform Pa element. It is from the *Ozarkodina aldridgei* fauna, upper *staurognathoides* Zone in member 4 of the Jupiter Formation (GSC loc. C-92693).

Figured specimen. GSC 65023.

Genus *Ozarkodina* Branson and Mehl, 1933

Type species. *Ozarkodina typica* Branson and Mehl, 1933 [=junior synonym of *Ozarkodina confluens* (Branson and Mehl, 1933)].

Ozarkodina aldridgei n. sp.

Plate 3, figures 16-24; Plate 8, figure 20

Neoprioniodus multiformis Walliser, ALDRIDGE, 1972, p. 195, Pl. 5, fig. 26 (M).

Spathognathodus n. sp. B, ALDRIDGE, 1972, p. 216, Pl. 4, fig. 5 (Pa).

Ozarkodina n. sp. B (Aldridge), ALDRIDGE, 1975, Pl. 3, figs. 3-5 (multielement); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 4 (Pa).

Remarks. The denticulation pattern of *Ozarkodina oldhamensis* (Rexroad), *O. aldridgei*, and O. n. sp. A of Aldridge (1972, p. 215) is similar and the three species may be phyletically related, as previously suggested by Aldridge (1972). The principal characteristic in common among them is the fusion of some denticles immediately above and/or adjacent to the flaring of the basal cavity. The main criterion in distinguishing these species appears to be the size and shape of the cavity flare. In *O. oldhamensis* the flare is relatively small and confined to an area about a third of the blade distance from the posterior tip. In contrast, the basal cavity flares of *O. aldridgei* and O. sp. A of Aldridge are wide, beginning slightly anterior of midlength of the blade and continuing posteriorly almost to the tip. In O. n. sp. A the flare is asymmetrical and heart-shaped, whereas in *O. aldridgei* it is symmetrical or nearly so and almost circular in outline. The fusion of denticles and the round basal cavity flare are also features characteristic of *Ozarkodina sagitta bohemica* (Walliser). In this subspecies, however, the basal cavity is relatively much larger, and extends to the posterior tip of the blade (see Barrick and Klapper, 1976, p. 81).

The accompanying Pb element of all three species is identical or very similar morphologically (Aldridge, 1975, Pl. 2, fig. 17, Pl. 3, figs. 5, 7; Cooper, 1975, Pl. 3, fig. 14). The possible Sb and Sa elements of *Ozarkodina oldhamensis*, illustrated by McCracken and Barnes (1981, Pl. 7, figs. 3, 5), are similar to those of *O. aldridgei*. In addition, the range of "*Neoprioniodus*" *multiformis* Walliser *sensu* Aldridge (1972, Table 3), the M element of *O. aldridgei*, is extremely long (B_{1-3} to lower Wenlock), suggesting the possibility that it, too, may have been shared by all three species.

Type locality and stratum. Member 4, Jupiter Formation, approximately 51 m above the base of the member, prominent bluff located 600 m southeast of the second creek section, south-central Anticosti Island, GSC loc. C-92702.

Holotype. The specimen illustrated on Plate 3, figure 17 (GSC 64918).

Paratypes. GSC 64833, 64919-64925, 65022.

Derivation of name. After Dr. R.J. Aldridge, who first described the species from the Welsh Borderland, and who provided the conodont zonation of this classic area.

Ozarkodina clavula, n. sp.

Plate 7, figures 4, 7-10

Ozarkodina n. sp. D, UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 12 (Pa).

Diagnosis. A species of *Ozarkodina* the Pa element of which is characterized by a wide basal cavity that is highly asymmetrical, and confined to near the posterior end. The upper margin is slightly convex with 13 to 15 denticles of uneven sizes that are free only at their tips. The Pb and Sa elements display similar denticulation.

Description. In upper view, the blade of the Pa element is straight with a basal cavity that is confined to an area close to the posterior end. The basal cavity is 4 to 5 times as wide as it is long, with the flare on the outer side about 3 to 4 times the width of the inner side, resulting in a highly asymmetrical outline. The cavity continues as a slit to the posterior end, and for a short distance anteriorly. The lower margin is straight, whereas the upper margin is slightly convex, bearing 13 to 15 evenly sized denticles that are free only at their tips.

The lower margin of the Pb element is straight with a narrow basal cavity that begins about midlength of the unit. The upper margin is gently convex with a high, centrally located cusp. As with the Pa element, the denticles are free only at their tips.

The symmetrical Sa element displays denticles that are confluent almost throughout their lengths, and a prominent cusp that is much higher than other denticles. The basal cavity is relatively large and extends slightly posteriorly under the basal protuberance of the cusp.

Remarks. Only the Pa, Pb and Sa elements of *Ozarkodina clavula* are known thus far. The highly asymmetrical basal cavity of the Pa element serves to distinguish the species from others.

Type locality and stratum. Member 4, Jupiter Formation, 0.5 m below the top of the member, Brisants Jumpers, south-central Anticosti Island, GSC locality C-92674.

Holotype. The specimen illustrated on Plate 7, figure 7 (GSC 64840).

Paratypes. GSC 64988-64991.

Derivation of name. From *clavula* (Latin, small club) in reference to the shape of the Pa element in upper view.

Ozarkodina gulletensis (Aldridge)

Plate 4, figures 11-14, 16, 17, 19

Spathognathodus gulletensis n. sp. ALDRIDGE, 1972, p. 212-213, Pl. 4, figs. 9-12 (Pa).

Ozarkodina gulletensis (Aldridge), ALDRIDGE, 1975, Pl. 2, figs. 7, 8 (multielement); HELFRICH, 1980, p. 568, Pl. 2, figs. 21-24, 26-29 (multielement; includes synonymy); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 10 (Pa).

Remarks. All elements of the apparatus of *Ozarkodina gulletensis* were recovered from member 4 of the Jupiter Formation at Brisants Jumpers (GSC loc. C-92674). The reconstruction follows that suggested by Helfrich (1980).

The relationship of *Ozarkodina plana* (Walliser), the apparatus of which was reconstructed by Sweet and Schönlaub (1975), to *Oulodus*? *fluegeli fluegeli* (Walliser), was recently discussed by Aldridge (1979, p. 15). According to Aldridge (*ibid.*), the Pa element of *O. plana* does not compare closely with "*Spathognathodus*" *gulletensis*, but is probably referable to "S." *inclinatus* (Rhodes) or its ancestor.

The Pb element and the transition series (Sa-c) of *Ozarkodina gulletensis* may have been shared with *O. polinclinata*, and this possibility is noted on Table 3. The Pb element of *O. gulletensis* ("*Ozarkodina*" *alisonae* Aldridge) is very similar to that of *O. polinclinata* ("*O.*" *hanoverensis* Nicoll and Rexroad), except perhaps the former may be slightly more arched.

Figured specimens. GSC 64838, 64938-64943.

Ozarkodina pirata, n. sp.

Plate 1, figures 16, 17, 21-25;

Plate 2, figures 12, 13, 19-28

Ozarkodina n. sp. C, UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 2 (Pa).

Diagnosis. A species of *Ozarkodina* the Pa element of which has a straight lower marginal outline, a small restricted basal cavity, with 7 to 10 unevenly sized denticles which form a convex upper margin. The Pb element is broadly similar to the Pa but its lower margin is slightly to moderately arched. All constituent elements are relatively small.

Description. The Pa element is a small flat unit with a straight lower margin and a narrow basal cavity which starts about midlength, becoming widest under the high denticles. The upper outline is unevenly convex with 4 to 6 denticles anteriorly of the cusp and 2 to 3 denticles posteriorly. The denticles are generally wide with discrete upper parts.

The Pb element is somewhat similar to the Pa with a lower margin that ranges from only slightly to moderately arched. The basal cavity is small and centrally located. The pattern of denticulation appears to have a wider variation than in the Pa element. Anterior of the cusp are 3 to 4 wide denticles in most specimens, but there may be as many as 7. The number of denticles posterior of the cusp ranges from 2 to 6. One extreme variation of the Pb element approaches "*Ozarkodina*" *edithae* Walliser, or "*O.*" *denckmanni* Ziegler. Forms referred to the latter have been reported in younger apparatuses such as *Ozarkodina remscheidensis* (Ziegler).

The posterior process of the M element is moderately inclined upward, with 6 to 7 slightly to moderately reclined denticles that are discrete throughout their lengths. A small gap may separate the cusp from the immediately adjacent denticle. The basal cavity is well visible from the inner side.

All the available elements in the transition series have relatively wide denticles that are discrete throughout their lengths. The basal cavity is relatively small, restricted to beneath the apical denticle, and is slightly flared on the inner lateral side, as in the M element, or on the posterior side. In the Sb and Sa elements, the angle between the lateral processes ranges between 90 and 120°.

Remarks. The M element is similar to what has been referred to as "*Neoprioniodus*" *latus* Walliser in the literature. This morphotype apparently existed in several apparatuses such as *Oulodus*? *fluegeli* (Walliser) and *Ozarkodina* aff. *O. polinclinata* (Nicoll and Rexroad) (see Aldridge, 1979, p. 14, 17). The counterpart element in *O. polinclinata* is similar to, but not identical with, "*N.*" *latus* (see Klapper and Murphy, 1975, p. 55; Cooper, 1977, p. 1061).

It should be noted here that the M element assigned to *Ozarkodina pirata* may have been shared with *Oulodus*? cf. *O.*? *fluegeli* (Walliser). The reconstruction of the apparatus of the latter species was based on material from the same locality.

Cooper (1975, p. 1006; *Ozarkodina protexcavata* Cooper) reconstructed an apparatus in which the Pa and Pb elements are morphologically similar. Both elements were previously assigned to "*Ozarkodina*" in form-taxonomy by Pollock, Rexroad and Nicoll (1970, p. 757).

The apparatus reconstructed by Aldridge (1979, p. 17-18) and referred to *Ozarkodina* aff. *O. polinclinata* Nicoll and Rexroad, appears to be closely related to *O. pirata*. The Pa element of the former exhibits more denticles, numbering 11 to 12, but the overall morphology is similar. These features in common include the size and shape of the basal cavity, and the outline of the upper and lower margins. The Pb elements of these apparatuses are less similar. In the Greenland specimen, the cusp is relatively more prominent and is slightly curved inwards. The M elements are identical. The Sb and Sa elements are similar in denticulation, but differ substantially in the angle between the lateral processes; this angle is about 60° in the Greenland species, in contrast to about 90-120° in the Anticosti specimens. The Anticosti Sc element is similar to, if not identical with, that illustrated by Cooper (1977, Pl. 1, fig. 14), with which the Greenland counterpart was compared (Aldridge, 1979, p. 18).

The Anticosti species ranges from the uppermost part of the *discreta-deflecta* Zone to the lower part of the *Ozarkodina aldridgei* fauna (C_2 to C_{3-4}). The Greenland species is younger, having been reported from the *celloni* Zone (C_5) and may well represent a descendant of the former.

Type locality and stratum. Member 1, Jupiter Formation, approximately 10 m above the base of the member, Fire Tower Road, south-central Anticosti Island, GSC loc. C-92669.

Holotype. The specimen illustrated on Plate 2, figure 12 (GSC 64831).

Paratypes. GSC 64871-64877, 64893-64903.

Derivation of name. From *pirata* (Latin, pirate), in reference to the real or apparent occupation of Oliver Louis Gamache (1784-1854) who made his home on Anticosti Island. Some believed that he clandestinely secured cargoes by drawing ships on to the surrounding reefs with false beacons (see McCracken et al., 1980, p. 105; McCracken, 1981, p. 10).

Ozarkodina polinclinata (Nicoll and Rexroad)

Plate 5, figures 11-16, 19

Spathognathodus polinclinatus n. sp. NICOLL and REXROAD, 1969, p. 60, Pl. 2, figs. 19, 20 (Pa); LIEBE and REXROAD, 1977, Pl. 1, fig. 27 (Pa); MILLER, 1978, Pl. 2, fig. 23 (Pa).

Ozarkodina polinclinata (Nicoll and Rexroad), BARRICK and KLAPPER, 1976, p. 80, Pl. 1, fig. 17 (Pa); COOPER, 1977, p. 1058, 1061-1062, Pl. 1, figs. 11, 13-15, 17, 18 (multielement; inlcudes synonymy); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 7 (Pa).

Remarks. Elements representing a complete apparatus of *Ozarkodina polinclinata* were recovered from the Chicotte Formation at Brisants Jumpers (GSC loc. C-92677). The reconstruction follows that suggested by Cooper (1977). See also remarks under *O. gulletensis*.

Figured specimens. GSC 64836, 64956-64961.

Genus *Panderodus* Ethington, 1959

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

Panderodus recurvatus (Rhodes)

Plate 9, figures 23-26

Paltodus recurvatus n. sp. RHODES, 1953, p. 297, Pl. 23, figs. 219, 220.

Panderodus recurvatus (Rhodes), BARRICK, 1977, p. 54-55, Pl. 3, figs. 3, 4, 7-12 (multielement; includes synonymy); MILLER, 1978, Pl. 1, fig. 6.

Panderodus sp., ALDRIDGE, 1979, Pl. 2, figs. 29, 30.

