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CONODONT BIOSTRATIGRAPHY OF THE
UPPER DEVONIAN REEF COMPLEXES OF
THE CANNING BASIN,
WESTERN AUSTRALIA

By

E. C. DRUCE



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DIRECTOR: N. H. FISHER

ASSISTANT DIRECTOR, GEOLOGICAL BRANCH: J. N. CASEY

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ERRATA

For some of the species described in pp. 49-221 the Plate and figure reference is wrong. The table below gives the correct reference.

Page	Species	Printed version	Correct version
58	<i>Ancryodella ioides</i>	Pl. 1, figs 5a, b	Pl. 4, figs 1a-4b
62	<i>Ancyrodella rotundiloba</i> <i>rotundiloba</i>	Pl. 9, figs 1a-7b; Pl. 10, figs 1a-3b; Pl. 12, fig. 1a, b	Pl. 9, figs 1a-7b; Pl. 10, figs 1a-3b; Pl. 12, fig. 1a, b; Pl. 71, fig. 8
66	<i>Ancyrodella rugosa</i>	Pl. 3, figs 4a, b	Pl. 3, fig. 4a-c
74	<i>Apathognathus</i> sp. nov. B	— Material: 5 specimens	Pl. 14, figs 1a-2b Material: 5 specimens; CPC 12781, 13807 figured
76	<i>Belodella resima</i>	Pl. 13, figs 7a-10b, 12a, b	Pl. 14, figs 7a-10b, 12a, b
89	<i>Hibbardella</i> (D.) <i>aurita</i>	Pl. 22, figs 3a, b, 5a, b; Pl. 23, fig. 1	Pl. 22, fig. 4a, b; Pl. 23, fig. 1
97	<i>Hindeodella subtilis</i>	Pl. 24, fig. 70 . . . etc.	Pl. 24, fig. 7 . . . etc.
98	<i>Hindeodella uncata</i>	Pl. 5, fig. 7	Pl. 26, figs 2a, b, 8a, b
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135	<i>Nothognathella palmatoformis</i>	Pl. 17, fig. 8; text-fig. 21	Pl. 42, figs 3a-c, 5a-7b; text-fig. 21
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<i>p. 115, line 15</i>		For <i>CPC 12494-8</i> read <i>CPC 12494-8, 12452</i>	
<i>p. 219, line 16</i>		For <i>denticle</i> read <i>denticulation</i>	
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SUMMARY

A diverse conodont fauna of Late Devonian age is described from reef complexes developed in the Canning Basin, Kimberley region, Western Australia.

An area of 20 000 km² yielded samples from each of the major facies of the complex. Detailed trough samples of thick sequences within each facies were collected. A total of 883 samples yielded 6400 identifiable specimens.

Conodonts are rare in the lagoonal back-reef facies and in the main reef-facies, but are reasonably abundant in the fore-reef (talus slope) and inter-reef facies. There appears to be some horizontal stratification of the faunas; three biofacies are recognized: (i) *Belodella*, (ii) *Icriodus-Pelekygnathus*, and (iii) *Palmatolepis* biofacies.

The thick fore- and inter-reef sequences indicate that reef growth was active at least as early as the beginning of the Late Devonian (Frasnian) and continued into the middle Famennian (toIV), when it was blanketed by Late Devonian-Early Carboniferous platform carbonates, the Fairfield Beds and Laurel Formation.

The conodont faunas consist of platforms, bars and blades, and cone units, in all 233 species and subspecies; no attempt has been made to examine the fauna for multi-element species. The form genera *Ancyrodella*, *Icriodus*, and *Nothognathella* have been examined in detail.

Ancyrodella arose from spathognathodid stock and is polyphyletic. No derivation of *Icriodus* is suggested, but a new classification of Late Devonian forms is proposed at the sub-specific level. The development of similar gross morphology on differing denticle types is considered to be a function of environment, notably water depth. *Nothognathella* is one of the few bar genera that develop lateral platforms. In the present faunas the genus is abundant enough to allow a tentative phylogeny to be constructed. A better understanding of *Nothognathella* may make it useful in biostratigraphic zonation.

Of the 233 species and subspecies, 6 are new (*Nothognathella palmatoformis*, *Polygnathus australis*, *P. janetae*, *P. pollocki*, *P. seddoni*, and *Spathognathodus fitzroyi*), and 65 are left in open nomenclature. Thus, 70% of the fauna has been described from localities outside the Canning Basin; the majority from outside Australia.

The ranges of individual species correspond closely with ranges from other continents, and most zones and subzones erected on the basis of European faunas could be recognized: altogether, 17 of the 21 subzones which theoretically should be present were found. The uppermost *Palmatolepis gigas* subzone and the subzones of the *Scaphignathus veliferus* zone could not be delineated.

The conspicuous presence of European species occurring with a similar vertical distribution enables the European zonation to be used with ease, and no special Australian zones have been erected. The zones are readily applicable to some fore-reef deposits and to the inter-reef deposits; but near-reef fore-reef deposits contain faunas lacking index species and the only satisfactory way of correlating them accurately is to walk the outcrop.

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INTRODUCTION

The Canning Basin, which covers some 450 000 km², is the largest sedimentary basin in Western Australia and the second largest in Australia.

The sediments deposited in the Basin overlie Precambrian metamorphic and sedimentary rocks. The earliest Palaeozoic sediments are widespread marine Ordovician limestones, shales, and sandstones, about 900 m thick. No undoubted Silurian rocks are known. Reefs were extensively developed in the Late Devonian, beginning in the Givetian, especially on the northern margin and possibly in the south; shale and sandstone are basinal equivalents. The Fitzroy Trough contains up to 2000 m of Carboniferous and 4250 m of Permian sediments, but they are thinner elsewhere (Veevers & Wells, 1961).

The basin, apart from its seaward extension, is surrounded by Precambrian rocks, although the southern boundary is unknown as yet.

In 1947 the Bureau of Mineral Resources began field work in the Canning Basin, which continued annually until 1958. The work consisted of geological mapping; seismic, gravity, and aeromagnetic surveys; and stratigraphic drilling. The results of these and other surveys were summarized and correlated by McWhae et al. (1958) and Veevers & Wells (1961).

In 1968 the Geological Survey of Western Australia and the Bureau of Mineral Resources undertook a detailed investigation of the Lennard Shelf, within the Canning Basin. This Bulletin is one contribution to that study. Other aspects are being dealt with mainly by officers of the Western Australian Survey.

The Bulletin describes the form genera and species of conodonts from the southeastern part of the reef complex, and also includes some specimens from the Napier Range and Geikie Gorge. It is based on a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the University of Michigan and written while I was in receipt of a financial grant from the Commonwealth Public Service.

I wish to thank Dr P. E. Playford and Dr A. Cockbain, of the Geological Survey of Western Australia, Dr J. S. Jell of Queensland University, and Dr M. Peterson of Brigham Young University for valuable help and discussions in the field. Messrs Doug Felsch, Stuart Harper, and Kelly O'Neil gave valuable help collecting samples. A. T. Wilson of the Bureau of Mineral Resources was in charge of the laboratory and photography. P. J. Jones (BMR), Dr G. Seddon (University of New South Wales) and Dr R. A. McTavish (WAPET) critically reviewed the text and made many helpful suggestions, although all opinions expressed are those of the author.

The staff of the Geology and Mineralogy Department of The University of Michigan gave considerable support. Professor F. H. T. Rhodes provided immense stimulation and counselling in all phases of this work.

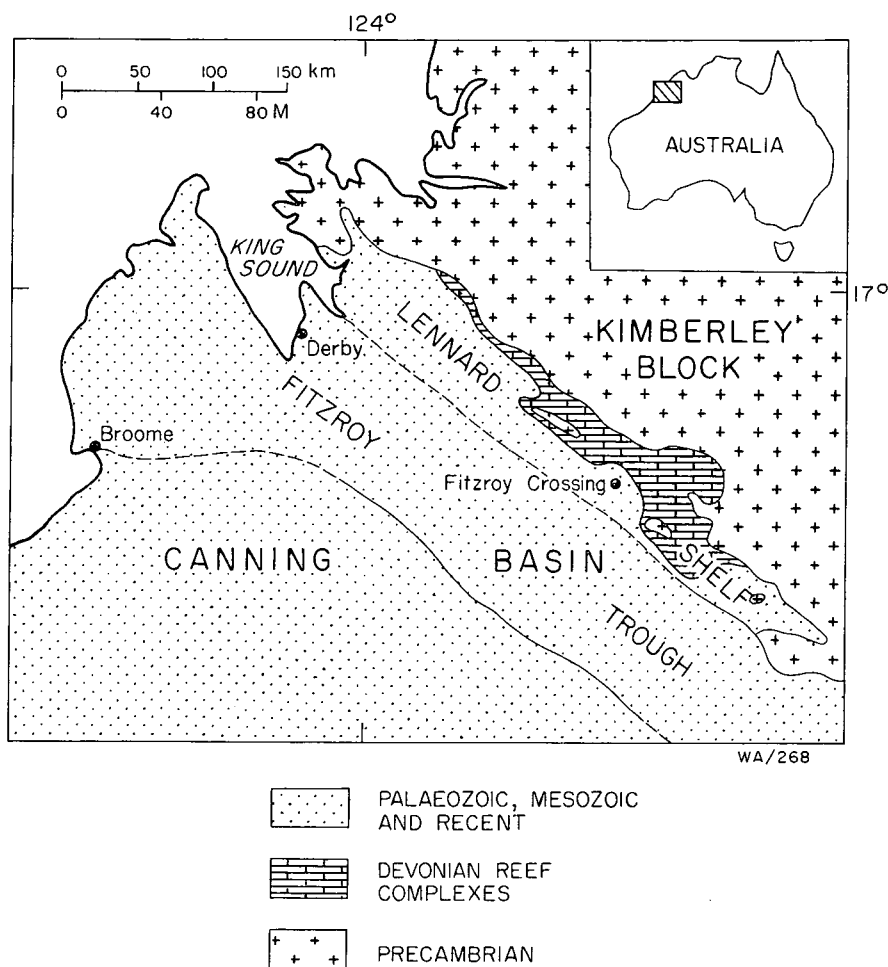


Fig. 1. Locality map, Lennard Shelf, Western Australia.

THE DEVONIAN REEF COMPLEXES

In 1884, Hardman described the Carboniferous Limestone ranges of the West Kimberley area; his fossil collections showed (Nicholson, 1890; Hinde, 1890; Foord, 1890) that the fauna was Devonian. Detailed accounts of later investigations are given by Veevers (1959), Veevers & Wells (1961), and Playford & Lowry (1966). The Devonian rocks were described in detail by Rattigan & Veevers (*in* Veevers & Wells, 1961).

The limestones were first interpreted as a reef complex by Wade (1924, 1936, 1938). Subsequent work by geologists of Caltex (Australia) Oil Development Pty Ltd enlarged the stratigraphic knowledge of the northern part of the Canning Basin (Playford & Lowry, 1966). Playford (1969) compares the Lennard Shelf reefs with extensive and different types of reef complexes in Alberta, Canada.

Playford & Lowry recognize four main facies in the reef-complexes: reef, back-reef, fore-reef, and inter-reef (Fig. 2). The facies are delineated from their depositional setting, mainly manifest in their bedding characteristics, rather than their lithology and faunal content. Playford & Lowry divided their facies into subfacies on the basis of lithology (p. 49) but also use faunal content to delineate some subfacies (e.g. stromatoporoid subfacies). However, the term sub-facies is not always used to delineate differing rock types. Thus we have different formations recognized by their lithology within the fore-reef facies, whereas the back-reef is assigned to a single formation and the various rock-types are separated by the recognition of sub-facies. In this Bulletin I have followed the same usage as Playford & Lowry.

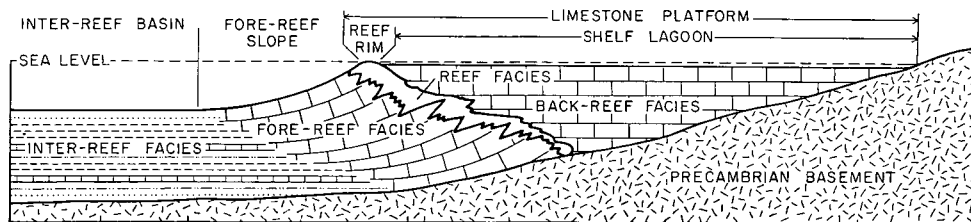


Fig. 2. Diagrammatic cross-section illustrating the structure and facies relationships of a typical reef complex of the Canning Basin, approximate dimensions 3 km across (after Playford & Lowry, 1966).

According to Playford & Lowry (p. 30) a reef usually grew upwards and outwards, advancing over its own talus. The reef rim is built of a framework of colonial organisms which are essentially *in situ*, having formed a wave-resistant barrier which supplied fore-reef talus. The rim isolated the back-reef shelf lagoon, which was shallow, with occasional intertidal mud flats (Fig. 2).

Reef Facies. Playford & Lowry (p. 36, figs 9-15) refer the reef facies to a single formation, the Windjana Limestone. It is normally a massive or crudely bedded limestone, built up of a framework of colonial organisms in their approximate growth position.

Important fossils in the reef include the blue-green algae *Renalcis* and *Sphaerocodium* (Wray & Playford, 1970) and stromatoporoids, including *Stachyodes* and *Actinostroma*. Other algae include the blue-green *Girvanella* and the red *Parachaetetes* and *Solenopora* (Playford & Lowry, p. 46; Wray, 1967; Wray & Playford, 1970).

Sponges are common, including *Sphaerospongia* and *Striatospongia*; also present is the problematic fossil *Receptaculites*. Corals are abundant only where the reef is narrow and merges with the back-reef facies; they include *Hexagonaria*. Brachiopods are present, usually in pockets; *Pugnax* is the most abundant genus. Goniatites are rare.

Back-Reef Facies. Playford & Lowry (p. 47) refer all the back-reef deposits to a single formation, the Pillara Limestone, although recent work has suggested that outcrops fall naturally into an early Upper Devonian unit and a late Upper Devonian unit. Five subfacies are recognized: the stromatoporoid, birdseye-limestone, oolite, coral, and oncolite subfacies (ibid., p. 49-59).

The stromatoporoid subfacies (Playford & Lowry, 1966, figs 18, 19) is the commonest, consisting of biostromal beds from some 10 cm to a metre thick,

built up of the remains of stromatoporoids, especially *Amphipora* and *Actinostroma*. They are extensively dolomitized in certain areas and in some areas units are cyclic (B. W. Logan, pers. comm.). Playford & Lowry do not record any late Famennian occurrences of this subfacies.

The birdseye-limestone subfacies (Playford & Lowry, 1966, figs 22, 23) consists of medium-bedded limestone, characterized by 1-10 mm patches of sparry calcite in a groundmass of calcilitite or calcarenite. Playford & Lowry (p. 54) interpret it as an algal mat deposit. It forms most of the late Famennian back-reef.

The oolite subfacies (Playford & Lowry, 1966, figs 24, 25) is composed of coarse to fine ooliths and is virtually devoid of fossils apart from oncolites and large pelecypods (*Eumegalodon*). Playford & Lowry (p. 58) compare it to the oolite sand of the Great Bahama Bank.

The coral subfacies is restricted to the Givetian and early Frasnian parts of the reef-complex. It is characterized by the presence of biostromal beds of branching corals, including *Alveolites*, *Thamnopora*, *Hexagonaria*, *Disphyllum*, *Temnophyllum*, and *Donia*. They are especially common close to the reef (Playford & Lowry, 1966, fig. 27).

The oncolite subfacies is composed of beds of oolite or calcarenite containing abundant algal oncolites. The oncolites commonly contain a nucleus of a gastropod or crinoid columnal.

Fore-Reef and Inter-Reef Facies. Playford & Lowry divide the fore-reef into several formations distinguished by their different lithological characters. In the northwest part of the Lennard Shelf both the fore- and inter-reef rocks are referred to the Napier Formation: dominantly limestone with some calcareous sandstone and siltstone and occasional shale and conglomerate. Megabreccia composed of enormous blocks of reef limestone is common; other breccia beds with clasts indistinguishable from the host sediment are probably formed by advanced stylolization (Logan, pers. comm.). Algae, sponges, and brachiopods are present in the upper parts of the fore-reef adjoining the reef.

In the southeast (which includes the Bugle Gap area) Playford & Lowry (1966, fig. 28) divide the fore-reef and inter-reef into five formations.

The Sadler Limestone (fore-reef) and Gogo Formation (inter-reef) are of early Frasnian age. The Sadler Limestone is composed of yellow-grey limestone, with minor interbedded calcareous shale. The limestone is a fine-grained, sparry to micritic, intraclastic calcarenite. The formation is richly fossiliferous, and is characterized by abundant brachiopods (Veevers, 1959; Coleman, 1951). Also present are corals (Hill, 1954; Hill & Jell, 1970), gastropods, bryozoans (Ross, 1961), and ammonoids (Glenister, 1958). The Gogo Formation is poorly exposed but is believed to consist of shale and siltstone, with thin lenticular limestone and layers of abundant limestone nodules. It contains early Frasnian goniatites (Glenister, 1958), radiolarians, sponge spicules, ostracods (Glenister & Crespin, 1959), and well preserved fish (Brunton et al., 1969) and phyllocarid crustaceans (Rolfe, 1966; Brunton et al., 1969).

The Sadler Limestone and Gogo Formation are of approximately the same age and intertongue with each other. Playford & Lowry (p. 75) interpret the Gogo Formation as the inter-reef equivalent to the fore-reef Sadler Limestone.

The Virgin Hills Formation is a sequence of red limestone, calcareous siltstone, and sandstone. It overlies the Sadler Limestone and Gogo Formations, and

Playford & Lowry (p. 76) consider it to include both fore-reef and inter-reef facies. Fossils are abundant, especially goniatites (Teichert, 1941, 1943), nautiloids (Teichert, 1939, 1940), brachiopods (Veevers, 1959), corals (Hill, 1954), and sponges (Howell, 1952). Also recorded are arenaceous foraminifers, radiolarians, and ostracods (Glenister & Crespin, 1959). The Foraminifera were described by Crespin (1961).

The Bugle Gap Limestone (fore-reef) interfingers with the upper part of the Virgin Hills Formation (Playford & Lowry, p. 81). It consists of white to pink, intraclastic, sparry, fine to very coarse-grained calcarenite. Crinoidal debris is abundant and depositional dips are as high as 30° (ibid.). Fossils are comparatively rare but include brachiopods (Veevers, 1959) and corals (Hill, 1954).

The Piker Hills Formation is the youngest formation of the reef complex and, like the Virgin Hills Formation, is considered by Playford & Lowry (p. 82) to include both fore-reef and inter-reef facies. Faunally, brachiopods are abundant (Veevers, 1959) and ammonoids (Playford & Lowry, 1966), foraminifers, and bryozoans (Ross, 1961) are known. These beds had previously been considered part of the Fairfield Formation; Playford & Lowry (1966) proposed the name for the sequence of limestone, shale, and siltstone which overlies the Virgin Hills Formation in the Mt Pierre-Piker Hills area.

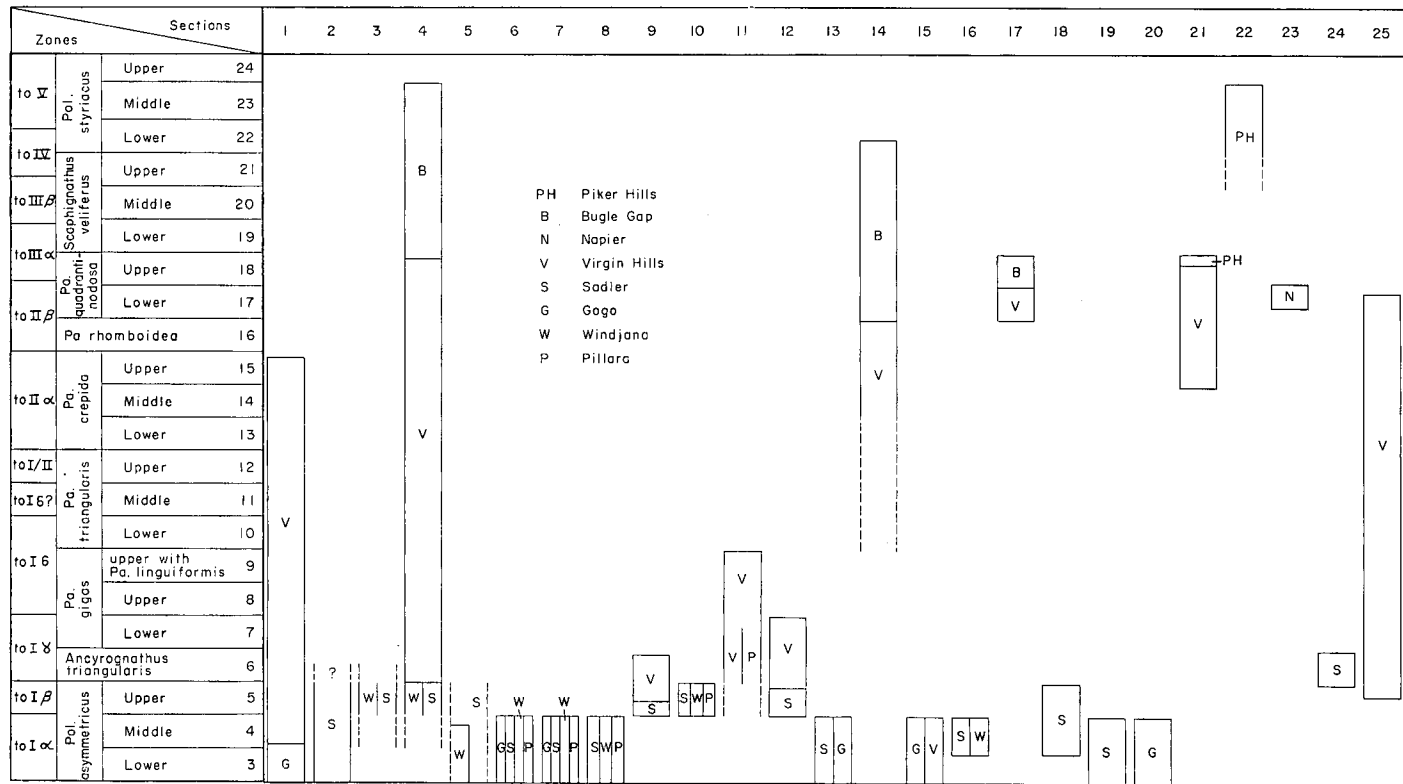
Collecting Localities

Most samples were collected from measured sections. Occasional spot samples were collected. All Windjana Limestone (reef) localities are spot samples, usually collected along a section line. Because of the steep depositional dip of fore-reef beds, up to 35° (Playford & Cockbain, 1969), the thicknesses measured were not true. Sections in poorly outcropping and ?flat-lying Gogo Formation (inter-reef) were collected at 160-m intervals. The sections are numbered, but the sample numbers are not duplicated, so sections were usually identified by the sample number sequence. A summary of the stratigraphic range of each section is given in Figure 3.

Section 1 (Figs 7 and 30). Samples BG 19001-19024, Bugle Gap Run 5, Photo 5133. Fore-reef deposits 45 m due west of McWhae Ridge. Sample interval 1.5 m.

The lower part of the section consists of thin-bedded nodular limestones (Gogo Formation); the base of the Virgin Hills Formation coincides with the base of Sample BG 19008, which is 30 cm thick. The next 6.7 m of section is covered; Sample BG 19009 is the Goniatite Bed. There is a 1.5-m covered interval above both BG 19010 and BG 19011. Samples BG 19008-19016 consist of fine interbedded limestone and shale. BG 19017 and BG-19018 are massive limestone, with a stromatolite bed in Sample BG 19018. BG 19010-19024 consist of thin limestone alternating with shale and massive limestone.

Samples BG 19001-19006 represent the Lower *Polygnathus asymmetricus* Zone; the Middle *P. asymmetricus* Zone is represented by Samples BG 19007 and BG 19008 and includes both the uppermost Gogo Formation and the basal Virgin Hills Formation at this point. The Upper *P. asymmetricus* Zone is represented by Samples BG 19009 (above a 6.7 m gap) to BG 19012. The sequence then appears to be condensed. Sample BG 19013 represents the *Ancyrognathus triangularis* Zone and Sample BG 19014 the Lower *Palmatolepis gigas* Zone. In this section the Upper *P. gigas* Zone could not be distinguished from the uppermost part of



M(P)563

Fig. 3. Stratigraphic range of section sampled.



Fig. 4. View, looking north, of the Laidlaw Range with Bugle Gap to the east and Paddys Valley to the west. The Laidlaw Range consists of a core of Pillara Limestone (back-reef) with rims of Windjana Limestone (reef) and Sadler Limestone (fore-reef) which form a 'tail' to the south (Glenister Knolls). The plains are underlain by Gogo Formation (inter-reef). Photo by P. E. Playford.

the Zone with *Palmatolepis linguiformis*; they are represented in Samples BG 19015 and BG 19016. The Lower and Middle *Palmatolepis triangularis* Zones are present in Sample BG 19017 and the Upper *P. triangularis* Zone is represented by a stromatolite bed (basal BG 19018), whereas the upper part of BG 19018 represents the Lower *Palmatolepis crepida* Zone. The Middle *P. crepida* Zone is represented by the uppermost part of Sample BG 19018 and BG 19019, and the remainder of the section to BG 19024 represents the Upper *P. crepida* Zone.

Section 2. Samples BG 19025-19042, Bugle Gap Run 5, Photo 5133, fore-reef deposits outcropping west of core of reef in the central part of McWhae Ridge. All samples consist of massive Sadler Limestone trough-sampled at 1.5 m intervals.

The conodont fauna is sparse and lacks good zone fossils. Age assignments are questionable, but Samples BG 19025-19032 probably belong to the Lower and Middle *Polygnathus asymmetricus* Zone. Samples BG 19033-19042 belong to the Upper *P. asymmetricus* Zone because they contain *Polygnathus normalis*. No upper limit can be placed on this section.

Section 3 (= section BC 76 of Seddon, 1970a, p. 730). Samples BG 19043-19050, Bugle Gap Run 5, Photo 5133, reef and fore-reef deposits west of south end of McWhae Ridge near the base of Section 1. Reef samples are spot-samples, fore-reef, collected in 1.5 m intervals.

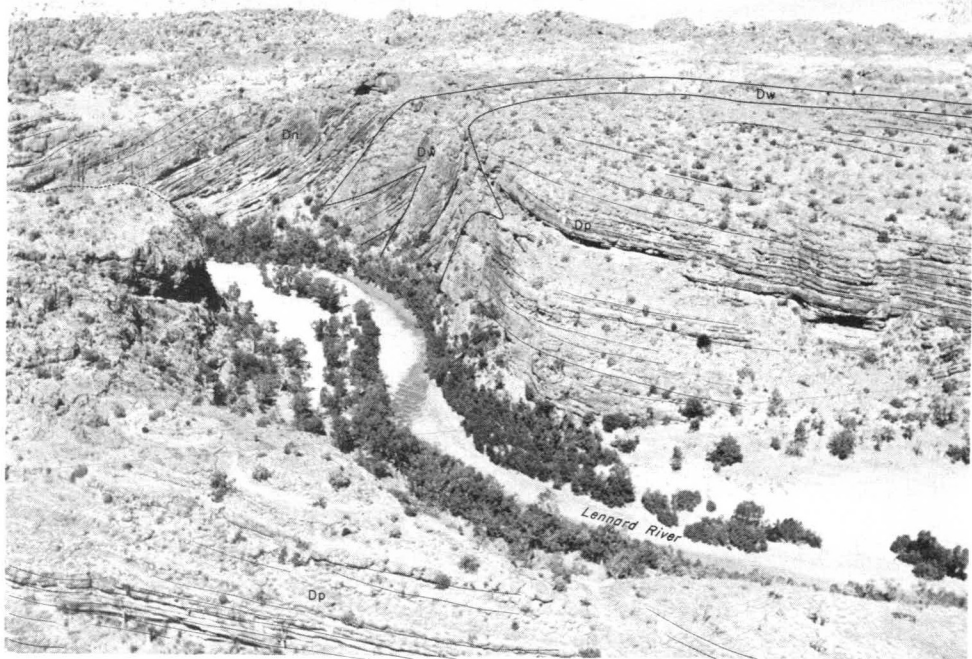


Fig. 5. Windjana Gorge. Aerial view of south wall showing back-reef, reef, and fore-reef facies of the Napier Range reef complex. Photo by P. E. Playford.

Sample BG 19043 is Windjana Limestone (reef) and is one of the few reef samples which yielded conodonts. None of the specimens in this section is very useful for dating, but the reef is probably of Upper *Polygnathus asymmetricus* Zone age. Samples BG 19044-19050 are from the Sadler Limestone, which is probably of Upper *P. asymmetricus* Zone age.

Section 4 (Figs 7 and 31) (basal part = Section BC 75 of Seddon, 1970a, p. 730). Samples BG 19051-19183, 19448A-19457; Bugle Gap Run 5, Photo 5133. This is the longest and most complete section and includes reef, fore-reef, and possibly inter-reef deposits. The section extends from McWhae Ridge northeastwards to Mimbi Creek. Trough samples were collected over 1.5 m intervals. Samples BG 19051-19056 are spot samples of Windjana Limestone (reef), which yielded very few conodonts. BG 19057 and BG 19058 were 6-m samples of Sadler Limestone.

Samples BG 19059-19061 were collected from thin shale and limestone belonging to the Virgin Hills Formation. The sequence is condensed in this region and samples BG 19064-19072 were re-collected at a section 45 m away at 30-cm intervals (BG 19448A-19457). Samples BG 19073-19104 are 1.5-m samples



Fig. 6. Aerial view, looking southeast along the Emanuel Range from Gap Creek. Thinly bedded limestones of the fore-reef facies (Sadler Limestone) on the left interfinger directly with the more massive limestones of the back-reef facies (Pillara Limestone). Photo by P. E. Playford.

in the Virgin Hills Formation. Samples BG 19105-19130 are from the Bugle Gap Limestone, collected at 3-m intervals, and BG 19131-19181 are from the same formation at 6-m intervals. Samples BG 19182 and BG 19183 are 1.5-m samples probably from the Piker Hills Formation.

Samples BG 19051-19058 yielded a few conodonts. They could not be dated accurately, but they are probably of late *Polygnathus asymmetricus* Zone age. Samples BG 19059 and BG 19061 contain fragments of ancyrodellids and palmatolepids and can probably be referred to the *Ancyrognathus triangularis* Zone, which can be recognized in BG 19062. The subsidiary section (BG 19448A-19457) begins in the Lower *Palmatolepis gigas* Zone (BG 19448A) and continues to the base of the *Palmatolepis triangularis* Zone (BG 19453B). As in Section 1 the Upper *P. gigas* Zone could not be separated from the uppermost *P. gigas* zone (with *Palmatolepis linguiformis*). Samples BG 19452C-E include the first stromatolite horizon. Samples BG 19453B-D represent the Lower *P. triangularis* Zone and BG 19453E-19454C the Middle *P. triangularis* Zone. The Upper *P. triangularis* Zone is confined to BG 19454D and the basal part of BG 19455, which is the second stromatolite bed. The Lower *Palmatolepis crepida* Zone is represented in the upper part of Sample BG 19455 and the Middle *P. crepida* Zone is present in Samples BG 19456 and BG 19457. Samples BG 19072 and BG 19073 represent the Upper *P. crepida* Zone. The *Palmatolepis rhomboidea* Zone is present in Samples BG 19074-19077. The Lower *Palmatolepis quadrantinodosa* Zone begins with the third stromatolite bed in Sample BG 19078 and ranges up through Sample

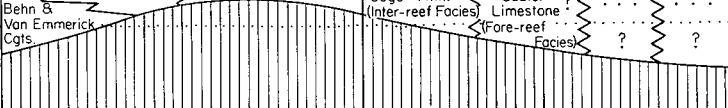
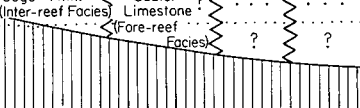


Fig. 7. View of McWhae Ridge looking southeast. A spine of reef (Windjana Limestone) is blanketed by steeply dipping fore-reef (Sadler Limestone). Overlying the Sadler Limestone is the more gently dipping fore-reef (Virgin Hills Formation). The flat plain is underlain by inter-reef (Gogo Formation) which interfingers with the Sadler Limestone. In the background, across a fault, is the massive bedded fore-reef deposit of the Bugle Gap Limestone. Section 1 was collected from the Gogo Formation through the Virgin Hills Formation to the south; section 3 was collected from the Windjana Limestone through the Sadler Limestone into the Gogo Formation in the southeast quarter. Photo by P. E. Playford.

BG 19106. BG 19105 is the base of the Bugle Gap Limestone. The interval BG 19107-19120 is referable to the Upper *Palmatolepis quadrantinodosa* Zone. The subzones of the *Scaphignathus veliferus* Zone cannot be readily recognized and the Zone ranges from sample BG 19121 to 19160. The Lower *Polygnathus styriacus* Zone is present in the interval BG 19161 to BG 19181, and the boundary between the Lower and Middle *P. styriacus* Zone is between BG 19181 and BG 19182. The possible equivalent of the Piker Hills Formation is only about 3 m thick and can all be referred to the Middle *Polygnathus styriacus* Zone.

Samples BG 19184-19200 and BG 19401-19447 were collected in the McWhae Ridge, Cave Spring area, in an attempt to elucidate the Windjana (reef), Sadler (fore-reef), and Pillara (back-reef) Limestones. Most of the faunas belonged to the *Icriodus* sequence of Seddon (1970a).

Section 5. Samples BG 19458-19481, Bugle Gap Run 4, Photo 5118. Reef and fore-reef deposits from a section through Lloyd Hill atoll. Samples BG 19458-19472 were collected at 15-m intervals, and the remainder at 3-m intervals.

		NAPIER RA. - GEIKIE RA. AREA				HULL RA. - EMANUEL RA. AREA				
Overlying Unit		Lower Permian Grant Formation				Lower Permian Grant Formation or ? Permian Conglomerate				
LOWER CARBONIFEROUS	TOURNAISIAN									
		Fairfield Formation				Fairfield Formation				
UPPER DEVONIAN	FAMENIAN	VI	Formation				Fairfield Formation			
		V								
		IV	Napier Formation	Windjana Limestone	Pillara Limestone	Piker Hills Formation (Fore-reef & Inter-reef Facies)	? Bugle Gap Ls. (Fore-reef Facies)	Windjana Limestone	Pillara Limestone	
		III		???	???	Virgin Hills Formation (Fore-reef & Inter-reef Facies)	???	???	???	
		II	 Stony Creek Cgt. (Fore-reef & Inter-reef Facies)	???	???	???	???	???	???	
		I		(Reef Facies)	(Back-reef Facies)	Bobbs Bore Cgt. (Reef Facies)	???	(Reef Facies)	(Back-reef Facies)	
MIDDLE DEVONIAN	FRASNIAN		Behn & Van Emmerick Cgls.		?	Gogo Fmn. (Inter-reef Facies)	Sadler Limestone (Fore-reef Facies)	???	???	
	GIVETIAN									
		Precambrian Basement				Precambrian Basement or Ordovician Gap Creek Formation				
Underlying Unit										

M(P) 564

Fig. 8. Stratigraphic correlation chart of Devonian formations, Lennard Shelf, Canning Basin (after Playford & Lowry, 1966).

The reef and lagoonal deposit samples yielded no conodonts. The fore-reef deposits yielded the *Icriodus* sequence. The sequence is probably of *Polygnathus asymmetricus* Zone age.

Section 6. Samples BG 19482-19493, Bugle Gap Run 4, Photo 5118. Section from Lloyd Hill atoll through Gogo Formation (inter-reef) (spot sampled at 160-m intervals) northeast to the Laidlaw Range, where the section crossed Sadler Limestone (fore-reef), and Windjana Limestone (reef), and entered Pillara Limestone (back-reef).

Only the Gogo Formation and the Sadler Limestone yielded conodonts. They are referable to the Lower and Middle *Polygnathus asymmetricus* Zones. All formations appear to be the same age.

Section 7 (Fig. 32). Samples BG 19494-19507, Bugle Gap Run 4, Photo 5117. Section west-southwest from Laidlaw Range to Emanuel Range across Paddys Valley, traversing Gogo Formation (inter-reef) sediments, folded into a gentle syncline, and Windjana Limestone (?) (reef) and Pillara Limestone (back-reef) in the Emanuel Range. Spot samples collected at 160-m intervals.

The sediments are all of *Polygnathus asymmetricus* Zone age, mainly Lower and Middle; no conodonts were recovered from the Pillara Limestone.

Section 8. Samples BG 19508-19521, Bugle Gap Run 3, Photo 5110. Section northwest from Wade Knoll, including Windjana Limestone (reef), Sadler Limestone (fore-reef), and ? Gogo Formation (inter-reef). Trough-sampled at 3-m intervals.

Only the Sadler and Gogo Limestones yielded conodonts. They are referable to the Lower and Middle *Polygnathus asymmetricus* Zone.

Section 9 (Fig. 33). Samples BG 19543-19550; BG 19531-19542, Bugle Gap Run 3, Photo 5105. Section from tributary south of Mt Pierre Creek, east of Waggon Pass to Balme Knoll, and east to McIntyre Knolls, through Gogo (inter-reef) and Virgin Hills (inter-reef) Formations. Trough-sampled at 3-m intervals.

The complete section is referable to the Upper *Polygnathus asymmetricus* Zone, although spot samples near McIntyre Knolls showed the presence of the *Ancyrognathus triangularis* Zone. The Gogo-Virgin Hills boundary is at the base of Sample BG 19547.

Section 10. Samples BG 19551-19562, Bugle Gap Run 3, Photo 5107. Traverse west across reef complex at Waggon Pass, spot samples of Sadler Limestone (fore-reef), Windjana Limestone (reef), and more Sadler Limestone.

The samples were barren, except for the Sadler, which is assigned to the Upper *Polygnathus asymmetricus* Zone.

Section 11. Samples BG 19563-19572, Bugle Gap Run 2, Photo 5094. Spot samples along creek about 3 km northeast of Galeru Gorge, in Windjana Limestone (reef) and Virgin Hills Formation (fore-reef) and questionable back-reef sediments.

The reef (Sample BG 19564) is probably of *Polygnathus asymmetricus* Zone age. The questionable back-reef is either of *Ancyrognathus triangularis* or *Palmatolepis gigas* Zone age. The fore-reef deposits are of Lower and Upper *P. gigas* Zone age.

Section 12 (Fig. 34) (= section BC 23 of Seddon, 1970a, p. 724). Samples BG 19577-19586, Bugle Gap Run 3, Photo 5107. Samples collected at 1.5-m intervals at low hill about 1.5 km southwest of the western end of Waggon Pass. The section begins in the Gogo Formation (inter-reef) and ends in the Virgin Hills Formation (inter-reef); the base of Sample BG 19579 represents the base of the Virgin Hills Formation.

The Gogo Formation samples lie in the Upper *Polygnathus asymmetricus* Zone and the Virgin Hills samples range from the same zone up to the Lower *Palmatolepis gigas* Zone.

Section 13. Samples BG 19857-19600; BG 21001-21003, Bugle Gap Run 4, Photo 5118. Section from Glenister Knolls due east, traversing Sadler (fore-reef) and Gogo (inter-reef) Formations. The two formations interfinger. Samples collected at 3-m intervals.

The section is confined to the Lower and Middle *Polygnathus asymmetricus* Zone.

Section 14 (Fig. 35). Samples BG 21011-21062, Bugle Gap Run 5, Photo 5136. Section southwest from Cadjebut Fault, 3 km northwest of Pinnacle Spring. Section through Virgin Hills Formation and Bugle Gap Limestone, trough-sampled at 3-m intervals. The Virgin Hills-Bugle Gap boundary is at the base of Sample BG 21023.

The section runs from the Middle *Palmatolepis crepida* Zone (BG 21011-21012) through the Upper *P. gigas* Zone (BG 21013), *Palmatolepis rhomboidea* Zone (BG 21014-21019), Lower *Palmatolepis quadrantinodosa* Zone (BG 21020-21028), Upper *P. quadrantinodosa* (BG 21029-21050), Lower *Scaphignathus*

veliferus Zone (? BG 21051-21052), Middle *veliferus* Zone (BG 21053-21056), Upper *veliferus* Zone (BG 21057-21058), into the Lower *P. styriacus* Zone (BG 21059-21062). Spot samples collected northwest along the Cadjebut Fault indicate the presence of Virgin Hills strata as old as the uppermost *P. gigas* Zone.

Section 15. Samples BG 21064-21076, Bugle Gap Run 4, Photo 5120. Section from Gogo Formation (inter-reef), Virgin Hills Formation (fore-reef), and Pillara Limestone (back-reef) in the east side of the Lawford Range, 2 km southwest of the southwest corner of Teichert Hills. Sample interval 3 m.

The Pillara Limestone did not yield any conodonts, but the fore-reef and inter-reef samples are referred to the Lower and/or Middle *Polygnathus asymmetricus* Zone.

Section 16. Samples BG 21077-21088, Bugle Gap Run 4, Photo 5120. Section from Virgin Hills Formation (fore-reef), Sadler Limestone (fore-reef), Windjana Limestone (reef), and Pillara Limestone (back-reef) at the southwest end of the Teichert Hills. Virgin Hills sample interval 3 m; other formations were spot-sampled.

The Virgin Hills Formation proved to be barren, as did the back-reef samples. The Sadler Limestone (BG 21081-21082) and Windjana Limestone (BG 21083) yielded faunas of Middle *Polygnathus asymmetricus* Zone age.

Section 17. Samples BG 21093-21102, Bugle Gap Run 6, Photo 5145. Section of Virgin Hills Formation and Bugle Gap Limestone from Ngumban Cliff near Pinnacle Spring east and then south-southeast. Sample interval 3 m.

Sample BG 21093 is immediately above the stromatolite bed and is of Lower *Palmatolepis quadrantinodosa* Zone age. The Upper *P. quadrantinodosa* Zone begins at the base of Sample BG 21099, which is the base of the Bugle Gap Limestone. No younger zones were recognized.

Samples BG 21103-21127 were all spot samples collected around the northern rim of the Lawford Range; only the fore-reef samples (Virgin Hills Formation) yielded conodonts, which were generally referable to the Lower *Palmatolepis gigas* Zone. Samples BG 21128-21149 were all spot samples of Pillara Limestone (back-reef), collected on a traverse between Lawford Spring and the southern rim of the eastern Lawford Range. No conodonts were recovered. Samples BG 21150-21167 were spot samples of Virgin Hills Formation in the Old Bohemia area. They ranged in age from Lower *Palmatolepis crepida* age up to the *Palmatolepis rhomboidea* Zone. Samples BG 21171-21186 were collected in Pillara Limestone (back-reef) along Kunian Gap in the Emmanuel Range and yielded no conodonts.

Section 18. Samples BG 21187-21204. Section collected on southeast side of Kudata Gap, Emmanuel Range, in Sadler Limestone (fore-reef). Sample interval 3 m.

Those samples which yielded conodonts indicate the Middle and/or Upper *Polygnathus asymmetricus* Zone.

Section 19. Samples BG 21205-21239. Section of Sadler Limestone (fore-reef) at Sadler Ridge, northeast side of Emmanuel Range. Sample interval 3 m.

The samples which yielded conodonts indicate the Lower and/or Middle *Polygnathus asymmetricus* Zone.

Section 20. Samples BG 21240-21255. Section of Gogo Formation (inter-reef) along Longs Well Creek, northeast side of Emanuel Range. Spot samples at 18-m intervals.

All the samples which yielded conodonts indicate the Lower and/or Middle *Polygnathus asymmetricus* Zone.

Section 21 (Fig. 36). Samples BG 21256-21282. Section along creek from Margaret River west to Needle-Eye Rocks (125° 52' E; 18° 16' S). Trough samples at 3-m intervals were collected through the Virgin Hills Formation into the Piker Hills Formation, the base of which was drawn at the base of sample BG 21281.

The section ranges from the Upper *Palmatolepis crepida* Zone (BG 21256-21265), through the *Palmatolepis rhomboidea* Zone (BG 21266), Lower *Palmatolepis quadrantinodosa* Zone (BG 21267) as high as the Upper *P. quadrantinodosa* Zone (BG 21268-21282).

Samples BG 21283-21287 were collected in Pillara Limestone (back-reef) and Sadler Limestone (fore-reef) from the south end of the Home Range, but yielded no conodonts.

Samples BG 21288-21341 were collected in Pillara Limestone (back-reef) and Sadler Limestone (fore-reef) through Menyous Gap in the Pillara Range.

Samples BG 21342-21351 were collected from the Fairfield Formation (post-reef platform carbonate rock and shale) at the eastern edge of the Horseshoe Range.

Section 22. Samples BG 21352-21359. Section at the end of the Piker Hills; trough-sampled at 1.5-m intervals in the Piker Hills Formation (inter-reef).

The age of the section cannot be accurately determined; it is younger than the Upper *Palmatolepis quadrantinodosa* Zone. Sample BG 21355 is of Lower *Polygnathus styriacus* Zone age and Samples BG 21358-21359 are of Middle *P. styriacus* Zone age.

Section 23. Samples BG 21360-21365, section of spot samples taken through the Napier Formation 3 km west of the mouth of Geikie Gorge.

All samples yielded a fauna indicative of the boundary between the Lower and Upper *Palmatolepis quadrantinodosa* subzones.

Section 24. Samples BG 21367-21372, Bugle Gap Run 4, Photo 5121. Section of 1.5-m samples in Sadler Limestone (fore-reef) and Windjana Limestone (reef), on east face of Teichert Hills, about 1 km north of southeast corner.

Only one sample (BG 21371) yielded an abundant fauna, which indicated the *Ancyrognathus triangularis* Zone.

Section 25 (Fig. 37). Samples BG 21612-21629. Section taken near Pinnacle Spring in the Virgin Hills Formation, sample interval 3 m.

The section ranges in age from the Upper *Polygnathus asymmetricus* Zone up to the Upper *Palmatolepis quadrantinodosa* Zone. Two stromatolite beds occur, one at the base of the Upper *Palmatolepis crepida* Zone and the other at the base of the Lower *P. quadrantinodosa* Zone.

CONODONTS

METHODS

The methods of recovery used were similar to those outlined by Druce & Wilson (1967).

Samples were collected from measured sections. Most sections were trough-sampled through 1.5-m intervals, though in some of the thicker sections, especially in the Bugle Gap Limestone, the intervals were at 3.0 m or rarely 6.0 m. In other cases where the sequence appeared to be condensed, the sampling interval was reduced to 30 cm. Reef samples were all spot samples, usually on a section line.

The samples were collected in heavy-duty plastic bags, the average weight being 2 kg in the pilot samples. The samples were returned to the field laboratory, where they were crushed in a 3-in. (7-cm) jaw crusher mounted on the rear of a 4-wheel-drive truck and driven by a 2 h.p. kerosene engine.

Each sample was crushed into $\frac{1}{4}$ -in. chips and then sieved through an 8-mesh sieve to remove the 'fines'. The 'fines' were collected and bagged and returned to Canberra for ostracod analysis. Many samples contained ostracods and the crushing action tends to liberate them from the matrix.

The chips were retained and about 0.5 kg of each sample was placed in a 2-gallon polyethylene bucket and a measured portion of crystalline monochloroacetic acid added. (The monochloroacetic acid was transported in 44-gallon drums by sea to Derby and then by truck to the laboratory site.)

Water pumped from a nearby spring was added and the buckets were left to react. After 24 hours, all the limestone had reacted and the samples were then sieved through a 120-mesh sieve, the 'fines' being discarded. The residue was then dried in the sun and bottled ready for separation.

Six separation funnels were mounted on an outdoor bench and each sample was separated in bromoform (S.G. 2.9); the light fraction was discarded and the heavy fraction was washed with methylated spirit and dried.

These concentrated residues were then searched under a binocular microscope and all conodonts and fragments still possessing a basal cavity were removed onto a slide. These specimens were then mounted on 100-square slides, each specimen to its own square. Rough identifications were made in the field to aid in the mapping, and problematical or abundant faunas were re-collected.

On return to the home laboratory all specimens which could not be identified with previously described forms were photographed and their distribution recorded. These were then checked systematically, using all known conodont publications.

After identification or designation as new species, each was described and its range and occurrence, and, where possible, its phylogenetic relationships were recorded. Specimens were selected for illustration purposes; all photographs were taken on Ilford KB14 film using a Leitz Orthomat microscope camera.

NATURE OF FAUNAS

Altogether, some 883 samples were collected from the various facies of the reef-complex, and some 6400 specimens were recovered which could be assigned to a species. Many fragments which could be referred only to genera were also recovered.

The distribution of conodonts was far from uniform both in terms of numbers and taxa. The back-reef and reef facies were virtually devoid of conodonts, a fact noted by Glenister & Klapper (1966, p. 787) and Seddon (1970, p. 726). Seddon

concluded that there was some facies control of conodont distribution in reef complexes and I had independently arrived at the same conclusions after studying Devonian and Carboniferous conodonts from the Bonaparte Gulf Basin (Druce, 1969).

These were not the first suggestions of facies control; Müller (1956b) and Merrill (1962) both noted considerable changes in the relative abundance of form-genera.

Seddon (1970a, b) and Druce (1970d, 1973) postulate that these lateral variations in the conodont faunal aspect of stratigraphic units constitute conodont biofacies. The factors which control the lateral variations are unknown, but both Seddon & Sweet (1971, p. 871) and Druce (1970d, p. 386; 1973) consider that water depth is important. The good exposures and well understood lithofacies variations in both the Canning and Bonaparte Gulf Basins support the idea that at least three biofacies existed in the Upper Devonian. One is characterized almost exclusively by the form-genus *Belodella*; a second by *Icriodus* and *Polygnathus* (Seddon's *Icriodus* sequence); and the third contains abundant *Palmatolepis* with smaller number of *Belodella* and *Icriodus* (*Palmatolepis* sequence of Seddon). I have labelled them Biofacies I, II, and III (Druce, 1973) and have extended the concept of three biofacies throughout the Late Palaeozoic and Triassic.

In general this means that shallow-water sediments yield only the conodonts which lived in the upper photic zone (Seddon & Sweet, 1971, p. 873), whereas deeper-water sediments contain abundant conodonts which lived in the deeper photic zones and a few members of the upper photic zone community. This ecological model helps to explain conodont distribution in reef-complexes. The back-reef facies, which formed in extremely shallow water, and the reef rim, which formed at or near wave base, tend either to lack conodonts, as in the Canning Basin, or to yield a few representatives of Biofacies II, as in the Bonaparte Gulf Basin. This difference is probably due to subtle differences in the depth of water in the two complexes. The fore-reef and inter-reef deposits in both basins formed in water sufficiently deep to record the presence of Biofacies III faunas.

The recognition of biofacies subtly affects both correlation and zonation; this is discussed below.

Generic Distribution

Acodina (4 species). *Acodina* is common in Biofacies I and II. The species show some chronological division. *A. formosa* occurs throughout the Frasnian and in the lower part of the Famennian; *A. inopinata* begins in the late Frasnian and continues into the middle Famennian; *A. sp. nov.* *A.* occurs in the early and middle Famennian; and *A. zionensis* is confined to the middle Famennian. However, the presence of these species may be a reflection of the environment and the stratigraphic ranges determined from my samples may not hold true in other regions or even in the same basin.

Ancyrodella (11 species) is confined to the Frasnian. The ranges and phylogenetic affinities are presented in Figure 15.

Ancyrognathus (2 species) is rare in the Canning Basin. Both species occur in the *Palmatolepis gigas* Zone.

Angulodus (2 species). Both species are rare and occur in the Famennian.

Apatognathus (6 species) is probably ecologically controlled. Five species occur in the Famennian; *Apatognathus* sp. C occurs in the Frasnian. *Apatognathus* sp. A ranges from the early Frasnian up to the middle Famennian.

Belodella (5 species) appears to be virtually confined to Biofacies I; most Biofacies I samples are early Frasnian, and all species are confined to that horizon in the present samples. But this does not indicate the true range even in the Canning Basin.

Bryantodus (3 species). *B. typicus* is early Frasnian; *B. nitidus* ranges from the base of the Frasnian into the early Famennian; *B. macrodentus* is of early Famennian age.

Camptognathus (2 species). Both species are confined to the early Frasnian.

Drepanodus (1 species). The species is facies-controlled and, in the present faunas, is restricted to the early Frasnian.

Elsonella (1 species). The single species ranges from middle Frasnian to middle Famennian.

Enantiognathus (2 species) appears to be facies-controlled and in the present faunas occurs in the early Frasnian.

Falcodus (7 species). All the species except *F. guntharii* and *F. sp. indet.* occur in the Famennian.

Hibbardella (8 species). All the species are long-ranging, except *H. (H.) multidens*, which is confined to the Frasnian, and *H. (Hassognathus) franca*, which is restricted to the middle Famennian.

Hindeodella (11 species). Many of the distinctive hindeodellids are not referable to any known species. These species, which have been left in open nomenclature, have restricted ranges and may be important. The described species are all long-ranging.

Icriodus (23 species). The distribution, facies control, and nomenclature problems are discussed under the generic heading in the systematics.

Kladognathus (1 species). The single species is rare, but ranges throughout the Frasnian into the early Famennian.

Ligonodina (7 species). All the species which are represented by more than one or two specimens appear to be long-ranging.

Lonchodina (5 species). All the species are early Frasnian, except *Lonchodina* sp., which is of late Frasnian age. The genus appears to be facies-controlled to some extent, being common in Biofacies II faunas.

Neoprioniodus (3 species). The *N. armatus-alatus* group and *N. semiseparatus* are long-ranging. *N. sp.* is confined to the middle Famennian.

Nothognathella (11 species) Nothognathellids are varied and are relatively short-ranging. A discussion on their range and relationships will be found on page 132 (Fig. 20).

Ozarkodina (12 species). The ozarkodinids are a very varied group and, though of distinctive morphology, many are difficult to assign to existing species and have been left in open nomenclature. Two named species, *O. homoarcuata* and *O. ? lacera*, are confined to the Famennian. *O. immersa* and *O. macra* are both long-ranging.

Palmatodella (3 species). *P. delicatula* ranges in age from late Frasnian to middle Famennian. *P. unca* and *P. sp. A* are both restricted to the middle Famennian.

Palmatolepis (35 species). The palmatolepids in the Canning Basin exhibit the chronological and phylogenetic relationships discussed and illustrated by Ziegler (1962) and Helms (1963).

Pelekysgnathus (2 species). This genus is probably ecologically controlled and local ranges of individual species may depend on local conditions rather than time. *P. elevatus* is restricted to the early Frasnian and *P. sp.* to the late Famennian in the present faunas.

Polygnathellus (2 species). Both *P. multidentis* and *P. cf. P. typicalis* are restricted to the early Frasnian.

Polygnathus (33 species). The genus falls into three distinct groups in the Devonian, the *germanus* group (*nodocostatus* group of Helms, 1961), the *decorosus* group, and the *asymmetricus* group. The *germanus* group is probably a member of Biofacies III (see later) and the species present in the Canning Basin agree closely both in range and phylogenetic relationships with the original specimens from Europe (Helms, 1961).

The *decorosus* group belongs to Biofacies II; it is plastic in its morphological variation and species are difficult to delineate. Early Frasnian forms are referable to *P. xylus*, *P. foliatus*, *P. australis*, *P. janetae*, *P. pollocki*, *P. spatulatus*, *P. seddoni*, and *P. cf. P. webbi*. Some of these species are restricted in their range and may be useful biostratigraphically. Late Frasnian forms include *P. decorosus* and *P. pennatus*. Early Famennian forms are *P. delicatulus*, *P. glaber* s.s., and *P. obliquicostatus*. The late Famennian is characterized by *P. collinsoni* and *P. znepolensis*. *P. subseratus* is late Famennian, but is probably of different lineage, being closely related to the pseudopolygnathids.

The *asymmetricus* group probably gave rise to the palmatolepids and does not play an important role in the polygnathid phylogeny. However, *P. dengleri*, and possibly *P. fallax*, should be considered part of this group.

The enigmatic *P. norrisi* cannot be assigned to any of these groups.

Polylophodonta (2 species). Both polylophodontids are stratigraphically restricted. *P. confluens* occurs in the *Palmatolepis rhomboidea* and Lower *Palmatolepis quadrantinodosa* Zones and *P. elongata* ranges throughout the *P. quadrantinodosa* Zone.

Prioniodina (1 species). The ubiquitous *P. ?smithi* ranges through most of the Famennian section.

Pseudopolygnathus (1 species). The single species is present in the Middle *Polygnathus asymmetricus* Zone.

Scaphignathus (2 species). *S. ziegleri* is the oldest species, occurring in the Lower *Palmatolepis quadrantinodosa* Zone, whereas *S. veliferus* first occurs in the Lower *Scaphignathus veliferus* Zone. Both range up to the Lower *Polygnathus styriacus* Zone.

Scutula (5 species). Most species are of Famennian age, but *S. venusta* ranges down into the middle Frasnian and *S. sp. A* is restricted to the uppermost *Palmatolepis gigas* Zone.

Spathognathodus (15 species). Many of the spathognathodids are distinctive but do not appear to belong to any recognized species. They have been left in open

nomenclature. Many of them have restricted ranges and may be useful biostratigraphically. The named species are all of Famennian age.

Synprioniodina (3 species). *S. cf. S. alternata* is long ranging but both *S. sp. A* and *S. sp. B* are restricted to the middle Famennian.

Tripodellus (1 species). The ubiquitous *T. robustus* is present in the middle Famennian.

General Discussion

Three genera, *Hindeodella*, *Ozarkodina*, and *Spathognathodus*, are represented by large numbers of, as yet, undescribed species. This is due to their 'plastic' morphology, a characteristic of Biofacies II faunas.

This is the third and most diverse fauna described from the Canning Basin. However, in comparison with the faunas described by Glenister & Klapper (1966) and Seddon (1970) some genera and species known to occur elsewhere in the Basin are not present in my faunas. They include:

Ancyrognathus princeps (Miller & Youngquist)
Palmatolepis crepida Sannemann
Palmatolepis delicatula clarki Ziegler
Palmatolepis rhomboidea Sannemann
Pelekysgnathus nodosus Thomas
Playfordia primitiva (Bischoff & Ziegler)
Polygnathus ancyrognathoidea Ziegler
Polygnathus dengleri Bischoff & Ziegler
Polygnathus pennatuloidea Holmes

LITHOLOGICAL DISTRIBUTION OF FAUNAS

Windjana Limestone. The reef facies was virtually devoid of conodonts. Only at the southern tip of McWhae Ridge and two localities in the Teichert Hills were faunas recovered. They were all indicative of Biofacies II and probably indicate slightly deeper water in these regions than in most of the main reef.

Pillara Limestone. The back-reef yielded virtually no conodonts. Where present they were all fragmentary. The only recorded faunas are of *S. costatus* Zone age from the Burrumundi Range (Glenister & Klapper, 1966) and the Oscar Range (Seddon, 1970a). Fragments have been recovered from brachiopod-rich layers in Menyous Gap.

Sadler Limestone. Much of this fore-reef deposit contains good conodont faunas. The 'nautiloid bed' is especially productive, whereas the 'oncolite bed' yields poor faunas. Most faunas are of Biofacies II aspect, but occasionally Biofacies III elements are present. Glenister & Klapper (1966, text-fig. 2) show the Type Section of the Sadler Limestone as straddling the Middle-Upper Devonian boundary but Seddon (1970a, p. 732) identifies Sadler as young as the Upper *P. asymmetricus* Zone. My evidence suggests that the Sadler is commonly as young as this.

Gogo Formation. This inter-reef formation commonly yields abundant conodonts of Biofacies III aspect. The majority of faunas lie in the Lower and Middle

Polygnathus asymmetricus Zone, but in at least one locality (Section 12) the Gogo is as young as Upper *P. asymmetricus* Zone.

Virgin Hills Formation. Some of the deposits close to the reef are barren, but usually the Virgin Hills Formation yields abundant conodonts. The oldest Virgin Hills strata occur in the east-central part of the Lawford Range (Section 15). In general, however, it is oldest in the south (Section 1, McWhae Ridge); the base becomes progressively younger northward and is as young as the Upper *P. asymmetricus* Zone at Section 12. In every section whose upper contact is seen, the Virgin Hills is overlain by Bugle Gap Limestone, except at Needle-Eye Rocks, where it is overlain by Piker Hills Formation. The three contacts are on an east-west line; the oldest upper contact is in the west (Section 14, Lower *Palmatolepis quadrantinodosa* Zone).

Bugle Gap Limestone. This formation (fore-reef and inter-reef) yields conodonts, though never in great abundance. Its lower boundary has been discussed. In one section (Section 4) the uppermost part of the sequence consists of thin-bedded flat-lying fossiliferous calcarenite which resembles the Piker Hills formation. The lithological boundary marks the lower limit of the Middle *Polygnathus styriacus* Zone.

Piker Hills Formation. This inter-reef deposit was collected in only two sections. At Piker Hills (Section 22) it can be referred to the Lower and Middle *Polygnathus styriacus* Zone; the lower limit is not exposed. The Margaret River—Needle-Eye Rocks section (21) shows a lower limit in the Upper *Palmatolepis quadrantinodosa* Zone. This suggests that the facies change to Piker Hills Formation was later in the south than in the north.

Napier Formation. This formation (fore-reef and inter-reef) yields good conodont faunas. The Napier was seen in only two sections; at Geikie Gorge (Section 23) it is of *Palmatolepis quadrantinodosa* Zone age, and in the Narlarla section (25) it is as old as the *Palmatolepis gigas* Zone, extending into the *P. quadrantinodosa* Zone.

Fairfield Formation (*sensu* Playford & Lowry, 1966). The Devonian part of this formation did not yield any conodonts, though I have previously recovered specimens from the Lower Carboniferous part (Laurel Formation of other authors: Playford & Lowry, 1966, p. 90). Faunas which Glenister & Klapper (1966, p. 838) assign to the Fairfield Formation come from the Lower Carboniferous part (GSWA 3240). During 1972, extensive faunas have been recovered from the Devonian and Carboniferous parts of the Fairfield Formation (*sensu* Playford & Lowry, 1966).

The Stromatolite Beds. Altogether three stromatolite beds are known in the Canning Basin. They lie in the Upper *Palmatolepis gigas* Zone (to I δ), Upper *Palmatolepis triangularis* Zone (basal Famennian), and earliest Lower *Palmatolepis quadrantinodosa* Zone (to II β). The oldest bed is known from Section 4, northeast of McWhae Ridge, and from the Pinnacle Spring area. The middle bed is more widespread, being known from both the east and west sides of McWhae Ridge and Pinnacle Spring. The upper bed is the widest; it is recorded from both sides of McWhae Ridge, at Ngumban Cliff, and at Narlarla, 210 km to the northwest. The fact that these horizons are of exactly the same age over wide areas is significant, and means that depositional conditions over wide areas of the reef complex changed at the same time. The horizons are also marked by a condensed conodont succession.

ZONATION

The ready applicability of the German conodont zones to the Canning Basin faunas has been noted by Glenister & Klapper (1966, p. 784). However, Seddon (1970a, p. 727) points out that, although the zonation is usable in most cases, faunas belonging to Biofacies II (his *Icriodus* sequence) lack the index fossils of Biofacies III (his *Palmatolepis* sequence) and the zonation is not applicable in these cases. In Figure 9 the ranges in the Canning Basin and Germany are plotted.

Seddon proposes the erection of a separate zonation based on Biofacies II faunas and designates three early Frasnian zones using species ranges of *Icriodus*. However, the present faunas suggest that these icriodids are ecologically controlled and, under optimum conditions, are possibly long ranging. Further research may show that a zonation based on Biofacies II faunas is practicable; the *decorosus*-group polygnathids probably offer the best solution, but their 'plastic' morphological variability may make speciation, and hence zonation, extremely difficult.

In considering the applicability of the German zonation we run into the problem of circular reasoning. In the present study I have plotted the range charts of species in the Canning Basin, and then added the German ranges to each index species. In this way the presence of the zones was very apparent. The only problem is that all the other species are now used to give interpretive zonal ages. In this fashion the zonation tends to be self-proving! However, the fact that the succession of faunas is identical in both Australia and Europe is compelling evidence for applicability.

Not only is the succession of faunas identical but the gross aspect of the faunas is the same. Secondly, species are consistent between Europe, North America, and Australia; no species, not even bars and blades, have radically different ranges. Thirdly, there is a consistency of association of conodont species. For example, two separate groups, the palmatolepids and the polygnathids of the *germanus* group, give the same zonation. Finally, there is a consistency of association between the conodonts and other members of the fauna, particularly the ammonoids. Both groups give the same relative age wherever they are found. This suggests that the German conodont zones are worldwide and probably represent the closest approximation to a chronological unit of any fossil zone.

The zonation is discussed below and the relationship of every species present in a zone is discussed. In some cases where ecologic factors are paramount, the ranges discussed may not be applicable in any other area, or, for that matter, to any other samples from the same Basin. Altogether, 9 zones, divided into 22 subzones, can be recognized.

Polygnathus asymmetricus Assemblage Zone

This zone is found in the Windjana and Sadler Limestones and the Gogo and Virgin Hills Formations. It is divided into three subzones.

Lower *Polygnathus asymmetricus* Zone

No strata older than this subzone were identified, although fore-reef deposits containing a Biofacies II fauna may represent the underlying *Schmidtognathus hermanni* Zone.

In the present faunas the upper limit is marked by the last occurrence of *Ancyrodella rugosa* Branson & Mehl, *Ligonodina spiculata* (Ulrich & Bassler),

Nothognathella sublaevis Sannemann, *Ozarkodina versa* (Stauffer), *Spathognathodus* sp. F, and *S.* sp. G.

The upper limit is also marked by the first occurrence of *Camptognathus* sp. nov. A, *Hindeodella uncata* Hass, *H.* sp. E, *Icriodus incrassatus* s.s. Youngquist & Peterson, *I. symmetricus* subsp. nov. a, *Nothognathella klapperi* Uyeno, *Ozarkodina* sp. A, *O.* sp. C, *Palmatolepis punctata* (Hinde), *P. transitans* Müller, *Pelekysgnathus elevatus* (Branson & Mehl), *Polygnathus australis* sp. nov., *P. pollocki* sp. nov., *Pseudopolygnathus* sp. nov. A, and *Spathognathodus* sp. nov. A.

Other important species present in this subzone include *Ancyrodella buckeyensis* Stauffer, *A. gigas* Youngquist, *A. lobata* Branson & Mehl, *A. rotundiloba* s.s. (Bryant), *A. rotundiloba alata* Glenister & Klapper, *A. rotundiloba binodosa* Uyeno, *A.* sp. nov. A, *Polygnathus asymmetricus* s.s. Bischoff & Ziegler, *P. asymmetrica ovalis* Glenister & Klapper, *P. foliatus* Bryant, *P. janetae* sp. nov., and *P. spatulus* Youngquist.

Middle *Polygnathus asymmetricus* Zone

The upper limit of this subzone is drawn at the last occurrence of *Ancyrodella rotundiloba alata* Glenister & Klapper, *A. rotundiloba binodosa* Uyeno, *A.* sp. A, *Icriodus brevis* s.s. Stauffer, *I. brevis darbyensis* Klapper, *I. brevis* subsp. a, *Polygnathus spatulus* Youngquist, and *Pseudopolygnathus* sp. A.

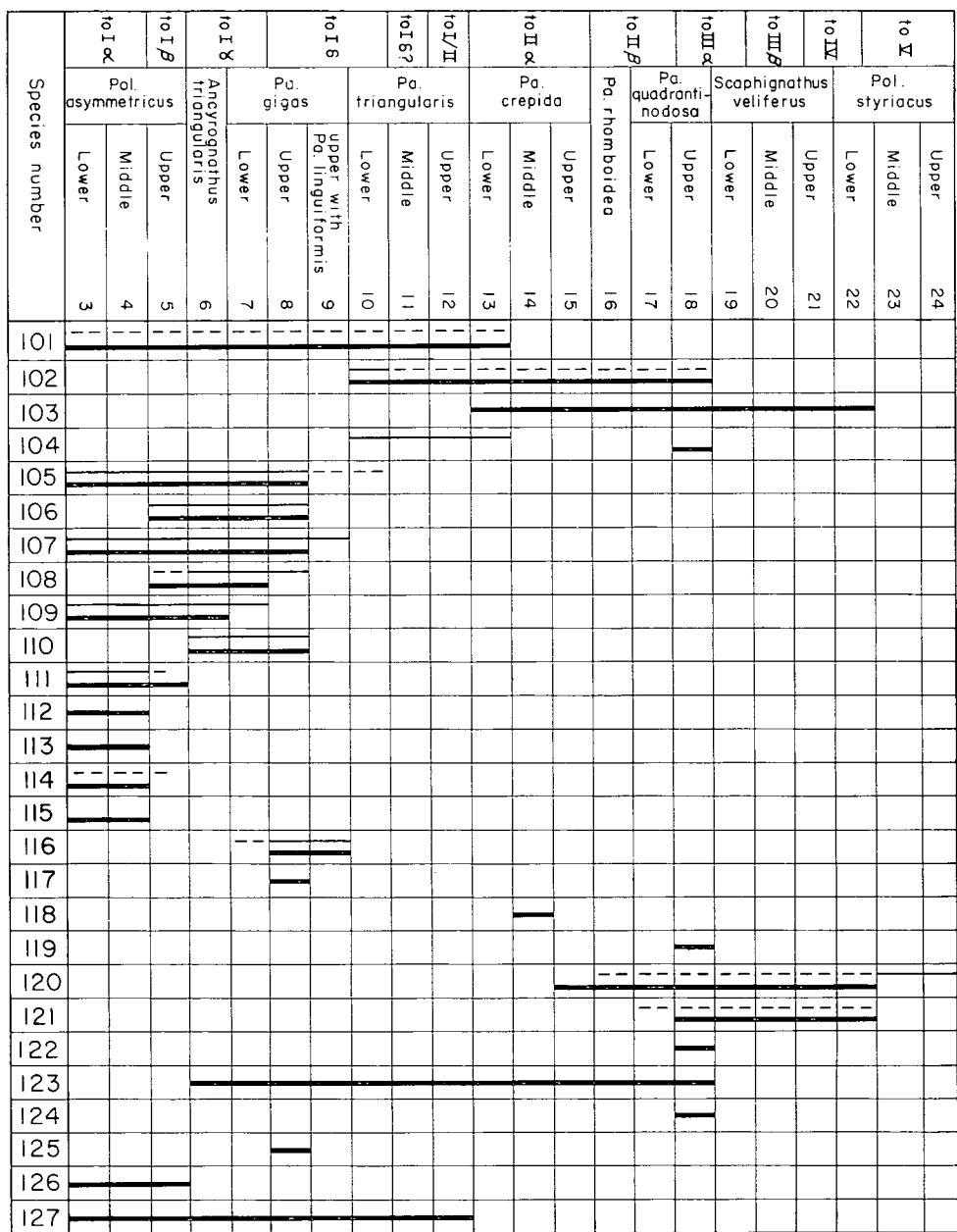
First occurrences include *Ancyrodella curvata* (Branson & Mehl), *A. ioides* Ziegler, *Palmatolepis hassi* Müller & Müller, *P. provera* Ziegler, *P. subrecta* Miller & Youngquist, *Polygnathus decorosus* Stauffer, *P. normalis* Miller & Youngquist, *P. seddoni* sp. nov., and *P.* sp. A.

Other important species in the zone include *Ancyrodella buckeyensis* Stauffer, *A. gigas* Youngquist, *A. lobata* Branson & Mehl, *A. rotundiloba* s.s. (Bryant), *P. asymmetricus* s.s. Bischoff & Ziegler, *P. asymmetricus ovalis* Glenister & Klapper, *P. foliatus* Bryant, and *P. janetae* sp. nov.

Upper *Polygnathus asymmetricus* Zone

The upper limit of this subzone is drawn at the last occurrence of *Ancyrodella rotundiloba* s.s. (Bryant), *Belodella erecta* (Rhodes & Dineley), *Camptognathus conus* Pollock, *C.* sp. nov. A, *Icriodus brevis spicatus* Youngquist & Peterson, *Icriodus symmetricus* subsp. nov. a, *Lonchodina arcuata* Ulrich & Bassler, *L.*

101	<i>Acodina formosa</i>	115	<i>Ancyrodella</i> sp. nov. A
102	<i>Acodina inopinata</i>	116	<i>Ancyrognathus asymmetricus</i>
103	<i>Acodina</i> sp. nov. A.	117	<i>Ancyrognathus altus</i>
104	<i>Acodina zionensis</i>	118	<i>Angulodus</i> sp. cf. <i>A. pergracilis</i>
105	<i>Ancyrodella buckeyensis</i>	119	<i>Angulodus</i> sp.
106	<i>Ancyrodella curvata</i>	120	<i>Apatognathus varians</i> s.s.
107	<i>Ancyrodella gigas</i>	121	<i>Apatognathus varians klapperi</i>
108	<i>Ancyrodella ioides</i>	122	<i>Apatognathus</i> sp. nov. A
109	<i>Ancyrodella lobata</i>	123	<i>Apatognathus</i> sp. A
110	<i>Ancyrodella nodosa</i>	124	<i>Apatognathus</i> sp. B
111	<i>Ancyrodella rotundiloba</i> s.s.	125	<i>Apatognathus</i> sp. C
112	<i>Ancyrodella rotundiloba alata</i>	126	<i>Belodella devonica</i>
113	<i>Ancyrodella rotundiloba binodosa</i>	127	<i>Belodella erecta</i>
114	<i>Ancyrodella rugosa</i>		



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Fig. 9(1). Range chart of conodont species arranged alphabetically.

typicalis Ulrich & Bassler, *Palmatolepis provera* Ziegler, *Palmatolepis transitans* Muller, *Polygnathellus multident* (Ulrich & Bassler), *Polygnathus asymmetricus* s.s. Bischoff & Ziegler, *P. asymmetricus ovalis* Glenister & Klapper, *P. janetae* sp. nov., and *P. seddoni* sp. nov. *Palmatolepis provera* and *Polygnathus seddoni* are confined to this subzone.

The upper limit also marks the first occurrence of *Ancyrodella nodosa* Ulrich & Bassler, *Nothognathella abbreviata* Branson & Mehl, *N. abnormis* Branson & Mehl, *N. falcata* Helms, *N. iowensis* Youngquist, and *Palmatolepis unicornis* Miller & Youngquist.

Other important species are *Ancyrodella buckeyensis* Stauffer, *A. curvata* Branson & Mehl, *A. gigas* Youngquist, *A. lobata* Branson & Mehl, *Palmatolepis hassi* Müller & Müller, *P. punctata* (Hinde), *Polygnathus australis* sp. nov., *P. foliata* Bryant, and *P. pollocki* sp. nov.

Ancyrognathus triangularis Zone

This zone is present in the Virgin Hills Formation and at one locality (Section 24) in the Sadler Limestone.

Its upper limit is marked by the last occurrence of *Ancyrodella lobata* Branson & Mehl, *Hibbardella* (*H.*) *angulata* (Hinde), *H. (H.) multident* Ulrich & Bassler, *Icriodus symmetricus* s.s. Branson & Mehl, *Lonchodina perlonga* Bassler, *Nothognathella klapperi* Uyeno, *Palmatolepis hassi* Müller & Müller, *P. punctata* (Hinde), *Pelekygnathus elevatus* (Branson & Mehl), and *Polygnathus australis* sp. nov.

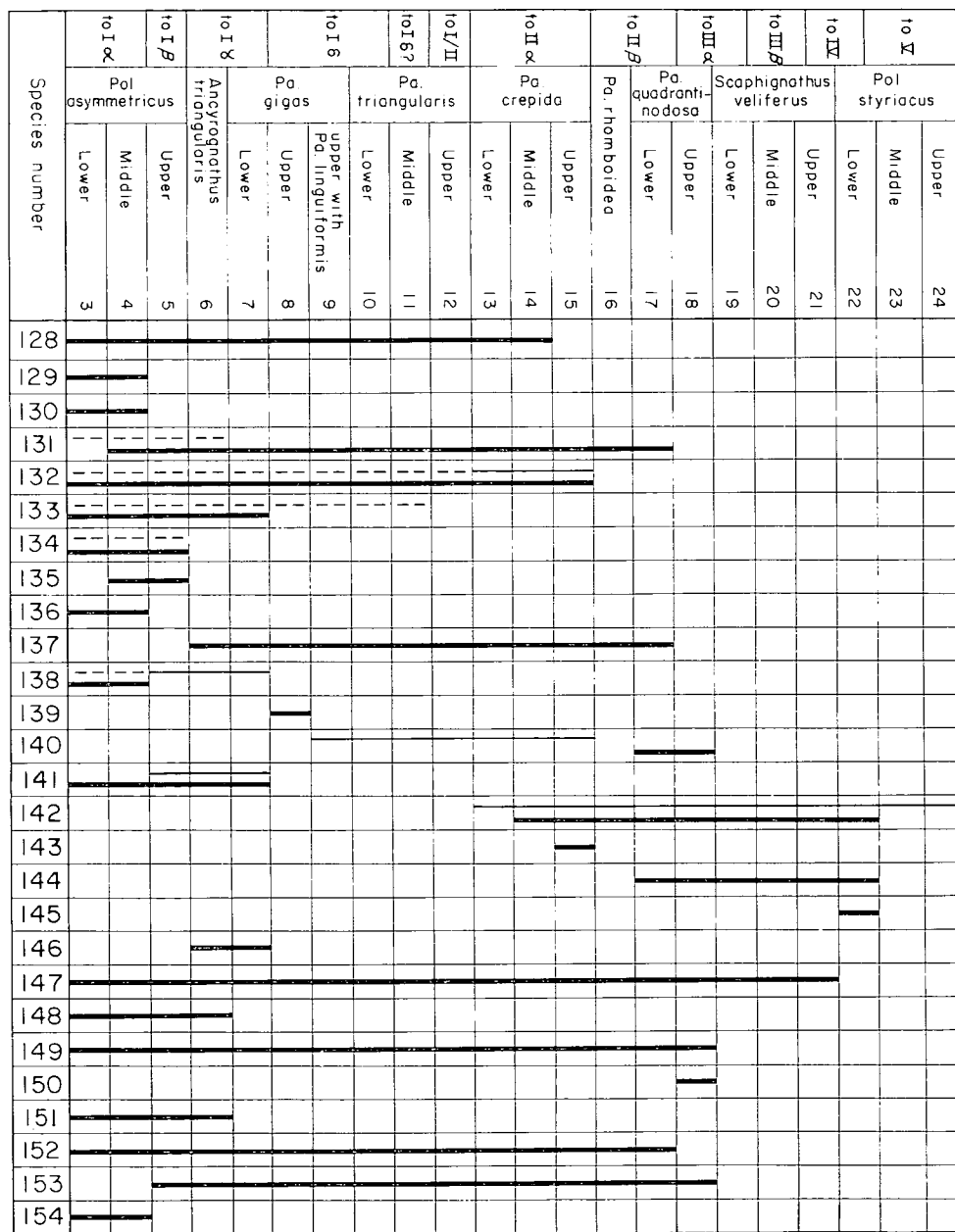
First occurrences at the upper boundary include *Nothognathella typicalis* Branson & Mehl, *Palmatolepis foliacea* Youngquist, *P. gigas* Miller & Youngquist, and *Scutula venusta* Sannemann.