Remarks. The symmetry transition series of *Panderodus recurvatus* was recently discussed by Barrick (1977). On Anticosti Island, the species was recovered from the Jupiter and Chicotte formations.

Figured specimens. GSC 65048-65051.

Panderodus unicostatus (Branson and Mehl)

Plate 9, figures 17-22

Panderodus unicostatus serratus n. subsp., REXROAD, 1967, p. 47, Pl. 4, figs 3, 4 (serrated element).

Panderodus simplex (Branson and Mehl), SAVAGE, 1973, p. 323-324, Pl. 32, figs. 7, 8, text-figs. 20A-C (M).

Panderodus unicostatus (Branson and Mehl), SAVAGE, 1973, p. 324, Pl. 32, figs. 5, 6, text-figs. 21A, B (Sb); COOPER, 1976, p. 213-214, Pl. 1, figs. 1-7, 22 (multielement; includes synonymy); BARRICK, 1977, p. 56-57, Pl. 3, figs. 1, 2, 5, 6 (multielement); REXROAD et al., 1978, p. 11, Pl. 1, figs. 6-8 (multielement); ALDRIDGE, 1979, Pl. 2, figs. 17-22 (multielement).

Panderodus gracilis (Branson and Mehl), SAVAGE, 1973, p. 324, Pl. 32, figs. 13-18, text-figs. 22A, B (Sa).

Panderodus serratus Rexroad, COOPER, 1975, p. 993-994, Pl. 1, figs. 3-5, 7-9, 13, 14, 23 (multielement; includes synonymy); MILLER, 1978, Pl. 1, figs. 1-5, 7-9 (multielement); HELFRICH, 1980, Pl. 2, figs. 12-14 (multielement); McCRACKEN and BARNES, 1981, Pl. 2, fig. 28 (serrated element); NOWLAN, 1981, Pl. 4, fig. 21 (serrated element).

Remarks. Multielement species *Panderodus serratus* was recently interpreted to be a minor reiterative variant of *P. unicostatus* (Rexroad et al., 1978, p. 11). The serrated element of *P. serratus*, the principal distinguishing unit of the species, is relatively rare and restricted to member 4 of the Jupiter Formation (see Fig. 3). Also on Anticosti Island, this element was recorded as low as the Upper Ordovician part of the Ellis Bay Formation (McCracken and Barnes, 1981), which suggests a lower range of the species than previously believed. The species ranges as high as Lower Devonian, as reported by Savage (1973) from the Mandagery Park Formation of New South Wales, Australia.

Figured specimens. GSC 65042-65047.

Genus *Pseudooneotodus* Drygant, 1974

Type species. Oneotodus? beckmanni Bischoff and Sannemann, 1958.

Remarks. Pseudooneotodus was emended as a multielement genus by Barrick (1977, p. 57), with two known species, each of which includes squat and slender forms with a single apical denticle. The distinguishing elements of these species are the two-denticle form in *P. bicornis* Drygant and the three-denticle form in *P. tricornis* Drygant. The conventional locational notation was found to be inapplicable owing to the lack of symmetry transition series in the two species.

An unnamed single-denticle form, characterized by irregular nodes and ridges ornamenting the sides of the cone, was illustrated by Cooper (1977, Pl. 2, figs. 12, 13). A similar form, together with what appears to be a transition series, are present in the Chicotte Formation, and are further discussed below. If the assignment of these forms to *Pseudooneotodus* is correct, then there is a marked divergence of this species from the two species cited above.

Pseudooneotodus bicornis Drygant

Plate 3, figures ?25, ?26, 27, 28

Pseudooneotodus bicornis n. sp. DRYGANT, 1974, p. 67, Pl. 2, figs. 40-48 (two-denticle, squat conical element); BARRICK and KLAPPER, 1976, p. 81, Pl. 1, fig. 15; BARRICK, 1977, p. 57-58, Pl. 2, figs. 14, 17, 19, 20 (multielement); COOPER, 1977, p. 1069, Pl. 2, figs. 8, 9, 11; HELFRICH, 1980, Pl. 1, fig. 21.

Remarks. The single denticle slender conical element is absent in the Anticosti collection. Furthermore, in two of the four samples from the Jupiter Formation, only the single denticle, squat conical element is present. Although the diagnostic element is missing in these two samples (GSC locs. C-92669 and C-92705), the single denticle element is tentatively assigned to *P. bicornis* since the three-denticle elements thus far have only been recovered from the Chicotte Formation. The total collection consists of 14 single denticle squat conical elements and two two-denticle elements.

Figured specimens. GSC 64926-64929.

Pseudooneotodus tricornis Drygant

Plate 6, figures 18-20

Pseudooneotodus tricornis n. sp. DRYGANT, 1974, p. 67-68, Pl. 2, figs. 49, 50 (three-denticle, squat conical element); BARRICK, 1977, p. 58, Pl. 2, fig. 18 (multielement); COOPER, 1977, p. 1069, Pl. 2, figs. 15, 16.

Remarks. The three-denticle squat conical element was recovered from the Chicotte Formation. At GSC locality C-92677, four specimens of slender cone-like elements were also recovered (Pl. 8, figs. 4, 8). These elements are not considered as parts of the apparatus since they are not truly conical, i.e., of round cross section, but are slightly laterally compressed. Furthermore, the single specimen that is free of basal attachment shows a shallow pit with an inverted basal cavity, in strong contrast to the deeper cavity displayed by the elements assigned without question to this species. The nature of the cavity is similar to some Ordovician "fibrous" forms, such as "*Polycaulodus*" Branson and Mehl. The specimens are discussed further under "Simple Cone Elements" at the end of the present Systematics. The collection consists of 27 single denticle, squat, and 34 three-denticle, squat conical elements.

Figured specimens. GSC 64980-64982.

Pseudooneotodus n. sp. of Cooper (1977)

Plate 6, figures 15-17, 21

Pseudooneotodus n. sp., COOPER, 1977, p. 1069, Pl. 2, figs. 12, 13 (Sa); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 22 (Sa).

Description. All the assigned elements of this species are single denticle units with irregular nodes and ridges on all sides. All elements have a relatively shallow basal cavity, extending to about one-quarter of the unit height. The Sc element exhibits a more regular pattern of longitudinal ridges than others, with a prominent posterior ridge that is developed into a stubby process. The Sb element exhibits two prominent ridges with development of irregular nodes on these ridges. The Sa element is symmetrical with evenly distributed irregular nodes surrounding the base of the prominent denticle. The longitudinal ridges are subdued in the Sa element. The fourth element, which does not fit into the transition series, also exhibits two ridges but these are less prominent than those of the Sb element. Both ridges have a few low irregular nodes near the base of the unit, with additional low nodes between the ridges. This element probably fills the M position.

Remarks. In addition to the presence of the symmetry transition series, *Pseudooneotodus* n. sp. differs from other species in its relatively shallow basal cavity. In the same collection as *P.* n. sp. are two cone-like specimens with a similar shallow basal cavity. The cones are flattened on the inner side and convex on the outer (Pl. 8, figs. 5, 13), with sharp anterior and posterior edges. The basal margin of the unit on the outer side is thick walled. These elements may form a constituent part of the apparatus, but because of uncertainty, are discussed at the end of the present Systematics under "Simple Cone Elements".

The collection consists of four specimens, all from the Chicotte Formation, at Brisants Jumpers (GSC loc. C-92677).

Figured specimens. GSC 64976-64979.

Genus *Pterospathodus* Walliser, 1964

Type species. *Pterospathodus amorphognathoides* Walliser, 1964.

Pterospathodus amorphognathoides Walliser

Plate 8, figure 24

Pterospathodus amorphognathoides n. sp. WALLISER, 1964, p. 67, Pl. 6, fig. 7, Pl. 15, figs. 9-15, text-fig. 1f (Pa); ALDRIDGE, 1975, Pl. 1, figs. 22, 23 (multielement); BARRICK and KLAPPER, 1976, p. 82, Pl. 1, figs. 4, 9-11, 16 (multielement; includes synonymy); COOPER, 1977, p. 1065-1066, Pl. 2, figs. 3, 6 (multielement); LIEBE and REXROAD, 1977, Pl. 1, fig. 9 (Pa); HELFRICH, 1980, Pl. 2, figs. 17-19 (multielement); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 24 (Pa); NOWLAN, 1981, Pl. 7, fig. 6 (Pa).

(?) *Pterospathodus amorphognathoides* (Walliser), KUWANO, 1976, Pl. 2, fig. 2 (Pb).

Ozarkodina gaertneri Walliser, LIEBE and REXROAD, 1977, Pl. 1, fig. 10 (Pb).

Apparatus "C" of Walliser (1964), MILLER, 1978, Pl. 4, figs. 8-11 (multielement).

Remarks. Only a single fragmentary Pa element of *Pterospathodus amorphognathoides* was recovered, from the Chicotte Formation at diamond drill hole, north of Brisants Jumpers (GSC loc. C-89848). Despite its incomplete preservation, the characteristic features including a bifurcated outer lateral process and well developed platform ledges are clearly visible, and serve to distinguish it from the counterpart element of *P. pennatus procerus*. The distinguishing features between *P. amorphognathoides* and *P. posteritenuis* are noted under the latter.

Kuwano (1976) noted the presence of *Pterospathodus amorphognathoides* in a collection from the Kurosegawa tectonic zone in Shikoku, Japan, on the basis of a Pb element. Since a very similar, if not identical, Pb element is present in the apparatus of *P. pennatus procerus*, a definite assignment cannot be made without the accompanying Pa element. (See also remarks under the latter subspecies.)

Figured specimen. GSC 64852.

Pterospathodus celloni (Walliser)

Plate 5, figures 17, 18, 20-24

Spathognathodus celloni n. sp. WALLISER, 1964, p. 73-74, Pl. 4, fig. 13, Pl. 14, figs. 3-16, text-figs. 1b, 7b-f (Pa); LIEBE and REXROAD, 1977, Pl. 1, fig. 12 (Pa).

Ozarkodina adiutricis n. sp. WALLISER, 1964, p. 54, Pl. 4, fig. 14, Pl. 27, figs. 1-10, text-figs. 1a, 7h-m (Pb); LIEBE and REXROAD, 1977, Pl. 1, fig. 10 (Pb); PICKETT, 1978, Pl. 1, fig. 27 (Pb).

Llandoverygnathus celloni (Walliser), ALDRIDGE, 1975, Pl. 1 figs. 20, 21 (multielement); ALDRIDGE, 1979, Pl. 1, figs. 9, 10 (Pa).

(?) *Neospathognathodus celloni* (Walliser), PICKETT, 1978, Pl. 1, fig. 26 (Pa?; figure too small for precise determination).

Pterospathodus celloni (Walliser), BARRICK and KLAPPER, 1976, p. 82-83, Pl. 1, figs. 3, 5 (multielement; includes synonymy); HELFRICH, 1980, Pl. 2, fig. 30 (Pa); UYENO in Uyeno and Barnes, 1981, Pl. 1, figs. 20, 21 (multielement).

Apparatus "B" of Walliser (1964), MILLER, 1978, Pl. 4, figs. 1-4 (multielement).

Remarks. The basal beds of the Chicotte Formation at Brisants Jumpers (GSC loc. C-92677) yielded an intermediate form between Pa and Pb elements of *Pterospathodus celloni*, similar to that illustrated by Walliser (1964, p. 73, text-fig. 7g). The accompanying M element has a single denticle on the short posterior process, and an undenticulated anticusp. The S element has two low ridges on the anterior process, a broadly serrated upper surface margin on the posterior process, and a low, undenticulated lateral costa.

Figured specimens. GSC 64848, 64849, 64962-64966.

Pterospathodus pennatus procerus (Walliser)

Plate 8, figures 1-3

Spathognathodus pennatus procerus n. subsp., WALLISER, 1964, p. 80, Pl. 15, figs. 2-8, text-fig. 1e (Pa).

Llandoverygnathus pennatus (Walliser), ALDRIDGE, 1975, Pl. 1, figs. 24, 25 (Pa).

Pterospathodus pennatus procerus (Walliser), BARRICK and KLAPPER, 1975, p. 83, Pl. 1, fig. 19 (Pa; includes synonymy); UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 23 (Pa).

Remarks. The Pb element of *Pterospathodus pennatus procerus* is identical with, or at least very similar to, that of *P. amorphognathoides*. This was previously implied by Walliser (1964, p. 16, text-fig. 1, p. 17, Conodonten-Apparat C).

Figured specimens. GSC 64851, 65004, 65005.

Pterospathodus posteritenuis, n. sp.

Plate 2, figures 1-11, 14-18

Pterospathodus n. sp. A, UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 5 (Pa).

Diagnosis. A species of *Pterospathodus* the Pa element of which is characterized by a short bifurcated inner lateral process and an offset short basal flare on the outer side. The main blade has a central cusp, with 5 to 6 denticles anteriorly and posteriorly of it.