Important species in this zone include *Ancyrodella buckeyensis* Youngquist, *A. curvata* Branson & Mehl, *A. gigas* Youngquist, *A. ioides* Ziegler, *Palmatolepis subrecta* Miller & Youngquist, *P. foliatus* Bryant, and *P. pollocki* sp. nov.

Palmatolepis gigas Zone

This zone is divided into two subzones; the Upper subzone is further divided into an uppermost part with *Palmatolepis linguiformis*. The zone occurs in the Virgin Hills and the Napier Formations.

128	<i>Belodella resima</i>	142	<i>Falcodus variabilis</i>
129	<i>Belodella costata</i>	143	<i>Falcodus</i> cf. <i>F. variabilis</i>
130	<i>Belodella triangularis</i>	144	<i>Falcodus</i> sp. nov. A
131	<i>Bryantodus macrodentus</i>	145	<i>Falcodus</i> sp.
132	<i>Bryantodus nitidus</i>	146	<i>Falcodus</i> sp. indet.
133	<i>Bryantodus typicus</i>	147	<i>Hibbardella</i> (<i>Diplododella</i>) <i>alternata</i>
134	<i>Camptognathus conus</i>	148	<i>Hibbardella</i> (<i>Hibbardella</i>) <i>angulata</i>
135	<i>Camptognathus</i> sp. nov. A	149	<i>Hibbardella</i> (<i>Diplododella</i>) <i>aurita</i>
136	<i>Drepanodus</i> sp.	150	<i>Hibbardella</i> (<i>Hassognathus</i>) <i>franca</i>
137	<i>Elsonella</i> sp.	151	<i>Hibbardella</i> (<i>Hibbardella</i>) <i>multident</i>
138	<i>Enantiognathus lipperti</i>	152	<i>Hibbardella</i> (<i>Diplododella</i>) <i>plana</i>
139	<i>Enantiognathus</i> cf. <i>E. inversus</i>	153	<i>Hibbardella</i> (<i>Hassognathus</i>) <i>separata</i>
140	<i>Falcodus aculeatus</i>	154	<i>Hibbardella</i> (<i>Hassognathus</i>) sp.
141	<i>Falcodus guntharii</i>		



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Fig. 9(2) Range chart of conodont species arranged alphabetically.

Lower *Palmatolepis* *gigas* Zone

The upper boundary is marked by the last occurrence of *Ancyrodella ioides* Ziegler, *Bryantodus typicus* Bassler, *Falcodus guntharii* Ziegler, *Icriodus symmetricus circularis* Youngquist & Peterson, *I. symmetricus expansus* Branson & Mehl, *Palmatolepis foliacea* Youngquist, *P. unicornis* Miller & Youngquist, *Polygnathus foliatus* Bryant, and *P. pollocki* sp. nov.

First occurrences at the upper boundary of the subzone include *Ancyrognathus asymmetricus* (Ulrich & Bassler), *A. altus* Müller & Müller, and *Palmatolepis linguiformis* Müller.

Important species occurring in this zone include *Ancyrodella buckeyensis* Youngquist, *A. curvata* Branson & Mehl, *A. gigas* Youngquist, *A. nodosa* Branson & Mehl, and *Palmatolepis subrecta* Miller & Youngquist.

Upper *Palmatolepis* *gigas* Zone

This subzone and the upper part with *Palmatolepis linguiformis* cannot be successfully differentiated, so they are considered together here. In one section, at Pinnacle Spring (Section 25) it is possible to recognize the distinctive fauna of the uppermost part. Normally, I have terminated the range of species in the Upper *P. gigas* Zone if they do not extend into the Lower *Palmatolepis triangularis* Zone.

The upper boundary of the zone can be recognized by the final occurrence of *Ancyrodella buckeyensis* Youngquist, *A. curvata* Branson & Mehl, *A. gigas* Youngquist, *A. nodosa* Branson & Mehl, *Ancyrognathus asymmetricus* (Ulrich & Bassler) and *A. altus* (Müller & Müller) (both confined to this subzone), *Nothognathella iowensis* Youngquist *Palmatolepis linguiformis* Müller, and *Polygnathus xylus* Stauffer.

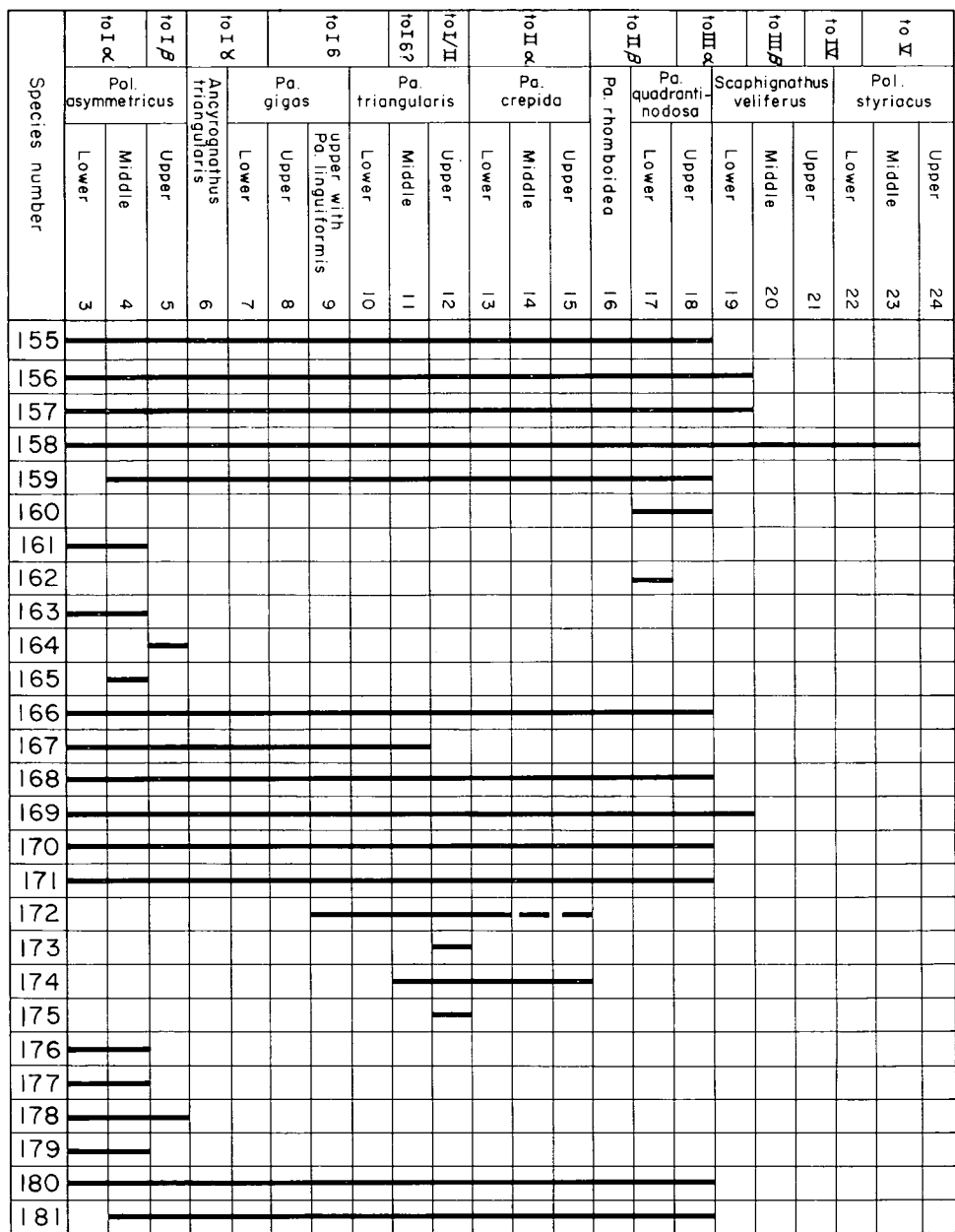
The upper limit, and lower limit of the *Palmatolepis triangularis* Zone, is also marked by the first occurrence of *Acodina inopinata* Stauffer, *Icriodus incrassatus* subsp. a, *Palmatolepis triangularis* Sannemann, and *Polygnathus pennatus* Hinde.

Other important species include *Icriodus arkonensis* s.s. Stauffer, *Nothognathella abbreviata* Branson & Mehl, *N. brevidonta* Youngquist, *Palmatolepis gigas* Youngquist, and *P. subrecta* Miller & Youngquist.

Palmatolepis triangularis Zone

This zone occurs in the Virgin Hills Formation; it is divided into three subzones.

155	<i>Hindeodella brevis</i>	169	<i>Icriodus alternatus cymbiformis</i>
156	<i>Hindeodella compressa</i>	170	<i>Icriodus alternatus elegantulus</i>
157	<i>Hindeodella corpulenta</i>	171	<i>Icriodus alternatus</i> subsp. a
158	<i>Hindeodella subtilis</i>	172	<i>Icriodus arkonensis</i> s.s.
159	<i>Hindeodella uncata</i>	173	<i>Icriodus arkonensis</i> subsp. a
160	<i>Hindeodella</i> cf. <i>H. moweri</i>	174	<i>Icriodus arkonensis</i> subsp. b
161	<i>Hindeodella</i> sp. nov. A	175	<i>Icriodus arkonensis</i> subsp. c
162	<i>Hindeodella</i> sp. nov. B	176	<i>Icriodus brevis</i> s.s.
163	<i>Hindeodella</i> sp. nov. C	177	<i>Icriodus brevis darbyensis</i>
164	<i>Hindeodella</i> sp. nov. D	178	<i>Icriodus brevis spicatus</i>
165	<i>Hindeodella</i> sp. nov. E	179	<i>Icriodus brevis</i> subsp. a
166	<i>Icriodus alternatus</i> s.s.	180	<i>Icriodus brevis</i> subsp. b
167	<i>Icriodus alternatus costatus</i>	181	<i>Icriodus incrassatus</i> s.s.
168	<i>Icriodus alternatus curvirostratus</i>		



M(P)565

Fig. 9(3) Range chart of conodont species arranged alphabetically.

Lower *Palmatolepis triangularis* Zone

The upper limit of this subzone is drawn at the last occurrence of *Nothognathella brevidonta* Youngquist and the first occurrence of *Palmatolepis delicatula* Branson & Mehl, *Scutula bipennata* Sannemann, and *Spathognathodus stabilis* Branson & Mehl.

Other important species in the zone include *Palmatolepis gigas* Youngquist (whose upper limit is in the lower part of the zone), and *Palmatolepis subrecta* Miller & Youngquist.

Middle *Palmatolepis triangularis* Zone

The upper limit of this subzone is marked by the last occurrence of *Nothognathella abbreviata* Branson & Mehl and *Palmatolepis subrecta* Miller & Youngquist, and the first occurrence of *Palmatolepis* cf. *P. regularis* Cooper and *P. subperlobata* s.s. Branson & Mehl; another important species is *Polygnathus* cf. *P. pennatus* Hinde.

Upper *Palmatolepis triangularis* Zone

The upper limit of this subzone is marked by the first occurrence of *Acodina* sp. nov. A, *Nothognathella polygnathoides* Branson & Mehl, *Palmatolepis quadrantinodosolata* Sannemann, *P. tenuipunctata* Sannemann, and *Polygnathus germanus* s.s. Ulrich & Bassler.

Other important species include *Icriodus arkonensis* subsp. a, *I. arkonensis* subsp. c, *Palmatolepis delicatula* Branson & Mehl, *P.* cf. *P. regularis* Cooper (confined to this subzone), *P. triangularis* Sannemann, and *Polygnathus pennatus* Hinde.

Palmatolepis crepida Zone

This zone occurs in the Virgin Hills Formation and in the Napier Formation. It is divided into three subzones, all of which can be recognized in the Canning Basin.

Lower *Palmatolepis crepida* Zone

The upper limit of this subzone is marked by the last occurrence of *Acodina formosa* Stauffer, *Palmatolepis delicatula* Branson & Mehl, *P. triangularis* Sannemann, and *Polygnathus decorosus* Stauffer. The first occurrences of *Nothognathella*

182	<i>Icriodus incrassatus</i> subsp. a	196	? <i>Ligonodina</i> sp.
183	<i>Icriodus incrassatus</i> subsp. b	197	<i>Lonchodina arcuata</i>
184	<i>Icriodus incrassatus</i> subsp. c	198	<i>Lonchodina perlonga</i>
185	<i>Icriodus symmetricus</i> s.s.	199	<i>Lonchodina typicalis</i>
186	<i>Icriodus symmetricus circularis</i>	200	<i>Lonchodina</i> sp. A
187	<i>Icriodus symmetricus expansus</i>	201	<i>Lonchodina</i> sp.
188	<i>Icriodus symmetricus</i> subsp. nov. a	202	<i>Neoprioniodus armatus</i> — <i>alatus</i> group
189	<i>Kladognathus</i> sp.	203	<i>Neoprioniodus semiseparatus</i>
190	<i>Ligonodina magnidens</i>	204	<i>Neoprioniodus</i> sp. nov. A
191	<i>Ligonodina panderi</i>	205	<i>Nothognathella abbreviata</i>
192	<i>Ligonodina spiculata</i>	206	<i>Nothognathella abnormis</i>
193	<i>Ligonodina</i> sp. nov. A	207	<i>Nothognathella brevidonta</i>
194	<i>Ligonodina</i> sp. nov. B	208	<i>Nothognathella falcata</i>
195	<i>Ligonodina</i> sp.		

palmatoformis sp. nov., *Palmatolepis minuta* s.s. Branson & Mehl, *P. subperlobata* subsp. A, and *Polygnathus glaber* s.s. Ulrich & Bassler also mark the top of the zone. Another important species in the zone is *Palmatolepis subperlobata* s.s. Branson & Mehl.

Middle *Palmatolepis crepida* Zone

The upper limit of this subzone is marked by the last occurrence of *Palmatolepis minuta loba* Helms. It is also marked by the first occurrence of *Palmatolepis glabra* s.s. Ulrich & Bassler, *P. glabra pectinata* Ziegler, *P. subgracilis* Bischoff, and *Scutula sinepennata* Ziegler.

Other important species include *Icriodus arkonensis* subsp. b, *Nothognathella polygnathoidea* Branson & Mehl, *Palmatolepis quadrantinosolobata* Sannemann, *P. subperlobata* s.s., Branson & Mehl, and *Polygnathus germanus* s.s. Ulrich & Bassler.

Upper *Palmatolepis crepida* Zone

The upper limit of this subzone is marked by the last occurrence of *Icriodus arkonensis* subsp. b, *Nothognathella typicalis* Bassler, *Palmatolepis quadrantinosolobata* Sannemann, *P. subgracilis* Bischoff, *P. subperlobata* s.s. Branson & Mehl, *P. subperlobata* subsp. A, and *P. tenuipunctata* Sannemann. The first occurrences of *Palmatolepis glabra pectinata* Ziegler, *P. quadrantinodosa inflexoidea* Ziegler, *P. quadrantinodosa marginifera* Helms, *Polygnathus obliquicostatus* Ziegler, *P. triphyllatus* (Ziegler), and *Polylophodonta confluens* Ulrich & Bassler.

Other important species present in the zone include *Nothognathella polygnathoidea* Branson & Mehl, *Polygnathus germanus* s.s. Ulrich & Bassler and *P. glaber* s.s. Branson & Mehl.

Palmatolepis rhomboidea Zone

This zone occurs in the Virgin Hills Formation.

The upper limit is marked by the last occurrence of *Polygnathus obliquicostatus* Ziegler (which is restricted to this zone), and the first occurrence of *Apatognathus varians* s.s. Branson & Mehl, *Falcodus aculeatus* Sannemann, *Falcodus* sp. nov. A, *Ozarkodina? lacera* Helms, *Palmatolepis distorta* Branson & Mehl, *P.*

209	<i>Nothognathella iowensis</i>	223	<i>Ozarkodina</i> sp. C
210	<i>Nothognathella klapperi</i>	224	<i>Ozarkodina</i> sp. D
211	<i>Nothognathella palmatoformis</i>	225	<i>Ozarkodina</i> sp. E
212	<i>Nothognathella polygnathoidea</i>	226	<i>Ozarkodina</i> sp. F
213	<i>Nothognathella sublaevis</i>	227	<i>Ozarkodina</i> ? sp.
214	<i>Nothognathella typicalis</i>	228	<i>Palmatodella delicatula</i>
215	<i>Nothognathella</i> sp. nov. A	229	<i>Palmatodella unca</i>
216	<i>Ozarkodina homoarcuata</i>	230	<i>Palmatodella</i> sp. A
217	<i>Ozarkodina immersa</i>	231	<i>Palmatolepis delicatula</i>
218	cf. <i>Ozarkodina</i> ? <i>lacera</i>	232	<i>Palmatolepis distorta</i>
219	<i>Ozarkodina macra</i>	233	<i>Palmatolepis foliacea</i>
220	<i>Ozarkodina versa</i>	234	<i>Palmatolepis gigas</i>
221	<i>Ozarkodina</i> sp. A	235	<i>Palmatolepis glabra</i> s.s.
222	<i>Ozarkodina</i> sp. B		

glabra acuta Helms, *P. minuta schleizia* Helms, *P. perlobata* s.s. Ulrich & Bassler, *Polygnathus delicatulus* Ulrich & Bassler, *P. fallax* Helms & Wolska, *P. germanus* subsp. B, *P. cf. P. norrisi* Uyeno, *Polylophodonta elongata* Druce, *Scaphignathus ziegleri* Druce, *Spathognathodus fitzroyi* sp. nov., and *S. strigosus* (Branson & Mehl).

Other species include *Nothognathella polygnathoidea* Branson & Mehl, *Palmatolepis glabra* s.s. Ulrich & Bassler, *Polygnathus glaber* s.s. Branson & Mehl, and *Scutula sinepennata* Ziegler.

Palmatolepis quadrantinodosa Zone

This zone occurs in the Virgin Hills Formation, Bugle Gap Limestone, Napier Formation, and Piker Hills Formation. It is divided into two subzones, both of which can be recognized in the Canning Basin.

Lower *Palmatolepis quadrantinodosa* Zone

The upper limit of this zone is marked by the last occurrence of *Nothognathella polygnathoidea* Branson & Mehl, *Palmatolepis distorta* Branson & Mehl (confined to this subzone), *P. perlobata sigmoidea* Ziegler, *P. quadrantinodosa inflexoidea* Ziegler and *Polygnathus fallax* Helms & Wolska (both confined to this zone), *P. triphyllatus* (Ziegler), *Polylophodonta confluens* Ulrich & Bassler, and *Scutula sinepennata* Ziegler.

Acodina zionensis Stauffer, *Hibberdella* (*Hassognathus*) *franca* (Sannemann), *Palmatolepis gracilis* Branson & Mehl, *P. rugosa ampla* Müller, *Polygnathus perplexus* Thomas, and *P. znepolensis* Spasov first appear in this subzone.

Other important species which occur in this subzone include *Palmatolepis quadrantinodosa marginifera* Ziegler, *P. glabra elongata* Holmes, *P. glabra pectinata* Ziegler, *P. perlobata* s.s. Ulrich & Bassler, and *Polygnathus germanus* s.s. Ulrich & Bassler.

Upper *Palmatolepis quadrantinodosa* Zone

The upper limit of this subzone is marked by the last appearance of a great number of long-ranging species. This may be influenced somewhat by the change in lithology from the Virgin Hills Formation to the Bugle Gap Limestone, and

236	<i>Palmatolepis glabra acuta</i>	250	<i>Palmatolepis quadrantinodosa</i>
237	<i>Palmatolepis glabra elongata</i>		<i>marginifera</i>
238	<i>Palmatolepis glabra pectinata</i>	251	<i>Palmatolepis quadrantinodosolobata</i>
239	<i>Palmatolepis gracilis</i>	252	<i>Palmatolepis cf. P. regularis</i>
240	<i>Palmatolepis hassi</i>	253	<i>Palmatolepis rugosa ampla</i>
241	<i>Palmatolepis linguiformis</i>	254	<i>Palmatolepis rugosa grossi</i>
242	<i>Palmatolepis minuta</i> s.s.	255	<i>Palmatolepis cf. P. rugosa trachytera</i>
243	<i>Palmatolepis minuta loba</i>	256	<i>Palmatolepis subgracilis</i>
244	<i>Palmatolepis minuta schleizia</i>	257	<i>Palmatolepis subperlobata</i> s.s.
245	<i>Palmatolepis perlobata</i> s.s.	258	<i>Palmatolepis subperlobata</i> subsp. A
246	<i>Palmatolepis perlobata sigmoidea</i>	259	<i>Palmatolepis subrecta</i>
247	<i>Palmatolepis proversa</i>	260	<i>Palmatolepis tenuipunctata</i>
248	<i>Palmatolepis punctata</i>	261	<i>Palmatolepis transitans</i>
249	<i>Palmatolepis quadrantinodosa</i>	262	<i>Palmatolepis triangularis</i>
	<i>inflexoidea</i>		

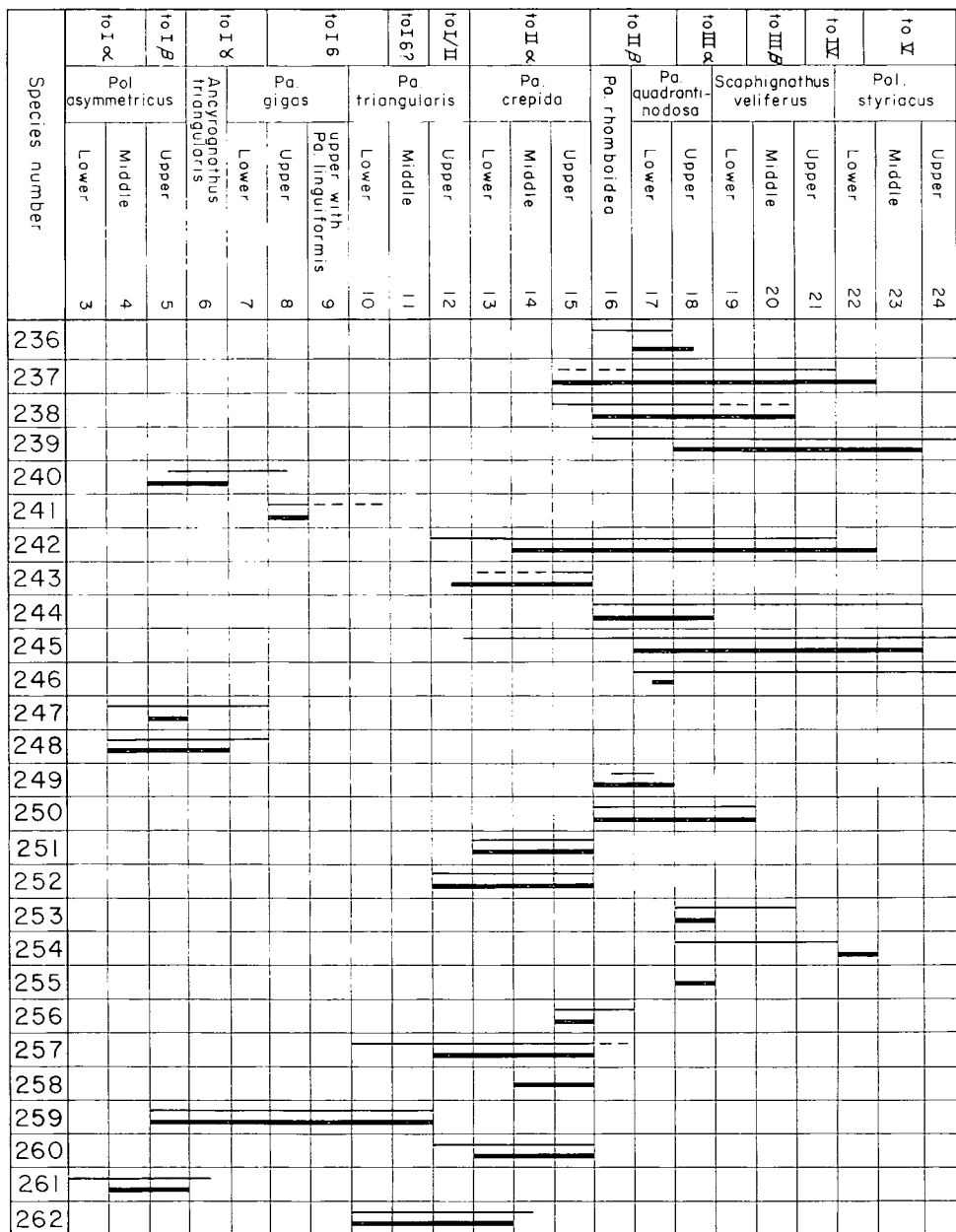


Fig. 9(6) Range chart of conodont species arranged alphabetically.

perhaps by the fewer samples collected of this and subsequent horizons. Among the more important final occurrences are *Palmatolepis glabra acuta* Helms, *P. minuta schleizii* Helms, *P. rugosa ampla* Müller, *P. cf. P. rugosa trachytera* Ziegler (confined to this subzone), *Polygnathus delicatulus* Ulrich & Bassler, *P. germanus* s.s. Ulrich & Bassler, and *Polylophodonta elongata* Druce.

Scaphignathus veliferus Zone

This zone occurs in the Bugle Gap Limestone and the Piker Hills Formation. In Europe it is divided into three subzones which were not recognized in the Canning Basin. Some long-ranging forms disappear within the zone and some rare species only occur within it.

The top of the zone is marked by the first occurrence of *Palmatolepis rugosa grossi* Ziegler, *Polygnathus germanus* subsp. B, *P. irregularis* (Thomas), and *Spathognathodus bohlenanus* Helms.

Important species which occur in the zone include sf. *Ozarkodina? lacera* Helms, *Palmatolepis glabra* s.s. Ulrich & Bassler, *P. glabra elongata* Holmes, *P. glabra pectinata* Ziegler, *P. gracilis* Branson & Mehl, *P. minuta* s.s. Branson & Mehl, *Polygnathus norrisi* Uyeno, *P. perplexus* Thomas, *P. semicostatus* Branson & Mehl, *P. subserratus* Branson & Mehl, *P. znepolensis* Spasov, and *Spathognathodus strigosus* (Branson & Mehl).

Polygnathus styriacus Zone

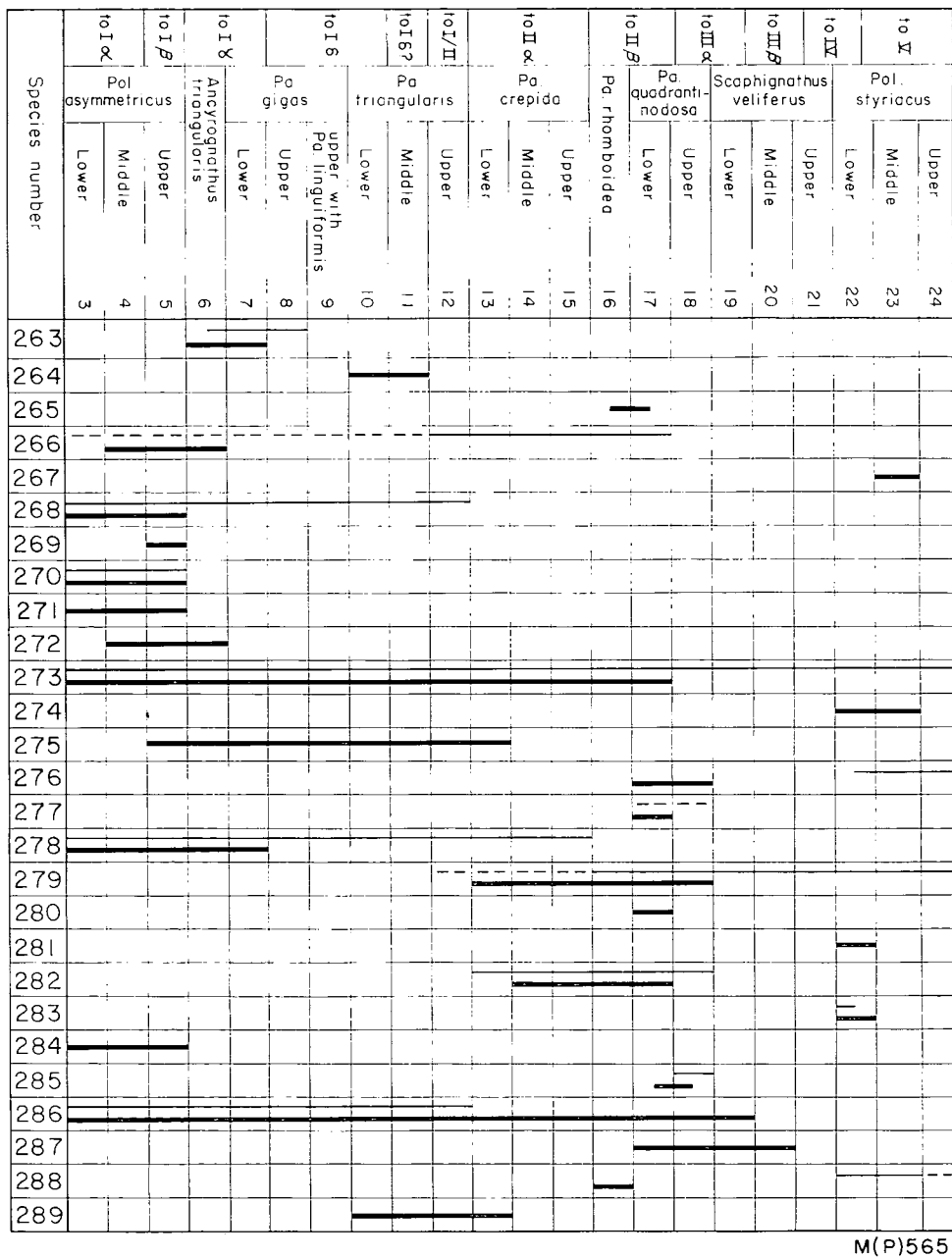
This zone occurs in the Bugle Gap Limestone and Piker Hills Formation. In Europe the zone is divided into three subzones and the two lower subzones are represented in the Canning Basin.

Lower *Polygnathus styriacus* Zone

The upper limit of this subzone is marked by the last occurrence of *Palmatolepis glabra elongata* Holmes, *P. minuta* s.s. Branson & Mehl, *P. rugosa grossi* Ziegler and *Polygnathus irregularis* (Thomas) (both of which are confined to this subzone), *P. semicostatus* Branson & Mehl, and *P. znepolensis* Spasov.

Other important species which occur in the subzone include *Palmatolepis perlobata* s.s. Ulrich & Bassler, *Polygnathus perplexus* Thomas and *P. subserratus* Branson & Mehl.

263	<i>Palmatolepis unicornis</i>	277	<i>Polygnathus fallax</i>
264	<i>Palmatolepis</i> cf. <i>P. triangularis</i>	178	<i>Polygnathus foliatus</i>
265	<i>Palmatolepis</i> sp. nov. A	279	<i>Polygnathus germanus</i> s.s.
266	<i>Pelekysgnathus elevatus</i>	280	<i>Polygnathus germanus</i> subsp. A
267	<i>Pelekysgnathus</i> sp.	281	<i>Polygnathus germanus</i> subsp. B
268	<i>Polygnathellus multidentis</i>	282	<i>Polygnathus glaber</i> s.s.
269	<i>Polygnathellus</i> cf. <i>P. typicalis</i>	283	<i>Polygnathus irregularis</i>
270	<i>Polygnathus asymmetricus</i> s.s.	284	<i>Polygnathus janetae</i>
271	<i>Polygnathus asymmetricus ovalis</i>	285	<i>Polygnathus nodoundatus</i>
272	<i>Polygnathus australis</i>	286	<i>Polygnathus normalis</i>
273	<i>Polygnathus brevilaminus</i>	287	<i>Polygnathus</i> cf. <i>P. norrisi</i>
274	<i>Polygnathus collinsoni</i>	288	<i>Polygnathus obliquicostatus</i>
275	<i>Polygnathus decorosus</i>	289	<i>Polygnathus</i> cf. <i>P. pennatus</i>
276	<i>Polygnathus delicatulus</i>		



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Fig. 9(7) Range chart of conodont species arranged alphabetically.

? Middle *Polygnathus styriacus* Zone

This subzone yields a poor fauna and the division is made on the relative abundance of *Polygnathus collinsoni* Druce. Other species include *Palmatolepis gracilis* Branson & Mehl, *P. perlobata* s.s. Ulrich & Bassler, *Polygnathus perplexus* Thomas, and *P. subseratus* Branson & Mehl.

FACIES CONTROL

Working independently and in different sedimentary basins, Seddon (1970b) and Druce (1969) came to the conclusion that there was some facies control of conodont distribution, especially in reef-complexes. This was not the first suggestion of facies control, but it was the first time that good exposures and well understood lithological facies variations could be used to demonstrate the differences. From this study, and those of Seddon (1970a, b) I have postulated that three major biofacies (designated I, II, and III) probably existed throughout the Late Palaeozoic (Druce, 1973).

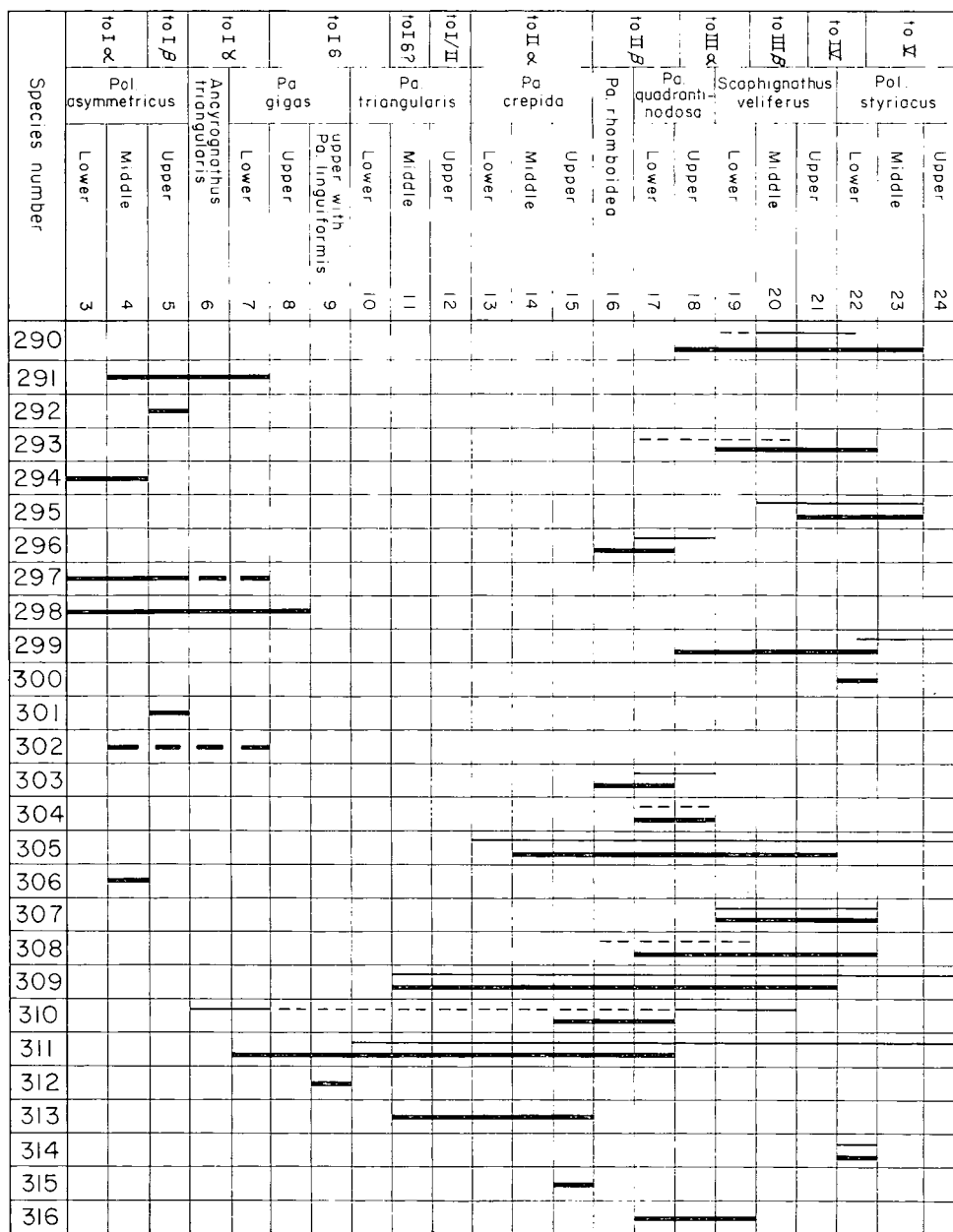
The major section through the Virgin Hills and Bugle Group Formation in the region of McWhae Ridge (Section 4) yields abundant palmatolepids (a Biofacies III fauna). However, certain horizons, characteristically those with abundant columnar stromatolites, contain a relatively large number of icriodids. Their presence and high morphologic variety suggest that these horizons may represent relative shallowing of the basin.

The section at Sadler Ridge consists of about 30 m of Sadler Limestone which can be referred to the lower part of the *Polygnathus asymmetricus* Zone. However, the fauna is variable and suggests the presence of two zones (Fig. 10). In an attempt to determine whether this was a chronological rather than an ecological distribution I assumed that there had been no postmortem mixing and distinguished between those horizons containing simple cones (Biofacies I), icriodids of the *brevis* group (Biofacies II), and ancyrodellids (Biofacies III) (Fig. 10). As can be seen, these faunas tended to be mutually exclusive and where there was mixing it was between adjacent biofacies.

The additional fauna found in each distinctive horizon was then assigned to its respective biofacies (Fig. 11) and in turn those horizons which were still in doubt could be interpreted using this additional information (Fig. 12).

Assuming that biofacies are basically controlled by depth it is possible to use this information to determine the relative depth through time (Fig. 12). The

290	<i>Polygnathus perplexus</i>	304	<i>Polyophodonta elongata</i>
291	<i>Polygnathus pollocki</i>	305	<i>Prioniodina? smithi</i>
292	<i>Polygnathus seddoni</i>	306	<i>Pseudopolygnathus</i> sp. A
293	<i>Polygnathus semicostatus</i>	307	<i>Scaphignathus veliferus</i>
294	<i>Polygnathus spatulatus</i>	308	<i>Scaphignathus zieglerei</i>
295	<i>Polygnathus subseratus</i>	309	<i>Scutula bipennata</i>
296	<i>Polygnathus triphyllatus</i>	310	<i>Scutula sinepennata</i>
297	<i>Polygnathus</i> cf. <i>P. webbi</i>	311	<i>Scutula venusta</i>
298	<i>Polygnathus xylus</i>	312	<i>Scutula</i> sp. A
299	<i>Polygnathus znepolensis</i>	313	<i>Scutula</i> sp. B
300	<i>Polygnathus</i> sp. nov. A	314	<i>Spathognathodus bohlenanus</i>
301	<i>Polygnathus</i> sp. nov. B	315	<i>Spathognathodus</i> cf. <i>S. brevis</i>
302	<i>Polygnathus</i> sp. nov. C	316	<i>Spathognathodus fitzroyi</i>
303	<i>Polyophodonta confluens</i>		



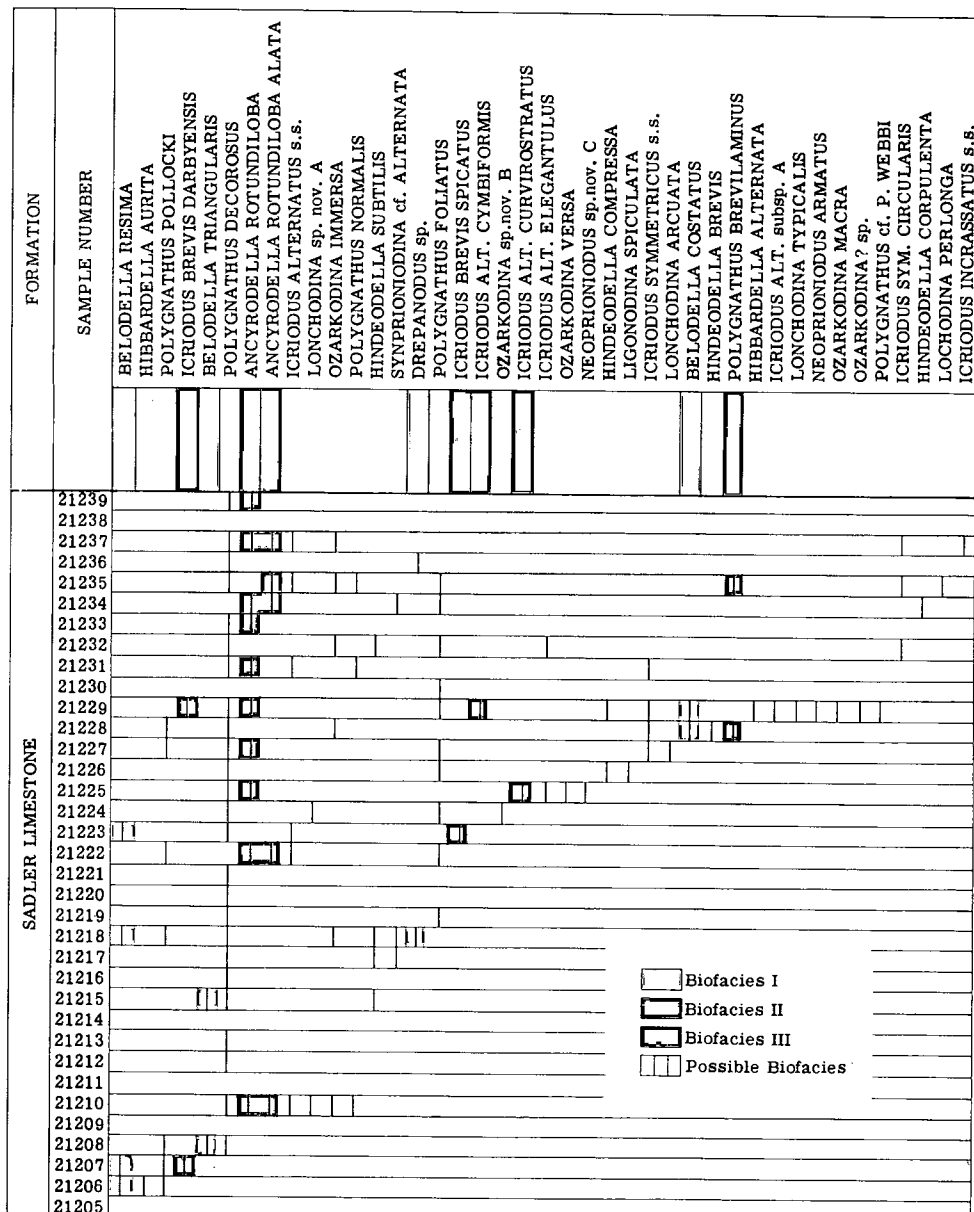
M(P)565

Fig. 9(8) Range chart of conodont species arranged alphabetically.

depth terminology is relative and no 'deep' water is recognized because of the absence of *Palmatolepis*.

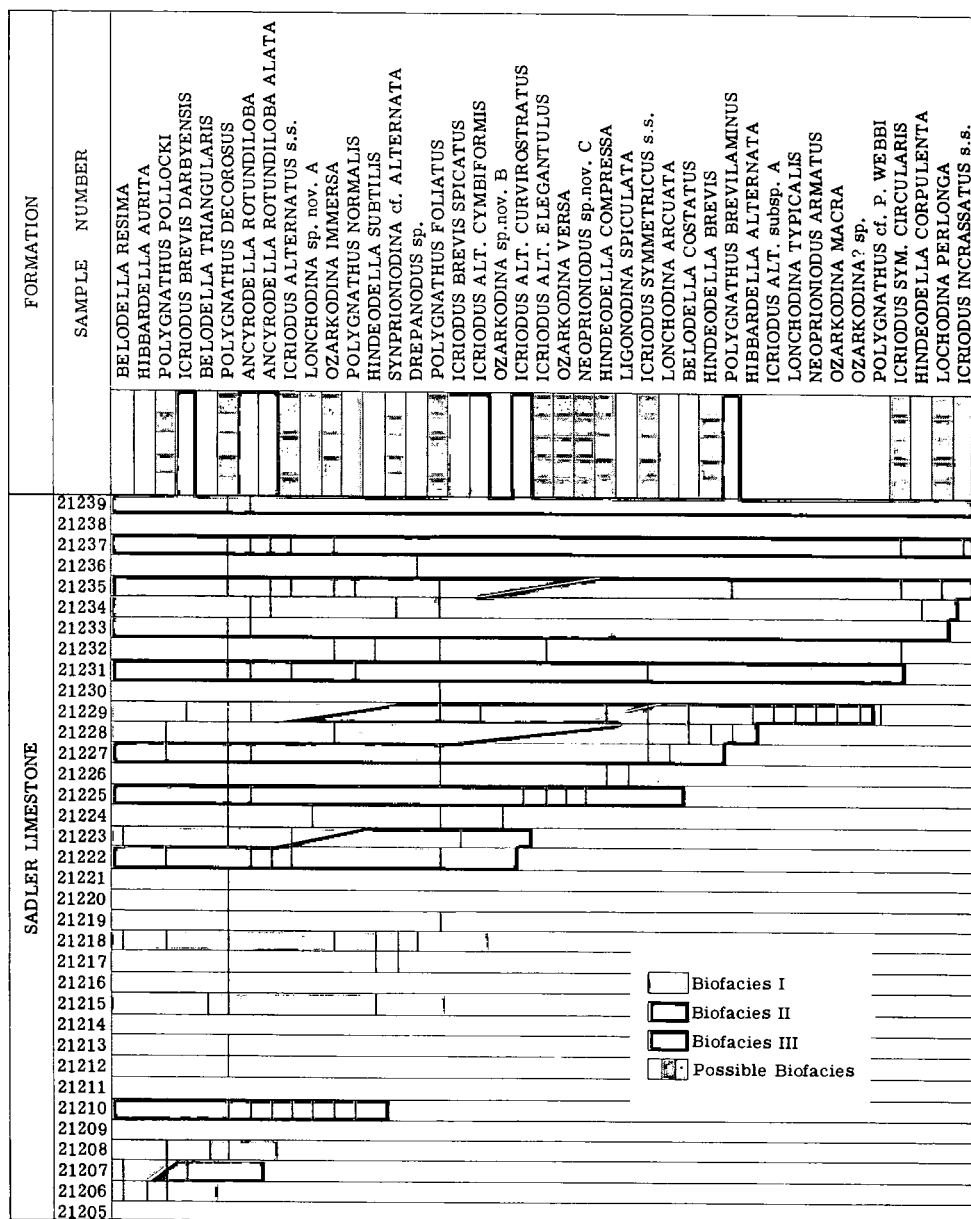
The results suggest that there were several fluctuations of relative sea level in the earliest Frasnian. This may be the result of local tectonic activity or may be regional in aspect. These results may prove important in local correlation; the depth changes may be manifest in such features as back- and fore-stepping of various facies in the complex.

317	<i>Spathognathodus</i> cf. <i>S. robustus</i>	326	<i>Spathognathodus</i> sp. G
318	<i>Spathognathodus stabilis</i>	327	<i>Spathognathodus</i> sp. H
319	<i>Spathognathodus strigosus</i>	328	<i>Spathognathodus</i> sp. I
320	<i>Spathognathodus</i> sp. nov. A	329	<i>Synprioniodina</i> cf. <i>S. alternata</i>
321	<i>Spathognathodus</i> sp. B cf. <i>S. werrieri</i>	330	<i>Synprioniodina</i> sp. A
322	<i>Spathognathodus</i> sp. C	331	<i>Synprioniodina</i> sp. B
323	<i>Spathognathodus</i> sp. D	332	<i>Tripodellus robustus</i>
324	<i>Spathognathodus</i> sp. E	333	Gen. et. sp. nov.
325	<i>Spathognathodus</i> sp. F.		



M(P)566

Fig. 10. Range chart of species from Section 19 with Biofacies indicator species marked.



M(P)567

Fig. 11. Interpretation of relative Biofacies for species in Section 19.

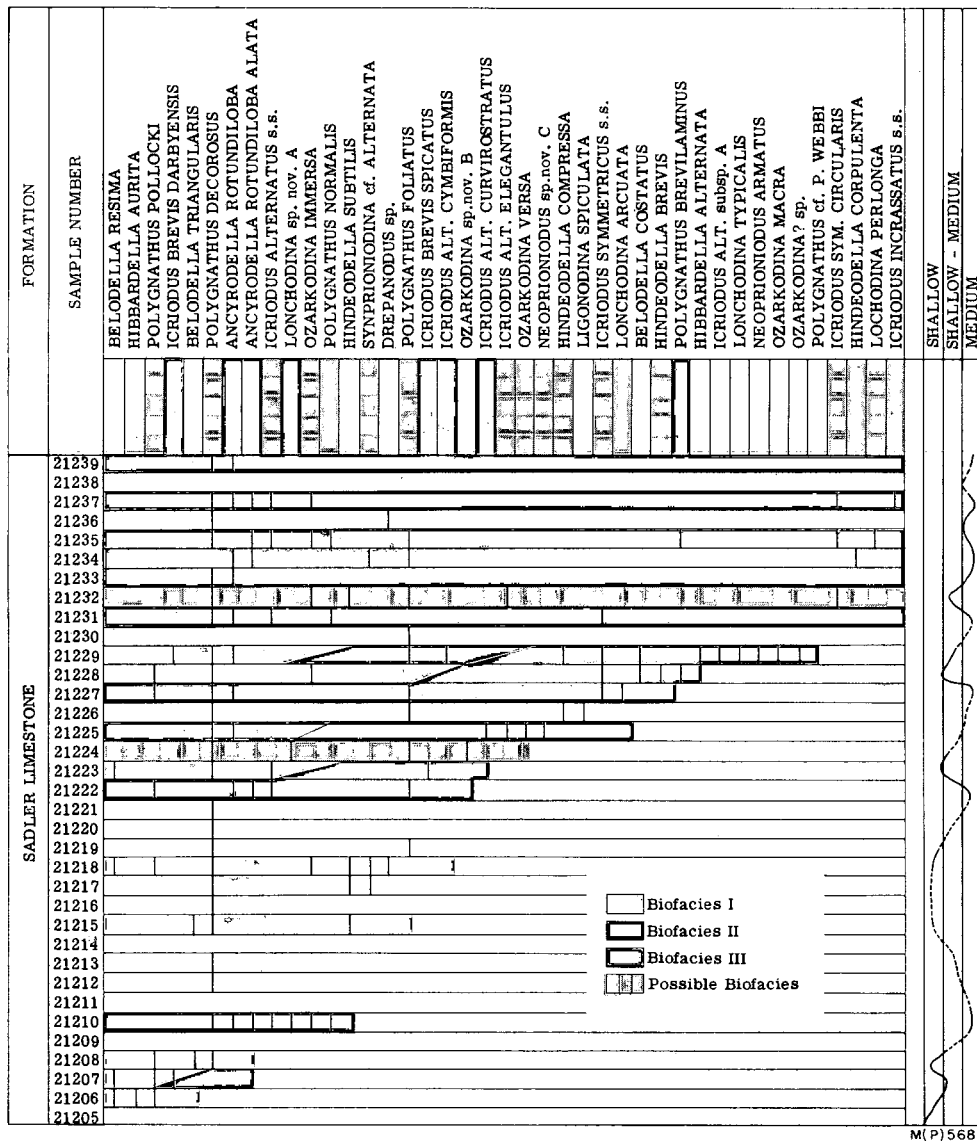


Fig. 12. Interpretation of relative water-depth, Sadler Limestone, Section 19.

The fact that the faunas within each horizon tend to be mutually exclusive suggests that little postmortem mixing has occurred and the recognition of these different faunas will provide another tool in the recognition of natural assemblages (Fig. 13).

Shallow	<i>Belodella costatus</i> <i>Belodella resima</i> <i>Belodella triangularis</i> <i>Drepanodus</i> sp. <i>Hibbardella aurita</i> <i>Hindeodella subtilis</i>		
Shallow-Medium	? <i>Hibbardella alternata</i> ? <i>Hindeodella compressa</i> <i>Icriodus alternatus</i> <i>curvirostratus</i> <i>Icriodus</i> alt. <i>cymbiformis</i> ? <i>Icriodus</i> alt. subsp. nov. a <i>Icriodus brevis darbyensis</i> <i>Icriodus brevis spicatus</i> ? <i>Lonchodina typicalis</i> ? <i>Neoprioniodus armatus</i> ? <i>Ozarkodina macra</i> ? <i>Ozarkodina?</i> sp. <i>Polygnathus brevilaminus</i> ? <i>Polygnathus</i> cf. <i>P. webbi</i>	<i>Hindeodella brevis</i>	<i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>Polygnathus pollocki</i> <i>Synprioniodina alternata</i>
		<i>Icriodus</i> alt. <i>elegantulus</i> <i>Ozarkodina versa</i> <i>Icriodus symmetricus</i> s.s. <i>Polygnathus foliatus</i>	
Medium	<i>Ancyrodella rotundiloba</i> s.s. <i>Ancyrodella rotundiloba alata</i> <i>Hindeodella corpulenta</i> <i>Icriodus symmetricus circularis</i> <i>Icriodus incrassatus</i> <i>Lonchodina perlonga</i>		

Fig. 13. Distribution of form-species with respect to postulated relative water depth, Sadler Limestone, Sadler Ridge.

CORRELATION

The ability to recognize European zones and subzones in the Canning Basin makes intra-basin correlation relatively easy. However, precise correlation is complicated by the presence of biofacies. Seddon (1970a, p. 727) has discussed in detail the problems of correlation between facies faunas, and constructed a parallel zonation based on his 'Icriodus Sequence' (my Biofacies II). However, from the distribution of the icriodid elements in the present faunas it appears that these forms are more likely to be controlled by ecological conditions than to be short-ranging species within Biofacies II. Seddon erected three zones together with an *angustulus* horizon (*Icriodus brevis darbyensis* in this paper) (Fig. 14). He pointed out that the *curvatus* Zone, overlying the *symmetricus* Zone and underlying the *alternatus* Zone, is not very satisfactory.

Biofacies II faunas are abundant in the lower Frasnian Sadler Limestone. I recognize one fauna which is characteristic and combines Seddon's *I. symmetricus* and *I. curvatus* Zones (Fig. 14). It is characterized by the *Icriodus brevis* and *I. symmetricus* groups; also present are *Enantiognathus lipperti*, hibbardellids, and

several polygnathids including *P. foliatus* and *P. xylus*. This fauna ranges in time from the base of the Frasnian (at least) as high as the *Ancyrognathus triangularis* Zone and is essentially early Frasnian in age.

Biofacies II faunas are rare in the Bugle Gap area in rocks younger than early Frasnian. They occur within the three main columnar stromatolite horizons of the Virgin Hills Formation, where they alternate with a rich palmatolepid fauna (Biofacies III). The late Frasnian and earliest Famennian is characterized by the *Icriodus arkonensis* group together with rare *Polygnathus* cf. *P. pennatus*. The middle part of the Famennian, *Palmatolepis crepida* to *Scaphignathus veliferus* Zone, is characterized by the *Icriodus incrassatus* fauna together with apatognathids, *Polygnathus delicatulus*, *Scaphignathus zieglerei*, and *Spathognathodus fitzroyi*.

The late Famennian is poorly represented in the Bugle Gap region; only two samples, BG 19182 and 19183, are of this age. They contain palmatolepids and also a new pelekysgnathid and *Polygnathus collinsoni*. These latter two may be late Famennian Biofacies II representatives.

Correlation between Biofacies II and III is difficult unless there are mixed faunas. However, the polygnathids may offer a solution: they are difficult to work with (see Seddon, 1970a, p. 729) and show some plasticity in morphology, but considerably less than the accompanying icriodids. Seddon (p. 727) remarked that even when he had erected an '*Icriodus* Sequence' zonation, it was difficult to correlate it with the '*Palmatolepis* Sequence' zonation, and the correlation was based, in part, on field relationships. This appears to be the most satisfactory of all the methods and the good outcrop in the exposed part of the Devonian basin makes the task simple.

However, we are left with the problem of dating and correlating subsurface samples. At the present time it is possible to recognize the difference between Frasnian and Famennian Biofacies II and to arrive at some palaeoecological conclusions. Further work will probably refine the zonation and correlation of Biofacies II, but whether it will ever be possible to achieve the fineness of the Biofacies III zones is doubtful.

Reports of conodonts from three other Australian Devonian basins have been published. A fauna from the Gneudna Formation of the Carnarvon Basin, Western Australia, was described by Seddon (1969). This fauna is indicative of Biofacies II and Seddon remarks that it is difficult to date it; either a late Middle Devonian or early Frasnian age is possible. The fauna is probably of early Frasnian age and is of equivalent age to the Sadler Limestone.

The conodont faunas of the Devonian reef complexes of the Bonaparte Gulf Basin were described by Druce (1969). These reef-complexes are of comparable age to the Canning Basin reefs but are relatively poorly exposed, except for the back-reef facies; virtually no fore-reef deposits are exposed. They are possibly connected to the Canning Basin reefs by a northward loop beneath the Sahul Shelf (Playford, 1970).

The Bonaparte Gulf Basin reef-complexes also differ in that conodonts, although rare, are found in the reef and back-reef facies. They are usually of Biofacies II aspect and suggest that the Bonaparte Gulf Basin reefs were deposited

in deeper water than the Canning Basin reefs. The correlation of the two basins is discussed by Druce (op. cit., p. 21). The Canning Basin faunas are much richer in species; however, one species, *Neoprioniodus ? tortus* Druce, from the Bonaparte Gulf Basin is, as yet, unknown in the Canning Basin.

Upper Devonian conodonts have also been reported from the Yarrol Basin, Queensland (Druce, 1970b). They were recovered from a limestone lens in a thick volcanic sequence. The presence of *Ancyrognathus asymmetricus* (Ulrich & Bassler) suggests an Upper *Palmatolepis gigas* Zone age (Druce, 1970b, p. 77). However, fragmentary palmatolepids appear to belong to *Palmatolepis punctata* (Hinde) (Frasnian to Ia-toIδ) and the presence of *P. australis* sp. nov. suggests that the fauna may be as old as the *Ancyrognathus triangularis* Zone (Frasnian toIγ). Recent work by Mouravieff (pers. comm.) on Belgian faunas has shown that the ancyrognathid is a homeomorph, distinguishable by the position of the basal cavity, and the fauna is early Frasnian.

Goniatite Zones		Seddon's (1970) zonation	Characteristic Biofacies II faunas
FAMENNIAN	toIIa	No zones erected	<i>Icriodus incrassatus</i> subsp. b <i>Icriodus incrassatus</i> subsp. c <i>Apatognathus varians</i> <i>Neoprioniodus</i> sp. nov. A <i>Polygnathus delicatulus</i> <i>Scaphignathus zieglerei</i> <i>Spathognathodus fitzroyi</i>
	toIIβ		
	toIIa		
	toI/II		
	toIδ		<i>Icriodus arkonensis</i> group <i>Polygnathus</i> cf. <i>P. pennatus</i>
FRASNIAN	toIδ	<i>Icriodus alternatus</i> Zone	
	toIγ	<i>Icriodus curvatus</i> Zone	<i>Icriodus brevis</i> group <i>Icriodus symmetricus</i> group <i>Bryantodus typicus</i> <i>Enantognathus lipperti</i> <i>Hibbardella angulata</i>
	toIβ	<i>angustulus</i> horizon	
	toIa	<i>Icriodus symmetricus</i> Zone	<i>Hibbardella multidentis</i> <i>Pelekysgnathus elevatus</i> <i>Polygnathus foliatus</i> <i>Polygnathus janetae</i> <i>Polygnathus pollocki</i> <i>Polygnathus</i> cf. <i>P. webbi</i> <i>Polygnathus xylus</i>

Fig. 14. Distribution of Biofacies II faunas with respect to Seddon's *Icriodus* zonation.

INTERNATIONAL CORRELATION

The work of Glenister & Klapper (1966) and Seddon (1970a) showed that many European and North American species are present in the Canning Basin and that the European zonation was readily applicable. The present study demonstrates that virtually all the species which are important in zonation, especially the palmatolepids and polygnathids of the *germanus* group, are present.

The sequence sampled in the Canning Basin ranges in age from the Lower *Polygnathus asymmetricus* Zone up to the Middle *Polygnathus styriacus* Zone, a total of 9 zones and 22 subzones. All the zones and most of the subzones are readily recognized. The exceptions are the Upper *Palmatolepis gigas* Zone with *Palmatolepis linguiformis* and the subzones of the *Scaphignathus veliferus* Zone. The former is recognized in the Pinnacle Spring section (25), but cannot be determined in other sections of comparable age.

The European subzones of the *Scaphignathus veliferus* Zone cannot be recognized and no obvious subdivisions could be distinguished in section 4.

Why the subzones of the *Scaphignathus veliferus* Zone cannot be recognized is not known. The subzones in Germany are characterized by subspecies of *Palmatolepis rugosa*, *Pseudopolygnathus granulosus*, and spathognathodids. The *Palmatolepis rugosa* gens is present in the Canning Basin, but numbers are few. Furthermore, the ranges of some subspecies differ slightly from those in Germany with reference to other species of the fauna. *Pseudopolygnathus granulosus* is not present. The spathognathodids are present, but once again their ranges differ. *S. stabilis* occurs earlier in the Canning Basin than it does in Germany, whereas *S. strigosus* and *S. bohlenanus* have similar ranges. Further collecting in this part of the section may yield sufficient data to recognize the *veliferus* subzones.

However, the recognition of 18 of the 22 subzones demonstrates the validity of Ziegler's (1962) zones for the world-wide correlation of Upper Devonian strata. The correlation is so precise, even at a distance of some 19 000 km, that there is no need to erect a separate and distinct Australian zonation and then correlate it with the European zonation.

SYSTEMATIC PALAEONTOLOGY

Genus ACODINA Stauffer, 1940

Type species: Acodina lanceolata Stauffer, 1940.

ACODINA FORMOSA (Stauffer, 1938)

(Pl. 28, fig. 1)

1938 *Acodus formosus* Stauffer, *J. Paleont.*, 12, 417, pl. 49, fig. 33.

1961 *Acodina delata* Stauffer; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 543, pl. 1, fig. 1.

1968 *Acodina inopinata* (Stauffer); Mound, *J. Paleont.*, 42, 469, pl. 65, fig. 2 only.

Material: 11 specimens; CPC 12849 figured, from Sample BG 21158, Old Bohemia, Virgin Hills Formation.

Description: An erect acodinid with an ovate base and shallow basal cavity. In some specimens the basal cavity is subtriangular, opening on the inner side. The cusp is elongate, slightly laterally compressed, and tapers to a point.

Occurrence and range: The species was originally described from Ontario and Ohio (Stauffer, 1938) from the Olentangy Shale of Late Devonian age. The French specimens are from Morvan and range from Middle Devonian up to earliest Famennian (toII_a). The Canning Basin specimens range from the base of the Frasnian up to the Lower *Palmatolepis crepida* Zone (toII_a).

ACODINA INOPINATA (Stauffer, 1938)

(Pl. 28, fig. 2)

1938 *Acodus inopinatus* Stauffer, *J. Paleont.*, 12, 417, pl. 49, fig. 23, 34, 35.

1940 *Acodina concava* Stauffer, *ibid.*, 14, 418, pl. 60, fig. 31.

1940 *Acodina covina* Stauffer, *ibid.*, 419, pl. 60, fig. 33.

1940 *Acodina lirata* Stauffer, *ibid.*, 419, pl. 60, figs 18, 45.

1940 *Acodina ursa* Stauffer, *ibid.*, 419, pl. 60, figs 1, 2.

1955 *Acodina delata* Stauffer; Sannemann, *Senck. leth.*, 36, 126, pl. 1, figs 15, 16.

1955 *Acodina lirata* Stauffer; Sannemann, *ibid.*, 126, pl. 1, fig. 18.

1959 *Acodina lirata* Stauffer; Helms, *Geologie*, 8, 641, pl. 4, fig. 10.

1961 *Acodina lirata* Stauffer; Freyer, *Freib. Forsch.*, C95, 31, text-fig. 4.

1967 *Acodina lirata* Stauffer; Wolska, *Acta palaeont. polon.* 12, 372, pl. 1, figs 2, 3.

1968 *Acodina inopinata* (Stauffer); Mound, *J. Paleont.*, 42, 469, pl. 65, figs 3, 4 [non-fig. 2 = *A. formosa*].

Material: 16 specimens; CPC 12850 figured, from Sample BG 19018, Section 1, McWhae Ridge, Virgin Hills Formation.

Occurrence: *A. inopinata* was first described from Ontario and Ohio (Stauffer, 1938) together with Frasnian index fossils. Elsewhere in North America it is known from Minnesota (Stauffer, 1940) and Alberta (Mound, 1968). In Europe the species is known from Germany (Sannemann, 1955b; Bischoff, 1956; Helms, 1959; and Freyer, 1961), Austria (Schönlaub, 1969a), and Poland (Wolska, 1967); Clark & Ethington (1962) have described it from North Africa (Spanish Sahara).

Range: The original specimens were from rocks that are, in part, Frasnian. Both Helms (1959) and Freyer (1961) record it from the toI₈ Zone. Wolska (1967) gives the occurrence as *Palmatolepis triangularis* Zone (toI₈-toI/II). Mound (1968) states that the species occurs in strata of toI₈ and toII₈/toIII_a age. In the

Canning Basin the species ranges from the Lower *Palmatolepis triangularis* Zone (toI δ) up to the Upper *Palmatolepis quadrantinodosa* Zone (toIII α).

ACODINA ZIONENSIS (Stauffer, 1938)

- 1938 *Acodus zionensis* Stauffer, *J. Paleont.*, 12, 417, pl. 49, fig. 30.
1940 *Acodina lanceolata* Stauffer, *ibid.*, 14, 419, pl. 60, figs 29, 30.
1940 *Acodina velva* Stauffer, *ibid.*, 14, 419, pl. 60, figs 19, 32, 39, 46.
1940 *Acodina zionensis* Stauffer; Stauffer, *ibid.*, 14, 419, pl. 60, fig. 38.
1955 *Acodina zionensis* (Stauffer); Sannemann, *Senck. leth.*, 36, 127, pl. 1, figs 13, 14.
1961 *Acodina zionensis* (Stauffer); Freyer, *Freib. Forsch.*, C95, 32, pl. 1, fig. 5.
1961 *Acodina zionensis* (Stauffer); Lys et al., *Rév. Inst. fr. Pétrole*, 16, 54, pl. 1, fig. 2.

Material: 2 specimens, from Sample BG 19105, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Occurrence: The species was originally described from Ohio (Stauffer, 1938). It is also known from Minnesota (Stauffer, 1940), and Alberta (Mound, 1968). In Europe the species is known from Germany (Sannemann, 1955b; Bischoff, 1956; Freyer, 1961, 1965), France (Lys et al., 1961), and Austria (Schönlaub, 1969a).

Range: The species was originally described from strata of probable Frasnian age in Ohio (Stauffer, 1938). Bischoff (1956) and Freyer (1961) both record it from the Frasnian toI δ Zone, whereas Sannemann's (1955b) specimens are from the Famennian (toII α). The Canning Basin specimens are from the uppermost part of the Lower *Palmatolepis quadrantinodosa* Zone.

ACODINA sp. nov. A

(Pl. 28, figs 3, 4)

- non 1940 *Acodina curvata* Stauffer, *J. Paleont.*, 14, 418, pl. 60, figs 3, 14-16.
1955 *Acodina curvata* Stauffer; Sannemann, *Senck. leth.*, 36, 126, pl. 1, fig. 17.
1959 *Acodina curvata* Stauffer; Helms, *Geologie*, 8, pl. 4, fig. 12.
1961 *Acodina curvata* Stauffer; Freyer, *Freib. Forsch.*, C95, 31, text-fig. 3.

Material: 30 specimens; CPC 12851, CPC 12852 figured, from Samples BG 21264 (CPC 12851), BG 21265 (CPC 12852), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Description: An elongate laterally compressed cone, recurved posteriorly. The base is ovate, with a thickened rim; a shallow basal cavity is present. The unit narrows rapidly above the basal cavity and becomes laterally compressed with a knife-like posterior edge reminiscent of the genus *Acanthodus* of Tremadocian age.

Range: The species ranges from the Lower *Palmatolepis crepida* Zone (toII α) to the Lower *Polygnathus styriacus* Zone (toIV).

Genus ANCYRODELLA Ulrich & Bassler, 1926

Type species: *Ancyrodella nodosa* Ulrich & Bassler, 1926.

- 1926 *Ancyrodella* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 48.
1957 *Ancyrodella* Ulrich & Bassler; Müller & Müller; *J. Paleont.*, 31, 1090.
1957 *Ancyropenta* Ulrich & Bassler; Müller & Müller, *ibid.*, 1092.
1962 *Ancyrodella* Ulrich & Bassler; Ethington & Furnish, *ibid.*, 36, 1260.

Remarks: In their original description Ulrich & Bassler (1926, p. 48) stated that the genus resembled *Polygnathus* but the platform was anchor-shaped. Their description was slightly expanded by Branson & Mehl (1934a, p. 238), who noted

the extra keels and carinae. Müller & Müller (1957, p. 1090) examined the *Ancyro*-group (*Ancyroides*, *Ancyrognathus*, *Ancyrodella*, and *Ancyropenta*) in detail; species such as *lobata* and *curvata* with extra lobes were placed in *Ancyropenta*. Ethington & Furnish (1962, p. 1260), in considering the *Ancyro*-group, stated that 'development of prominent keels and platform lobes is one of the principal characters of *Ancyrodella*' (see also Ziegler, 1958). Thus, they conclude that *Ancyropenta* is a junior synonym of *Ancyrodella*. This view is accepted by Lindström (1964, p. 168).

Phylogeny: The phylogenetic relationships of *Ancyrodella* were discussed and illustrated in a paper by Ziegler (1962). Ziegler suggests that *Ancyrodella* arose from a polygnathid ancestor, the first species being *rotundiloba*, then *rugosa* to *gigas*; and that *gigas* was the root stock for two trends, one the lobate branch (*lobata-curvata*), the other the 'reduced platform' branch (*buckeyensis-nodosoides*). The ancestral polygnathid was considered to be *P. asymmetricus*. This idea was followed by Lindström (1964, p. 100).

Müller & Clark (1967, text-fig. 6) illustrate a sequence of growth stages for *A. rotundiloba*, the earliest ancyrodellid. These show that juveniles (text-fig. 6a, b) resemble the genus *Spathognathodus*; in fact, it would be extremely difficult to separate them from subspecies of *S. sannemanni*, illustrated by Pollock (1968, pl. 61). Mound (1968, p. 470) points out that growth stages of *A. curvata* also show juveniles reminiscent of spathognathodids (see Ethington & Furnish, 1962, pl. 172), Ethington & Furnish (1962, p. 1260) suggest descent from a spathognathodid ancestor.

Papers by Uyeno (1967) and Pollock (1968) on Middle to Late Devonian faunas from Alberta, Canada, tend to confirm this view. Uyeno (p. 4) erects a new subspecies, *binodosa*, of *A. rotundiloba*, having a single denticle on either side of the main carina and lacking any other dentition. Pollock (1968, p. 440) erects a new species, *Spathognathodus swanhillensis*, which is identical with *binodosa* but lacks the platform nodes. He also describes and illustrates several subspecies of *S. sannemanni* which show the development of a transverse basal cavity with nodes developed on the oral surface.

I consider that the genus *Ancyrodella* is polyphyletic, developing from at least two species of the genus *Spathognathodus* (Fig. 15).

Spathognathodus sannemanni develops a wide transverse basal cavity with nodes on the oral surface (*variabilis* of Pollock); the nodes increase in number and a platform is developed (Pollock, 1968, p. 439). The basal cavity remains wide beneath the platform. An increase in the number of nodes and platform size would give *A. rotundiloba* s.s., the wide basal cavity developed transversely being retained. Conversely, *A. rotundiloba* s.s. could have developed via *A. rotundiloba binodosa* from *S. swanhillensis*. However, this latter species also shows the wide transverse basal cavity present in *S. sannemanni*. *Ancyrodella* develops from *Spathognathodus* by the development of nodes on the oral surface of the cavity and tumidity of the medial part of the blade. The two evolutionary paths described above—(a) development of nodes first and tumidity later (b) tumidity first, nodes later—may in fact be the same, the different order of priority being related to the environment.

The similarity of oral ornamentation between *A. rotundiloba* and *Polygnathus cristatus* cannot be denied. In spite of this, and however it is interpreted in terms

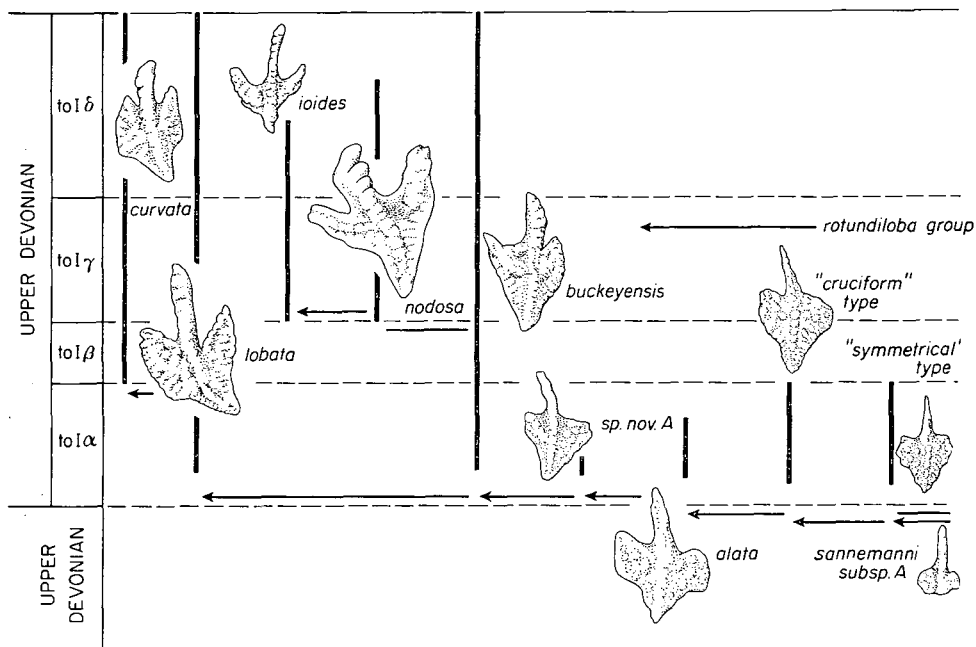


Fig. 15(1) Phylogenetic relationships of the genus *Ancyrodella*.

of functional homeomorphy, the very different basal cavities and free blades set them apart. It is interesting to note that *P. cristatus* is ancestral to *P. asymmetricus* and *Palmatolepis? disparalvea* (Orr & Klapper, 1968) mirroring the zoning of dentition and development of lobation seen in the *Ancyrodella* group.

Within the genus *Ancyrodella* two main trends are apparent: lineation of dentition, and reduction in platform size. Superimposed on the latter is the development of additional lobation.

In the upper part of the Lower *Polygnathus asymmetricus* Zone, *A. rotundiloba* shows considerable diversification (see remarks under that species). Two variations appear to be the root stocks for the two major trends. The 'cruciform' type gives rise to *A. rotundiloba alata*, which appears to be an evolutionary blind alley, and to *A. sp. nov. A*, which shows the development of lateral keels. Development of lateral carinae and anterior lobation gives *A. buckeyensis*. From *A. buckeyensis* two trends are apparent: one of platform reduction gives *A. nodosa* and then *A. ioides* (Ziegler, 1962; Ethington, 1965); the other, of lobation and minor platform reduction, gives *A. lobata* and *A. curvata*. This differs from Bischoff (1956), who suggests that *A. nodosa* is ancestral to *A. lobata*, and Ziegler (1962), who suggests that *lobata* was derived from *gigas*.

The other main branch from *A. rotundiloba* is characterized by development of linear ornament via 'lobate' forms to *A. rugosa*. Alignment of the platform ornament gives rise to *A. gigas*. I consider that *A. gigas* is probably an end member of an evolutionary trend rather than a 'rootstock' as suggested by Ziegler (1962).