Description. The central blade of the Pa element is typically slightly curved, with its highest point and the main cusp located centrally. The symmetrically sloping anterior and posterior sides of the blade bear 5 to 6 similarly sized denticles. On the inner side is a short bifurcated lateral process; the anteriorly directed wing of the process is slightly longer than the posterior one, and they bear 3 and 2 small denticles, respectively. The two wings converge and meet at a single denticle that is offset from the blade and positioned posteriorly of the main cusp. A short, posteriorly directed lateral lobe of the basal cavity occurs in offset position on the outer side of the blade. The lower surface is completely excavated.

The Pb element has a high dominant cusp which is flanked on either side by a short process, each bearing 2 to 3 small similarly sized denticles. A lateral costa is developed from the cusp, and this may be either undenticulated or may bear 2 to 3 minute denticles. The downward extension of the costa (anticusp) may protrude beyond the lower margin of the anterior and posterior processes.

The M element has a small denticle located anteriorly of the dominant high cusp. The long posterior process bears 9 sharply pointed, unevenly sized denticles.

The transition series (S) is notable for its delicate construction. It is characterized by a dominant high cusp, flanked by sharply pointed, irregularly sized denticles.

The Sc element is ligonodiniform. The form transitional between Sc and Sb differs from the Sc element in that the angle between the lateral and posterior processes is wider, the denticles on the posterior process range from upright to proclined, and those on the lateral process are directed more laterally.

The Sb element is markedly asymmetrical with two denticles on the outer process, and an undenticulated inner process. The short posterior process bears 2 to 3 denticles. The form transitional between Sb and Sa is only slightly asymmetrical with denticulated lateral and posterior processes. The symmetrical Sa element is similar to transitional form except the posterior process is undenticulated.

Remarks. The bifurcated lateral process of the Pa element of *Pterospathodus posteritenuis* is similar to that of *P. amorphognathoides*, but differs in that the anterior wing is usually much longer than the posterior one in the latter. In lateral view, *P. amorphognathoides* has evenly sized denticles, resulting in an upper margin that is more or less parallel with the lower margin. Furthermore, *P. amorphognathoides* displays well-developed platform ledges and in this regard, the Pa element of *P. posteritenuis* is closer to *P. pennatus*.

The Pa element of *Pterospathodus posteritenuis* has superficial resemblance to *Amorphognathus tenuis* Aldridge (1972, Pl. 2, figs. 3, 4). The latter, however, displays a long, posteriorly directed lateral process on the outer side, as opposed to a stubby lobe at this site in *P. posteritenuis*. *A. tenuis* ranges from late Idwian to early Fronian (Aldridge, 1972, p. 164; 1975, Fig. 1), so in its upper range is contemporaneous with the Anticosti species. The overlap in ranges and morphologic similarities of the two species suggest some sort of phyletic linkage, although the exact nature of this relationship is far from clear.

The transition series of *Pterospathodus posteritenuis* is remarkably complete, with morphologically intermediate forms filling the gaps between the Sc-Sb and Sb-Sa elements. Its delicate nature is reminiscent of an older taxon, *Amorphognathus superbus* (Rhodes) (e.g., Sweet and Bergström, 1970, text-figs. 6A, B, C, E).

Another species with which *Pterospathodus posteritenuis* may be compared is *Kockelella suglobovi* Mashkova from central Siberia. This is remarkably similar to *Amorphognathus tenuis*, but possesses a relatively shorter, anteriorly directed outer lateral process that is denticulated on its upper surface. This process is still longer than that on the Anticosti species. "*Huddlella*" *johni* Mashkova, the probable accompanying Pb element of *K. suglobovi*, is vaguely similar to its counterpart in *P. posteritenuis*. Both are highly arched with a dominant main cusp that protrudes downward as an anticusp. "*H.*" *johni*, however, is quadaxial with a short, opposing lateral process on the inner side. According to Mashkova (1979a, Table 1), *K. suglobovi* is associated with *K. variabilis* Walliser, *Ozarkodina excavata excavata* (Branson and Mehl), and *O. highlandensis* (Helfrich), and is therefore much younger than the Anticosti species (mid to late Wenlock).

Type locality and stratum. Member 1, Jupiter Formation, approximately 10 m above the base of the member, Fire Tower Road, south-central Anticosti Island, GSC loc. C-92669.

Holotype. The specimen illustrated on Plate 2, figure 1 (GSC 64834).

Paratypes. GSC 64874-64892.

Derivation of name. In reference to its possible phyletic relationship to *Amorphognathus tenuis* Aldridge.

Pterospathodus siluricus (Pollock, Rexroad and Nicoll)

Plate 1, figures 7-13

Aphelognathus siluricus n. sp. POLLOCK, REXROAD and NICOLL, 1970, p. 749, Pl. 114, figs. 1-4 (Pa).

Llandoverygnathus siluricus (Pollock, Rexroad and Nicoll), COOPER, 1977, p. 1064-1065, Pl. 1, figs 2-4, 8-10, Pl. 2, figs. 4, 7 (multielement; includes synonymy).

Pterospathodus siluricus (Pollock, Rexroad and Nicoll), UYENO in Uyeno and Barnes, 1981, Pl. 1, fig. 1 (Pa).

Remarks. The apparatus of *Pterospathodus siluricus* was initially described by Cooper (1977, p. 1064-1065). It is herein assigned to *Pterospathodus*, following the practice of Klapper and Murphy (1975, p. 27, 28) and Barrick and Klapper (1976, p. 81-82).

In lateral view, the Pa element of *Pterospathodus siluricus* is similar to that of *P. celloni*. The principal difference between the two elements may be observed in the lower view. The Pa of the former species has a basal marginal flare only on the outer side, whereas that of *celloni* exhibits such flares on both sides that are always and typically offset. The M element of *P. siluricus* in the reconstruction herein differs from that proposed by Cooper (1977). It exhibits a triangular lower marginal outline formed by a high lateral costa, with 8 to 10 irregularly sized denticles on the posterior process and two minute denticles on a short anticusp.

Figured specimens. GSC 64830, 64860-64865.

Genus *Walliserodus* Serpagli, 1967

Type species. Paltodus debolti Rexroad, 1967.

Walliserodus sancticlairi Cooper

Plate 7, figures 1-3, 5, 6

Walliserodus sancticlairi n. sp. COOPER, 1976, p. 214-215, Pl. 1, figs. 8-11, 16-21 (multielement); BARRICK, 1977, p. 59, Pl. 1, figs. 11, 13-20 (multielement).

"*Walliserodus curvatus*" apparatus of Cooper (1975), MILLER, 1978, Pl. 1, figs. 10-17 (multielement).

Walliserodus curvatus (Branson and Branson), REXROAD et al., 1978, p. 12, Pl. 1, figs. 1-5 (multielement).

(?) *Walliserodus curvatus* (Branson and ranson) HELFRICH, 1980, Pl. 2, figs. 20, 25 (multielement).

Remarks. Cooper (1976, p. 214-215) and Barrick (1977, p. 59) noted that the only distinguishing criterion to separate *Walliserodus sancticlairi* and *W. curvatus* (Branson and Branson) lay in the Sc (="costate element I" of Cooper, *op. cit.*). This element in the apparatus of *W. curvatus* bears one to three pronounced costae on the inner lateral face, whereas in that of *W. sancticlairi* it is typically noncostate.

Based on the available literature, there appears to be a general age difference between *Walliserodus sancticlairi* and *W. curvatus*, with possibly some overlap. The latter has been reported as low as the base of the *nathani* Zone (McCracken and Barnes, 1981), the oldest conodont zone in the Llandovery, and ranging up into the *kentuckyensis* Zone (Cooper, 1975) and the *inconstans* Zone (Aldridge, 1972). *W. sancticlairi* ranges almost throughout the Jupiter and Chicotte formations on Anticosti Island. Elsewhere it ranges from the *amorphognathoides* through *amsdeni* zones (Clarita Formation, Oklahoma; Barrick, 1977, p. 59) and as high as the *variabilis* Zone (Louisville Limestone and Wabash Formation, Indiana and Kentucky; Rexroad et al., 1978).

The specimens from the Rose Hill Formation of West Virginia, illustrated by Helfrich (1980, Pl. 2, figs. 20, 25), may belong to *Walliserodus sancticlairi*. They are from the *amorphognathoides* Zone.

Figured specimens. GSC 64983-64987.

Simple Cone Elements

Plate 8, figures 4-19

Remarks. A few simple cones are present in the Anticosti Island collections that cannot be readily placed in previously published taxa. These simple forms are grouped according to their, at least apparent, affinity as follows:

(a) Four specimens of simple cone elements were recovered from the *inconstans* Zone of the Chicotte Formation (GSC loc. C-92677) in the same collection as *Pseudooneotodus tricornis* (Pl. 8, figs. 4, 8). They may constitute the slender conical elements of the latter apparatus, as advanced by Barrick (1977, p. 58). The specimens differ from the description given by Barrick, however, in that they are slightly compressed laterally, and in one specimen that is free of basal attachment, a shallow pit, surrounded by an inverted basal cavity, can be observed. White matter is present.

(b) An additional two, cone-like, robust specimens were recovered from the locality cited above (GSC loc. C-92677) (illustrated on Pl. 8, figs. 5, 13). They have a shallow basal cavity, with a flattened inner side and slightly convex outer side. Both lateral sides are essentially smooth, with fine striae on the outer side. The anterior and posterior edges are sharp. The basal margin on the outer side is thick-walled. The robust, stout characteristics of the cones may suggest their affinity with *Pseudooneotodus* n. sp. of Cooper (1977), although the elements of the latter apparatus are further featured with irregular nodes and ridges on all sides. White matter is present.

(c) Yet another set of simple cone elements from GSC locality C-92677 has been recovered, that differs from the two mentioned above. This set, illustrated on Plate 8, figures 6, 7, 9-12, 18, 19, morphologically approaches "*Acodina*", and appears to have a symmetry transition series. All units have a shallow basal cavity with smooth to slightly striated sides. The slightly asymmetrical Sa element is typically acodinan, with sharp lateral margins, only slightly convex to flattened anterior face and a convex posterior surface. The Sb element is similar to the Sa, but has a laterally twisted cusp. The Sc element has sharp anterior and posterior margins, with slightly convex lateral sides. Two specimens similar to this transition series, but with an additional small basal keel, are also present. With the exception of this aberration, they are similar to the Sb and Sc elements of the main series.

It should be noted that simple acodinan-like elements are also present in other collections in addition to that cited above. They are found in isolation, however, and cannot be fitted into any symmetry transition series.

(d) The fourth and final set of symmetry transition series from GSC locality C-92677 consists of small forms with a prominent cusp and shallow basal cavity (Pl. 8, figs. 14-17). The Sc element exhibits an abrupt posterior process with a single minute denticle, and a lateral costa that extends the entire length of the cusp. The Sb element is a slightly asymmetric unit with two postero-lateral costae, each of which has two extremely minute denticles near the base. This unit can conceivably be derived from the Sc element by growth of the lateral costa and lateral twisting of the cusp. The symmetrical Sa element is similar to the other two in possessing minute denticles near the base of the cusp. In addition it exhibits a short posterior process with two minute denticles.

Figured specimen. GSC 65006-65021.

FORAMINIFERA

Remarks. Some agglutinated foraminifers were recovered from residues during preparation of conodonts. They are from member 1 of the Jupiter Formation (*discreta-deflecta* Zone) at Fire Tower Road (GSC loc. C-92669), and include *Webbinelloidea*? sp. and *Thurammina* sp. (Pl. 8, figs. 22, 23). (Generic assignments made with kind assistance from Dr. J.H. Wall, Geological Survey of Canada.)

Figured specimens. GSC 65024, 65025.

REFERENCES

Aldridge, R.J.
1972: Llandovery conodonts from the Welsh Borderland; British Museum of Natural History (Geology), Bulletin, v. 22, no. 2, p. 125-231.

1974: An *amorphognathoides* Zone conodont fauna from the Silurian of the Ringerike area, south Norway; Norsk Geologisk Tidsskrift, v. 54, p. 295-303.

1975: The stratigraphic distribution of conodonts in the British Silurian; Journal Geological Society of London, v. 131, p. 607-618.

1979: An upper Llandovery conodont fauna from Peary Land, eastern North Greenland; Grønlands Geologiske Undersøgelse, Rapport no. 91, p. 7-23.

Aldridge, R.J., Dorning, K.J., Hill, P.J., Richardson, J.B., and Siveter, D.J.
1979: Microfossil distribution in the Silurian of Britain and Ireland; The Caledonides of the British Isles - reviewed, Geological Society of London, p. 433-438.

Barnes, C.R. and Fåhraeus, L.E.
1975: Provinces, communities, and the proposed nektobenthic habit of Ordovician conodontophorids; Lethaia, v. 8, p. 133-149.

Barnes, C.R., Nowlan, G.S., and Mirza, K.
1976: Lower Paleozoic conodont biostratigraphy of the Canadian Arctic [abstract only]; Program with Abstracts, Geological Association of Canada, Mineralogical Association of Canada, Annual Meetings, v. 1, p. 38.