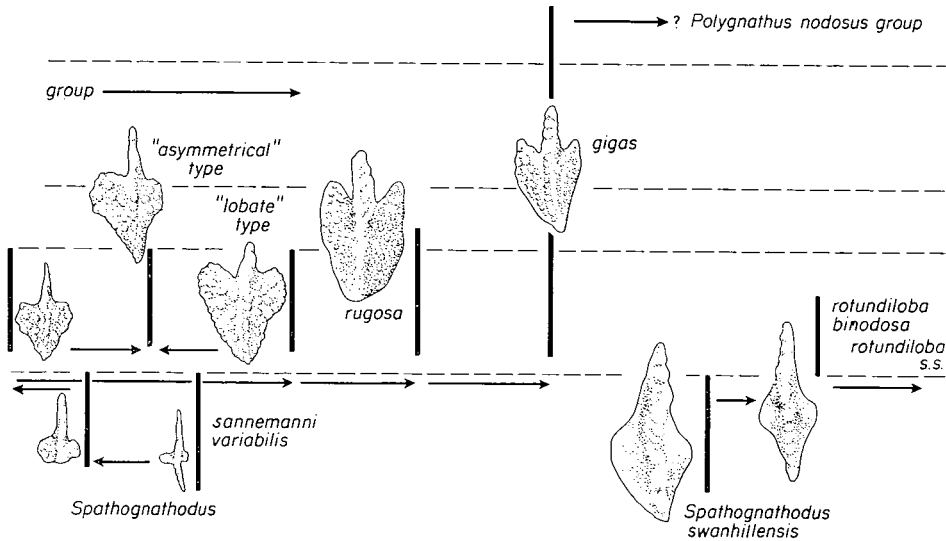


Fig. 15(2) Phylogenetic relationships of the genus *Ancyrodella*.

In both main trends there is a conspicuous fining of the nodose ornament and also a narrowing of the lateral extensions of the basal cavity to a narrow medial trough and then to absence in the keels.

It is possible that the wide cavity was needed to develop the platform on the blade-like ancestor and that this became obsolescent after the true platform had been formed. If this is the case, then perhaps *Ancyrodella* could develop into a polygnathid form. Perhaps the linearly ornamented *A. gigas* is ancestral to the *P. nodocostatus* group.

ANCYRODELLA BUCKEYENSIS Stauffer, 1938

(Pl. 1, figs 2a, b; 4a, b; Pl. 2, figs 1a-5b)

- 1938 *Ancyrodella buckeyensis* Stauffer, *J. Paleont.*, 12, 418, pl. 52, figs 17, 18, 23, 24.
- 1938 *Ancyrodella plena* Stauffer, *ibid.*, 418, pl. 52, figs 21, 22.
- 1945 *Ancyrodella buckeyensis* Stauffer; Youngquist, *J. Paleont.*, 19, 356, pl. 54, fig. 11.
- 1947 *Polygnathus spinulosa* Youngquist, *ibid.*, pl. 24, fig. 9.
- 1947 *Ancyrodella* sp. Miller & Youngquist, *J. Paleont.*, 21, 503, pl. 74, fig. 13.
- 1947 *Ancyrodella lobata* Branson & Mehl; Miller & Youngquist, *ibid.*, 21, 502, fig. 12.
- 1948 *Ancyrodella nodosa* Ulrich & Bassler; Youngquist & Miller, *J. Paleont.*, 22, 441, pl. 68, figs 13, 14.
- 1953 Conodont; Beckmann, *Hess. Landesamt Bodenf., Notizbl.*, 81, pl. 2, fig. 3e.
- 1956 *Ancyrodella* sp. Müller, *J. Paleont.*, 30, pl. 145, fig. 13.
- 1957 *Ancyrodella buckeyensis* Stauffer; Müller & Müller, *J. Paleont.*, 31, 1091, pl. 136, figs 5, ?2.
- 1957 *Ancyrodella subrotunda* Miller & Youngquist; Müller & Müller, *ibid.*, 1092, pl. 136, fig. 6.
- 1958 *Ancyrodella buckeyensis* Stauffer; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 40, pl. 11, fig. 7.

- 1958 *Ancyrodella gigas* Miller & Youngquist; Ziegler (in part), *ibid.*, pl. 11, fig. 10 only [non fig. 8 = *A. gigas*].
 1959 *Ancyrodella buckeyensis* Stauffer; Krebs, *Senck. leth.*, 40, pl. 1, fig. 6.
 1960 *Ancyrodella nodosa* Ulrich & Bassler; Müller, *Geol. Rdsch.*, 40, pl. 2, fig. 2.
 1964 *Ancyrodella buckeyensis* Stauffer; Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, pl. 3, figs 4a, b.
 1964 *Ancyrodella cf. nodosa* Ulrich & Bassler; Budurov & Tschunev, *ibid.*, pl. 3, figs 7a, b.
 1965 *Ancyrodella buckeyensis* Stauffer; Ethington, *J. Paleont.*, 39, 570, pl. 68, fig. 3.
 1967 *Ancyrodella buckeyensis* Stauffer; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 29.
 1969 *Ancyrodella buckeyensis* Stauffer; Chorowska, *Kwart. Geol.*, 13, 66, pl. 1, figs 2, 3.
 ?1970 *Ancyrodella buckeyensis* Stauffer; Spasov, *Rev. Bulg. geol. Soc.*, 31, 180, pl. 2, fig. 8.

Material: 52 specimens, CPC 12353-9 figured.

Locality of figured material: Sample BG 19001, Section 1, McWhae Ridge, Gogo Formation (CPC 12353); BG 19537, Section 9, McPhee Knoll, Virgin Hills Formation (CPC 12355); BG 19548, Section 12, southwest of Waggon Pass, Virgin Hills Formation (CPC 12354); BG 21371, Section 24, Teichert Hills, Sadler Limestone (CPC 12356-9).

Description: The unit is arrow-shaped. The blade is as long as or somewhat shorter than the platform, the ratio changing from 1:1 in smaller specimens to as low as 0.8:1 in mature specimens. The platform is tripartite, with two anterior lobes and a posterior extension. The carina is continuous with the blade; in some specimens it is slightly constricted at the blade-platform junction, with the nodes tending to be larger in the median part of the platform. Lateral carinae are present on the lobes; they are nodose near the main carina but become more denticulate toward the anterior terminations. In some cases the lateral carina is developed as an extremely short free blade on each lobe. As well as the lateral carinae the platform ornamentation consists of ridges normal to the platform margin in small specimens, which tend to break up into two nodes giving double rows paralleling the margin in more robust forms. There is no ornament anterior to the lateral carinae.

In lateral view the free blade is extremely high in its median part, shallowing rapidly posteriorly and less rapidly anteriorly. The denticles are fused, with free chevron tips which are slightly inclined posteriorly.

Aborally, the unit is bisected by a narrow keel with a median trough. At its midpoint a very small basal cavity is developed; it is diamond-shaped, with two apices at the keel junction. The other two apices mark the junction with lateral keels which run anteriorly along the lateral lobes at an angle of about 45°. The basal cavity size remains constant for large and small specimens.

Remarks: There is some variation in dentition. Some specimens exhibit fairly coarse nodose ornament, whereas others have much finer nodes or ridges. In some very small specimens the lateral carinae are represented by a fine isolated node which does not fuse with the main carina. In others they are composed of many low fused nodes which also fuse with the main carina.

These variations are probably due to two factors. The ornament tends to change from small to large specimens. The juvenile specimens tend to be finely ornamented with ridges which in the adults become coarser and divided into rows of nodes normal to the platform margin in such a way that rows of nodes parallel to the margin are developed.

The other factor is phylogeny; *A. buckeyensis* appears to have evolved from the *A. rotundiloba* group. Specimens close to *A. rotundiloba* show coarse dentition

with tall isolated nodes. *A. buckeyensis* is ancestral to *A. nodosa* and some specimens show much finer low denticles, similar to the ornament on *A. nodosa*.

A. buckeyensis can be distinguished from *A. rotundiloba* by the arrow-shaped platform ornament, the well developed lateral carinae, and the less coarse ornament. The difference between *A. buckeyensis* and *A. nodosa* is more subtle. In the latter the platform posterior to the lobes is greatly reduced and commonly bears only one row of nodes or ridges, compared with the two or more of *A. buckeyensis* (Pl. 1, fig. 2, and P. 2, fig. 4, show specimens with a wide platform but only a single row of nodes). The platform outline is triangular in *A. buckeyensis*; in *A. nodosa* it is tripartite.

Distribution: The species was originally described from the Upper Devonian Olentangy Shale of Ohio (Stauffer, 1938). In North America the species has also been recorded from the Upper Devonian of Iowa (Youngquist & Miller, 1948; Müller, 1956; Müller & Müller, 1957), Arizona (Ethington, 1965), and Utah (Clark & Ethington, 1967).

In Europe the species is abundant in the Frasnian of the Rhenish Schiefergebirge (Bischoff, 1956; Ziegler, 1958; Krebs, 1959; Krebs & Rabien, 1964; Bar, 1968; Schneider, 1969; Eder et al., 1969) and the Harz (Meyer, 1965) of Germany. It has been recorded in the Upper Devonian of the Carnic Alps, Austria (Schönlaub, 1969a) and from the Montagne Noire of France (Boyer et al., 1968). Budurov & Tschunov (1964) and Spasov (1970) have recorded the species from northwest Bulgaria and it is also known from Poland (Chorowska, 1969).

Müller (1960) illustrates a specimen from the Kimberley District of Western Australia and identifies it as *A. nodosa*. However, from the illustration the specimen should clearly be referred to *A. buckeyensis*. Pollock (1968) records the species from the Majeau Lake Formation (Upper Devonian) of Alberta, Canada.

Range: Ziegler (1958) gives the range of the species as Upper Devonian (upper toI_a-toI₈). In the Montagne Noire it has a composite range of middle toI_{β(a)}-upper toI₈. In all the known occurrences the species is confined to the Frasnian. Krebs (1959) and Krebs & Rabien (1964) record the species as low as the Lower *P. asymmetricus* Zone (lower toI_a). The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toI_a) to the Upper *Palmatolepis gigas* Zone (toI₈).

ANCYRODELLA CURVATA (Branson & Mehl, 1934)

(Pl. 1, figs 3a, b, c)

- 1934 *Ancyrognathus curvata* Branson & Mehl, *Univ. Mo. Stud.* 8, 241, pl. 19, figs 6, 11.
- 1938 *Ancyrognathus asteroideus* Stauffer, *J. Paleont.*, 12, 418, pl. 52, figs 8, 9.
- 1955 *Ancyrognathus curvata* Branson & Mehl; Sannemann, *N. Jb. Geol. Paläont., Abh.*, 100, pl. 24, figs 11a, b.
- 1956 *Ancyrodella curvata* (Branson & Mehl); Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 118, pl. 8, figs 9-11.
- 1956 *Ancyrodella* sp. B Hass, *U.S. geol. Surv. prof. Pap.* 286, pl. 4, fig. 20.
- 1957 *Ancyrodella curvata* (Branson & Mehl); Ziegler in Flügel & Ziegler, *Mitt. naturw. Ver. Steiermark*, 87, pl. 1, fig. 8.
- 1957 *Ancyropenta asteroideus* (Stauffer); Müller & Müller, *J. Paleont.*, 31, 1093, pl. 136, figs 7a-8.
- 1957 *Ancyrodella curvata* (Branson & Mehl); Lys, Serre, & Deroo, *Rév. Inst. fr. Pétrole*, 12, 795, pl. 7, fig. 1.

- 1958 *Ancyrodella curvata* (Branson & Mehl); Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 40, pl. 11, fig. 5.
- 1959 *Ancyrodella curvata* (Branson & Mehl); Panzeri & Barsotti, *Not. Comun. Inst. Geol. Min. Espana*, 55, pl. 2, fig. 1.
- 1961 *Ancyrodella curvata* (Branson & Mehl); Freyer, *Freib. Forsch.*, C95, 32, pl. 1, fig. 6.
- 1962 *Ancyrodella curvata* (Branson & Mehl); Ethington & Furnish, *J. Paleont.*, 36, 1261, pl. 172, figs 12-20.
- 1966 *Ancyrodella curvata* (Branson & Mehl); Anderson, *J. Paleont.*, 40, 403, pl. 48, figs 2, 4, 6, 9, 11, 13.
- 1966 *Ancyrodella curvata* (Branson & Mehl); Glenister & Klapper, *J. Paleont.*, 40, 798, pl. 86, figs 13-15.
- 1966 *Ancyrodella curvata* (Branson & Mehl); Koverdynsky & Zikmundova, *Vestnik U.U. G.*, 1, pl. 1, figs 6, 8.
- 1967 *Ancyrodella curvata* (Branson & Mehl); Wolska, *Acta palaeont. polon.*, 12, 373, pl. 1, figs 12, 13.
- 1967 *Ancyrodella curvata* (Branson & Mehl); Boogaert, *Leidse geol. Med.*, 39, 177, pl. 1, fig. 1.
- 1967 *Ancyrodella curvata* (Branson & Mehl); Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 203, pl. 19, figs 1a, b.
- 1968 *Ancyrodella curvata* (Branson & Mehl); Mound, *J. Paleont.*, 42, 469, pl. 65, figs 5, 6 [non figs 13-16 = ? *A. buckeyensis*].
- 1968 *Ancyrodella curvata* (Branson & Mehl); Figge, *N. Jb. Geol. Paläont., Monatsh.*, 197, fig. 3.
- 1970 *Ancyrodella curvata* (Branson & Mehl); Seddon, *J. geol. Soc. Aust.*, 16, pl. 16, figs 3, 4.
- 1970 *Ancyrodella curvata* (Branson & Mehl); Seddon, *Texas Bur. econ. Geol. Rep. Inv.*, 68, 37, pl. 7, figs 12, 13.

Material: 32 specimens; CPC 12360 figured, from Sample BG 19014, Section 1, McWhae Ridge, Virgin Hills Formation.

Description: The unit is symmetrical and the platform is developed as four lobes. One is the posterior extension of the carina, the others are lateral: two are symmetrical anteriorly inclined lobes and the fourth is a posteriorly directed lobe on the outer side. The main carina is an extension of the free blade, which is the same length as the platform. Lateral carinae are developed on each lobe. They are composed of low nodes; none of them fuse with the main carina, although all approach the same point on it. The two lateral carinae on the outer side fuse in a large node. Each carina develops as a minute free blade at its marginal termination; the dentition is taller and laterally compressed. Ornament is lacking on most of the platform, but small low nodose ridges normal to and confined to the posterior platform margin are developed.

In lateral view the free blade is highest at the anterior and is composed of fused denticles with free posteriorly inclined chevron tips. A few small denticles are developed on the anterior face of the blade. There is a short free blade at the posterior termination.

Aborally, the unit is bisected by a main keel in which lies a narrow trough. At its midpoint a diamond-shaped basal cavity is developed; each apex of the diamond merges with a keel. Three lateral keels with troughs are present; on the outer side two diverge at 45° and 135° to the main keel from an apex of the basal cavity; on the inner side a single keel radiates from the opposite apex.

Remarks: Only two species of *Ancyrodella*, *lobata* and *curvata*, possess the extra lateral lobe directed posteriorly. *A. curvata* appears to have developed from *A. lobata* by a reduction in ornament and in massiveness of the lobes. Further reduction of the platform would produce an *A. ioides*-like form with an extra lobe. No

such forms have been described, although one broken specimen in this fauna appears to have four very narrow lobes.

Distribution: The species was originally described from the Upper Devonian Grassy Creek Shale of Missouri (Branson & Mehl, 1934a). Elsewhere in North America it has been reported from Iowa (Müller & Müller, 1957; Anderson, 1966), Ohio (Stauffer, 1938), New York State (Oliver et al., 1967), Texas (Seddon, 1970c) and Alberta (Pollock, 1968; Mound, 1968).

A. curvata is common in Europe, especially Germany, where it has been recorded in the *Manticoceras*-Stufe (Sannemann, 1955; Bischoff, 1956; Bischoff & Ziegler, 1956; Stoppel, 1958; Walliser, 1958; Ziegler, 1958, 1962b; Freyer, 1961; Krebs & Rabien, 1964; Meyer, 1965; Zitzmann, 1966, 1967, 1968; Bering, 1967; Figge, 1968; Bar, 1968, 1969; Schneider, 1969; Eder et al., 1969). It has also been recorded in France (Lys, Serre, & Deroo, 1957; Boyer et al., 1968), Austria (Flügel & Ziegler, 1957; Schönlaub, 1969), Poland (Wolska, 1967), Spain (Boogaert, 1967; Wirth, 1967), and Czechoslovakia (Koverdynsky & Zikmundova, 1966).

In North Africa *A. curvata* has been recorded from the Spanish Sahara (Panseri & Barsotti, 1959; Ethington & Furnish, 1962), Algeria (Remack-Petitot, 1960; Massa, 1965), and Morocco (Massa, 1965). The species has previously been recorded from the Canning Basin, Australia, by Glenister & Klapper (1966) and Seddon (1970a).

Range: Ziegler (1958) gives the range of the species as Upper Devonian (toI β -toI δ). Boyer et al. (1968) give roughly the same range for their French occurrences. The species is confined to the Frasnian. In New York State the species ranges through the Cohocton Series (equivalent to upper toI β -toI δ) (Oliver et al., 1967). The Canning Basin specimens range from the *Ancyrognathus triangularis* Zone (toI γ) to the Lower *Palmatolepis triangularis* Zone (toI δ).

ANCYRODELLA GIGAS Youngquist, 1947

(Pl. 3, figs 1a-3b)

- 1947 *Ancyrodella gigas* Youngquist, *J. Paleont.*, 21, 96, pl. 25, fig. 23.
1947 *Polygnathus rotundiloba* Ulrich & Bassler; Youngquist, *ibid.*, 110, pl. 26, fig. 6.
1957 *Ancyrodella gigas* Youngquist; Müller & Müller, *J. Paleont.*, 31, 1091, pl. 142, fig. 1 [non pl. 141, fig. 8 = *A. lobata*].
1958 *Ancyrodella gigas* Youngquist; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 41, pl. 11, figs 8a, b [non figs 10a, b = *A. buckeyensis*].
1965 *Ancyrodella gigas* Miller & Youngquist [sic]; Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 538, pl. 1, fig. 1.
1965 *Ancyrodella gigas* Youngquist; Ziegler, *ibid.*, 737, pl. 2, fig. 7.
1966 *Ancyrodella gigas* Youngquist; Anderson, *J. Paleont.*, 40, 403, pl. 48, figs 10, 14.
1968 *Ancyrodella gigas* Youngquist; Mound, *J. Paleont.*, 42, 470, pl. 65, figs 17, 18.
non 1969 *Ancyrodella gigas* Youngquist; Chorowska, *Kwart. Geol.*, 13, 66, pl. 1, figs 4, 5 [= *A. rotundiloba* s.s.].
1970 *Ancyrodella gigas* Youngquist; Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 37, pl. 7, figs 6, 7.

Material: 9 specimens; CPC 12361-3 figured, from sample BG 19544, Section 9, McPhee Knoll, Gogo Formation.

Description: The platform is arrow-like and bisected by the carina, which is a continuation of the anterior free blade. The free blade is just shorter than the

platform. No true lateral lobes are present, although the outer edges of the platform are produced anteriorly. Similarly, there are no true lateral carinae, although each anteriorly produced platform bears a conspicuous row of nodes which approach the main carina at a low angle. However, rather than terminating just before the main carina or fusing with it, the ornament curves to parallel it, terminating near the posterior edge of the platform. On the outer side of these rows of nodes secondary rows are developed which parallel them and also terminate at the platform margin, which is crenulate.

In lateral view the blade is higher than the platform. In some specimens denticles are fused and share a chevron tip, but the tips are always free and are inclined posteriorly.

Aborally the unit is bisected by a main keel with a medial trough. At midpoint the trough widens slightly to give a very small diamond-shaped cavity. From this run two lateral keels, which terminate at the anterolateral edges of the platform. No troughs appear to be developed in these keels.

Distribution: The species was originally described from the Upper Devonian of Iowa (Youngquist, 1947); further Iowa occurrences have been noted by Müller & Müller (1957) and Anderson (1966). Elsewhere in North America it has been recorded from Texas (Seddon, 1970c), Missouri (Klapper et al., 1971) and Alberta (Clark & Ethington, 1965; Uyeno, 1967; Pollock, 1968; Mound, 1968).

In Europe the species has been recorded from the Upper Devonian of Germany (Ziegler, 1958, 1965a, b; Krebs & Rabien, 1964; Eder et al., 1969), Austria (Schönlaub, 1969a), and France (Boyer et al., 1968).

Range: Ziegler (1958) gives the range as Upper Devonian to Ia-to Iδ. Boyer et al. (1968) give a cumulative range of to Ia-to Iδ. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (to Ia) up to the Upper *Palma-tolepis gigas* Zone (to Iδ).

ANCYRODELLA IOIDES Ziegler, 1958

(Pl. 1, figs 5a, b)

1958 *Ancyrodella ioides* Ziegler, *Hess. Landesamt Bodenf., Abh.*, 87, 42, pl. 11, figs 2-4.

?1968 *Ancyrodella ioides* Ziegler; Spasov et al., *Inst. Rech. Geol. Geophys. Bull.* 26, 158, pl. 1, figs 4, 17.

?1970 *Ancyrodella ioides* Ziegler; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 6.

1970 *Ancyrodella ioides* Ziegler; Spasov, *Rev. Bulg. geol. Soc.*, 31, 180, pl. 2, fig. 5.

Material: 11 specimens; CPC 12364-7 figured, from sample BG 19013, Section 1, McWhae Ridge, Virgin Hills Formation.

Description: The unit is cruciform and symmetrical. The anterior free blade is as long as the platform and posterior free blade together. The carina is continuous with both free blades and is marked by a shortening and fattening of the denticulation. The platform consists of two narrow lateral lobes and a posterior lobe which narrows to form the posterior free blade. The ornament consists of lateral carinae which terminate near the main carina. The lateral carinae are formed of denticles rather than nodes and the denticles increase in size and height toward the lobe termination. The platform margin is crenulate and occasionally a few nodes are present posterior to the lateral carinae.

In lateral view the anterior free blade increases in height anteriorly and is formed of laterally compressed fused denticles, with free posteriorly inclined chevron tips.

Aborally, the unit is keeled; a trough is developed near the midpoint on either side of the small basal cavity. Two lateral keels are present on each platform lobe; they do not contain a trough and meet the median keel at the basal cavity. There is some extension of the cavity along both lateral keels.

Remarks: *A. ioides* developed from *A. nodosa* by a general reduction in the platform to give the cruciform plan. It is very difficult to place a boundary between *A. nodosa* and *A. ioides* and some of the illustrated specimens (e.g., Spasov et al., 1968; Seddon, 1970a) are probably transitional forms, as is one of the specimens illustrated here (Pl. 4, fig. 4a, b).

The restricted distribution of *A. ioides* is interesting; the Canning Basin occurrences are the only ones outside Europe. This suggests that there was some restriction on its movement: all other species of *Ancyrodella* appear to have a world-wide distribution.

Distribution: The species was originally described from the Adorfstufe of Germany (Ziegler, 1958), and since then it has been recorded from the *Manticoceras*-Stufe by several authors (Krebs & Rabien, 1964; Schriel & Stoppel, 1965; Zitzmann, 1968; Bar, 1968; Schneider, 1969; Eder et al., 1969). Elsewhere in Europe the species has been recorded from Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1970), France (Boyer et al., 1968), and Yugoslavia (Spasov et al., 1967, 1968).

The only record of this species outside Europe is in the Canning Basin (Seddon, 1970a). It is noteworthy that the species is unrecorded from North America.

Range: Upper Devonian (middle to γ -lower to δ) (Ziegler, 1958). Boyer et al. (1968) extend the range downward to the base of the to β Zone. The Canning Basin specimens range from the Upper *Polygnathus asymmetricus* Zone (to β) up to the Lower *Palmatolepis gigas* Zone (to γ).

ANCYRODELLA LOBATA Branson & Mehl, 1934

(Pl. 5, figs 1a-2b; Pl. 6, figs 1a-3b)

- 1934 *Ancyrodella lobata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 239, pl. 19, fig. 14; pl. 21, figs 22, 23.
- 1947 *Ancyrodella magister* Miller & Youngquist, *J. Paleont.*, 21, 503, pl. 74, fig. 14.
- 1949 *Ancyrodella lobata* Branson & Mehl; Beckmann, *Senckenbergiana*, 30, 155, pl. 4, fig. 1.
- 1955 *Ancyrodella lobata* Branson & Mehl; Sannemann, *N. Jb. Geol. Paläont., Abh.*, 100, 331, pl. 24, fig. 2.
- 1957 *Ancyrodella gigas* Youngquist; Müller & Müller (part), *J. Paleont.*, 31, 1091, pl. 141, fig. 8 [non pl. 142, fig. 1 = *A. gigas*].
- 1957 *Ancyropenta longidenticulata* Müller & Müller, *ibid.*, 1093, pl. 136, figs 3a-c; pl. 137, figs 1a-2.
- 1958 *Ancyrodella lobata* Branson & Mehl; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 43, pl. 11, figs 6, 9.
- 1965 *Ancyrodella lobata* Branson & Mehl; Krebs & Ziegler, *Forsch. Geol. Rheinl. Westf.*, 9, 754, pl. 1, fig. 14.
- 1966 *Ancyrodella lobata* Branson & Mehl; Anderson, *J. Paleont.*, 40, 403, pl. 48, figs 15, 16.
- 1966 *Ancyrodella lobata* Branson & Mehl; Flajs, *N. Jb. Geol. Paläont., Abh.*, 124, 228, pl. 23, fig. 2.
- 1967 *Ancyrodella lobata* (Branson & Mehl); Wirth, *ibid.*, 127, 203, pl. 19, figs 3a-24.

- 1968 *Ancyrodella lobata* Branson & Mehl; Mound, *J. Paleont.*, 42, 470, pl. 65, figs 7-12.
1970 *Ancyrodella lobata* Branson & Mehl; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 2.
1970 *Ancyrodella lobata* Branson & Mehl; Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 35, pl. 7, figs 8-11, 14-17.

Material: 19 specimens; CPC 12368-72 figured.

Localities of figured material: Sample BG 19534 (CPC 12369), 19548 (CPC 12370), Section 9, McPhee Knoll, Virgin Hills Formation; BG 19575 (CPC 12371), mouth of Waggon Pass, Virgin Hills Formation; BG 19580 (CPC 12368), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 21371 (CPC 12372), Section 24, Teichert Hills, Sadler Limestone.

Description: The unit is massive, with a free blade as long as the platform in small specimens and about half as long in large specimens. The carina bisects the curved unit: it is considerably lower than the free blade, with which it merges. The platform is developed as two anteriorly directed lobes and a lobate extension of the outer posterior platform margin. Platform ornament consists of two lateral carinae which are present on the inner margin of the anterior lobes. They terminate near the main carina. The remainder of the platform anterior to these carinae is covered with nodes. They are arranged in a roughly linear pattern subparallel to the main carina. Nodes in the lobate outer portion of the platform are developed as an incipient carina at a 45° angle to the main carina.

In lateral view the free blade increases in height anteriorly. The denticles are laterally compressed with free posteriorly inclined chevron tips. They increase in width anteriorly.

Aborally a medial keel with a very narrow trough bisects the unit. At mid-point a basal cavity is present. It is small and is the focal point of the radiating keels beneath the anterior lobes and sometimes the outer posterior lobate portion.

Remarks: The species is easily recognized by the lobate outer margin. It is probably developed from *A. rotundiloba* and/or *A. buckeyensis*. Some specimens possess well developed carinae and keels on the postero-lateral lobe; others show an incipient carina and keel (Pl. 6, fig. 3a, b). The species appears to be ancestral to *A. curvata* and can be distinguished by the more massive platform and the less well developed postero-lateral lobe. Stauffer (1938, pl. 52, figs 28, 29) illustrates a lobate specimen and refers it to a new species, *A. robusta*. No extra lateral keel is present, so it is difficult to decide whether *A. robusta* is a junior synonym of *A. buckeyensis* or *A. lobata*.

Distribution: The species was originally described from the Upper Devonian Grassy Creek Shale of Missouri (Branson & Mehl, 1934a). Other North American occurrences are known from Iowa (Miller & Youngquist, 1947; Müller & Müller, 1957; Anderson, 1966), Texas (Seddon, 1970c), and Alberta (Pollock, 1968; Mound, 1968).

The species occurs abundantly in Europe, especially in the *Manticoceras*-Stufe of Germany (Beckmann, 1949; Sannemann, 1955a; Bischoff & Ziegler, 1956; Bischoff, 1956; Ziegler, 1958; Freyer, 1961; Krebs & Ziegler, 1965; Bar, 1968; Schneider, 1969; Eder et al., 1969; Meischner & Schneider, 1970). Elsewhere in Europe it has been recorded from Austria (Flajs, 1966; Schönlaub, 1969a), Czechoslovakia (Dvorak & Freyer, 1968), France (Serre & Lys, 1960; Boyer et al., 1968), and Spain (Wirth, 1967).

Seddon (1970a) has recorded the species from the Canning Basin and it is also known from Morocco (Massa, 1965).

Range: Ziegler (1958) gives the range as Upper Devonian (toI α -toI γ). Boyer et al. (1968) give a composite range of toI β -lower toI γ for occurrences in France. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toI α) up to the *Ancyrognathus triangularis* Zone (toI γ).

ANCYRODELLA NODOSA Ulrich & Bassler, 1926

(Pl. 7, figs 1a-3b; Pl. 8, figs 1a-3b)

- 1926 *Ancyrodella nodosa* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 48, pl. 1, figs 10-13.
1926 *Ancyrodella hamata* Ulrich & Bassler, *ibid.*, 48, pl. 7, fig. 7.
1926 *Ancyrodella malleus* Ulrich & Bassler (part), *ibid.*, 49, pl. 7, fig. 2.
1926 *Ancyrodella symmetrica* Ulrich & Bassler, *ibid.*, 49, pl. 8, fig. 1.
1932 *Ancyrodella hamata* Ulrich & Bassler; Bassler, *Tenn. Div. Geol. Bull.* 38, 234, pl. 26, fig. 14.
1935 *Ancyrodella hamata* Ulrich & Bassler; Cooper, *J. Paleont.*, 9, 312, pl. 27, fig. 39.
non 1948 *Ancyrodella nodosa* Ulrich & Bassler; Youngquist & Miller, *J. Paleont.*, 22, 441, pl. 68, figs 13, 14 [= *A. buckeyensis*].
1956 *Ancyrodella nodosa* Ulrich & Bassler; Bischoff, *Hess. Landesamt Bodenf. Notizbl.*, 84, 119, pl. 8, figs 12, 15.
?1956 *Ancyrodella* sp., Dineley & Rhodes, *Geol. Mag.*, 93, 245, text-fig. 7.
1956 *Ancyrodella* sp., Müller, *J. Paleont.*, 30, 1340, pl. 145, figs 12, 14.
1957 *Ancyrodella hamata* Ulrich & Bassler; Müller & Müller, *J. Paleont.*, 31, 1091, pl. 136, fig. 4.
1958 *Ancyrodella nodosa* Ulrich & Bassler; Ziegler, *Hess. Landesamt Bodenf. Notizbl.*, 87, 44, pl. 11, fig. 1.
non 1960 *Ancyrodella nodosa* Ulrich & Bassler; Müller, *Geol. Rdsch.*, 49, 88, pl. 2, fig. 2 [= *A. buckeyensis*].
1966 *Ancyrodella nodosa* Ulrich & Bassler; Glenister & Klapper, *J. Paleont.*, 40, 798, pl. 86, figs 5-12.
1966 *Ancyrodella nodosa* Ulrich & Bassler; Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 13.
1966 *Ancyrodella nodosa* Ulrich & Bassler; Flajs, *N. Jb. Geol. Paläont., Abh.*, 124, 238, pl. 23, fig. 4.
1968 *Ancyrodella nodosa* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 6, pl. 13, figs 1-4, 7-10.
1970 *Ancyrodella nodosa* Ulrich & Bassler; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 5.
1970 *Ancyrodella nodosa* Ulrich & Bassler; Spasov, *Rev. Bulg. geol. Soc.*, 31, 180, pl. 2, fig. 3.
1970 *Ancyrodella nodosa* Ulrich & Bassler; Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 30, pl. 7, fig. 18.

Material: 138 specimens; CPC 12373-8 figured.

Localities of figured material: Sample BG 19009 (CPC 12373), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19581 (CPC 12374), 19582 (CPC 12375-78), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Description: An arrow-shaped unit comprising an anterior free blade and a tripartite platform, consisting of two anterior lobes and a posterior extension. The nodose carina is continuous with the free blade and extends slightly beyond the platform as a free blade. The dentition on this extension reverts to denticles rather than nodes. Two lateral carinae extend along the inner margin of the anterior lobes. They are nodose and arcuate; the dentition reverts to denticles near the crenulate and the platform bears nodes arranged in a sigmoidal pattern bordering the lateral and main carinae.

In lateral view the free blade increases in height anteriorly. It is composed of laterally compressed fused denticles with free posteriorly inclined chevron tips.

Aborally the unit is keeled; at its midpoint is a basal cavity, the focal point for the radiating lateral keels. Median troughs extend along all keels for a short distance.

Remarks: *A. nodosa* is the median species in the continuous sequence from *A. buckeyensis* to *A. ioides*. It is extremely difficult to draw any watertight line between these species. However, in general *A. nodosa* differs from *A. buckeyensis* in having a sigmoidal platform outline on both sides and a general reduction of platform ornament; it possesses more ornament than *A. ioides* and the platform extends farther posteriorly than *ioides*, which is essentially cruciform.

Distribution: The species was originally described from the Upper Devonian Rhinestreet Shale of New York State (Ulrich & Bassler, 1926; Huddle, 1968; Oliver et al., 1967). Bassler (1932, p. 234) states that it is present in the Hardin Sandstone, Tennessee, although the specimen illustrated is obviously the one from the Rhinestreet Shale illustrated in the 1926 paper. Elsewhere in North America the species is recorded from Iowa (Müller, 1956b; Müller & Müller, 1957), Texas (Seddon, 1970c), and Alberta (Pollock, 1968).

In Europe the species has been reported many times from the *Manticoceras*-Stufe (Bischoff, 1956; Ziegler, 1958; Stoppel, 1958; Freyer, 1961; Krebs & Rabien, 1964; Meyer, 1965; Schriel & Stoppel, 1965; Zitzmann, 1966, 1967, 1968; Eder et al., 1969). Other occurrences include Austria (Flajs, 1966; Schönlaub, 1969a), Bulgaria (Spasov, 1966, 1970), France (Boyer et al., 1968), and questionably England (Dineley & Rhodes, 1956).

The species has been reported extensively from the Canning Basin (Müller, 1956b; Glenister & Klapper, 1966; Seddon, 1970a). It has also been recorded from the Malay Peninsula (Alexander & Müller, 1963).

Range: Upper Devonian (toI₇-toI₈) in Germany (Ziegler, 1958) and in France (Boyer et al., 1968). The Canning Basin specimens range from the *Ancyrognathus triangularis* Zone (toI₇) up to the Upper *Palmatolepis gigas* Zone.

ACYRODELLA ROTUNDILOBA ROTUNDILOBA (Bryant, 1921)

(Pl. 9, figs 1a-7b; Pl. 10, figs 1a-3b; Pl. 12, fig. 1a, b)

- 1879 *Polygnathus tuberculatus* Hinde, *Quart. J. geol. Soc. Lond.*, 35, 366, pl. 17, fig. 10 only.
1921 *Polygnathus rotundilobus* Bryant, *Bull. Buffalo Soc. nat. Sci.*, 13, 26, pl. 12, figs 1-6.
1933 *Polygnathus tuberculata* Hinde; Branson & Mehl, *Univ. Mo. Stud.*, 8, 148, pl. 11, fig. 9.
1934 *Polygnathus rotundiloba* Bryant; Huddle, *Bull. Am. Paleont.*, 21, 102, pl. 8, figs 36, 37.
non 1947 *Polygnathus rotundiloba* Bryant; Youngquist, *J. Paleont.*, 21, 110, pl. 26, fig. 6
[= *A. gigas*].
1957 *Ancyrodella rotundiloba* (Bryant); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 42, pl. 16, fig. 15 [non figs 5-12, 14, 16, 17 = *A. rotundiloba alata*].
1958 *Ancyrodella rotundiloba* (Bryant); Ziegler, *ibid.*, *Notizbl.*, 87, 44, pl. 11, fig. 11
[non fig. 12 = *A. rotundiloba alata*].
1959 *Ancyrodella rotundiloba* (Bryant); Krebs, *Senck. leth.*, 40, 384, pl. 1, fig. 15.
1965 *Ancyrodella rotundiloba rotundiloba* (Bryant); Krebs & Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 754, pl. 1, figs 10-13, 15, 16.
1966 *Ancyrodella rotundiloba rotundiloba* (Bryant); Glenister & Klapper, *J. Paleont.*, 40, 799, pl. 85, figs 9-13.
1967 *Ancyrodella rotundiloba* (Bryant); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 29, pl. 2, figs 4, 6, 7, 9, 10, 13-15 [non fig. 8 = *A. rotundiloba alata*].

- 1967 *Ancyrodella rotundiloba rotundiloba* (Bryant); Boogaert, *Leidse geol. Med.*, 39, 178, pl. 1, fig. 3.
 1967 *Ancyrodella rotundiloba* (Bryant); Müller & Clark, *J. Paleont.*, 41, 908, pl. 116, figs 1-5; text-fig. 6c-i, n-p, s-w [non pl. 115, fig. 8; text-fig. 6j-m, q, r = *A. rotundiloba alata*].
 1969 *Ancyrodella gigas* Youngquist; Chorowska, *Kwart. Geol.*, 13, 66, pl. 1, figs 4, 5.
 1970 *Ancyrodella rotundiloba* (Bryant); Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 1.
 1970 *Ancyrodella rotundiloba* (Bryant); Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 33, pl. 7, fig. 1; pl. 9, fig. 16.

Material: 46 specimens; CPC 12379-90 figured.

Localities of figured material: Samples BG 19186 (CPC 12379), 19189 (CPC 12380-81), hill at base of Section 1, McWhae Ridge, Gogo Formation; BG 19482, Section 6, Lloyd Hill-Laidlaw Range, Gogo Formation; BG 19534 (CPC 12384), Section 9, McPhee Knoll, Virgin Hills Formation; BG 19598, Section 13, Glenister Knolls, Gogo Formation; BG 12222 (CPC 12386), 21228 (CPC 12387-8), 21229 (CPC 12389), 21237 (CPC 12390), Section 19, Sadler Ridge, Sadler Limestone.

Description: Unit heart-shaped to oval. The anterior free blade is as long as the platform. A medial carina bisects the platform; it is a continuation of the free blade and is composed of low nodes. The platform is ornamented by coarse nodes, arranged irregularly in some specimens, but forming incipient lateral carinae in others. In some specimens the two halves of the platform are mirror images; in others the inner platform is narrower and extends farther anteriorly.

In lateral view the free blade is exceptionally high, the highest point being just anterior to the midpoint. It is composed of laterally compressed fused denticles with posteriorly inclined free chevron tips.

Aborally, the unit is keeled over its whole length. At about the midpoint a basal cavity is developed; it extends as a cruciform extension along the keel and at right angles to it. The lateral keels are short and do not reach to the crimp. Some specimens (Pl. 10, fig. 1a, b) have basal 'bone' material, opaque and white, adhering to the undersurface of the conodont and showing the cruciform attachment pattern.

Remarks: Variation of platform morphology of *A. rotundiloba* has been analysed in detail by Müller & Clark (1967, text-fig. 6) in dealing with a fauna from the lowermost Upper Devonian Squaw Bay Limestone of Michigan. They recognize three main variations in the adult forms: (a) 'cross pattern' forms which have incipient lateral carinae; (b) 'normal pattern' forms which are generally asymmetrical and lack the anterior lobation on both platforms but may be alate (see their text-fig. 6r); (c) 'symmetrical' forms with lobation of both antero-lateral processes.

Glenister & Klapper (1966) have elevated the alate forms to subspecific rank; and Pollock (1968) suggests that even though the subspecies has the same range as the nominate subspecies, the difference in morphology is sufficient to make the subspecies *alata* valid. Uyeno (1967) erects a further subspecies *binodosa* to include forms whose only ornament is two large nodes, one on each platform. He also leaves in open nomenclature subspecific forms which he distinguishes from *rotundiloba* s.s. by their coarse nodose dentition. I consider that these belong in the nominate subspecies.

It appears that *A. rotundiloba* has at least six recognizable forms. They include: (i) alate forms = *alata*, (ii) binodose forms = *binodosa*, (iii) cruciform

forms = Müller & Clark text-fig. 6h-m (placed in *alata* here), (iv) asymmetrical forms = Müller & Clark text-fig. 6o-q (placed in *alata* here), (v) symmetrical lobate forms = Müller & Clark text-fig. 6t-w (placed in *rotundiloba* s.s. here). Work with abundant faunas should help to elucidate some of these differences and show whether they are stratigraphically or ecologically important.

The present faunas show excellent sequences from small to large forms. They agree strikingly with the growth stages shown by Müller & Clark (1967, text-fig. 6). It would appear that the *A. rotundiloba* group developed from a spathognathodid ancestor. In fact, it could be polyphyletic; forms such as *A. rotundiloba binodosa* could have developed from *Spathognathodus swanhillensis* Pollock, whereas *A. rotundiloba* s.s. would arise more logically from *S. sannemannii variabilis* Pollock.

Distribution: The species was originally described from the Upper Devonian Genessee Shale of New York (Bryant, 1921). It had already been illustrated as *Polygnathus tuberculatus* (Hinde, 1879; Branson & Mehl, 1933) from the Genessee Shale. It has also been recorded in the Appalachians by Oliver et al. (1967) and from the Genundera Limestone of New York (Klapper et al., 1971). Hass & Huddle (1965) record the species from the Woodford Shale of Oklahoma and Seddon (1970c) illustrates specimens from Texas. The species has been recorded but not illustrated from Alberta (Clark & Ethington, 1965), Illinois and Nevada (Klapper et al., 1971).

In Europe the species has been recorded from Germany (Bischoff & Ziegler, 1957; Ziegler, 1958; Krebs, 1959; Krebs & Ziegler, 1965; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970), Austria (Schulze, 1968; Schönlaub, 1969a), France (Boyer et al., 1968), Spain (Boogaert, 1967), and Poland (Chorowska, 1969).

Gupta et al. (1967) record but do not illustrate the species from Kashmir. The nominate subspecies has been illustrated from the Canning Basin (Glenister & Klapper, 1966; Seddon, 1970a).

Range: Ziegler (1958) gives the range in Germany as earliest Upper Devonian (Middle/Upper Devonian boundary-toI_a). Boyer et al. (1968) suggest that the species can get as high as lowermost toI_β. The Canning Basin specimens range from the Lower to the lowest Upper *Polygnathus asymmetricus* Zone (toI_a-basal toI_β).

ANCYRODELLA ROTUNDILOBA ALATA Glenister & Klapper, 1966

(Pl. 11, figs 1a-4)

- 1956 *Ancyrodella rotundiloba* (Bryant); Hass, *U.S. geol. Surv. prof. Pap.* 286, pl. 4, fig. 21.
- 1957 *Ancyrodella rotundiloba* (Bryant); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 42, pl. 16, figs 5-12, 14, 16, 17 [non fig. 15 = *A. rotundiloba* s.s.].
- 1958 *Ancyrodella rotundiloba* (Bryant); Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 44, pl. 11, fig. 12 [non fig. 11 = *A. rotundiloba* s.s.].
- 1966 *Ancyrodella rotundiloba alata* Glenister & Klapper, *J. Paleont.*, 40, 799, pl. 85, figs 1-8; pl. 86, figs 1-4.
- 1967 *Ancyrodella rotundiloba* (Bryant); Müller & Clark, *J. Paleont.*, 41, 908, pl. 115, fig. 8; text-fig. 6j-m, q, r [non pl. 116, figs 1-5; text-fig. 6a-i, n-p, s-w = *A. rotundiloba* s.s.].
- 1967 *Ancyrodella rotundiloba* (Bryant); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 29, pl. 2, fig. 8 [figs 4, 6, 7, 9, 10, 13-15 = *A. rotundiloba* s.s.].

- 1968 *Ancyrodella rotundiloba alata* Glenister & Klapper; Pollock, *J. Paleont.*, 42, 424, pl. 61, figs 2, 3.
1970 *Ancyrodella rotundiloba alata* Glenister & Klapper; Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, pl. 7, fig. 4; pl. 9, figs 5, 6.

Material: 8 specimens; CPC 12391-4 figured.

Localities of figured material: Sample BG 19001 (CPC 12391), Section 1, McWhae Ridge, Gogo Formation; BG 19482 (CPC 12392-3), Section 6, Lloyd Hill-Laidlaw Range, Gogo Formation; BG 21234 (CPC 12934), Section 19, Sadler Ridge, Sadler Limestone.

Description: In this subspecies, unlike the nominate subspecies, the outline of the platform is alate. In some forms the lateral keels extend farther toward the crimp.

Remarks: I have included forms with a 'wing' developed on only one side, although these may be a separate subspecies. The variations are discussed under the nominate subspecies.

Distribution: The subspecies was originally described from the Upper Devonian Gogo Formation of the Canning Basin (Glenister & Klapper, 1966) from a section about 800 m north of my section 13. These authors recognized that some of the specimens illustrated by Bischoff & Ziegler (1957) and Ziegler (1958) from Germany belonged to the subspecies. I consider that the specimen illustrated by Hass (1956) from the Chattanooga Shale of Tennessee also belongs in it.

Recently, the subspecies has been recorded from Alberta, Canada (Uyeno, 1967; Pollock, 1968), Texas (Seddon, 1970c), and Michigan (Müller & Clark, 1967—the subspecies was not recognized but its presence is obvious from the abundant illustrations). A specimen assigned to *A. rotundiloba* by Clark & Ethington (1967, pl. 2, fig. 8) from Utah should also be placed in *alata*. Klapper et al. (1971) record the subspecies from Missouri and New York.

Range: No author has given an exact range for the subspecies. Uyeno (1967, p. 9) suggests that its earliest occurrence is at the base of the Middle *Polygnathus asymmetricus* Zone (toIa). The Canning Basin specimens occur in the Lower and Middle *Polygnathus asymmetricus* Zone (toIa).

ANCYRODELLA ROTUNDILOBA BINODOSA Uyeno, 1967

- 1967 *Ancyrodella rotundiloba binodosa* Uyeno, *Geol. Surv. Can. Pap.* 67-30, 4, pl. 1, figs 2, 4, 5.

Material: One specimen, from sample BG 19489, Section 6, northeast of Lloyd Hill, Sadler Formation.

Description: The platform is triangular, with very restricted dentition confined to two large nodes, one on either side of the carina. Small nodes are present on part of the margin of the outer platform.

In lateral view the free blade height increases anteriorly. It is composed of laterally compressed denticles with free chevron tips.

Aborally, a large cruciform basal cavity extends along the keel as a narrowing trough and laterally nearly to the crimp.

Remarks: Though the specimen bears extra nodes on one platform, it is considered to be so close to *binodosa* that it is confidently referred to that subspecies. It seems

to have developed from *Spathognathodus swanhillensis* Pollock by development of nodes on the oral portion of the tumid pseudo-platform.

Occurrence and Range: The subspecies was originally described from the Waterways Formation of Alberta, Canada (Uyeno, 1967) and occurs in the uppermost part of the Lower and lowermost part of the Middle *Polygnathus asymmetricus* Zone (to1a).

ANCYRODELLA RUGOSA Branson & Mehl, 1934

(Pl. 3, figs 4a, b)

- 1934 *Ancyrodella rugosa* Branson & Mehl, *Univ. Mo. Stud.*, 8, 239, pl. 19, figs 15, 17.
1947 *Ancyrodella subrotunda* Miller & Youngquist, *J. Paleont.*, 21, 503, pl. 74, fig. 17.
1949 *Ancyrodella rugosa* Branson & Mehl; Beckmann, *Senckenbergiana*, 30, 155, pl. 1, fig. 1; pl. 4, fig. 2.
1957 *Ancyrodella rugosa* Branson & Mehl; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 84, 42, pl. 16, fig. 13.
1959 *Ancyrodella rugosa* Branson & Mehl; Krebs, *Senck. leth.*, 40, 384, pl. 1, fig. 14.
1968 *Ancyrodella rugosa* Branson & Mehl; Pollock, *J. Paleont.*, 42, 428, pl. 61, fig. 1.
1970 *Ancyrodella rugosa* Branson & Mehl; Seddon, *Texas Bur. econ. Geol. Rep. Inv.*, 68, 35, pl. 7, figs 2, 3.

Material: 3 specimens; CPC 12395 figured, from sample BG 21247, Section 20, Longs Well Creek, Gogo Formation.

Description: The unit is quadrate to ovate, with a free blade slightly shorter than the platform. The carina is low and nodose, the nodes being similar to the platform nodes: at its junction with the free blade it has practically disappeared. The platform is ornamented with low coarse nodes arranged in linear rows subparallel to the carina.

The free blade is composed of exceptionally tall, fused, laterally compressed denticles. The height decreases abruptly at the platform junction.

Aborally, a main keel runs the length of the unit. At its midpoint a small diamond-shaped basal cavity extends as narrowing troughs along the keel for a short distance. Two lateral keels are developed from the basal cavity; they lack troughs.

Remarks: *A. rugosa* appears to have developed from *A. rotundiloba* by alignment of the platform ornament and reduction of the cruciform basal cavity. The development of linear platform ornament and the lack of lateral carinae suggest that it may be ancestral to *A. gigas*.

Occurrence: The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). It has also been recorded from Iowa (Miller & Youngquist, 1947), Texas (Seddon, 1970c), and Alberta (Pollock, 1968) in North America. In Europe the species has been reported from Germany (Beckmann, 1949; Bischoff & Ziegler, 1957; Krebs, 1959; Meyer, 1965; Krebs & Ziegler, 1965). Gupta et al. (1967) record it from Kashmir.

Range: No exact range has been given, but a composite range from known occurrences suggests that the species is confined to the *Polygnathus asymmetricus* Zone, although it may occur in the underlying *Schmidtognathus hermanni*-*Polygnathus cristatus* Zone. The Canning Basin specimens are from either the Lower or Middle *Polygnathus asymmetricus* Zone.

ANCYRODELLA sp. nov. A

(Pl. 1, figs 1a-c)

1965 *Ancyrodella rotundiloba* (Bryant) n. subsp., Krebs & Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 754, pl. 1, figs 6-9.

?1966 *Ancyrodella* n. sp., aff. *lobata* Branson & Mehl; Flajs, *N. Jb. Geol. Paläont., Abh.*, 124, 228, pl. 24, fig. 8; text-fig. 3b.

?1967 *Ancyrodella rotundiloba* (Bryant); Müller & Clark, *J. Paleont.*, 41, 908, text-fig. 6t only.

Material: CPC 12352, sample BG 21003, *Timanites* Hill, near Glenister Knolls, Gogo Formation.

Description: The unit is trefoil-shaped. The free blade is the same length as the platform. The platform is developed as three lobes, two lateral and one posterior. The unit is bisected by the main carina, which is low and nodose, and merges with the free blade. Two lateral carinae bisect the two lateral lobes. The remainder of the ornamentation consists of low nodes arranged around the platform margins. Laterally, the free blade is tall, composed of fused, laterally compressed denticles. Aborally, the unit resembles *A. buckeyensis*.

Remarks: This form is probably developed from *A. rotundiloba*. In fact the specimen illustrated by Pollock (1968, pl. 61, figs 2, 3) probably belongs here. The variety has been recognized by several authors but has never been formally named. It is not practicable to name it here, from one specimen only. Because of its dissimilarity aborally to *A. rotundiloba*, it should not be placed in that species.

Distribution: This distinctive form is known from North America (Müller & Clark, 1967) and Europe (Krebs & Ziegler, 1965; Flajs, 1966).

Range: Unknown, but all illustrated forms come from faunas of Late Devonian (to Ia) age. The Canning Basin specimen is from either the Lower or Middle *Polygnathus asymmetricus* Zone.

Genus ANCYROGNATHUS Branson & Mehl, 1934

Type species: *Ancyrognathus symmetricus* Branson & Mehl, 1934.

ANCYROGNATHUS ALTUS Müller & Müller, 1957

(Pl. 12, fig. 2a, b, c)

1947 *Ancyrognathus irregularis* Branson & Mehl; Youngquist, *J. Paleont.*, 21, 97, pl. 25, fig. 21.

?1948 *Ancyroides ? rudis* Youngquist & Miller, *J. Paleont.*, 22, 442, pl. 68, fig. 19.

1957 *Ancyrognathus alta* Müller & Müller, *J. Paleont.* 31, 1094, pl. 138, fig. 4a-c.

?1957 *Ancyrognathus* aff. *A. alta* Müller & Müller, *ibid.*, 1955, pl. 141, fig. 5.

Material: 2 specimens; CPC 12397 figured, from sample BG 19572, Section 11, northeast of Galeru Gorge, Virgin Hills Formation.

Remarks: The single specimen recovered is badly worn, and only the posterior portion is preserved. The unit is distinguished by the high main and lateral carinae, the complete lack of ornament, and the shagreen-like surface.

Distribution: The species has only been recorded from Iowa (Youngquist, 1947; Youngquist & Miller, 1948; Müller & Müller, 1957).

Range: Unknown but confined to early Late Devonian. The Canning Basin specimen is from the Upper *Palmatolepis gigas* Zone.

ANCYROGNATHUS ASYMMETRICUS (Ulrich & Bassler, 1926)

(Pl. 12, fig. 3a, b, c)

- 1926 *Palmatolepis asymmetrica* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 50, pl. 7, fig. 18.
- ?1938 *Ancyrodella euglypheus* Stauffer, *J. Paleont.*, 12, 418, pl. 53, fig. 18.
- 1947 *Ancyroides princeps* Miller & Youngquist (part), *J. Paleont.*, 21, 505, pl. 75, fig. 2 [non fig. 3 = *A. princeps*].
- 1948 *Ancyroides calvini* Miller & Youngquist; Youngquist & Miller, *J. Paleont.*, 22, 441, pl. 68, fig. 16.
- 1948 *Ancyroides ornatissimus* Youngquist & Miller, *ibid.*, 441, pl. 68, fig. 18.
- 1956 *Ancyrognathus euglypheus* Stauffer; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 120, pl. 8, figs 1-8, 14.
- 1956 *Ancyroides* aff. *A. uddeni* Miller & Youngquist; Müller, *J. Paleont.*, 30, 1340, pl. 145, figs 15-18.
- 1957 *Ancyrognathus euglypheus* Stauffer; Lys, Serre, & Deroo, *Rév. Inst. fr. Pétrole*, 12, 796, pl. 7, fig. 2.
- 1957 *Ancyroides asymmetrica* (Ulrich & Bassler); Müller & Müller, *J. Paleont.*, 31, 1098, pl. 138, figs 8, 9; pl. 141, figs 4, 6, 7.
- 1958 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 45, pl. 10, figs 10, 11.
- 1962 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Ziegler, *N. Jb. Geol. Paläont., Abh.*, 114, 152, text-fig. 6.
- 1962 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Bartenstein & Bischoff in Simon et al., *Leitfossilien der Mikropaläont.*, p. 56, pl. 3, figs 29-32.
- 1962 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Ethington & Furnish, *J. Paleont.*, 36, 1262, pl. 172, fig. 11.
- 1963 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Klapper & Furnish, *Proc. Iowa Acad. Sci.*, 1962, 69, 406, text-fig. 2/6.
- 1965 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Krebs & Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 737, pl. 2, figs 3, 4.
- 1966 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Glenister & Klapper, *J. Paleont.*, 40, 801, pl. 87, figs 1-5.
- 1966 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 10.
- 1966 *Ancyrognathus* sp. Koverdynsky & Zikmundova, *Vestnik U.U.G.*, 41, 369, pl. 1, figs 10a, b.
- ?1967 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Wolska, *Acta palaeont. polon.*, 12, 373, pl. 1, fig. 6a, b.
- 1967 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Boogaert, *Leidse geol. Med.*, 39, 178, pl. 1, figs 2a-c.
- 1968 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Huddle, *U.S. geol. Surv. prof. Pap.* 578, 7, pl. 13, figs 11, 12.
- 1970 *Ancyrognathus asymmetrica* (Ulrich & Bassler); Seddon, *Texas Bur. econ. Geol. Rep. Inv.*, 68, 37, pl. 8, figs 12-14.

Material: 2 specimens; CPC 12396 figured, from sample BG 21614, Section 25, Pinnacle Spring, Virgin Hills Formation.

Description: An elongate and bifid unit, with the blade situated laterally at the anterior end of the platform. The carina merges with the free blade and is curved, formed of low isolated nodes. The lateral process, on the outer posterior margin, bears a carina which joins the main carina at an azygous node. The platform ornament is composed of low round nodes paralleling the main carina, and on the outer side curving to parallel the secondary carina.

In lateral view the carina is very high, sloping anteriorly, with the posterior-most denticle the most massive.

Aborally, the unit is keeled; at about midpoint a small narrow basal cavity is present. A lateral keel fuses with the main keel immediately behind the basal cavity.

Remarks: As was pointed out by Glenister & Klapper (1966, p. 801), *A. princeps* can be distinguished by the convex outer posterior margin.

Occurrence: The species was originally described from the 'Hardin sandstone' of Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). Elsewhere in North America it is extremely widespread in the Upper Devonian of Iowa (Miller & Youngquist, 1947; Youngquist & Miller, 1948; Müller & Müller, 1957; Klapper & Furnish, 1963). It is also known from Ohio (Stauffer, 1938).

A. asymmetricus is also known from Germany (Bischoff, 1956; Ziegler, 1958, 1962; Walliser, 1958; Krebs & Rabien, 1964; Krebs & Ziegler, 1965; Wachendorf, 1966; Bar, 1968; Schneider, 1969), Austria (Schönlaub, 1969a), Czechoslovakia (Koverdynsky & Zikmundova, 1966), France (Lys et al., 1957; Boyer et al., 1968), Poland (Wolska, 1967), Spain (Boogaert, 1967), and Yugoslavia (Spasov, 1966).

Ethington & Furnish (1962) record the species from Spanish Sahara, and Massa (1965) from Algeria. It has also been recorded from the Canning Basin (Müller, 1956b; Glenister & Klapper, 1966). The specimen from Central Queensland (Druce, 1970b) belongs to an earlier species (Mouravieff, pers. comm.).

Range: Ziegler (1958) gives the range of the species in Germany as Upper Devonian (toI δ). Krebs & Rabien (1964) & Ziegler (1962) give the range as Upper *gigas* Zone (toI δ). In France the range is toI γ -upper toI δ (Boyer et al., 1968). The Canning Basin specimens occur in the Upper *Palmatolepis gigas* Zone.

ANCYROGNATHUS IRREGULARIS Branson & Mehl, 1934

Pl. 95, figs 1a-2b)

1934 *Ancyrognathus irregularis* Branson & Mehl, *Univ. Mo. Stud.*, 8, 242, pl. 19, figs 4, 10, 16 only.

1970 *Ancyrognathus irregularis* Branson & Mehl; Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 52, pl. 8, figs 7-10 (Synonymy).

Material: Two specimens, CPC 13805, 13806 figured.

Locality of figured material: Sample BG 21522 (CPC 13805), 1.5 km north of Waggon Pass, Virgin Hills; BG 21571 (CPC 13806), McWhae Ridge, Virgin Hills Formation.

Remarks: Two specimens are referable to *A. irregularis*; one appears to have been damaged on the inner platform margin and to have re-grown (Pl. 95, fig. 2). The other (Pl. 95, fig. 1) appears to be intermediate between *A. asymmetricus* and *A. irregularis*.

Occurrence: The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). It has also been recorded from Tennessee (Hass, 1956) and Texas (Hass, 1959; Seddon, 1970c). Ziegler (1958) figured a specimen from Germany, and Glenister & Klapper (1966) one from the Canning Basin.

Range: The species was originally described from the Grassy Creek Shale, which ranges in age from Frasnian (toI δ) into the Famennian (toIII γ). Seddon (1970c) finds it associated with conodonts indicating the Upper *Palmatolepis gigas* Zone. In the Canning Basin the specimens are from the *Palmatolepis linguiformis* subzone.

Genus ANGULODUS Huddle, 1934

Type species: Angulodus walrathi (Hibbard, 1927).

ANGULODUS sp. cf. *A. PERGRACILIS* (Ulrich & Bassler, 1926)

(Pl. 13, fig. 1a, b)

cf. 1926 *Bryantodus pergracilis* Ulrich & Bassler; *Proc. U.S. nat. Mus.*, 68, 27, pl. 10, fig. 11.

1957 *Angulodus gravis* Huddle; Bischoff & Ziegler (part), *Hess. Landesamt Bodenf., Abh.*, 22, 43, pl. 20, figs 3, 6 only.

cf. 1968 *Angulodus pergracilis* (Ulrich & Bassler); Huddle, *U.S. geol. Surv. prof. Pap.* 578, 8, pl. 2, figs 1, 2.

Material: CPC 12398 figured, from sample BG 19019, Section 1, McWhae Ridge, Virgin Hills Formation.

Description: The unit is short; the anterior bar is about twice as long as the posterior bar. Both are laterally compressed and deep, bearing fine posteriorly inclined denticles which tend to alternate in size. Some of the small ones only just erupt from the oral surface. The apical denticle is offset to the interior and is slightly more massive than most of the bar denticles. The anterior bar is flexed inward through 90° a little way in front of the apical denticle; it narrows distally and is deflected downward, giving the appearance of a hook. The posterior bar is straight, narrowing slightly posteriorly. The backward slope of the dentition increases distally from the apical denticle. The last two denticles are as massive as the apical denticle; aborally a group of small denticles form the characteristic angulodid 'hook'.

Aborally there is no basal cavity, but the bar narrows beneath the apical denticle, which suggests that the cavity might be inverted.

Remarks: The species is extremely close to *Hindeodella brevis* Branson & Mehl, from which it can be distinguished only by the posterior angulodid 'hook'. The offset apical denticle is characteristic of *Plectospathodus*, but the basal cavity is distinctive. The form is very close to *Angulodus flexus* Druce, 1969, from the Lower Carboniferous of the Bonaparte Gulf Basin, the alternating dentition being the only difference. Similar forms are also known from the Middle Devonian (Bischoff & Ziegler, 1957), referred (in part) to *A. gravis* Huddle. The specimen identified as *A. sp.* by Seddon (1969, pl. 1, fig. 7) is also comparable, and the specimen identified by Loranger (1965) as *Hindeodella milleri* Stauffer possibly belongs here. The Canning Basin specimens are from the Middle *Palmatolepis crepida* Zone.

ANGULODUS sp.

(Pl. 13, figs 2a, b; 4a, b)

Material: CPC 12399-400 figured.

Localities of figured material: Sample BG 19115 (CPC 12400), Section 4, north-east of McWhae Ridge, Bugle Gap Limestone; BG 19534 (CPC 12399), Section 9, McPhee Knoll, Virgin Hills Formation.

Description: The unit is small; the bars are of equal size and slightly to strongly flexed, so that the unit is bowed. The apical denticle is offset to the inner side. The denticles are small near the apical denticle, but terminally the dentition

becomes elongate and more posteriorly inclined. On the posterior bar the last two denticles are the most massive; a group of minute denticles is present on the aboral face of the last denticle.

Aborally, there is no basal cavity; beneath the apical denticle the bar becomes thinner and an inverted basal cavity may be present.

Remarks: Small symmetrical angulodid units are known from the Carboniferous of England (*Angulodus* sp. C Rhodes, Austin, & Druce, 1969) and Australia (*A. minutus* Druce, 1969). The present specimens are similar to *A. minutus*, but because of the break in the known occurrence I have preferred to leave the nomenclature open.

Philip (1966a) illustrates a very similar specimen (pl. 3, fig. 2) from the Middle Devonian Moore Creek Limestone; however, the presence of a basal cavity is distinctive and sets this form apart. Philip suggests that his species (*Plectospathodus heterodontatus* Stauffer) is a descendant of the Late Silurian and Early Devonian plectospathodids. The offset apical denticles of the present specimens suggests that they may have evolved from a plectospathodid possibly via *P. heterodontatus* of Philip. The specimens are from the Upper *Palmatolepis quadrantinodosa* Zone.

Genus APATOGNATHUS Branson & Mehl, 1934

Type species: *Apatognathus varians* Branson & Mehl, 1934.

Considerable problems have arisen in the naming of 'tuning fork' arched blades; but they are now resolved. *Apatognathus* is restricted to arched units with the bars and denticulation pointing inward; *Enantiognathus* includes forms with bars and denticulation pointing outward; *Gnamptognathus* is restricted to forms with an additional process.

Varker (1967) discusses some of the taxonomic problems and the probability that the genus is polyphyletic. This view was based on the belief that *Apatognathus* was confined to two horizons, Famennian and Visean. Druce (1969) points out that, although rare, it is known from the Early Carboniferous of Belgium (Conil, 1959) and Great Britain (Rhodes et al., 1969). The earliest occurrence is in the Frasnian.

The ancestry of *Apatognathus* is unknown. Collinson et al. (1962) suggest that homeomorphs could have arisen from *Synprioniodina*. I suggest that *Apatognathus* sp. A developed from *Prioniodina? smithi*. Furthermore, *A. varians* could have developed from forms such as *Ligonodina franconica* Sannemann (see Bischoff, 1956, pl. 10, fig. 22). *Apatognathus* is therefore apparently polyphyletic, although whether it developed separately in the Visean is still in doubt.

APATOGNATHUS VARIANS VARIANS Branson & Mehl, 1934

(Pl. 13, figs 3, 5a, b, 8a-9b)

1934 *Apatognathus varians* Branson & Mehl, *Univ. Mo. Stud.*, 8, 201, pl. 17, figs 1, 2 [*non* pl. 17, fig. 3 = *A. varians klapperi*].

non 1939 *Apatognathus ? varians* Branson & Mehl; Cooper, *J. Paleont.*, 13, 385, pl. 47, fig. 30.

- 1956 *Apatognathus varians* Branson & Mehl; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 84, 145, pl. 14, fig. 3.
- 1958 *Apatognathus varians* Branson & Mehl; Klapper, *J. Paleont.*, 32, 1085, pl. 141, fig. 6.
- 1961 *Apatognathus varians* Branson & Mehl; Ethington, Furnish, & Wingert, *J. Paleont.*, 35, 763, pl. 90, fig. 11.
- non 1961 *Apatognathus varians* Branson & Mehl; Freyer, *Freib. Forsch.*, C-95, 36, pl. 1, fig. 13 [= *Gnamptognathus? lipperti*].
- 1965 *Apatognathus varians* Branson & Mehl; Ethington, *J. Paleont.*, 39, 571.
- non 1965 *Apatognathus varians* Branson & Mehl; Spasov, *Trav. géol. Bulg.*, Sér. paléont., 7, 84, pl. 1, fig. 3 [= *Gnamptognathus? lipperti*].
- 1966 *Apatognathus varians* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, 803, pl. 96, figs 14, 15 [non fig. 16 = *A. sp. nov. A. Druce*].
- 1966 *Apatognathus varians* Branson & Mehl; Klapper, *Univ. Kansas paleont. Contr. Pap.* 3, 28, pl. 6, figs 13, 14 [non fig. 12 = *A. varians klapperi*].
- 1967 *Apatognathus varians* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 31, pl. 2, fig. 1.
- 1968 *Apatognathus varians* Branson & Mehl; Mound, *J. Paleont.*, 42, 474, pl. 65, fig. 49.
- 1969 *Apatognathus varians* Branson & Mehl; Rhodes, Austin, & Druce, *Bull. Brit. Mus. nat. Hist. (Geol.) Suppl.* 5, 75, pl. 20, figs 5a, b.
- 1969 *Apatognathus varians varians* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 42, pl. 1, figs 16a, b.
- 1969 *Apatognathus varians ethingtoni* Druce, *ibid.*, 43, pl. 1, figs 12a, b, 15, text-fig. 10.

Material: 15 specimens; CPC 12573, 12613, 12719, 12681 figured, from samples BG 19105 (CPC 12681), 19138 (CPC 12719), 19152 (CPC 12573), 19158 (CPC 12613), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: An apatognathid with subequal slender bars. Each bar bears long slender denticles arranged in groups of three en echelon, and each denticle of the trio decreases in size toward the bar terminations. The denticles curve inwards in some specimens by as much as 90°.

The apical denticle is elongate and slender, with a fine costa along each lateral face. It curves inward through about 90°. Subapically, a small basal cavity is developed and on the outer side a wide fringe is present. The separation of the bars varies from subparallel to 30°. The bars also vary considerably in length and width.

Remarks: Druce (1969) erected two new subspecies of *A. varians*. The distinction between the nominate subspecies and *A. varians ethingtoni* was that the former had subparallel shallow bars whereas the latter had deep bars diverging at 20°-30°. I now consider that this is within the range of variability of the nominate subspecies and have placed *A. varians ethingtoni* in synonymy. The second subspecies, *A. varians klapperi*, I consider to be valid.

Distribution: The species was originally described from the Upper Devonian Grassy Creek Shale of Missouri. Elsewhere in North America it has been reported from Wyoming (Ethington, Furnish, & Wingert, 1961; Klapper, 1958), Nevada and Utah (Clark & Ethington, 1967), South Dakota (Klapper & Furnish, 1962; Klapper, 1966) and Alberta (Mound, 1968).

The species is less common in Europe, being reported from the Upper Devonian of Germany (Bischoff & Ziegler, 1956) and the Lower Carboniferous of Great Britain (Rhodes et al., 1969).

In Australia the species is known from the Canning Basin (Glenister & Klapper, 1966) and the Bonaparte Gulf Basin (Druce, 1969) in strata of Famennian age.

Range: In North America the species is recorded from strata correlated with the toV-toVI interval (Collinson et al., 1962; Klapper, 1966) and also in strata equivalent to toII β -toIII α in Canada (Mound, 1968).

In Germany the species was recognized from the toV Zone (Bischoff & Ziegler, 1956) and cuIII β (Bischoff, 1957); in Britain from the Lower Carboniferous Z Zone (? = cuII α). Conil (1959) has reported the species from the tnI Zone of Belgium.

The Canning Basin specimens range from the Upper *P. crepida* Zone (toII α) up to the *Spathognathodus costatus* Zone (toVI) (Glenister & Klapper, 1966; Klapper, 1966). In the Bonaparte Gulf Basin it occurs in strata equivalent to the toII β -toVI interval. The range of the species would appear to be Late Devonian (toII α -toVI) and questionably into the Carboniferous (cuII α).

APATOGNATHUS VARIANS KLAPPERI Druce, 1969

(Pl. 13, figs 6a-7b)

1966 *Apatognathus varians* Branson & Mehl; Klapper, *Univ. Kansas paleont. Contr. Pap.* 3, 28, pl. 6, fig. 12 [non figs 13, 14 = *A. varians* s.s.].

1969 *Apatognathus varians klapperi* Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 44, pl. 1, figs 13a-14, text-fig. 11.

Material: 5 specimens; CPC 12682, 12744 figured, from sample BG 19113 (CPC 12682), 19160 (CPC 12744), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: This subspecies lacks the well developed en echelon arrangement of bar denticles characteristic of the nominate subspecies (Ethington et al., 1961; Druce, 1969). Perhaps, therefore, it should be regarded as a separate species, because of the distinctive bi- or tricuspid apical area.

Distribution: Bi- or tricuspid varieties of *A. varians* have been reported from Wyoming and South Dakota (Ethington et al., 1961; Klapper & Furnish, 1962; Klapper, 1966). The subspecies was originally described from the Bonaparte Gulf Basin of Australia (Druce, 1969).

Range: In the Bonaparte Gulf the subspecies is present in faunas with an age range of toII β -toVI. The Canning Basin specimens range from the Upper *Palmatolepis quadrantinodosa* Zone (toIII α) up to the Lower *Polygnathus styriacus* Zone (toIV).

APATOGNATHUS sp. A Druce, 1969

1966 *Apatognathus varians* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, pl. 96, fig. 16 only.

1969 *Apatognathus* sp. nov. A, Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 46, pl. 1, figs 11a, b; text-fig. 12.

Material: A single specimen from sample BG 19109, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: Druce (1969, p. 46) points out that this form cannot be placed in any known species. The species is left in open nomenclature because only one further specimen has been found.

Distribution: The species is known only from Australia, being present in both the Canning and the Bonaparte Gulf Basins.

Range: Unknown, but appears to be confined to the early Famennian. The Canning Basin specimen is from the Upper *Palmatolepis quadrantinodosa* Zone.

APATOGNATHUS sp. nov. B

Material: 5 specimens.

Description: An asymmetrical apatognathid with bars diverging at 90°. If the anterior bar is oriented vertically, the apical denticle is then vertical and the posterior bar horizontal. The dentition is fine and the denticulation increases its inclination terminally, although the denticles incline toward the apical denticle.

The bar dentition runs onto the lateral faces of the apical denticle.

Remarks: This species probably developed from *Prioniodina? smithi* by enlargement of the anterior dentition. A closely similar form is illustrated by Ziegler (1962, pl. 12, fig. 8) and referred to *Falcodus* n. sp. The Canning Basin specimens range from the Upper *Polygnathus asymmetricus* Zone (toI β) to the Upper *Palmatolepis quadrantinodosa* Zone (toIII α).

Genus BELODELLA Ethington, 1959

Type Species: *Belodus devonicus* Stauffer, 1940.

After much initial doubt, the presence of simple cones in the Devonian is now accepted by most authors. The homeomorphic development of posteriorly denticulate cones in the Devonian was recognized by Ethington (1959), who referred them to the genus *Belodella*.

Recently, Lange (1968) has shown that the skeleton of the belodellid-bearing conodontifer may have been composed solely of that genus; Seddon (1970d) points out that the genus has a restricted facies distribution and is common in near-reef limestones. This distribution has also been observed by Krebs (1959, p. 378, and pers. comm.), Müller (1962b), and Massa (1965), who recorded near-reef rocks of Emsian age in Morocco yielding faunas containing up to 10% *Belodella triangularis*. In a limestone lens in a volcanic sequence of Middle Devonian age near Mount Morgan, Central Queensland, I have recovered a large fauna composed solely of belodellids.

BELODELLA COSTATA Druce, 1970

?1964 *Belodus* [sic] *triangularis* Stauffer; Budurov & Tschunev (part), *Bull. Inst. Sci. Rech. Géol.*, 1, 258, pl. 1, fig. 4 [non fig. 2 = *B. triangularis*].

1970 *Belodella costatus* Druce, *Bur. Miner. Resour. Aust. Bull.* 108, 78, pl. 12, figs 1a-3c.

Material: 6 specimens.

Remarks: These specimens agree closely with the specimens from Queensland.

Distribution: Apart from a questionable occurrence in Bulgaria, the species is only known from Australia.

Range: The Queensland specimens are from the Frasnian, probably toI α (Mouravieff, pers. comm.). The present specimens are from the Lower and/or Middle *Polygnathus asymmetricus* Zone.

BELODELLA DEVONICA (Stauffer, 1940)

(Pl. 14, fig. 11a, b)

- 1940 *Belodus devonicus* Stauffer, *J. Paleont.*, 14, 420, pl. 59, figs 47, 48.
1956 *Belodus* sp. Dineley & Rhodes, *Geol. Mag.*, 93, 245, text-fig. 15.
1961 *Belodus devonicus* Stauffer; Freyer, *Freib. Forsch.*, C-95; 37, text-fig. 16.
1966 *Belodella devonicus* (Stauffer); Clark & Ethington, *J. Paleont.*, 40, 677, pl. 82, figs 8, 9.
1968 *Belodella devonica* (Stauffer); Lange, *Geol. Paleont.*, 2, 42, pl. 5, figs 1-9.

Material: 5 specimens; CPC 12723 figured, from sample BG 19588, Section 13, Glenister Knolls, Gogo Formation.

Description: A slim erect unit with a small main denticle. The base is narrow and elongate, elliptical in cross-section; the apex of the cavity is below the point of recurvature. The posterior margin bears a sequence of fine needle-like denticles which extend along the posterior margin of the main denticle. The lateral faces of the apical denticle bear low costae.

Remarks: *B. devonica* appears to be ancestral to the other belodellids; it is simple in plan and lacks anterior flanges and strong lateral costae. Lange (1968) illustrated nine specimens associated together in a bituminous blob, which he suggested might be a coprolitic association. There is a distinct possibility that it is also an original association.

Distribution: The species was originally described from the Devonian and associated clays of Minnesota (Stauffer, 1940). It has also been recorded from Lower Devonian rocks in Nevada (Clark & Ethington, 1966) and Upper Devonian of Alberta (Pollock, 1968).

In Europe the species has been reported from the Upper Devonian of Germany (Freyer, 1961; Lange, 1968) and illustrated from the Middle Devonian of England (Dineley & Rhodes, 1956). It has also been recorded from the Lower Devonian of Austria (Schönlaub, 1969a), and Bulgaria (Budurov & Tschunev, 1964).

Range: The species is known from Lower Devonian strata (Clark & Ethington, 1966) and also as high as the uppermost Frasnian (Freyer, 1961). The Canning Basin specimens are from the *Polygnathus asymmetricus* Zone.

BELODELLA ERECTA (Rhodes & Dineley, 1957)

- 1957 *Belodus erectus* Rhodes & Dineley, *J. Paleont.*, 31, 359, pl. 38, fig. 8.
1958 *Belodus triangularis* Stauffer; Bischoff & Sannemann, *Hess. Landesamt Bodenf., Notizbl.*, 86, 94, pl. 15, figs 8, 9.
1964 *Belodus* n. sp. ? Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, 253, pl. 1, fig. 5.

Material: 2 specimens from sample BG 19036, Section 2, McWhae Ridge, Sadler Limestone.

Description: A slightly recurved unit with an elongate main denticle. The posterior dentition is fine and small and does not appear on the posterior margin of the apical denticle. The basal cavity is deep and extends beyond the point of recurvature. The unit is elliptical in cross-section and lacks any well developed costae or knife edges.

Remarks: *B. erecta* is closely related to *B. devonica*, having the same cross-section. However, it is more erect and has a longer apical denticle.

Distribution: Previously the species was unrecorded outside Europe. It was initially described from the Devonian limestone of Devon, England (Rhodes & Dineley, 1957). Forms considered to belong to it have been illustrated from the Lower Devonian of the Frankenwald, Germany (Bischoff & Sannemann, 1958). The only other references to the species are from the Upper Devonian of the Vogtlande, Germany (Freyer, 1961), and the Lower Devonian of Northwest Bulgaria (Budurov & Tschunev, 1964).

Range: Rhodes & Dineley (1957) considered their faunas to be Late Devonian, although they note that typical Frasnian genera such as *Ancyrodella*, *Ancyrognathus*, *Palmatolepis*, and *Icriodus* are absent. From the presence of *Polygnathus linguiformis*, *P. varcus*, and *P. xylus*, it is probable that the fauna is of late Middle Devonian age. The German specimens come from the Early Devonian and the youngest Frasnian (toI δ). The range of the species is Early Devonian to latest Frasnian. The Canning Basin specimens are from the Lower and/or Middle *Polygnathus asymmetricus* Zone (toI α).

BELODELLA RESIMA (Philip, 1965)

(Pl. 13, figs 7a-10b, 12a, b)

1965 *Belodus resimus* Philip, *Proc. Roy. Soc. Vic.* 79, 98, pl. 8, figs 15-17, 19; text-fig. 2e-f.

1970 *Belodella resima* Philip; Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 14, figs 13, 17.

Material: 92 specimens, CPC 12720, 13808-11 figured.

Localities of figured material: Samples BG 19462 (CPC 12720), 19463 (CPC 13808), 19465 (CPC 13809), 19474 (CPC 13810), Section 5, Lloyd Hill, Sadler Limestone; BG 19490 (CPC 13811), Section 6, Lloyd Hill-Laidlaw Range, Sadler Limestone.

Description: Unit variable; the base varies from triangular to elongate with sub-parallel anterior and posterior edges. The main denticle is recurved; in some specimens it is as long as the posterior denticles; in others nearly as long as the base. The posterior dentition varies from peg-like isolated denticles to fine, needle-like, fused denticles of unequal length. In some specimens the dentition extends along the main denticle, either the lateral or posterior face.

The anterior margin is diagnostic; on one or both edges a distinct costa is developed. This tends to become deeper apically and sometimes runs along the lateral faces of the main denticle. The basal cavity is very deep and extends to just beyond the point of recurvature. In the forms with very small main denticles the cavity occupies nearly the whole unit.

Remarks: *B. resima* is probably ancestral to *B. triangularis* and developed from *B. devonica* with the addition of the flanges to the anterior margin.

Distribution: Apart from two occurrences in Australia, in the Lower Devonian of Victoria (Philip, 1965) and the Frasnian of the Canning Basin (Seddon, 1970a) the species has only been recorded from Austria (Schönlaub, 1969a).

Range: Philip records the species in the Early Devonian and Seddon records it from toI α -toI γ strata in the Canning Basin. My specimens range from the *Polygnathus asymmetricus* Zone (toI α /I β) to the Middle *Palmatolepis crepida* Zone (toII α).

BELODELLA TRIANGULARIS (Stauffer, 1940)

(Pl. 14, figs 3a-6b)

- 1940 *Belodus triangularis* Stauffer, *J. Paleont.*, 14, 420, pl. 59, fig. 49.
 1957 *Belodus triangularis* Stauffer; Rhodes & Dineley, *J. Paleont.*, 31, pl. 37, fig. 2 only [fig. 1 = ? *B. erecta*].
 non 1958 *Belodus triangularis* Stauffer; Bischoff & Sannemann, *Hess. Landesamt Bodenf., Notizbl.*, 86, 94, pl. 15, figs 8, 9 [= *B. erecta*].
 1959 *Belodus triangularis* Stauffer; Panseri & Barsotti, *Notas Comm. Inst. Geol. Min. Espana*, 55, 154, pl. 2, fig. 6.
 1961 *Belodus triangularis* Stauffer; Freyer, *Freib. Forsch.*, C95, 37, text-fig. 17.
 1961 *Belodus triangularis* Stauffer; Budurov, *Rev. Bulg. geol. Soc.*, 22, 261, pl. 3, fig. 7.
 ?1961 *Belodus triangularis* Stauffer; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 544, pl. 1, fig. 4.
 1964 *Belodus triangularis* Stauffer; Budurov & Tschunev, *Rév. Inst. Sci. Géol.*, 1, 253, pl. 1, fig. 2 [fig. 4 = ? *B. striatus*].
 1965 *Belodus cf. triangularis* Stauffer; Philip, *Proc. Roy. Soc. Vic.*, 79, 99, pl. 8, figs 22, 26-28; text-fig. 2c-d.
 1965 *Belodella triangularis* (Stauffer); Merrill, *Texas J. Sci.*, 7, 369, pl. 3, figs 11, 13.
 1966 *Belodella triangularis* (Stauffer); Clark & Ethington, *J. Paleont.*, 40, 677, pl. 82, figs 1, 7.
 ?1968 *Belodella triangularis* (Stauffer); Schulze, *N. Jb. Geol. Paläont., Abh.*, 130, 185, pl. 16, fig. 14 [? = *B. resima*].
 1968 *Belodella triangularis* (Stauffer); Mound, *J. Paleont.*, 42, 475, pl. 65, fig. 32.
 ?1968a *Belodella triangularis* (Stauffer); Durdanovic, *Geol. Vjesnik*, 21, 86, pl. 1, figs 4, 5.
 ?1968b *Belodella triangularis* (Stauffer); Durdanovic, *ibid.*, 95, pl. 1, fig. 1.
 1970 *Belodella triangularis* (Stauffer); Seddon, *Texas Bur. econ. Geol. Rep. Inv.* 68, 84, pl. 2, fig. 16.

Material: 9 specimens, CPC 13812-5 figured.

Localities of figured materials Samples BG 19467 (CPC 13812), 19473 (CPC 13813), 19481 (CPC 13814), Section 5, Lloyd Hill, Sadler Limestone; BG 19533 (CPC 13815), McPhee Knoll, Virgin Hills Formation.

Description: A simple cone unit with a greatly recurved main denticle which lies at nearly 90° to the base. The base is completely excavated by a large pyramidal basal cavity which extends nearly to the point of recurvature. The basal cavity sometimes contains greyish white basal 'bone' material which exhibits interference colours. In cross-section the unit is triangular; the posterior edge bears a row of very fine, short, needle-like denticles crowded together. The anterior edges are usually dissimilar, one being rounded, the other knife-edged. The cross-section is sometimes an equilateral triangle. The dentition does not extend onto the main denticle; in some specimens the dentition terminates on the lateral face.

Remarks: *B. triangularis* is easily distinguishable by its triangular cross-section. *B. resima* has knife-edged costae on its posterior face and is sub-triangular in cross-section (see Philip, 1965, text-fig. 2). *B. triangularis* probably developed from *B. resima* by inflation of the unit.

Distribution: *B. triangularis* is the most widely distributed belodellid. It was originally described from the Devonian clays of Minnesota (Stauffer, 1940). Other occurrences in North America are rare. It has been reported from early Devonian fissure fillings in both the Burnham Limestone (Ordovician) (Merrill, 1965) and Pillar Bluff Limestone (Lower Devonian) of Texas (Seddon, 1970c); from the Lower Devonian of Nevada (Clark & Ethington, 1966) and the Upper Devonian (Frasnian) of Alberta (Pollock, 1968; Mound, 1968). The unidentified species noted by Orr (1964) from the early Upper Devonian of Illinois may belong to *B. triangularis*.

In Europe the species has been recorded from the Lower Devonian of Austria (Schulze, 1968; Schönlaub, 1969a); the Lower and Middle Devonian of Bulgaria (Budurov, 1961; Budurov & Tschunev, 1964); the Middle Devonian of England (Rhodes & Dineley, 1957); from the Upper Devonian of France (Lys et al., 1961; Boyer et al., 1968); from the Silurian-Devonian boundary as high as the toI Zone of the Upper Devonian in Germany (Freyer, 1961; Schriel & Stoppel, 1965; Zitzmann, 1966, 1968); from the Middle Devonian of Roumania (Mirauta & Mirauta, 1964); and the Lower Devonian of Yugoslavia (Durdanovic, 1968a, b).

Elsewhere, it has been recorded from the Middle Devonian of Spanish Sahara (Panseri & Barsotti, 1959); the Middle Devonian of Afghanistan (Weippert & Wittekindt, 1964); and, in Australia, the Lower Devonian of Victoria (Philip, 1965) and Queensland (Druce, 1970a), and the Upper Devonian (toIa) of the Canning Basin (Seddon, 1970a).

Range: The species is found in Lower, Middle, and Upper Devonian strata. Its earliest occurrence is near the Silurian-Devonian boundary and its latest in the Late Devonian (toI Zone). The present specimens are from the Lower and/or Middle *Polygnathus asymmetricus* Zone.

Genus BRYANTODUS Bassler, 1925

Type species: *Bryantodus typicus* Ulrich & Bassler, 1926

BRYANTODUS MACRODENTUS (Bryant, 1921)

(Pl. 15, figs 1a-4)

1921 *Prioniodus macrodentatus* Bryant, *Bull. Buffalo Soc. nat. Sci.* 13, 18, pl. 8, fig. 10.

1957 *Bryantodus macrodentatus* (Bryant); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 49, pl. 21, fig. 17.

non 1968 *Bryantodus macrodentatus* (Bryant); Mound, *J. Paleont.*, 42, 479, pl. 65, figs 45, 47 [= *B. typicus*].

Material: 7 specimens, CPC 12905, 13816-8 figured.

Localities of figured material: Samples BG 19104 (CPC 12905), 19105 (CPC 13816), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone; BG 19543 (CPC 13817), Section 9, McPhee Knoll, Gogo Formation; BG 19598 (CPC 13818), Glenister Knolls, Gogo Formation.

Description: An arched unit with distinctive dentition. The bar is tumid, with ledges on one or both sides. The dentition consists of laterally compressed fused denticles; the anterior bar denticles are high and massive, often formed by the fusion of several denticles; the posterior denticles are small and decrease in size posteriorly. The basal cavity is small and extends farther laterally on the outer than on the inner side. The unit is keeled over its whole length.

Remarks: The species is of variable length. Short forms resemble, and perhaps belong in, *B. petilus* Youngquist & Miller; but if length is only an intraspecific variation, *B. petilus* is a junior synonym of *B. macrodentus*.

Distribution: The species has been reported from the Upper Devonian of New York (Bryant, 1921) and from the upper Middle Devonian of Germany (Bischoff & Ziegler, 1957).

Range: The species ranges from the latest Givetian (Bischoff & Ziegler, 1957) into the Frasnian (Bryant, 1921). The Canning Basin specimens range from the Middle *Polygnathus asymmetricus* Zone (to Ia) to the Lower *Palmatolepis quadrantinodosa* Zone (to II β).

BRYANTODUS NITIDUS Ulrich & Bassler, 1926

(Pl. 16, figs 1a-4b; Pl. 17, figs 1a-2)

1926 *Bryantodus nitidus* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 24, pl. 4, fig. 8 only.

1968 *Bryantodus nitidus* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 10, pl. 2, figs 8-16 (Synonymy).

Material: 48 specimens, CPC 12906, 12575, 13819-22 figured.

Localities of figured material: Sample BG 19072 (CPC 12906), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 19482 (CPC 13819), Section 6, Lloyd Hill-Laidlaw Range, Gogo Formation; BG 19495 (CPC 13820), Section 7, Laidlaw Range-Emanuel Range, Sadler Limestone; BG 19547 (CPC 13821), Section 9, McPhee Knoll, Virgin Hills Formation; BG 19582 (CPC 13822), BG 19584 (CPC 12575), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Description: An arched unit with a tumid base. The basal expansion occurs mainly on the inner face, and sometimes (Pl. 16, fig. 1a) this ledge bears low nodes. The apical denticle is near the midpoint of the unit and is twice as high and wide as the bar denticles. The anterior bar denticles are larger than the posterior; they are all posteriorly inclined, laterally compressed and fused, with free chevron tips.

Beneath the apical denticle is a subovate basal cavity, which is sometimes situated rather on the outer side than truly medial. The whole unit is keeled and the aboral outline arches through about 45°.

Remarks: The species is highly variable, but is characterized by the large main denticle and a platform on the inner side. I consider that presence or lack of ornamentation on the platform and the flaring of the basal cavity lips are within the range of variation of the species. Development of a strong platform on the other side gives rise to *Polygnathellus germanus*.

Distribution: *B. nitidus* and its junior synonyms have been reported extensively from New York (Ulrich & Bassler, 1926; Youngquist, Hibbard & Reimann, 1948), Ohio (Stauffer, 1938; Bond, 1947), and Indiana (Huddle, 1934).

In Europe the species is known from Germany (Sannemann, 1955b; Bischoff, 1957; Freyer, 1961; Stoppel, 1958; Stoppel & Zscheke, 1966; Zitzmann, 1966), Austria (Schönlaub, 1969a), Poland (Freyer & Zakowa, 1967), and Italy (Manzoni, 1965).

Range: The species appears to range throughout the Late Devonian. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone to the Upper *Palmatolepis crepida* Zone.

BRYANTODUS TYPICUS Bassler, 1925

(Pl. 17, figs 3-5b)

- 1925 *Bryantodus typicus* Bassler, *Bull. geol. Soc. Am.*, 36, 219.
1926 *Bryantodus typicus* Bassler; Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 21, pl. 6, figs 11, 12.

For complete synonymy of Ulrich & Bassler's specimens see:

- 1968 *Bryantodus typicus* Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 11, pl. 3, figs 1-15; pl. 4, figs 12-15.

I consider the following to be junior synonyms:

- 1934 *Bryantodus attenuatus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 219, pl. 16, fig. 4.
1938 *Bryantodus andersonensis* Stauffer, *J. Paleont.*, 12, 419, pl. 49, fig. 17.
1938 *Bryantodus bryanti* Stauffer, *ibid.*, 420, pl. 49, fig. 18.
1938 *Bryantodus nobilis* Stauffer, *ibid.*, 422, pl. 49, fig. 14.
1947 *Bryantodus iowaensis* Youngquist, *J. Paleont.*, 21, 98, pl. 24, fig. 18.
1947 *Bryantodus machaerodus* Youngquist, *ibid.*, 98, pl. 26, fig. 5.
1947 *Bryantodus flabellatus* Miller & Youngquist, *J. Paleont.*, 21, 506, pl. 73, fig. 23.
1948 *Bryantodus flabellatus* Miller & Youngquist; Youngquist & Miller, *J. Paleont.*, 22, 443, pl. 67, fig. 21.
1948 *Bryantodus nitens* Youngquist & Miller, *ibid.*, 444, pl. 68, fig. 1.
1956 *Bryantodus dignatus* Stauffer; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 122, pl. 10, fig. 6 only.
1957 *Bryantodus* cf. *radiatus* (Hinde) (Exempl. B); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 52, pl. 19, fig. 41a, b.
1959 *Bryantodus* sp. Panseri & Barsotti, *Not. Com. Inst. Geol. Min. Espana*, 55, 155, pl. 2, fig. 5.
1962 *Bryantodus dignatus* Stauffer; Ethington & Furnish, *J. Paleont.*, 36, 1265, pl. 173, fig. 18.
1968 *Bryantodus dignatus* Stauffer; Mound, *J. Paleont.*, 42, 478, pl. 65, fig. 41.
1968 *Bryantodus macrodentus* (Bryant); Mound, *ibid.*, 479, pl. 65, figs 45, 47.

Material: 5 specimens, CPC 12907, 13823, 13824 figured.

Localities of figured material: Sample BG 19547 (CPC 12907), Section 9, McPhee Knoll, Virgin Hills Formation; BG 19580 (CPC 13623), BG 19584 (CPC 13824), Section 12, southeast of Waggon Pass, Virgin Hills Formation.

Description: An arched blade unit with a tumid bar. The bar is expanded on the inner side to give a narrow ledge which widens at the apical denticle to a triangular lip. The blade is formed of laterally compressed fused denticles with free chevron tips. The apical denticle is larger and wider than the bar denticles and lies about one-third to half the distance from the posterior termination.

Beneath the apical denticle is a basal cavity which may be slightly flared beneath the inner projecting lip.

Remarks: Huddle (1968, p. 10) points out that the genus *Bryantodus* needs a complete revision. Many species have been erected on minor variations and it is difficult to draw any significant specific boundaries. I have considered that species with an extended lip on the inner apical face all belong in *B. typicus* and that variations in dentition are not specifically distinctive. *Bryantodus radiatus* (Bryant) may be a senior synonym.

Distribution: The species placed in synonymy with *B. typicus* are known from New York (Ulrich & Bassler, 1926; Huddle, 1968), Ohio (Stauffer, 1938), Iowa (Youngquist, 1947; Miller & Youngquist, 1947; Youngquist & Miller, 1948), and Missouri (Branson & Mehl, 1934). The species is also present in Alberta (Mound, 1968).

In Europe *B. typica* has been recorded from Germany (Bischoff, 1956; Bischoff & Ziegler, 1957) and in Africa from Spanish Sahara (Panseri & Barsotti, 1959; Ethington & Furnish, 1962).

Range: The species appears to be confined to the Frasnian. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toIa) to the Lower *Palmatolepis gigas* Zone (toI₇).

Genus CAMPTOGNATHUS Pollock, 1968

Type species: *Camptognathus conus* Pollock, 1968.

CAMPTOGNATHUS CONUS Pollock, 1968

(Pl. 18, figs 1a-3)

- ?1957 *Falcodus* sp. c Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 56, pl. 19, fig. 32.
?1964 *Prioniodina smithi* (Stauffer) (sic); Budurov & Tschunев, *Bull. Inst. Sci. Rech. Géol.*, 1, 256, pl. 4, fig. 15.
?1965 *Angulodus bidentatus* Sannemann; Spasov, *Trav. Géol. Bulg., Ser. paléont.*, 7, 83, pl. 1, figs 1, 2.
1968 *Camptognathus conus* Pollock, *J. Paleont.*, 42, 429, pl. 61, figs 23-25.

Material: 3 specimens, CPC 12908, 13825, 13826 figured.

Localities of figured material: Sample BG 19547 (CPC 12908, 13825), Section 9, McPhee Knoll, Virgin Hills Formation; BG 21253 (CPC 13826), Longs Well Creek, near Sadler Ridge, Gogo Formation.

Description: A bar unit with the anterior bar deflected downward through about 90°. Both bars are deep, have a distinctive granular surface, and bear fine needle-like denticles inclined posteriorly. The anterior bar is about half the length of the posterior bar and the denticles decrease in height anteriorly, whereas the posterior bar dentition is even. There is no really distinctive apical denticle except in one specimen (Pl. 18, fig. 3), but a group of slightly taller denticles are conspicuously recurved posteriorly.

Immediately above the aboral edge both sides of the unit carry a narrow flange; it extends along both bars to their terminations.

The basal cavity is a distinctive cone-shape; the apex is beneath the denticle situated at the point of flexure.

Remarks: Pollock (1968, p. 429) points out that *Camptognathus* can be distinguished from *Falcodus* by the cone-like cavity, a feature which also distinguishes it from *Dinodus*. Specimens illustrated by Bischoff & Ziegler (1957), Budurov & Tschunев (1964), and Spasov (1965) have a similar morphology, but it is impossible to tell whether the basal cavity is cone-like. *Falcodus secundus* Youngquist is also very similar, but appears to lack the cone-like cavity. It is possible that *Camptognathus* is ancestral to *Dinodus* of the Early Carboniferous.

Distribution and Range: Pollock (1968) records the species from the lower Frasnian of Alberta, Canada. The other previously described specimens which I have tentatively included in this species also appear to be of Frasnian age. The Canning Basin specimens are confined to the *Polygnathus asymmetricus* Zone (toIa-toI_β).

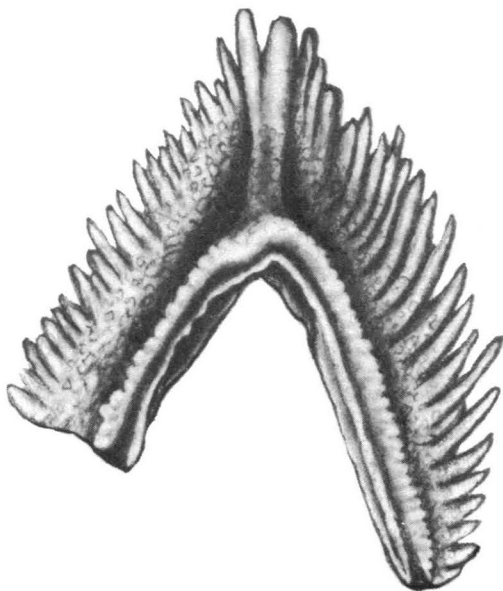


Fig. 16. *Camptognathus* sp. nov. A, specimen CPC 12909, lateral view, x60.

CAMPTOGNATHUS sp. nov. A
(Pl. 18, figs 5a-6; text-fig. 16)

Material: 3 specimens; CPC 12909, 13827 figured, from sample BG 19547, Section 9, McPhee Knoll, Virgin Hills Formation.

Description: A unit composed of two bars of subequal length, arched through 135° and with a granular surface. The dentition consists of fine needle-like denticles inclined towards the apex on both bars; at the apex there is a group of taller denticles but no distinctive apical denticle.

A narrow ledge is present on both sides of both bars immediately above the aboral keel. At the apex a ridge on the inner lateral face extends to the base of the apical group of denticles, where it meets the aboral ledge; the bar is thickened at this point and the ledge is bowed out.

The basal cavity is cone-shaped and is present beneath the inner lateral ridge. Narrow troughs run along the keels.

Remarks: In the type species, *C. conus*, the dentition on both bars is posteriorly inclined. In *C. sp. nov. A* the dentition on each bar is inclined toward the apex of the unit. The present specimens are very close to the *Roundya*-element of the presumed natural species *Elsonella rhenana* Lindström & Ziegler but lack the posterior bar. They are also similar to *Dinodus youngquisti* Klapper. *Dinodus* cf. *D. wilsoni* Druce lacks a posterior bar and has similar dentition, but lacks the cone-like basal cavity.

Lindström & Ziegler (1965) described a presumed natural species from the Middle-Late Devonian boundary distinguished by the pitted and granular nature of the surface. It contained forms similar to the two species of *Camptognathus* in these faunas. Pollock (1968) reports that in the lowest Upper Devonian of Alberta, Canada, forms with similar pitted surfaces are present and, although they vary in

generic designation, their broad morphological features are very similar. In the present faunas the two camptognathid species would probably correspond to the *Falcodus*-element. The only other form with a granular and pitted surface is *Falcodus guntharii* Ziegler, which is known from a single specimen from a different locality. It could correspond to the *Oulodus*-element.

Range: The specimens come from the Middle and Upper *Polygnathus asymmetricus* Zones (toI α -toI β).

Genus DREPANODUS Pander, 1856

Type species: *Drepanodus arcuatus* Pander, 1856.

DREPANODUS sp.

(Pl. 28, figs 5, 6)

Material: 14 specimens; CPC 12853, 12854 figured.

Localities of figured material: Sample BG 19462 (CPC 12853), Section 5, Lloyd Hill, Sadler Limestone; BG 21218 (CPC 12854), Section 19, Sadler Ridge, Sadler Limestone.

Remarks: The unit is recurved and laterally compressed. The basal cavity is very deep, reaching to the point of recurvature. The anterior margin is slightly wider than the knife-edged posterior margin. The species bears a distinct resemblance to early Tremadocian oneotodids.

Range: The Canning Basin specimens come from the Lower and/or Middle *Polygnathus asymmetricus* Zone.

Genus ELSONELLA Youngquist, 1945

Type species: *Elsonella prima* Youngquist, 1945.

ELSONELLA sp.

(Pl. 19, figs 6a-8)

Material: 3 specimens; CPC 12913, 13828, 13829 figured, from samples BG 19062 (CPC 12913), 19105 (CPC 13828), 19107 (CPC 13829), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Description: A small symmetrical arched unit with short bars bearing up to six even needle-like denticles. Some denticles are fused; they tend to be tallest near the bar terminations, and the apical denticle is only slightly taller.

A minute basal cavity, opening on the posterior side, is present beneath the apical denticle.

Remarks: The specimens are obviously very close to the genus *Falcodus*, having the same dentition and basal cavity. However, their symmetry places them in *Elsonella*, even though the bars are not depressed to the usual extent.

Range: The species ranges from the *Ancyrognathus triangularis* Zone (toI γ) to the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

Genus ENANTIOGNATHUS Mosher & Clark, 1965

Type species: Apatognathus inversa Sannemann, 1955.

ENANTIOGNATHUS LIPPERTI (Bischoff, 1956)

(Pl. 19, figs 1a-4b, 9)

- 1956 *Apatognathus lipperti* Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 121, pl. 9, figs 27, 31.
1956 *Apatognathus lipperti* Bischoff; Bischoff & Ziegler, *ibid.*, pl. 14, figs 1, 2.
1957 *Apatognathus lipperti* Bischoff; Lys, Serre, & Deroo, *Rév. Inst. fr. Pétrole*, 12, 1040, pl. 1, fig. 4.
1957 *Apatognathus* cf. *A. lipperti* Bischoff; Lys, Serre, & Deroo, *ibid.*, 797, pl. 7, fig. 7.
1958 *Apatognathus lipperti* Bischoff; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, pl. 12, figs 10, 22.
1959 *Apatognathus lipperti* Bischoff; Helms, *Geologie*, 8, 665, pl. 1, fig. 16.
1961 *Apatognathus lipperti* Bischoff; Scott & Collinson, *Kansas geol. Soc., Guidebook*, 26th Ann. Conf., pl. 10, fig. 2.
1962 *Apatognathus lipperti* Bischoff; Ethington & Furnish, *J. Paleont.*, 36, 1264, pl. 173, fig. 16.
1965 *Enantiognathus lipperti* (Bischoff); Mosher & Clark, *J. Paleont.*, 39, 559.
1966 *Gnamptognathus? lipperti* (Bischoff); Glenister & Klapper, *J. Paleont.*, 40, 803, pl. 96, figs 10-12.
1967 *Enantiognathus lipperti* (Bischoff); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 34, pl. 2, fig. 2.
1968 *Enantiognathus lipperti* (Bischoff); Mound, *J. Paleont.*, 42, 481, pl. 65, figs 30, 46, 51-54.
1970 *Enantiognathus lipperti* (Bischoff); Seddon, *J. geol. Soc. Aust.*, 12, 748, pl. 14, figs 14, 15.

Material: 20 specimens; CPC 12911, 13830-3 figured.

Localities of figured material: Sample BG 19411 (CPC 12911), east side McWhae Ridge, Sadler Limestone; BG 19585 (CPC 13830), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 19595 (CPC 13831), Section 13, Glenister Knolls, Gogo Formation; BG 21242 (CPC 13832), Longs Well Creek, Gogo Formation; BG 21371 (CPC 13833), east side Teichert Hills, Sadler Limestone.

Description: An arched unit with the dentition inclined outward. At the apex are either one or two major denticles which are about twice as large as the bar denticles. The bars, which are flexed to the outer side, may be bar-like or blade-like. The bar-like forms bear inclined isolated denticles; the blade-like forms have cyclic needle-like dentition.

A shallow basal cavity is developed on the inner face.

Remarks: The bar- and blade-like forms are very different and possibly should be separated. Glenister & Klapper (1966, p. 804) note that, like *Apatognathus varians*, this species has monocuspid and bicuspid forms.

Distribution: The species was originally described from the toI8 Zone of the Upper Devonian of Germany (Bischoff, 1956). Other German occurrences are reported by Bischoff & Ziegler (1956, 1957), Ziegler (1958), and Helms (1959). Elsewhere in Europe it is known from Austria (Schönlaub, 1969a), France (Lys & Serre, 1957), and Portugal (van den Boogaard, 1963).

Ethington & Furnish (1962) record the species from the Spanish Sahara. In North America the species is known from Utah (Clark & Ethington 1967), Mis-

souri, Illinois (Scott & Collinson, 1961), and Alberta (Uyeno, 1967; Pollock, 1968; Mound, 1968).

Range: Ziegler (1958) gives the range in Germany as Upper Devonian (toI β -toI δ). Glenister & Klapper (1966) extend the range down to the toI α Zone. The present specimens are all from the *Polygnathus asymmetricus* Zone.

ENANTIOGNATHUS cf. E. INVERSUS (Sannemann, 1955)

(Pl. 19, fig. 5a, b)

cf. 1955 *Apatognathus inversus* Sannemann, *Senck. leth.*, 36, 127, pl. 6, figs 18a-c.

Material: Single specimen, CPC 12912, from Sample BG 19450C, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: The single specimen recovered bears outwardly-directed bars and an inwardly-directed apical denticle. The specimen is only compared with *E. inversus* because the apical denticle is subcircular in cross-section rather than flattened.

Range: The type species was described from the Late Devonian (toII α) of Germany. The present specimen is from the upper Frasnian Upper *Palmatolepis gigas* Zone.

Genus FALCODUS Huddle, 1934

Type species: *Falcodus angulatus* Huddle, 1934.

FALCODUS ACULEATUS Sannemann, 1955

(Pl. 20, figs 7-8b)

1955 *Falcodus aculeatus* Sannemann, *Senck. leth.*, 36, 128, pl. 6, fig. 14.

Material: 4 specimens; CPC 12916, 13834 figured, from samples BG 19105 (CPC 13834), BG 19113 (CPC 12916), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: An asymmetrical unit with an elongate depressed anterior bar, bearing small, posteriorly inclined, fused denticles with free tips. The apical denticle is larger than any of the anterior bar denticles and is erect. The posterior bar is about half as long as the anterior bar. It bears a sequence of fused denticles, which increase in height rapidly posteriorly, culminating in two massive denticles which are taller than the apical denticle. The posterior margin of the ultimate denticle bears up to five small denticles.

A minute basal cavity is present beneath the apical denticle; it opens on the inner side.

Remarks: This species differs from *F. angulus* Huddle, 1934, lacking the distinctive lateral ridge on the bars and possessing a distinct apical denticle.

Distribution: *F. aculeatus* was originally described from the Upper Devonian of Germany (Sannemann, 1955b). This is the first record of the species outside Germany; other occurrences have been noted by Bischoff (1956) and Stoppel & Zscheke (1966).

Range: The species was originally described from the early Famennian (toII) of Germany (Sannemann, 1955b). Bischoff's (1956) specimens came from the early Frasnian (toI) and Stoppel & Zscheke (1966) recorded their specimens from the upper part of the upper Adorf-Stufe (toI). The Canning Basin specimens are from the *Palmatolepis quadrantinodosa* Zone (toII β -toIII α).

FALCODUS GUNTHERII Ziegler, 1958

(Pl. 18, fig. 4a, b)

1958 *Falcodus guntharii* Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 52, pl. 12, figs 4-7.

1968 *Falcodus guntharii* Ziegler; Spasov et al., *Inst. Réch. Geol. Geophys.*, 26, 159, pl. 1, figs 2, 3.

Material: CPC 12910 figured, from sample BG 21065, Section 15, east side of Lawford Range, south of Waggon Pass, Gogo Formation.

Description: An arched, erect unit with subequal bars, which bear laterally-compressed fused denticles with free chevron tips. The denticles increase in height and are inclined towards the apical denticle, which is tall and sigmoidal with knife edges and a thick ridge on the inner lateral face. The outer face has a granular and pitted surface.

The aboral edge is thickened to give a pseudo-platform on both sides of both bars and extends as a lip where it meets the ridge on the apical denticle. Along the aboral margin is a shallow keel with a trough extending along it. The basal cavity cannot be seen in CPC 12910 because there is a cone of basal 'bone' material inserted in the unit which extends along both bars as an open sheath.

Remarks: This specimen exhibits the pitting and granular texture used by Lindström & Ziegler (1965) to distinguish a possible natural species. *F. guntharii* is very close to *Camptognathus* sp. nov. A, but the presence of an apical denticle on the former is distinctive. Possibly the basal cavity is also different, but I cannot determine its exact nature from the present specimen because of the presence of basal 'bone'.

Distribution: *F. guntharii* was originally described from the Adorf-Stufe of Germany (Ziegler, 1958). It has also been recorded from northwest Serbia, Yugoslavia (Spasov et al., 1968).

Range: Ziegler (1958) records the species from the Frasnian (toI β -toI δ). The Yugoslavian specimens are associated with *Palmatolepis subrecta*, which has a range of toI β -toI δ . The Canning Basin specimen is from the Lower and/or Middle *Polygnathus asymmetricus* Zone (toI α).

FALCODUS VARIABILIS Sannemann, 1955

(Pl. 20, figs 1-4b, 6)

1955 *Falcodus variabilis* Sannemann, *Senck. leth.*, 36, 129, pl. 4, figs 1-4.

1969 *Falcodus variabilis* Sannemann; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 58, pl. 6, figs 10a, b (Synonymy to 1961).

1961 *Falcodus variabilis* Sannemann; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 544, pl. 1, figs 5, 6.

1961 *Falcodus variabilis* Sannemann; Zimmermann, *Freib. Forsch.*, C-89, pl. 1, figs 10, 11.

1965 *Falcodus variabilis* Sannemann; Spasov, *Trav. Géol. Bulg., Sér. paléont.*, 7, 84, pl. 1, fig. 4.

- 1967 *Falcodus variabilis* Sannemann; Nehring, *Inst. Geol., Bull.* 209, 127, pl. 4, fig. 2.
 1967 *Falcodus variabilis* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 376, pl. 1, fig. 9.
 1967 *Falcodus variabilis* Sannemann; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 61, pl. 1, figs 17, 18.
 1968 *Falcodus variabilis* Sannemann; Lange, *Geol. Palaeont.*, 2, 40, pl. 2, fig. Fa.
 1969 *Falcodus variabilis* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 75, pl. 10, fig. 7.

Material: 40 specimens, CPC 12914, 13835-8 figured.

Localities of figured material: Samples BG 19079 (CPC 12914), 19105 (CPC 13835), 19130 (CPC 13836), 19151 (CPC 31837), Section 4, northeast of McWhae Ridge, Virgin Hill Formation and Bugle Gap Limestone; BG 21014 (CPC 13838), Section 14, northwest of Pinnacle Spring, Virgin Hills Formation.

Description: A slightly arched unit consisting of two bars; the posterior is slightly longer than the anterior. Both are deep and bear tall denticles. The dentition varies, however, between equidimensional denticles subcircular in cross-section, and cyclic needle-like denticles. There is no distinctive apical denticle.

The posterior bar is flexed in some cases and the dentition is inclined to the inner side. The unit varies from subsymmetrical to highly asymmetrical. There is no distinctive basal cavity.

Remarks: *F. variabilis* is extremely variable. The dentition varies from isolated peg-like denticles to cyclic needle-like denticles; the symmetry is also highly variable.

Distribution: The species was originally described from the Late Devonian (toII_a) of Germany (Sannemann, 1955b). Since then, the species has been reported extensively from Germany (Bischoff, 1956; Bischoff & Ziegler, 1956; Bender, 1958; Helms, 1959; Krebs, 1959; Zimmermann, 1960; Freyer, 1961; Schriell & Stoppel, 1965; Freyer, 1965; Zitzmann, 1966, 1968; Stoppel & Zscheke, 1966; and Lange, 1968). Elsewhere in Europe the species is known from Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1965; Spasov & Filipovic, 1967), Czechoslovakia (Zikmundova & Chlupac, 1962; Dvorak & Freyer, 1965), France (Serre & Lys, 1958; Lys et al., 1961; Boyer et al., 1968), Italy (Forti & Nocchi, 1963; Manzoni, 1965; Olivieri, 1965), Poland (Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967), and Portugal (van den Boogaard, 1963).

The species is much rarer outside Europe. It has been recorded from the Mississippi Valley (Collinson et al., 1961) and Alberta (Pollock, 1968; Mound, 1968) in North America and from the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: The species was originally described from the early Famennian (toII_a) of Germany (Sannemann, 1955b); Bischoff & Ziegler (1956) extended the range up into the toV Zone. Nehring (1967) gives the range in Poland as toI_γ-toV, and in France it is toII_β-toV (Boyer et al., 1968). The Canning Basin specimens range from the Middle *Palmatolepis crepida* Zone (toII_a) to the Lower *Polygnathus styriacus* Zone (toIV).

FALCODUS cf. *F. VARIABILIS* Sannemann, 1955

(Pl. 20, fig. 5a, b)

Material: CPC 12915 figured, sample BG 19023, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: A single specimen exhibits the extreme variation of isolated subcircular dentition with no germ denticles. The specimen is from the Upper *Palmatolepis crepida* Zone (toII_a).

FALCODUS sp. nov. A

(Pl. 24, fig. 1a-4b)

Material: 5 specimens; CPC 12416-9 figured, from samples BG 19109 (CPC 12416), 19113 (CPC 12417), 19130 (CPC 12418), 19134 (CPC 12419), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: Unit composed of a short anterior bar and a posterior bar twice as long as the anterior bar. The anterior bar is depressed through about 60° and flexed inward about 45°. It bears up to six fused needle-like denticles which are recurved posteriorly. The apical denticle is about twice as large as the bar denticles, though on one specimen (CPC 12417) it is not distinguishable from them.

The posterior bar denticles are similar and are inclined posteriorly, tending to increase terminally. A minute basal cavity is present beneath the apical denticle and the aboral margin is finely keeled.

Remarks: Some specimens approximate to *Angulodus bidentatus*, but the posterior bar is not depressed and they cannot be referred to that genus. I have placed these specimens in *Falcodus* rather than *Hindeodella* because of the similarity of the bars, dentition, and basal cavity to other falcodids in the fauna. The fine needle-like fused denticles are diagnostic of *Falcodus* according to Lindström (1964, p. 151).

The species is also close to *Falcodus tortus* Huddle and perhaps should be so placed. If so, I probably referred specimens from the Bonaparte Gulf Basin (Druce, 1969) incorrectly to *F. tortus*. The Canning Basin specimens range from the Lower *Palmatolepis quadrantinodosa* Zone (toII_β) to the Upper *Polygnathus styriacus* Zone (toIV).

FALCODUS sp.

Material: One specimen from sample BG 19113, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: Unit elongate, with bars of equal length, bearing a sequence of fine, posteriorly inclined, needle-like denticles, the terminal ones being the largest and of the same order of size as the apical denticle.

Beneath the apical denticle is a minute basal cavity. The aboral margin is upwardly inclined away from the cavity on both bars.

Remarks: This form is very close to *Falcodus variabilis*, but the unit has been extended into a hindeodellid form.

Hindeodella? reversa has the same aboral outline, but the bars are much longer and the dentition is more hindeodellid-like (Pollock, 1968). The specimen is from the Lower *Polygnathus styriacus* Zone.

Genus HIBBARDELLA Bassler, 1925

Type species: *Prioniodus angulatus* Hinde, 1879.

HIBBARDELLA (DIPLODODELLA) ALTERNATA Branson & Mehl, 1934

(Pl. 21, figs 1a-4)

- 1934 *Diplododella alternata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 204, pl. 16, figs 23, 24.
1934 *Hibbardella insignis* Huddle, *Bull. Am. Paleont.*, 21, 80, pl. 3, fig. 15.
1949 *Diplododella alternata* Branson & Mehl; Thomas, *Bull. geol. Soc. Am.*, 60, 408, pl. 1, fig. 22.
1949 *Diplodella* sp. A, Thomas, *ibid.*, 420, pl. 1, fig. 21.
1965 *Diplododella alternata*; Murray & Chronic, *J. Paleont.*, 39, pl. 73, figs 1, 2.
1968 *Hibbardella alternata* (Branson & Mehl); Mound, *J. Paleont.*, 42, pl. 66 (pl. 2 in text), fig. 3.
1969 *Hibbardella* (*Hibbardella*) sp. A, Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 66, pl. 8, figs 11a, b.

Material: 17 specimens; CPC 12401-4 figured.

Localities of figured material: Samples BG 19001 (CPC 12401), 19019 (CPC 12402), Section 1, McWhae Ridge, Gogo and Virgin Hills Formations; BG 19534 (CPC 12403), Section 9, McPhee Knoll, Virgin Hills Formation; BG 19571 (CPC 12404), Section 11, 3 km northeast of Galeru Gorge, Virgin Hills Formation.

Description: The anterior arch is symmetrical and the individual bars are of medium length. They bear a sequence of cyclically arranged denticles, larger denticles alternating with one or two smaller ones; the tallest denticles are in the middle of each bar. The apical denticle is tall and laterally compressed, extending somewhat slightly onto the posterior bar.

The posterior bar is laterally compressed and bears a sequence of small needle-like denticles which are inclined posteriorly. The basal cavity is minute and lies beneath the apical denticle. On some specimens (Pl. 21, fig. 1a) it extends along the posterior bar as a narrowing trough.

Remarks: *H. (D.) alternata* is distinguished by the denticle alternation on the anterior arch and lateral compression of the bars and apical denticle.

Distribution: The species was originally described from the Upper Devonian of Missouri (Branson & Mehl, 1934). It is also known from Iowa (Thomas, 1949) and Colorado (Murray & Chronic, 1965); Alberta (Pollock, 1968; Mound, 1968); and the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: The species was originally described from the early Late Devonian. However, Murray & Chronic (1965) describe it from Pennsylvanian strata. The great gap in its stratigraphic range has been closed somewhat by the illustration of forms from the Lower Carboniferous of Australia (Druce, 1969) and the upper Famennian of Alberta (Mound, 1968). Thus, it seems that *H. (D.) alternata* could range from earliest Late Devonian to Late Carboniferous. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (to Ia) to the Upper *Scaphignathus veliferus* Zone (to IV).

HIBBARDELLA (DIPLODODELLA) AURITA (Sannemann, 1955)

(Pl. 22, figs 3a, b, 5a, b; Pl. 23, fig. 1)

- 1955 *Roundya aurita* Sannemann, *Senck. leth.*, 36, 153, pl. 2, figs 3a, b; pl. 5, fig. 11.
1957 *Ellisonia* sp. Lys, Serre, & Deroo, *Rév. Inst. fr. Pétrole*, 12, 799, pl. 8, fig. 4.
?1957 *Roundya aurita* Sannemann; Ziegler in Flügel & Ziegler, *Sond. Mitteil. naturw. Ver. Steiermark*, 87, 50, pl. 5, fig. 17, 20.

- 1959 *Roudnya aurita* Sannemann; Helms (part), *Geologie*, 8, 664, pl. 1, figs 6a, b [non fig. 12 = ? *H. multidentis*].
 ?1961 *Roundya aurita* Sannemann; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 553, pl. 5, fig. 7.
 1962 *Roundya aurita* Sannemann; Ethington & Furnish, *J. Paleont.*, 36, 1284, pl. 173, fig. 14.
 ?1967 *Roundya aurita* Sannemann; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 78, pl. 4, fig. 15 [? = *H. angulata*].
 1967 *Diplododella aurita?* (Sannemann); Müller & Clark, *J. Paleont.*, 41, 911, pl. 116, figs 9, 10.
 1967 *Roundya aurita* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 421, pl. 5, figs 5, 6.
 1968 *Hibbardella aurita* Sannemann; Mound, *J. Paleont.*, 42, 483, pl. 66, figs 4, 5.

Material: 14 specimens; CPC 12408, 12409 figured.

Localities of figured material: Sample BG 21015 (CPC 12408), Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation; BG 21206 (CPC 12409), Section 19, Sadler Ridge, Sadler Limestone.

Description: The anterior arch is small. Both bars are flexed anteriorly and deflected aborally. They bear a sequence of cyclically arranged needle-like denticles. The apical denticle is slightly laterally compressed, with an elliptical cross-section, and is fairly massive. The posterior bar is laterally compressed and blade-like, bearing a sequence of cyclically arranged needle-like denticles. The large denticles are inclined, and increase in size, posteriorly alternating with two or three small needle-like denticles.

The basal cavity consists of a minute pit beneath the apical denticle.

Remarks: The specimens are similar to the holotype (Sannemann, 1955, pl. 5, fig. 11). However, the paratype (*ibid.*, pl. 2, figs 3a, b) appears to belong to a different species. Some of the forms illustrated in later papers are similar to the holotype; others are similar to the paratype. Until the original types and topotype material are re-examined it is impossible to decide if the difference is intraspecific. The forms that I have questionably included in the synonymy I consider to be similar to the paratype.

Distribution and Range: Because of the nomenclature problems the areal and temporal distribution of *H. (D.) aurita* cannot be accurately deduced. However, it appears to be Late Devonian in age and of worldwide distribution. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (to Ia) to the Upper *Palmatolepis quadrantinodosa* Zone (to IIIa).

HIBBARDELLA (DIPLODODELLA) PLANA Thomas, 1949

(Pl. 21, fig. 5a, b)

- 1949 *Hibbardella plana* Thomas, *Bull. geol. Soc. Am.*, 60, 422, pl. 2, fig. 28.
 non 1959 *Roundya plana* Helms, *Geologie*, 8, 654, pl. 6, fig. 26.
 non 1963 *Roundya plana* Helms; van den Boogaard, *Geol. Mijnb.*, 42, 253, table 1.
 non 1967 *Roundya plana* Helms; Wolska, *Acta palaeont. polon.*, 12, 422, pl. 5, fig. 4.
 non 1968 *Hibbardella plana* Thomas; Pollock, *J. Paleont.*, 42, 430, pl. 61, figs 4, 5 [? = *H. (D.) aurita*].
 non 1969 *Roundya plana* Helms; Schönlaub, *Jb. geol. Bundesanst.*, 112, 307.

Material: 2 specimens; CPC 12413 figured, from sample BG 19050, Section 3, McWhae Ridge, Sadler Limestone.

Description: Both specimens have a broken posterior bar. The arch is greatly depressed, the angle between the bars being about 60°. Each bar bears a sequence of up to 6 squat, laterally compressed, fused denticles. A low shoulder is present at the bar-denticle junction. The posterior bar is laterally compressed; the apical denticle is broken. The basal cavity is minute and is situated beneath the apical denticle at the junction of the three bars.

Remarks: Until Huddle (1968) showed that the types of *Hibbardella* illustrated by Ulrich & Bassler (1926) possessed a posterior bar, there was considerable doubt about the generic assignment of conodonts with a posterior bar and anterior arch. Many workers assigned these forms to *Roundya* as being the oldest described genus with this morphology. Now that the true nature of *Hibbardella* is known, forms originally placed in *Roundya* should be brought to *Hibbardella* and thus *Roundya plana* becomes a junior homonym and should be renamed.

Distribution: The species is only known from the Maple Hill Shale of Iowa (Thomas, 1949). Druce (1969) illustrates specimens from the Bonaparte Gulf Basin of Australia which he compares to *H. plana*.

Range: Unknown, but the presence of *Ancyrognathus* in the same sample in Iowa suggests Frasnian (Thomas, 1949). The forms illustrated by Druce (1969) are from the Early Carboniferous. The Canning Basin specimens occur in the Lower *Polygnathus asymmetricus* Zone (toIa) and the the Lower *Palmatolepis quadrantodosa* Zone (toIIβ).

HIBBARDELLA (HASSOGNATHUS) FRANCA (Sannemann, 1955)

(Pl. 21, fig. 6a, b)

1955 *Roundya franca* Sannemann, *Senck. leth.*, 36, 153, pl. 5, figs 5-7.

1956 *Roundya franca* Sannemann; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 136, pl. 10, figs 32-34.

1967 *Roundya franca* Sannemann; Nehring, *Inst. Geol. Bull.* 209, 157, pl. 4, fig. 9.

1967 *Roundya franca* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 422, pl. 5, fig. 8.

Material and Locality: Single specimen, CPC 12410, from Sample BG 21100, Section 17, Bugle Gap Limestone.

Description: Arch short and depressed to give an angle of about 60° between bars each of which bears up to three short isolated denticles. The posterior bar is elongate and laterally compressed, with cyclic dentition. The large denticles, which increase in size posteriorly, alternate with two or three small denticles. The apical denticle is subcircular in cross-section and recurved, and beneath it is a small basal cavity. Troughs extend from their cavity along both lateral bars.

Distribution: The species was originally described from the *Cheiloceras*-Stufe of the Frankenwald, Germany (Sannemann, 1955b). The species has been reported from elsewhere in Germany by Bischoff (1956), Bender (1958), Freyer (1961), and Zimmermann (1961); and also from Austria (Schönlaub, 1969), Italy (Manzoni, 1965), and Poland (Nehring, 1967; Wolska, 1967).

Range: The species was originally described from the toIIa zone of the Upper Devonian (Sannemann, 1955). Most of the occurrences are in the toII zone, but Zimmermann (1961) records it as low as toIδ and Freyer (1961) as high as toV.

HIBBARDELLA (HASSOGNATHUS) SEPARATA (Branson & Mehl, 1934)

(Pl. 23, figs 4a-5b)

- 1934 *Trichognathus separata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 200, pl. 23, fig. 30.
- 1934 *Trichognathus breviclata?* Branson & Mehl, *ibid.*, 291, pl. 23, fig. 29.
- 1938 *Trichognathus separata* Branson & Mehl; Branson & Mehl, *ibid.*, 13, pl. 33, fig. 42.
- 1939 *Trichognathus separata?* Branson & Mehl; Cooper, *J. Paleont.*, 13, 421, pl. 46, figs 45, 49.
- 1944 *Trichognathus separata* Branson & Mehl; Branson & Mehl in Shimer & Schrock, *Index Fossils of North America*, 243, pl. 93, fig. 72.
- 1955 *Roundya separata* (Branson & Mehl); Sannemann, *Senck. leth.*, 36, 154, pl. 2, figs 2a, b.
- 1956 *Roundya separata* (Branson & Mehl); Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 136, pl. 10, fig. 35.
- 1962 *Roundya* aff. *R. laminata* (Branson & Mehl); Ethington & Furnish, *J. Paleont.*, 36, 1285, pl. 173, fig. 4.
- 1962 *Roundya separata* (Branson & Mehl); Spasov & Stefanovic, *Geol. Akad. Balkan.*, 29, 62, pl. 1, fig. 7.
- 1965 *Roundya* sp. Ethington, *J. Paleont.*, 39, 586, pl. 67, fig. 1.
- 1965 *Roundya separata* (Branson & Mehl); Spasov, *Trav. géol. Bulg. Sér. paléont.* 7, 100, pl. 3, fig. 15.
- 1967 *Roundya separata* (Branson & Mehl); Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 78, pl. 4, fig. 16.
- 1969 *Hibbardella (Hassognathus) separata* (Branson & Mehl); Rhodes et al., *Bull. Brit. Mus. (nat. Hist.), geol. Suppl.* 5, 117, pl. 25, figs 13a-14.
- 1969 *Hibbardella (Hassognathus) separata* (Branson & Mehl); Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 67.

Material: 5 specimens; CPC 12414, 12415 figured.

Locality of figured material: Sample BG 19080 (CPC 12414), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 19538 (CPC 12415), Section 9, McIntyre Knolls, Virgin Hills Formation.

Description: The anterior arch is short and depressed to give an angle of less than 90° between the bars. The dentition consists of isolated elongate denticles, sub-circular in cross-section. The apical denticle is massive and has a trough on the lower posterior face. The basal cavity is subtriangular and extends along the posterior bar as a groove.

Remarks: The trough on the posterior face of the apical denticle is reminiscent of the subgenus *Roundya*, but the absence of a large basal cavity places it in *Hassognathus*.

Distribution: The species was originally described from the Bushberg Sandstone of Missouri (Branson & Mehl, 1934). It has been illustrated from Arizona as *Roundya* sp. (Ethington, 1965). It is very common in Germany, having been recorded by Sannemann (1955b), Bischoff (1956, 1957), Bischoff & Ziegler (1956), Stoppel (1958), Freyer (1961), and Zitzmann (1966). Elsewhere in Europe, it has been recorded from Bulgaria (Spasov & Stefanovic, 1962), Yugoslavia (Spasov & Filipovic, 1967), and Great Britain (Rhodes et al., 1969).

Range: Bischoff (1957) gives the range of *Hibbardella separata* as Late Devonian (pre-toVI), with a possible occurrence in the Early Carboniferous (cuIIIa). Sannemann (1955) records the species from the toIIa Zone. In Great Britain (Rhodes et al., 1969) and Australia (Druce, 1969) the species is present in the Early Carboniferous; and in the Canning Basin, in the Upper *Polygnathus asymmetricus* Zone (toIβ). The overall range appears to be Late Devonian (toIβ) to Early Carboniferous (cuIIγ).

HIBBARDELLA (HIBBARDELLA) ANGULATA (Hinde, 1879)

(Pl. 22, figs 3a, b; 5a, b)

- 1879 *Prioniodus angulatus* Hinde, *Quart. J. geol. Soc. Lond.*, 35, 360, pl. 15, fig. 17.
1968 *Hibbardella angulata* (Hinde), Huddle, *U.S. geol. Surv. prof. Pap.* 578, 14, pl. 8, figs 2, 7; pl. 9, fig. 3 (Synonymy to 1948).
1957 *Hibbardella angulata* (Hinde); Rhodes & Dineley, *J. Paleont.*, 31, 361.
1957 *Hibbardella* n. sp. Rhodes & Dineley, *ibid.*, 362, pl. 38, fig. 13.
1957 *Roundya* sp. c, Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 113, pl. 21, fig. 13.
1961 *Roundya* sp. c, Bischoff & Ziegler; Freyer, *Freib. Forsch.*, C-95, 83, pl. 5, fig. 130.
1965 *Hibbardella angulata* (Hinde); Freyer, *Abh. Ber. Naturkundemuseums Gorlitz*, 40, 8, text-fig. 1/12.
1967 *Roundya* sp. Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 78, pl. 4, fig. 15.
?1967 *Diplodella aurita*? (Sannemann); Müller & Clark, *J. Paleont.*, 41, 911, pl. 116, figs 9, 10.

Material: 6 specimens; CPC 12405, 12406 figured.

Localities of figured material: Sample BG 19419 (CPC 12406), McWhae Ridge, Sadler Limestone; BG 19534 (CPC 12405), McPhee Knoll, Virgin Hills Formation.

Description: Anterior arch of medium size with the bars making an angle of about 75°. Both arms bear a sequence of tall isolated denticles, circular in cross-section. The denticles are tallest in the middle of each bar. The bars are circular in cross-section near the apical denticle but are more compressed and bar-like towards their terminations.

The apical denticle is massive and subcircular in cross-section. The posterior bar is fairly massive, with isolated denticles. In all specimens the posterior bar is broken and the nature of the posterior termination is unknown.

The basal cavity is sub-apical and is triangular, with extensions beneath each bar in the form of narrowing troughs.

Remarks: *H. (H.) angulata* is distinguished by its non-cyclic, isolated dentition. It can be distinguished from *H. (H.) multidens* by the acute angle between the bars; the angle is obtuse in *H. (H.) multidens*.

Distribution: The species was originally described from New York and Ohio (Hinde, 1879). It is also known from Indiana (Huddle, 1934), ?Michigan (Müller & Clark, 1967), and Alberta (Pollock, 1968). In Europe the species has been recorded from England (Rhodes & Dineley, 1957), Germany (Bischoff & Ziegler, 1961; Freyer, 1961, 1965), and Bulgaria (Spasov & Filipovic, 1967).

Range: The species was originally described from the early Late Devonian (Hinde, 1879; Branson & Mehl, 1933; Huddle, 1968). The earliest occurrence appears to be from the Middle Devonian of England (Rhodes & Dineley, 1957). The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toI_a) to the *Ancyrognathus triangularis* Zone (toI_γ).

HIBBARDELLA (HIBBARDELLA) MULTIDENS Ulrich & Bassler, 1926

(Pl. 23, figs 2a-3b)

- 1926 *Hibbardella multidens* Ulrich & Bassler, *Proc. U.S. nat. Mus.* 68, 38, pl. 3, figs 8, 9.
1968 *Hibbardella multidens* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 14, pl. 8, fig. 10; pl. 9, fig. 1 (Synonymy).

Material: 4 specimens; CPC 12411, 12412 figured.

Locality of figured material: Sample BG 19061 (CPC 12411), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21371 (CPC 12412), Section 24, east side of Teichert Hills, Virgin Hills Formation.

Description: Anterior arch very long and only slightly depressed. It bears a sequence of short, greatly separated, denticles. The anterior bar is subcircular and bears isolated peg-like denticles. The basal cavity is subtriangular and extends along each bar as a rapidly narrowing trough.

Remarks: The low arch with the widely separated denticles distinguish this species.

Distribution: The species was originally described from the Rhinestreet Shale of New York (Ulrich & Bassler, 1926; Huddle, 1968). It has also been recorded from New York by Hibbard (1927) and Youngquist et al. (1948). Rhodes & Dineley (1957) recorded similar forms from England.

Range: Unknown, but it occurs in the middle Frasnian (toI β) of New York (Huddle, 1968, p. 3). The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toI α) to the *Ancyrognathus triangularis* Zone (toI γ).

Genus HINDEODELLA Bassler, 1925

Type species: *Hindeodella subtilis* Ulrich & Bassler, 1926.

HINDEODELLA BREVIS Branson & Mehl, 1934

(Pl. 24, figs 5a-6b)

- 1934 *Hindeodella brevis* Branson & Mehl, *Univ. Mo. Stud.*, 8, 195, pl. 14, figs 6, 7.
1934 *Hindeodella* cf. *H. brevis* Branson & Mehl, *ibid.*, pl. 14, fig. 12.
1956 *Hindeodella brevis* Branson & Mehl; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 184, 147, pl. 14, figs 10, 11.
non 1957 *Hindeodella brevis* Branson & Mehl; Bischoff, *ibid.*, 19, 19, 26, pl. 6, fig. 24 [= *H. sp. nov.*].
non 1959 *Hindeodella brevis* Branson & Mehl; Helms, *Geologie*, 6, pl. 4, fig. 31 [= *H. uncata*].
?1961 *Hindeodella brevis* Branson & Mehl; Freyer, *Freib. Forsch.*, C95, 44, pl. 1, fig. 26.
non 1967 *Hindeodella brevis* Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 63, pl. 1, figs 8, 9 [= *H. sp. nov.*].
1969 *Hindeodella brevis* Branson & Mehl; Rhodes, Austin, & Druce, *Bull. Brit. Mus. (nat. Hist.) geol. Suppl.* 5, 119, pl. 31, fig. 17.
1969 *Hindeodella brevis* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 67, pl. 10, figs 1, 2.

Material: 7 specimens; CPC 12420, 12421 figured.

Localities of figured material: Sample BG 19023 (CPC 12421), Section 1, McWhae Ridge, Virgin Hills; BG 19115 (CPC 12420), Section 4, northeast McWhae Ridge, Bugle Gap Limestone.

Description: The unit is small, consisting of an anterior and posterior bar. The anterior bar is deflected through 90°; it bears denticles which vary from needle-like to massive, depending on the form of the bar. Blade-like bars bear needle-like denticles; massive bars, subcircular in cross-section, bear massive denticles. The posterior bar is twice as long as the anterior bar and bears similar dentition. Near the posterior termination the denticles become more posteriorly inclined and massive.

The apical denticle is slightly offset from the bars. It is borne on a corresponding thickening on the inner side of the bar. The aboral surface is knife-edged; a true basal cavity is absent on many specimens but may be represented by an inverted cavity.

Remarks: *Hindeodella brevis* is very close to both *H. corpulenta*, differing only in being much smaller and having different dentition, and to *Angulodus flexus* Druce, differing in the lack of the downward projection of the posterior bar termination.

Distribution: *Hindeodella brevis* was originally described from the Upper Devonian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Elsewhere in North America it has been recorded from the Upper Devonian of Alberta (Pollock, 1968). The species is also known from many occurrences in Europe, from the Upper Devonian and Lower Carboniferous of Austria (Schönlaub, 1969a), from the Upper Devonian of Germany (Bischoff & Ziegler, 1956); Stoppel, 1958; Helms, 1959; Freyer, 1961; 1968), the Lower Carboniferous of Great Britain (Rhodes et al., 1969), the Upper Devonian of Italy (Manzoni, 1965), Portugal (van den Boogaard, 1963), and Poland (Freyer & Zakowa, 1967).

Other occurrences include the Upper Devonian of the Spanish Sahara (Ethington & Furnish, 1962) and Lower Carboniferous of the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: Bischoff & Ziegler (1957) record the species range as Upper Devonian (toI-toV). Rhodes et al. (1969) record the species as high as the uppermost Lower Carboniferous (D₃ Zone). The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toIa) up to the Upper *Palmatolepis quadrantinodosa* Zone (toIIIa).

HINDEODELLA COMPRESSA Huddle, 1934

(Pl. 26, figs 1, 4-7)

- 1934 *Hindeodella compressa* Huddle, *Bull. Am. Paleont.*, 31, 41, pl. 5, fig. 4.
1934 *Hindeodella elongata* Huddle, *ibid.*, 42, pl. 5, figs 5, 6.
1943 *Hindeodella elongata* Huddle; Cooper & Sloss, *J. Paleont.*, 17, 172, pl. 28, figs 18, 19, 21, 36.
1943 *Hindeodella compressa* Huddle; Cooper & Sloss, *ibid.*, 172, pl. 28, fig. 25.
1961 *Hindeodella elongata* Huddle; Scott & Collinson, *Guidebk, 26th Ann. Field Conf., Kansas geol. Soc.*, pl. 2, fig. 15.
1961 *Hindeodella similis* Ulrich & Bassler; Freyer, *Freib. Forsch.*, C95, pl. 1, figs 30, 31.
1964 *Hindeodella similis* Ulrich & Bassler; Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, pl. 4, fig. 20.
1965 *Hindeodella similis* Ulrich & Bassler; Spasov, *Trav. géol. Bulg., Sér. paléont.*, 7, 87, pl. 1, fig. 11.
1968 *Hindeodina compressa* (Huddle); Mound, *J. Paleont.*, 42, 486, pl. 66, figs 20, 25.
1969 *Hindeodella compressa* Huddle; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, pl. 9, figs 8, 9.

Material: 33 specimens; CPC 12432-6 figured.

Localities of figured material: Sample BG 19049 (CPC 12432), Section 3, McWhae Ridge, Sadler Limestone; 19007 (CPC 12435), Section 1, McWhae Ridge, Gogo Formation; BG 19108 (CPC 12436), BG 19119 (CPC 12434), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 21229 (CPC 12433), Section 19, Sadler Ridge, Sadler Limestone.

Description: An elongate unit lacking an apical denticle. The bar is slightly arched and the posterior and anterior bars are often separated by a slightly offset bar denticle. The complete bar dentition is extremely fine but may be cyclic. The posterior inclination increases posteriorly and the termination is sharp, the bar shallowing aborally. The anterior bar is often depressed through about 30°. The basal cavity is minute or absent, the aboral margin being knife-edged.

Remarks: Hass (1959) erected a new genus *Hindeodina* on the absence of a well developed apical denticle. Lindström (1964) considers *Hindeodina* to be a junior synonym of *Hindeodella*, and I agree.

Distribution: *Hindeodella compressa* was originally described from the Upper Devonian New Albany Shale of Indiana (Huddle, 1934). Elsewhere in North America it has been illustrated by Scott & Collinson (1961) from the Upper Devonian Louisiana Limestone of Illinois; from the Devonian/Carboniferous boundary of Alberta and Montana (Cooper & Sloss, 1943) and from the Upper Devonian subsurface rocks of Alberta (Mound, 1968). In Europe the species has been recorded from Germany (Freyer, 1961) and Bulgaria (Budurov & Tschuneev, 1964; Spasov, 1965). It is also known from the Bonaparte Gulf Basin of Australia (Druce, 1969).

Range: The species is known as low as the Upper Devonian to I_γ Zone (Mound, 1968). It has also been recorded from the Carboniferous (Cooper & Sloss, 1943), as high as the CuIIa Zone (Druce, 1969). The Canning Basin specimens extend the range as low as the Lower *Polygnathus asymmetricus* Zone.

HINDEODELLA CORPULENTA Branson & Mehl, 1934

(Pl. 94, fig. 3a, b)

- 1934 *Hindeodella corpulenta* Branson & Mehl, *Univ. Mo. Stud.*, 8, 281, pl. 22, figs 32, 33.
1969 *Hindeodella corpulenta* Branson & Mehl; Rhodes et al., *Bull. Brit. Mus. (nat. Hist.), geol. Suppl.* 5, 120, pl. 29, figs 16a-17c (Synonymy).
1969 *Hindeodella corpulenta* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 68, pl. 10, figs 5-7.
1969 *Ligonodina* sp. Ziegler, *Fortschr. Geol. Rheinld Westf.*, 17, pl. 2, fig. 19.

Material: 22 specimens; CPC 12322 figured, from sample BG 19422, McWhae Ridge, Sadler Limestone.

Description: Unit massive, with a short anterior bar and a long posterior bar. The anterior bar is deflected through 90° and depressed through about 60°. It bears about four small needle-like denticles. The apical denticle is massive and laterally compressed; the oral termination is slightly twisted. The posterior bar is elongate, bearing a sequence of 7 or more tall, isolated, needle-like denticles which increase in height toward the posterior.

A small basal cavity is present beneath the apical denticle. An attachment scar is present of the lower part of both sides of both bars.

Remarks: *Hindeodella corpulenta* is morphologically close to the genus *Ligonodina*, from which it is differentiated by the anterior bar, which although deflected through 90° merges posteriorly rather than laterally with the apical denticle. The species is probably an intermediate form between *Hindeodella* and *Ligonodina*.

Distribution: *Hindeodella corpulenta* was originally described from the Bushberg Sandstone of Missouri (Branson & Mehl, 1934). The species or other species considered to be junior synonyms are known from Oklahoma (Cooper, 1939), Indiana (Huddle, 1934), Iowa (Thomas, 1949), and Alberta (Pollock, 1968).

The species has been illustrated from France (Lys, Serre, & Deroo, 1957) and described from Great Britain (Rhodes et al., 1969). It has also been described from the Bonaparte Gulf Basin of Australia (Druce, 1969).

Range: The majority of occurrences are from the Lower Carboniferous. Rhodes et al. (1969) record the species as high as the top of the *Zaphrentis* Zone and Druce (1969) records it throughout the Tournaisian in the Bonaparte Gulf Basin, Australia. The species has been recorded from the Upper Devonian Maple Hill Shale of Iowa (Thomas, 1949). The Canning Basin specimens are from the *Polygnathus asymmetricus* Zone (toIa) and range into the *Scaphignathus veliferus* Zone (toIV).

HINDEODELLA SUBTILIS Ulrich & Bassler, 1926

(Pl. 24, fig. 70; Pl. 25, figs 1a-5b; Pl. 26, fig. 9)

- 1926 *Hindeodella subtilis* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 39, pl. 8, figs 17-19.
- 1969 *Hindeodella subtilis* Ulrich & Bassler; Rhodes et al., *Bull. Brit. Mus. (nat. Hist.)*, *geol. Suppl.* 5, 125, pl. 29, figs 6a-7b, 9-10b (Synonymy).
- 1961 *Hindeodella germana* Holmes; Freyer, *Freiberger Fortschr.*, C95, 45, pl. 1, figs 27, 28.
- ?1967 *Hindeodella germana* Holmes; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 64, pl. 1, fig. 5.
- 1967 *Hindeodella germana* Holmes; Freyer & Zakowa, *Acta geol. polon.*, 17, 109, pl. 1, fig. 16.
- non 1967 *Hindeodella germana* Holmes; Nehring, *Inst. Geol. Bull.* 209, *Strat. Paleont. Polse*, 3, 129, pl. 2, fig. 5.
- 1967 *Hindeodella deflecta* Hibbard; Wolska, *Acta paleont. polon.*, 12, 378, pl. 2, fig. 13.
- 1967 *Hindeodella germana* Holmes; Wolska, *ibid.*, 378, pl. 2, fig. 12.
- 1967 *Hindeodella subtilis* Ulrich & Bassler; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 35, pl. 3, fig. 15.
- 1968 *Hindeodella subtilis* Ulrich & Bassler; Mound, *J. Paleont.*, 42, 485, pl. 66, figs 10, 11, 17.
- ?1968 *Hindeodella germana* Holmes; Durdanovic, *Geol. Vjesnik*, 21, 98, pl. 1, fig. 8.
- 1969 *Hindeodella subtilis* Ulrich & Bassler; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 69, pl. 10, figs 3, 4.
- 1969 *Hindeodella* sp. Ziegler, *Fortschr. Geol. Rheinld Westf.*, 17, pl. 2, fig. 18.
- 1970 *Hindeodella alternata* Ulrich & Bassler; Seddon, *J. geol. Soc. Aust.*, 16, pl. 12, fig. 31.
- 1970 *Hindeodella subtilis* Bassler; Seddon, *ibid.*, pl. 12, fig. 34.

Material: 159 specimens; CPC 12423-9 figured.

Localities of figured material: Samples BG 19014 (CPC 12427), 19019 (CPC 12425), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19167 (CPC 12423), 19448A (CPC 12429), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone; BG 19188 (CPC 12424), McWhae Ridge, Sadler Limestone; BG 21215 (CPC 12426), 21216 (CPC 12428), Section 19, Sadler Ridge, Sadler Limestone.

Description: A laterally compressed hindeodellid with a short anterior bar and a long posterior bar. The anterior bar is depressed and deflected through 30°. The

dentition on most specimens is cyclic: two or three small denticles alternate with a much larger denticle. The basal cavity is minute and is situated beneath the apical denticle.

Remarks: Some forms with cyclic dentition have been referred to *H. alternata* Ulrich & Bassler. There appears to be a complete gradation between cyclic forms and non-cyclic forms; many non-cyclic forms have germ denticles which, if they erupted, would give cyclic dentition.

Distribution: *Hindeodella subtilis* is ubiquitous in Late Devonian and Early Carboniferous faunas. It has been reported extensively from North America, Europe, and Australia.

Range: Bischoff & Ziegler (1956) report the species from as early as the toI Zone of the Upper Devonian. Rhodes et al. (1969) record the species as high as the top of the Lower Carboniferous 'Zaphrentis' Zone. In the Canning Basin the species ranges throughout the section.

HINDEODELLA UNCATA (Hass, 1959)

(Pl. 5, fig. 7)

1959 *Hindeodina uncata* Hass, *U.S. geol. Surv. prof. Pap.* 294-J, 383, pl. 47, fig. 6.

1959 *Hindeodella brevis* Branson & Mehl; Helms, *Geologie*, 6, pl. 4, fig. 31.

?1961 *Hindeodella* cf. *H. uncata* (Hass); Scott & Collinson, *Guidebk, 26th Ann. Field Conf., Kansas geol. Soc.*, pl. 2, figs 18, 19.

1969 *Hindeodella uncata* (Hass); Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 69, pl. 10, figs 8-96.

1970 *Hindeodella uncata* (Hass); Seddon, *J. geol. Soc. Aust.*, 16, 737, pl. 14, figs 18, 19.

Material: 4 specimens; CPC 12430-1 figured, from samples BG 19072 (CPC 12430), 19109 (CPC 12431), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Limestone.

Description: A hindeodellid with a long posterior bar and a shorter anterior bar deflected through 90°; the deflection occurs about 2 bar denticles on the anterior side of the apical denticle. The apical denticle is tall and needle-like and is inclined greatly to the inner side. The posterior bar is straight and bears up to 10 large denticles, with small denticles cyclically interspersed. All the denticles are inclined toward the inner side and posterior termination; the inclination increases posteriorly. A minute cavity is present beneath the apical denticle.

Remarks: *Hindeodella uncata* can be distinguished from *H. brevis* by its elongate posterior bar, and from *H. croka* Collinson & Druce by the lack of a double flexure of the anterior bar.

Distribution: *Hindeodella uncata* was originally described from the Lower Mississippian Chappel Limestone of Texas (Hass, 1959). Scott & Collinson (1961) compare specimens from the Louisiana Limestone of Illinois to *H. uncata*. In Europe the species has been illustrated as *H. brevis* (Helms, 1959). In Australia it is known from the Bonaparte Gulf Basin (Druce, 1969) and the Canning Basin (Seddon, 1970a).

Range: The species was described originally from the *Gnathodus punctatus* Zone of the Carboniferous of Texas. The specimens illustrated by Scott & Collinson

(1961) come from an Upper Devonian horizon equivalent to toVI. The specimens from the Bonaparte Gulf Basin are confined to Lower Carboniferous cuII_a strata (Druce, 1969). Seddon (1970a) records the species from the Sadler Limestone of the Canning Basin; he considers the fauna to be Late Devonian (toI_β). Seddon also points out that the specimens illustrated by Helms come from a toI_δ horizon at Saalfeld, Germany. The range of the species appears to be from the Late Devonian (toI_a) to the Early Carboniferous (cuII_β). The Canning Basin occurrences extend the range as low as the Middle *Polygnathus asymmetricus* Zone (toI_a).

HINDEODELLA cf. *H. moweri* Stauffer, 1940

(Pl. 27, fig. 1a, b)

cf. 1940 *Hindeodella moweri* Stauffer, *J. Paleont.*, 14, 424, pl. 58, figs 3-7, 9.

Material: 7 specimens; CPC 12437 figured, from sample BG 19105, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: All specimens are broken; only the anterior bar and a little of the posterior bar are preserved. The anterior bar is short and depressed through 120°. It bears 2 to 4 denticles, one of which (usually the second denticle in front of the apical denticle) is massive. The apical denticle is laterally compressed and recurved posteriorly.

The basal cavity is quite distinctive. It is a long thin groove situated beneath the apical denticle and the anterior bar, with an apex anterior to the apical denticle rather than beneath it as in most hindeodellids.

Remarks: The species is compared to *H. moweri* Stauffer because the basal cavity appears to be of a similar type. In overall morphology it resembles the Ordovician genus *Phragmodus*. The Canning Basin specimens occur in the *Palmatolepis quadrantinodosa* Zone (toII_β-toIII_a).

HINDEODELLA sp. nov. A

(Pl. 27, figs 3a-4b)

Material: 6 specimens; CPC 12438, 12439 figured, from sample BG 19001 (CPC 12438), 19007 (CPC 12439), Section 1, McWhae Ridge, Gogo Formation.

Description: An elongate hindeodellid with a massive apial denticle. Both bars are deep and laterally compressed; in one specimen (Pl. 27, fig. 3a, b) a narrow ledge runs along the aboral edge of both sides of the posterior bar. The anterior bar is short and bears one or two massive recurved isolated denticles interspersed with small denticles. The posterior bar is elongate and bears a sequence of tall, isolated, posteriorly inclined denticles. The anteriormost denticles are smaller than the denticles of the anterior bar, whereas the posteriormost are taller.

The basal cavity is slit-like; it lies beneath or just in front of the apical denticle and extends for a short distance along the anterior bar. The specimens are from the Lower and Middle *Polygnathus asymmetricus* Zone.

HINDEODELLA sp. nov. B

(Pl. 27, fig. 2a, b)

Remarks: One specimen, CPC 12440, from sample BG 19102, Section 4, northeast of McWhae Ridge, Virgin Hills Formation, resembles *H. compressa* Huddle but possesses an apical denticle. The short anterior bar is deflected through 45° and bears 6 fused needle-like denticles. The apical denticle is broken; at its base it is twice as wide as long as the anterior bar denticles. The anterior bar bears 5 fused and posteriorly inclined denticles. The specimens occur in the Lower *Palmatolepis quadrantinodosa* Zone (toIIβ).

HINDEODELLA sp. nov. C

(Pl. 27, fig. 5)

Remarks: Two specimens, CPC 12441 figured, are very similar to *Hindeodella subtilis* Ulrich & Bassler but differ in having a doubly depressed anterior bar. The dentition is coarse and resembles that of *H. aculeata* Huddle, which I consider to be a junior synonym of *H. subtilis*. The specimens are from the Lower or Middle *Polygnathus asymmetricus* Zone (toIa) or both. The illustrated specimen is from sample BG 19468, Section 5, Lloyd Hill, Sadler Limestone.

HINDEODELLA sp. nov. D

(Pl. 28, fig. 9)

Remarks: Five specimens, CPC 12442, figured, are unlike any described species of *Hindeodella*. They consist of short equidimensional anterior and posterior bars. The anterior bar is deflected through 90° and depressed through 60°. This is similar to *H. corpulenta*, but the bar is laterally compressed. The posterior bar differs from *H. corpulenta* in being short, laterally compressed, and deep. The denticles are massive, fused, and needle-like.

The aboral margin is knife-like and a minute basal cavity is situated beneath the apical denticle. The specimens are from the Upper *Polygnathus asymmetricus* Zone (toIβ). The figured specimen is from sample BG 19543, Section 9, McPhee Knoll, Gogo Formation.

HINDEODELLA sp. nov. E

(Pl. 28, figs 8a, b, 10)

Remarks: Two specimens, CPC 12443, 12444 figured, differ from known hindeodellids in having a very short anterior bar deflected and depressed through 45°. The posterior bar dentition is cyclic and extremely even. This bar is depressed through up to 45°. The extremely even dentition and the depressed posterior bar distinguish it from *H. subtilis*. The specimens are from the Middle *Polygnathus asymmetricus* Zone (toIa). The illustrated specimens are from samples BG 19482 (CPC 12444), Section 6, Lloyd Hill, Laidlaw Range, Gogo Formation, and BG 21232 (CPC 12443), Section 19, Sadler Ridge, Sadler Limestone.

Genus *ICRIODUS* Branson & Mehl, 1934

Type species: Icriodus alternatus Branson & Mehl, 1934.

The genus *Icriodus* was erected by Branson & Mehl in 1934, who named the type species *Icriodus expansus*. Unfortunately, the illustrations and description of *I. expansus* did not appear until 1938. However, in a 1934 publication they did describe *I. alternatus* and *I. symmetricus*, and in a later publication (Branson & Mehl in Shimer & Shrock, 1944) *Icriodus alternatus* became the type species by subsequent designation. (I am indebted to Professor F. H. T. Rhodes for drawing my attention to this.)

Apart from the problems of the identity of the type species, the distinctions between species are in a state of considerable confusion.

In their 1938 paper Branson & Mehl state (p. 158) that species are sharply defined, although *I. nodosus*, *I. curvatus*, and *I. expansus* approach one another and immature forms of *I. symmetricus* resemble mature forms of *I. cymbiformis*. They also point out that species of *Icriodus* are good horizon markers.