Barnes, C.R., Petryk, A.A., and Bolton, T.E.
1981: Anticosti Island, Québec; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. I: Guidebook, p. 1-24, P.J. Lespérance, ed., Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Barnes, C.R., Telford, P.G., and Tarrant, G.A.
1978: Ordovician and Silurian conodont biostratigraphy, Manitoulin Island and Bruce Peninsula, Ontario; in Geology of the Manitoulin Area, Michigan Basin Geological Society, Special Paper no. 3, p. 63-71.

Barrick, J.E.
1977: Multielement simple-cone conodonts from the Clarita Formation (Silurian), Arbuckle Mountains, Oklahoma; Geologica et Palaeontologica, v. 11, p. 47-68.

Barrick, J.E. (cont'd.)
1981: Wenlockian (Silurian) conodont biostratigraphy and biofacies, Wayne Formation, central Tennessee [abstract only]; Abstracts with Programs, Geological Society of America, v. 13, no. 6, p. 270.

Barrick, J.E. and Klapper, G.
1976: Multielement Silurian (late Llandoverian-Wenlockian) conodonts of the Clarita Formation, Arbuckle Mountains, Oklahoma, and phylogeny of *Kockelella*; Geologica et Palaeontologica, v. 10, p. 59-100.

Berry, W.B.N. and Boucot, A.J.
1970: Correlation of the North American Silurian rocks; Geological Society of America, Special Paper 102.

Billings, E.
1857: Report for the year 1856; Geological Survey of Canada, Report of Progress for 1853-56, p. 247-345.

Bischoff, G. and Sannermann, D.
1958: Unterdevonische Conodonten aus dem Frankenwald; Notizblatt des Hessischen Landesamt für Bodenforschung, v. 86, p. 87-110.

Bolton, T.E.
1957: Silurian stratigraphy and palaeontology of the Niagara Escarpment in Ontario; Geological Survey of Canada, Memoir 289.

1961: Ordovician and Silurian formations of Anticosti Island, Quebec; Geological Survey of Canada, Paper 61-26.

1972: Geological map and notes on the Ordovician and Silurian litho- and biostratigraphy, Anticosti Island, Quebec; Geological Survey of Canada, Paper 71-19.

1981: Ordovician and Silurian biostratigraphy, Anticosti Island, Québec; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 41-59, P.J. Lespérance, ed., Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Bolton, T.E. and Copeland, M.J.
1972: Paleozoic formations and Silurian biostratigraphy, Lake Timiskaming region, Ontario and Quebec; Geological Survey of Canada Paper 72-15.

Boucot, A.J., Dean, W.T., Martinsson, A., Potter, A., Rexroad, C., Rohr, D., Savage, N.M., and Wright, A.J.
1973: Pre-late Middle Devonian biostratigraphy of the eastern Klamath Belt, northern California [abstract only]; Abstracts with Programs, Geological Society of America, v. 5, p. 15.

Branson, E.B. and Branson, C.C.
1947: Lower Silurian conodonts from Kentucky; Journal of Paleontology, v. 21, p. 549-556.

Branson, E.B. and Mehl, M.G.
1933: Conodont studies; University of Missouri Studies, v. 8, p. 1-349.

Cooper, B.J.
1975: Multielement conodonts from the Brassfield Limestone (Silurian) of southern Ohio; Journal of Paleontology, v. 49, p. 984- 008.

1976: Multielement conodonts from the St. Clair Limestone (Silurian) of southern Illinois; Journal of Paleontology, v. 50, p. 205-217.

1977: Toward a familial classification of Silurian conodonts; Journal of Paleontology, v. 51, p. 1057-1071.

1980: Toward an improved Silurian conodont biostratigraphy; Lethaia, v. 13, p. 209-227.

Copeland, M.J.
1974: Silurian Ostracoda from Anticosti Island, Quebec; Geological Survey of Canada, Bulletin 241.

Copper, P.
1981: Atrypoid brachiopods and their distribution in the Ordovician-Silurian sequence of Anticosti Island; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 137-141, P.J. Lespérance, ed., Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Druce, E.C.
1973: Upper Paleozoic and Triassic conodont distribution and the recognition of biofacies; in Conodont paleozoology, F.H.T. Rhodes, ed., Geological Society of America, Special Paper 141, p. 191-237.

Drygant, D.M.
1974: Simple conodonts from the Silurian and lowermost Devonian of the Volyno-Podolian area; Paleontologicheskiy Sbornik, v. 10, p. 64-69, English summary, p. 70.

Duffield, S.L. and Legault, J.A.
1981: Acritarch biostratigraphy of Upper Ordovician-Lower Silurian rocks, Anticosti Island, Québec: preliminary results; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 91-99, P.J. Lespérance, ed.; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Elles, G.L. and Wood, E.M.R.
1901-1918: A monograph of British graptolites; Palaeontographical Society, London, 539 p.

Epstein, A.G., Epstein, J.B., and Harris, L.D.
1977: Conodont color alteration - an index to organic metamorphism; United States Geological Survey, Professional Paper 995, 27 p.

Ethington, R.L.
1959: Conodonts of the Ordovician Galena Formation; Journal of Paleontology, v. 33, p. 257-292.

Fåhraeus, L.E. and Barnes, C.R.
1981: Conodonts from the Becscie and Gun River formations (Lower Silurian) of Anticosti Island, Québec; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 165-172, P.J. Lespérance, ed.; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Helfrich, C.T.
1980: Late Llandovery-early Wenlock conodonts from the upper part of the Rose Hill and the basal part of the Mifflintown Formations, Virginia, West Virginia, and Maryland; Journal of Paleontology, v. 54, p. 557-569.

Johnson, M.E., Cocks, L.R.M., and Cooper, P.
1981: Late Ordovician-Early Silurian fluctuations in sea-level from eastern Anticosti Island, Quebec; Lethaia, v. 14, p. 73-82.

Klapper, G. and Murphy, M.A.
1975: Silurian-Lower Devonian conodont sequence in the Roberts Mountains Formation of central Nevada; University of California Publications in Geological Sciences, v. 111 [imprint 1974].

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

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

Kuwano, Y.
1976: Finding of Silurian conodont assemblages from the Kurosegawa tectonic zone in Shikoku, Japan; Memoirs of the National Science Museum, Tokyo, Japan, no. 9, p. 17-22, Pl. 2.

Le Fèvre, J., Barnes, C.R., and Tixier, M.
1976: Paleoecology of Late Ordovician and Early Silurian conodontophorids, Hudson Bay Basin; in Conodont paleoecology, C.R. Barnes, ed.; Geological Association of Canada, Special Paper no. 15, p. 69-89.

Lespérance, P.J. (ed.)
1981: Field Meeting, Anticosti-Gaspé, Québec 1981, v. II: Stratigraphy and Paleontology; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montreal, 321 p.

Liebe, R.M. and Rexroad, C.B.
1977: Conodonts from Alexandrian and early Niagaran rocks in the Joliet, Illinois, area; Journal of Paleontology, v. 51, p. 844-857.

Mashkova, T.V.
1977: New conodonts of the *amorphognathoides* Zone from the Lower Silurian of Podolia; Paleontologicheskiy Zhurnal, 1977, no. 4, p. 127-131. [in Russian; English translation, Scripta Publishing Co., v. 11, no. 4, p. 513-517, 1978].

1979a: New Silurian conodonts from central Siberia; Paleontologicheskiy Zhurnal, 1979, p. 98-105. [in Russian; English translation, Scripta Publishing Co., v. 13, no. 2, p. 215-221, 1980].

Mashkova, T.V. (cont'd.)
1979b: Conodont assemblages in the Silurian of USSR (*Ozarkodina* biozone); in Ezhegodnik Vsesoyuznogo Paleontologicheskogo Obshchestvo, E.A. Modzalevskaya and L.M. Donakova, eds.; Akademia Nauk SSSR, v. 22, p. 199-209.

Mayr, U., Uyeno, T.T., and Barnes, C.R.
1978: Subsurface stratigraphy, conodont zonation, and organic metamorphism of the Lower Paleozoic succession, Bjorne Peninsula, Ellesmere Island, District of Franklin; Geological Survey of Canada, Paper 78-1A, p. 393-398.

Mayr, U., Uyeno, T.T., Tipnis, R.S., and Barnes, C.R.
1980: Subsurface stratigraphy and conodont zonation of the Lower Paleozoic succession, Arctic Platform, southern Arctic Archipelago; Geological Survey of Canada, Paper 80-1A, p. 209-215.

McCracken, A.D.
1981: Anticosti Island, Québec: a historical perspective of the nugget of the east; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 9-10, P.J. Lespérance, ed.; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

McCracken, A.D. and Barnes, C.R.
1981: Conodont biostratigraphy and paleoecology of the Ellis Bay Formation, Anticosti Island, Québec, with special reference to the Late Ordovician-Early Silurian chronostratigraphy and the systemic boundary; Geological Survey of Canada, Bulletin 329, Part 2, p. 51-134.

McCracken, A.D., Nowlan, G.S., and Barnes, C.R.
1980: *Gamachignathus*, a new multielement conodont genus from the latest Ordovician, Anticosti Island, Québec; Geological Survey of Canada, Paper 80-C, p. 103-112.

Miller, R.H.
1978: Early Silurian to Early Devonian conodont biostratigraphy and depositional environments of the Hidden Valley Dolomite, southeastern California; Journal of Paleontology, v. 52, p. 323-344.

Mostler, H.
1967: Conodonten aus dem tieferen Silur der Kitzbühler Alpen (Tirol); Annalen des Naturhistorischen Museums in Wien, v. 71, p. 295-303.

Murphy, M.A., Dunham, J.B., Berry, W.B.N., and Matti, J.C.
1979: Late Llandovery unconformity in central Nevada; Brigham Young University Geology Studies, v. 26, pt. 1, p. 21-36.

Nicoll, R.S. and Rexroad, C.B.
1969: Stratigraphy and conodont paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in southeastern Indiana and adjacent Kentucky; Indiana Geological Survey, Bulletin 40 [imprint 1968].

Norford, B.S.
1976: Faunas and correlation of the uppermost Lower Silurian Tegart Formation, southeastern British Columbia [abstract only]; Program with Abstracts, Geological Association of Canada, Mineralogical Association of Canada, Annual Meetings, v. 1, p. 39.

Nowlan, G.S.
1981: Late Ordovician - Early Silurian conodont biostratigraphy of the Gaspé Peninsula - a preliminary report; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 257-291, P.J. Lespérance, ed.; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Nowlan, G.S. and Barnes, C.R.
1981: Late Ordovician conodonts from the Vauréal Formation, Anticosti Island, Québec; Geological Survey of Canada, Bulletin 329, Part 1, p. 1-49.

Orchard, M.J.
1980: Upper Ordovician conodonts from England and Wales; Geologica et Palaeontologica, v. 14, p. 9-44.

Ovenshine, A.T. and Webster, G.D.
1970: Age and stratigraphy of the Heceta Limestone in northern Sea Otter Sound, southeastern Alaska; United States Geological Survey, Professional Paper 700-C, p. C170-C174.

Petryk, A.A.
1979: Stratigraphie revisée de l'Ile d'Anticosti; Ministère de l'Énergie et des Ressources, Québec, DPV-711, 24 p.

1981: Stratigraphy, sedimentology and paleogeography of the Upper Ordovician-Lower Silurian of Anticosti Island, Québec; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 11-39, P.J. Lespérance, ed.; Subcommission on Silurian Stratigraphy, Ordovician-Silurian Working Group, Université de Montréal.

Pickett, J.
1978: Silurian conodonts from Blowclear and Liscombe Pools, New South Wales; Journal and Proceedings, Royal Society of New South Wales, v. 111, p. 35-39.

Pollock, C.A., Rexroad, C.B., and Nicoll, R.S.
1970: Lower Silurian conodonts from northern Michigan and Ontario; Journal of Paleontology, v. 44, p. 743-764.

Rexroad, C.B.
1967: Stratigraphy and conodont paleontology of the Brassfield (Silurian) in the Cincinnati Arch area; Indiana Geological Survey, Bulletin 36.

1980: Stratigraphy and conodont paleontology of the Cataract Formation and the Salamonie Dolomite (Silurian) in northeastern Indiana; Indiana Geological Survey, Bulletin 58.

Rexroad, C.B., Noland, A.V., and Pollock, C.A.
1978: Conodonts from the Louisville Limestone and the Wabash Formation (Silurian) in Clark County, Indiana and Jefferson County, Kentucky; Indiana Geological Survey, Special Report 16.

Rexroad, C.B. and Rickard, L.V.
1965: Zonal conodonts from the Silurian strata of the Niagara Gorge; Journal of Paleontology, v. 39, p. 1217-1220.

Rhodes, F.H.T.
1953: Some British Lower Paleozoic conodont faunas; Philosophical Transactions of the Royal Society of London, Series B, v. 237, no. 647, p. 261-334.

Richardson, J.
1857: Report for the year 1856; Geological Survey of Canada, Report of Progress 1853-56, p. 191-245.

Roliff, W.A.
1968: Oil and gas exploration - Anticosti Island, Quebec; Proceedings of the Geological Association of Canada, v. 19, p. 31-36.

Savage, N.M.
1973: Lower Devonian conodonts from New South Wales; Palaeontology, v. 16, p. 307-333.