The genus ranges from Silurian (upper Ludlovian *latialatus* Zone) (Walliser, 1964) to Devonian (Famennian, *Spathognathodus costatus* Zone (to V-VI) (Klapper, 1966). The Early Devonian and some Middle Devonian forms either belong to the *latericrescens* group, which is characterized by the possession of one or more lateral processes, or have a close phylogenetic relationship to forms with a lateral process, i.e., *I. woschmidtii*. The *latericrescens* group has been dealt with in detail by Klapper & Ziegler (1967) and Carls (1969).

The simple icriodids lacking lateral processes are common in the Middle and Late Devonian and their detailed nomenclature is in some confusion. As Branson & Mehl (1934, p. 158) state, characteristics of some forms merge, and Freyer (1961, p. 49) illustrates the cyclic interrelationship of forms referred to *nodosus*, *symmetricus*, and *curvatus*, from the Upper Devonian of the Vogtlandes, Germany. Clark & Ethington (1967), in discussing the *cornutus-rectus-alternatus* group (intergrading *Icriodus* complex of Seddon, 1970a, p. 735) state that 'a monographic study is necessary to resolve the problems'.

Recent studies have thrown light on the relationship of the genus within the conodont animal and also its ecological distribution. Lange (1968) reports the genus in 'associations' of *Icriodus-Acodina*, suggesting that some icriodids, at least, were partnered in the conodont animal by simple cone forms. Seddon (1970b) distinguishes an *Icriodus* biofacies, as opposed to a *Palmatolepis* biofacies. I have also separated an *Icriodus* fauna from a *Palmatolepis* fauna and suggested that the *Icriodus* fauna inhabited shallow water, whereas the *Palmatolepis* fauna inhabited deep water (Druce, 1970d, 1973). Seddon & Sweet (1971) agree with this broad picture, but add that the faunas may be depth-stratified, the *Icriodus* biofacies living above the *Palmatolepis* biofacies, rather than adjacent to it, as suggested by my original terminology. I agree with them, though it is interesting to note that, from the numbers of specimens obtained from samples of differing facies, the *Icriodus* biofacies is much more abundant in the shallow water than in the deeper water. This suggests that, even though the *Icriodus* biofacies may have been able to occupy the upper water niche of the ocean, it preferred to live in near-coastal regions or at least in regions where the underlying *Palmatolepis* fauna was not present.

In examining the icriodid faunas throughout the Devonian sequence of the Canning Basin I have recognized that the presence or absence of *Icriodus* is related

to some extent to facies, and to some extent to probable water depth (Druce, 1973).

I have suggested that in the Devonian the icriodids with and without lateral processes are probably members of different biofacies (Druce, 1973). The present study suggests that within the group lacking lateral processes some of the minor morphological characters on which species have been erected could possibly be controlled by facies and/or water depth.

In order to obtain some semblance of order in the taxonomy and also to isolate various characters, I have classified the icriodids on the basis of their oral ornament. I do not wish to convey the idea that oral ornament is either the most important or the only morphological character which can be used; but surface ornament is easily observed and fairly easy to qualify, and is the most conspicuous part of the icriodid illustrated by all authors over the past forty years.

I have divided the oral ornament into five categories:

1. Symmetrical ornament, characterized by the transverse lineation of the nodes of all three rows.
2. Alternating ornament, characterized by alternation of the nodes of the median row with those of the outer rows. Two stages can be recognized, an *en echelon* arrangement and a true alternating arrangement. The *en echelon* arrangement is probably an intermediate step between symmetrical ornament and alternating ornament.
3. Irregular ornament, characterized by no true symmetry of node arrangement.
4. Central row reduction, characterized by the partial or complete disappearance of the median row of nodes and complementary enlargement of the lateral rows.
5. Lateral row reduction, characterized by partial disappearance of some lateral nodes. These forms appear to be transitional to the genus *Pelekysgnathus*.

Arbitrarily, I have designated these as species characteristics, and thus, in the Upper Devonian at least, there are five species: *I. symmetricus* Branson & Mehl for the symmetrical group; *I. alternatus* Branson & Mehl for the alternating group; *I. incrassatus* Youngquist & Peterson for the irregular group; *I. arkonensis* Stauffer for the group with central row reduction; and *I. brevis* Stauffer for the group with lateral row reduction.

These icriodids possess several other characters; they are not always present and can also appear on any of the oral ornament types. In the classification scheme I have drawn up a chart (Fig. 17) to show the relationship between these characteristics and the basic oral ornament.

For the sake of clarity in nomenclature, I have assumed these characteristics to be of sub-specific rank. This is useful because it preserves the binomial system. Its limitations are that it cannot take into account more than one prominent sub-specific character. In most cases icriodids exhibit only one prominent subspecific characteristic and in the present fauna this type of classification is easy to use. However, some species, noticeably *I. corniger*, have two prominent subspecific characters and cannot be placed accurately within this classification. This could be solved by the erection of each type of oral ornament as a subgeneric type and each additional characteristic could then be of specific or subspecific rank. Some decision will have to be made on the order of priority of these characters, and a trinomial

	UNIT ELONGATION	UNIT REDUCTION	POSTERIOR BLADE EXTENSION	POSTERIOR HORN	POSTERIOR FLARE	ELONGATE BASAL FLARE	BASAL ASYMMETRY (NOTCH)	LATERAL NODES	ANTERIOR BLADE	CIRCULAR POSTERIOR BASAL FLARE
SYMMETRICAL <u>SYMMETRICUS</u>		<i>expansus</i> 		<i>„curvatus „ angustus“</i>	<i>corniger</i>		<i>circularis</i> 		<i>rectus</i>	<i>subterminus</i>
ALTERNATING <u>ALTERNATUS</u>			<i>cymbiformis</i> 	<i>costatus</i> 		<i>elegantulus</i> 	<i>„nodosa“ „curvirostratus“</i> 		<i>postiflexus</i> 	<i>introlevatus</i>
IRREGULAR <u>INCRASSATUS</u>	<i>iowaensis</i> 									
CENTRAL ROW REDUCTION <u>ARKONENSIS</u>										
LATERAL ROW REDUCTION <u>BREVIS</u>				<i>darbyensis</i> 			<i>spicatus</i> 			

M (P) 570

Fig. 17. Classification chart for the Late Devonian representatives of the genus *Icriodus*.

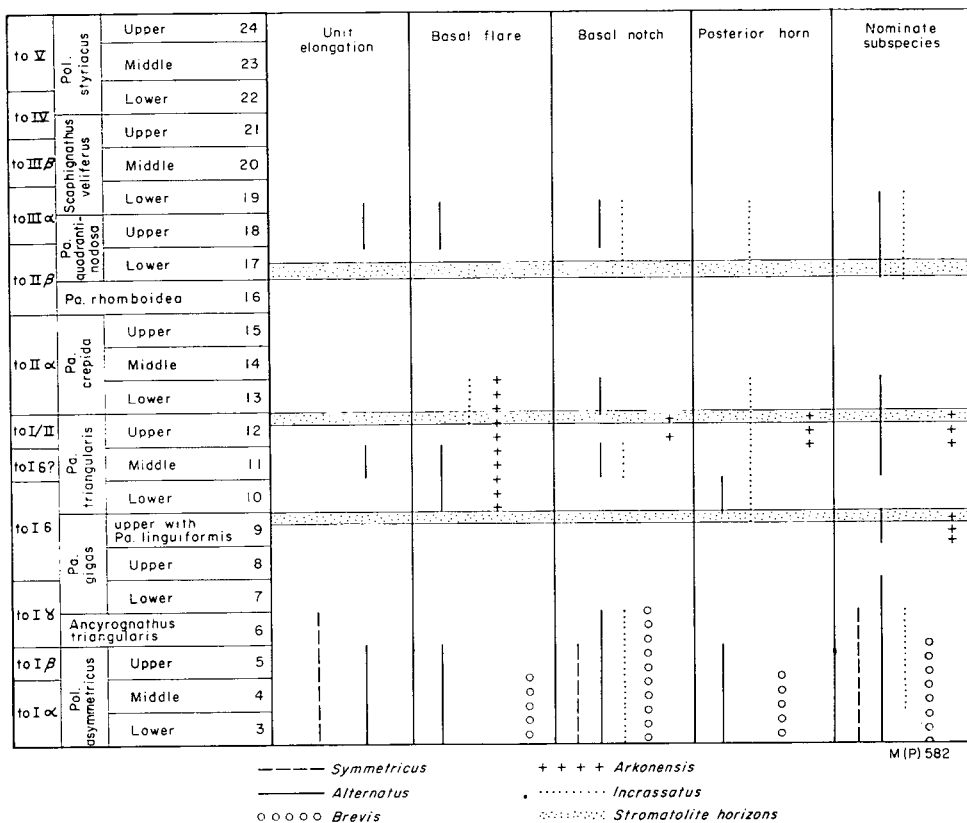


Fig. 18. Range chart of subspecies of the genus *Icriodus* arranged in groups reflecting their subspecific characteristic.

nomenclature system will be introduced. Furthermore, the extension of this system into the other icriodid groups could cause more problems than the system is worth.

As can be seen from Figure 17 many of these morphological combinations have been named. Some, of course, may not exist; others definitely do, being present in the Canning Basin faunas. I have left in open nomenclature the unnamed combinations present in the Canning Basin to avoid any more confusion in icriodid nomenclature.

From Figure 18 it can be seen that icriodids are not present throughout the section. In fact, they come and go repeatedly. The three marked horizons represent stromatolite horizons present in the Bugle Gap area and probably throughout the Lennard Shelf. These probably represent shallowing of the basin; current-oriented nautiloids are conspicuous on their upper surfaces. In general, the icriodids are associated with these horizons. The nominate subspecies are often present in strata beneath these horizons whereas the other subspecies are absent; conversely, immediately above the stromatolite horizons the nominate subspecies are absent.

This suggests that the characters used to divide the subspecies are controlled by facies and/or water depth. From Figure 17 it can be seen that the present fauna, most of which has been recovered from the shallow-water facies of the reef complex, is dominated by certain characters while others are absent. Three charac-

teristics are common: the development of the posterior horn, an elongate basal flare, and a notch in the lateral basal cavity flare. Perhaps these are characteristic of the very shallow-water biofacies. Other characters, such as a posterior flare of the cavity lip, posterior blade extension, and the development of lateral carinae, are not present and possibly represent a deeper-water facies.

If, in fact, the minor morphological characters are dependent on environment, this would explain the plastic nature of the group and the great problems of nomenclature. However, the recognition of this could greatly increase our ability to interpret the environment of deposition of sedimentary rocks and the morphology of sedimentary basins.

ICRIODUS ALTERNATUS ALTERNATUS Branson & Mehl, 1934

(Pl. 29, figs 1a-4b)

- 1934 *Icriodus alternatus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 225, pl. 13, figs 4-6.
- 1938 *Icriodus alternatus* Branson & Mehl, *J. Paleont.*, 12, 161, pl. 26, figs 4-6.
- 1938 *Icriodus expansus* Branson & Mehl; Stauffer, *J. Paleont.*, 12, 430, pl. 52, figs 19, 20 only.
- 1940 *Icriodus expansus* Branson & Mehl; Stauffer, *J. Paleont.*, 14, 425, pl. 60, figs 59, 60, 62, 63.
- 1947 *Icriodus alternatus* Branson & Mehl; Youngquist & Peterson, *J. Paleont.*, 21, 246, pl. 37, fig. 19 only.
- 1957 *Icriodus curvatus* Branson & Mehl; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 61, pl. 6, fig. 6a, b.
- 1957 *Icriodus elengatulus* Stauffer; Lys & Serre, *Rév. Inst. fr. Pétrole*, 12, 801, pl. 9, fig. 2.
- 1959 *Icriodus alternatus* Branson & Mehl; Helms, *Geologie*, 8, 642, pl. 1, fig. 1; pl. 4, fig. 7.
- 1964 *Icriodus alternatus* Branson & Mehl; Orr, *Ill. St. geol. Surv. Circ.* 36, 9, pl. 2, figs 12a, b, only.
- ?1964 *Icriodus nodosus* (Huddle); Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, pl. 2, fig. 8.
- 1965 *Icriodus alternatus* Branson & Mehl; Ethington, *J. Paleont.*, 39, 575, pl. 67, fig. 8.
- 1967 *Icriodus symmetricus* Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 64, pl. 2, fig. 9 only.
- 1967 *Icriodus alternatus* Branson & Mehl; Wolska, *Acta paleont. polon.*, 12, 379, pl. 2, fig. 6 only.
- 1968 *Icriodus alternatus* Branson & Mehl; Mound, *J. Paleont.*, 42, 486, pl. 66, figs 13, 15, 19, 24.
- 1968 *Icriodus symmetricus* Branson & Mehl; Mound, *ibid.*, 488, pl. 66, figs 40, 41.

Material: 132 specimens; CPC 12445-8 figured from samples BG 19105 (CPC 12448), 19111 (CPC 12447), 19113 (CPC 12446), 19114 (CPC 12445), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: Elongate platform units about five times as long as wide, bearing nodose ornament. The ornament consists of three linear rows of denticles or nodes. The nodes of the centre row alternate with those of the lateral rows. The alternation can vary from slight, with a typical chevron pattern, to extreme, where the median row denticle is equidistant from two denticles of one lateral row. The degree of alteration tends to increase posteriorly. The median denticle row commonly extends beyond the lateral rows for about two denticles.

The basal cavity extends over the whole unit; it is widest at the posterior, where a small pit is often developed. The cavity is nearly symmetrical; on the inner side the lip may be more flared but often it does not flare as far anteriorly.

Remarks: The nominate subspecies is characterized by the alternating dentition and the lack of any of the major morphological characteristics which are present in other subspecies.

Distribution: Illustrated specimens which appear to belong to this subspecies have been described extensively from the United States and Europe. The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Since then, it has been described from Ohio (Stauffer, 1938), Illinois (Orr, 1964), Iowa (Youngquist & Peterson, 1947), Minnesota (Stauffer, 1940), and Arizona (Ethington, 1965). Mound (1968) has illustrated the subspecies from Alberta. In Europe it has been reported from Germany (Bischoff & Ziegler, 1957; Helms, 1959), France (Lys & Serre, 1957), Poland (Wolska, 1967), Bulgaria (Budurov & Tschunev, 1964), and Yugoslavia (Spasov & Filipovic, 1967).

Range: It is impossible to determine the range of the subspecies from previously recorded faunas because the separate subspecies were not individually recognized. In the Canning Basin the subspecies ranges from at least the base of the Late Devonian to the Upper *Palmatolepis quadrantinodosa* Zone (to III_a).

ICRIODUS ALTERNATUS COSTATUS (Thomas, 1949)

(Pl. 29, figs 5a-7c)

- ?1941 *Icriodus curvatus* Branson & Mehl; Branson & Mehl, *J. Sci. Lab. Denison Univ.*, 35, 192, pl. 7, figs 2, 14.
1949 *Pelekysgnathus costata* Thomas, *Bull. geol. Soc. Am.*, 60, 424, pl. 2, fig. 9.
1955 *Icriodus cornutus* Sannemann, *Senck. leth.*, 36, 130, pl. 4, figs 19a-21.
?1961 *Icriodus cornutus* Sannemann; Freyer, *Freib. Forsch.*, C95, 47, pl. 1, fig. 32; pl. 2, fig. 33.
1965 *Icriodus incrassatus* Youngquist & Peterson; Loranger, privately published, 17, pl. 3, figs 14-16.
1965 *Icriodus costatus* (Thomas); Anderson, *Iowa Acad. Sci.*, 72, pl. 1, figs 6, 10.
1966 *Icriodus costatus* (Thomas); Anderson, *J. Paleont.*, 40, 406, pl. 52, figs 3-5, 10 only.
1967 *Icriodus cornutus* Sannemann; Wolska, *Acta palaeont. polon.* 12, 380, pl. 2, figs 5a, b.
1969 *Icriodus rectus* Youngquist & Peterson; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 70, pl. 11, figs 3-5.
1970 *Icriodus brevis angustulus* Seddon, *J. geol. Soc. Aust.*, 16, 736, pl. 11, figs 19-24 only.

Material: 10 specimens; CPC 12449-51 figured.

Localities of figured material: Sample BG 21222 (CPC 12449), Section 19, Sadler Ridge, Sadler Limestone; BG 21242 (CPC 12450), 21246 (CPC 12451), Section 20, Longs Well Creek, Gogo Formation.

Remarks: The subspecies is characterized by the development of alternating dentition and the horn-like elongation of the posteriormost median row denticles. The extension occurs on both posterior free denticles. In early forms it is nearly vertical but in advanced forms the denticles become fused and incline more to the posterior.

Distribution: The subspecies was originally described from Iowa (Thomas, 1949; Anderson, 1965, 1966). A form questionably assigned to this subspecies was referred to by Branson & Mehl (1941) as *Icriodus curvatus* from the Late Devonian of Missouri. Elsewhere in North America it has been illustrated by Loranger (1965) from Alberta.

In Europe the species has only been illustrated from Germany (Sannemann, 1955; Freyer, 1961) and Poland (Wolska, 1967). In Australia it is known from both the Canning and Bonaparte Gulf Basins (Druce, 1969; Seddon, 1970a).

Range: The range of the subspecies is unknown, but in the Canning Basin it ranges through the Frasnian.

ICRIODUS ALTERNATUS CURVIROSTRATUS Bultynck, 1970

(Pl. 29, figs 8a-11b)

- 1938 *Icriodus nodosus* (Huddle); Branson & Mehl, *J. Paleont.*, 12, 160, pl. 26, figs 14, 15.
1947 *Icriodus alternatus* Branson & Mehl; Youngquist & Peterson, *J. Paleont.*, 21, pl. 37, fig. 21 only.
1955 *Icriodus nodosus* (Huddle); Sannemann, *Senck. leth.*, 36, 130, pl. 4, fig. 18 only.
1957 *Icriodus nodosus* (Huddle); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 62, pl. 6, fig. 2 only.
1961 *Icriodus nodosus* (Huddle); Freyer, *Freib. Forsch.*, C95, 47, pl. 2, fig. 35.
?1965 *Icriodus symmetricus* Branson & Mehl; Merrill, *Texas J. Sci.*, 17, 379, pl. 4, fig. 6.
1967 *Icriodus curvatus* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 214, pl. 20, figs 17a, b.
1967 *Icriodus nodosus* (Huddle); Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 64, pl. 2, fig. 11.
1967 *Icriodus nodosus* (Huddle); Wolska, *Acta palaeont. polon.*, 12, 380, pl. 2, figs 1-3.
1969 *Icriodus nodosus* (Huddle); Seddon, *J. Roy. Soc. W. Aust.*, 52, 27, pl. 1, figs 4a-c, 6a-c.
1970 *Icriodus nodosus* (Huddle); Seddon, *J. geol. Soc. Aust.*, 16, 736, pl. 11, figs 27-29, 33-35.
1970 *Icriodus nodosus curvirostratus* Bultynck, *Mem. Inst. Geol. Univ. Louvain*, 26, 108, pl. 3, figs 2-4, 8, 9; pl. 4, figs 1, 5, 6.
1970 *Icriodus nodosus* a Bultynck, *ibid.*, 109, pl. 3, figs 5, 6, 10; pl. 4, fig. 3, 4.
1970 *Icriodus symmetricus* a Bultynck, *ibid.*, 114, pl. 5, figs 3a-c, ? 7a, b.

Material: 48 specimens; CPC 12453-6 figured.

Localities of figured material: Samples BG 19112 (CPC 12453), 19454 A (CPC 12456), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone and Virgin Hills Formation; BG 21242 (CPC 12454, 12455), Section 20, Longs Well Creek, Gogo Formation.

Remarks: The subspecies is characterized by alternating dentition and the development of a notch in the inner margin of the basal lip. The margin is flared, and develops a sulcus with marked asymmetry of the cavity outline. The subspecies shows development from two lineages, from *I. brevis* and from *I. alternatus* s.s.

Distribution: Forms included in this subspecies have mainly been referred to *Icriodus nodosus* (Huddle). As has been pointed out by several authors (Glenister & Klapper, 1966; Seddon, 1969), the aboral margin of the holotype is broken and from the illustrations it is impossible to distinguish which subspecific characters it possesses. Furthermore, the holotype is missing (Glenister & Klapper, p. 805).

Illustrated forms of the subspecies are known from Iowa (Youngquist & Peterson, 1947), Texas (Merrill, 1965), and New York (Branson & Mehl, 1938). In Europe the species is common in Germany (Sannemann, 1965; Bischoff & Ziegler, 1957; Freyer, 1961), Poland (Wolska, 1967), Spain (Wirth, 1967), and Yugoslavia (Spasov & Filipovic, 1967). In Belgium, Bultynck (1970) recognized several forms with the basic plan of this subspecies and *Icriodus curvirostratus* is the first named species erected specifically to cover these characters.

In Australia the species has been recorded from the Carnarvon and Canning Basins (Seddon, 1969, 1970a) of Western Australia.

Range: The range of the subspecies is as low as the early Middle Devonian (Couvinian) (Bultynck, 1970), and as high as the Upper *Palmatolepis quadratinodoso* Zone of the Famennian (to IIIa) of the Canning Basin.

ICRIODUS ALTERNATUS CYMBIFORMIS Branson & Mehl, 1938

(Pl. 30, figs 1a-3b)

- 1938 *Icriodus cymbiformis* Branson & Mehl, *J. Paleont.*, 12, 164, pl. 26, figs 27-29.
 1938 *Icriodus cymbiformis* ? Branson & Mehl; Stauffer, *J. Paleont.*, 430, pl. 52, figs 11, 13.
 1940 *Icriodus cymbiformis* Branson & Mehl; Stauffer, *J. Paleont.*, 14, 425, pl. 60, figs 37, 51, 56-58, 68.
 1940 *Icriodus expansus* Branson & Mehl; Stauffer, *ibid.*, 425, pl. 60, figs 64, 70, 71 only.
 ?1947 *Icriodus symmetricus* Branson & Mehl; Youngquist, *J. Paleont.*, 21, 103, pl. 25, fig. 5.
 1949 *Icriodus symmetricus* Branson & Mehl; Beckmann, *Senckenbergiana*, pl. 4, fig. 5, some specimens.
 1956 *Icriodus* sp. Hass, *U.S. geol. Surv. prof. Pap.* 286, pl. 4, figs 4, 5.
 1957 *Icriodus cymbiformis* Branson & Mehl; Lys & Serre, *Rév. Inst. fr. Pétrole*, 12, 800, pl. 9, fig. 3.
 1959 *Icriodus*, cfr. *I. curvatus* Branson & Mehl; Panseri & Barsotti, *Not. Comm. Inst. Geol. Min. Espana*, 55, 156, pl. 1, fig. 3.
 1959 *Icriodus cymbiformis* Branson & Mehl; Panseri & Barsotti, *ibid.*, 157, pl. 1, fig. 5.
 1964 *Icriodus alternatus* Branson & Mehl; Orr, *Ill. St. geol. Surv. Circ.* 361, 9, pl. 2, fig. 11 only.
 1965 *Icriodus* sp. Philip, *J. Proc. Roy. Soc. N.S.W.*, 100, 154, pl. 2, fig. 11.
 1967 *Icriodus cymbiformis* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 215, pl. 20, figs 18a-19b.
 1968 *Icriodus alternatus* Branson & Mehl; Spasov, Stojanovic-Kuzenko, & Pajic, *Inst. Rech. Géol. Géophys. Bull.* 26, 160, pl. 2, fig. 6.
 1969 *Icriodus alternatus* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 70, pl. 11, figs 2a-c.

Material: 16 specimens; CPC 12457-9 figured.

Localities of figured material: Sample BG 19529 (CPC 12457), McIntyre Knolls, Virgin Hills Formation; BG 19576 (CPC 12458), Lawford Range near McIntyre Knolls, Virgin Hills Formation; BG 21229 (CPC 12459), Section 19, Sadler Ridge, Sadler Limestone.

Remarks: The subspecies is characterized by the development of an elongate posterior carina. The nominate subspecies usually bears two denticles posterior to the lateral denticles; *I.a. cymbiformis* characteristically has four denticles, though often they are fused to give the appearance, orally, of two. This character can be seen even in juveniles, and the subspecies is one of the easier ones to separate.

Distribution: The species has been illustrated extensively from the midwest of the U.S.A. and in Canada (Stauffer, 1938). In Europe, it has been recorded from Germany (Beckmann, 1949), France (Lys & Serre, 1957), Spain (Wirth, 1967), and Yugoslavia (Spasov et al., 1968). It is also known from North Africa (Panseri & Barsotti, 1959) and Australia (Philip, 1965; Druce, 1969).

Range: The range of the subspecies is unknown, but in the Canning Basin it ranges as high as the Lower *Scaphignathus veliferus* Zone (to III). It ranges as low as the Middle Devonian (Philip, 1965).

ICRIODUS ALTERNATUS ELEGANTULUS Stauffer, 1938

(Pl. 30, figs 4a, b, c; 7a-8b)

- 1938 *Icriodus elegantulus* Stauffer, *J. Paleont.*, 12, 430, pl. 52, figs 26, 27.
 1955 *Icriodus nodosus* (Huddle); Sannemann, *Senck. leth.*, 36, 130, pl. 4, fig. 17.
 1967 *Icriodus alternatus* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 214, pl. 20, figs 15-16b.

- 1967 *Icriodus nodosus* (Huddle); Nehring, *Inst. Geol. Poland, Bull.* 209, 131, pl. 3, figs 2a, b (non text-fig. 9).
- 1970 *Icriodus regularicrescens* Bultynck, *Mem. Inst. Geol. Univ. Louvain*, 26, 111, pl. 7, figs 3-5, 7.
- 1970 *Icriodus alternatus* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 108, 80, pl. 14, figs 4a-d.

Material: 14 specimens; CPC 12460-2 figured from sample BG 21242, Section 20, Longs Well Creek, Gogo Formation.

Remarks: The subspecies is characterized by alternating dentition and a flaring basal cavity. The basal flare is very pronounced around the whole unit, forming a wide apron except at the anterior termination. Most specimens appear to have developed from an *I. brevis* lineage, with characteristic peg-like denticles; others from *I. alternatus* subsp. nov. a.

Distribution: The species was originally described from the Upper Devonian of Ontario and Ohio (Stauffer, 1938). These are the only described or illustrated forms from North America.

In Europe the subspecies has been illustrated from Belgium (Bultynck, 1970), Germany (Sannemann, 1955), Poland (Nehring, 1967), and Spain (Wirth, 1967). In Australia the species has been illustrated from central Queensland (Druce, 1970).

Range: The range of the subspecies is unknown, but it occurs near the top of the Couvinian (Middle Devonian) (Bultynck, 1970) and ranges as high as the Upper *Palmatolepis quadrantinodosa* Zone (Famennian, toIIIa) in the Canning Basin.

ICRIODUS ALTERNATUS subsp. nov. a

(Pl. 30, figs 5a-6b; 9a-10b)

- 1956 *Icriodus* spp. Hass, *U.S. geol. Surv. prof. Pap.* 286, pl. 4, fig. 6.
- 1967 *Icriodus alternatus* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 379, pl. 2, fig. 4 only.
- 1970 *Icriodus curvatus* Branson & Mehl; Bultynck, *Mem. Inst. Geol. Univ. Louvain*, 26, 103, pl. 5, fig. 6 only.
- 1970 *Icriodus nodosus* n. subsp. b. Bultynck, *ibid.*, 109, pl. 3, fig. 7.

Material: 30 specimens; CPC 12463-6 figured.

Localities of figured material: Sample BG 19117 (CPC 12464), Section 4, north-east of McWhae Ridge, Bugle Gap Limestone; BG 19534 (CPC 12466), 19539 (CPC 12465), Section 9, McPhee Knoll, Virgin Hills Formation, BG 19576 (CPC 12463), McIntyre Knolls, Virgin Hills Formation.

Remarks: An icriodid with alternating dentition and a width-length ratio of about 1:7. These forms are very similar to *Icriodus alternatus* s.s. but are distinctively elongated, and commonly bear 7 nodes on the lateral rows compared with about 5 on the nominate subspecies. Forms which bear 6 lateral nodes can be separated because the nominate subspecies is more massive and wide.

The type of dentition also varies; the nominate subspecies is characterized by isolated tall peg-like denticles often truly alternating. This subspecies bears low nodes; the medial row nodes are elongate and are connected by low ridges to one another. Occasionally, the lateral row denticles are also connected to the medial row by low ridges and then the dentition pattern is often of the chevron type.

Distribution: Elongate specimens bearing alternating dentition have been described by Hass (1956) from Texas. Elsewhere similar forms have been illustrated by Wolska (1967) from Poland and Bultynck (1970) from Belgium.

Range: The range is unknown, but it must range as low as Middle Devonian (Couvinian) (Bultynck, 1970). In the Canning Basin the subspecies occurs as high as the Late Devonian Upper *Palmatolepis quadrantinodosa* Zone (toIIIa).

ICRIODUS ARKONENSIS ARKONENSIS Stauffer, 1938

(Pl. 30, figs 11a-12b)

1938 *Icriodus arkonensis* Stauffer, *J. Paleont.*, 12, 429, pl. 52, figs 10, 15.

1938 *Icriodus expansus* Branson & Mehl; Stauffer, *ibid.*, pl. 2, fig. 25 only.

1959 *Icriodus* cf. *nodosus* Branson & Mehl; Helms, *Geologie*, 8, 642, pl. 4, fig. 8.

Material: 4 specimens; CPC 12467-12468 figured.

Localities of figured material: Sample BG 19016 (CPC 12467), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19454B (CPC 12468), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Description: An elongate unit, slightly curved, with a platform ornament consisting of three rows of nodes. The two lateral rows are composed of massive nodes, some showing transformation to short transverse ridges which are angled slightly to the anterior. The median row is characteristic; the nodes are greatly reduced and may be absent, leaving a median trough. At the posterior termination a median node blocks the trough and posterior to it and separated by a low saddle is an isolated pointed node. This rather characteristic node can be seen in other specimens of other species and subspecies, e.g. *I. alternatus curvirostratus* (Pl. 29, fig. 10a) and may be a useful character for tracing lineages. At the posterior end the lateral ornament is often denticulate rather than nodose; commonly the anteriormost denticles of each row are taller than all the other nodes and have sharp oral terminations.

The basal cavity is open, but the flaring is not excessive and no asymmetry is developed.

Remarks: The reduction in the median row of dentition is characteristic. This reduction may be complete, leaving a trough, or it may vary from extremely low elongate nodes, which alternate with the lateral nodes, to only occasional nodes.

A median trough is seen in other genera, e.g. *Spathognathodus bipennatus*, *Patrognathus*, *Clydagnathus*, *Taphrognathus*, *Cavusgnathus*, and *Adetognathus*. Presumably this is a functional feature, possibly related to the ecology.

Distribution: *A. arkonensis* s.s. is extremely rare, being known from Ontario, Canada, and adjacent Ohio (Stauffer, 1938). A solitary specimen illustrated by Helms (1959) from Germany also belongs to this species.

Range: The range of the species is unknown. In the Canning Basin it ranges from the uppermost *Palmatolepis gigas* Zone (toI8) to at least the top of the Lower *Palmatolepis crepida* Zone and possibly as high as the top of the Upper *P. crepida* Zone (toIIa).

ICRIODUS ARKONENSIS subsp. nov. a

(Pl. 31, figs 1a-3b, 5a, b)

Material: 14 specimens; CPC 12469-72 figured from samples BG 19453D (CPC 12469), 19454B (CPC 12470-12472), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: The subspecies is characterized by the reduction of the median row of nodes and by the increase in size of the posteriormost isolated denticle. The enlargement of the posteriormost median denticle is seen in other species, where it is usually horn-like, but in this species it never appears to develop that far. In some specimens the cavity is flared, but the enlargement of the posteriormost denticle is considered to be of greater importance in assigning specimens to a subspecies.

Distribution and Range: So far this is the only report of this subspecies. In the Canning Basin it occurs in the Upper *Palmatolepis triangularis* Zone (earliest Famennian).

ICRIODUS ARKONENSIS subsp. nov. b

(Pl. 31, figs 4a, b, c, 6a-8b)

Material: 14 specimens; CPC 12473-6 figured.

Localities of figured material: Sample BG 19017 (CPC 12473), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19453B (CPC 12476), E (CPC 12475), 19454B (CPC 12474), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: The subspecies is characterized by the reduction in the median row of nodes and the development of a flaring basal cavity. A slight undulation is present in some specimens on the inner side of the cavity margin, but it is not developed into a distinct notch. In some specimens the posteriormost denticle is more lateral than medial and is fused with the nearest lateral node, leaving a wide shallow opening on the other posterolateral margin.

Distribution and Range: The subspecies has only been recorded from the Canning Basin, where it ranges from the Middle *Palmatolepis triangularis* Zone (earliest Famennian) to possibly the Upper *Palmatolepis crepida* Zone (toII_a).

ICRIODUS ARKONENSIS subsp. nov. c

(Pl. 32, figs 4a, b, 8a-10b)

Material: 16 specimens; CPC 12477-80 figured from samples BG 19453B (CPC 12477), 19454B (CPC 12478-12480), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: The subspecies is characterized by the reduction of the median row of nodes and the development of a marked notch in the inner basal cavity margin. There is also a distinct lateral shift in the usually medial posteriormost denticle to produce an asymmetrical platform ornament. The posteriormost denticle is fused

to one lateral row of denticles and is separated by a wide opening from the other lateral row.

Distribution and Range: This subspecies is only known from the Canning Basin, where it occurs in the Upper *Palmatolepis triangularis* Zone.

ICRIODUS BREVIS BREVIS Stauffer, 1940

(Pl. 32, figs 1a-2b)

- 1940 *Icriodus brevis* Stauffer, *J. Paleont.*, 14, 424, pl. 60, figs 36, 43, 44, 52.
1947 *Icriodus parvus* Youngquist & Peterson, *J. Paleont.*, 21, 248, pl. 37, figs 11, 12.
1962 *Icriodus nodosus* Huddle (sic); Budurov, *Rev. Bulg. geol. Soc.*, 23, 263, pl. 2, fig. 3a, b only.
1965 *Icriodes* (sic) n. sp. Krebs & Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, pl. 2, figs 14, 15 only.
1968 *Icriodus angustus* Stewart & Sweet; Mound, *J. Paleont.*, 42, 487, pl. 66, figs 23, 33.

Material: 24 specimens; CPC 12481, 12482 figured.

Localities of figured material: Sample BG 19057 (CPC 12481), Section 4, north-east of McWhae Ridge, Sadler Limestone; BG 21242 (CPC 12482), Section 20, Longs Well Creek, Gogo Formation.

Description: A short unit with peg-like denticles. The denticles are arranged in an alternating pattern, but the species can be distinguished from *I. alternatus* by the occasional missing lateral denticle and the fact that the median row tends to be much longer than the lateral rows, which often consist of only 3 or 4 denticles. The median row commonly bears 7-9 denticles and there is a conspicuous posterior carina, usually formed of 3 laterally compressed denticles. The denticles on the platform are low and nodose. An anterior blade where present usually consists of 2 laterally compressed denticles.

Remarks: The peg-like denticles and the fact that some lateral denticles are often missing are very characteristic. The species is very close to *Pelekysgnathus*, species of which are commonly found in the same samples.

Distribution: The species was originally described from the Devonian and associated clays of Minnesota (Stauffer, 1940). Since then, it has been illustrated from Iowa (Youngquist & Peterson, 1947) and Alberta (Mound, 1968). In Europe, it has been illustrated by Krebs & Ziegler (1965) from Germany and by Budurov (1962) from Bulgaria. In Australia, Seddon (1970) has illustrated forms from the Canning Basin.

Range: The range of the nominate subspecies is unknown, but in the Canning Basin it occurs in the Lower and Middle *Polygnathus asymmetricus* Zone.

ICRIODUS BREVIS DARBYENSIS Klapper, 1958

(Pl. 32, figs 3a-c, 5a-7)

- ?1956 *Icriodus cornutus* Sannemann; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 125, pl. 10, fig. 42.
1958 *Icriodus darbyensis* Klapper, *J. Paleont.*, 32, 1086, pl. 141, figs 9, 11, 12.
1961 *Pelekysgnathus darbyensis* (Klapper); Ethington, Furnish, & Wingert, *J. Paleont.*, 35, 765, pl. 90, figs 12-17.

- ?1965 *Icriodus cymbiformis* Branson & Mehl; Loranger, private publ., 16, pl. 3, figs 11-13.
 1965 *Icriodus costatus* (Thomas); Anderson, *Iowa Acad. Sci.*, 72, pl. 1, figs 1, 2, 4, 5.
 1966 *Icriodus costatus* (Thomas); Anderson, *J. Paleont.*, 40, 406, pl. 52, figs 1, 2 only.
 1968 *Icriodus cornutus* Sannemann; Mound, *J. Paleont.*, 42, 487, pl. 66, figs 32, 34, 35.
 1970 *Icriodus brevis angustulus* Seddon, *J. geol. Soc. Aust.*, 16, 736, pl. 11, figs 13-18 only.

Material: 12 specimens; CPC 12483-6 figured.

Localities of figured material: Sample BG 19050 (CPC 12483-5), Section 3, McWhae Ridge, Sadler Limestone; BG 21242 (CPC 12486), Section 20, Longs Well Creek, Gogo Formation.

Remarks: The subspecies is characterized by the irregular occurrence of the lateral dentition, peg-like denticles, and the extension of the posteromedial denticles into a horn.

The horn develops first by an increase in height and often fusion of the two posterior denticles. In later development the fusion is complete and the horn tends to be inclined posteriorly (this type of horn development is seen in *I. alternatus*).

A further development is an increase in height in other but not all platform denticles. Often they are lateral or anterior denticles.

Distribution: The subspecies was first described by Klapper (1958) from Wyoming. It has also been illustrated from Wyoming by Ethington et al. (1961); from Iowa (Anderson, 1965, 1966); and from Alberta (Loranger, 1965; Mound, 1968). There is a solitary questionable occurrence in Germany (Bischoff, 1956).

Seddon (1970) has illustrated forms from the Canning Basin, Australia.

Range: The range of the subspecies is unknown, but in the Canning Basin it occurs in the Lower and Middle *Polygnathus asymmetricus* Zone.

ICRIODUS BREVIS SPICATUS Youngquist & Peterson, 1947

(Pl. 33, figs 1a-2b)

- 1947 *Icriodus brevis spicatus* Youngquist & Peterson, *J. Paleont.*, 21, 248, pl. 37, figs 8, 9.
 1968 *Icriodus* n. sp. Pollock, *J. Paleont.*, 42, 431, pl. 61, figs 6, 7, 13, 14, 16, 17 only.
 1969 *Icriodus* sp. Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 71, pl. 11, fig. 6a-c.

Material: 3 specimens; CPC 12487-8 figured.

Localities of figured material: Sample BG 19594 (CPC 12488), Section 13, Glenister Knolls, Gogo Formation; BG 21246 (CPC 12487), Section 20, Longs Well Creek, Gogo Formation.

Remarks: A subspecies characterized by the irregular development of the lateral peg-like dentition and an asymmetrical basal cavity. The inner side of the cavity develops a sulcus and a distinct notch in the margin anterior to the sulcus.

Distribution: The subspecies was first described by Youngquist & Peterson (1947) from Iowa. Elsewhere, it has been illustrated from Alberta, Canada (Pollock, 1968), and the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: The range of the subspecies is unknown, but in the Canning Basin it ranges throughout the *Polygnathus asymmetricus* Zone.

ICRIODUS BREVIS subsp. nov. a

(Pl. 22, fig. 41a-c)

1967 *Icriodus parvus* Youngquist & Peterson; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 39, pl. 3, fig. 11.

1968 *Icriodus* n. sp. Pollock, *J. Paleont.*, 42, 431. pl. 61, figs 8, 9, 15, 18.

?1968 *Icriodus alternatus* Branson & Mehl; Lange, *Geol. Paleont.*, 2, pl. 6, fig. 1c.

Material: 3 specimens; CPC 12489 figured, from sample BG 21242, Section 20, Longs Well Creek, Gogo Formation.

Remarks: A subspecies characterized by a small platform ornamented by peg-like denticles and irregular development of the lateral denticles and a wide flaring basal cavity producing an apron all around the unit. The flare is widest at the posterior, narrows anteriorly, and extends beyond the anterior termination as a 'siphon'.

Distribution: The subspecies has been illustrated from the Great Basin (Clark & Ethington (1967) and Alberta (Pollock, 1968). The specimens illustrated by Lange (1968) could belong here but also could be referred to *I. alternatus elegantulus*.

Range: The range of the subspecies is unknown, but in the Canning Basin it occurs in the Lower and Middle *Polgnathus asymmetricus* Zone.

ICRIODUS BREVIS subsp. nov. b

(Pl. 33, figs 3a-5b)

Material: 4 specimens; CPC 12490-2 figured, from samples BG 19058 (CPC 12490), BG 19117 (CPC 12491-2), Section 4, northeast of McWhae Ridge, Sadler and Bugle Gap Limestones.

Remarks: A subspecies characterized by an anterior extension of the median row to form an anterior free blade. The lateral dentition is still irregular; odd lateral denticles may occur on the anterior free blade.

Distribution: This is the first time that this subspecies has been illustrated.

Range: In the Canning Basin it occurs in the Frasnian *Polygnathus asymmetricus* Zone and as high as the Famennian Upper *Palmatolepis quadrantinodosa* Zone.

ICRIODUS INCRASSATUS INCRASSATUS Youngquist & Peterson, 1967

(Pl. 33, fig. 7a, b, c)

1947 *Icriodus incrassatus* Youngquist & Peterson, *J. Paleont.*, 21, 247, pl. 37, figs 1, 2, 25.

1949 *Icriodus constrictus* Thomas, *Bull. geol. Soc. Am.*, 60, 416, pl. 1, fig. 25.

1965 *Icriodus constrictus* Thomas; Anderson, *Iowa Acad. Sci.*, 72, pl. 1, figs 11, 13, 15.

1966 *Icriodus constrictus* Thomas; Anderson, *J. Paleont.*, 40, pl. 52, figs 14-16.

1966 *Icriodus constrictus* Thomas; Klapper, *Univ. Kansas paleont. Contr. Pap.* 3, 29, pl. 6, fig. 18.

Material: 4 specimens, CPC 12493 figured.

Locality of figured material: Sample BG 21090, Cave Spring, Sadler Limestone.

Description: A species characterized by irregular arrangement of the nodes; the pattern is neither truly alternating nor developed in rows. Many lateral nodes are

extended as transverse ridges, breaking up any symmetry of the ornament. The nominate subspecies lacks the characteristics used to distinguish the subspecies.

Remark: The dentition of *Icriodus brevis* is also irregular; but because some nodes are absent, not, as in this species, because irregular growth of platform nodes has destroyed the symmetry of the ornament.

Distribution: The species was first described from Iowa (Youngquist & Peterson, 1947), where it is common (Thomas, 1949; Anderson, 1965, 1966). The only other record is from Wyoming (Klapper, 1966).

Range: The range is unknown, but in the Canning Basin it ranges from the Middle *Polygnathus asymmetricus* Zone (Frasnian to Ia) as high as the Famennian Upper *Palmatolepis quadrantinodosa* Zone (to III β).

ICRIODUS INCRASSATUS subsp. nov. a
(Pl. 34, figs 1a-5)

1966 *Icriodus cornutus* Sannemann; Glenister & Klapper, *J. Paleont.*, 40, 804, pl. 95, figs 2, 3.

Material: 141 specimens; CPC 12494-8 figured.

Localities of figured material: Sample BG 19016 (CPC 12498), 19018 (CPC 12494), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19454D (CPC 12495), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21011 (CPC 12406, 12497) Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation; BG 21257, Section 20, Longs Well Creek, Gogo Formation.

Remarks: A subspecies characterized by extremely irregular development of the platform ornament and a large posterior horn. The platform ornament developed from an alternating pattern by the enlargement and extension of the lateral nodes into transverse and diagonal ridges which fuse with medial nodes, either adjacent or posteriorly. The posterior horn is very well developed. Sometimes, it consists of one lateral set of denticles which increase in height and incline posteriorly. The horn and ridge may curl inwardly and leave an opening on the other posterolateral margin, a character seen in the subspecies of *arkonensis* which developed a horn. Other horns are produced by the extension and growth of both lateral rows to form a rampart with a central trough. Still other horns are produced by the extension of the median row with no participation by the lateral rows.

Distribution: The subspecies has been illustrated from the Canning Basin (Glenister & Klapper, 1966). So far, this is the only known occurrence.

Range: In the Canning Basin the subspecies ranges from the Lower *Palmatolepis triangularis* Zone (uppermost Frasnian) as high as the Upper *Palmatolepis quadrantinodosa* Zone (to II β).

ICRIODUS INCRASSATUS subsp. nov. b
(Pl. 34, fig. 6a-c)

Material: 2 specimens; CPC 12499 figured, from sample BG 19018, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: The subspecies is characterized by its irregular dentition and the flaring of the basal cavity. The flaring is greatest on the outer side and at the posterior end.

Distribution and Range: The subspecies has only been recorded from the Canning Basin, where it occurs in the Famennian Lower *Palmatolepis crepida* Zone (toIIa).

ICRIODUS INCRASSATUS subsp. nov. c
(Pl. 35, figs 1a-4b)

Material: 40 specimens; CPC 12500-3 figured.

Localities of figured material: Samples BG 19106 (CPC 12500), 19115 (CPC 12501), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 19594 (CPC 12502), Section 13, Glenister Knolls, Gogo Formation; BG 21242 (CPC 12503), Section 20, Longs Well Creek, Gogo Formation.

Remarks: This subspecies is characterized by irregular dentition and an asymmetrical cavity with a distinct notch in the outer edge. The irregular dentition shows that it is closely related to the nominate subspecies and that forms with a horn and a flaring base belong to a different lineage. The posteriormost denticle of the median row on some specimens is very similar to *Icriodus arkonensis* s.s.

Distribution and Range: The subspecies is known only from the Canning Basin, where it ranges from the Lower *Polygnathus asymmetricus* Zone (toIa) up to the Upper *Palmatolepis quadrantinodosa* Zone (toIIIa).

ICRIODUS INCRASSATUS subsp. nov. d
(Pl. 97, figs 1a-3c)

Material: 7 specimens; CPC 13839-41 figured.

Locality of figured material: Sample BG 21530 (CPC 13839), 2.5 km south of Teichert Hills, Virgin Hills Formation; BG 21571 (CPC 13840, 13841) McWhae Ridge, Virgin Hills Formation.

Remarks: The development of nodes on the oral surface of the basal cavity and their extension to form lateral processes is common in Early Devonian forms, referred to as the *latericrescens* group. Icriodids with lateral dentition are extremely rare in the Late Devonian but appear to be a natural development from forms with asymmetrical basal cavities.

Distribution and Range: The subspecies has only been recorded from the Canning Basin, where it occurs throughout the Famennian *Palmatolepis crepida* Zone (toIIa).

ICRIODUS SYMMETRICUS SYMMETRICUS Branson & Mehl, 1934
(Pl. 35, figs 5a-8b)

1934 *Icriodus symmetricus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 226, pl. 13, figs 1-3.

1938 *Icriodus symmetricus* Branson & Mehl; Branson & Mehl, *J. Paleont.*, 12, 161, pl. 26, figs 1-3.

- 1960 *Icriodus expansus* Branson & Mehl; Müller, *Geol. Rdsch.*, 49, pl. 2, fig. 3.
 1961 *Icriodus symmetricus* Branson & Mehl; Freyer, *Freib. Forsch.*, C95, 48, text-fig. 36 (right-hand side).
 1962 *Icriodus curvatus* Branson & Mehl; Budurov, *Rev. Bulg. geol. Soc.*, 23, 263, pl. 2, figs 5a, b, 7a-c, 9a-10.
 1964 *Icriodus symmetricus* Branson & Mehl; Orr, *Ill. St. geol. Surv. Circ.* 361, 10, pl. 2, figs 15a, b.
 1966 *Icriodus symmetricus* Branson & Mehl; Anderson, *J. Paleont.*, 40, 407, pl. 52, fig. 7.

Material: 62 specimens; CPC 12504-7 figured.

Localities of figured material: Samples BG 19534 (CPC 12504), 19537 (CPC 12505), Section 9, Balme Knoll, Virgin Hills Formation; BG 21229 (CPC 12506, CPC 12507), Sadler Ridge, Sadler Formation.

Description: An elongate icriodid with distinctive oral dentition. The dentition is arranged in three linear rows; each denticle is subjacent. The medial row nodes are elongate antero-posteriorly with a low ridge connecting each. The lateral nodes are also connected to median nodes, especially in the posterior half. The nodes number 7-9 in each row. The medial row extends posteriorly beyond the lateral rows. The extension is of 2 or 3 denticles which in some specimens became taller and horn-like.

Distribution: The nominate subspecies was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934), and has also been illustrated from Illinois (Orr, 1964) and Iowa (Anderson, 1966). In Europe the species has been illustrated from Germany (Müller, 1960; Freyer, 1961) and Bulgaria (Budurov, 1962).

Range: The exact range of the nominate subspecies is unknown. In the Canning Basin it is recorded from the Lower *Polygnathus asymmetricus* Zone (toIa) to the *Ancyrognathus triangularis* (toI8) of the Frasnian).

ICRIODUS SYMMETRICUS CIRCULARIS Youngquist & Peterson, 1947

(Pl. 22, figs 2a, b; Pl. 36, figs 1a-3b)

- 1947 *Icriodus circularis* Youngquist & Peterson, *J. Paleont.*, 21, 246, pl. 37, fig. 15.
 1959 *Icriodus nodosus* (Huddle); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 62, pl. 6, figs 2, 3.
 ?1967 *Icriodus nodosus* (Huddle); Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 218, pl. 20, figs 24a, b.
 1967 *Icriodus cornutus* Sannemann; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 37, pl. 3, figs 3, 4.
 1970 *Icriodus nodosus rectirostratus* Bultynck, *Mem. Inst. Geol. Univ. Louvain*, 26, 107, pl. 3, fig. 1; pl. 30, figs 7, 8.

Material: 29 specimens; CPC 12508-11 figured.

Localities of figured material: Sample BG 19534 (CPC 12508-10), Section 9, McPhee Knoll, Virgin Hills Formation; BG 21235 (CPC 12511), Section 19, Sadler Ridge, Sadler Limestone.

Remarks: A subspecies characterized by linear dentition both longitudinally and transversely and by an asymmetric basal cavity with a distinct notch in the inner margin. Forms with both elongate and short linear dentition are illustrated.

Distribution: The subspecies was originally described from Iowa (Youngquist & Peterson, 1947). The only other illustrated occurrence in North America is from the Great Basin of Utah-Nevada (Clark & Ethington, 1967).

In Europe the subspecies has been illustrated by Bischoff & Ziegler (1959) from Germany, Bultynck (1970) from Belgium, and Wirth (1967) from Spain, though the assignment of Wirth's specimen is questionable.

Range: The range of the subspecies is unknown, but in the Canning Basin it ranges from the Lower *Polygnathus asymmetricus* Zone (toIa) to the Lower *Palmatolepis gigas* Zone (toIδ).

ICRIODUS SYMMETRICUS EXPANSUS Branson & Mehl, 1938
(Pl. 36, figs 4a-7b)

1938 *Icriodus expansus* Branson & Mehl; *J. Paleont.*, 12, 160, pl. 26, figs 18-21.

1949 *Icriodus* cf. *I. rectus* Youngquist & Peterson; Thomas, *Bull. geol. Soc. Am.*, 60, pl. 1, figs 17, 18.

1965 *Icriodus* sp. Merrill, *Texas J. Sci.*, 17, 380, pl. 4, fig. 7 only.

1965 *Icriodus iowaensis* Youngquist & Peterson; Anderson, *Iowa Acad. Sci.*, 72, pl. 1, figs 17, 18.

Material: 16 specimens; CPC 12512-5 figured.

Localities of figured material: Sample BG 19537 (CPC 12512), Section 9, McPhee Knoll, Virgin Hills Formation; BG 21191 (CPC 12513), Section 18, Kudata Gap, Sadler Limestone; BG 21231 (CPC 12514), 21232 (CPC 12515), Section 19, Sadler Ridge, Sadler Limestone.

Remarks: The subspecies is characterized by the development of linear dentition, both longitudinally and laterally, and by its relative shortness. Commonly only 5 or 6 nodes are developed in the lateral rows and the unit is wider than the nominate subspecies. The central row extends about 2 nodes beyond the lateral rows.

The subspecies is easily distinguished from the nominate subspecies and it appears that they could have developed along different phylogenetic lines.

Distribution: The original description was by Branson & Mehl (1938) from several localities in Missouri, New York, Ohio, Indiana, Arkansas, and Michigan.

The subspecies has also been described from Iowa (Thomas, 1949; Anderson, 1966) and Texas (Merrill, 1965). This is the first record outside North America.

Range: The range of the subspecies is unknown is unknown, but in the Canning Basin it ranges from the Lower *Polygnathus asymmetricus* Zone (toIa) as high as the Lower *Palmatolepis gigas* Zone (toIδ).

ICRIODUS SYMMETRICUS subsp. nov. a
(Pl. 36, figs 8a-9c)

Material: 2 specimens, CPC 12516-7, both figured, from sample BG 19534, Section 9, Balme Knoll, Virgin Hills Formation.

Remarks: A subspecies characterized by the development of linear dentition both longitudinally and transversely and a flaring basal cavity. The flaring tends to be

greatest on the inner side and possesses a crinkle in the basal apron, showing the close relationship to forms with a well developed basal notch.

Distribution and Range: The subspecies is only known from the Canning Basin, though some specimens illustrated by Bultynck (1970) as *I. regularicrescens* probably belong to it. In the Canning Basin it occurs in the upper half of the *Polygnathus asymmetricus* Zone.

Phylogeny of *Icriodus*

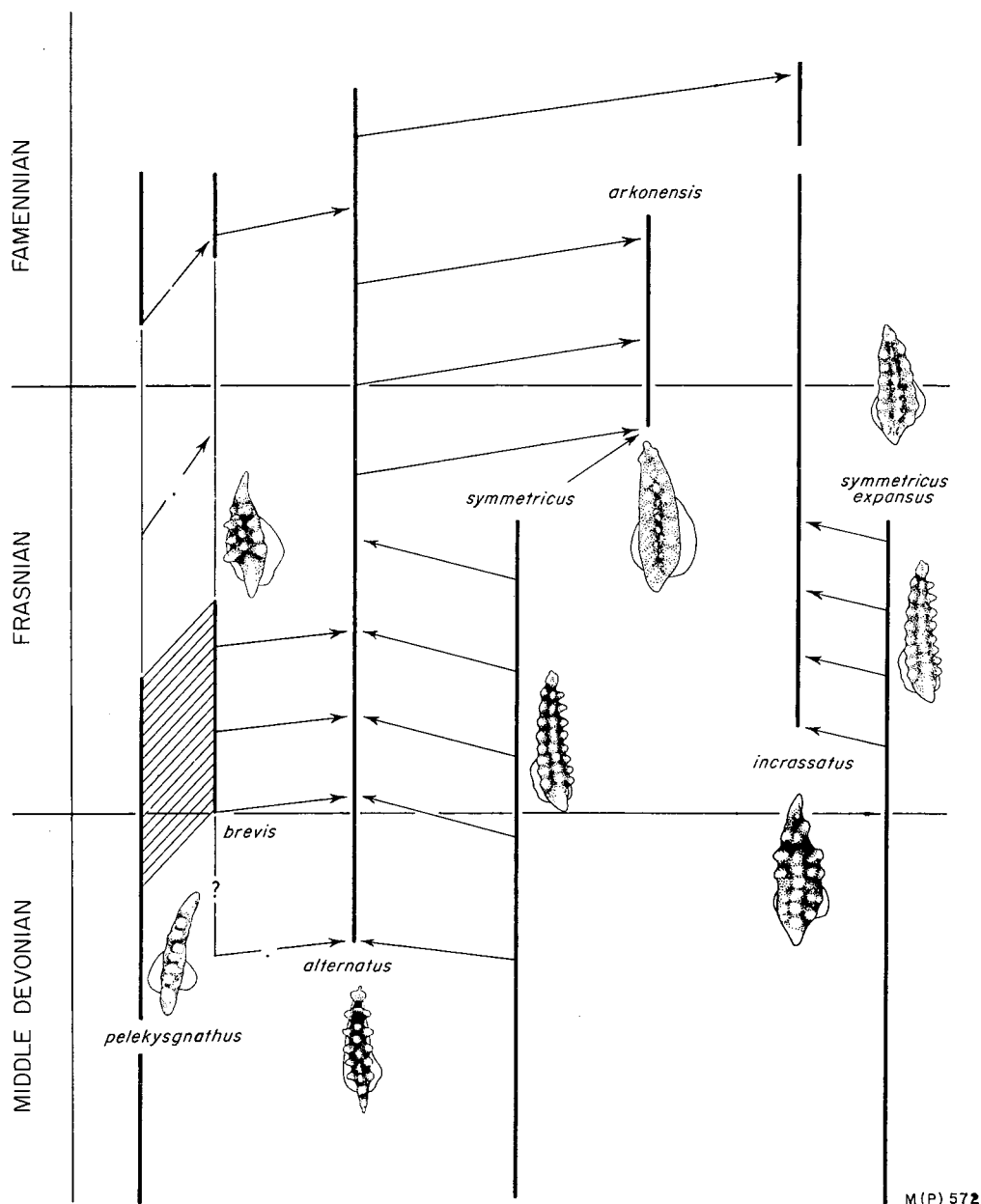
It is rather difficult to discuss *Icriodus* phylogeny, owing to the plasticity of the genus in its evolutionary development and the state of flux of the nomenclature. However, in discussing the major denticle type (species in this publication) it is possible to see some phylogenetic development. I am going to discuss only the phylogenetic development in the Late Devonian, although, in fact, it is probable that similar homeomorphic developments took place in the Middle Devonian.

In the Late Devonian it appears that there were three Middle Devonian root stocks. The first is *Pelekyognathus*, which is known from the earliest Devonian and presumably has contributed to the icriodid stock at several times. Secondly, there is *Icriodus symmetricus* s.s., which ranges from the Middle Devonian into the Frasnian; and thirdly, there is *Icriodus symmetricus expansus*, which also ranges from Middle Devonian into Frasnian.

The main phylogenetic changes appear to take place because of changes in environment, probably mainly water depth, but there is a general temporal change from transverse linear dentition to alternating dentition. Forms referred to *Icriodus symmetricus* are not known from strata younger than the Lower *Palmatolepis gigas* Zone (Frasnian to I8). *I. symmetricus* seems to develop along two lineages. Firstly, the transverse linear dentition breaks down and becomes alternating. Intermediate forms show alternating dentition on the posterior half and transverse linear dentition on the anterior half. Specimens of *I. alternatus* with *I. symmetricus* ancestors commonly show chevron-type alternation. *I. symmetricus* also develops into *I. arkonensis* by reduction of the central row of nodes and the formation of a trough. The lateral nodes become elongate transversely and pear-shaped.

A subspecies of *I. symmetricus*, *expansus*, appears to belong to a separate lineage, and is characteristically shorter and wider. In the early Frasnian it gives rise to *Icriodus incrassatus*, which ranges up to the Upper *Palmatolepis quadrantodosa* Zone; but not all the subspecies of *I. incrassatus* are of the *I. symmetricus expansus* lineage. This evolutionary trend is probably an adaptation to a shallower water environment.

The third ancestral form is *Pelekyognathus*. This is considered to be a shallow-water genus (Druce, 1969, 1973; Seddon, 1970a) and it shows an intimate evolutionary relationship with *Icriodus brevis* (Klapper, 1966; Seddon, 1970a). In the present faunas the evolutionary development is seen in the early Frasnian and also in the Famennian. The development of icriodid dentition appears to be an adaptation to a deeper water environment, although *I. brevis* is considered to be a shallow-water form with respect to the overall conodont fauna. If the development of icriodid dentition is just an environmental adaptation there is not necessarily



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Fig. 19. Phylogeny of the genus *Icriodus* in the Late Devonian.

any stratigraphic significance in its development and those horizons which yield it in the Canning Basin reflect changing conditions in the Basin. Thus the transition from *Pelekysgnathus* to *Icriodus* cannot be used in correlation.

Icriodus brevis develops into forms referable to *I. alternatus*, but *I. alternatus* forms can also develop from the *I. symmetricus* lineage; the forms developed from

I. brevis can be distinguished by symmetrical alternation of the denticles rather than the chevron type developed in descendants of *I. symmetricus*. This difference probably becomes less apparent with time. However, *I. alternatus* forms probably developed in the Middle Devonian from both *I. symmetricus* forms and *Pelekysgnathus*.
x

Icriodus alternatus also gave rise to *I. arkonensis*. In some specimens of *arkonensis* the median row is reduced, rather than absent, and the alternating nature of the dentition can be seen. *I. arkonensis* arose by reduction and elongation of the medial nodes; finally the medial row disappeared and a trough developed.

Unfortunately, this phylogeny is of little use in interpreting chronostratigraphy because these evolutionary sequences probably occur more than once and possibly at different horizons in different basins. For example, *I. arkonensis* develops in the Middle Devonian of Ontario (Stauffer, 1938; Stumm & Wright, 1958); its only other known occurrence is in the Canning Basin, where it occurs in the latest Frasnian and early Famennian.

Phylogenetic Relationships Between Subspecies of the Genus Icriodus

The minor characters on which I have based by subspecific divisions appear to be environmentally controlled. For example, in Figure 17 it can be seen that of the many modifications which can effect icriodids, only a few are found in the present fauna, but that those present tend to be found on all dentition forms (species). This suggests that these modifications are environmental rather than phylogenetic. In Figure 18 we see that these modifications are commonly found in sediments directly overlying stromatolite horizons whose upper surface is covered by oriented nautiloids. Playford & Cockbain (1969) consider these horizons to indicate basinwide shallowing of the Late Devonian sea. Thus, it would appear that the major environmental feature affecting the possession of minor characters is water depth. The development of a wide-flaring basal cavity, an asymmetrical cavity with a distinct notch, and a posterior horn are considered to be shallow-water modifications. It is interesting that, considering that conodonts were probably covered by tissue (Lindström, 1964, pl. 123), all these features increase the surface area and power of attachment of the conodont unit, presumably giving the animal greater efficiency in the higher-energy environments.

However, with regard to platform ornamentation environmental considerations are also obvious. *Icriodus brevis* is a shallow-water form, whereas *I. symmetricus* appears to be a deeper water form, as is *I. alternatus*. *I. arkonensis* and *I. incrassatus* appear to be shallow-water forms, or more probably intermediate.

Thus, in response to environment three possible changes can take place:

1. Changes within a species at the subspecific level. The surface ornament remains constant but the minor characters change.
2. Changes at specific rank but with the minor characters remaining constant. In these cases only the surface ornament is changed.
3. Changes at both specific and subspecific level. In these cases both the surface ornament and minor characters alter.

The taxonomy suggested here is also shown to be artificial. For instance, subspecies of *Icriodus incrassatus* may be more closely related to subspecies of other species than to each other.

Conclusions

The apparent dependence of icriodid morphology on environmental factors creates difficulty in delineating species. The artificial classification of morphologic characters can be used to divide the Late Devonian icriodids; this division furnishes information on the ecological conditions rather than illustrating phylogenetic relationships.

Certain morphological characters (i.e. wide flaring basal cavity, basal asymmetry, and horn-like nodes) are considered to be shallow-water adaptations rather than genetic characters. If this is correct, then it would appear that a close study of these characters in other genera may show similar environmental adaptations.

Similarly, the presence of a median trough or irregular dentition, or symmetrical dentition, may be important in ecological considerations.

Genus KLADOGNATHUS Rexroad, 1958

Type species: Cladognathus prima Rexroad, 1957.

?KLADOGNATHUS sp.

(Pl. 37, figs 1a-2)

Material: Two specimens, CPC 12522-3, both figured, from samples BG 19001 (CPC 12522), 19019 (CPC 12523), Section 1, McWhae Ridge, Gogo and Virgin Hills Formations.

Remarks: Two specimens appear to be pathological variants of *Hindeodella*, possessing an extra lateral process at or near the apical denticle. In both the process is short, bearing 5 isolated denticles on one specimen and 2 on the other. The overall plan is similar to *Kladognathus* Rexroad. However, this genus is typically Chesterian (late Early Carboniferous) and is not known from any other levels. Thus, I prefer to regard these forms as pathological rather than as true representatives of the genus *Kladognathus*. The specimens come from the Lower *Polygnathus asymmetricus* Zone (CPC 12522) and the Middle *Palmatolepis crepida* Zone (CPC 12523).

Genus LIGONODINA Bassler, 1925

Type species: Ligonodina pectinata Ulrich & Bassler, 1926.

LIGONODINA MAGNIDENS Ulrich & Bassler, 1926

(Pl. 37, figs 3a, b, 5)

1926 *Ligonodina magnidens* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 12, pl. 2, figs 5, 6.

1968 *Ligonodina magnidens* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 18, pl. 9, fig. 8; pl. 10, figs 9, 12, 14-16; pl. 11 (figs 1-4 (Synonymy to 1968).

1970 *Ligonodina magnidens* Ulrich & Bassler; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 15, figs 11, 15.

Material: 14 specimens; CPC 12524-5 figured.

Localities of figured material: Sample BG 19016 (CPC 12524), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19081 (CPC 12525), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Description: An arched ligonodinid unit. The apical denticle is massive, twice as large as any bar denticles, and is slightly twisted and laterally compressed. The lateral bar is short and at an angle of 90° to the rest of the unit, and is depressed through 45° ; it lies slightly behind the apical denticle, and bears up to 5 needle-like isolated denticles which curve toward the posterior of the unit.

The posterior bar is fairly massive and long, bearing a sequence of denticles which increase greatly in size and posterior inclination toward the posterior termination. The dentition on some specimens is cyclic, large and small denticles alternating.

Remarks: *Ligonodina magnidens* can be distinguished from *L. panderi* by the slightly anterior position of the lateral bar with respect to the apical denticle.

Distribution: Apart from the previous recognition of this species in the Canning Basin (Seddon, 1970a) it has only been reported from the Rhinestreet Shale Member of the West Falls Formation, New York (Huddle, 1968).

Range: In New York the species occurs in a horizon dated as toI β . In the Canning Basin the species ranges from the Lower *Polygnathus asymmetricus* Zone (toI α) to the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

LIGONODINA PANDERI (Hinde, 1879)

(Pl. 37, fig. 41)

1879 *Prioniodus panderi* Hinde, *Quart. J. geol. Soc. Lond.*, 35, 361, pl. 16, fig. 4.

1968 *Ligonodina panderi* (Hinde); Huddle, *U.S. geol. Surv. Prof. Pap.* 578, 19, pl. 9, fig. 11; pl. 10, figs 1-8, 11 (Synonymy to 1968).

1970 *Ligonodina panderi* (Hinde); Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 15, figs 8, 10.

Material: 20 specimens; CPC 12526-7 figured, from sample BG 19583, Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Description: An elongate ligonodinid with a long posterior bar and short lateral bar. The apical denticle is massive, twice as tall and wide as any bar denticles, laterally compressed, twisted, and posteriorly inclined. The lateral bar is short, depressed through about 60° , and recurved slightly towards the posterior of the unit. The denticles number from 2 to 4 and are isolated, needle-like, and inclined towards the posterior. The posterior bar is elongate, bearing a sequence of isolated, needle-like denticles.

The basal cavity is situated beneath the apical denticle and extends along the posterior bar as a narrowing trough.

Remarks: The clean sweep of the anterior face of the apical denticle and the anterior face of the lateral process distinguishes this species from *L. magnidens*.

Distribution: The holotype comes from Kettle Point, Ontario. The species is also known from New York, Ohio, and Indiana (Huddle, 1968). Huddle also points out that it is known from Germany and France. Recently, it has been described from the Canning Basin (Seddon, 1970a).

Range: Huddle (1968) records the range as Eifelian to upper Famennian. In the Canning Basin the species ranges from Lower *Polygnathus asymmetricus* Zone (toI α) to the Upper *Palmatolepis quadrantinodosa* Zone (toIII α).

LIGONODINA SPICULATA (Ulrich & Bassler, 1926)

(Pl. 38, fig. 1a, b)

1926 *Prioniodus spiculatus* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 9, pl. 9, figs 2, 3.

For complete synonymy up to 1968 see:

1968 *Ligonodina spiculata* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 21, pl. 9, fig. 10.

Material: CPC 12528 figured, from sample BG 21226, Section 19, Sadler Ridge, Sadler Limestone.

Description: A ligonodinid with an elongate lateral bar, bearing 5 isolated denticles which are curved towards the posterior. The posterior bar is elongate and bears up to 8 isolated, needle-like denticles.

Distribution: The species was originally described from the 'Hardin Sandstone', Tennessee. In the Canning Basin the single specimen, the only other record of the species, was recovered from earliest Frasnian strata.

LIGONODINA sp. nov. A

(Pl. 38, fig. 3a, b)

Material: 6 specimens; CPC 12529 figured, from sample BG 19005, Section 1, McWhae Ridge, Gogo Formation.

Description: A delicate ligonodinid with fairly deep bars and a deep and slightly flared basal cavity. The dentition is small, cyclic, and needle-like.

Range: The species ranges from the Lower *Polygnathus asymmetricus* Zone (toI α) to the Upper *Palmatolepis gigas* Zone (toI δ).

LIGONODINA sp. nov. B

(Pl. 38, fig. 4a, b)

Material: 4 specimens; CPC 12530 figured, from sample BG 19113, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: A massive ligonodinid with a reflexed lateral bar. The apical denticle is nearly upright and is massive. The lateral bar is flexed towards the posterior and is then reflexed toward the anterior. The posterior bar bears 4 massive denticles toward the posterior end. The anterior half of the bar bears minute needle-like denticles.

Range: The species ranges from the Upper *Polygnathus asymmetricus* Zone (toI β) to the Upper *Palmatolepis quadrantinodosa* Zone (toIII α).

LIGONODINA sp.

(Pl. 39, fig. 2)

Material: 2 specimens; CPC 12531 figured, from sample BG 19061, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Description: A small ligonodinid with no conspicuous apical denticle. The lateral bar curves away from the posterior bar and bears 3 small denticles. Both bars are deep; the posterior bar bears a sequence of denticles which increase in height posteriorly. They are fused at their bases with free chevron tips.

Range: The two specimens occur in the Frasnian *Ancyrognathus triangularis* Zone and the basal Famennian Zone of *Palmatolepis triangularis*.

? LIGONODINA sp.

(Pl. 39, fig. 1a, b)

Material: A single specimen, CPC 12532 figured, from sample BG 19166, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: A small arched unit with needle-like denticles. The lateral bar is flexed and deflected through about 45°, but the peculiar inclination of all the bar denticles gives the impression that it is just a simple arched unit. It may be a transition between a ligonodinid and an apatognathid form.

Occurrence: The single specimen was recovered from the Lower *Polygnathus styriacus* Zone (toIV).

Genus LONCHODINA Bassler, 1925

Type species: *Lonchodina typicalis* Ulrich & Bassler, 1926.

LONCHODINA ARCUATA Ulrich & Bassler, 1926

(Pl. 44, figs 2a-4b; Pl. 93, fig. 8a-c)

1926 *Lonchodina arcuata* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 32, pl. 5, fig. 15.

1968 *Lonchodina arcuata* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 21, pl. 11, figs 5-13 (Synonymy).

Material: 20 specimens, CPC 12831-4 figured.

Localities of figured specimens: Sample BG 19502 (CPC 12831), Section 7, Laidlaw Range-Emanuel Range, Gogo Formation; BG 19534 (CPC 12832), Section 9, Balme Knoll, Gogo Formation; BG 19582 (CPC 12833), 19585 (CPC 12834), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Occurrence: The species was originally described from the 'Hardin Sandstone' of Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). It is also known from Indiana (Huddle, 1934), Missouri (Branson & Mehl, 1934), and New York (Holmes, 1928). In Europe it has been reported from Germany (Bischoff & Ziegler, 1956, 1957) and France (Lys & Serre, 1957). Ethington & Furnish (1962) report the species from the Spanish Sahara.

Range: Unknown; Bischoff & Ziegler (1957) record it from the Middle Devonian. In the Canning Basin the species occurs from the *Polygnathus asymmetricus* Zone (toIa/β) to the Middle *Palmatolepis crepida* Zone (toIIa).

LONCHODINA PERLONGA Ulrich & Bassler, 1926

(Pl. 44, fig. 1a-c; Pl. 45, fig. 1a-b)

1926 *Lonchodina perlonga* Ulrich & Bassler, *Proc. U.S. nat. Mus.* 68, 32, pl. 5, figs 6, 7.

1968 *Lonchodina perlonga* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 22, pl. 12, figs 1-3 (Synonymy).

Material: 5 specimens, CPC 12835-6 figured.

Localities of figured material: Sample BG 19583 (CPC 12835), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 21371 (CPC 12836), Section 24, Teichert Hills, Sadler Limestone.

Occurrence and Range: The species has only been reported from New York (Ulrich & Bassler, 1926) in the *Ancyrognathus triangularis* Zone (Frasnian to I8). The present specimens range from the *Polygnathus asymmetricus* Zone into the *A. triangularis* Zone.

LONCHODINA TYPICALIS Bassler, 1925

(Pl. 45, figs 2, 3, 5)

1925 *Lonchodina typicalis* Bassler, *Bull. geol. Soc. Am.*, 36, 219.

1926 *Lonchodina typicalis* Bassler; Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 31, pl. 5, fig. 1 only.

1968 *Lonchodina typicalis* Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 23, pl. 12, figs 14-22 (Synonymy).

Material: 15 specimens, CPC 12837-9 figured.

Localities of figured material: Sample BG 19543 (CPC 12837), Section 9, McPhee Knoll, Gogo Formation; BG 19594 (CPC 12838), 21003 (CPC 12839), Section 13, Glenister Knolls and *Timanites* Hill, Gogo Formation.

Occurrence and Range: The species was originally described from the *Ancyrognathus triangularis* Zone of the West Falls Formation of New York (Ulrich & Bassler, 1926). It is also known from Indiana (Huddle, 1934), Iowa (Youngquist & Miller, 1948), and Ohio (Bond, 1947). In Europe it has been reported from the Givetian to the Frasnian (Bischoff & Ziegler, 1957). The Canning Basin specimens are all from the *Polygnathus asymmetricus* Zone.

LONCHODINA sp. nov. A

(Pl. 45, figs 4a, b; 6; Pl. 46, fig. 1; Pl. 94, fig. 4)

Material: 12 specimens, CPC 12840-3 figured.

Localities of figured material: Sample BG 19538 (CPC 12840), Section 9, Balme Knoll, Virgin Hills Formation; BG 21107 (CPC 12841), 6.5 km northeast of Galeru Gorge, Virgin Hills Formation; BG 21210 (CPC 12482), Section 19, Sadler Ridge, Sadler Limestone; BG 21371 (CPC 12485), Section 24, Teichert Hills, Sadler Limestone.

Remarks: These specimens are similar to *L. discreta* Ulrich & Bassler, which Huddle (1968, p. 22) considers to fall within the range of variability of *L. arcuata*.

Range: The specimens range from the Lower *Polygnathus asymmetricus* Zone to the *Ancyrognathus triangularis* Zone.

Genus NEOPRIONIODUS Rhodes & Müller, 1956

Type species: *Prioniodus conjunctus* Gunnell, 1931.

NEOPRIONIODUS ARMATUS-ALATUS group
(Pl. 39, figs 3a-6b; Pl. 40, figs 1a, b, 5a, b)

1879 *Prioniodus ? alatus* Hinde, *Quart. J. geol. Soc. Lond.*, 35, 361, pl. 16, fig. 5.

1879 *Prioniodus armatus* Hinde, *ibid.*, 360, pl. 15, figs 20, 21.

For complete synonymy of both species see:

1968 *Neoprioniodus alatus* (Hinde); Huddle, *U.S. geol. Surv. prof. Pap.* 578, 25, pl. 6, figs 1, 2.

1968 *Neoprioniodus armatus* (Hinde); Huddle, *ibid.*, 25, pl. 6, fig. 11, pl. 7, figs 1, 4.

Material: 18 specimens, CPC 12533-8 figured.

Localities of figured material: Sample BG 19001 (CPC 12537), Section 1, McWhae Ridge, Gogo Formation; BG 19072 (CPC 12536), 19170 (CPC 12535), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone; BG 19583 (CPC 12533, 12534), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 21361 (CPC 12538), Section 23, Geikie Gorge, Napier Formation.

Remarks: Freyer (1961, p. 78) demonstrates that there is a complete gradation from *N. armatus* to *N. alatus*. *N. armatus* is distinguished by having a narrower main cusp and a longer posterior bar. *N. alatus* has a wide apical denticle formed by the fusion of bar denticles and a reduced posterior bar with considerable denticle fusion. The specimens in this fauna lie between the end members of the morphological sequence, but many of them appear to be intermediate, and so I have discussed the two species as a group rather than separately.

Huddle (1968, p. 25) notes that secondary dentition is often present on the ante-cusp. He suggests that this may be the result of a synprioniodinid ancestry. However, the presence of secondary denticles on the ante-cusp does not appear to be necessarily inherited and most neoprioniodid species exhibit secondary dentition on some specimens. The development may be due to ecological rather than phylogenetic factors.

Distribution: The species are widely distributed around the world. They were first described by Hinde from New York State, and since then have been reported from Ohio (Stauffer, 1938; Bond, 1947), Indiana (Huddle, 1934), Michigan (Müller & Clark, 1967), Illinois (Orr, 1964), Iowa (Youngquist, 1945; Youngquist & Peterson, 1947), Missouri (Branson & Mehl, 1934; Scott & Collinson, 1961), Tennessee (Hass, 1956), Oklahoma (Cooper, 1939), Nevada (Clark & Ethington, 1967), Montana (Cooper & Sloss, 1943), and Alberta (Mound, 1968). In Europe the species are common in Germany (Beckmann, 1949; Sannemann, 1955; Bischoff, 1956; Bischoff & Ziegler, 1957; Helms, 1959; Zimmerman, 1960; Freyer, 1961; and Stoppel & Zscheke, 1966); Britain (Rhodes & Dineley, 1957); Portugal (Boogaard, 1963); France (Lys & Serre, 1957; Boyer et al., 1968); Belgium (Bultynck, 1970); Austria (Schönlaub, 1969a); Czechoslovakia (Friakova, 1964); and Poland (Nehring, 1967; Wolska, 1967).