Schönlaub, H.P.
1971: Zur Problematik der Conodonten-Chronologie an der Wende Ordoviz/Silur mit besonderer Berücksichtigung der Verhältnisse im Llandovery; Geologica et Palaeontologica, v. 5, p. 35-57.

1975: Conodonten aus dem Llandovery der Westkarawanken (Österreich); Verhandlungen der Geologischen Bundesanstalt, v. 2-3, p. 45-65.

1980: [with contributions from H. Jaeger, M.R. House, J.D. Price, B. Göddertz, H. Priewalder, O.H. Walliser, J. Kriz, W. Haas, and G.B. Vai] Carnic Alps, Field Trip A; in Second European Conodont Symposium - ECOS II, Guidebook and Abstracts; Abhandlungen der Geologischen Bundesanstalt, v. 35, p. 5-57.

Schuchert, C. and Twenhofel, W.H.
1910: Ordovicic-Siluric section of the Mingan and Anticosti Islands, Gulf of St. Lawrence; Geological Society of America, Bulletin, v. 21, p. 677-716.

Seddon, G. and Sweet, W.C.
1971: An ecologic model for conodonts; Journal of Paleontology, v. 45, p. 869-880.

Serpagli, E.
1967: I conodonti dell'Ordoviciano superiore (Ashgilliano) delle Alpi Carniche; Bolletino della Società Paleontologica Italiana, v. 6, no. 1, p. 30-111.

Stauffer, C.R.
1930: Conodonts from the Decorah shale; Journal of Paleontology, v. 4, p. 121-128.

Sweet, W.C. and Bergström, S.M.
1970: The generic concept in conodont taxonomy; Proceedings of the North American Paleontological Convention, Part C, p. 157-173 [imprint 1969].

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

Telford, P.G.
1978: Silurian stratigraphy of the Niagara Escarpment, Niagara Falls to the Bruce Peninsula; in Toronto '78, Field trips guidebook, A.L. Currie and W.O. Mackasey, eds., Geological Society of America, Geological Association of Canada, and Mineralogical Association of Canada, p. 28-42.

Twenhofel, W.H.
1921: Faunal and sediment variation in the Anticosti sequence; Geological Survey of Canada, Museum Bulletin 33, Geological Series 40, p. 1-14.

1928: Geology of Anticosti Island; Geological Survey of Canada, Memoir 154.

Uyeno, T.T., and Barnes, C.R.
1981: A summary of Lower Silurian conodont biostratigraphy of the Jupiter and Chicotte formations, Anticosti Island, Québec; in Field Meeting, Anticosti-Gaspé, Québec, 1981, v. II: Stratigraphy and Paleontology, p. 173-184, P.J. Lespérance, ed., Subcommission on Silurian Stratigraphy, Ordovician-Silurian Boundary Working Group, Université de Montréal.

Viira, V.Y.
1977: The composition and distribution of the conodonts in the Silurian of the Baltic region; in The facies and fauna of the Baltic Silurian, D. Kaljo, ed., Academy of Sciences Estonian SSR, Institute of Geology, p. 179-192.

Walliser, O.H.
1957: Conodonten aus dem oberen Gotlandium Deutschlands und der Karnischen Alpen; Notizblatt des Hessischen Landesamtes für Bodenforschung zu Wiesbaden, v. 85, p. 28-52.

1962: Conodontenchronologie des Silurs (=Gotlandiums) und des tieferen Devons mit besonderer Berücksichtigung der Formationsgrenze; 2. Internationalen Arbeitstagung über die Silur/Devon-Grenze und die Stratigraphie von Silur und Devon, Bonn-Bruxelles 1960, Symposiums-Band, p. 281-287.

1964: Conodonten des Silurs; Abhandlungen des Hessischen Landesamtes für Bodenforschung, Heft 41, 106 p.

1972: Conodont apparatuses in the Silurian; in Symposium on conodont taxonomy, M. Lindström and W. Ziegler, eds., Geologica et Palaeontologica, v. SB1, p. 75-79.

Wilson, J.L.
1970: Depositional facies across carbonate shelf margins; Transactions of the Gulf Coast Association of Geological Societies, v. 20, p. 229-233.

1974: Characteristics of carbonate platform margins; American Association of Petroleum Geologists, Bulletin, v. 58, p. 810-824.

Ziegler, A.M.
1966: The Silurian brachiopod *Eocoelia hemisphaerica* (J. de C. Sowerby) and related species; Palaeontology, v. 9, Pt. 4, p. 523-543.

Ziegler, A.M., Cocks, L.R.M., and Bambach, R.K.
1968: The composition and structure of Lower Silurian marine communities; Lethaia, v. 1, p. 1-27.

Ziegler, W. (ed.)
1981: Catalogue of Conodonts; E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, v. IV.

PLATES

1-9

PLATE 1

Figures 1-6. *Oulodus*? cf. *O.*? *fluegeli* (Walliser).

All from GSC loc. C-92669, member 1, Jupiter Formation.

1, 2. GSC 64854 and 64855, respectively, posterior view of two Pa elements (both x100).

3. GSC 64856, posterior view of Pa element (x75).

4. GSC 64857, inner lateral view of Pb element (x100).

5. GSC 64858, posterior view of Sb element (x100).

6. GSC 64859, posterior view of Sa element (x100).

Figures 7-13. *Pterospathodus siluricus* (Pollock, Rexroad and Nicoll).

All from GSC loc. C-92699, member 1, Jupiter Formation.

7, 8. GSC 64860 and 64861, respectively, inner lateral view of two M elements (both x100).

9. GSC 64862, outer lateral view of Pa element (x50).

10. GSC 64863, upper view of Pa element (x75).

11. GSC 64830, outer lateral view of Pa element (x75).

12. GSC 64864, outer lateral view of Pb element (x75).

13. GSC 64865, inner lateral view of Pb element (x100).

Figures 14, 15, 18-20. *Oulodus* sp. A.

All from GSC loc. C-92669, member 1, Jupiter Formation.

14, 15. GSC 64866 and 64867, respectively, inner lateral view of two Sc elements (both x100).

18, 19. GSC 64868 and 64869, respectively, inner lateral view of two M elements (x100 and x75, respectively).

20. GSC 64870, lateral view of Sa element (x100).

Figures 16, 17, 21, 22. *Ozarkodina pirata*, n. sp.

All from GSC loc. C-92691, member 4, Jupiter Formation.

16. GSC 64871, lateral view of paratype Pa element (x150).

17. GSC 64872, lateral view of paratype Pb element (x75).

21. GSC 64873, inner lateral view of paratype Sc element (x100).

22. GSC 64874, posterior view of paratype Sa element (x150).

Figures 23-25. *Ozarkodina pirata*, n. sp.

All from GSC loc. C-92652, member 1, Jupiter Formation.

23. GSC 64875, posterior view of paratype Sa element (x95).

24. GSC 64876, lateral view of paratype Pa element (x125).

25. GSC 64877, lateral view of paratype Pb element (x125).

PLATE 1

PLATE 2

Figures 1-11, 14-18. *Pterospathodus posteritenuis*, n. sp.

All from GSC loc. C-92669, member 1, Jupiter Formation.

1. GSC 64834, upper view of holotype Pa element (x100).

2. GSC 64878, oblique lower view of paratype Pa element (x100).

3. GSC 64879, inner lateral view of paratype Pa element (x100).

4. GSC 64880, posterior view of paratype Pb element (x100).

5. GSC 64881, outer lateral view of paratype Pb element (x150).

6. GSC 64882, inner lateral view of paratype M element (x75).

7, 8. GSC 64883 and 64884, respectively, inner lateral view of two paratype Sc elements (both x100).

9, 10. GSC 64885 and 64886, respectively, inner lateral view of two paratype Sc-Sb transitional elements (both x100).

11. GSC 64887, inner lateral view of paratype M element (x75).

14. GSC 64888, posterior view of paratype Sa element (x100).

15. GSC 64889, outer lateral view of paratype Sb element (x100).

16, 17. GSC 64890 and 64891, respectively, posterior view of two paratype Sb elements (both x100).

18. GSC 64892, posterior view of paratype Sb-Sa transitional element (x100).

Figures 12, 13, 19-28. *Ozarkodina pirata*, n. sp.

All from GSC loc. C-92669, member 1, Jupiter Formation.

12. GSC 64831, lateral view of holotype Pa element (x100).

13. GSC 64893, lateral view of paratype Pa element (x100).

19. GSC 64894, lateral view of paratype Pb element (x100).

20. GSC 64895, posterior view of paratype Sa element (x100).

21. GSC 64896, inner lateral view of paratype Sc element (x50).

22, 23. GSC 64897 and 64898, respectively, inner lateral view of two paratype M elements (both x75).

24. GSC 64899, posterior view of paratype Sb element (x75).

25. GSC 64900, lateral view of paratype Pb element (x75).

26. GSC 64901, inner lateral view of paratype Sc element (x75).

27, 28. GSC 64902 and 64903, respectively, posterior view of two paratype Sb-Sa transitional elements (both x100).

PLATE 2

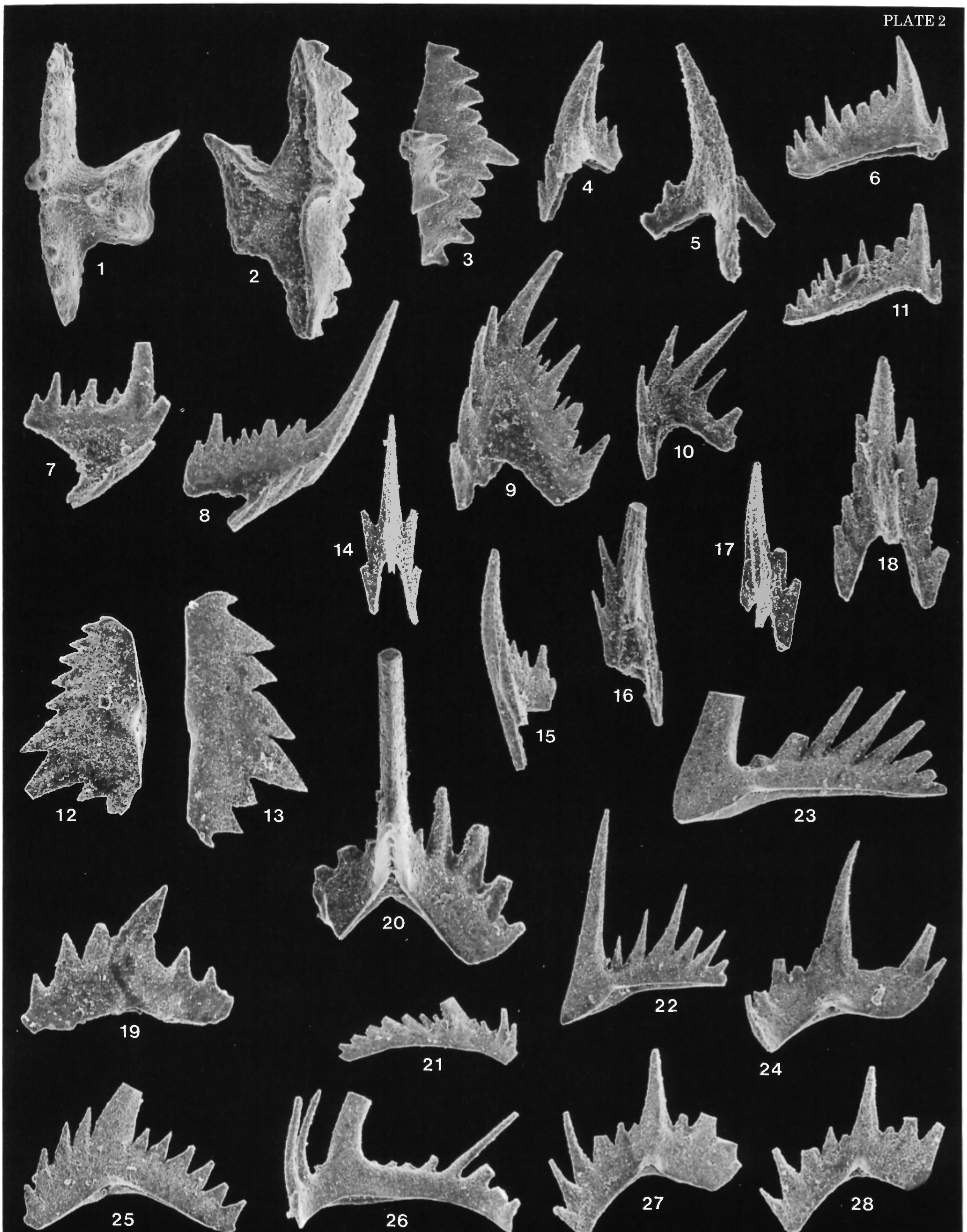

PLATE 3

Figures 1, 2. *Distomodus staurognathoides* (Walliser).

Both from GSC loc. C-92651, member 1, Jupiter Formation.

1. GSC 64904, posterior view of Sa element (x75).

2. GSC 64832, upper view of Pa element (x50).

Figures 3-6. *Distomodus staurognathoides* (Walliser).

All from GSC loc. C-92674, member 4, Jupiter Formation.