The group has previously been reported from the Canning Basin (Seddon, 1970a).

Range: The species occur as low as the Middle Devonian (Eifelian) (Bultynck, 1970). The youngest occurrence is in the Lower Carboniferous pre-Welden shale of Oklahoma (Cooper, 1939). The Canning Basin specimens range throughout the section.

NEOPRIONIODUS SEMISEPARATUS (Branson & Mehl, 1934)

(Pl. 40, figs 4, 6)

1934 *Prioniodus semiseparatus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 206, pl. 15, figs 9, 10.

Material: 15 specimens, CPC 12540-1 figured.

Localities of figured material: Sample BG 1910⁴ (CPC 12540), Section 4, north-east of McWhae Ridge, Virgin Hills Formation; BG 21225 (CPC 12541), Section 19, Sadler Ridge, Sadler Limestone.

Description: A neoprioniodid with a massive apical denticle and a long, deflected, and depressed posterior bar. The bar denticles number up to 15 and are discrete or barely fused at their bases and about one-third the size of the apical denticle. The fairly deep posterior bar is marked on its lower half by an attachment scar and in some specimens by an inverted basal cavity. A basal pit lies beneath the apical denticle and on the inner side the aboral cavity lip is flared slightly.

Remarks: Huddle (1968, p. 25) includes *N. semiseparatus* in *N. armatus*. However, the much greater depression of the posterior bar, its greater depth, and attachment scar all serve to distinguish it. Branson & Mehl (1934) note germ denticles on the ante-cusp, and several specimens in the present fauna also exhibit this feature.

Distribution and Range: The species was originally described from the Upper Devonian Grassy Creek shale of Missouri (Branson & Mehl, 1934). In the Canning Basin the species ranges from the earliest Late Devonian as high as the Famennian Lower *Polygnathus styriacus* Zone (toIV).

NEOPRIONIODUS sp. nov. A

(Pl. 40, figs 2a, b)

Material: 11 specimens, CPC 12539 figured.

Localities of figured material: Sample BG 21278, Section 21, Margaret River-Needle-Eye Rock, Virgin Hills Formation.

Description: A delicate neoprioniodid with a slender apical denticle and a short posterior bar bearing a sequence of fine needle-like, partly fused denticles. The ante-cusp is fairly long and a small basal cavity lies at the junction of the bar and the posterior face of the ante-cusp. The ante-cusp occasionally bears fine denticles, and some forms have developed enough of an anterior bar to be referred to *Euprioniodina*.

Range: The species is stratigraphically restricted in the Canning Basin to the *Palma-tolepis rhomboidea* and *P. quadrantinodosa* Zones of the Famennian (toII β -lower toIII α).

Genus NOTHOGNATHELLA Branson & Mehl, 1934

Type species: Nothognathella typicalis Branson & Mehl, 1934.

Nothognathella was erected by Branson & Mehl to include arched forms with 'an outer and inner flange'.

Nothognathellids have the basic morphology of ozarkodinids with the addition of platforms. The general phylogenetic tendency of the group is to develop an increasingly large and nodose platform and reduce the posterior blade and become pseudo-platforms. These general phylogenetic tendencies are recorded in Figure 20. The ranges in the Canning Basin lie outside the maximum ranges recorded elsewhere.

Nothognathellids appear to have evolved along two lines. One root stock is *N. sublaevis* and the other is either *N. abnormis* Branson & Mehl or *N. brevidonta* Youngquist. I prefer *abnormis* because of its obvious primitive character; however, it appears later in the geological column than *brevidonta*.

Nothognathella sublaevis group

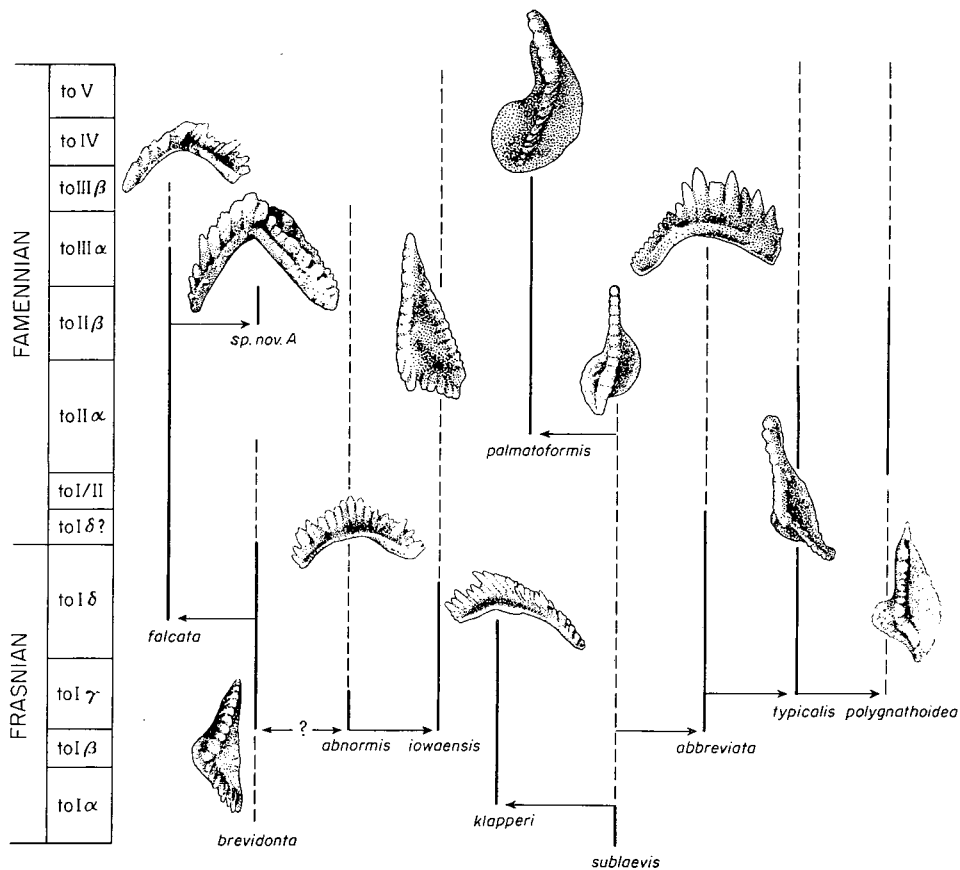
N. sublaevis is characterized by a coxcomb-like blade with small ornate platforms confined to the posterior end. It gives rise to two species, *N. klapperi*, an aberrant line in which two of the blade denticles become enlarged, one over the basal cavity and the other half way to the anterior termination. The platform is larger and bears nodes rather than 'shagreen' ornament of *N. sublaevis*. The other species is *N. abbreviata* Branson & Mehl, which is very similar to *N. sublaevis* in platform development, with the addition of nodes, but has a shorter posterior carina.

The next development is *N. typicalis* Branson & Mehl, in which the blade height continues to decrease and the platforms are enlarged and nodose. The culmination of this development is *N. polygnathoidea*, with a platform as large as, or larger than, most polygnathid platforms, the anterior part of the blade developed as a free blade, and the posterior part low and carina-like. One late development from *N. sublaevis* is a large platform retaining the 'shagreen' ornament. The posterior part of the blade is greatly reduced and the unit looks like a palmatolepid but lacks the azygous node. I have named it *N. palmatoformis*.

Nothognathella abnormis group

The most primitive form in the second lineage is *N. abnormis* Branson & Mehl, which is little more than a tumid ozarkodinid with a lateral flexure at the posterior end. It probably gives rise to two other species. *N. iowensis* is characterized by having a platform on the inner side only. (Youngquist's specimens varied somewhat, some having platforms on both sides, but he states (1945, p. 363) '[the] outer nodose flange . . . at best is not well developed'.) The other development is seen in *N. brevidonta* Youngquist, where the posterior flexure is present and platforms are developed on both sides near this termination. The blade is still convex on its oral margin.

Increased flexure and the extension of the platforms anteriorly are seen in *N. falcata* Helms. This line culminates in *N. sp. nov. A*, where the flexure exceeds 90°, the platforms are extensive, especially on the outer side, and ornamented with nodes and transverse ridges, and the posterior part of the blade is reduced in height.



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Fig. 20. Phylogeny of the genus *Nothognathella*.

Although nothognathellids do not appear to have the zonal significance of the palmatolepids or polygnathids, the fact that they show phylogenetic development may help in refining their ranges. Furthermore, it is interesting to note that an ozarkodinid ancestor can produce obvious platform types. This may be extremely important in determining the phylogeny and evolutionary development of the whole conodont skeleton.

NOTHOGNATHELLA ABBREVIATA Branson & Mehl, 1934

(Pl. 40, figs 3a, b)

- 1934 *Nothognathella abbreviata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 229, pl. 13, fig. 15.
 1961 *Nothognathella* aff. *N. abbreviata* Branson & Mehl; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 546, pl. 2, fig. 5.
 1966 *Nothognathella abbreviata* Branson & Mehl; Anderson, *J. Paleont.*, 40, 407.
 1968 *Nothognathella abbreviata* Branson & Mehl; Mound, *J. Paleont.*, 42, 495, pl. 67, figs 18, 19.

Material: 8 specimens, CPC 12542 figured.

Locality of figured material: Sample BG 19454B, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Description: A nothognathellid with a very high anterior and low posterior carina and lacking an apical denticle. The anterior carina is composed of about 8 tall fused denticles with free chevron tips. They are equidimensional and are inclined slightly posteriorly. The posterior carina is composed of about 10 very low nodose denticles. The platforms are unequal in size; the inner platform is situated at the midpoint of the unit, narrowing rapidly anteriorly and slowly posteriorly. The outer platform is very narrow and lies entirely in the posterior half of the unit.

Remarks: *N. abbreviata* can be distinguished from *N. typicalis* by the lack of a massive apical denticle. It differs from *N. brevidonta* in possessing a carina of uneven height.

Distribution: The species was originally described from the Grassy Creek shale (middle Famennian) of Missouri (Branson & Mehl, 1934). Lys et al. (1961) record a form with affinities to *N. abbreviata* from the early Famennian of Morvan, France. Anderson (1966) has recorded the species from the Juniper Hill Member of the Lime Creek Formation of north-central Iowa. The other North American occurrence is from Alberta, where Mound (1968) records it from the lower middle Duvernay Formation.

Range: Mound (1968) and Anderson (1966) both record *N. abbreviata* from early Frasnian (toI) strata. Branson & Mehl's specimens were probably middle Famennian and those figured by Lys et al. (1961) are early Famennian. In the Canning Basin the species ranges from the *Ancyrognathus triangularis* Zone (toI8) to the Middle *Palmatolepis triangularis* Zone (basal Famennian). The range of the species is apparently basal Frasnian to middle Famennian (toII or toIII).

NOTHOGNATHELLA ABNORMIS Branson & Mehl, 1934

(Pl. 40, figs 7a-10c)

- 1934 *Nothognathella* (?) *abnormis* Branson & Mehl, *Univ. Mo. Stud.*, 8, 231, pl. 14, figs 1, 2.
?1948 *Nothognathella* (?) *abnormis* Branson & Mehl; Youngquist & Miller, *J. Paleont.*, 22, 447, pl. 67, fig. 5.
1955 *Nothognathella abnormis* Branson & Mehl; Sannemann, *Senck. leth.*, 36, 132, pl. 6, figs 16, 17.
1957 *Nothognathella* (?) *abnormis* Branson & Mehl; Lys & Serre, *Rév. Inst. fr. Pétrole*, 12, 1047, pl. 4, figs 6a, b.
1959 *Nothognathella* (?) *abnormis* Branson & Mehl; Helms, *Geologie*, 8, 663, pl. 4, figs 5, 6.
1967 *Nothognathella* ? *abnormis* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 383, pl. 3, fig. 9.
1967 *Nothognathella abnormis* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 45, pl. 6, fig. 17.
1967 *Nothognathella abnormis* Branson & Mehl; Nehring, *Inst. Geol. Bull.* 209, 135, pl. 5, figs 4, 5.
1968 *Nothognathella abnormis* Branson & Mehl; Spasov et al., *Inst. Rech. Géol. Géophys.*, 26, 160, pl. 1, fig. 5.
?1970 *Nothognathella abnormis* Branson & Mehl; Seddon, *J. geol. Soc. Aust.*, 16, 751, pl. 12, figs 22-25.

Material: 8 specimens, CPC 12543-6 figured.

Locality of figured specimens: Sample BG 19583, Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Description: A nothognathellid with a reduced platform. The unit is arched and bowed, the carina being highest in the mid-portion. Toward the anterior the carina is high, composed of fused denticles with free chevron tips. In the posterior half the carina is low and formed of low nodose denticles, occasionally isolated. The posterior termination is deflected inward through 45°-70°. In some specimens the platform is only a tumidity at about mid-bar height. This tumidity expands into genuine platforms, especially in the inner side at about midpoint. On the outer side the platform development is confined to the posterior portion.

The unit is keeled and a minute cavity is present.

Remarks: *N. abnormis* is the most ozarkodinid-like of the nothognathellids. Greater platform development leads to *N. brevidonta*; greater flexure leads to *N. cf. N. valida*.

Distribution: The species was originally described from the Grassy Creek Formation of Missouri (Branson & Mehl, 1934). Elsewhere in North America it has been reported from the Sweetland Creek Shale of Iowa (Youngquist & Miller, 1947) and the Pilot Shale of Utah (Clark & Becker, 1960; Clark & Ethington, 1967).

The species is very common in Europe, especially in Germany (Sannemann, 1955b; Bischoff, 1956; Bischoff & Ziegler, 1956; Flügel & Ziegler, 1957; Ziegler, 1958; Stoppel, 1958; Helms, 1959; Freyer, 1961; Schriel & Stoppel, 1965; Stoppel & Zscheke, 1966); it has been recorded from Austria (Schönlaub, 1969a), France (Lys & Serre, 1957; Serre & Lys, 1958; Boyer et al., 1968), Poland (Nehring, 1967; Wolska, 1967), and Yugoslavia (Spasov et al., 1968).

Range: The original description of the species from the Grassy Creek shale is from strata of Famennian age (toII-toIII). The species is known from the Frasnian in North America (Youngquist & Miller, 1947); the oldest occurrence is in the Pilot Shale (Frasnian toIδ).

The range in Europe is similar; the majority of ranges indicate a first occurrence in the toI_γ zone of the Frasnian (Bischoff, 1956; Freyer, 1961; Helms, 1959; Wolska, 1967). However, Nehring (1967) gives a first occurrence in the toIδ zone. The upper limit is also variable; in France it is in the toII_a zone of the Famennian. Helms (1959) and Wolska (1967) also record the upper limit as toII, while Stoppel (1958) records the species from the toII_β zone. Nehring (1967) extends the range as high as the toIII_β zone.

In the Canning Basin the species is rare; it has been recorded from the Frasnian (toI_γ-toIδ).

N. abnormis has an absolute range of toI_γ-toIII_β.

NOTHOGNATHELLA BREVIDONTA Youngquist, 1947
(Pl. 41, figs 1a-4b)

- 1947 *Nothognathella brevidonta* Youngquist, *J. Paleont.*, 21, 108, pl. 25, fig. 1.
1956 *Nothognathella brevidonta* Youngquist; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 127, pl. 10, fig. 29.
1967 *Nothognathella brevidonta* Youngquist; Nehring, *Inst. Geol., Bull.* 209, 137, pl. 5, fig. 7.

Material: 12 specimens, CPC 12547-50 figured.

Localities of figured material: Sample BG 19014 (CPC 12547), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19583 (CPC 12548), 19584 (CPC 12549), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 21371 (CPC 12550), east side Teichert Hills, Sadler Limestone.

Description: An arched nothognathellid with a conspicuous platform on the inner side. The arching varies from as little as 30° to near 90°. The platform is well developed, especially on the inner side, where it stretches from end to end, widest in the middle and gradually narrowing. The ornament consists of 'shagreen' in some cases and isolated nodes and faint transverse ridges at the platform edge on others. The medial carina consists of a sequence of up to 28 low nodose denticles fused at their bases with free tips. The unit is deflected through about 70° as well as being arched. Sometimes the carina is sinuous. The outer platform is extremely narrow and is roughly the same width over the whole length.

In aboral view the unit is keeled. At about the platform midpoint the keel bifurcates for a short distance, forming a small, shallow pit. In some specimens the pit is asymmetric and is similar to the cavity in *Schmidtognathus* Ziegler, 1966.

Remarks: The species appears to have developed from *N. abbreviata* by an increase in size of the platform and reduction in height of the anterior portion of the carina. It is also probably that some of the more flexed specimens could have developed from *N. abnormis* by increase in platform width.

Distribution: The species was originally described from a shale horizon overlying the Cedar Valley Limestone of Iowa (Youngquist, 1947). The only other record of the species in North America is from Alberta (Uyeno, 1967). In Europe the species is known from France (Serre & Lys, 1958), Germany (Bischoff, 1956; Stoppel, 1958; Stoppel & Zscheke, 1966), and Poland (Nehring, 1957).

Range: The original record of the species is from Frasnian strata. In Alberta, Uyeno (1967) records the species from a horizon within the toIa zone. In Europe the species is recorded in the Frasnian (Bischoff, 1956; Stoppel & Zscheke, 1966) and in the toIIa zone of the Famennian (Stoppel, 1958). Nehring gives a range of Frasnian (toIδ to Famennian (toIIa).

In the Canning Basin the species is restricted to the Frasnian (toIγ-toIδ). The range of the species appears to be Frasnian (toIa) to Famennian (toIIa).

NOTHOGNATHELLA FALCATA Helms, 1959

(Pl. 41, figs 5-8b)

1959 *Nothognathella* (?) *falcata* Helms, *Geologie*, 8, 645, pl. 5, fig. 27a, b.

1967 *Nothognathella* ? *falcata* Helms; Wolska, *Acta palaeont. polon.*, 12, 384, pl. 3, fig. 8.

Material: 12 specimens, CPC 12551-4 figured.

Localities of figured material: Sample BG 19018 (CPC 12551), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19451B (CPC 12552), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21267 (CPC 12553, 12554), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Description: A slightly arched and distinctly deflected nothognathellid. The posterior bar is deflected through 90°. Both bars are tumid, and narrow platforms extend along both sides of both platforms. The carina is composed of low fused

denticles with free tips, inclined posteriorly, and, near the point of flexure, often outwardly. The unit is keeled, but no basal cavity is obvious.

Remarks: The extreme deflection of the posterior bar is similar to that seen in *N. abnormis* and some specimens of *N. brevidonta*. Previous illustrations of the species show little development of platforms, though the species was questionably assigned to *Nothognathella*. The present specimens have good platforms and the assignment appears to be correct.

Distribution: The species has previously been reported exclusively from Europe. It was originally described from Germany (Helms, 1959). Other reports of the species are known from Portugal (Boogaard, 1963) and Poland (Wolska, 1967).

Range: The original report of the species from the Saalfelder Upper Devonian was from a Famennian (toIII?) horizon. The Portuguese occurrence is from strata considered to be toIV and/or toV (Boogaard, 1963). The Polish range is Famennian (toII β -toIV).

In the Canning Basin the species ranges from Frasnian (toI δ) (uppermost *Palmatolepis gigas* Zone) to Famennian (toIIIa) (upper *P. quadrantinodosa* Zone). The overall range appears to be toI δ -toIV.

NOTHOGNATHELLA IOWAENSIS Youngquist, 1945

(Pl. 42, figs 1a-2b)

1945 *Nothognathella iowaensis* Youngquist, *J. Paleont.*, 19, 363, pl. 55, fig. 7.

1956 *Nothognathella iowaensis* Youngquist; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 84, 151, pl. 14, fig. 17.

?1961 *Nothognathella iowaensis* Youngquist; Freyer, *Freib. Forsch.*, C95, 56, pl. 2, fig. 59; pl. 3, fig. 60.

1966 *Nothognathella iowaensis* Youngquist; Anderson, *J. Paleont.*, 40, 407, pl. 50, fig. 3.

Material: 3 specimens, CPC 12555-6 figured.

Locality of figured material: Sample BG 19528 (CPC 12555), McIntyre Knolls, Virgin Hills Formation; BG 19547 (CPC 12556), Section 9, McPhee Knoll, Virgin Hills Formation.

Description: A nothognathellid with a platform virtually restricted to the inner posterior portion of the unit. The carina is composed of up to 25 laterally compressed, fused denticles with free chevron tips. The anterior half consists of tall denticles and is gently curved; the posterior part consists of much lower denticles and is slightly curved in the opposite direction, producing a sigmoidal carina.

The platform is virtually restricted to the posterior half of the unit. It is mainly present on the inner side and bears sparse low nodes, and the edge is sometimes serrated. On the outer side a faint ridge suggests a latent outer platform. The unit is keeled, with a minute cavity at the point of flexure.

Remarks: *N. iowaensis* and *N. klapperi* are the two nothognathellids which greatly resemble the genus *Elictognathus*. The carina in both cases is high and comb-like, with the highest denticles near the point of flexure.

Distribution: The species was originally described from the Independence shale of Iowa (Youngquist, 1945). It has also been recorded from the Juniper Hill Member of the Lime Creek Formation (Anderson, 1966). The only other record of the

species from North America is from Alberta (Pollock, 1968). In Europe the species is common in Germany (Bischoff & Ziegler, 1956; Stoppel, 1958; Freyer, 1961; Stoppel & Zscheke, 1966). The other European occurrences are in Austria (Schulze, 1968; Schönlaub, 1969a).

Range: Specimens come from the Frasnian of southeastern Iowa (Youngquist, 1945) and of north-central Iowa (Anderson, 1966). The specimens reported by Pollock (1968) are post-toI_a (early Frasnian). In Europe Frasnian forms are reported by Freyer (1961), and Stoppel & Zscheke (1966). However, the species is common in the Famennian; Bischoff & Ziegler (1956) record it from toII_β-toIII strata and Freyer (1961) shows a range of Frasnian (toI_δ) up to late Famennian (toV); Stoppel records the species in strata of toII_a age. In the Canning Basin the species is confined to the Frasnian and ranges from the *Ancyrognathus triangularis* Zone (toI_γ) to the top of the *Palmatolepis gigas* Zone (toI_δ).

The overall recorded range is Frasnian (? toI_β) to late Famennian (toV).

NOTHOGNATHELLA KLAPPERI Uyeno, 1967

(Pl. 42, figs 4a, b)

1967 *Nothognathella klapperi* Uyeno, *Geol. Surv. Can. Pap.* 67-30, 5, pl. 1, figs 7, 8; pl. 2, fig. 1.

Material: 2 specimens, CPC 12557 figured.

Locality of figured material: Sample BG 19548, Section 9, McPhee Knoll, Virgin Hills Formation.

Description: A nothognathellid with a small platform restricted to the inner posterior part of the unit. The blade is distinctive: the posterior part is fairly low with a high apical denticle over the cavity; the anterior is saddle-shaped in profile with a secondary peak near the anterior end.

Remarks: *N. klapperi* is very close to *N. iowaensis* but can be distinguished by the double peak of tall denticles on the blade. As Uyeno pointed out (p. 6) this species is a homeomorph of species of *Elictognathus*.

Distribution and Range: Uyeno (1967) records *N. klapperi* in the Middle *Polygnathus asymmetricus* Zone (Frasnian toI_a) of the Waterways Formation of Alberta. In the Canning Basin the species ranges from the Middle *Polygnathus asymmetricus* Zone as high as the *Ancyrognathus triangularis* Zone (toI_γ).

NOTHOGNATHELLA PALMATOFORMIS sp. nov.

(Pl. 17, fig. 8; text-fig. 21)

1966 *Nothognathella sublaevis* Sannemann; Glenister & Klapper, *J. Paleont.*, 40, 806, pl. 95, figs 7-9.

Derivation of name: From the general similarity of the platform to the genus *Palmatolepis*.

Material: 12 specimens, Holotype CPC 12558, Paratype CPC 12559-61.

Localities of figured material: Holotype, sample BG 19019, Section 1, McWhae Ridge, Virgin Hills Formation; paratypes, sample BG 19019 (CPC 12559),

19023 (CPC 12560), as holotype; BG 19130 (CPC 12561), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Diagnosis: A nothognathellid with a well developed platform bearing 'shagreen' ornament.

Description: The platform is well developed on both sides of the carina. The outer platform has a convex outer edge and is sub-parallel to the convex carina. The inner platform is wide and has a well developed notch just anterior to the midpoint. Both platforms bear shagreen-like ornament. The carina is tallest in the anterior half and extends anteriorly as a short free blade. The posterior half is much shorter and on some specimens barely reaches the posterior termination.

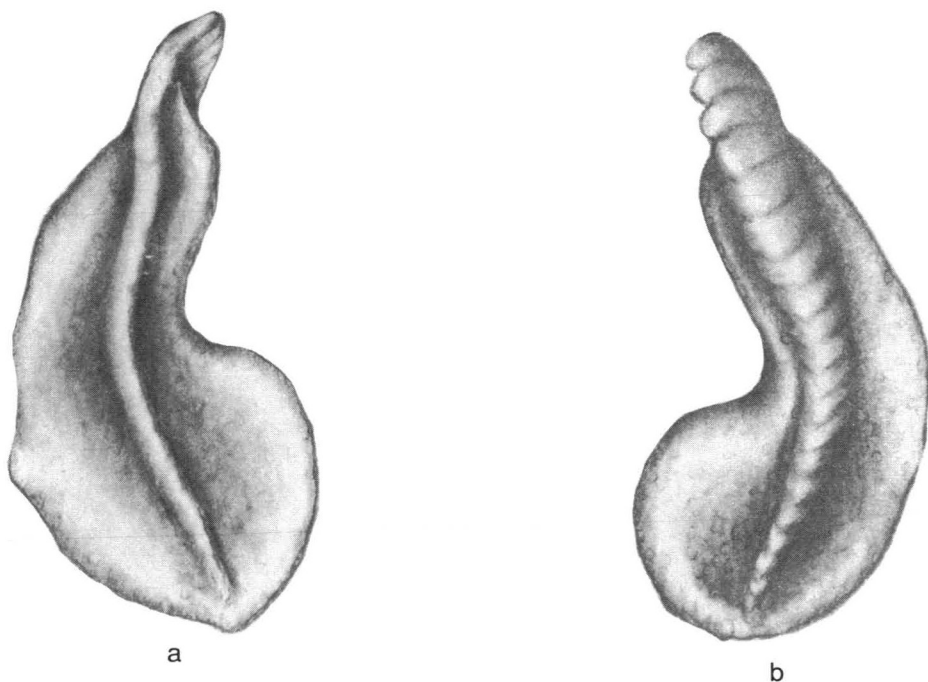


Fig. 21. *Nothognathella palmatoformis* sp. nov. holotype CPC 12558, (a) aboral view, (b) oral view, both x130.

In aboral view the unit is keeled but lacks a basal cavity. In specimens where the carina does not reach the spatulate posterior termination the keel also terminates before reaching the margin.

Remarks: Glenister & Klapper (1966) note that their specimens of *N. sublaevis* are more advanced than those illustrated by Sannemann, but the possession of shagreen-like ornament is diagnostic. I have separated this species from *N. sublaevis* because the platform shows greater development and closely approaches the genus *Palmatolepis*.

Distribution and Range: The only record of the species at present is from the Canning Basin, although a specimen illustrated by Clark & Becker (1960, pl. 2, fig. 2) may belong here. *N. palmatoformis* ranges from the Middle *Palmatolepis crepida* to the Middle *Scaphignathus veliferus* Zone (Famennian toII_a-toIII_β).

NOTHOGNATHELLA POLYGNATHOIDEA Branson & Mehl, 1934

(Pl. 10, figs 8a, b)

- 1934 *Nothognathella polygnathoidea* Branson & Mehl, *Univ. Mo. Stud.*, 8, 228, pl. 13, figs 16-20.
1944 *Nothognathella polygnathoidea* Branson & Mehl; Branson, *ibid.*, 19, pl. 28, figs 34-36, 39, 40.
1961 *Nothognathella polygnathoidea* Branson & Mehl; Freyer, *Freib. Forsch.*, C-95, 56, pl. 3, fig. 61.
?1968 *Nothognathella* (?) aff. *N. polygnathoidea* Branson & Mehl; Mound, *J. Paleont.*, 42, 496, pl. 67, figs 27-29 (fig. 28 not named in plate descriptions).

Material: 4 specimens, CPC 12562 figured.

Localities of figured material: Sample BG 19018, Section 1, McWhae Ridge, Virgin Hills Formation.

Description: A nothognathellid with a very well developed platform. The anterior part of the carina is straight and high and the posterior part lower and curved. The platform on the inner side is very well developed, with a convex margin, and is ornamented with low nodes which are concentrated near the margin. The platform on the outer side is restricted to the posterior portion; it is widest near the carina flexure and narrows toward the posterior termination. It is ornamented with low nodes which are fused into transverse ridges near the margin. The aboral side is keeled; a cavity is present at the point of flexure of the keel.

Remarks: Like *P. palmatoformis* this nothognathellid approaches the genus *Palmatolepis*. The platform approaches very closely to that of *Palmatolepis foliacea* Youngquist, but it lacks an azygous node.

Distribution: The species was originally described from the Grassy Creek shale of Missouri (Branson & Mehl, 1934; Branson, 1944). Mound has recorded questionable specimens from Alberta (1968). The only record from Europe is by Freyer (1961), who describes it from the Vogtlandes.

Range: The Grassy Creek shale is early Famennian (Collinson et al., 1962). The specimens recorded by Freyer (1961) come from widely different horizons, Frasnian (toI_γ) and Famennian (toV). In the Canning Basin the species ranges from the Lower *Palmatolepis crepida* Zone (toII_a) to the Lower *P. quadrantinodosa* Zone (toII_β).

NOTHOGNATHELLA SUBLAEVIS Sannemann, 1955

Remarks: A single broken specimen was recovered from the Lower *Polygnathus asymmetricus* Zone (Frasnian toI_a).

NOTHOGNATHELLA TYPICALIS Branson & Mehl, 1934

(Pl. 43, figs 1a-4b)

- 1934 *Nothognathella typicalis* Branson & Mehl, *Univ. Mo. Stud.*, 8, 227, pl. 13, figs 7, 8.
1944 *Nothognathella typicalis* Branson & Mehl; Branson, *ibid.*, 19, 157, pl. 28, figs 16, 17.
1955 *Nothognathella typicalis* Branson & Mehl; Sannemann, *Senck. leth.*, 36, 133, pl. 3, figs 11a, b.
1959 *Nothognathella typicalis* Branson & Mehl; Helms, *Geologie*, 8, 645, pl. 1, figs 8-10; pl. 4, figs 26-28.
?1961 *Nothognathella* cf. *typicalis* Branson & Mehl; Zimmermann, *Freib. Forsch.*, C-89, 189, pl. 4, fig. 9.
1967 *Nothognathella typicalis* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 384, pl. 3, fig. 10.
1967 *Nothognathella typicalis* Branson & Mehl; Nehring, *Poland, Inst. Geol. Bull.* 209, 134, pl. 2, figs 7a, b.
?1968 *Nothognathella typicalis* Branson & Mehl; Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 160, pl. 2, fig. 16.

Material: 16 specimens, CPC 12563-6 figured.

Localities of figured material: Samples BG 19014 (CPC 12563), 19016 (CPC 12564), 19018 (CPC 12565), Section 1, McWhae Ridge, Virgin Hills Formation; BG 21011 (CPC 12566), Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation.

Description: The blade is extremely high in the anterior half; the denticle height gradually increases toward the posterior, terminating in a massive apical denticle. The posterior half of the carina is extremely low and consists of about 8 low node-like denticles; the anterior part consists of about 8 laterally compressed, basally fused denticles with free chevron tips.

Platforms are present on both sides of the carina and are widest medially, narrowing to the posterior termination. Both platform edges are sigmoidal and both platforms bear low nodes. In aboral view the unit is keeled, with a faint cavity beneath the apical denticle.

Remarks: *N. typicalis* is close to *N. abbreviata*, from which it is distinguished by the larger platform.

Distribution: The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934; Branson, 1944), the only record from North America. It is common in Europe, especially in Germany (Sannemann, 1955b; Bischoff & Ziegler, 1956; Stoppel, 1958; Helms, 1959; Zimmermann, 1961; Freyer, 1961; Stoppel & Zscheke, 1966) and Poland (Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967). Elsewhere it has been reported from Austria (Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), France (Boyer et al., 1968), Italy (Manzoni, 1965), Yugoslavia (Spasov et al., 1968), and Portugal (Boogaard, 1963).

Range: The Grassy Creek Shale of Missouri is early Famennian. The earliest record of the species is in the Frasnian (toI_γ) of Poland (Nehring, 1967) and France (Boyer et al., 1968). The latest occurrence is late Famennian (toV) reported by Freyer (1961) (who gives a range of toI_δ-toV) and Bischoff & Ziegler (1956). In the Canning Basin the species ranges from the Lower *Palmatolepis gigas* Zone (toI_γ) to the Upper *P. crepida* Zone (toII_a).

NOTHOGNATHELLA sp. nov. A

(Pl. 17, fig. 5)

Material: 3 specimens, CPC 12567-8 figured.

Localities of figured material: Samples BG 19082 (CPC 12567), 19106 (CPC 12568), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Description: A highly flexed and arched nothognathellid. The unit is flexed through 90° and arched through 45°; platforms are developed on both sides of the carina, which is massive in the anterior part with tall fused denticles with free chevron tips, and composed of low fused nodes in the posterior part. The inner platform is narrow, with small nodes at the platform margin. The outer platform is massive, and near the point of flexure it is elevated into a secondary blade with a fluted margin with broad transverse ridges. Aborally, the unit is keeled.

Remarks: This species is similar to *N. postsublaevis* in possessing a secondary carina formed by the outer platform margin. However, in *N. sp. nov. A* the carina is at unit midpoint whereas in *N. postsublaevis* it is at the posterior end of the unit.

Distribution: So far the only record is from the Canning Basin, where it occurs in the Lower *Palmatolepis quadrantinodosa* Zone (Famennian, toIIa).

Genus OZARKODINA Branson & Mehl, 1933

Type species: *Ozarkodina typica* Branson & Mehl, 1933

OZARKODINA HOMOARCUATA Helms, 1959

(Pl 47, figs 1a, b, 3a, b)

- 1934 *Subbryantodus arcuatus* Branson & Mehl, Univ. Mo. Stud., 8, 286, pl. 23, figs 10, 11.
1934 *Subbryantodus flexus* Branson & Mehl, *ibid.*, 286, pl. 23, fig. 12.
non 1934 *Ozarkodina arcuata* Branson & Mehl, *ibid.*, 193, pl. 17, fig. 7.
1955 *Subbryantodus arcuatus* Branson & Mehl; Sannemann, *Senck. leth.*, 36, 154, pl. 4, fig. 15.
1956 *Ozarkodina arcuata* (Branson & Mehl); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 84, 152, pl. 13, fig. 24.
1959 *Ozarkodina homoarcuata* Helms, *Geologie*, 8, 646, pl. 2, fig. 5.
1961 *Ozarkodina homoarcuata* Helms; Freyer, *Freib. Forsch.*, C-95, 58, pl. 3, figs 64-66.
1967 *Ozarkodina homoarcuata* Helms; Freyer & Zakowa, *Acta geol. polon.*, 17, pl. 2, fig. 14.
1967 *Ozarkodina homoarcuata* Helms; Nehring, *Poland, Inst. Geol. Bull.*, 209, 138, pl. 5, fig. 6.
1967 *Ozarkodina homoarcuata* Helms; Wolska, *Acta palaeont. polon.*, 12, 385, pl. 4, fig. 13.
1969 *Ozarkodina homoarcuata* Helms; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 80, pl. 15, figs 2, 3.
1969 *Ozarkodina homoarcuata* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 90, pl. 13, figs 14, 15.

Material: 14 specimens, CPC 12569, 12570 figured.

Localities of figured material: Samples BG 19104 (CPC 12569), 19117 (CPC 12570), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Remarks: The distinctive arcuate form distinguishes this species from other ozarkodinids.

Distribution: The species was originally described from the Lower Carboniferous Bushberg Sandstone, from a locality at Frenchmans Creek, Missouri (Branson & Mehl, 1934), together with abundant reworked Devonian (Grassy Creek) conodonts. The only other report of the species in North America is by Pollock (1968) from Alberta, Canada.

In Europe the species is known from Germany (Bischoff & Ziegler, 1956); Helms, 1959; Freyer, 1961; Schriell & Stoppel, 1965; Meyer, 1965; Stoppel & Zscheded, 1966; Freyer, 1968), Poland (Freyer & Zakowa, 1967; Wolska, 1967; Nehring, 1967), Austria (Schönlaub, 1969a), France (Boyer et al., 1968), and Portugal (Boogaard, 1963). In Australia the species is present in the Bonaparte Gulf Basin (Druce, 1969).

Range: The species was originally described from Carboniferous strata but it is possible that it is reworked from the Devonian Grassy Creek Formation (Famennian). Nehring (1967) records the species from Frasnian (toIa) to late Famennian (toV); Boyer et al. (1968) record the species from late Frasnian (toIδ) into Early Carboniferous (cuI). Pollock (1968) records the species in the earliest Frasnian. Helms (1959) gave a range of Famennian (toIII-toVI), but it appears that the complete range is earliest Frasnian (toIa) to earliest Carboniferous (cuI). In the Canning Basin the species ranges from the Middle *Palmatolepis crepida* (toIIa) Zone to the Lower *Polygnathus styriacus* (toIV).

OZARKODINA IMMERSA (Hinde, 1879)

(Pl. 47, figs 2a, b, 4a, b)

- 1879 *Polygnathus immersus* Hinde, *Quart. J. geol. Soc. Lond.*, 35, 365, pl. 16, fig. 21.
- 1931 *Bryantodus inequalis* Holmes; Cooper, *J. Paleont.*, 5, 147, pl. 20, fig. 5.
- 1934 *Bryantodus immersus* (Hinde); Branson & Mehl, *Univ. Mo. Stud.*, 8, 140, pl. 11, fig. 22.
- 1938 *Ctenognathus elegans* Stauffer, *J. Paleont.*, 12, 424, pl. 48, figs 9-12.
- 1938 *Ctenognathus falcatus* Stauffer, *ibid.*, 425, pl. 48, figs 1, 5.
- 1938 *Ctenognathus firmus* Stauffer, *ibid.*, 425, pl. 48, figs 2, 6, 15.
- 1940 *Ctenognathus elegans* Stauffer; Stauffer, *J. Paleont.*, 14, 422, pl. 59, figs 3-5, 8.
- 1945 *Ctenognathus falcatus* Stauffer; Youngquist, *J. Paleont.*, 19, 385, pl. 55, fig. 1.
- 1947 *Ctenognathus falciformis* Stauffer; Youngquist, *J. Paleont.*, 21, 99, pl. 25, fig. 3.
- 1951 *Ozarkodina* sp. Youngquist & Downs, *J. Paleont.*, 24, 670, pl. 87, figs 1, 2.
- 1955 *Ozarkodina elegans* (Stauffer); Sannemann, *Senck. leth.*, 36, 133, pl. 6, fig. 9.
- 1957 *Ozarkodina elegans* (Stauffer); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 76, pl. 20, figs 29-33.
- 1961 *Ozarkodina regularis* Branson & Mehl; Freyer, *Freib. Forsch.*, C95, 59, pl. 3, fig. 70.
- 1962 *Ozarkodina elegans* (Stauffer); Budurov & Tschunev, *Bull. Inst. Sci. Réch. Géol.*, 1, pl. 4, fig. 13.
- 1965 *Ozarkodina elegans* (Stauffer); Ethington, *J. Paleont.*, 39, 577, pl. 68, fig. 15.
- 1967 *Ozarkodina immersa* (Hinde); Müller & Clark, *J. Paleont.*, 41, 915, pl. 117, fig. 13.
- 1967 *Ozarkodina immersa* (Hinde); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 48, pl. 6, fig. 10.
- 1968 *Ozarkodina elegans* (Stauffer); Mound, *J. Paleont.*, 42, 497, pl. 67, figs 32, 37.
- 1969 *Ozarkodina elegans* (Stauffer); Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 78, pl. 16, figs 1a, b.
- 1969 *Ozarkodina immersa* (Hinde); Seddon, *J. roy. Soc. W. Aust.*, 52, 27, pl. 1, figs 10, 11.
- 1969 *Ozarkodina immersa* (Hinde); Olivieri, *Bull. Soc. paleont. ital.*, 8, 91, pl. 10, figs 4a, b; pl. 13, fig. 6.
- 1970 *Ozarkodina immersa* (Hinde); Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 14, fig. 2.

Material: 55 specimens, CPC 12571-2 figured.

Localities of figured material: Sample BG 19023 (CPC 12571), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19108 (CPC 12572), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Remarks: *Ozarkodina immersa* lacks the really massive apical denticle of *O. macra*, but the two species appear to grade into one another. In some specimens the apical denticle is the same size as the bar denticles and can only be distinguished by its apical position.

Distribution: The species is extremely widespread, having been recorded extensively in North America and Europe. It is also present in the Bonaparte Gulf, Canning, and Carnarvon Basins in Australia (Druce, 1969; Seddon, 1969, 1970a).

Range: The earliest record of the species is in the upper Givetian (Bischoff & Ziegler, 1957). The majority of the reports are from the Frasnian and Famennian, but Youngquist & Downs (1951) record it from the Early Mississippian of Iowa. In the Canning Basin the species ranges through the Devonian sequence.

cf. *OZARKODINA?* *LACERA* Helms, 1959
(Pl. 47, figs 5a-8b)

cf. 1959 *Ozarkodina lacera* Helms; *Geologie*, 8, 647, pl. 2, fig. 16; pl. 5, fig. 10.

Material: 11 specimens, CPC 12518-21 figured.

Localities of figured material: Samples BG 19105 (CPC 12518), 19140 (CPC 12519), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 21093 (CPC 12520), Ngumbyan Cliff, Virgin Hills Formation; BG 21271 (CPC 12521), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Description: The unit is arched, consisting of an anterior blade and posterior platform. The blade consists of 7 to 8 tall posteriorly inclined denticles which increase in height posteriorly. The denticles are fused at their bases and have free chevron tips. The apical denticle is about twice as high as the blade denticles and is posteriorly inclined and inwardly bowed. The posterior bar is tumid on both sides. The dentition varies from the original bar denticles with occasional platform denticles to complete coverage of the platform by brush-like denticles which completely mask the original bar denticles. The platform is usually flexed outward at the apical denticle; it varies from elongate, with sub-parallel margins, to pear-shaped.

Aborally, the unit is keeled; a minute pit may be present beneath the apical denticle, but often a basal cavity appears to be absent.

Remarks: The development of brush-like denticles has been recorded previously. Müller (1969) has studied many specimens belonging to various form-genera, and notes that Sannemann's (1955) nov. gen. et sp. is a brush-like form. Previously, Uyeno (1967) had referred brush-like polygnathids to *P. norrisi*. Uyeno points out that Helms (1959) illustrated one form which he included in *Polygnathus diversus*. Müller records specimens from northwest Germany, Eastern Thuringia, Carinthian Alps, and Morocco. He points out that there appears to be

no relation between the occurrence and substrate, region or facies, and considers them to be pathological sports.

It is difficult to interpret these forms. They are only known from the Upper Devonian, but range in age from early Frasnian (toI β / γ) to late Famennian (toVI). The broad similarity of the polygnathid forms and their wide distribution suggests that they may have been a useful adaptation, albeit for only a short duration, rather than pathological variants.

These brush-like forms may be extremely useful in determining the skeletal make-up of the original conodontifer since all elements of the unit probably developed this dentition. In one sample I have forms referable to *Ozarkodina*, *Polygnathus*, and *Hindeodella* and it is possible that they are all associated in the same animal. Nearly every sample that yielded *Ozarkodina*? *lacera* also yielded a brush-like polygnathid.

Distribution and Range: Müller (1969) refers to ozarkodinids with brush-like dentition but does not illustrate any forms. Thus, at the present the species is confined to the Canning Basin: it ranges from the Lower *Palmatolepis quadrantinodosa* Zone (toII β) to the Middle *Scaphignathus veliferus* Zone (toIII β).

OZARKODINA MACRA Branson & Mehl, 1934

(Pl. 40, figs 1a-2b)

- 1934 *Ozarkodina macra* Branson & Mehl, *Univ. Mo. Stud.*, 8, 192, pl. 17, fig. 5.
1955 *Ozarkodina regularis* Sannemann (part); *Senck. leth.*, 36, 133, pl. 6, fig. 5.
1957 *Ozarkodina macra* Branson & Mehl; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 77, pl. 12, figs 13a, b; pl. 13, figs 9a, b.
1957 *Ozarkodina* cf. *O. macra*, Bischoff & Ziegler, *ibid.*, 78, pl. 13, figs 11a, b; pl. 19, figs 43.
1957 *Ozarkodina lata* Bischoff & Ziegler, *ibid.*, 22, 76, pl. 20, figs 9-16.
1967 *Ozarkodina macra* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 48, pl. 4, fig. 2; pl. 5, fig. 2.
1968 *Ozarkodina macra* Branson & Mehl; Mound, *J. Paleont.*, 42, 497, pl. 67, figs 24, 34, 38, 40.
1970 *Ozarkodina macra* Branson & Mehl; Bultynck, *Mem. Inst. Geol. Univ. Louvain*, 26, 120, pl. 24, fig. 1.

Material: 168 specimens, CPC 12574, 12576 figured.

Localities of figured material: Sample BG 19016 (CPC 12574), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19584 (CPC 12576), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Remarks: *Ozarkodina macra* is characterized by the massive apical denticle and fine bar dentition. As noted above, it appears to be transitional to *O. immersa*.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934); elsewhere in North America it has been reported from Arizona (Ethington, 1965), the Great Basin (Clark & Ethington, 1967) and Alberta (Clark & Ethington, 1965; Mound, 1968). In Europe the species is common in Germany (Bischoff & Ziegler), 1957; Sannemann, 1955; Freyer, 1965; Schriel & Stoppel, 1965), and is also present in Austria (Schönlaub, 1969a), Belgium (Bultynck, 1970, and Roumania (Mirauta & Mirauta, 1965). In the Canning Basin it ranges throughout the sequence.

OZARKODINA VERSA (Stauffer, 1940)

(Pl. 48, figs 3a, b)

1940 *Bryantodus versus* Stauffer, *J. Paleont.*, 14, 421, pl. 59, figs 10, 14-16, 21.

Material: 3 specimens, CPC 12577 figured.

Locality of figured material: Sample BG 19170, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: An ozarkodinid characterized by a virtually straight aboral margin. The apical denticle is massive, at least twice as wide and twice as tall as the largest bar denticle. The bar denticles are elongate, basally fused, posteriorly inclined, with free needle-like tips. The smallest denticles are nearest the apical denticle on both bars. There is a small basal cavity beneath the apical denticle.

Distribution and Range: The species was originally described from clays overlying the Devonian Cedar Valley Limestone at Austin, Minnesota. The three specimens come from widely different horizons ranging from toI_a as high as toIV.

OZARKODINA sp. nov. A

(Pl. 48, figs 41)

Material: 1 specimen, CPC 12578 figured, from sample BG 19008, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: The single specimen is very distinctive; it is highly arched with long needle-like denticles which are fused at their bases but free over most of their length. The apical denticle is twice as large as the bar denticles and all are posteriorly inclined. The basal cavity is large and flaring beneath the apical denticle extending along both bars as a narrowing groove. The specimen was recovered from the Middle *Polygnathus asymmetricus* Zone (toI_a).

OZARKODINA sp. nov. B

(Pl. 40, figs 5a, b)

Material: 12 specimens, CPC 12579, 12580 figured.

Localities of figured material: Samples BG 19534 (CPC 12579), BG 19538 (CPC 12580), Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: A robust ozarkodinid with a massive apical denticle about 4 times as large as the bar denticles. The bars are elongate, bearing up to 10 short denticles which are basally fused and posteriorly inclined, the massive denticles at the anterior end. The bars are slightly tumid, forming a ledge at the base of the denticles. The basal cavity is distinctive; it is small and subapical but is widely flared and often contains basal 'bone' material.

Range: The species ranges from the Middle *Polygnathus asymmetricus* Zone (toI_a) to the *Ancyrognathus triangularis* Zone (toI₇).

OZARKODINA sp. nov. C

(Pl. 49, fig. 4a, b)

Material: 6 specimens; CPC 12581 figured, from sample BG 19421, Cave Spring, Sadler Limestone.

Remarks: An ozarkodinid with distinctive pear-shaped denticles. The denticles are tumid and are widest above their fused bases. The tips are free and are sub-triangular. All denticles are recurved posteriorly. The bar is tumid and an attachment scar extends along it just above the aboral margin.

Range: The species ranges from the Lower *Polygnathus asymmetricus* Zone (toI_a) as high as the Upper *Palmatolepis triangularis* Zone (toI/II).

OZARKODINA sp. nov. D

(Pl. 49, figs 2a, b)

Material: 4 specimens; CPC 12582 figured, from Sample BG 19014, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: An ozarkodinid lacking a prominent apical denticle, and with fine needle-like denticles and a twisted posterior bar. The basal cavity appears to be inverted. This species is similar to *Bryantodus* sp. illustrated by Spasov & Filipovic (1967).

Range: This species ranges from the Lower *Palmatolepis gigas* Zone (toI_γ) to the Lower *Palmatolepis triangularis* Zone (toI_δ).

OZARKODINA sp. E

(Pl. 49, fig. 3)

Material: 1 specimen, CPC 12583, from sample BG 21354, Section 22, Piker Hills, Piker Hills Formation.

Remarks: A crescent-shaped ozarkodinid lacking an obvious apical denticle. The 12 denticles are elongate and needle-like with fused bases; they are tallest centrally, shortening rapidly towards the terminations. No basal cavity is obvious.

Range: The single specimen comes from the Lower *Polygnathus styriacus* Zone (toIV).

OZARKODINA sp. F

(Pl. 49, fig. 5)

Material: Single specimen, CPC 12584, from sample BG 19101, Section 4, north-east of McWhae Ridge, Virgin Hills Formation.

Remarks: An ozarkodinid with a massive apical denticle and extremely short bars. The anterior bar is deflected and slightly depressed and bears 4 denticles basally fused with free chevron tips. A germ denticle is present immediately anterior to the apical denticle. The posterior bar is twisted and bears 3 triangular and virtually isolated denticles.

Beneath the apical denticle there is a faint depression. The unit is rather hindeodellid or ligonodinid in its appearance, but the fact that the bars are of the same order of size suggests that it may belong in *Ozarkodina*.

Range: The specimen comes from the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

OZARKODINA? sp. Seddon, 1970

(Pl. 46, figs 2a-5b)

1970 *Ozarkodina?* sp. Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 14, figs 8, 12, 16, 20, 22.

Material: 64 specimens, CPC 12844-8 figured.

Localities of figured material: Sample BG 19001 (CPC 12845), Section 1, McWhae Ridge, Gogo Formation; BG 19050 (CPC 12844, 12846), Section 3, McWhae Ridge, Sadler Limestone; BG 19123 (CPC 12848), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 19421 (CPC 12847), McWhae Ridge, Sadler Limestone.

Remarks: Seddon (1970a, pl. 752) points out that this is a very variable form ranging in morphology from spathognathodid-like to polygnathellid-like forms with bryantodid, ozarkodinid, and prioniodinid variants. I can add nothing to this except that it is common in near-reef samples, and that could be a natural assemblage. It ranges from the *Polygnathus asymmetricus* Zone to the Upper *Palmatolepis quadrantinodosa* Zone.

Genus PALMATODELLA Bassler, 1925

Type species: *Palmatodella delicatula* Ulrich & Bassler, 1926.

PALMATODELLA DELICATULA Ulrich & Bassler, 1926

- 1925 *Palmatodella delicatula* Bassler, *Bull. geol. Soc. Am.*, 36, 219.
1926 *Palmatodella delicatula* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 72, 29, pl. 10, fig. 10.
1969 *Palmatodella delicatula* Ulrich & Bassler; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 85, pl. 17, fig. 1 (Synonymy to 1966).
1966 *Palmatodella delicatula* Ulrich & Bassler; Spasov & Filipovic, *Geol. Glasnik*, 2, 45, pl. 3, fig. 16.
1967 *Palmatodella delicatula* Ulrich & Bassler; Nehring, *Inst. Geol. Bull.* 209, 140, pl. 2, fig. 6.
1967 *Palmatodella delicatula* Ulrich & Bassler; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 69, pl. 2, fig. 13.
1967 *Palmatodella delicatula* Ulrich & Bassler; Wolska, *Acta palaeont. polon.*, 12, 386, pl. 5, figs 1, 2.
1967 *Palmatodella delicatula* Ulrich & Bassler; Freyer & Zakowa, *Acta geol. polon.*, 17, 111, pl. 1, fig. 3.
1968 *Palmatodella delicatula* Ulrich & Bassler; Mound, *J. Paleont.*, 42, 498, pl. 67, figs 30, 33, 36.
1968 *Palmatodella delicatula* Ulrich & Bassler; Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 161, pl. 1, fig. 1.
1968 *Palmatodella delicatula* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 27, pl. 6, fig. 7.
1969 *Palmatodella delicatula* Bassler; Olivieri, *Boll. Soc. paleont. ital.*, 8, 93, pl. 15, figs 8-10.

Material: 27 specimens.

Remarks: All the specimens are broken but fit into the general concept of *P. delicatula*, with some forms similar to *P. orthogonica* present. The species is well-known and I have not illustrated it.

Distribution: The species was originally described from Alabama (Ulrich & Bassler, 1926; Huddle, 1968). Elsewhere in North America it has been described from Arkansas (Cooper, 1931; 1935), Arizona (Ethington, 1965), Illinois and Missouri (Scott & Collinson, 1961), Indiana (Huddle, 1934), and Ohio (Bond, 1947). In Canada the species is common in Alberta (Uyeno, 1967; Pollock, 1968; Mound, 1968) and is also present in Ontario (Winder, 1962, 1966). The species is virtually ubiquitous in Europe and is especially common in Germany (Sannemann, 1955b; Bischoff, 1956; Bischoff & Ziegler, 1956, 1957; Bischoff, 1957; Ziegler, 1958; Bender, 1958; Stoppel, 1958; Helms, 1959; Zimmermann, 1960; Freyer, 1961; Reichstein, 1961; Schriell & Stoppel, 1965; Freyer, 1965; Meyer, 1965; Zitzmann, 1966; Stoppel & Zscheked, 1966; Freyer, 1968). It has also been reported from Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1965), Czechoslovakia (Koverdinsky & Zikmundova, 1966; Zikmundova & Chlupac, 1962), France (Lys & Serre, 1957; Serre & Lys, 1958; Lys et al., 1961; Boyer et al., 1968), Italy (Manzoni, 1965), Yugoslavia (Spasov & Stevanovic, 1962; Spasov & Filipovic, 1966, 1967; Spasov et al., 1968), Poland (Nehring, 1967; Freyer & Zakowa, 1967; Wolska, 1967), Portugal (Boogaard, 1963), and Spain (Boogaard, 1965).

P. delicatula is also known from Spanish Sahara, Africa (Ethington & Furnish, 1962) and from the Canning Basin (Glenister & Klapper, 1966) and Bonaparte Gulf Basin (Druce, 1969) in Australia.

Range: The species was originally described from the Gassaway Member of the Chattanooga Shale in Tennessee and Alabama (Ulrich & Bassler, 1926; Huddle, 1968). The earliest occurrence is in the basal Frasnian (toIa) (Ziegler, 1958) and the species ranges as high as the uppermost Famennian (toVI) (Helms, 1959; Freyer, 1961; Nehring, 1967). In the Canning Basin specimens have been recovered from the uppermost *Palmatolepis gigas* Zone (toIδ) to the Middle *Scaphignathus veliferus* Zone (toIIIβ).

PALMATODELLA UNCA Sannemann, 1955

(Pl. 49, fig. 7a, b)

1955 *Palmatodella unca* Sannemann, *Senck. leth.*, 36, 134, pl. 4, figs 10, 11.

1961 *Palmatodella unca* Sannemann; Freyer, *Freib. Forsch.*, C-95, 61, pl. 3, fig. 75.

1967 *Palmatodella unca* Sannemann; Nehring, *Poland Inst. Geol., Bull.* 209, 141, pl. 3, figs 3, 4.

1967 *Palmatodella unca* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 387, pl. 4, figs 1, 2.

Material: 2 specimens; CPC 12585 figured, from sample BG 21269, Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Description: *P. unca* is an extremely delicate unit with a elongate anterior bar which is depressed through nearly 90°. The bar dentition is confined to germ denticles which just erupt at the surface. The posterior bar is very short and bears compressed needle-like denticles which are tallest near the apex. No basal cavity is apparent.

Remarks: This is the first record of *P. unca* outside Europe. Some specimens in the fauna show transition between *P. unca* and *P. delicatula* and have been placed in *P. delicatula*.

Distribution: The majority of reports of the species are from Germany (Sannemann, 1955; Bischoff & Ziegler, 1956; Ziegler, 1958; Stoppel, 1958; Zimmermann, 1960; Freyer, 1961, 1965; and Stoppel & Zscheded, 1966), but recently it has been reported from Poland (Nehring, 1967; Wolska, 1967) and Austria (Schönlaub, 1969a).

Range: The species was originally described from the Famennian (toII_a) (Sannemann, 1955). The earliest record of the species is from the late toI_γ (Ziegler, 1958). Freyer (1961) gives the range as Frasnian (toI_δ) to late Famennian (toVI). In Poland the species is confined to the early Famennian (Nehring, 1967; Wolska, 1967). In the Canning Basin the two sequences come from the *Palmatolepis quadrantinodosa* Zone (toII_β-toIII_a).

PALMATODELLA sp. nov. A
(Pl. 49, fig. 6)

Material: A single specimen, CPC 12586, from sample BG 19104, Section 4, north-east of McWhae Ridge, Virgin Hills Formation.

Description: An elaborate palmatodellid with a slim anterior bar bearing 7 small isolated triangular denticles on the anterior half. The main denticle is massive and leaf-like with anterior and posterior knife-edges. The posterior bar is greatly reduced and consists of 3 fused denticles, the largest being the posteriormost. There is a slight lateral projection on the posterior bar. No basal cavity is apparent.

Remarks: This form may be an extreme variant of *P. unca*. The single specimen comes from the Lower *Palmatolepis quadrantinodosa* Zone (toII_β).

Genus PALMATOLEPIS Ulrich & Bassler, 1926

Type species: *Palmatolepis perlobata*, Ulrich & Bassler, 1926.

PALMATOLEPIS DELICATULA DELICATULA Branson & Mehl, 1934
(Pl. 50, figs 1a-4b)

- 1934 *Palmatolepis delicatula* Branson & Mehl, *Univ. Mo. Stud.*, 8, 237, pl. 18, figs 4, 10.
?1951 *Palmatolepis marginata* Stauffer; Hass, *Bull. Am. Ass. Petrol. Geol.*, 35, 2534, pl. 1, fig. 18.
?1956 *Palmatolepis marginata* Stauffer; Hass, *Ardmore geol. Soc. Guide Book*, 30, fig. 14.
?1956 *Palmatolepis marginata* Stauffer; Hass, *U.S. geol. Surv. prof. Pap.* 286, 17, pl. 4, figs 25, 26.
1957 *Palmatolepis marginatus* Stauffer; Lys & Serre, *Rév. Inst. fr. Pétrole*, 804, pl. 11, fig. 4.
1960 *Palmatolepis (Manticolepis) marginata* (Stauffer) var. A; Clark & Becker, *Bull. geol. Soc. Am.*, 71, 1672, pl. 1, figs 9, 11.
1962 *Palmatolepis marginata marginata* Stauffer; Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 61, pl. 2, figs 13-19; text-fig. 4.

- 1963 *Palmatolepis marginata marginata* Stauffer; Klapper & Furnish, *Iowa Acad. Sci.*, 69, fig. 2.2.
- 1965 *Palmatolepis delicatula delicatula* Branson & Mehl; Bouckaert & Ziegler, *Mém. Expl. Cartes Géol. Min. Belg.*, 5, 21, pl. 2, fig. 4.
- 1966 *Palmatolepis delicatula delicatula* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, 807, pl. 95, fig. 17.
- 1967 *Palmatolepis delicatula delicatula* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 50, pl. 4, fig. 12.
- 1967 *Palmatolepis delicatula delicatula* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 389, pl. 6, figs 6, 7.
- 1969 *Palmatolepis delicatula delicatula* Branson & Mehl; Schönlaub, *Jber. geol. Bundesanst. Wien*, 112, 306, pl. 2, fig. 6.
- 1968 *Palmatolepis marginata marginata* Stauffer; Schulze, *N. Jb. Paläont. Abh.*, 130, 207, pl. 19, fig. 13.
- 1969 *Palmatolepis delicatula delicatula* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 97, pl. 11, figs 6-8b; pl. 16, figs 1-3b.

Material: 33 specimens; CPC 12587-90 figured, all from sample BG 19018, Section 1, McWhae Ridge, Virgin Hills Formation.

Description: A small palmatolepid with a diamond-shaped outline. The inner platform is triangular, both anterior and posterior margins being straight. The outer platform is very narrow and begins well behind the inner platform. The ornament consists of virtually smooth 'shagreen' ridges. The free blade is low, formed of denticles of equal height. It fuses with the carina, which decreases in height towards the azygous node. Posterior to the azygous node the carina is short and decreases in height, disappearing about halfway to the posterior termination.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934). It has also been reported from Arkansas (Hass, 1951, 1956a), Tennessee (Hass, 1956b), Iowa (Klapper & Furnish, 1963), and Nevada (Clark & Ethington, 1967). In Europe the species is common in Germany (Bischoff & Ziegler, 1956; Ziegler, 1962a; Wachendorf, 1966; Zitzmann, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). It has also been reported from Austria (Schulze, 1968), Belgium (Bouckaert & Ziegler, 1965), France (Lys & Serre, 1957), Italy (Olivieri, 1969) and Poland (Freyer & Zakowa, 1967; Wolska, 1967). Glenister & Klapper (1966) have illustrated it from the Canning Basin, Australia.

Range: The species was originally described from the early Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Bischoff & Ziegler (1956) record the species from late Famennian (toV) strata, but they do not illustrate any specimens, so there is some doubt about the identification. Ziegler (1962) records it from the Middle *Palmatolepis triangularis* Zone, but in his table 2 he shows it ranging into the earliest *Palmatolepis crepida* Zone, a range similar to that recorded by Wolska (1967) from Poland. In the Canning Basin the range is identical, Middle *P. triangularis* Zone to Lower *P. crepida* Zone. This range was also recorded by Glenister & Klapper (1966).

PALMATOLEPIS DISTORTA Branson & Mehl, 1934

(Pl. 51, fig. 1a, b)

- 1934 *Palmatolepis distorta* Branson & Mehl, *Univ. Mo. Stud.*, 8, 237, pl. 18, figs 13, 14.
- 1934 *Palmatolepis pectenifera* Huddle, *Bull. Am. Paleont.*, 21, 107, pl. 9, figs 6, 7.
- 1955 *Palmatolepis distorta* Branson & Mehl; Sannemann, *N. Jb. Geol. Paläont., Abh.*, 100, 326, pl. 24, fig. 24.

- 1956 *Palmatolepis distorta* Branson & Mehl; Hass, *U.S. geol. Surv. prof. Pap.* 286, 19, pl. 2, fig. 1.
- 1956 *Palmatolepis (Palmatolepis) distorta* Branson & Mehl; Müller, *Abh. Senck. naturf. Ges.*, 494, 26, pl. 7, figs 20, 21.
- 1957 *Palmatolepis distorta* Branson & Mehl; Ziegler in Flügel & Ziegler, *Naturw. Ver. Steiermark, Mitt.*, 57, pl. 1, fig. 5.
- 1959 *Palmatolepis distorta* Branson & Mehl; Helms, *Geologie*, 8, 674, pl. 5, fig. 24.
- non 1960 *Palmatolepis (Palmatolepis) distorta* Branson & Mehl; Clark & Becker, *Bull. geol. Soc. Am.*, 71, 1669, pl. 2, figs 2, 6-8.
- 1962 *Palmatolepis distorta* Branson & Mehl; Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 57, pl. 5, figs 8-13.
- 1963 *Palmatolepis (Panderolepis) distorta distorta* Branson & Mehl; Helms, *Geologie*, 12, text-fig. 2.26.
- 1963 *Palmatolepis distorta* Branson & Mehl; Abdusselamoglu, *Bull. Miner. Res. Expl. Inst. Turkey*, 60, 4, pl. 1, fig. 6.
- non 1965 *Palmatolepis (Panderolepis) distorta* (Branson & Mehl); Spasov, *Trav. Géol. Bulg. Sér. paléont.*, 7, 93, pl. 2, fig. 11.
- 1966 *Palmatolepis distorta* Branson & Mehl; Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 9.
- 1966 *Palmatolepis distorta* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, 809, pl. 89, fig. 8; pl. 91, figs 2, 4.
- ?1967 *Palmatolepis distorta* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont., Abh.*, 127, 219, pl. 21, fig. 14.
- 1967 *Palmatolepis distorta* Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 69, pl. 3, figs 3-5.
- 1967 *Palmatolepis distorta* Branson & Mehl; Kodsi, *N. Jb. Geol. Paläont., Monatsh.*, 27, 421, pl. 6, fig. 1.
- 1967 *Palmatolepis distorta* Branson & Mehl; Nehring, *Poland, Inst. Geol. Bull.*, 209, 145, pl. 1, fig. 4.
- 1967 *Palmatolepis distorta* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 19, 390, pl. 8, figs 11, 12.
- 1967 *Palmatolepis distorta* Branson & Mehl; Boogaert, *Leidse geol. Med.*, 39, 182, pl. 2, fig. 24.
- 1968 *Palmatolepis distorta* Branson & Mehl; Schulze, *N. Jb. Geol. Paläont., Abh.*, 130, 206, pl. 19, fig. 14.
- 1969 *Palmatolepis distorta* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 98, pl. 17, figs 5-7.

Material: 3 specimens; CPC 12591 figured, from Sample 19095, Section 4, north-east of McWhae Ridge, Virgin Hills Formation.

Remarks: Ziegler (1962) and Glenister & Klapper (1966) point out that the distinguishing feature of *P. distorta* is the convexity of the anterior inner platform, which separates it from *P. glabro pectinata*.

Distribution: The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Other occurrences in North America are reported from Indiana (Huddle, 1934), Tennessee (Hass, 1956) and New York (Oliver et al., 1967).

The species is common in Europe and has been reported extensively from German (Sannemann, 1955a, c; Bischoff & Ziegler, 1956; Bender, 1958; Walliser 1958; Helms, 1959, 1963; Kronberg et al., 1960; Ziegler, 1962a; Henningsen, 1965; Meyer, 1965; Zitsmann, 1966; Wachedorf, 1966; Bering, 1967; Lutzens, 1967; Meischner & Schneider, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). Elsewhere in Europe it has been reported from Australia (Ziegler in Flügel & Ziegler, 1957; Kodsi, 1967; Schulze, 1968; and Schönlaub, 1969a), Bulgaria (Spasov, 1965, 1966), Czechoslovakia (Zikmundova & Chlupac, 1962), Italy (Manzoni, 1965; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967), Poland

(Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967), Portugal (Boogaard, 1963), and Spain (Budinger & Kullman, 1964; Wirth, 1967; and Boogaert, 1967).

The only other recorded occurrences are in Turkey (Abudusselamoglu, 1963) and the Canning Basin, Australia (Glenister & Klapper, 1966).

Range: The species was originally described from the early Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Ziegler (1962) gives the range as Lower *Palmatolepis quadrantinodosa* Zone (toII β) to Lower *Scaphignathus veliferus* Zone (toIII α). Helms (1963) shows the species ranging from late toII into toIII β . Wirth (1967) gives the same range as Ziegler, but Nehring (1967) suggests that the species may range into toIII β strata, i.e., the Middle *Scaphignathus veliferus* Zone. In the Canning Basin the species is known only from the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

PALMATOLEPIS FOLIACEA Youngquist, 1945

(Pl. 50, figs 5a-8b)

- 1945 *Palmatolepis foliaceus* Youngquist, *J. Paleont.*, 19, 364, pl. 56, figs 11, 12.
1967 *Palmatolepis foliacea* (Youngquist); Müller & Müller, *J. Paleont.*, 31, 1102, pl. 140, figs 6-9.
1958 *Palmatolepis foliacea* Youngquist; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 59, pl. 7, figs 8, 16.
non 1960 *Palmatolepis* (*Manticolepis*) *foliacea* (Youngquist); Clark & Becker, *Bull. Geol. Soc. Am.*, 71, 1670, pl. 1, fig. 13 [= *P. hassi*].
1962 *Palmatolepis foliacea* Youngquist; Ziegler, *N. Jb. Geol. Paläont., Abh.*, 114, 166, text-fig. 8 (centre left).
1963 *Palmatolepis* (*Manticolepis*) *foliacea* (Youngquist); Helms, *Geologie*, 12, 456, text-fig. 2.5.
1966 *Palmatolepis foliacea* (Youngquist); Anderson, *J. Paleont.*, 407, 408, pl. 48, figs 7, 8.
1967 *Palmatolepis foliacea* Youngquist; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 51, pl. 8, figs 3, 14.

Material: 8 specimens; CPC 12592-12595 figured, from samples BG 21104 (CPC 12595), 21108 (CPC 12592, 12593, 12594) north face of Lawford Range, 3 km east of Galeru Gorge, Virgin Hills Formation.

Description: A pear-shaped palmatolepid with the inner platform slightly larger than the outer. Both are ornamented with sparse nodes which are more conspicuous towards the margins.

The free blade fuses with the carina and consists of about 20 laterally compressed fused denticles with free chevron tips. They are of about equal height but decrease in height gently toward the azygous node. The azygous node is low, circular, and needle-tipped; the nodes of the posterior carina are similar type and extend about half the distance to the posterior termination.

Distribution: The species was originally described from Iowa (Youngquist, 1945). It has been reported extensively from Iowa (Müller & Müller, 1957; Klapper & Furnish, 1963; Anderson, 1966); the only other record from North America is from Nevada and Utah (Clark & Ethington, 1967). In Europe the species has been reported extensively from Germany (Ziegler, 1958, 1962; Helms, 1963; Krebs & Rabien, 1964; Schriel & Stoppel, 1965; Wachendorf, 1966; Lutzens, 1967; Bar, 1968; Schneider, 1969), but not from the remainder of Europe.

Glennister & Klapper (1966) record one specimen from the Canning Basin. The species appears to be restricted in its distribution.

Range: The species was originally described from the Frasnian Independence Shale of Iowa (Youngquist, 1945; Müller & Müller, 1957). It is also present in the late Frasnian Cerro Gordo Member of the Lime Creek Formation (Anderson, 1966). Ziegler (1958) gives the range as being confined to the late toI Zone of the Frasnian, as does Helms (1963). Ziegler (1962) extends the range down to include the early toI_γ Zone and Clark & Ethington (1967) give the range as *Ancyrognathus triangularis* and Lower *Palmatolepis gigas* Zone.

The Canning Basin specimen comes from the Lower *P. gigas* Zone.

PALMATOLEPIS GIGAS Miller & Youngquist, 1947

(Pl. 65, figs 1a-2b)

- 1926 *Palmatolepis perlobata* (part) Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 49, pl. 7, fig. 23 only.
- 1934 *Palmatolepis perlobata* Ulrich & Bassler; Branson & Mehl, *Univ. Mo. Stud.*, 8, 234, pl. 18, fig. 24.
- 1947 *Palmatolepis gigas* Miller & Youngquist, *J. Paleont.*, 21, 512, pl. 75, fig. 1.
- 1956 *Palmatolepis rhenana* Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 129, pl. 8, figs 26-28, 30; pl. 10, fig. 7.
- 1956 *Palmatolepis* (*Manticolepis*) *prominens* Müller, *Senck. naturf. Ges., Abh.*, 494, 22, pl. 5, figs 25, 26, 28-30.
- 1956 *Palmatolepis* (*Manticolepis*) *nasuta* Müller, *ibid.*, 23, pl. 6, figs 31-35.
- 1956 *Palmatolepis subrecta* Miller & Youngquist; Hass, *U.S. geol. Surv. prof. Pap.* 286, 19, pl. 3, fig. 14; pl. 4, figs 14, 15.
- 1957 *Palmatolepis* (*Manticolepis*) *amana* Müller & Müller, *J. Paleont.*, 31, 1101, pl. 140, fig. 5.
- 1957 *Palmatolepis* (*Manticolepis*) *flabelliformis* Stauffer; Müller & Müller, *ibid.*, 1101, pl. 139, fig. 3-6.
- 1958 *Palmatolepis rhenana* Bischoff; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 63, pl. 4, fig. 15, 16; pl. 5, figs 1-10; pl. 6, figs 1-3, 7; pl. 8, fig. 20.
- 1963 *Palmatolepis* (*Manticolepis*) *rhenana* (Bischoff); Helms, *Geologie*, 12, text-fig. 2.11.
- 1965 *Palmatolepis gigas* Miller & Youngquist; Ethington, *J. Paleont.*, 39, 579, pl. 68, figs 14, 16.
- 1966 *Palmatolepis gigas* Miller & Youngquist; Anderson, *J. Paleont.*, 40, 408, pl. 49, figs 1, 2, 4-10, 16, 20.
- 1966 *Palmatolepis gigas* Miller & Youngquist; Glenister & Klapper, *J. Paleont.*, 40, 810, pl. 88, fig. 12.
- 1966 *Palmatolepis* (*Manticolepis*) *rhenana* Bischoff; Koverdynsky & Zikmundova, *Vestnik U.U.G.*, 42, 369, pl. 1, fig. 1, 2.
- 1966 *Palmatolepis gigas* Miller & Youngquist; Winder, *J. Paleont.*, 40, 1281, pl. 156, fig. 11.
- 1967 *Palmatolepis gigas* Miller & Youngquist; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 51, pl. 4, fig. 19.
- 1967 *Palmatolepis gigas* Miller & Youngquist; Boogaert, *Leidse geol. Med.*, 39, 182, pl. 2, fig. 27.
- 1968 *Palmatolepis gigas* Miller & Youngquist; Mound, *J. Paleont.*, 42, 499, pl. 68, figs 1-3, 6.
- 1970 *Palmatolepis gigas* Miller & Youngquist; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 9.

Material: 14 specimens; CPC 12612, 12615 figured, from sample BG 19451A (CPC 12612), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21108 (CPC 12615), 3 km northeast of Galeru Gorge, Virgin Hills Formation.

Description: A palmatolepid with a prominent lateral lobe. The inner platform is extended as a long distinct lateral lobe, the axis of which is anterior to the azygous

node. The outer platform is narrow, with a sigmoidal margin. The anterior free blade merges with the carina; they are composed of about 20 fused needle-like denticles which are tallest near the anterior termination, decreasing rapidly in height anteriorly and slowly posteriorly to the azygous node. The azygous node is isolated and circular in cross-section. The posterior carina is composed of nodes similar to the azygous node but smaller, decreasing in size posteriorly until they merge with the scattered nodose ornament of the platform. The overall form of the carina is sigmoidal. In some specimens a lateral carina is present; it extends about half the distance to the lateral lobe termination.

Remarks: *P. gigas* is close to *P. subrecta*, but the elongate lateral lobe serves to distinguish it. One specimen (Pl. 64, figs 5a, b) is compared to *P. gigas*. It is distinguished by the coarse ornament and a lateral carina.

Distribution: The species was originally described from the Sweetland Creek Shale (Frasnian) of Iowa (Miller & Youngquist, 1947), although it had already been illustrated from the 'Hardin sandstone' of Tennessee (Ulrich & Bassler, 1926; Huddle, 1968) and the Grassy Creek shale of Missouri (Branson & Mehl, 1934). It has been reported from other localities in Iowa (Klapper & Furnish, 1963; Anderson, 1966), and from Arizona (Ethington, 1965), New York (Oliver et al., 1967), Utah (Clark & Ethington, 1967), and Alberta (Mound, 1968) and Ontario (Winder, 1966) in Canada.

In Europe the majority of occurrences are in Germany (Bischoff, 1956; Ziegler, 1958; Walliser, 1958; Helms, 1963; Krebs & Rabien, 1964; Schriel & Stoppel, 1965; Stoppel & Zscheke, 1966; Wachendorf, 1966; Lutzens, 1967; Schneider, 1969). Elsewhere in Europe it is known from Austria (Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Koverdynsky & Zikmundova, 1966), and Spain (Boogaert, 1967).

Both Glenister & Klapper (1966) and Seddon (1970a) have recorded the species in the Canning Basin.

Range: The species was originally described from the Frasnian Sweetland Creek Shale of Iowa (Miller & Youngquist, 1947). Ziegler (1958, 1962) gives a range of late to γ (Lower *Palmatolepis gigas* Zone) to to δ (Lower *Palmatolepis triangularis* Zone). This range is confirmed by Helms (1963), and is identical with that in the Canning Basin.

PALMATOLEPIS GLABRA GLABRA Ulrich & Bassler, 1926

(Pl. 51, figs 2a-5b)

- 1926 *Palmatolepis glaber* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 51, pl. 9, fig. 20.
- 1934 *Palmatolepis glabra* Ulrich & Bassler; Branson & Mehl, *Univ. Mo. Stud.*, 8, 233, pl. 18, figs 9, 26.
- ?1947 *Palmatolepis glabra* Ulrich & Bassler; Bond, *Ohio J. Sci.*, 47, 33, pl. 2, fig. 25.
- 1955 *Palmatolepis glabra* Ulrich & Bassler; Sannemann, *Senck. leth.*, 36, 135, pl. 1, fig. 4.
- 1956 *Palmatolepis (Palmatolepis) glabra* Ulrich & Bassler; Müller, *Senck. naturf. Ges. Abh.*, 494, 25, pl. 7, figs 8-10, 13, 14.
- 1956 *Palmatolepis glabra* Ulrich & Bassler; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 128, pl. 8, figs 34, 35.
- 1956 *Palmatolepis glabra* Ulrich & Bassler; Hass, *U.S. geol. Surv. prof. Pap.* 286, pl. 3, figs 15-17.
- 1957 *Palmatolepis glabra* Ulrich & Bassler; Hass in Cloud et al., *Bull. geol. Soc. Am.*, 68, pl. 4, fig. 6.