3, 4. GSC 64905 and 64906, respectively, inner lateral view of two M elements (x50 and x100, respectively).

5. GSC 64907, posterior view of Sb element (x75).

6. GSC 64908, lateral view of Sb element (x100).

Figures 7-11. *Distomodus staurognathoides* (Walliser).

All from GSC loc. C-92675, Chicotte Formation.

7. GSC 64909, upper view of Pa element (x50).

8. GSC 64910, inner lateral view of M element (x50).

9. GSC 64911, lateral view of Sa element (x75).

10. GSC 64912, oblique posterior view of Sb element (x75).

11. GSC 64913, inner lateral view of Sc element (x38).

Figures 12-15. *Distomodus staurognathoides* (Walliser).

All from GSC loc. C-92677, Chicotte Formation.

12. GSC 64914, posterior view of Sb element (x50).

13. GSC 64915, inner lateral view of M element (x50).

14. GSC 64916, oblique posterior view of Sa element (x50).

15. GSC 64917, inner lateral view of Sc element (x38).

Figures 16-24. *Ozarkodina aldridgei*, n. sp.

All from GSC loc. C-92702, member 4, Jupiter Formation.

16. GSC 64833, lateral view of paratype Pa element (x50).

17. GSC 64918, lateral view of holotype Pa element (x50).

18. GSC 64919, posterior view of paratype Sa element (x50).

19. GSC 64920, upper view of paratype Pa element (x50).

20. GSC 64921, lateral view of paratype Pb element (x100).

21, 22. GSC 64922 and 64923, respectively, inner lateral view of two paratype M elements (both x50).

23. GSC 64924, posterior view of paratype Sb element (x50).

24. GSC 64925, inner lateral view of paratype Sc element (x50).

Figures 25, 26. *Pseudooneotodus bicornis* Drygant?

Both from GSC loc. C-92669, member 1, Jupiter Formation.

25, 26. GSC 64926 and 64927, respectively, upper and lateral views of two single-denticle, squat conical elements (both x150).

Figures 27, 28. *Pseudooneotodus bicornis* Drygant.

Both from GSC loc. C-92674, member 4, Jupiter Formation.

27. GSC 64928, upper view of a two-denticle, squat conical element (x100).

28. GSC 64929, upper view of a single-denticle, squat conical element (x150).


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PLATE 4

Figures 1-6. *Oulodus* sp. B.

All from GSC loc. C-92702, member 4, Jupiter Formation.

1. GSC 64930, posterior view of Pa element (x100).

2. GSC 64931, posterior view of Sa element (x38).

3. GSC 64932, inner lateral view of Pb element (x50).

4. GSC 64933, inner lateral view of M element (x50).

5. GSC 64934, inner lateral view of Sc element (x50).

6. GSC 64935, posterior view of Sb element (x50).

Figures 7, 8. *Icriodella inconstans* Aldridge.

From GSC loc. C-92673, member 4, Jupiter Formation.

7, 8. GSC 64837, upper and oblique inner lateral views of I element (x50).

Figures 9, 10, ?15. *Icriodella inconstans* Aldridge.

Both from GSC loc. C-92674, member 4, Jupiter Formation.

9, 10. GSC 64936, inner lateral and upper views of I element (x75).

15. GSC 64937, oblique upper view of saggitodontiform? element (x75).

Figures 11-14, 16, 17, 19. *Ozarkodina gulletensis* (Aldridge).

All from GSC loc. C-92674, member 4, Jupiter Formation.

11. GSC 64938, inner lateral view of M element (x38).

12, 13. GSC 64838 and 64939, respectively, lateral view of two Pa elements (both x38).

14. GSC 64940, lateral view of Pb element (x50).

16. GSC 64941, posterior view of Sb element (x50).

17. GSC 64942, inner lateral view of Sc element (x38).

19. GSC 64943, posterior view of Sa element (x50).

Figures 18, 20-22. *Aulacognathus bullatus* (Nicoll and Rexroad).

All from GSC loc. C-92674, member 4, Jupiter Formation.

18. GSC 64944, inner lateral view of Pb element (x38).

20, 21. GSC 64835 and 64945, respectively, upper view of two Pa elements (x25 and x50, respectively).

22. GSC 64946, upper view of Pb element (x38).

Figures 23, 24. *Astropentagnathus irregularis* Mostler.

Both from GSC loc. C-92675, Chicotte Formation.

23. GSC 64947, upper view of rhynchognathodiform element (x75).

24. GSC 64841, upper view of Pa_2 element (x38).

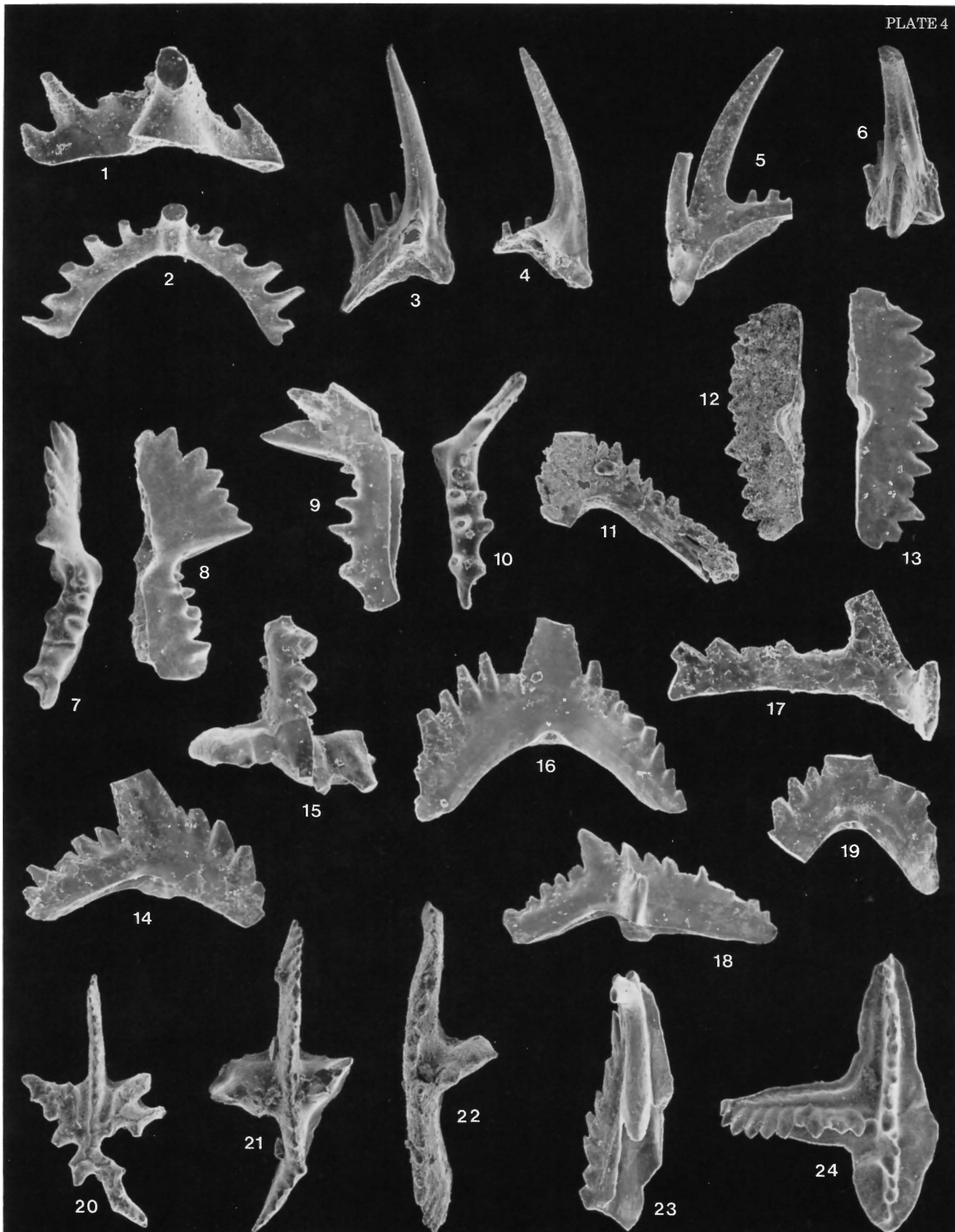
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PLATE 5

Figures 1-10. *Carniodus carnulus* Walliser.

All from GSC loc. C-92677, Chicotte Formation.

1, 2. GSC 64948 and 64847, respectively, outer lateral view of two Pa elements (both x75).

3, 8. GSC 64846 and 64949, respectively, outer lateral view of two Pb elements (both x75).

4. GSC 64950, lateral view of M element (x75).

5. GSC 64951, outer lateral view of Sb element (x75).

6. GSC 64952, outer lateral view of Sc element (x75).

7. GSC 64953, outer lateral view of Pb element ("abbreviated" form; x100).

9. GSC 64954, inner lateral view of Pb element ("abbreviated" form; x100).

10. GSC 64955, posterior view of Sa element (x75).

Figure 11. *Ozarkodina polinclinata* (Nicoll and Rexroad).

From GSC loc. C-92678, Chicotte Formation.

11. GSC 64836, lateral view of Pa element (x50).

Figures 12-16, 19. *Ozarkodina polinclinata* (Nicoll and Rexroad).

All from GSC loc. C-92677, Chicotte Formation.

12. GSC 64956, lateral view of Pa element (x50).

13. GSC 64957, inner lateral view of Sc element (x38).

14. GSC 64958, inner lateral view of M element (x75).

15. GSC 64959, posterior view of Sb element (x50).

16. GSC 64960, posterior view of Sa element (x100).

19. GSC 64961, lateral view of Pb element (x50).

Figures 17, 18, 20-24. *Pterospathodus celloni* (Walliser).

All from GSC loc. C-92677, Chicotte Formation.

17, 22. GSC 64962 and 64849, respectively, lateral view of two Pb elements (x75 and x100, respectively).

18. GSC 64963, outer lateral view of S element (x75).

20. GSC 64848, lateral view of Pa element (x50).

21. GSC 64964, lower view of Pa element (x50).

23. GSC 64965, lateral view of Pb element (x50).

24. GSC 64966, inner lateral view of M element (x75).

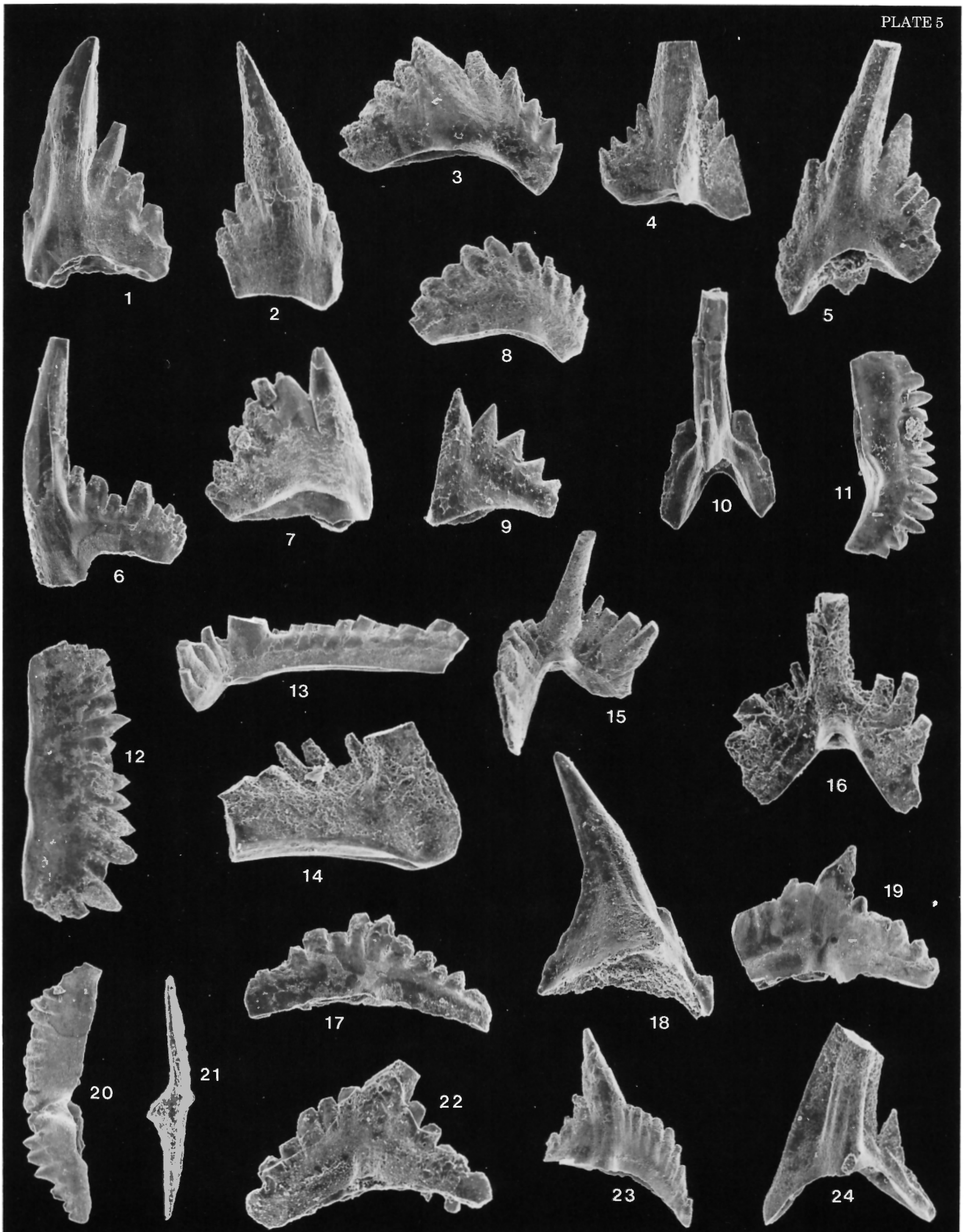
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PLATE 6

Figures 1-4. *Kockellella ranuliformis* (Walliser).