- 1959 *Palmatolepis glabra* Ulrich & Bassler α morphotype Scott & Collinson, *J. Paleont.*, 33, 599, pl. 75, figs 1-5.
- 1959 *Palmatolepis glabra* Ulrich & Bassler β morphotype Scott & Collinson, *ibid.*, pl. 75, figs 6, 7, 9.
- 1960 *Palmatolepis glabra glabra* Ulrich & Bassler; Ziegler, *Fortschr. Geol. Rheinld Westf.*, 6, 7, pl. 1, figs 11-13.
- 1961 *Palmatolepis glabra* Ulrich & Bassler; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 548, pl. 3, fig. 1.
- 1963 *Palmatolepis glabra* Branson & Mehl (sic); Abdusselamoglu, *Bull. Min. Res. Expl. Inst. Turkey*, 60, 4, pl. 1, fig. 4.
- 1963 *Palmatolepis* (*Panderolepis*) *serrata* (Hinde) subsp. α Helms, *Geologie*, 12, 478, pl. 1, fig. 2; text-fig. 2.
- 1965 *Palmatolepis glabra glabra* Ulrich & Bassler; Freyer, *Abh. Ber. naturk. Mus. Gortitz*, 40, V/9, text-fig. 1.1.
- 1965 *Palmatolepis glabra glabra* Ulrich & Bassler; Bouckaert & Ziegler, *Mém. Expl. Cartes géol. Min. Belg.*, 5, 23, pl. 3, fig. 8.
- 1966 *Palmatolepis glabra glabra* Ulrich & Bassler; Glenister & Klapper, *J. Paleont.*, 40, 811, pl. 89, figs 6, 7; pl. 90, fig. 3.
- 1966 *Palmatolepis glabra glabra* Ulrich & Bassler; Spasov & Filipovic, *Geol. Glasnik*, 11, 45, pl. 3, figs 4, 5.
- 1967 *Palmatolepis glabra glabra* Ulrich & Bassler; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 219, pl. 21, fig. 2.
- 1967 *Palmatolepis glabra glabra* Ulrich & Bassler; Nehring, *Poland, Inst. Geol. Bull.* 209, 146, pl. 3, figs 6a, b.
- 1967 *Palmatolepis glabra glabra* Ulrich & Bassler; Boogaert, *Leidse geol. Med.*, 39, 182, pl. 2, fig. 25.
- 1967 *Palmatolepis glabra glabra* Ulrich & Bassler; Wolska, *Acta paleont. polon.*, 12, 390, pl. 7, figs 8-12b; text-fig. 7.
- 1967 *Palmatolepis glabra glabra* Ulrich & Bassler; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 51, pl. 9, fig. 8.
- 1968 *Palmatolepis glabra* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 29, pl. 14, figs 2-16.
- 1968 *Palmatolepis glabra glabra* Ulrich & Bassler; Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 162, pl. 2, fig. 15.
- 1968 *Palmatolepis glabra glabra* Ulrich & Bassler; Manzoni, *G. Geol.*, 34, 661, pl. 62, fig. 10.
- 1969 *Palmatolepis glabra glabra* Ulrich & Bassler; Olivieri, *Boll. Soc. paleont. ital.*, 8, 100, pl. 17, figs 1-4.

Material: 90 specimens. CPC 12596-9 figured.

Localities of figured material: Sample BG 19019 (CPC 12596, 12597) Section 1, McWhae Ridge, Virgin Hills Formation; BG 19072 (CPC 12598), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21261 (CPC 12599), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: The outer platform parapet is the diagnostic character of the nominate subspecies. In *P. glabra pectinata* the parapet is elongate and reaches the azygous node. In *P. glabra elongata* the parapet is restricted to the anterior part and is relatively more elevated; when this elevation becomes triangular the specimens are referred to *P. glabra acuta*. The parapet on the nominate subspecies is low and of medium length. The relationship of *P. serrata* (Hinde) and *P. glabra* is discussed by Huddle (1968, p. 30).

Distribution: The species was originally described from the 'Hardin sandstone' of Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). It has also been reported from Missouri (Branson & Mehl, 1934) and Nevada (Clark & Ethington, 1967).

The species is very common in Europe and has been reported extensively from Germany (Sannemann, 1955a, b, c; Müller, 1956; Bischoff, 1956; Bischoff &

Ziegler, 1956; Ziegler, 1960; Kronberg et al., 1960; Helms, 1963; Freyer, 1965; Wachendorf, 1966; Bering, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). It has also been reported from Austria (Ziegler in Flügel & Ziegler, 1957; Schönlaub 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Koverdynsky & Zikmundova, 1962), France (Lys et al., 1961; Boyer et al., 1968), Italy (Manzoni, 1965, 1968; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1966; Spasov et al., 1968), Poland (Nehring, 1967; Wolska, 1967), Portugal (Boogaard, 1963), and Spain (Wirth, 1967; Boogaert, 1967).

Elsewhere the species has been reported from Morocco (Massa, 1965), Turkey (Abdusselamoglu, 1963), and Australia (Glenister & Klapper, 1966).

Range: The original description of the species was from the 'Hardin sandstone', which is of problematical age. The only accurately dated occurrence in North America is from the *Palmatolepis rhomboidea* Zone (early toII β). Ziegler (1962) records the range as Lower *Palmatolepis quadrantinodosa* Zone (late toII β) to Upper *Schaphignathus veliferus* Zone (toIII β -IV). However, it seems that the species can range as low as the Upper *Palmatolepis crepida* Zone (late toIIa) (Wirth, 1967; Wolska, 1967; Boyer et al., 1968).

In the Canning Basin the species ranges from the Upper *P. crepida* Zone (late toIIa) to the Middle *S. veliferus* Zone (toIII β).

PALMATOLEPIS GLABRA ACUTA Helms, 1963

(Pl. 52, fig. 3; Pl. 53, fig. 4)

- 1960 *Palmatolepis* (*Palmatolepis*) *distorta* Clark & Becker, *Bull. Soc. Am. geol.*, 71, 1669, pl. 2, fig. 8.
- 1962 *Palmatolepis glabra* n. subsp. A Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 59, pl. 5, figs 1, 2.
- 1963 *Palmatolepis* (*Panderolepis*) *serrata acuta* Helms, *Geologie*, 12, 468, pl. 3, figs 1-4, 6.
- 1967 *Palmatolepis glabra* n. subsp. A Ziegler; Clark & Ethington, *Geol. Soc. Am. Mem.*, 103, 52, pl. 4, fig. 18.
- 1967 *Palmatolepis glabra acuta* Helms; Wolska, *Acta palaeont. polon.*, 12, 394, pl. 8, figs 13, 14; text-fig. 10.
- 1969 *Palmatolepis glabra acuta* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 101, pl. 17, figs 8, 9.

Material: 6 specimens; CPC 12602, 12607 figured, from sample BG 21267, Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: The subspecies is easily distinguished from *P. glabra elongata* by the upright triangular parapet on the outer margin. In some specimens the parapet is not conspicuously triangular, but the outer platform is always wider at the anterior termination than it is at the posterior termination of the parapet.

Distribution: The subspecies was originally described from Germany (Helms, 1963) (see also Bar, 1960; Schneider, 1969), and has been reported from Poland (Freyer & Zakowa, 1967; Wolska, 1967) and Italy (Manzoni, 1965; Olivieri, 1969). The only reference to the species in North America is from Nevada (Clark & Becker, 1960; Clark & Ethington, 1967).

Range: The subspecies was originally described from Famennian toIII strata (Helms, 1963). Ziegler (1962b) gives the range as *Palmatolepis rhomboidea* Zone

(toIII β) to Lower *Palmatolepis quadrantinodosa* Zone (late toIII β). Wolska (1967) records the species in the *quadrantinodosa* Zone and Clark & Ethington report it from the *rhomboidea* Zone. In the Canning Basin the specimens occur in samples from the boundary between the Lower and Upper *quadrantinodosa* Zones.

PALMATOLEPIS GLABRA ELONGATA Holmes, 1928

(Pl. 52, figs 1a, b, c, 4a, b)

- 1928 *Palmatolepis elongata* Holmes, *Proc. U.S. nat. Mus.*, 72, 33, pl. 11, fig. 13.
1969 *Palmatolepis glabra elongata* Holmes; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 87, pl. 17, fig. 9 (Synonymy to 1966).
1967 *Palmatolepis glabra elongata* Holmes; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 220, pl. 21, figs 5, 6.
1967 *Palmatolepis glabra elongata* Holmes; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 69, pl. 3, figs 1, 2.
1967 *Palmatolepis glabra elongata* Holmes; Boogaert, *Leidse geol. Med.*, 39, 182, pl. 2, fig. 26.
1967 *Palmatolepis glabra elongata* Holmes; Freyer & Zakowa, *Acta geol. polon.*, 17, 111, pl. 2, fig. 7.
1967 *Palmatolepis glabra elongata* Holmes; Wolska, *Acta palaeont. polon.*, 12, 391, pl. 8, figs 1-5, text-fig. 8.
1969 *Palmatolepis glabra elongata* Holmes; Olivieri, *Boll. Soc. paleont. ital.*, 8, 102, pl. 19, figs 9a-11.

Material: 20 specimens, CPC 12600-1 figured.

Localities of figured material: Sample BG 21014 (CPC 12600), Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation; BG 21267 (CPC 12601), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: The distinctive parapet on the outer platform of this subspecies was mentioned under the nominate subspecies. The unit is also slimmer than any other subspecies than *P. glabra acuta*.

Distribution: The subspecies was originally described from the Famennian Chattanooga Shale of Alabama (Holmes, 1928). Elsewhere in North America it has been reported from Arkansas (Cooper, 1935; Hass, 1951), Indiana (Huddle, 1934), and Nevada (Clark & Ethington, 1965). In Europe it has been reported extensively from Germany (Walliser, 1958; Helms, 1959; Kronberg et al., 1960; Ziegler, 1960, 1962; Freyer, 1965; Bering, 1967; Meischner & Schneider, 1967, 1970; Dvorak & Freyer, 1968; Bar, 1968; Schneider, 1969). It has also been reported from Austria (Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Koverdynsky & Zikmundova, 1962), France (Boyer et al., 1968), Italy (Manzoni, 1965, 1968; Forti & Nocchi, 1963; Olivieri, 1965) including Sardinia (Olivieri, 1965), Yugoslavia (Spasov & Filipovic, 1967, Poland (Freyer & Zakowa, 1967; Wolska, 1967), Portugal (Boogaard, 1963), and Spain (Wirth, 1967; Boogaert, 1967).

The subspecies is also known from Morocco (Massa, 1965) and Australia (Glenister & Klapper, 1966; Druce, 1969).

Range: The subspecies was originally described from an unknown horizon in the Chattanooga Shale. It has been recorded from the *Palmatolepis rhomboidea* Zone (early toII β). Ziegler (1962) records it from the Lower *Palmatolepis quadrantino-*

dosa Zone to the Upper *Scaphignathus veliferus* Zone, and this range is also recorded by Wirth (1967). However, Boyer et al. (1968) record the subspecies in the late toII_a Zone of the Montagne Noir of France.

In the Canning Basin the subspecies ranges from the Upper *Palmatolepis crepida* Zone to the Lower *Polygnathus styriacus* Zone (toIV).

PALMATOLEPIS GLABRA PECTINATA Ziegler, 1962

(Pl. 52, figs 2a, b, 5a, b; Pl. 53, figs 1a-3b; Pl. 64, fig. ? a, b)

- 1962 *Palmatolepis glabra pectinata* Ziegler, Hess. Landesamt Bodenf., Abh., 38, 59, pl. 4, fig. 16, pl. 5, figs 3-5.
- 1969 *Palmatolepis glabra pectinata* Ziegler; Druce, Bur. Miner. Resour. Aust. Bull. 98, 87, pl. 17, figs 7, 8; pl. 18, figs 1a-3 (Synonymy to 1966).
- 1966 *Palmatolepis glabra pectinata* Ziegler; Glenister & Klapper, J. Paleont., 40, 814, pl. 89, figs 1-3, 5, 9, 10; pl. 90, figs 4, 5; pl. 91, figs 1, 3, 5.
- 1967 *Palmatolepis glabra pectinata* Ziegler; Wirth, N. Jb. Geol. Paläont. Abh., 127, 220, pl. 21, figs 3, 4.
- 1967 *Palmatolepis glabra pectinata* Ziegler; Clark & Ethington, Geol. Soc. Am. Mem. 103, 52, pl. 4, fig. 8.
- non 1967 *Palmatolepis glabra pectinata* Ziegler; Freyer & Zakowa, Acta geol. polon., 17, 137, pl. 2, fig. 8 (= *P. glabra* s.s.).
- 1967 *Palmatolepis glabra pectinata* Ziegler; Wolska, Acta palaeont. polon., 12, 392, pl. 8, figs 6-9; text-fig. 9.
- 1968 *Palmatolepis glabra pectinata* Ziegler; Manzoni, G. Geol., 34, 662, pl. 62, figs 8, 9.
- 1968 *Palmatolepis glabra pectinata* Ziegler; Schulze, N. Jb. Geol. Paläont. Abh., 130, 207, pl. 19, fig. 10.

Material: 216 specimens, CPC 12603-6, 12608, 12639 figured.

Localities of figured material: Samples BG 19083 (CPC 12603), 19102 (CPC 12604), 19108 (CPC 12605), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone. BG 21361 (CPC 12606), Section 23, Geikie Gorge, Napier Formation; BG 21267 (CPC 12608, 12639), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: This subspecies is easily recognized by the elongate outer platform parapet. One specimen (Pl. 53, fig. 2a, b) has a sigmoidal outline and is fairly narrow. It is a variant not illustrated by Scott & Collinson (1959).

Distribution: The subspecies was originally described from Germany (Ziegler, 1962a), where it has been extensively recorded (Sannemann, 1955; Zimmermann, 1960; Freyer, 1961, 1965; Ziegler, 1962b; Helms, 1963; Wachendorf, 1966; Meischner & Schneider, 1967, 1970; Bering, 1967; Dvorak & Freyer, 1968; Bar, 1968; Schneider, 1969). Elsewhere in Europe it has been recorded from Austria (Kodsi, 1967; Schulze, 1968; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Italy (Manzoni, 1968; Olivieri, 1969), Spain (Wirth, 1967), and Poland (Greyer & Zakowa, 1967; Wolska, 1967).

In North America the subspecies is reported by Scott & Collinson (1959) from Illinois and by Clark & Ethington (1967) from Nevada. Winder (1966) has recorded it from Ontario, Canada.

Range: The subspecies was originally described from the upper *Cheiloceras*-Stufe of Germany (Ziegler, 1962a) and the range was given as Upper *Palmatolepis crepida* Zone (latest toII_a) to Upper *Palmatolepis quadrantinodosa* Zone (lowest

toIIIa). This range is extended into the *Scaphignathus veliferus* Zone by Wolska (1967). The subspecies occurs in the *Palmatolepis rhomboidea* Zone in North America (Clark & Ethington, 1967). In the Canning Basin it ranges from the *rhomboidea* Zone to the Middle *veliferus* Zone.

PALMATOLEPIS GRACILIS GRACILIS Branson & Mehl, 1934

(Pl. 64, figs 2a-4c)

- 1934 *Palmatolepis gracilis* Branson & Mehl, *Univ. Mo. Stud.*, R, BCR, pl. 18, figs 2, 8 (non fig. 5).
- 1962 *Palmatolepis gracilis* Branson & Mehl; Mehl & Ziegler, *J. Sci. Lab. Denison Univ.*, 45, 200, pl. 1, figs 1a-2b (Complete synonymy up to 1962).
- 1969 *Palmatolepis gracilis gracilis* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 88, pl. 17, figs 3a-5b (Synonymy 1962-1965).
- 1966 *Palmatolepis gracilis gracilis* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, 814, pl. 90, fig. 6.
- 1967 *Palmatolepis gracilis* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 221, pl. 2, fig. 1.
- 1967 *Palmatolepis gracilis gracilis* Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 70, pl. 2, figs 7, 8; pl. 3, figs 19, 20.
- 1967 *Palmatolepis gracilis deflectens* Müller; Spasov & Filipovic, *ibid.*, pl. 1, fig. 7.
- 1967 *Palmatolepis gracilis gracilis* Branson & Mehl; Boogaert, *Leidse geol. Med.*, 39, 182, pl. 2, figs 28, 29.
- 1967 *Palmatolepis deflectens deflectens* Müller; Freyer & Zakowa, *Acta geol. polon.*, 17, 126, pl. 2, fig. 3.
- 1967 *Palmatolepis gracilis* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, pl. 11, figs 1-5.
- 1968 *Palmatolepis gracilis* Branson & Mehl; Schulze, *N. Jb. Geol. Paläont. Abh.*, 130, 207, pl. 19, fig. 16.
- 1969 *Palmatolepis gracilis gracilis* Branson & Mehl; Matthews, *Palaeontology*, 12, 269, pl. 47, fig. 9.
- 1969 *Palmatolepis gracilis gracilis* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 104, pl. 20, figs 6, 7.

Material: 16 specimens; CPC 12609-11 figured, from samples BG 19171 (CPC 12609), 19173 (CPC 12610), 19182 (CPC 12611), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: A palmatolepid with a greatly reduced platform centred around the azygous node. The blade is relatively high and free.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934). It has also been recorded from Wyoming (Klapper, 1958). In Europe the great number of reports of the species from Germany have been listed by Mehl & Ziegler (1962). Elsewhere it has been reported from Austria (Ziegler in Flügel & Ziegler, 1957; Schulze, 1968; Schönlaub, 1969a), Bulgaria (Spasov, 1965), England (Matthews, 1969), Italy (Manzoni, 1965, 1968; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Spain (Boogaert, 1967; Wirth, 1967).

The species has been reported from both the Bonaparte Gulf Basin (Druce, 1969) and the Canning Basin (Glenister & Klapper, 1966) in Australia.

Range: The species was originally described from the Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Ziegler (1962) gives the German range as *Palmatolepis rhomboidea* Zone (early toII β) to Upper *Spathognathodus*

costatus Zone (toVI). The only extension of the range is by Matthews (1969), who records it in an Early Carboniferous fauna, but he states (p. 266) that 'the limits of occurrence seen in the Upper Dovenian by Ziegler can be accepted as real'.

In the Canning Basin the species ranges from the Upper *Palmatolepis quadrantinodosa* Zone (toIIIa) into the Middle *Polygnathus styriacus* Zone (toV).

PALMATOLEPIS HASSI Müller & Müller, 1957

(Pl. 65, figs 3a-5b)

- 1957 *Palmatolepis* (*Manticolepis*) *hassi* Müller & Müller, *J. Paleont.*, 31, 1102, pl. 139, fig. 2; pl. 140, figs 2, 4.
- 1958 *Palmatolepis hassi* Müller & Müller; Ziegler, *Hess. Landesamt Bodenf., Abh.*, 87, 60, pl. 7, figs 3-7, 10, 13.
- 1962 *Palmatolepis hassi* Müller & Müller; Ziegler, *N. Jb. Geol. Paläont., Abh.*, 114, 166, text-fig. 8 (part).
- 1963 *Palmatolepis hassi* Müller & Müller; Klapper & Furnish, *Iowa Acad. Sci.*, 69, 406, fig. 2, 9.
- 1967 *Palmatolepis hassi* Müller & Müller; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 52, pl. 8, fig. 13.
- 1968 *Palmatolepis hassi* Müller & Müller; Figge, *N. Jb. Geol. Paläont., Monatsh.*, 13, 198, fig. 2.

Material: 14 specimens; CPC 12616-8 figured, from samples BG 19009 (CPC 12616, 12617), 19012 (CPC 12618), Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: *Palmatolepis hassi* is closely related to several species. It is very similar to *P. subrecta* but lacks a secondary carina, and has a less sigmoidal keel and a more nodose platform. *P. subperlobata* can be distinguished by its upward arching posterior tip (Müller & Müller, 1957).

Distribution: The species was originally described from the Independence Shale of Iowa (Müller & Müller, 1957; Klapper & Furnish, 1963). It has also been reported from Utah (Clark & Ethington, 1967) and Alberta (Pollock, 1968).

The species has been recorded from Germany (Ziegler, 1958, 1962a; Krebs & Rabien, 1964; Schriel & Stoppel, 1965; Stoppel & Zscheke, 1966; Wachendorf, 1966; Figge, 1968; Bar, 1968; Schneider, 1969). The only other European report is from Montagne Noir, France (Boyer et al., 1968).

Range: In Iowa the species is present in the *Ancyrognathus triangularis* Zone (toI β) (Klapper & Furnish, 1963). Ziegler (1958) gives the range in Germany as late Upper *Polygnathus asymmetricus* Zone (toI β) to Upper *Palmatolepis gigas* Zone (toI δ). In Utah the species is present in either the Upper *P. asymmetricus* Zone or the *A. triangularis* Zone.

In the Canning Basin the species is present in both the *P. asymmetricus* and *A. triangularis* Zones.

PALMATOLEPIS LINGUIFORMIS Müller, 1956

(Pl. 65, figs 6a, b)

- 1956 *Palmatolepis* (*Palmatolepis*) *linguiformis* Müller, *Abh. Senck. naturf. Gesell.*, 494, 24, pl. 7, fig. 1-7.
- 1960 *Palmatolepis* (*Palmatolepis*) *linguiformis* Müller; Clark & Becker, *Bull. geol. Soc. Am.*, 71, 1672, pl. 1, fig. 14.

- 1958 *Palmatolepis crepida* Sannemann; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 59, pl. 9, figs 5, 7, 12.
 1963 *Palmatolepis* (*Manticolepis*) *linguiformis* Müller; Helms, *Geologie*, 12, text-fig. 2.12.
 1966 *Palmatolepis linguiformis* Müller; Glenister & Klapper, *J. Paleont.*, 40, 815, pl. 88, figs 4, 5.
 1967 *Palmatolepis linguiformis* Müller; Wolska, *Acta paleont. polon.*, 12, pl. 6, figs 9-10b.
 1967 *Palmatolepis linguiformis* Müller; Clark & Ethington, *Geol. Soc. Am. Mem.*, 103, 53, pl. 4, fig. 16.

Material: 2 specimens; CPC 12619 figured, from sample BG 19448E, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *P. linguiformis* is a small, nearly rectangular species with platforms which extend nearly to the anterior termination of the free blade. Glenister & Klapper (1966, p. 816) note that both platforms merge with the blade at about the same position, and this distinguishes it from *Palmatolepis crepida*.

Distribution: The species was originally described from Wildungen, Germany (Müller, 1956); other occurrences in Germany are recorded by Ziegler (1958, 1962a), Bender (1958), Freyer (1961), Helms (1963), and Lutzens (1967). It has also been reported from Austria (Schönlaub, 1969) and Poland (Wolska, 1967). Outside Europe the species is rare, having been reported from Australia (Glenister & Klapper, 1966), and from Utah (Clark & Becker, 1960; Clark & Ethington, 1967).

Range: The species was first described from the upper part of the *Manticoceras*-Stufe (Müller, 1956). Ziegler (1962a) records occurrence in the Upper *Palmatolepis gigas* Zone (to I8). Clark & Ethington (1967) also record it in this zone in North America. However, Wolska (1967) records it from the *Palmatolepis triangularis* Zone. In the Canning Basin the species occurs in the Upper *P. gigas* Zone.

PALMATOLEPIS MINUTA MINUTA Branson & Mehl, 1934

(Pl. 66, figs 1a-3b)

- 1934 *Palmatolepis minuta* Branson & Mehl, *Univ. Mo. Stud.*, 8, 236, pl. 18, figs 1, 6, 7.
 1969 *Palmatolepis minuta minuta* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 89, pl. 17, figs 7, 8, pl. 18; figs 1a-3 (Synonymy to 1966).
 1966 *Palmatolepis minuta minuta* (Branson & Mehl); Anderson, *J. Paleont.*, 40, 408, pl. 49, fig. 18.
 1966 *Palmatolepis minuta* Branson & Mehl; Spasov & Filipovic, *Geol. Glasnik*, 11, 45, pl. 3, fig. 2.
 1967 *Palmatolepis minuta minuta* Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 70, pl. 3, figs 6, 7.
 1967 *Palmatolepis minuta* (Branson & Mehl); Nehring, *Inst. Geol. Bull.* 209, 147, pl. 3, figs 5a, b [non pl. 1, figs 3a, b = *P. minuta schleizia*].
 1967 *Palmatolepis minuta minuta* Branson & Mehl; Kodsi, *N. Jb. Geol. Paläont., Monatsh.*, 27, pl. 6, fig. 2.
 1967 *Palmatolepis minuta* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 53, pl. 9, fig. 2.
 1967 *Palmatolepis minuta minuta* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 397, pl. 7, figs 1-4; text-fig. 11.
 1968 *Palmatolepis minuta* Branson & Mehl; Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 161, pl. 2, figs 7, 8.
 1969 *Palmatolepis minuta minuta* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 106, pl. 20, figs 1-4.

Material: 460 specimens, CPC 12620-2 figured.

Localities of figured material: Sample BG 19019 (CPC 12620), Section 1, McWhae Ridge, Virgin Hills Formation; BG 21267 (CPC 12621), 21271 (CPC 12622), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: The species *P. minuta* has been divided into three subspecies; both *P. minuta loba* and *P. minuta schleizia* are lobate forms. However, platform area and margin shape vary considerably and the species may be subdivided further.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934); elsewhere in North America it has been reported from Iowa (Anderson, 1966), Utah and Nevada (Clark & Becker, 1960; Clark & Ethington, 1967), Alberta (Clark & Ethington, 1965), and Ontario (Winder, 1966).

In Europe the subspecies has been reported extensively from Germany (Sannemann, 1955a, b, c; Bischoff, 1956; Müller, 1956; Zimmermann, 1960; Freyer, 1961, 1965, 1968; Ziegler, 1962a; Helms, 1963; Henningsen, 1965; Wachendorf, 1966; Bering, 1967; Dvorak & Freyer, 1968; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). The subspecies has also been reported from Austria (Kodsi, 1967; Schönlaub, 1969a), Bulgaria (Spasov, 1966), Czechoslovakia (Zikmundova, 1964), France (Boyer et al., 1968), Italy (Manzoni, 1968; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1966, 1967; Spasov et al., 1968), and Poland (Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967).

Other reports of the subspecies are from Turkey (Abdusselamoglu, 1963) and Australia (Glenister & Klapper, 1966; Druce, 1969).

Range: The species was originally described from the Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Elsewhere in North America it occurs in the Lower *Palmatolepis crepida* and *Palmatolepis rhomboidea* Zones of Utah and Nevada (Clark & Ethington, 1967).

In Europe Ziegler (1962a) gives the range as Upper *Palmatolepis triangularis* Zone (toI/II) to Upper *Scaphignathus veliferus* Zone (toIV). A similar range was recorded by Nehring (1967) and Wolska (1967). In the Canning Basin the species ranges from the Lower *Palmatolepis crepida* Zone (toIIa) to the earliest Lower *Polygnathus styriacus* Zone (toIV).

PALMATOLEPIS MINUTA LOBA Helms, 1963

(Pl. 66, figs 4a, b, 6a, b)

- 1963 *Palmatolepis* (*Deflectolepis*) *minuta loba* Helms, *Geologie*, 12, 470, pl. 2, figs 13, 14; pl. 3, fig. 12; text-figs 2, 33.
1966 *Palmatolepis minuta loba* Helms; Glenister & Klapper, *J. Paleont.*, 40, 818.
1967 *Palmatolepis minuta loba* Helms; Wolska, *Acta palaeont. polon.*, 12, 398, pl. 7, figs 5-7; text-fig. 12.
1969 *Palmatolepis minuta loba* Helms; Olivieri, *Bull. Soc. paleont. ital.* 8, 107, pl. 20, fig. 5a, b.

Material: 65 specimens, CPC 12623-4 figured.

Localities of figured material: Sample BG 19019 (CPC 12623), Section 1, McWhae Ridge, Virgin Hills Formation; BG 21262 (CPC 12624), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: The conspicuous inner platform distinguishes this subspecies.

Distribution: The subspecies was originally described from the Rheinisches Schiefergebirge, Germany (Helms, 1963). The only other reports are from Italy (Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Australia (Glenister & Klapper, 1966).

Range: The subspecies was described by Helms (1963) from the Upper *Palmatolepis crepida* Zone, from which Wolska (1967) also reports it. In the Canning Basin it occurs from the Upper *Palmatolepis triangularis* Zone to the Upper *P. crepida* Zone.

PALMATOLEPIS MINUTA SCHLEIZIA Helms, 1963

(Pl. 66, fig. 5; Pl. 67, figs 1a, b)

- 1963 *Palmatolepis* (*Deflectolepis*) *schleizia* Helms, *Geologie*, 12, 471, pl. 3, fig. 13; pl. 4, figs 1-11. (For synonymy)
1966 *Palmatolepis schleizia* Helms; Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 15.
1967 *Palmatolepis minuta schleizia* Helms; Wolska, *Acta paleont. polon.*, 12, 399, pl. 7, figs 13-16; text-fig. 13.
1967 *Palmatolepis schleizia* (sic) Helms; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 73, pl. 3, figs 21, 22.
1968 *Palmatolepis schleizia* Helms; Manzoni, *G. Geol.*, 34, 665, pl. 62, fig. 13.
1969 *Palmatolepis minuta schleizia* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 107, pl. 20, figs 8, 10.

Material: 3 specimens; CPC 12625-12626 figured, from samples BG 19081 (CPC 12625), 19116 (CPC 12626), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Remarks: This subspecies is distinguished by having a reduced lobate platform with conspicuous rolled edges.

Distribution: The species was originally described from Thuringia, Germany (Helms, 1963). It has also been reported from Germany by Sannemann (1955b), Müller (1956), Helms (1969), Ziegler (1962a), Bering (1967), Lutzens (1967), Schneider (1969), and Meischner & Schneider 1970). Elsewhere in Europe it is known from Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1963), France (Boyer et al., 1968), Italy (Manzoni, 1968; Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Yugoslavia (Spasov & Filipovic, 1967).

Range: The subspecies was originally described from the Middle *Scaphignathus veliferus* Zone (Helms, 1963). Ziegler (1962a) records it from the *Palmatolepis rhomboidea* Zone (toII β) to the Middle *Polygnathus styriacus* Zone (toV). In the Canning Basin the subspecies occurs from the *Palmatolepis rhomboidea* Zone to the *Palmatolepis quadrantinodosa* Zone. In France (Boyer et al., 1968) and Poland (Wolska, 1967) it occurs in the *P. quadrantinodosa* Zone.

PALMATOLEPIS PERLOBATA PERLOBATA Ulrich & Bassler, 1926

(Pl. 67, figs 2a-5b)

- 1926 *Palmatolepis perlobata* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 49, pl. 7, fig. 22.
For complete synonymy up to 1965 see:
1966 *Palmatolepis perlobata perlobata* Ulrich & Bassler; Glenister & Klapper, *J. Paleont.*, 40, 818, pl. 92, figs 8, 13; pl. 93, figs 1-6.

- 1966 *Palmatolepis perlobata* Ulrich & Bassler; Winder, *J. Paleont.*, 40, 1275, pl. 156, fig. 4.
 1967 *Palmatolepis perlobata schindewolfi* Müller; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 221, pl. 21, figs 9-13.
 1967 *Palmatolepis perlobata schindewolfi* Müller; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 71, pl. 2, fig. 6; pl. 3, figs 9, 10.
 ?1967 *Palmatolepis perlobata schindewolfi* Müller; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 53, pl. 4, fig. 5.
 1967 *Palmatolepis perlobata schindewolfi* Müller; Freyer & Zakowa, *Acta geol. polon.*, 17, 136, pl. 2, fig. 1.
 1967 *Palmatolepis perlobata perlobata* Ulrich & Bassler; Wolska, *Acta palaeont. polon.*, 12, 400, pl. 10, figs 1-8; pl. 12, figs 8, 9; text-fig. 14.
 1968 *Palmatolepis perlobata schindewolfi* Müller; Schulze, *N. Jb. Geol. Paläont. Abh.*, 130, 207, pl. 19, fig. 9.
 ?1968 *Palmatolepis perlobata schindewolfi* Müller; Manzoni, *G. Geol.*, 34, 663, pl. 62, fig. 15.
 1968 *Palmatolepis perlobata schindewolfi* Müller; Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 161, pl. 2, fig. 1.
 1968 *Palmatolepis perlobata* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 32, pl. 15, figs 1-10; pl. 16, figs 8, 9.
 1969 *Palmatolepis perlobata schindewolfi* Müller; Matthews, *Palaeontology*, 12, 269, pl. 47, figs 1-3.

Material: 25 specimens, CPC 12627-30 figured.

Localities of figured material: Samples BG 19083 (CPC 12627), 19100 (CPC 12628), 19183 (CPC 12629), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21093 (CPC 12630), Section 17, Ngumban Cliff, Virgin Hills Formation.

Remarks: There has been some discussion about the differences between *P. perlobata* s.s. and *P. perlobata schindewolfi*. Glenister & Klapper (1966, p. 818) consider that the two subspecies are indistinguishable because the coarse ornament and secondary carina are highly variable. Clark & Ethington (1967, p. 53) do not consider that Glenister & Klapper's views are substantiated by their illustrations. Huddle (1968, p. 33) thinks that the two subspecies can be distinguished but that the difference is difficult to describe.

The variation in ornamentation may be due to ecological factors and until a detailed study of the species is completed, I prefer to accept the view of Glenister & Klapper, and to place *P. perlobata schindewolfi* in the nominate subspecies.

Distribution: This species is widespread. It was originally described from Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). Elsewhere in North America it occurs in Indiana (Huddle, 1934), Iowa (Thomas, 1949), Missouri (Branson & Mehl, 1934), Texas (Hass, 1959), and Nevada (Clark & Ethington, 1967). Winder (1966) has recorded the species from Ontario.

In Europe the species has been reported extensively from Germany (Sanne-mann, 1955a, b, c; Bischoff, 1956; Müller, 1956; Ziegler, 1958, 1962a; Helms, 1959, 1963; Zitzmann, 1966, 1967; Meischner & Schneider, 1967; Bering, 1967; Freyer, 1968; and Bar, 1968). Elsewhere in Europe it has been reported from Austria (Kodsi, 1967; Schulze, 1968; Schönlaub, 1969a), England (Matthews, 1969), Italy (Manzoni, 1968), Yugoslavia (Spasov & Filipovic, 1967; Spasov et al., 1968), Poland (Freyer & Zakowa, 1967; Wolska, 1967), Portugal (Boogaard, 1963), and Spain (Wirth, 1967). The species is also known from Australia (Glenister & Klapper, 1966).

Range: The species was originally described from Famennian strata in Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). Clark & Ethington (1967) record it from

a horizon of probable Upper *Palmatolepis crepida* Zone age. Ziegler (1962a) records the composite range of the two subspecies as Upper *Palmatolepis triangularis* Zone (toI/II) as high as the Lower *Spathognathodus costatus* Zone (toV). In the Canning Basin the species ranges from the Lower *Palmatolepis quadrantinodosa* Zone (toII β to the Middle *Polygnathus styriacus* Zone (toV).

PALMATOLEPIS PERLOBATA SIGMOIDEA Ziegler, 1962
(Pl. 68, figs 5a-c)

- 1956 *Palmatolepis* (*Palmatolepis*) *schindewolfi* Müller, *Abh. senck. naturf. Ges.*, 494, 27, pl. 8, figs 22, 24, 28 only.
 1962 *Palmatolepis perlobata sigmoidea* Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 71, pl. 8, figs 7, 9-11.
 1963 *Palmatolepis* (*Palmatolepis*) *perlobata sigmoidea* Ziegler; Helms, *Geologie*, 12, text-fig. 2.48.
 ?1963 *Palmatolepis perlobata* Sannemann (sic); Abdusselamoglu, *Bull. Min. Res. Expl. Inst. Turkey*, 60, 4, pl. 1, fig. 9.

Material: Single specimen, CPC 12631 figured, from sample BG 19105, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: The expanded lobate posterior inner platform edge is the distinguishing feature of the subspecies.

Distribution: The subspecies was originally described from Germany (Ziegler, 1958) and has also been recorded from that country by Müller (1956) and Helms (1963). The only other reference is from Belgium (Bouckaert & Ziegler, 1965). A specimen illustrated as *P. perlobata* by Abdusselamoglu (1963) from Turkey is tentatively placed in this subspecies.

Range: Ziegler (1962a) records the range as Lower *Palmatolepis quadrantinodosa* Zone (to II β) up to the Upper *Polygnathus styriacus* Zone (toV). In the Canning Basin the single specimen comes from the latest Lower *quadrantinodosa* Zone.

PALMATOLEPIS PROVERSA Ziegler, 1958
(Pl. 54, figs 1a-2b)

- 1958 *Palmatolepis proversa* Ziegler, *Hess. Landesamt Bodenf. Abh.*, 87, 62, pl. 3, figs 11, 12; pl. 4, figs 1-14.
 1947 *Palmatolepis marginata* Stauffer; Youngquist, *J. Paleont.*, 21, 108, pl. 24, figs 4, 14.
 1947 *Palmatolepis* sp. Youngquist, *ibid.*, 108, pl. 24, fig. 5.
 1958 *Palmatolepis* (*Manticolepis*) sp. Müller & Müller, *J. Paleont.*, 31, 1104, pl. 142, fig. 12.
 1963 *Palmatolepis* (*Manticolepis*) *proversa* Ziegler; Helms, *Geologie*, 12, text-fig. 2.7.
 1963 *Palmatolepis proversa* Ziegler; Klapper & Furnish, *Proc. Iowa Acad. Sci.*, 1962, 406, text-fig. 2.8.
 1966 *Palmatolepis proversa* Ziegler; Winder, *J. Paleont.*, 40, 1275, pl. 156, fig. 14.
 1968 *Palmatolepis proversa* Ziegler; Mound, *J. Paleont.*, 42, 500, pl. 68, figs 14, 16, 21; pl. 71, ? figs 15, 19.

Material: 11 specimens; CPC 12632-3 figured, from sample BG 19548, Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: *P. proversa* is distinguished by its strongly anteriorly directed lateral platform lobe. The acute angle of the inner platform margin distinguishes it from *P. punctata* (Hinde).

Distribution: The species was originally described from Adorf, Germany (Ziegler, 1958, 1962a). It has also been reported by Helms (1963), Krebs & Rabien (1964), Schriel & Stoppel (1965), Wachendorf (1966), Dvorak & Freyer (1968), Bar (1968), and Schneider (1969) from Germany, and by Schönlaub (1969a) from Austria.

In North America the species is known from Iowa (Müller & Müller, 1957; Klapper & Furnish, 1963), Ontario (Winder, 1966), and Alberta (Mound, 1968). Glenister & Klapper (1966) record the species from the Canning Basin.

Range: Ziegler (1962a) records the range as Frasnian (toI_a-toI_γ), Middle *Polygnathus asymmetricus* Zone to the lower part of the Lower *Palmatolepis gigas* Zone. In North America the species occurs in the *Ancyrognathus triangularis* Zone (toI_γ) (Klapper & Furnish, 1963). In the Canning Basin the species occurs in either the Upper *Polygnathus asymmetricus* or *A. triangularis* Zones.

PALMATOLEPIS PUNCTATA (Hinde, 1879)

(Pl. 54, figs 3a, b; Pl. 55, figs 4a-5b)

- 1879 *Polygnathus punctatus* Hinde, *Quart. J. geol. Soc., Lond.*, 35, 367, pl. 17, fig. 14.
1966 *Palmatolepis punctata* (Hinde); Glenister & Klapper, *J. Paleont.*, 40, 819, pl. 88, fig. 8, 9. (Synonymy to 1965)
1966 *Palmatolepis punctata* (Hinde); Winder, *J. Palaeont.*, 40, 1275, pl. 156, fig. 13.
1968 *Palmatolepis punctata* (Hinde); Huddle, *U.S. geol. Surv. prof. Pap.* 578, 33, pl. 16, figs 1-3.
1968 *Palmatolepis punctata* (Hinde); Mound, *J. Paleont.*, 42, 500, pl. 68, figs 4, 5, 10-13.
1970 *Palmatolepis punctata* (Hinde); Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 7.

Material: 25 specimens; CPC 12634-6 figured, from sample BG 19548, Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: *Palmatolepis punctata* is distinguished by its virtually straight carina, coarse dentition, and downturned posterior termination. *P. unicornis* can be distinguished by its sigmoidal carina and *P. proversa* by its anteriorly pointing lateral lobe.

Distribution: The species was originally described from New York (Hinde, 1879; Branson & Mehl, 1933). Other occurrences in North America include New York (Ulrich & Bassler, 1926; Oliver et al., 1967; Huddle, 1968), Iowa (Müller & Müller, 1957), and Texas (Hass, 1959). In Canada the species is known from Alberta (Mound, 1968) and Ontario (Winder, 1966).

In Europe most of the reported occurrences of the species are from Germany, where it was originally referred to *P. martenbergensis* Müller (Müller, 1956; Bischoff & Ziegler, 1957; Bischoff & Sannemann, 1958; Ziegler, 1958; Meyer, 1965; Schneider, 1969). Other European occurrences are in Austria (Schönlaub, 1969a), Bulgaria (Budurov & Tschunev, 1964), and France (Boyer et al., 1968).

The species has been reported twice from the Canning Basin, Australia (Glenister & Klapper, 1966; Seddon, 1970a).

Range: The species was originally described from the Famennian Genesee Shale of New York (Hinde, 1879; Branson & Mehl, 1933). Ziegler (1962a) records the range as base of Middle *Polygnathus asymmetricus* Zone (toI_a) to Lower *Palmatolepis gigas* Zone (toI_γ). In the Canning Basin the species ranges from the Middle *Polygnathus asymmetricus* Zone to the *Ancyrognathus triangularis* Zone.

PALMATOLEPIS QUADRANTINODOSA INFLEXOIDEA Ziegler, 1962

(Pl. 56, figs 4a-5b)

- 1962 *Palmatolepis quadrantinodosa inflexoidea* Ziegler, Hess. Landesamt Bodenf. Abh., 38, 74, pl. 5, figs 14-18.
- 1962 *Palmatolepis* (*Panderolepis*) *elegans* Helms in Müller, TREATISE ON INVERTEBRATE PALEONTOLOGY, Pt W, MISCELLANEA, W 89, text-fig. 47.58.
- 1963 *Palmatolepis* (*Panderolepis*) *inflexoidea* Ziegler; Helms, *Geologie*, 12, 482, pl. 3, figs 5, 7-9, 11; text-fig. 2.58.
- 1966 *Palmatolepis quadrantinodosa inflexoidea* Ziegler; Glenister & Klapper, *J. Paleont.*, 40, 820, pl. 93, figs 11, 12.
- 1967 *Palmatolepis quadrantinodosa inflexoidea* Ziegler; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 71, pl. 3, figs 14, 15.
- 1969 *Palmatolepis quadrantinodosa inflexoidea* Ziegler; Olivieri, *Boll. Soc. paleont. ital.*, 8, 110, pl. 19, figs 4-6.

Material: 5 specimens; CPC 12641, 12642 figured, from sample BG 19080, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *P. quadrantinodosa inflexoidea* is an elongate subspecies showing some affinities to the *P. glabra* group. The ornament is 'shagreen'-like and the subspecies is distinguished by the absence of an outer platform parapet.

Distribution: The subspecies was originally described from Germany (Ziegler, 1962a). Other German occurrences have been noted by Helms (1963), Budinger & Kullman (1964), Wachendorf (1966), Bering (1967), Bar (1968), and Schneider (1969). It has also been reported from France (Boyer et al., 1968), Italy (Manzoni, 1965; Olivieri, 1969), and Yugoslavia (Spasov & Filipovic, 1967). The only record of the subspecies outside Europe is from the Canning Basin, Australia (Glenister & Klapper, 1966).

Range: Ziegler (1962a) gives the range as upper part of the *Palmatolepis rhomboidea* Zone into Lower *Palmatolepis quadrantinodosa* Zone (all to II β). However, Boyer et al. (1968) record the subspecies as low as the *Palmatolepis crepida* Zone (to II α) in the Coumiac section, France. In the Canning Basin the subspecies has the same range as in Germany.

PALMATOLEPIS QUADRANTINODOSA MARGINIFERA Helms, 1959

(Pl. 55, figs 1a-3b)

- 1959 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic) Helms, *Geologie*, 8, 649, pl. 5, figs 22, 23.
- 1966 *Palmatolepis quadrantinodosa marginifera* Helms; Glenister & Klapper, *J. Paleont.*, 40, 820, pl. 91, figs 6-15. (Synonymy to 1965)
- 1966 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 14.
- 1966 *Palmatolepis quadrantinodosa marginifera* Helms; Winder, *J. Paleont.*, 40, 1275, pl. 156, fig. 3.
- 1967 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 222, pl. 21, fig. 7, 8.
- 1967 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 72, pl. 3, fig. 8, 16.
- 1967 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Kodsi, *N. Jb. Geol. Paläont. Monatsh.*, 7, 424, text-figs 6, 11.
- 1967 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Boogaert, *Leidse geol. Med.*, 39, 183, pl. 2, fig. 30.

- ?1967 *Palmatolepis quadrantinodosa marginifera* Ziegler (sic); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 55, pl. 5, fig. 5.
 1967 *Palmatolepis quadrantinodosa marginifera* Helms; Wolska, *Acta palaeont. polon.*, 12, pl. 9, figs 10-13; text-fig. 15.
 1969 *Palmatolepis quadrantinodosa marginifera* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 110, pl. 19, figs 1-3.

Material: 28 specimens, CPC 12637, 12638, 12640 figured.

Localities of figured material: Samples BG 19089 (CPC 12637), 19130 (CPC 12638), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone; 21275 (CPC 12640), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: There has been some problem over the authorship of this subspecies. Helms first published the name, but he took it from a Ziegler MS which was published in 1962.

The subspecies is small and ovate and can be distinguished from the nominate subspecies by a ridge-like parapet on the outer platform rather than a group of nodes.

Distribution: The subspecies was originally described from Thuringia, Germany (Helms, 1959). Other German occurrences have been noted by Bischoff & Ziegler (1956), Müller (1956), Ziegler (1962a), Helms (1963), Wachendorf (1966), Bering (1967), Meischner & Schneider (1967; 1970), Lutzens (1967), Dvorak & Freyer (1968), Freyer (1968), Bar (1968), and Schneider (1969). Other European countries from which the subspecies has been recorded include Austria (Ziegler in Flügel & Ziegler, 1957; Kodosi, 1967; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), France (Boyer et al., 1968), Italy (Manzoni, 1965; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Spain (Boogaert, 1967; Wirth, 1967).

The subspecies has been recorded from three localities in North America, the Mississippi Valley (Scott & Collinson, 1961), Utah (Clark & Ethington, 1967) and Ontario, Canada (Winder, 1966).

Range: Helms (1959) recorded the subspecies from the Famennian to III Zone. Ziegler (1962a) records the range from the upper part of the *Palmatolepis rhomboidea* Zone (to II β) as high as the lowest part of the *Scaphignathus veliferus* Zone (to III α). The subspecies seems to be most common in the *Palmatolepis quadrantinodosa* Zone (to II β) (Boyer et al., 1968; Clark & Ethington, 1967) but its presence in the *S. veliferus* Zone is confirmed by Glenister & Klapper (1966) and Wolska (1967). In the Canning Basin the subspecies ranges from the *P. rhomboidea* Zone (to II β) into the Lower *S. veliferus* Zone (to III α).

PALMATOLEPIS QUADRANTINODOSALOBATA Sannemann, 1955

(Pl. 14, figs 3a, b)

- 1955 *Palmatolepis quadrantinodosalobata* Sannemann, *N. Jb. Geol. Paläont., Abh.*, 100, 328, pl. 24, fig. 6.
 1966 *Palmatolepis quadrantinodosalobata* Sannemann; Glenister & Klapper, *J. Paleont.*, 40, 821, pl. 92, figs 1-3. (Synonymy to 1964).
 1965 *Palmatolepis quadrantinodosalobata* Sannemann; Bouckaert & Ziegler, *Mém. expl. Cartes géol. Min. Belg.*, 5, 23, pl. 1, figs 9-12.

- 1967 *Palmatolepis quadrantinodosalobata* Sannemann; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 54, pl. 9, figs 1, 4.
 1967 *Palmatolepis quadrantinodosalobata* Sannemann; Nehring, *Poland, Inst. Geol. Bull.* 209, 143, pl. 2, fig. 1.
 1967 *Palmatolepis quadrantinodosalobata* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 403, pl. 13, figs 5-10.
 1969 *Palmatolepis quadrantinodosalobata* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 112, pl. 18, figs 9-11.

Material: 10 specimens, CPC 12643, 12644 figured.

Locality of figured material: Sample BG 19018 (CPC 12643), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19455 (CPC 12644), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *P. quadrantinodosalobata* is easily recognized by the nodose parapet on the outer platform and the elongate lateral lobe on the inner platform.

Distribution: The species was originally described from Germany (Sannemann, 1955a, b). It has also been recorded by Bischoff (1956), Müller (1956), Stoppel (1958), Bender (1958), Walliser (1958), Helms (1959; 1963), Freyer (1961), Ziegler (1962a), Schriel & Stoppel (1965), Zitzmann (1966), Wachendorf (1966), Stoppel & Zscheke (1966); Bar (1968), Schneider (1969), Meischner & Schneider (1970). The species is also known from Austria (Ziegler in Flügel & Ziegler, 1957; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Dvorak et al., 1959), France (Lys et al., 1961; Boyer et al., 1968), Italy (Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967), and Spain (Boogaard, 1965).

In North America the species has been reported from the Mississippi Valley (Scott & Collinson, 1961), Iowa (Anderson, 1964), Tennessee (Hass, 1956), New York (Oliver et al., 1967), and Utah (Clark & Becker, 1960; Clark & Ethington, 1967). Other occurrences are in Morocco (Massa, 1965) and Australia (Glenister & Klapper, 1966).

Range: Ziegler (1962a) restricts the species to the *Palmatolepis crepida* Zone. However, he notes that transitional forms are present in the *Palmatolepis triangularis* Zone. This range was confirmed in North America (Clark & Ethington, 1967). In the Canning Basin the species is confined to the *P. crepida* Zone (toII_a).

PALMATOLEPIS cf. P. REGULARIS Cooper, 1931

(Pl. 57, figs 1a-2b)

- cf. 1931 *Palmatolepis regularis* Cooper, *J. Paleont.*, 5, 242, pl. 28, fig. 36.
 1966 *Palmatolepis* cf. *P. regularis* Cooper; Glenister & Klapper, *J. Paleont.*, 40, 821, pl. 92, figs 14-16. (Synonymy to 1964)
 1967 *Palmatolepis* cf. *regularis* Cooper; Wolska, *Acta palaeont. polon.*, 12, 404, pl. 6, figs 11-15.
 1969 *Palmatolepis* cf. *P. regularis* Cooper; Olivieri, *Boll. Soc. paleont. ital.*, 8, 113, pl. 19, figs 12a, b.

Material: 11 specimens; CPC 12645, 12646 figured, from sample BG 19455, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: Glenister & Klapper (1966, p. 822) point out that the original specimen is embedded in shale and only the aboral surface can be seen; hence subsequent

specimens have only been compared with the species. The sigmoidal carina with equidimensional platforms on either side is diagnostic.

Distribution: The species was originally described from Oklahoma (Cooper, 1931) and the only other record in North America is by Bond (1947).

In Europe the species is common in Germany (Sannemann, 1955b; Bischoff, 1956; Bischoff & Ziegler, 1956; Bender, 1958; Stoppel, 1958; Walliser, 1958; Ziegler, 1962; Helms, 1963; Bar, 1968). It is also known from Austria (Ziegler in Flügel & Ziegler, 1957 Schönlaub, 1969), Italy (Olivieri, 1969), and Poland (Freyer & Zakowa, 1967; Wolska, 1967). Apart from the listing from Morocco (Massa, 1965) the only other record is from the Canning Basin (Glenister & Klapper, 1966).

Range: The species was originally described from the Woodford Formation of Oklahoma (Cooper, 1931). Ziegler (1962) gives the range as Upper *Palmatolepis triangularis* Zone to the top of the *Palmatolepis crepida* Zone. The species appears to be common in the *P. crepida* Zone; in the Canning Basin it occurs from the Upper *P. triangularis* Zone to the Upper *P. crepida* Zone.

PALMATOLEPIS RUGOSA AMPLA Müller, 1956

(Pl. 57, fig. 3a, b, c)

- 1956 *Palmatolepis* (*Palmatolepis*) *ampla* Müller, *Abh. senck. naturf. Ges.*, 494, 28, pl. 9, figs 35, 36.
1961 *Palmatolepis ampla* (Müller); Freyer, *Freib. Forsch.*, C-95, 62, pl. 3, figs 78, 79.
1962 *Palmatolepis rugosa ampla* Müller; Ziegler in Kronberg et al., *Fortschr. Geol. Rheinld Westf.*, 3, 38, pl. 2, figs 1-9; pl. 1, fig. 6; text-figs 12, 13.
1962 *Palmatolepis rugosa ampla* Müller; Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 78, pl. 8, fig. 15.
?1965 *Palmatolepis* (*Palmatolepis*) *ampla* Müller; Spasov, *Trav. géol. Bulg.*, Ser. paleont., 7, 92, pl. 2, fig. 8.
1967 *Palmatolepis rugosa ampla* Müller; Wolsk, *Acta palaeont. polon.*, 12, 405, pl. 11, fig. 9a-10.
1967 *Palmatolepis rugosa ampla* Müller; Boogaert, *Leidse geol. Med.*, 39, 183, pl. 2, fig. 31.
1969 *Palmatolepis rugosa ampla* Müller; Schönlaub, *Jb. geol. Bundesanst.* 112, 306, pl. 2, fig. 9.

Material and Locality: Single specimen, CPC 12648 figured, from sample BG 19119, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: The lack of coarse ornament distinguishes this subspecies from others of *P. rugosa*.

Distribution: This is the first report of the subspecies outside Europe. It was first described from Germany (Müller, 1956b), since when it has been frequently reported (Bender, 1958; Freyer, 1961; Ziegler, 1962a, b; Henningsen, 1965; Bering, 1967; Bar, 1968; Schneider, 1969). Elsewhere in Europe it is known from Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1965), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Spain (Boogaert, 1967).

Range: The subspecies was originally described from the Famennian *Platyclymenia*-Stufe (Müller, 1956). Freyer (1961) does not record the subspecies outside the toV Zone; but Ziegler (1962b) gives the range as Upper *Palmatolepis quadrantinos*-dosa Zone (toIIIa) to at least the Middle *Scaphignathus veliferus* Zone (toIIIβ). The Canning Basin specimen occurs in the Upper *P. quadrantinos*dosa Zone.

PALMATOLEPIS RUGOSA GROSSI Ziegler, 1962

(Pl. 57, fig. 5a, b, c)

- 1962 *Palmatolepis rugosa grossi* Ziegler in Kronberg et al., *Fortschr. Geol. Rheinld Westf.*, 3, 37, pl. 1, figs 1, 2.
1962 *Palmatolepis rugosa grossi* Ziegler; Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 78, pl. 8, fig. 8.
1966 *Palmatolepis rugosa grossi* Ziegler; Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 11.
1967 *Palmatolepis rugosa grossi* Ziegler; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 72, pl. 2, figs 1, 2, 4.
1967 *Palmatolepis rugosa grossi* Ziegler; Wolska, *Acta palaeont. polon.*, 12, 406, pl. 10, fig. 4; pl. 11, figs 8a, b.

Material: 3 specimens; CPC 12647 figured, from sample BG 19163, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Distribution: The species was originally described from the Rheinisches Schiefergebirge (Ziegler in Kronberg et al., 1962) and since then has been reported extensively from Germany (Ziegler, 1962a; Helms, 1963; Henningsen, 1965; Bering, 1967; Meischner & Schneider, 1967; Bar, 1968; Schneider, 1969). The other records of the species are from Austria (Schönlaub, 1969a), Yugoslavia (Spasov, 1966; Spasov & Filipovic, 1967), and Poland (Freyer & Zakowa, 1967; Wolska, 1967). This is the first record of the species outside Europe.

Range: The species was originally described from the Famennian (toIIIa) (Ziegler, 1962a); later Ziegler (1962b) gives the range as Upper *Palmatolepis quadrantinodosa* Zone (toIIIa) to Upper *Scaphignathus veliferus* Zone (toIV), a range confirmed by Wolska (1967). The Canning Basin specimens extend the range slightly, coming from the basal part of the Lower *Polygnathus styriacus* Zone.

PALMATOLEPIS cf. P. SUBGRACILIS Bischoff, 1956

(Pl. 15, figs 1a, b)

- cf. 1956 *Palmatolepis subgracilis* Bischoff, *Hess. Landesamt Bodenf. Notizbl.*, 84, 130, pl. 9, figs 12, 19; pl. 10, fig. 13.

Material: 5 specimens; CPC 12649 figured, from sample BG 19023, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: Glenister & Klapper (1966, p. 822) point out that *P. subgracilis* can be recognized as a palmatolepid by the presence of a distinctive azygous node. The present specimens lack an azygous node, but in every other respect they resemble Glenister & Klapper's specimens, although the lateral platform of some is reduced to a single node. They are closest to the genus *Spathognathodus*. Two interpretations are possible: either *Palmatolepis* is a polyphyletic genus or one branch of *Palmatolepis* evolved into a spathognathodid form.

Range: The specimens occur in the Upper *Palmatolepis crepida* Zone, which agrees with the German range of Upper *P. crepida* Zone to *Palmatolepis rhomboidea* Zone.

PALMATOLEPIS SUBPERLOBATA Branson & Mehl, 1934

(Pl. 58, figs 1a, b, c, 4a, b; Pl. 63, figs 3a-4b)

- 1934 *Palmatolepis subperlobata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 235, pl. 18, figs 11, 21.
- 1966 *Palmatolepis subperlobata* Branson & Mehl; Glenister & Klapper, *J. Paleont.*, 40, 822, pl. 92, figs 5-7. (Synonymy to 1965)
- non 1965 *Palmatolepis subperlobata* (sic) Branson & Mehl; Loranger, privately published, 16, pl. 3, figs 9, 10 (? = *P. proversa*).
- 1965 *Palmatolepis subperlobata* Branson & Mehl; Bouckaert & Ziegler, *Mém. Cartes géol. Min. Belg.*, 5, 22, pl. 2, figs 12, 13.
- 1966 *Palmatolepis subperlobata* Branson & Mehl; Winder, *J. Paleont.*, 40, 1275, pl. 156, fig. 9.
- ?1966 *Palmatolepis* (*Manticolepis*?) *subperlobata* (Branson & Mehl); Koverdynsky & Zikmundova, *Vestnik U.U.G.*, 41, 369, pl. 1, fig. 5.
- 1967 *Palmatolepis subperlobata* Branson & Mehl; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 55, pl. 8, fig. 16; pl. 9, figs 5, 6 (fig. 12 = subsp. a).
- 1967 *Palmatolepis subperlobata* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 407, pl. 12, figs 7a, b, 10.
- 1969 *Palmatolepis subperlobata* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 115, pl. 18, figs 12a-13b.

Material: 36 specimens, CPC 12651, 12654, 12662, 12663 figured.

Localities of figured material: Samples BG 19454D (CPC 12651), 19455 (CPC 12652, 12653), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21011 (CPC 12654), Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation.

Remarks: *P. subperlobata* can be distinguished from *P. tenuipunctata* by the presence of a well developed lateral lobe. It differs from *P. triangularis* in having 'shagreen' ornament. Specimens with an elongate lateral lobe have been isolated as *P. subperlobata* subsp. a Helms.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934). Other localities in North America include New York (Oliver et al., 1967), Nevada and Utah (Clark & Becker, 1960; Clark & Ethington, 1967), Ohio (Bond, 1947), and Tennessee (Hass, 1956).

In Europe the species is common in Germany (Sannemann, 1955a, b, c; Bischoff, 1956; Bischoff & Ziegler, 1956; Walliser, 1958; Helms, 1959, 1963; Kronberg et al., 1962; Ziegler, 1962a, b; Schriel & Stoppel, 1965; Zitzmann, 1966; Wachendorf, 1966; Stoppel & Zscheke, 1966; Bering, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). Other occurrences in Europe include Austria (Ziegler in Flügel & Ziegler, 1957; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Koverdynsky & Zikmundova, 1966), France (Serre & Lys, 1958; Lys et al., 1961), Italy (Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Spain (Boogaard, 1965).

It has also been reported from Morocco (Massa, 1965) and the Canning Basin, Australia (Glenister & Klapper, 1966).

Range: The species was originally described from the Famennian Grassy Creek Shale (Branson & Mehl, 1934). In North America it has been described from the Middle *Palmatolepis triangularis* as high as the *Palmatolepis rhomboidea* Zone. Ziegler (1962a) records the range in Germany as Lower *P. triangularis* Zone as

high as the Upper *Palmatolepis crepida* Zone (toI δ -toII α) and Wolska (1967) records it in the *Palmatolepis quadrantinodosa* Zone (toII β).

The Canning Basin specimens range from the Upper *P. triangularis* Zone as high as the Upper *P. crepida* Zone.

PALMATOLEPIS SUBPERLOBATA subsp. a Helms, 1963

(Pl. 58, figs 2a-3b, 5a, b)

- 1963 *Palmatolepis subperlobata* subsp. a Helms, *Geologie*, 12, 458, pl. 1, fig. 19; text-fig. 2.17.
1966 *Palmatolepis subperlobata* (sic) Branson & Mehl; Spasov, *Bull. 'Strasimir Dimitrov' Inst. Geol.*, 15, 96, pl. 1, fig. 16.
1966 *Palmatolepis subperlobata* Branson & Mehl; Spasov & Filipovic, *Geol. Glas*, 11, 46, pl. 3, figs 1, 2.

Material: 10 specimens, CPC 12655-7 figured.

Localities of figured material: Sample BG 19019 (CPC 12655), 19020 (CPC 12656), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19455 (CPC 12657), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: Helms (1963) distinguished a subspecies of *P. subperlobata* on the presence of an elongate lateral lobe. This morphological variant is easy to distinguish and is possibly of stratigraphic value. Olivieri (1969) erects a new species, *P. delicatalobata*, with an elongate lobe, but the ornament appears to be nodose rather than 'shagreen'-like.

Distribution and Range: The subspecies was originally recognized from German faunas (Helms, 1963) and the only other record is from Yugoslavia (Spasov, 1966; Spasov & Filipovic, 1966). It ranges throughout the Famennian *Cheiloceras*-Stufe and possibly into the *Platyclymenia*-Stufe.

In the Canning Basin the subspecies ranges throughout the *Palmatolepis crepida* Zone.

PALMATOLEPIS SUBRECTA Miller & Youngquist, 1947

(Pl. 59, figs 1a-4b)

- 1947 *Palmatolepis subrecta* Miller & Youngquist, *J. Paleont.*, 21, 513, pl. 75, figs 7-11.
1966 *Palmatolepis subrecta* Miller & Youngquist; Glenister & Klapper, *J. Paleont.*, 40, 823, pl. 88, figs 1-3. (Synonymy to 1965)
1966 *Palmatolepis subrecta* Miller & Youngquist; Anderson, *J. Paleont.*, 40, 409, pl. 49, figs 11-15, 17, 19.
1966 *Palmatolepis subrecta* Miller & Youngquist; Winder, *J. Paleont.*, 1275, pl. 156, fig. 8.
1967 *Palmatolepis subrecta* Miller & Youngquist; Boogaert, *Leidse geol. Med.*, 39, 183, pl. 2, fig. 32.
1967 *Palmatolepis subrecta* Miller & Youngquist; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 55, pl. 4, fig. 4; pl. 9, fig. 9.
1967 *Palmatolepis subrecta* Miller & Youngquist; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 73, pl. 3, fig. 18.
1967 *Palmatolepis subrecta* Miller & Youngquist; Wolska, *Acta paleont. polon.*, 12, 407, pl. 12, figs 1-6.
1968 *Palmatolepis subrecta* Miller & Youngquist; Mound, *J. Paleont.*, 42, 501, pl. 68, figs 7, 15, 17; pl. 71, figs 5-7, 9, 10.

- 1968 *Palmatolepis subrecta* Miller & Youngquist; Spasov et al., *Bull. Inst. Rech. Géol. Géophys.*, 26, 162, pl. 1, figs 8, 9, 14, 15.
 1968 *Palmatolepis subrecta* Miller & Youngquist; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 34, pl. 16, figs 5, 6, 7.
 1970 *Palmatolepis subrecta* Miller & Youngquist; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, fig. 8.

Material: 206 specimens, CPC 12658-61 figured.

Localities of figured material: Samples BG 19448a (CPC 12658), 19451B (CPC 12659), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 19581 (CPC 12660), 19585 (CPC 12661), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Remarks: *P. subrecta* is quite variable but is characteristically ornamented with coarse nodes. However, juvenile specimens show little ornament and the nodes are a late ontogenetic development. Juveniles also possess a slightly different platform shape; the lateral lobe is poorly developed and the platform is rhomboid in outline, however, but the posterior termination is always downturned, distinguishing it from *P. triangularis*. The difference between *P. subrecta* and *P. gigas* is less distinct; the inner platform of *P. gigas* tends to be larger and the lateral lobe is more elongate. Some specimens show a transition to *P. coronata*.

Distribution: The species was originally described from Iowa (Miller & Youngquist, 1947). Several other occurrences in Iowa have been noted (Youngquist & Miller, 1948; Müller & Müller, 1957; Klapper & Furnish, 1963; and Anderson, 1966). Elsewhere in North America the species is known from Arkansas (Hass, 1951), New York (Oliver et al., 1967), Ohio (Stauffer, 1938), Oklahoma (Hass & Huddle, 1965), Tennessee (Hass, 1956; Huddle, 1968), Utah (Clark & Becker, 1960; Clark & Ethington, 1967), Alberta (Clark & Ethington, 1965; Mound, 1968), and Ontario (Winder, 1966).

In Europe the species is extremely common in Germany (Bischoff, 1956; Müller, 1956; Ziegler, 1958, 1962a, b; Helms, 1959; Krebs & Rabien, 1964; Meyer, 1965; Schriel & Stoppel, 1965; Stoppel & Zscheke, 1966; Wachendorf, 1966a, b; Zitzmann, 1967; Bering, 1967; Bar, 1968; Figge, 1968; Schneider, 1969). Elsewhere in Europe it has been reported from Austria (Flajs, 1966; Schulze, 1968; and Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Friakova, 1961), France (Boyer et al., 1968), Yugoslavia (Spasov & Stefanovic, 1962; Spasov & Filipovic, 1967; Spasov et al., 1968), Poland (Wolska, 1967), and Spain (Boogaert, 1967).

In Africa the species has been noted in the Spanish Sahara (Ethington & Furnish, 1962) and Morocco (Massa, 1965); the Canning Basin, Australia, has previously yielded specimens (Glenister & Klapper, 1966; Seddon, 1970a).

Range: The species was originally described from the Frasnian Sweetland Creek Shale of Iowa (Miller & Youngquist, 1947). In North America it has been recorded from the *Palmatolepis gigas* Zone (Clark & Ethington, 1967). Ziegler (1962) records the European range as Upper *Polygnathus asymmetricus* Zone (to I β) up to the Middle *Palmatolepis triangularis* Zone (basal Famennian).

The Canning Basin specimens range from the Upper *P. asymmetricus* Zone up to the Middle *P. triangularis* Zone.

PALMATOLEPIS TENUIPUNCTATA Sannemann, 1955

(Pl. 60, figs 1a-4b)

- 1955 *Palmatolepis tenuipunctata* Sannemann, *Senck. Leth.*, 36, 136, pl. 6, fig. 22.
- 1966 *Palmatolepis tenuipunctata* Sannemann; Glenister & Klapper, *J. Paleont.*, 40, 824, pl. 89, fig. 4; pl. 92, figs 9-11. (Synonymy to 1965)
- 1965 *Palmatolepis tenuipunctata* Sannemann; Bouckaert & Ziegler, *Mém. expl. Cartes géol. Min. Belg.*, 5, 21, pl. 2, figs 10, 11.
- ?1965 *Palmatolepis tenuipunctata* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 4, 51, pl. 5, figs 5a, b.
- 1967 *Palmatolepis tenuipunctata* Sannemann; Nehring, *Poland Inst. Geol. Bull.* 209, 147, pl. 1, figs 1, 2.
- 1967 *Palmatolepis tenuipunctata* Sannemann; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 56, pl. 9, fig. 11.
- 1967 *Palmatolepis tenuipunctata* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 408, pl. 13, figs 11-13; text-fig. 16.
- 1969 *Palmatolepis tenuipunctata* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 117, pl. 18, figs 1, 2.

Material: 60 specimens; CPC 12652, 12653, 12664, 12665 figured, from sample BG 19455, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *P. tenuipunctata* is transitional between *P. subperlobata* and *P. glabra* s.s. However, the elongate unit with a small lateral lobe is distinctive.

Distribution: The species was originally described from the Frankenwald, Germany (Sannemann, 1955). Since then it has been reported extensively from Germany (Müller, 1956; Bischoff, 1956; Bischoff & Ziegler, 1957; Stoppel, 1958; Walliser, 1958; Helms, 1959, 1963; Freyer, 1961; Ziegler, 1962a, b, c; Zitzmann, 1966; Wachendorf, 1966a, b; Stoppel & Zscheke, 1966; Bering, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970). Elsewhere in Europe the species has been recorded in Austria (Ziegler in Flügel & Ziegler, 1957; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), France (Serre & Lys, 1958; Lys et al., 1961; Boyer et al., 1968), Italy (Olivieri, 1965, 1969), and Poland (Nehring, 1957; Wolska, 1967).

There are only three reports of the species outside Europe; Utah, U.S.A. (Clark & Becker, 1960; Clark & Ethington, 1967), Morocco (Massa, 1965), and Australia (Glenister & Klapper, 1966).

Range: Sannemann (1955) described the original species from the Famennian toIIa Zone. Freyer (1961) recorded the species from toIδ to toIIa. Ziegler (1962a) recorded the range as Upper *Palmatolepis triangularis* Zone (toI/II) to Upper *Palmatolepis crepida* Zone (toIIa). This is also the range in Poland (Wolska, 1967). In North America, Clark & Ethington (1967) recorded it from the Upper *P. triangularis* and Lower *P. crepida* Zone. In the Canning Basin the species ranges throughout the *P. crepida* Zone.

PALMATOLEPIS TRANSITANS Müller, 1956

(Pl. 63, figs 1a-2b)

- 1956 *Palmatolepis (Manticolepis) transitans* Müller, *Abh. senck. naturf. Ges.*, 494, 18, pl. 1, figs 1, 2.
- 1957 *Palmatolepis transitans* Müller; Bischoff & Ziegler, *Hess. Landesamt Bodenf. Abh.*, 22, 81, pl. 16, figs 23-27.
- 1958 *Palmatolepis transitans* Müller; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 66, pl. 1, figs 9, 11-13; pl. 2, figs 1-3, 8.

- 1959 *Palmatolepis transitans* Müller; Krebs, *Senck. Leth.*, 40, 379, pl. 1, fig. 2.
 1962 *Palmatolepis transitans* Müller; Ziegler, *N. Jb. Geol. Paläont., Abh.*, 114, 166, part of text-fig. 8.
 1963 *Palmatolepis (Manticolepis) transitans* Müller; Helms, *Geologie*, 12, 454, text-fig. 2.3.
 1964 *Palmatolepis transitans* Müller; Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, 255, pl. 2, figs 2a, b; ?9.
 1965 *Palmatolepis transitans* Müller; Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 538, pl. 1, fig. 2.
 1967 *Palmatolepis transitans* Müller; Boogaert, *Leidse geol. Med.*, 39, 183, pl. 2, fig. 33.

Material: 2 specimens; CPC 12666-7 figured, from sample BG 19534 (CPC 12666), 19544 (CPC 12667), Section 9, McPhee Knoll, Gogo and Virgin Hills Formation.

Remarks: *P. transitans*, as its name implies, is transitional between the genera *Polygnathus* and *Palmatolepis*. It can be distinguished from polygnathids by the presence of an azygous node. It differs from other species of *Palmatolepis* in having a straight carina. The presence of an azygous node places it firmly in the genus *Palmatolepis*.

Distribution: The species was originally described from Adorf, Germany (Müller, 1956). Since then it has been described from the Adorf-Stufe several times (Ziegler, 1958; Krebs, 1959; Ziegler, 1962a; Krebs & Rabien, 1964). Other occurrences in Germany are reported by Bischoff & Ziegler (1957), Ziegler (1965a), and Bar (1968). Previously, the species was only known from Europe and it has been reported from Austria (Flajs, 1966; Schulze, 1968; Schönlaub, 1969a), Bulgaria (Budurov & Tschunev, 1964), France (Boyer et al., 1968), and Spain (Boogaert, 1967).

Range: Ziegler (1958) gives the range as Middle-Upper Devonian boundary up to the basal part of the toI_γ Zone. Flajs (1966), however, shows the species restricted to the lower part of the *Polygnathus asymmetricus* Zone (toI_a) in Austria. Boyer et al. (1968) suggest that it is possibly present in the lowest part of the toI_γ Zone in France. In the Canning Basin the species is present in the Middle to Upper *Polygnathus asymmetricus* Zone (toI_a-β).

PALMATOLEPIS TRIANGULARIS Sannemann, 1955

(Pl. 61, figs 1a-3b; Pl. 62, fig. 2a, b)

- 1955 *Palmatolepis triangularis* Sannemann, *N. Jb. Geol. Paläont., Abh.*, 100, 327, pl. 24, fig. 3.
 1966 *Palmatolepis triangularis* Sannemann; Glenister & Klapper, *J. Paleont.*, 40, 825, pl. 92, figs 17, 18. (Synonymy to 1964)
 ?1964 *Palmatolepis triangularis* Sannemann; Budurov & Tschunev, *Bull. Inst. Sci. Rech. Géol.*, 1, 256, pl. 3, figs 1a, b; 5, 6a, b; 9, 10a, b; pl. 4, figs 1a, b.
 1965 *Palmatolepis triangularis* Sannemann; Freyer, *Abh. Ber. Naturk. Górlitz*, 40, V8, text-fig. 1.4.
 1965 *Palmatolepis triangularis* Sannemann; Bouckaert & Ziegler, *Mém. expl. Cartes géol. Min. Belg.*, 5, 21, pl. 1, figs 1-6.
 1966 *Palmatolepis triangularis* Sannemann; Anderson, *J. Paleont.*, 40, 409, pl. 48, figs 3, 12, 18?; pl. 49, fig. 3.
 1967 *Palmatolepis triangularis* Sannemann; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 56, pl. 9, figs 7, 13, 14.
 non 1967 *Palmatolepis triangularis* Sannemann; Nehring, *Poland Inst. Geol. Bull.* 209, 142, pl. 14, fig. 11 (? = *P. minuta*); pl. 5, figs 10a, b (= *P. quadrantinodosalobata*).
 1967 *Palmatolepis triangularis* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 410, pl. 13, figs 1-4b.

- 1968 *Palmatolepis triangularis* Sannemann; Lange, *Geol. Palaeont.*, 2, 41, pl. 2, fig. Pa.
 1969 *Palmatolepis triangularis* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 118, pl. 18, figs 3a-5.

Material: 125 specimens; CPC 12668-12671 figured, from samples BG 19453E (CPC 12668), 19454A (CPC 12669), 19454B (CPC 12670, 12671), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *P. triangularis* is easily distinguished by its upturned posterior termination; otherwise in general outline and ornamentation it is extremely similar to *P. subrecta*.

Distribution: The species was originally described from the Frankenwald, Germany, by Sannemann (1955a, c). Since that time it has been recorded many times from Germany (Müller, 1956; Bischoff, 1956; Bischoff & Ziegler, 1956, 1957; Ziegler, 1962a, b, c; Helms, 1959, 1963; Freyer, 1961, 1965; Kronberg et al., 1962; Schriel & Stoppel, 1965; Zitzmann, 1966, 1967; Wachendorf, 1966; Stoppel & Zschecked, 1966; Bering, 1967; Lange, 1968; Bar, 1968; Schneider, 1969). Elsewhere in Europe the species has been reported from Austria (Ziegler in Flügel & Ziegler, 1957; Schönlaub, 1969a), Bulgaria (Budurov & Tschunov, 1964), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Friakova, 1964; Dvorak et al., 1959), France (Lys & Serre, 1957; Serre & Lys, 1958; Lys et al., 1961; Boyer et al., 1968), Italy (Olivieri, 1969), and Poland (Freyer & Zakowa, 1967; Wolska, 1967).

The species is rarer in North America but is known from Iowa (Klapper & Furnish, 1963; Anderson, 1964, 1966), Missouri (Branson & Mehl, 1934), New York (Oliver et al., 1967), Nevada and Utah (Clark & Becker, 1960; Clark & Ethington, 1967), and Tennessee (Hass, 1956).

The only other records are from Morocco (Massa, 1965) and Australia (Glenister & Klapper, 1966).

Range: The species was originally described from the upper toI and lower toII Zones of the Frankenwald (Sannemann, 1955). Helms (1959) records the species from the uppermost toI_γ Zone, as does Freyer (1961). Ziegler (1962a) gives the range as *Palmatolepis triangularis* Zone (toI_γ) into the Middle *Palmatolepis crepida* Zone (toII_a). Boyer et al. (1968) find the same range in France.

In North America Clark & Ethington (1967) recorded the range as Middle *P. triangularis* Zone up to the Lower *P. crepida* Zone. The Canning Basin specimens have exactly the same range as the Great Basin specimens.