All from GSC loc. C-92677, Chicotte Formation.

1. GSC 64839, upper view of Pa element (x75).
2. GSC 64967, inner lateral view of Sc element (x75).
3. GSC 64968, posterior view of Sb element (x75; pyrite? crystal attached to lateral process).
4. GSC 64969, posterior view of Sa element (x50).

Figure 5. *Kockelella* cf. *K. ranuliformis* (Walliser).

From GSC loc. C-92674, member 4, Jupiter Formation.

5. GSC 64970, upper view of Pa element [x75; transitional to *Ozarkodina manitoulinensis* (Pollock, Rexroad and Nicoll)].

Figures 6-10. *Apsidognathus tuberculatus* Walliser.

All from GSC loc. C-92678, Chicotte Formation.

6, 8. GSC 64971 and 64972, respectively, upper view of Pa_1 and Pa_2 elements (both x38).

7. GSC 64973, upper view of Pa_2 element (x50).

9. GSC 64845, oblique upper view of Pb element (x100).

10. GSC 64974, lateral view of Sa element (x50).

Figures 11-14. *Apsidognathus tuberculatus* Walliser.

All from GSC loc. C-92677, Chicotte Formation.

11. GSC 64843, upper view of Sa element (x50).
12. GSC 64842, upper view of Pa_1 element (x30).
13. GSC 64975, oblique antero-lower view of Pa_2 element (x50).
14. GSC 64844, upper view of Pa_2 element (x50).

Figures 15-17, 21. *Pseudooneotodus* n. sp. of Cooper (1977).

All from GSC loc. C-92677, Chicotte Formation.

15. GSC 64976, lateral view of M? element (x125).
16. GSC 64977, posterior view of Sb element (x100).
17. GSC 64978, lateral view of Sa element (x100).
21. GSC 64979, upper view of Sc element (x150).

Figures 18-20. *Pseudooneotodus tricornis* Drygant.

All from GSC loc. C-92677, Chicotte Formation.

18. GSC 64980, upper view of a three-denticle, squat conical element (x70).
19. GSC 64981, lateral view of a single denticle, squat conical element (x125).
20. GSC 64982, lateral view of a three-denticle, squat conical element (x125).

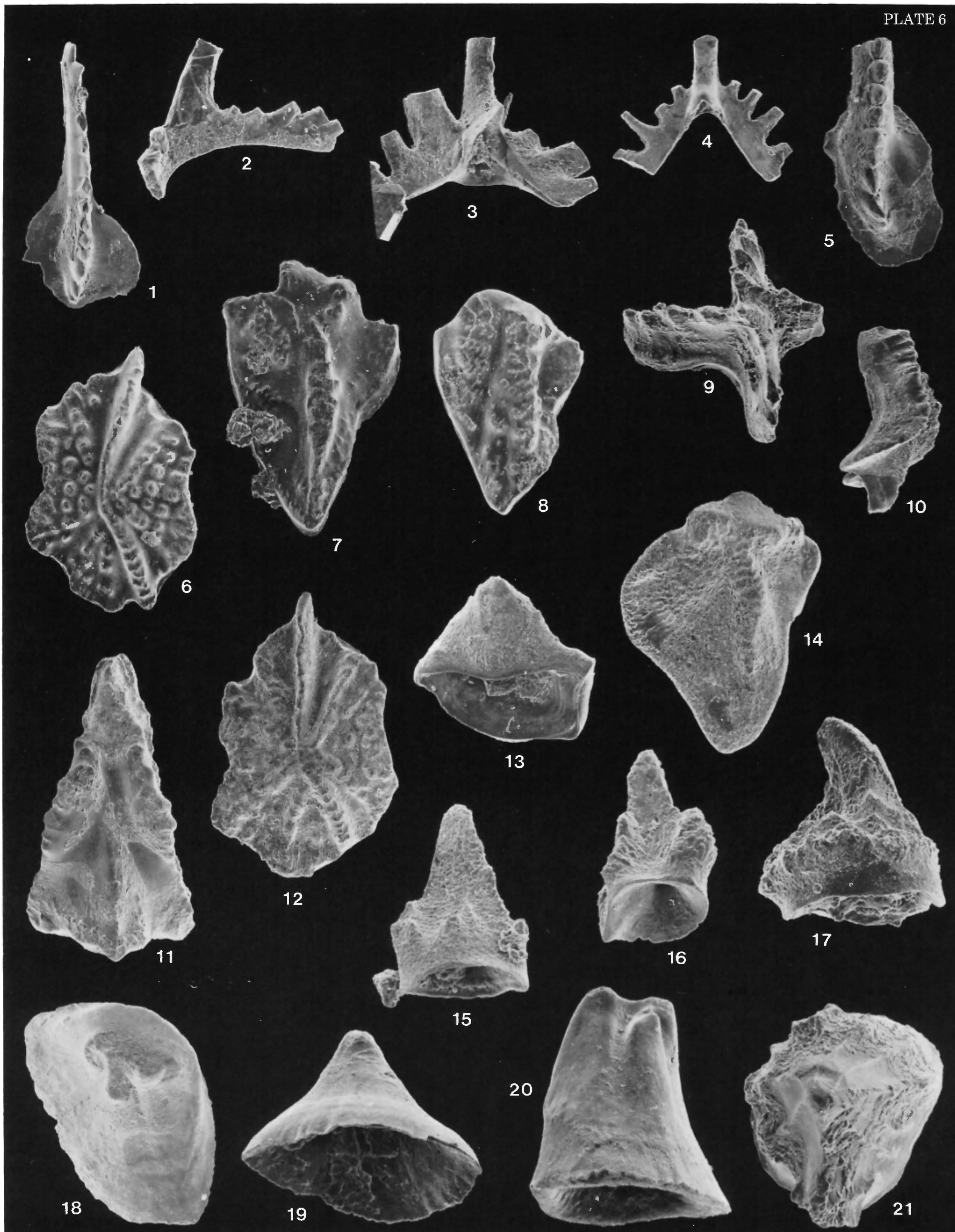
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PLATE 7

Figures 1-3, 5, 6. *Walliserodus sancticlairi* Cooper.

All from GSC loc. C-92702, member 4, Jupiter Formation.

1. GSC 64983, lateral view of Sb element (x50).
2. GSC 64984, lateral view of Sc element (x50).
3. GSC 64985, lateral view of Sd element (x50).
5. GSC 64986, lateral view of Sa element (x50).
6. GSC 64987, lateral view of M element (x50).

Figures 4, 7-10. *Ozarkodina clavula*, n. sp.

All from GSC loc. C-92674, member 4, Jupiter Formation.

4. GSC 64988, posterior view of paratype Sa element (x100).
7. GSC 64840, outer lateral view of holotype Pa element (x100).
8. GSC 64989, inner lateral view of paratype Pa element (x75).
9. GSC 64990, upper view of paratype Pa element (x100).
10. GSC 64991, lateral view of paratype Pb element (x100).

Figures 11-18, 22. *Oulodus? fluegeli* subsp. A.

All from GSC loc. C-92674, member 4, Jupiter Formation.

11. GSC 64992, inner lateral view of Pb element (x75).

12, 13. GSC 64993 and 64994, respectively, posterior view of two Pa elements (x50 and x75, respectively).

14. GSC 64995, oblique posterior view of Sb element (x75).

15. GSC 64996, oblique posterior view of Sa element (x150).

16, 17. GSC 64997, and 64998, respectively, inner lateral view of two M elements (both x75).

18. GSC 64999, posterior view of Sb-Sa transitional element (x75).

22. GSC 65000, inner lateral view of Sc element (x75).

Figures 19-21. *Oulodus? fluegeli* subsp. A.

All from GSC loc. C-92678, Chicotte Formation.

19. GSC 65001, posterior view of Pa element (x50).
20. GSC 65002, posterior view of Sb element (x75).
21. GSC 65003, inner lateral view of Sc element (x38).

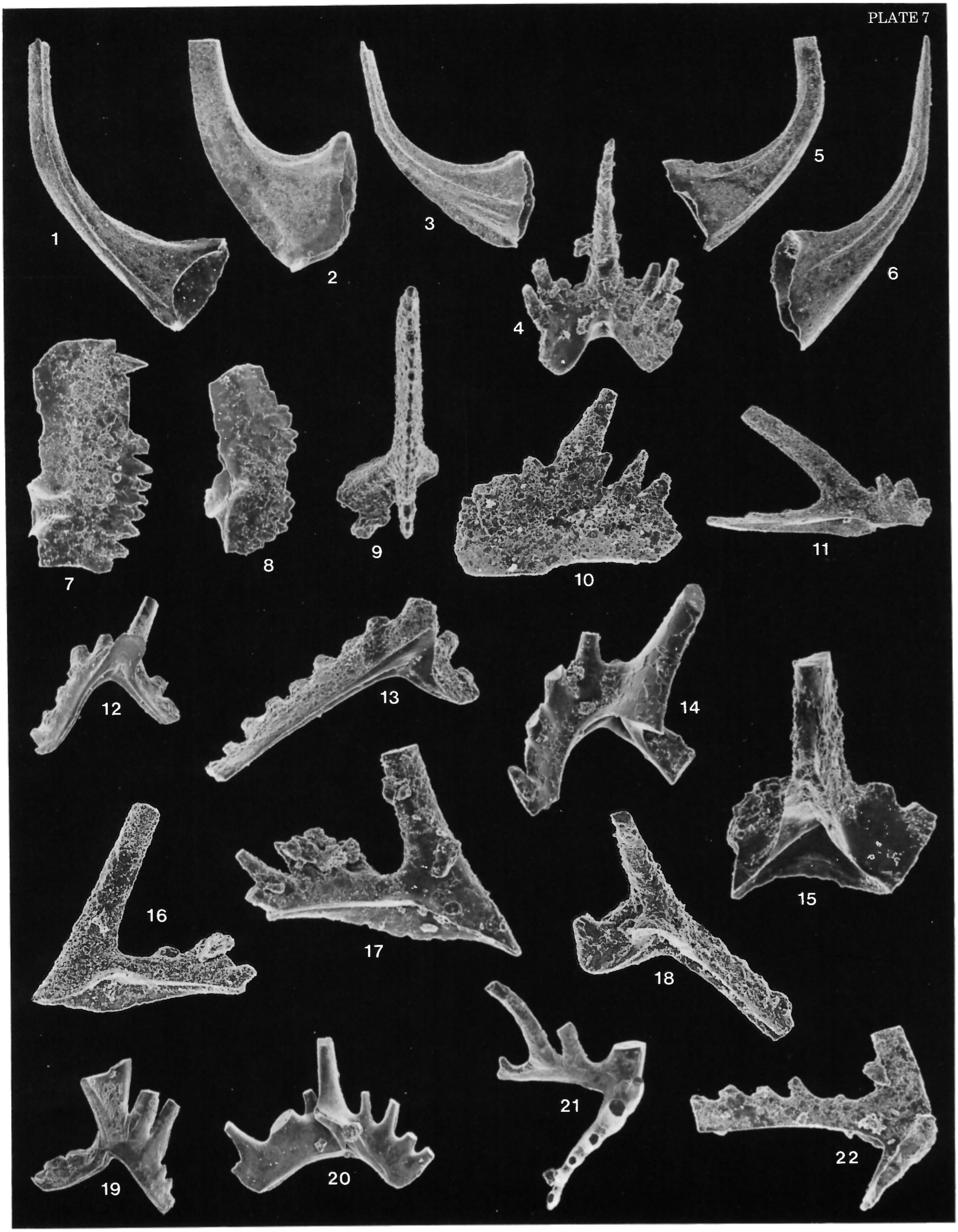
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PLATE 8

Figure 1. *Pterospathodus pennatus procerus* (Walliser).

From GSC loc. C-92678, Chicotte Formation.

1. GSC 64851, upper view of Pa element (x75).

Figures 2, 3. *Pterospathodus pennatus procerus* (Walliser).

Both from GSC loc. C-92677, Chicotte Formation.

2. GSC 65004, upper view of Pa element (x50).

3. GSC 65005, outer lateral view of Pb element (x38).

Figures 4, 8. Simple cone elements, group "a".

Both from GSC loc. C-92677, Chicotte Formation.

4. GSC 65006, lateral view (x200).

8. GSC 65007, oblique posterior view (x100).

Figures 5, 13. Simple cone elements, group "b".

Both from GSC loc. C-92677, Chicotte Formation.

5, 13. GSC 65008 and 65009, respectively, lateral views (x150 and x75, respectively).

Figures 6, 7, 9-12, 18, 19. Simple cone elements, group "c".

All from GSC loc. C-92677, Chicotte Formation.

6. GSC 65010, posterior view of Sa element (x100).

7. GSC 65011, inner lateral view of Sb-Sa transitional element (x100).

9, 10. GSC 65012 and 65013, respectively, posterior view of two Sa elements (both x125).

11. GSC 65014, oblique posterior view of Sb element (x125).

12. GSC 65015, outer laterial view of Sc element (x125).

18. GSC 65016, inner lateral view of Sb element (x125).

19. GSC 65017, outer lateral view of Sc? element (x75).

Figures 14-17. Simple cone elements, group "d".

All from GSC loc. C-92677, Chicotte Formation.

14. GSC 65018, inner lateral view of Sc element (x100).

15, 17. GSC 65019 and 65020, respectively, posterior and anterior views of two Sb elements (both x100).

16. GSC 65021, posterior view of Sa element (x100).

Figure 20. *Ozarkodina aldridgei*, n. sp.

From GSC loc. C-92693, member 4, Jupiter Formation.

20. GSC 65022, inner lateral view of paratype M element (x75).

Figure 21. *Oulodus* sp.

From GSC loc. C-92693, member 4, Jupiter Formation.

21. GSC 65023, anterior view of Pa element (x50).

Figures 22, 23. Agglutinated foraminifers.

Both from GSC loc. C-92669, member 1, Jupiter Formation.

22. GSC 65024, *Thurammina* sp. (x75).

23. GSC 65025, *Webbinelloidea*? sp. (x75).

Figure 24. *Pterospathodus amorphognathoides* Walliser.

From GSC loc. C-89848, Chicotte Formation.

24. GSC 64852, upper view of Pa element (x100; anterior process missing).

Figure 25. ?"*Johnognathus*" *huddlei* Mashkova.

From GSC loc. 76229, Chicotte Formation.

25. GSC 64853, upper view of Pa? element (x38; posterior part of unit missing).

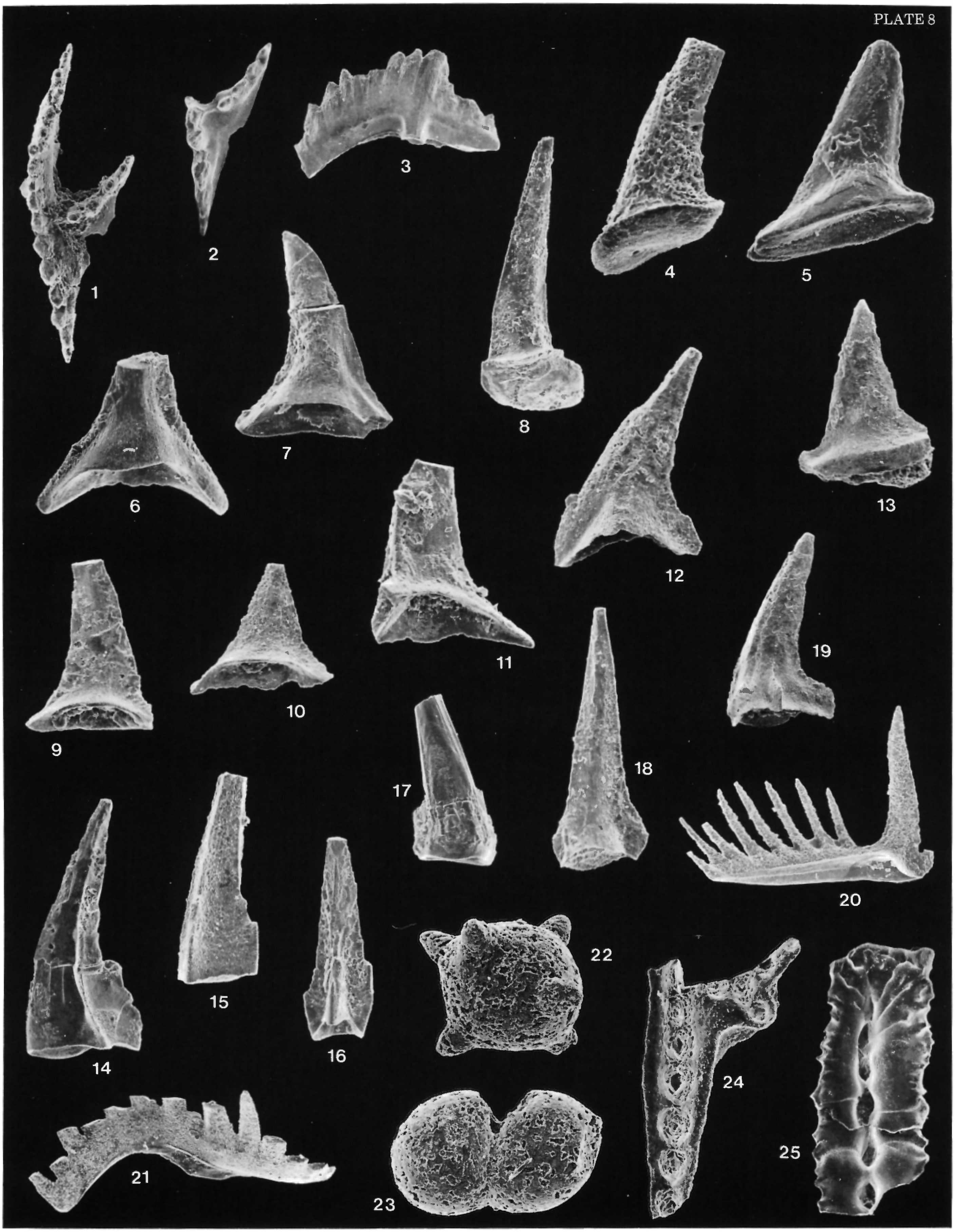
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PLATE 9

Figures 1-7. *Decoriconus fragilis* (Branson and Mehl).

All from GSC loc. C-92669, member 1, Jupiter Formation; all lateral views.

1, 5. GSC 65026 and 65027, respectively, Sc elements (both x125).

2, 3. GSC 65028 and 65029, respectively, Sb elements (both x100).

4, 6. GSC 65030 and 65031, respectively, Sa elements (both x125).

7. GSC 65032, Sb element (x125).

Figure 8. *Decoriconus fragilis* (Branson and Mehl).

From GSC loc. C-92691, member 4, Jupiter Formation.

8. GSC 65033, inner lateral view of Sb element (x125).

Figures 9, 10. *Decoriconus fragilis* (Branson and Mehl).

Both from GSC loc. C-92651, member 1, Jupiter Formation.

9. GSC 65034, inner lateral view of Sa element (x100).

10. GSC 65035, inner lateral view of Sc element (x125).

Figures 11, 12. *Dapsilodus obliquicostatus* (Branson and Mehl).

Both from GSC loc. C-92690, member 4, Jupiter Formation.

11. GSC 65036, outer lateral view of S element (x100).

12. GSC 65037, outer lateral view of S element (x125).

Figures 13, 14. *Decoriconus fragilis* (Branson and Mehl).

Both from GSC loc. C-89848, Chicotte Formation.

13, 14. GSC 65038 and 65039, respectively, inner lateral view of two Sa elements (both x100).

Figures 15, 16. *Decoriconus fragilis* (Branson and Mehl).

Both from GSC loc. C-92690, member 4, Jupiter Formation.

15. GSC 65040, inner lateral view of Sb element (x150).

16. GSC 65041, inner lateral view of Sc element (x125).

Figures 17-20. *Panderodus unicostatus* (Branson and Mehl).

All from GSC loc. C-92673, member 4, Jupiter Formation.

17. GSC 65042, reverse view of M element (x50).

18. GSC 65043, obverse view of Sa element (x50).

19. GSC 54044, obverse view of Sc element (x50).

20. GSC 65045, obverse view of Sb element (x50).

Figure 21. *Panderodus unicostatus* (Branson and Mehl).

From GSC loc. C-92690, member 4, Jupiter Formation.

21. GSC 65046, reverse view of a serrated element (x75).

Figure 22. *Panderodus unicostatus* (Branson and Mehl).

From GSC loc. C-92667, member 4, Jupiter Formation.

22. GSC 65047, reverse view of a serrated element (x75).

Figures 23, 25, 26. *Panderodus recurvatus* (Rhodes).

All from GSC loc. C-92702, member 4, Jupiter Formation.

23. GSC 65048, outer obverse view of Sb element (x38).

25. GSC 65049, reverse view of Sc element (x75).

26. GSC 65050, obverse view of Sc element (x50).

Figure 24. *Panderodus recurvatus* (Rhodes).

From GSC loc. C-92699, member 4, Jupiter Formation.

24. GSC 65051, reverse view of Sc element (x50).

Figures 27, 28. *Distomodus* cf. *D. kentuckyensis* Branson and Branson of Cooper (1975).

Both from GSC loc. C-92702, member 4, Jupiter Formation.

27. GSC 65052, lateral view of a fused simple cone (Pa?) element (x75).

28. GSC 65053, lateral view of a simple cone (Pa?) element (x150).

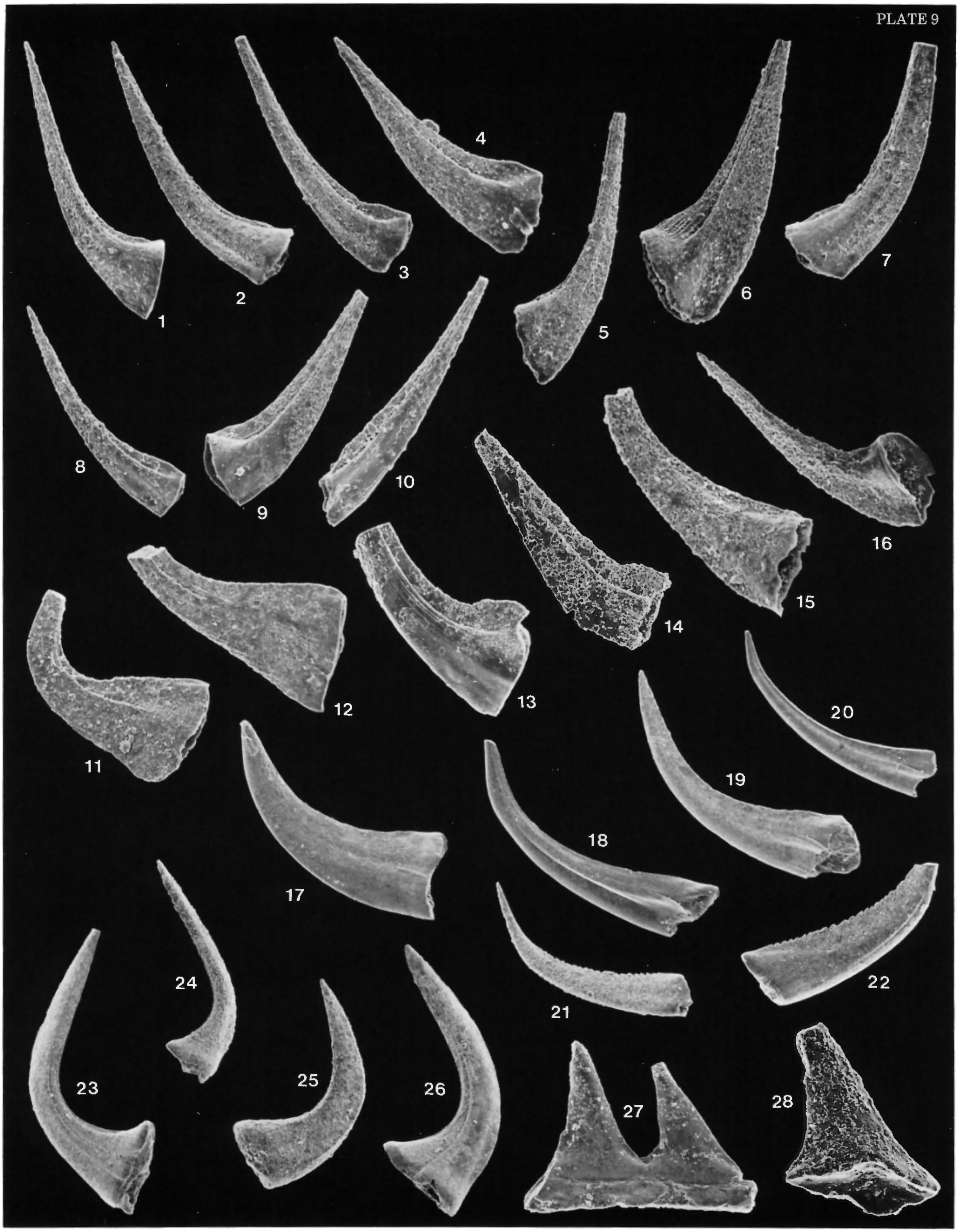
PLATE 9
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