PALMATOLEPIS UNICORNIS Miller & Youngquist, 1947

(Pl. 62, figs 1a, b, 3a-4b)

- 1947 *Palmatolepis unicornis* Miller & Youngquist, *J. Paleont.*, 21, 514, pl. 75, fig. 15.
 1966 *Palmatolepis unicornis* Miller & Youngquist; Glenister & Klapper, *J. Paleont.*, 40, 826, pl. 88, figs 10, 11. (Synonymy to 1965)
 1966 *Palmatolepis unicornis* Miller & Youngquist; Winder, *ibid.*, 1275, pl. 156, fig. 10.
 1967 *Palmatolepis unicornis* Miller & Youngquist; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 56, pl. 4, fig. 13; pl. 9, fig. 3.

Material: 22 specimens; CPC 12672-4 figured, from samples BG 19583 (CPC 12672, 12673), 19584 (CPC 12674), Section 12, southwest of Waggon Pass, Virgin Hills Formation.

Remarks: *Palmatolepis unicornis* can be distinguished from other palmatolepids of similar shape by its high anterior blade termination. It differs from *P. punctata* in having a more sigmoidal carina and an inner lobe adjacent to the azygous lobe (Glenister & Klapper, 1966, p. 826).

Distribution: The species was originally described from Iowa (Miller & Youngquist, 1947) and subsequently again from that state (Müller & Müller, 1957; Klapper & Furnish, 1963). Elsewhere in North America the species has been recorded from Oklahoma (Hass & Huddle, 1965), Tennessee (Hass, 1956), Utah (Clark & Ethington, 1967, and Ontario (Winder, 1966).

In Europe the species has only been described and recorded from Germany (Ziegler, 1958, 1962; Walliser, 1958; Krebs & Rabien, 1964; Meyer, 1965; Wachendorf, 1966; Stoppel & Zscheke, 1966; Bar, 1968).

Range: The species was originally described from the Frasnian Sweetland Creek Shale of Iowa (Miller & Youngquist, 1947). Ziegler (1962a) records its range from the upper part of *Ancyrognathus triangularis* Zone (toI₇) to the top of the *Palmatolepis gigas* Zone (toI₈). Clark & Ethington (1967) record it in the Lower *P. gigas* Zone in North America.

In the Canning Basin the species appears to be restricted to the Lower *P. gigas* Zone.

PALMATOLEPIS sp. nov. A

(Pl. 56, fig. 3a-c)

1966 *Palmatolepis quadrantinodosa marginifera* Helms; Glenister & Klapper (part), *J. Paleont.*, 40, 820, pl. 91, fig. 6 only.

Material: One specimen, CPC 12650, figured from sample BG 19092, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: *Palmatolepis quadrantinodosa marginifera* has, typically, a rather elongate rhomboidal platform outline. The single specimen in the present fauna and one illustrated by Glenister & Klapper (pl. 91, fig. 6) are pear-shaped and have extensive nodes developed on the anterior part of the inner platform. These characters are certainly distinct from *P. quadrantinodosa marginifera*, which typically bears 'shagreen' ornament.

The present specimen comes from the Lower *P. quadrantinodosa* Zone.

PALMATOLEPIS sp. nov. B

(Pl. 96, fig. 1a-c)

Material: One specimen, CPC 13842, from sample BG 21550, McWhae Ridge, Virgin Hills Formation.

Remarks: A lanceolate, sigmoidal palmatolepid with approximately equal platforms. The ornament is shagreen-like and a minor carina is present behind the azygous node. The free blade and anterior carina are low, decreasing in height slightly toward the posterior. 'Basal bone' is attached to the aboral surface. The specimen appears to be intermediate between the *P. glabra* and *P. minuta* groups. It was recovered from the Upper *Palmatolepis crepida* Zone (Famennian toII_a).

Genus PELEKYSGNATHUS Thomas, 1949

Type species: *Pelekysgnathus inclinatus* Thomas, 1949.

PELEKYSGNATHUS ELEVATUS (Branson & Mehl, 1938)

(Pl. 84, figs 1a-4c)

- 1938 *Icriodus elevatus* Branson & Mehl, *J. Paleont.*, 12, 160, pl. 26, figs 18-21.
1955 *Pelekysgnathus planus* Sannemann, *Senck. Leth.*, 36, 149, pl. 4, figs 22, 23.
1961 *Pelekysgnathus planus* Sannemann; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 551, pl. 2, fig. 11.
1967 *Pelekysgnathus planus* Sannemann; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 57, pl. 6, figs 1, 14.
1967 *Pelekysgnathus* sp. Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 73, pl. 1, fig. 16.
1967 *Pelekysgnathus planus* Sannemann; Nehring, *Inst. Geol. Bull.* 209, 153, pl. 1, fig. 6, 7.
1968 *Pelekysgnathus elevatus* (Branson & Mehl); Pollock, *J. Paleont.*, 42, 435, pl. 62, figs 24-26.
1968 *Pelekysgnathus* cf. *P. plana* Sannemann; Mound, *J. Paleont.*, 42, 502, pl. 68, fig. 18.
1969 *Pelekysgnathus peejayi* Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 90, pl. 18, figs 4a-7c; text-fig. 18.
1970 *Pelekysgnathus planus* Sannemann; Seddon, *J. geol. Soc. Aust.*, 16, 738, pl. 11, figs 1-12.
1969 *Pelekysgnathus planus* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 120, pl. 10, figs 3a, b; pl. 13, figs 11a-12.

Material: 16 specimens, CPC 12763-6 figured.

Localities of figured material: Sample BG 19056 (CPC 12763), Section 4, north-east of McWhae Ridge, Sadler Limestone; BG 21092 (CPC 12764, 12765), Cave Spring, Sadler Limestone; BG 21242 (CPC 12766), Section 19, Longs Well Creek, Gogo Formation.

Remarks: Seddon (1970a, p. 737) notes that *P. elevatus* and *P. planus* are probably conspecific. Pollock (1968) illustrates specimens of *P. elevatus* which are within the range of variability of *P. planus* as defined by Clark & Ethington (1967, p. 57). The broadening of the concept of *P. planus* to include most pelekysgnathids that lack a massive posterior denticle and an arched aboral margin means that *P. peejayi* Druce is a junior synonym of *P. elevatus*. Seddon (1970a, pl. 11, figs 10-12) illustrates a specimen with a lateral denticle on either side of the carina; my fauna also contains one identical specimen which is intermediate between *Icriodus* and *Pelekysgnathus*. I prefer to think of specimens with lateral ornament as belonging in *Icriodus*.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1938) and has since been recorded from Utah (Clark & Ethington, 1967) and Alberta (Pollock, 1968; Mound, 1968). In Europe the species has been described as *P. planus* from Germany (Sannemann, 1955b), where it has also been noted by Bischoff & Ziegler (1956), Ziegler (1959; 1962), and Bar (1968). Elsewhere it has been reported from Austria (Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Czechoslovakia (Friakova, 1964), France (Lys et al., 1961), Italy (Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967), and Poland (Nehring, 1967). The species is also present in Australia (Druce, 1969; Seddon, 1970a).

Range: The species was originally described from the Mineola Formation (Middle Devonian) of Missouri (Branson & Mehl, 1938). Clark & Ethington (1967) record

the range in the Great Basin as Middle *Palmatolepis triangularis* Zone through Lower *P. crepida* Zone. Both Pollock (1968) and Mound (1968) recorded the species from the Lower Frasnian Duvernay Formation. In Europe the first record was in the Famennian (toIIa) of Germany (Sannemann, 1955). Ziegler (1962a) records the range as Upper *Palmatolepis triangularis* Zone to the Lower *P. quadrantinodosa* Zone. Nehring (1967) records the range in Poland as late Frasnian to the top of the Famennian toIV Zone. In the Bonaparte Gulf Basin the species is present in the early Famennian (toII β -toIIIa) (Druce, 1969). In the Canning Basin the species ranges from the Middle *Polygnathus asymmetricus* Zone up to the *Ancyrognathus triangularis* Zone. The overall range appears to be Middle Devonian to late Famennian (toVI), but most occurrences appear to be in the Frasnian and earliest Famennian.

PELEKYSGNATHUS sp.

(Pl. 84, fig. 6a-c)

Remarks: A single specimen, CPC 12767, from the top 60 cm of the (?) Bugle Gap Formation, sample BG 19183, Section 4, northeast of McWhae Ridge, is distinctive. It bears an elongate posterior denticle resembling *P. inclinatus* but lacks the conspicuous aboral arching. Seddon (1970a) notes that there are two distinct groups of pelekysgnathids, one with a highly arched aboral margin, and the other with a straight aboral margin. Using this criterion this specimen belongs to the second group with *P. elevatus*. The dentition consists of five fused denticles, only two having free tips, the remainder forming a 'sail'.

Another odd feature is the development of twin apices at the posterior end of the basal cavity, which is filled with basal 'bone'. The apices correspond to the growth axis of the two posteriormost denticles. The specimen occurs in the ? Middle *Polygnathus styriacus* Zone (toV).

Genus POLYGNATHELLUS Bassler, 1925

Type species: *Polygnathellus typicalis* Bassler, 1925

POLYGNATHELLUS MULTIDENS (Ulrich & Bassler, 1926)

(Pl. 22, fig. 12)

- 1926 *Bryantodus multidens* Ulrich & Bassler, *Proc. U.S. natl Mus.* 68, 22, pl. 6, fig. 15 [non pl. 6, fig. 16 = *Bryantodus nitidus*].
- 1926 *Bryantodus conjunctus* Ulrich & Bassler, *ibid.*, 24, pl. 4, fig. 9 [non pl. 4, fig. 8 = *B. nitidus*].
- 1926 *Polygnathellus typicalis* [part] Bassler; Ulrich & Bassler, *ibid.*, 53, pl. 1, fig. 3 [non pl. 1, figs 1, 2 = *P. typicalis*].
- 1926 *Polygnathellus curvatus* Ulrich & Bassler, *ibid.*, 54, pl. 1, fig. 4.
- 1948 *Bryantodus obtusiuspus* Youngquist, Hibbard, & Reimann, *J. Paleont.*, 22, 51, pl. 15, fig. 6.
- non 1956 *Bryantodus multidens* Ulrich & Bassler; Bischoff, *Hess. Landesamt Bodenf., Notizbl.*, 84, 122, pl. 10, figs 1, 2 [? = *P. germanus*].
- 1957 *Bryantodus colligatus* (Bryant); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 47, pl. 19, fig. 39.
- ?1967 *Bryantodus multidens* Ulrich & Bassler; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 33, pl. 3, fig. 14.

- 1967 *Bryantodus colligatus* (Bryant); Müller & Clark, *J. Paleont.*, 41, 910, pl. 117, figs 2, 9.
 1968 *Polygnathellus multidentis* (Ulrich & Bassler); Huddle, *U.S. geol. Surv. prof. Pap.* 578, 36, pl. 4, figs 2-5.
 1968 *Bryantodus chesteri* Youngquist [part]; Mound, *J. Paleont.*, 42, 478, pl. 65, fig. 35 only.
 1970 *Polygnathellus multidentis* (Ulrich & Bassler); Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 14, fig. 24.

Material: 38 specimens, CPC 12769-72 figured.

Localities of figured material: Sample BG 19001 (CPC 12769), Section 1, McWhae Ridge, Gogo Formation; BG 19543 (CPC 12770), Section 9, McPhee Knoll, Gogo Formation; BG 19585 (CPC 12771), Section 12, southwest of Waggon Pass, Virgin Hills Formation; BG 19598 (CPC 12772), Section 13, Glenister Knolls, Gogo Formation.

Description: Elongate arched bar unit with tumid base which is expanded as a narrow platform along both sides of bar. The unit bears a row of laterally compressed fused denticles with free chevron tips. The denticles tend to be highest in the mid-region above the basal cavity and generally higher on the anterior than on the posterior portion.

At the point of flexure, which is slightly anterior to or at the midpoint, a basal cavity is developed. It is slightly flared and is situated within a deep keel which runs the length of the unit.

Remarks: *P. multidentis* is close to *Bryantodus*, but is separated from it by the development of definite platforms on both sides of the bar; it probably developed from *Bryantodus nitidus* by growth of the platform and reduction of the apical denticle.

Distribution: The species was originally described from the Upper Devonian Rhinestreet Shale of New York State (Ulrich & Bassler, 1926; Youngquist, Hibbard, & Reimann, 1948; Huddle, 1968). Elsewhere in North America it is known from Utah (Clark & Ethington, 1967) and Alberta (Mound, 1968, who described forms referable to *P. multidentis* as *Bryantodus chesteri*). It has also been recorded in Austria (Schönlaub, 1969a). Specimens from Michigan have been referred to *Bryantodus colligatus* (Bryant) by Müller & Clark (1967). The species has also been recorded from Arizona (Ethington, 1965). It has been recorded as *B. colligatus* from Germany (Bischoff & Ziegler, 1957), Spanish Sahara (Ethington & Furnish, 1962), and the Canning Basin, Australia (Seddon, 1970a).

Range: The species ranges from the late Middle Devonian (Bischoff & Ziegler, 1957) as high as the toI/II boundary in the Late Devonian (Clark & Ethington, 1967). Most occurrences are in the Frasnian.

POLYGNATHELLUS cf. *P. TYPICALIS* Bassler, 1925

(Pl. 87, fig. 7a, b)

- cf. 1926 *Polygnathellus typicalis* Bassler; Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 53, pl. 1, figs 1, 2.

Material: Single specimen, CPC 12773, figured, from Sample BG 19541, Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: The single broken specimen is referred to *P. typicalis* because of the well-developed ornamented platform on either side of the bar. It closely resembles forms referred to *P. n. sp.* by Clark & Ethington (1967).

Genus POLYGNATHUS Hinde, 1879

Type species: *Polygnathus dubius* Hinde, 1879.

POLYGNATHUS ASYMMETRICUS ASYMMETRICUS Bischoff & Ziegler, 1957

(Pl. 68, figs 1a, b, c; Pl. 69, figs 1a-3b)

- 1957 *Polygnathus dubia asymmetrica* Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 88, pl. 16, figs 18, 20-22; pl. 21, fig. 3.
1958 *Polygnathus dubia asymmetrica* Bischoff & Ziegler; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, pl. 1, figs 4-6, 8, 10.
1959 *Polygnathus dubia asymmetrica* Bischoff & Ziegler; Krebs, *Senck. Leth.*, 40, 384, pl. 1, fig. 3.
1966 *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Flajs, *N. Jb. Geol. Paläont. Abh.*, 124, 230, pl. 26, figs 1-9.
1966 *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Glenister & Klapper, *J. Paleont.*, 40, 828, pl. 88, figs 6, 7.
1967 *Polygnathus dubia asymmetrica* Bischoff & Ziegler; Boogaert, *Leidse geol. Med.*, 39, 183, pl. 2, fig. 36.
?1968 *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Mound, *J. Paleont.*, 42, 503, pl. 68, figs 8, 9.

Material: 35 specimens, CPC 12676-9 figured.

Localities of figured material: Sample BG 19186 (CPC 12676), McWhae Ridge, Gogo Formation; BG 19544 (CPC 12677, 12678), Section 9, McPhee Knoll, Gogo Formation; BG 21253 (CPC 12679), Section 20, Longs Well Creek, Gogo Formation.

Remarks: The nomenclatural problems caused by the fact that the lectotype of *P. dubius* Hinde is fragmentary have been adequately covered by Glenister & Klapper (1966, p. 828) and Clark & Ethington (1967, p. 58). Huddle (1970) points out that the lectotype is now lost and proposes a neotype of *P. dubius* which is a lectotype of *P. foliatus*.

Distribution: The species was originally described from Germany (Bischoff & Ziegler, 1957). Other German occurrences have been reported by Ziegler (1958), Krebs (1959), Helms (1963), Krebs & Rabien (1964), Bar (1968), and Schneider (1969). Other European countries from which the subspecies has been recorded include Austria (Flajs, 1966; Schulze, 1968; and Schönlaub, 1969a) and Spain (Boogaert, 1967).

Reports of the subspecies from North America are concentrated in Alberta (Clark & Ethington, 1965; Uyeno, 1967; Pollock, 1968; Mound, 1968), the only other occurrence being from Nevada (Clark & Ethington, 1967). Glenister & Klapper (1966) have reported it from the Canning Basin, Australia.

Range: Ziegler (1962a) records the subspecies throughout the Frasnian *Polygnathus asymmetricus* Zone (toI α -toI β). All other reports of the subspecies are within this range; in the Canning Basin the range is identical with that in Germany.

POLYGNATHUS ASYMMETRICUS OVALIS Ziegler & Klapper, 1964

(P. 68, figs 2a-3c)

- 1949 *Polygnathus dubia* Hinde; Beckmann, *Senckenbergiana*, 30, 154, pl. 1, fig. 3; pl. 2, fig. 10; pl. 4, fig. 4.
1957 *Polygnathus dubia dubia* Hinde; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 88, pl. 16, fig. 19; pl. 21, fig. 1.

- 1958 *Polygnathus dubia dubia* Hinde; Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, pl. 1, figs 1-3, 7.
 1963 *Polygnathus dubia dubia* Hinde; Helms, *Geologie*, 12, text-fig. 2.1.
 1964 *Polygnathus asymmetrica ovalis* Ziegler; Klapper & Lindström, *J. Paleont.*, 38, 422.
 1965 *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Ziegler, *Fortschr. Geol. Rheinld Westf.*, 9, 538, pl. 1, figs 3, 4.
 1966 *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Flajs, *N. Jb. Geol. Paläont. Abh.*, 124, 239, pl. 25, figs 1-3.
 1967 *Polygnathus dubius* Hinde; Müller & Clark, *J. Paleont.*, 41, 916, pl. 115, figs 5a-6.
 1967 *Polygnathus dubia dubia* Hinde (= *asymmetrica ovalis* Ziegler & Klapper); Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 60, pl. 7, figs 14, 15; pl. 8, figs 8, 9.
 1968 *Polygnathus asymmetrica ovalis* Ziegler & Klapper, *J. Paleont.*, 42, 504, pl. 69, figs 4, 5.

Material: 15 specimens; CPC 12680, 12683 figured.

Localities of figured material: Sample BG 19001 (CPC 12680), Section 1, McWhae Ridge, Gogo Formation; BG 19482 (CPC 12683), Section 6, Lloyd Hill-Laidlaw Range, Gogo Formation.

Remarks: The problems of nomenclature due to Hinde's specimens being fragmentary have been discussed by Ziegler, Klapper, & Linström (1964) and Clark & Ethington (1967). I prefer to keep the name *P. asymmetricus ovalis* because, at the present time, the zone in which it occurs is labelled the *P. asymmetricus* Zone. Müller & Clark (1967) note that the range of *P. asymmetricus* s.s. and *P. asymmetrica ovalis* are identical, but that in their fauna only the latter was present, suggesting that the difference may be real rather than imaginary. The distribution of the two subspecies throughout the world is very similar; faunas containing one usually contain both. However, there are exceptions (apart from the Squaw Bay fauna of Müller & Clark), including faunas reported by Beckman (1949), Schriell & Stoppel (1965), and Ziegler (1965a) from Germany. One fauna reported by Krebs (1959) contains *P. asymmetricus* but lacks *P. asymmetricus ovalis*.

Distribution and Range: Ziegler, Klapper, & Lindström (1964) selected a form illustrated by Ziegler (1958) from the Adorfstufe, Germany. Other German occurrences have been reported by Beckmann (1949), Bischoff & Ziegler (1957), Helms (1963), Krebs & Rabien (1964), Schriell & Stoppel (1965), Ziegler (1965a), Bar (1968), Schneider (1969), and Meischner & Schneider (1970). The only other European occurrence is in Austria (Flajs, 1966; Schulze, 1968; Schönlaub, 1969a).

In North America the species has been reported from Alberta (Clark & Ethington, 1965; Uyena, 1967; Pollock, 1968; Mound, 1968), Michigan (Müller & Clark, 1967), and Nevada (Clark & Ethington, 1967). Glenister & Klapper (1966) have reported it from the Canning Basin, Australia.

POLYGNATHUS AUSTRALIS sp. nov.

(Pl. 68, figs 1a-c; text-fig. 22)

- ?1965 *Polygnathus normalis* Miller & Youngquist s.l.; Krebs & Ziegler, *Forschr. Geol. Rheinld Westf.*, 9, pl. 2, fig. 1.
 1970 *Polygnathus* sp. Druce, *Bur. Miner. Resour. Aust. Bull.* 108, 81, pl. 14, figs 1a-3b.
 1970 *Polygnathus* sp. Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, figs 13, 14.

Derivation of name: From its common occurrence in Australia.

Material: 14 specimens, holotype CPC 12685, paratypes CPC 12684, 12686.

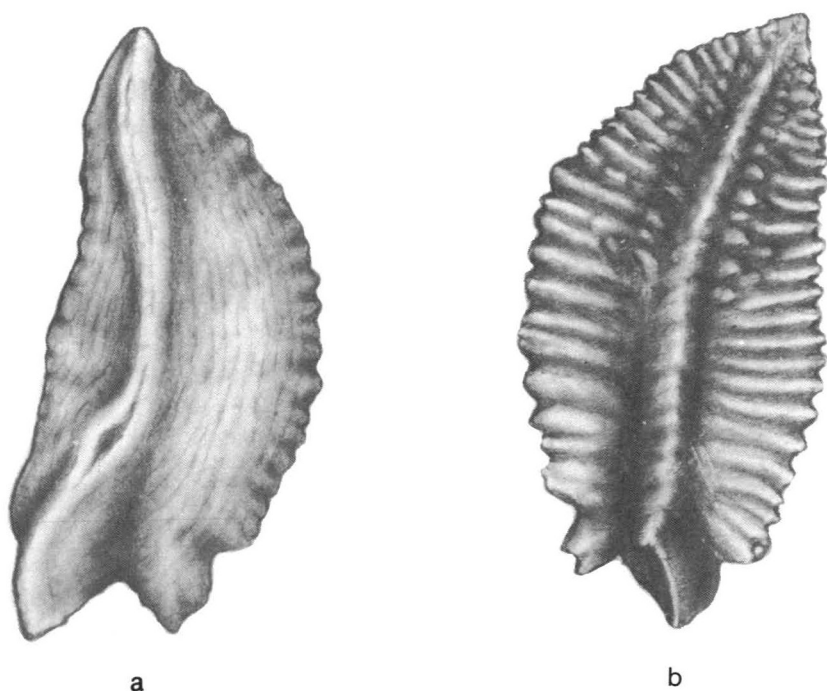


Fig. 22. *Polygnathus australis* sp. nov. paratype CPC 12684, (a) aboral view, (b) oral view, x80.

Localities of figured material: Holotype, sample BG 19425, 1.5 km north of Cave Spring, Sadler Limestone; Paratypes, BG 19412 (CPC 12684), east side of McWhae Ridge, Virgin Hills Formation; and BG 19577 (CPC 12686), Section 12, southwest of Waggon Pass, Gogo Formation.

Diagnosis: A polygnathid with a massive platform equal in length to the free blade and bearing transverse ridge ornament on the anterior half and nodes on the posterior half.

Description: An elongate lanceolate unit, the platform being slightly larger than the free blade. The free blade is tall; it is highest at its midpoint. It consists of about 7 fused denticles with free chevron tips.

In the anterior part 2 adcarinal troughs are present and the platform edges are upturned, bearing strong transverse ridges. The ridges on any one specimen are often fused laterally into pairs. Posteriorly, the platform is wider and the troughs disappear, to be replaced by low unornamented areas. The posterior area is ornamented by low diffuse nodes. The carina is slightly bowed and consists of low nodes which decrease in size posteriorly.

Aborally, the unit is strongly keeled. The basal cavity is situated in the anterior quarter of the platform and is small and circular.

Remarks: This species belongs to a group of polygnathids characterized by *P. foliatus* Bryant. *P. australis* differs from *P. foliatus* in the nodose platform ornament. *P. webbi* is also a member of this group, but differs in platform ornament.

and also in platform symmetry, being very narrow on the inner platform. *P. australis* possibly developed from *P. foliatus* by a broadening of the posterior part of the platform and the breakdown of the transverse ridges into nodes. *P. amarus* can be distinguished by its transverse ridges and lack of carina in the posterior half.

Occurrence: At present the species is definitely known only from Australia, being originally described from Frasnian strata in Queensland (Druce, 1970b). Seddon (1970a) also records it from the Canning Basin.

Range: A questionable example of the species was illustrated from the boundary beds of the Middle/Upper Devonian in Germany (Krebs & Ziegler, 1965). The Queensland specimens come from late Frasnian, possibly to I δ (Druce, 1970b)*. The Western Australian specimens of Seddon (1970a) come from the *Palmatolepis gigas* Zone (to I γ). In the present fauna the species is common in the *Polygnathus asymmetricus* Zone (to I α -to I β). The species range appears to be essentially Frasnian, probably early Frasnian.

POLYGNATHUS BREVILAMINUS Branson & Mehl, 1934

(Pl. 18, fig. 1a, b)

- 1934 *Polygnathus brevilamina* Branson & Mehl, *Univ. Mo. Stud.*, 8, 246, pl. 21, figs 3-6.
- 1968 *Polygnathus brevilamina* Branson & Mehl; Mound, *J. Paleont.*, 42, 504, pl. 69, figs 6, 7. (Synonymy to 1966)
- 1967 *Polygnathus brevilamina* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 224, pl. 21, figs 15-17.
- 1967 *Polygnathus cf. brevilamina* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 411, pl. 14, figs 5a, b.
- 1968 *Polygnathus brevilamina* Branson & Mehl; Schulze, *N. Jb. Geol. Paläont. Abh.*, 130, 211, pl. 20, figs 5, 6.
- 1969 *Polygnathus cf. P. brevilamina* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 92, pl. 19, figs 1-4.

Material: 55 specimens; CPC 12687-9 figured, from samples BG 19452D (CPC 12687), 19453D (CPC 12688), 19454B (CPC 12689), Section 4, north-east of McWhae Ridge, Virgin Hills Formation.

Remarks: *Polygnathus brevilaminus* has recently been studied by Anderson & Ozias (1966). They discuss the validity of the genus *Ctenopolygnathus* used by Müller & Müller to distinguish polygnathiform species intermediate between *Spathognathodus* and *Polygnathus*. Anderson & Ozias conclude that the distinction between *Polygnathus* and *Ctenopolygnathus* is not valid; however, *P. brevilaminus* does appear to be a polygnathid development from a spathognathid ancestor, and *Ctenopolygnathus* may be useful as a subgeneric name for such forms.

Anderson & Ozias also point out that there is considerable variation in morphology, especially in platform size and situation, although gross morphology, especially blade profile, is consistent. This species is easily distinguishable and Anderson & Ozias comment that broader species concepts should be used. However, using very broad species concepts it is extremely difficult to place many Frasnian polygnathids in named species.

Occurrence: The species was originally described from the Grassy Creek Shale, Missouri (Branson & Mehl, 1934). Elsewhere in North America it has been

* This fauna is probably early Frasnian, Mouravieff, pers. comm.

recorded from Iowa (Müller & Müller, 1957; Youngquist & Peterson, 1947; Anderson, 1964, 1966; Anderson & Ozias, 1966), Arizona (Ethington, 1962), Utah (Clark & Becker, 1960), and Alberta (Mound, 1968).

In Europe the species is common in Germany (Sannemann, 1955b; Bischoff, 1956; Bischoff & Ziegler, 1956; Stoppel, 1958; Freyer, 1961; Ziegler, 1962a; and Bar, 1968). Other European occurrences include Austria (Schulze, 1968), Czechoslovakia (Friakova, 1964), Poland (Wolska, 1967), and Spain (With, 1967).

The species has also been reported from the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: The species was originally described from the Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). It is also abundant in the early Famennian Sheffield Formation of Iowa (Anderson, 1966). Ziegler (1962a) gives the range in Germany as *Manticoceras* and *Cheiloceras*-Stufen (toI-toII), although both Bischoff & Ziegler (1956) and Freyer (1961) record the species from Famennian toV strata.

In the Canning Basin the species ranges from the Lower *Polygnathus asymmetricus* Zone (Frasnian toI) as high as the Lower *Palmatolepis quadrantinodosa* Zone (Famennian toII β).

POLYGNATHUS COLLINSONI Druce, 1969

(Pl. 18, fig. 2a, b)

1961 *Polygnathus communis* Branson & Mehl; Scott & Collinson, *Kansas geol. Soc. 26th Ann. Field Conf. Guidebook*, 130, pl. 1, figs 8, 10 only.

1969 *Polygnathus collinsoni* Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 93, pl. 23, figs 3, 4; text-fig. 19.

Material: 22 specimens; CPC 12690-1 figured, from sample BG 19183, Section 4, northeast of McWhae Ridge, ? Bugle Gap Formation.

Remarks: The present specimens agree closely with those described from the Bonaparte Gulf Basin. Both specimens show crenulate margins, suggesting a transverse-ridged ancestor.

Occurrence: The species was first illustrated from the Louisiana Limestone of the Mississippi Valley (Scott & Collinson, 1961). The only other reported occurrence is from the Bonaparte Gulf Basin, Australia (Druce, 1969).

Range: The Louisiana Limestone is considered to be late Famennian (toVI) by Collinson et al. (1962). In the Bonaparte Gulf Basin the species is present with *Polygnathus znepolensis* of toV-toVI age (Spasov, 1965). The present specimens are probably of Lower to Middle *Polygnathus styriacus* Zone age.

POLYGNATHUS DECOROSUS Stauffer, 1938

(Pl. 71, figs 3a-5b)

1938 *Polygnathus decorosus* Stauffer, *J. Paleont.*, 12, 438, pl. 53, figs 1, 5, 6, 10, 11, 15, 16, 20, 30.

1970 *Polygnathus decorosus* Stauffer; Seddon, *J. geol. Soc. Aust.*, 16, 738, pl. 12, figs 17-19.

Material: 75 specimens, CPC 12692-4 figured.

Localities of figured material: Sample BG 19007 (CPC 12692), Section 1, McWhae Ridge, Gogo Formation; BG 19449B, (CPC 12693, 12694), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: Seddon (1970, pl. 739) has discussed in detail the problems of differentiating *P. decorosus* and *P. xylus*. Seddon suggests that the ranges of *P. decorosus* and *P. xylus* differ: but there is some overlap in range and in morphology. Smooth forms (*P. xylus*) show considerable variation in platform morphology, and ornamented forms (*P. decorosus*) appear to be transitional to or from other polygnathids. A complete revision of Frasnian polygnathids other than the *P. asymmetricus* group is needed.

Distribution and Range: Because of the wide interpretation of the species by many conodont workers it is impossible to comment on the range and occurrence of *P. decorosus* as originally designated by Stauffer. A revision of polygnathids from the Frasnian will provide information on ranges which may be stratigraphically useful.

POLYGNATHUS DELICATULUS Ulrich & Bassler, 1926

(Pl. 18, fig. 4a, b)

- 1926 *Polygnathus delicatulus* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 45, pl. 7, figs 9, 10.
non 1939 *Polygnathus delicatula* Ulrich & Bassler; Cooper, *J. Paleont.*, 13, 400, pl. 40, figs 37, 38 (= *P. radinus* Cooper).
1956 *Polygnathus rimulata* Ulrich & Bassler; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 84, 158, pl. 12, fig. 7.
1958 *Polygnathus wyomingensis* Klapper, *J. Paleont.*, 32, 1090, pl. 142, figs 5-8.
1961 *Polygnathus wyomingensis* Klapper; Ethington et al., *J. Paleont.*, 35, 765, pl. 90, figs 1-3.
1966 *Polygnathus delicatula* Ulrich & Bassler; Klapper, *Univ. Kansas paleont. Contr.*, Pap. 3, 22, pl. 6, figs 7, 9, 10.
1968 *Polygnathus delicatula* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 38, pl. 14, figs 20, 22-24; pl. 16, fig. 19.
1968 *Polygnathus delicatula* Ulrich & Bassler; Mound, *J. Paleont.*, 42, 506, pl. 69, figs 23, 24.

Material: 16 specimens; CPC 12695-7 figured, from samples BG 19097 (CPC 12696), 19107 (CPC 12695), BG 19109 (CPC 12697), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Description: The unit consists of a free blade and platform of about equal length. The free blade consists of about nine fused denticles with free chevron tips; they are usually tallest in the central region, but some specimens have the highest denticles at the anterior end. The free blade and carina are continuous; the carina is composed of low fused nodes and runs to the posterior termination, where the nodes become more isolated. In lateral view the carina is higher than the platform margins.

The platform is lanceolate and bears two fairly deep adcarinal troughs. The ornament consists of scattered nodes arranged into a rough linearity. They are situated a little way from the platform margin and in lateral view are higher than the platform margin, though not as high as the carina.

The unit is keeled; the keel deepens at the platform/free blade junction and merges with the aboral margin of the free blade.

The basal cavity is slit-like and situated on the anterior part of the platform within the deepening keel.

Remarks: Klapper (1966, p. 22) distinguishes *P. delicatulus* from *P. symmetricus* on the basal cavities; in *P. delicatulus* the cavity is situated in the raised keel whereas in *P. symmetricus* it is set into the platform. However, Huddle (1968, p. 38), who, like Klapper, examined the type material of *P. delicatulus*, described the cavity as 'a large, shallow, thick-lipped pit'. The present specimens have a basal cavity similar to that described by Klapper.

Distribution: The species was originally described from the 'Hardin Sandstone', Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). It is also known from Wyoming (Klapper, 1958, 1966; Ethington et al., 1961) and Alberta (Mound, 1968). In Europe it has been reported by Bischoff & Ziegler (1956) from Germany and by Boogaert (1967) from Spain.

Range: The 'Hardin Sandstone' was originally thought to be Mississippian, but Huddle (1968) points out that the formation contains Ordovician, Middle Devonian, Frasnian, and Famennian conodonts and the whole fauna is probably reworked. The Wyoming specimens come from strata equivalent to the toV Zone (Klapper, 1966), and the questionable Alberta specimen from Famennian strata. The German specimens come from toV strata, and the Spanish from toV/toVI. The Canning Basin specimens come from the *Palmatolepis quadrantinodosa* Zone (toII β /toIII α).

POLYGNATHUS FALLAX Helms & Wolska, 1967

(Pl. 18, fig. 5a, b)

1960 *Polygnathus* cf. *procera* Sannemann; Zimmermann, *Freib. Forsch.*, C89, 192, pl. 6, figs 2a, b.

1967 *Polygnathus fallax* Helms & Wolska, *Acta paleont. polon.*, 12, 231, text-figs 3a, b.

Material: 4 specimens, CPC 12698, 12699 figured.

Localities of figured material: Sample 19080 (CPC 12698), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21093 (CPC 12699), Section 17, Ngumban Cliff, Virgin Hills Formation.

Description: Unit lanceolate with platform about 4 times as long as free blade. The free blade is tallest in the mid-region. The platform is elongate, bearing irregular transverse ridges which occasionally break down into scattered nodes. Adcarinal troughs are present in the extreme anterior. The carina merges with the free blade and consists of low fused nodes. In lateral view the unit is slim and slightly bowed.

The unit is keeled, with a small elongate basal cavity. The platform bears a chine.

Remarks: Helms & Wolska (1967) point out that *P. fallax* is close to *P. pennatulus* Ulrich & Bassler, but its ornament is much finer. It is difficult to tell *P. fallax* and *P. dengleri* apart. The ornament of *P. dengleri* tends to be more nodose and the blade is usually shorter. The very distinctive ranges of the two species (*P. dengleri* is Frasnian) suggest that they are homeomorphs.

Distribution: The first record of the species was from Saxony, Germany (Zimmermann, 1960). Helms & Wolska (1967) record it from Germany and Poland.

Range: In Europe the species occurs in all but the lowermost part of the *P. quadrantinodosa* Zone (Helms & Wolska, 1967, p. 233, table 1). In the Canning Basin the species occurs in the same zone.

POLYGNATHUS FOLIATUS Bryant, 1921

(Pl. 73, figs 1a-4b)

- 1921 *Polygnathus foliatus* Bryant, *Bull. Buffalo Soc. nat. Sci.*, 13, 24, pl. 10, figs 13-16.
1957 *Polygnathus foliata* Bryant; Bischoff & Ziegler, *Hess. Landesamt Bodenf., Abh.*, 22, 90, pl. 4, figs 1-4.
1957 *Polygnathus foliata* Bryant; Müller & Müller, *J. Paleont.*, 31, 1086, pl. 135, fig. 1.
1959 *Polygnathus foliata* Bryant; Helms, *Geologie*, 8, 651, pl. 1, figs 2a-3; pl. 4, figs 3, 4.
1964 *Polygnathus foliata* Bryant; Budurov & Tschunov, *Bull. Inst. Sci. Rech. Géol.*, 1, 256, pl. 2, figs 12, 13, 19a-c, 22a-c.
?1965 *Polygnathus foliata* Bryant; Olivieri, *Boll. Soc. paleont. ital.*, 4, 28, pl. 5, fig. 7.
1967 *Polygnathus foliata* Bryant; Müller & Clark, *J. Paleont.*, 41, 916, pl. 115, fig. 4.
1967 *Polygnathus foliata* Bryant; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 61, p. 15, fig. 7; pl. 7, fig. 7.
1970 *Polygnathus foliatus* Bryant; Seddon, *J. geol. Soc. Aust.*, 16, 751, pl. 13, fig. 6.

Material: 180 specimens, CPC 12700-3 figured.

Localities of figured material: Sample BG 19561 (CPC 12700), Section 10, Waggon Pass, Sadler Limestone; BG 19594 (CPC 12701), Section 13, Glenister Knolls, Gogo Formation; BG 21197 (CPC 12702), Section 18, Kudata Gap, Sadler Limestone; BG 21234 (CPC 12703), Section 19, Sadler Ridge, Sadler Limestone.

Description: The unit consists of a free blade and platform of equal length. The free blade consists of about 12 laterally compressed fused denticles with free chevron tips. Some denticles are suppressed and do not erupt on the oral surface. The denticle height is reasonably constant, giving a rectangular free blade. The anteriormost denticles are usually the largest. The carina is a continuation of the free blade and consists of low fused nodes which become more widely spaced toward the posterior termination. The carinal nodes are low and broad; the largest occur in the median part.

The platform is asymmetrical, the outer part being flared at its midpoint. The platform edges are upturned and are separated from the carina by adcarinal troughs which deepen anteriorly. The ornament consists of short transverse ridges on the platform margin. In some specimens these are so short that they are node-like. In many specimens the posteriormost ornament is completely nodose.

Aborally, the unit is keeled and a cavity is present in the keel near the junction of the blade and platform; the cavity lips are flared to give a near-circular cavity outline. In many specimens 'basal bone' material is present over nearly all the aboral platform area.

Remarks: One specimen (Pl. 73, figs 1a, b) is only compared to *P. foliatus*. The free blade is considerably shorter and the platform is more symmetrical and the ornament is more distinct. Three specimens of this form were recovered and appear to be intermediate between *P. foliatus* and *P. dengleri*.

Müller & Müller (1957) drew a very wide interpretation of the species, including *P. decorosus* and *P. xylus* within it. Most workers would prefer to keep these

forms separate, and even though there is considerable intergradation between species it is possible to recognize them.

Distribution: The species was first described from New York State (Bryant, 1921). Elsewhere in North America it has been recorded from Iowa (Müller & Müller, 1957; Klaper & Furnish, 1962), Michigan (Müller & Clark, 1967), Nevada (Clark & Ethington, 1967), and Alberta (Clark & Ethington, 1965).

In Europe the species has been recorded from Germany (Bischoff & Ziegler, 1957; Helms, 1959; Schriel & Stoppel, 1965; Zitzmann, 1966; Stoppel & Zscheke, 1966), Austria (Schulze, 1968; Schönlaub, 1969a), Belgium (Bultynck, 1965), Bulgaria (Buderov & Tschunev, 1964), Italy (Manzoni, 1965; Olivieri, 1965), and Poland (Freyer & Zakowa, 1967).

P. foliatus has also been reported from Morocco (Massa, 1965), Afghanistan (Weippert & Wittekindt, 1964), and Australia (Seddon, 1970a).

Range: The species was originally described from the Conodont bed near Buffalo. The fauna contains *P. linguiformis* and *Ancyrodella rotundiloba*, a fauna characteristic of the Middle/Upper Devonian boundary (Bryant, 1921). Other North American occurrences include the Frasnian Independence Shale of Iowa (Müller & Müller, 1957) and the Middle *Polygnathus asymmetricus* Zone in Nevada (Clark & Ethington, 1967). Clark & Ethington also report the form from the Famennian *Palmatolepis crepida* Zone, but this appears to be anomalous.

In Europe Bischoff & Ziegler record the species from the Middle Devonian Eifel-Stufe; these forms may represent a *P. foliatus* ancestor rather than *P. foliatus* s.s. Ziegler (1962a) gives the range as upper Middle Devonian to Upper *Palmatolepis crepida* Zone (toIIa). Schulze (1968) records the species from the early Upper Devonian and Freyer & Zakowa (1967) record it from lowermost toII Strata. Bultynck records it from the latest Couvinian in Belgium. In the Canning Basin the range is Lower *Polygnathus asymmetricus* Zone as high as the Lower *Palmatolepis gigas* Zone (toIa-toI_γ).

POLYGNATHUS GERMANUS GERMANUS Ulrich & Bassler, 1926

(Pl. 74, figs 1a-3b, 6a, b)

- 1926 *Polygnathus germanus* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 46, pl. 7, figs 11, 12.
- 1968 *Polygnathus germana* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 38, pl. 14, figs 29, 30. (Synonymy to 1962)
- 1967 *Polygnathus nodocostata nodocostata* Branson & Mehl; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 229, pl. 22, fig. 10.
- 1967 *Polygnathus nodosocostata* (sic) Branson & Mehl; Spasov & Filipovic, *Bull. geol. Inst. Ser. paléont.*, 16, 75, pl. 1, fig. 19.
- 1967 *Polygnathus nodocostata nodocostata* Branson & Mehl; Nehring, *Inst. Geol. Bull.* 209, 150, pl. 4, fig. 10; text-fig. 23.
- 1967 *Polygnathus nodocostata* Branson & Mehl; Wolska, *Acta paleont. polon.*, 12, 414, pl. 17, figs 1, 2.
- ?1967 *Polygnathus nodocostata* Branson & Mehl; Loranger, privately published, 16, pl. 3, figs 7, 8.
- 1968 *Polygnathus nodocostata* Branson & Mehl; Mound, *J. Paleont.*, 42, 507, pl. 69, figs 26, 27.
- 1968 *Polygnathus nodocostata nodocostata* Branson & Mehl; Spasov et al., *Inst. Rech. Géol. Géophys.*, 26, 162, pl. 2, fig. 11.

- 1969 *Polygnathus nodocostatus nodocostatus* Branson & Mehl; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 101, pl. 19, fig. 6. (Synonymy from 1962 to 1966)
- 1969 *Polygnathus nodocostatus nodocostatus* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 125, pl. 22, figs 1-5b.

Material: 55 specimens, CPC 12704-7 figured.

Locality of figured material: Sample BG 19024 (CPC 12704), Section 1, McWhae Ridge, Virgin Hills Formation; BG 21014 (CPC 12705), Section 14, 3 km north-east of Pinnacle Spring, Virgin Hills Formation; BG 21262 (CPC 12706), 21263 (CPC 12707), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Remarks: Glenister & Klapper (1966, p. 829) point out that the lectotype of *P. nodocostatus* Branson & Mehl is in fact within the limits of *P. nodocostatus incurvus* Helms. The holotype of *P. germanus* also appears to be the same as *P. nodocostatus incurvus*. However, these are two easily recognized forms, one with X-shaped ornament and one with parallel linear ornament; and perhaps the form with linear ornament should be erected as a subspecies.

Distribution: *P. germanus* is one of the commonest polygnathids. It was originally described from the 'Hardin Sandstone' of Tennessee (Ulrich & Bassler, 1926; Huddle, 1968). It has also been reported from Arkansas (Cooper, 1931), Indiana (Huddle, 1934), Iowa (Klapper & Furnish, 1962; Anderson, 1966), Ohio (Bond, 1947), Utah (Beach, 1961), Wyoming (Klapper, 1958) and Alberta (Loranger, 1967; Mound, 1968).

In Europe the species is common in Germany (Helms, 1961; Freyer, 1961; Zimmermann, 1961; Ziegler, 1962; and Bering, 1967). It has also been reported from Austria (Schulze, 1968; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), France (Boyer et al., 1968), Italy (Manzoni, 1965), Yugoslavia (Spasov & Filipovic, 1967; Spasov et al., 1968), Poland (Nehring, 1967; Wolska, 1967), and Spain (Boogaard, 1965; Wirth, 1967; Boogaert, 1967). In Australia the species has been recorded by Glenister & Klapper (1966) and Druce (1969) from the Canning and Bonaparte Gulf Basins respectively.

Range: Helms (1961) records the range from toI δ to toIII. Ziegler (1962a) amends the range to Famennian (toII β -toV): *Palmatolepis rhomboidea* Zone to Upper *Polygnathus styriacus* Zone. In the Canning Basin the species ranges from the Lower *Palmatolepis crepida* Zone (toIIa) up to the Upper *Palmatolepis quadrantinodosa* Zone (toIIIa).

POLYGNATHUS GERMANUS subsp. nov. a

(Pl. 73, figs 5a, b)

Remarks: One specimen (CPC 12708) from sample BG 19082, Section 4, north-east of McWhae Ridge, Virgin Hills Formation, shows a breakdown in the carina nodes in the posterior half. The platform ornament is nodose, but they are not arranged in a linear fashion except in the anterior half of the platform. The specimen comes from the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

POLYGNATHUS GERMANUS *subsp. nov. b*

(Pl. 73, fig. 6a, b)

- 1961 *Polygnathus nodocostata nodocostata* Branson & Mehl; Helms, *Geologie*, 10, text-fig. 17, late toIII specimen.

Remarks: One specimen, CPC 12709, from sample 19164, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone, is very similar to a specimen illustrated by Helms (1961). The unit is sub-triangular with deep anterior carinal troughs and subparallel linear nodose platform ornament. The ornament is similar to that of *P. germanus* s.s.; it is the platform shape which is distinctive. Helms' specimen is from the late toIII Zone and the present specimen comes from the Lower *Polygnathus styriacus* (toIV) Zone, so the platform shape may be distinctive enough to separate a subspecies useful in zonation.

POLYGNATHUS GLABER GLABER Ulrich & Bassler, 1926

(Pl. 74, figs 4a-5b; Pl. 76, figs 1a-2c)

- 1926 *Polygnathus glaber* Ulrich & Bassler, *Proc. U.S. nat Mus.*, 68, 46, pl. 7, fig. 13.
 1955 *Polygnathus glaber* Ulrich & Bassler; Sannemann, *Senck. Leth.*, 36, 149, pl. 3, fig. 14.
 1961 *Polygnathus glaber* Ulrich & Bassler; Lys et al., *Rév. Inst. fr. Pétrole*, 16, 552, pl. 5, figs 1, 2.
 1962 *Polygnathus glabra glabra* Ulrich & Bassler; Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 89, pl. 10, figs 18-20.
 ?1965 *Polygnathus glabra* Ulrich & Bassler; Spasov, *Trav. géol. Bulg. Sér. paléont.*, 7, 96,
 ?1965 *Polygnathus glabra* Ulrich & Bassler; Spasov, *Trav. géol. Bulg., Sér. paléont.*, 7, 96, pl. 2, fig. 16.
 1966 *Polygnathus glabra glabra* Ulrich & Bassler; Glenister & Klapper, *J. Paleont.*, 40, 829, pl. 94, figs 5, 6.
 1966 *Polygnathus glabra glabra* Ulrich & Bassler; Spasov & Filipovic, *Geol. Glas.*, 11, 47, pl. 3, figs 20, 21.
 1967 *Polygnathus glabra glabra* Ulrich & Bassler; Spasov & Filipovic, *Bull. geol. Inst. Séer. paléont.*, 16, 74, pl. 6, fig. 10.
 1967 *Polygnathus glaber* Ulrich & Bassler; Nehring, *Inst. Geol. Bull.* 209, 149, pl. 4, fig. 5.
 1967 *Polygnathus glabra glabra* Ulrich & Bassler; Wolska, *Acta palaeont. polon.*, 12, 413, pl. 15, figs 1a, b.
 1968 *Polygnathus glabra glabra* Ulrich & Bassler; Huddle, *U.S. geol. Surv. prof. Pap.* 578, 39, pl. 15, figs 13-17.
 1969 *Polygnathus glabra glabra* Ulrich & Bassler; Schönlaub, *Jb. geol. Bundesanst.*, 112, 307, pl. 2, fig. 14.
 1969 *Polygnathus glaber glaber* Ulrich & Bassler; Olivieri, *Boll. Soc. paleont. ital.*, 8, 122, pl. 21, figs 1a-5b.

Material: 69 specimens, CPC 12710-3 figured.

Localities of figured material: Sample BG 19007 (CPC 12710), Section 1, McWhae Ridge, Gogo Formation; BG 19077 (CPC 12711), 19082 (CPC 12712), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21015 (CPC 12713), Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation.

Remarks: The present specimens all appear to fall within the limits of *P. glaber* s.s. No specimens of *P. glaber bilobatus* were recovered. Helms & Wolska (1967) erected a new subspecies, *P. glaber medius*, distinguished by a carina formed of isolated nodes. Some of the specimens from the upper range exhibit some isolation of the nodes, but not as much as that figured by Helms & Wolska.

Distribution: The species was originally described from the 'Hardin Sandstone' (Ulrich & Bassler, 1926), but is probably reworked (Huddle, 1968, p. 39). Unusually, this is the only record of the species from the North American continent.

In Europe the species is common, especially in Germany (Sannemann, 1955b; Bischoff & Ziegler, 1956; Ziegler, 1956, 1962a; Stoppel, 1958; Helms, 1959; Zimmermann, 1960; Freyer, 1961; Schriel & Stoppel, 1965; Henningsen, 1965; Zitzmann, 1966; Stoppel & Zscheke, 1966; Bering, 1967; Bar, 1968; Schneider, 1969). It is also known from Austria (Schulze, 1968; Schönlaub, 1969a), Belgium (Bouckaert & Ziegler, 1965), Bulgaria (Spasov, 1965), France (Serre & Lys, 1958; Lys et al., 1961), Italy (Manzoni, 1965, 1968; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1966, 1967; Nehring, 1967; Wolska, 1967), and Spain (Boogaard, 1965; Wirth, 1967; Boogaert, 1967). The only other report of the species is from the Canning Basin, Australia (Glenister & Klapper, 1966).

Range: The original specimens are probably reworked and thus no information on the range is available from North America. In Europe Ziegler gives the range as Lower *Palmatolepis crepida* Zone (toIIa) to Upper *P. quadrantinodosa* Zone (toIIIa). However, Nehring suggests that the first occurrence may be in the earliest Frasnian (toIa). In the Canning Basin the species ranges from the Middle *P. crepida* Zone to the boundary between the Lower and Upper *P. quadrantinodosa* Zone. One specimen (Pl. 76, figs 2a-c) occurs in the Middle *Polygnathus asymmetricus* Zone. This specimen has a markedly asymmetrical platform and basal cavity and may be ancestral to *P. glaber* s.s.

POLYGNATHUS IRREGULARIS (Thomas, 1949)

(Pl. 75, figs 1a-3b)

1949 *Palmatolepis? irregularis* Thomas, *Bull. geol. Soc. Am.*, 60, 416, pl. 2, fig. 27.

1949 *Polygnathus granulosa* Branson & Mehl; Thomas, *ibid.*, pl. 1, fig. 34 [non fig. 33 = *P. nodocostatus* s.s.].

1961 *Polygnathus irregularis* (Thomas); Helms, *Geologie*, 10, 685, pl. 3, figs 3, 5-7.

Material: 12 specimens, CPC 12714-6 figured.

Localities of figured material: Sample BG 19170 (CPC 12714), Section 4, north-east of McWhae Ridge, Bugle Gap Limestone; BG 21059 (CPC 12715), Section 14, 3 km northwest of Pinnacle Spring, Bugle Gap Limestone; BG 21355 (CPC 12716), Section 22, Piker Hills Formation.

Description: An asymmetric unit with a large platform and a short free blade. The freeblade consists of between 7 and 10 laterally compressed fused denticles with free chevron tips; they are tallest in the mid-part of the blade. The free blade is continuous with the carina, which is low and nodose and is conspicuously bent at about its midpoint. The platform is ovate and bears nodose ornament. On the outer platform, which is the larger, the nodes are often partly fused to give sinuous ridges which tend to parallel the carina. The inner platform bears irregular nodes which, in some specimens, are fused into a single elongate ridge. In the anterior half deep adcarinal grooves separate 'siphonal ridges' from the carina. Posteriorly, the troughs become shallow and the 'siphonal ridges' merge with the carina near the major carinal flexure.

In aboral view the platform is fairly flat, with a longitudinal keel containing a slit-like basal cavity in the anterior half.

Distribution: The original description of the species was from Iowa (Thomas, 1949). The only other reports are from Germany (Helms, 1961; Bar, 1968).

Range: Thomas's specimens came from the Maple Hill Shale of Iowa, considered to be equivalent to the early Saverton of toIV age (Collinson et al., 1961). Helms (1961) records the species from the latest toIV Zone in Germany. In the Canning Basin the species occurs in the Lower *Polygnathus styriacus* Zone (toIV).

POLYGNATHUS JANETAE sp. nov.

(Pl. 76, figs 3a-4c; text-fig. 23)

Derivation of name: For my wife.

Material: 10 specimens, CPC 12717 (holotype), CPC 12718 (paratype).

Localities of figured material: Holotype, Sample BG 19418, Cave Spring, Sadler Limestone; Paratype, sample BG 19482 (CPC 12718), Section 6, Lloyd Hill-Laidlaw Range, Gogo Formation.

Diagnosis: A polygnathid with a large platform virtually devoid of ornament except for a pitted surface and faint ridges on the posterior half.

Description: A polygnathid with a large platform, nearly twice as large as the free blade, which consists of about 7 fused, laterally compressed denticles. They have free chevron tips and are tallest in the mid-region. The free blade merges with the carina, which consists of fused nodes which tend to be widest medially and die out posteriorly. The platform is asymmetric and twisted in many specimens. The platform margins tend to be upturned but in some specimens the platform is virtually flat. The ornament consists of minute pitting; some faint transverse ridges are seen on most specimens; in the juveniles the ridges are more conspicuous. In the anterior part, deep adcarinal troughs are present.

Aborally, the unit is flat, with a longitudinal keel with an elongate pit in its anterior part.

Remarks: Smooth platformed polygnathids occur in the Devonian and Carboniferous. *P. communis* differs in having an elongate rectangular free blade. *P. glaber* differs in having a pear-shaped platform. *P. collinsoni* possesses lateral siphons.

Distribution and Range: This is the first record of the species and it occurs throughout the *Polygnathus asymmetricus* Zone.

POLYGNATHUS NODOUNDATUS Helms, 1961

(Pl. 77, fig. 4a, b)

- 1961 *Polygnathus nodoundata* Helms, *Geologie*, 10, 690, pl. 1, figs 9-11, 20; pl. 2, figs 7, 11-14; text-fig. 8.
1962 *Polygnathus bicavata* Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 86, pl. 10, figs 1, 3, 6-8.
1967 *Polygnathus nodoundata* Helms; Kodsí, *N. Jb. Geol. Paläont. Monatsh.*, 27, 426, figs 6, 7.
1967 *Polygnathus nodoundata* Helms; Wolska, *Acta palaeont. polon.*, 12, 414, pl. 15, fig. 8.
1968 *Polygnathus nodoundata* Helms; Mound, *J. Paleont.*, 42, 508, pl. 69, figs 15, 16.

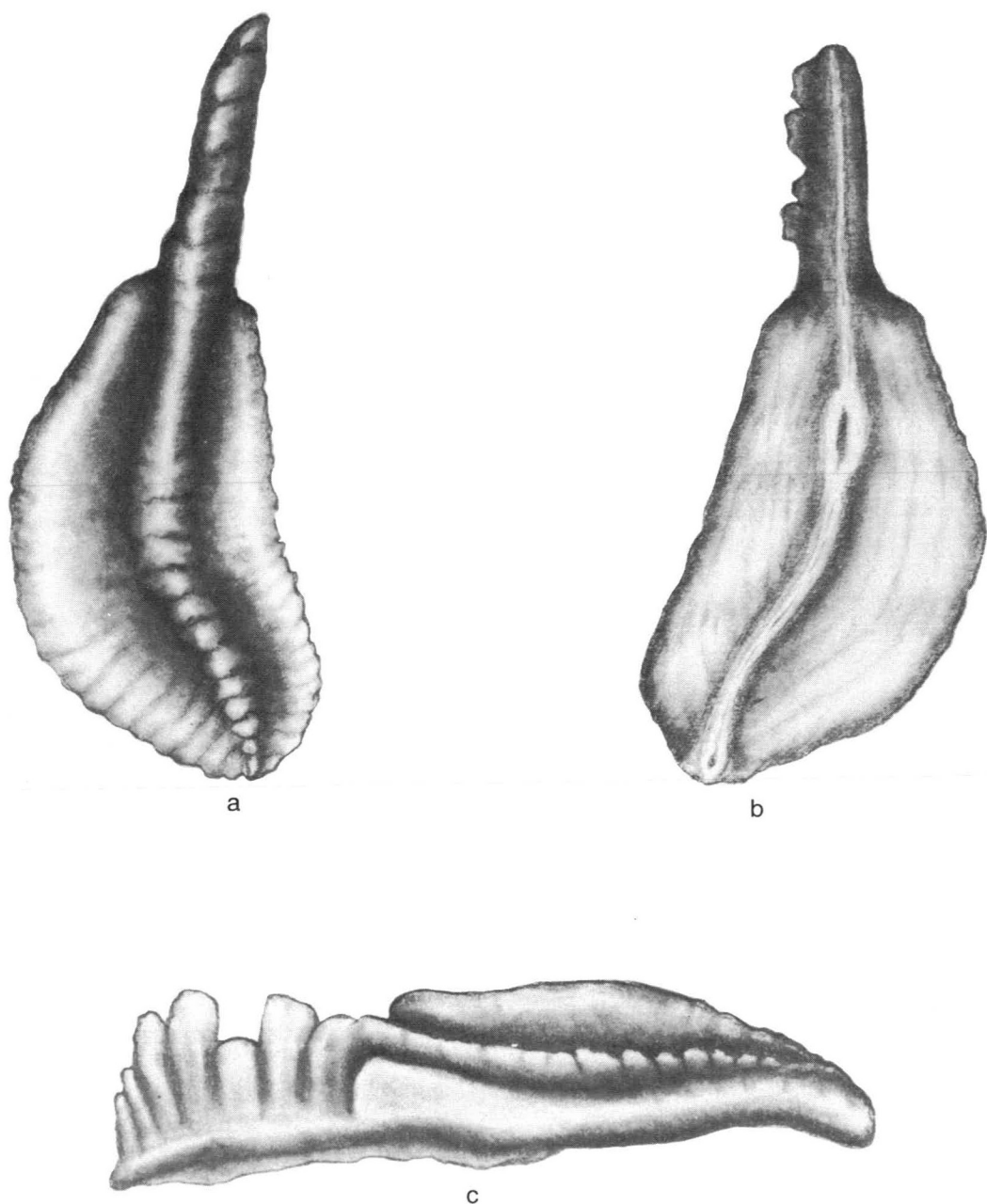


Fig. 23. *Polygnathus janetae* sp. nov. holotype CPC 12717, (a) oral view, (c) lateral view, (b) aboral view, all x56.

Material: 2 specimens; CPC 12721 figured, from sample BG 21362, Section 23, Geikie Gorge, Napier Formation.

Description: An ovate polygnathid with an irregular nodose platform. The carina terminates before the posterior margin; it consists of low fused nodes with shallow troughs on either side. The dentition is irregularly nodose. The nodes are larger in the posterior part and fuse to form ridges parallel to the carina. In aboral view the unit is keeled, with a minute slit-like basal cavity inset near the anterior end.

Remarks: The figured specimen is slimmer than most specimens referred to this species. However, it seems to fall within the range of variability illustrated by Helms (1961, pl. 1, fig. 20).

Distribution: The species was originally described from Thuringia, Germany (Helms, 1961). Other reports in Germany have been made by Ziegler (1962), Henningsen (1965), Bering (1967), Bar (1968), Schneider (1969), and Meischner & Schneider (1970). Other European occurrences are noted from Austria (Kodsi, 1967) and Poland (Wolska, 1967).

In North America the species has been reported by Mound (1968) from Alberta.

Range: Helms (1961) records the species from the middle toIII Zone of the Famennian. Ziegler (1962a) gives the range as Upper *Palmatolepis quadrantinodosa* Zone (toIIIa), as do Wolska (1967), Henningsen (1965), and Bering (1967). Kodsi records the range as toI-toIII, but his range chart shows a restricted range within the toIII Zone. In the Canning Basin the species occurs in the Lower/Upper *Palmatolepis quadrantinodosa* Zone boundary.

POLYGNATHUS NORMALIS Miller & Youngquist, 1947

(Pl. 77, figs 1a-3b)

- 1947 *Polygnathus normalis* Miller & Youngquist, *J. Paleont.*, 21, 515, pl. 74, fig. 4.
1969 *Polygnathus normalis* Miller & Youngquist; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 102, pl. 19, figs 7a-106. (Synonymy to 1966)
1967 *Polygnathus normalis* Miller & Youngquist; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, pl. 22, figs 8, 9.
1967 *Polygnathus normalis* ssp. Wirth, *ibid.*, 230, pl. 22, figs 5-7.
1967 *Polygnathus normalis* Miller & Youngquist; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 63, pl. 5, fig. 10 [non pl. 4, fig. 3 = ?*P. cf. webbi*].
?1967 *Polygnathus normalis* Youngquist & Miller (sic); Loranger, privately published, 15, pl. 3, figs 5, 6.
1967 *Polygnathus normalis* Miller & Youngquist; Wolska, *Acta palaeont. polon.*, 12, 415, pl. 14, figs 9-11.
1968 *Polygnathus normalis* Miller & Youngquist; Mound, *J. Paleont.*, 42, 509, pl. 69, figs ?30, ?31; pl. 70, figs 1, 2, 5.
1968 *Polygnathus normalis* Müller & Youngquist (sic); Spasov et al., *Inst. Rech. Géol. Géophys. Bull.* 26, 162, pl. 2, fig. 13.
1970 *Polygnathus normalis* Miller & Youngquist; Seddon, *J. geol. Soc. Aust.*, 16, 753, pl. 16, figs 19-22.

Material: 650 specimens, CPC 12722, 12724, 12725 figured.

Localities of figured material: Sample BG 19014 (CPC 12722), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19071 (CPC 12724), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 19548 (CPC 12725), Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: Stratigraphically this species shows some variation and it may be possible to subdivide it. Younger specimens become progressively smaller, with a more denticulate outer anterior margin. The youngest specimens show an almost complete lack of platform ornament.

Distribution: *P. normalis* is one of the most common species of polygnathids and has been reported extensively from North America, Europe, Asia, North Africa, and Australia.

Range: Ziegler (1962a) gives the range as late Middle Devonian to Upper *Palma-tolepis triangularis* Zone (Famennian to I/II). The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone as high as the Lower *Scaphi-gnathus veliferus* Zone (to IIIa).

POLYGNATHUS cf. *P. NORRISI* Uyeno, 1967
(Pl. 78, figs 1a-4b)

- 1959 *Polygnathus diversa* Helms, *Geologie*, 8, 674, pl. 5, fig. 8 only.
cf. 1967 *Polygnathus norrisi* Uyeno, *Geol. Surv. Can. Pap.* 67-30, 10, pl. 2, figs 4, 5.
1968 *Polygnathus* sp. a Schulze, *N. Jb. Geol. Paläont. Abh.*, 130, 217, pl. 20, fig. 18.
1969 *Polygnathus* Müller, *Paläont. Z.*, 43, 67, pl. 6, figs 1, 4.
1969 *Polygnathus diversus* Helms; Müller, *ibid.*, pl. 6, fig. 2.

Material: 8 specimens; CPC 12726-8, 12768 figured, from samples BG 19108 (CPC 12768), 19109 (CPC 12727), BG 19117 (CPC 12726), BG 19147 (CPC 12728), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: An elongate unit with distinctive brush-like platform ornament. The free blade is elongate, low and rectangular, composed of about 14 fused denticles with free chevron tips. The platform is about the same length as the free blade and is narrow and triangular. The dentition, which consists of a multitude of fine needle-like denticles, is diagnostic.

Remarks: The present specimens differ from Uyeno's specimens of *P. norrisi* in having a long, low blade, unlike the short, high blade of *P. norrisi*. The platform is also smaller. Müller (1969) considers that the brush-like ornament seen in several genera is a pathological differentiation, and if this is correct, then this peculiar ornament cannot be used to differentiate a separate species. The rather different ranges of *P. norrisi* from Canada and *P. cf. P. norrisi* from Australia suggest this although, in general, the forms already described by Helms (1959) and Müller (1969) tend to be of the same age. It is possible that this type of denticulation is a response to a particular environment, but Müller notes that there appears to be no relation between the occurrence and substrate, region, and facies.

However, this type of denticulation may be useful in determining the composition of natural assemblages. The present specimens usually occur with *O.?* *lacera* (which has brush-like dentition) and sometimes a brush-like hindeodellid.

Distribution: The form was originally described from Germany (Helms, 1959) and has also been reported from Germany and Austria (Müller, 1969). The species was originally described from Alberta, Canada (Uyeno, 1967).

Range: Uyeno (1967) records *P. norrisi* from the Lower *Polygnathus asymmetricus* Zone (Frasnian to Ia). However, the European specimens are from the Famennian (to III-to V) (Müller, 1969). In the Canning Basin the species ranges from the uppermost Lower *Palmatolepis quadrantinodosa* Zone (to II β) up to at least the Middle *Scaphignathus veliferus* Zone (to III β).

POLYGNATHUS OBLIQUICOSTATUS Ziegler, 1962

(Pl. 78, fig. 2a, b)

- 1962 *Polygnathus obliquicostata* Ziegler, Hess. Landesamt Bodenf. Abh., 38, 92, pl. 11, figs 8-12.
1966 *Polygnathus obliquicostata* Ziegler; Klapper, Univ. Kansas Paleont. Contr., Pap. 3, 22, pl. 6, figs 2, 4.
?1969 *Polygnathus obliquicostata* Ziegler; Schönlaub, Jb. Geol. Bundesanst., 112, 307, pl. 2, fig. 6.
1969 *Polygnathus obliquicostatus* Ziegler; Olivieri, Boll. Soc. paleont. ital., 8, 128, pl. 23, figs 4a-5.

Material and Locality: A single specimen CPC 12729, sample 21015, Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation.

Remarks: A single specimen falls within the range of the species as illustrated by Ziegler (1962a). *P. obliquicostatus* differs from *P. semicostatus* Branson & Mehl in the lack of a tongue-like posterior projection and in possessing a carina in the posterior half. It appears to have developed from *P. normalis* Miller & Youngquist by the development of strong oblique ridges on the posterior half of the platform. Specimens compared to *P. obliquicostatus* by Glenister & Klapper (1966, p. 830) probably belong to *P. znepolensis* Spasov, although the forms are only described and not illustrated.

Distribution: The species was originally described from Germany (Ziegler, 1962a) and has also been reported by Bering (1967) from the Kellerwald and the Sauerland (Bar, 1968). The form illustrated by Schönlaub (1969a) from Austria is questionable and may not belong to this species. Boyer et al. (1968) record the species from the Montagne Noir of France, and Olivieri (1969) from Sardinia.

The only record of the species from North America is from Wyoming (Klapper, 1966).

Range: Ziegler (1962a, p. 93) gives the range as Lower and Middle *Polygnathus styriacus* Zone (to IV-to V). Klapper's specimens come from the Lower *Spathognathodus costatus* Zone (to V). The single specimen from the Canning Basin occurs in the Lower *Palmatolepis quadrantinodosa* Zone (to II β), which appears to be anomalous.

POLYGNATHUS cf. *P. PENNATUS* Hinde, 1879

(Pl. 78, figs 6a-7b)

- cf. 1879 *Polygnathus pennatus* Hinde; Quart. J. geol. Soc. Lond., 35, 366, pl. 16, fig. 17; pl. 17, fig. 8.
cf. 1933 *Polygnathus pennata* Hinde; Branson & Mehl, Univ. Mo. Stud., 8, 144, pl. 11, fig. 3.

Material: 25 specimens; CPC 12730-1 figured, from samples BG 19453B (CPC 12731), 19454D (CPC 12730), Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: The present specimens are very similar to *P. pennatus* illustrated by Branson & Mehl from Hinde's specimens. If anything, the ornament is slightly coarser. However, Branson & Mehl suggest that the species is usually less ornamented than the specimen figured by them. This, together with the range discrepancy and the fact that the posterior margin of the present specimens exhibit considerable variation, prevents inclusion in *P. pennatus*. There is some resemblance to *P. triangularis* Branson & Mehl (1934, pl. 21, fig. 20).

Range: In the Canning Basin this form ranges throughout the *Palmatolepis triangularis* Zone (Frasnian/Famennian boundary).

POLYGNATHUS PERPLEXUS Thomas, 1949

(Pl. 79, figs 1a, b, 5a-c)

- 1949 *Polygnathus perplexa* ? Thomas, *Bull. geol. Soc. Am.*, 60, 418, pl. 2, fig. 23.
1959 *Polygnathus perplexa* Thomas; Helms, *Geologie*, 8, 652, pl. 6, fig. 27.
1961 *Polygnathus perplexa* (Thomas); Helms, *Geologie*, 10, 692, pl. 1, figs 18, 19; pl. 4, figs 1-3, 5; text-fig. 10.
non 1966 *Polygnathus* cf. *P. perplexa* (Thomas); Anderson, *J. Paleont.*, 40, 413, pl. 5, figs 7, 9, 11, 14.
1967 *Polygnathus perplexa* (Thomas); Wolska, *Acta palaeont. polon.*, 12, 415, pl. 15, figs 9-11.
1969 *Polygnathus perplexus* Thomas; Olivieri, *Boll. Soc. paléont. ital.*, 8, 129, pl. 22, figs 6-7c.

Material: 6 specimens, CPC 12732, 12733 figured.

Localities of figured material: Sample BG 19114 (CPC 12732), Section 4, north-east of McWhae Ridge, Bugle Gap Limestone; BG 21355 (CPC 12733), Section 22, Piker Hills, Piker Hills Formation.

Description: A lanceolate polygnathid with a short free blade consisting of about 8 fused denticles with free chevron tips highest in the mid-region. The free blade merges with the carina, which is ridge-like and is composed of fused nodes. Either side of the carina are deep troughs separating siphons. The outer siphon is distinctive, being developed into a denticulate blade. Both siphons continue nearly to the posterior end of the unit. On the outer side, the platform edges are tumid and bear linear rows of nodes. Aborally, the unit is keeled, with a slit-like basal cavity in the anterior part.

Remarks: The presence of a secondary lateral blade is seen in other specimens such as *P. normalis* Miller & Youngquist and *P. communis dentatus* Druce.

Distribution: The species was originally described from Iowa (Thomas, 1949), the only record from North America. In Europe the species is noted from Belgium (Bouckaert & Ziegler, 1965), France (Boyer et al., 1968), Germany (Helms, 1959, 1961; Bering, 1967; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1970), Poland (Wolska, 1967), Italy (Olivieri, 1969), and Portugal (Boogaard, 1963).

Range: The original specimens came from the Maple Hill Shale of Iowa (Thomas, 1949), which is probably equivalent to the lower part of the Saverton Shale

(probably Famennian toIV). Helms (1961) records the range as Famennian (highest toIII and toIV), and a similar range is indicated by Wolska (1967). However, Boyer et al. (1968, fig. 7) record the species from the early toIII_a Zone. The Canning Basin specimens have a range of Upper *Palmatolepis quadrantinodosa* Zone (toIII_a) as high as the Middle *Polygnathus styriacus* Zone (toV).

POLYGNATHUS POLLOCKI sp. nov.

(Pl. 79, figs 2a-4b; text-fig. 24)

1968 *Polygnathus* n. sp. A Pollock, *J. Paleont.*, 142, 436, pl. 62, figs 32, 33, 38.

Derivation of name: After Dr C. A. Pollock.

Material: 26 specimens, CPC 12734 (holotype), CPC 12735, 12736 (paratypes), figured.

Localities of figured types: Holotype, sample BG 19543, Section 9, McPhee Knoll, Gogo Formation; Paratypes, sample BG 19554 (CPC 12735), Section 10, Waggon Pass, Sadler Formation; BG 21207 (CPC 12736), Section 15, Sadler Ridge, Sadler Limestone.

Diagnosis: A polygnathid with a very elongate and narrow platform.

Description: An elongate unit with a narrow platform about twice as long as the free blade. The platform is between 5 and 6 times as long as wide. The free blade consists of between 6 and 10 denticles, which are basally fused with free chevron tips. The highest denticles are mainly in the anterior part. The free blade merges with the low carina, which consist of nodes fused into a ridge. The platform consists of two deep continuous adcarinal troughs, and virtually unornamented platform edges. Sometimes the platform edges bear serrations giving the appearance of nodes.

Aborally, the unit is keeled and the basal cavity is present at the junction of the blade and platform. Often there is 'basal bone' attached at the cavity. A wide 'attachment scar' is present either side of the keel with a corresponding chine developed.

Remarks: This species probably developed from the *P. xylus*-*P. decorosus* group by simple elongation of the platform, which is very distinctive. The present specimens agree closely with those figured and described by Pollock, although my specimens have a smaller basal cavity.

Distribution and Range: Pollock's specimens occur in strata considered to belong to the *Polygnathus asymmetricus* Zone in Alberta, Canada. In the Canning Basin the species ranges from the Middle *Polygnathus asymmetricus* Zone (toI_a) as high as the Lower *Palmatolepis gigas* Zone (toI_γ).

POLYGNATHUS SEDDONI sp. nov.

(Pl. 80, figs 1a-4b; text-fig. 25)

Derivation of name: After Dr G. Seddon, who was the first to recognize conodont biofacies in the Canning Basin.

Material: 63 specimens, holotype CPC 12737 and paratypes CPC 12738-40 from sample BG 19543, Section 9, McPhee Knoll, Gogo Formation.

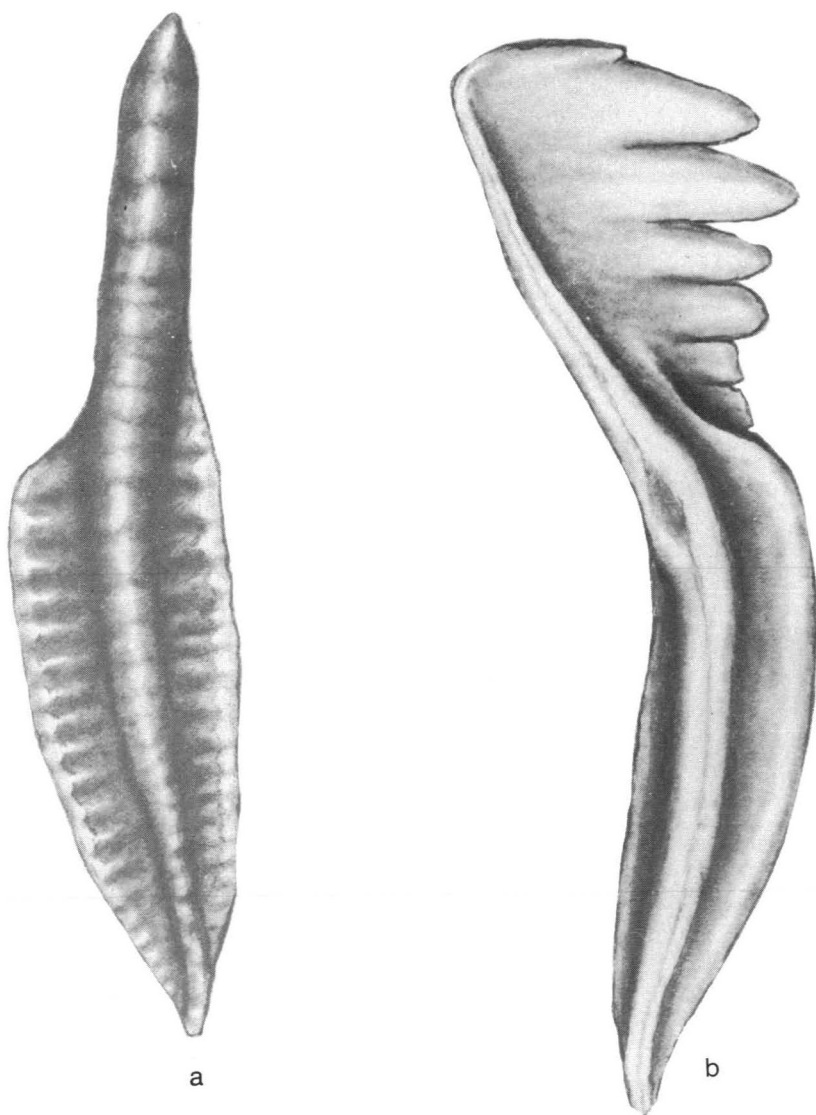


Fig. 24. *Polygnathus pollocki* sp. nov. holotype CPC 12734, (a) oral view, (b) lateral view, both x135.

Diagnosis: A polygnathid with a distinctive lower secondary platform anterior to the main platform.

Description: An asymmetrical polygnathid consisting of a short free blade and relatively large platform. The free blade consists of about 6 laterally compressed fused denticles with free chevron tips. The denticles tend to be of equal height but decrease in height posteriorly. The free blade merges with the carina, which consists of low nodes, fused in the anterior and isolated in the posterior half.

The platform is very distinctive, consisting of a normal posterior platform but a lower platform anteriorly. The posterior platform is ornamented by transverse ridges which are often broken into nodes.

The anterior platform is often wider than the posterior platform, especially on the inner side. It is much lower and is fused with the carina low anteriorly, often asymmetrically: the inner lateral junction is anterior to the outer. This platform is characteristically smooth.

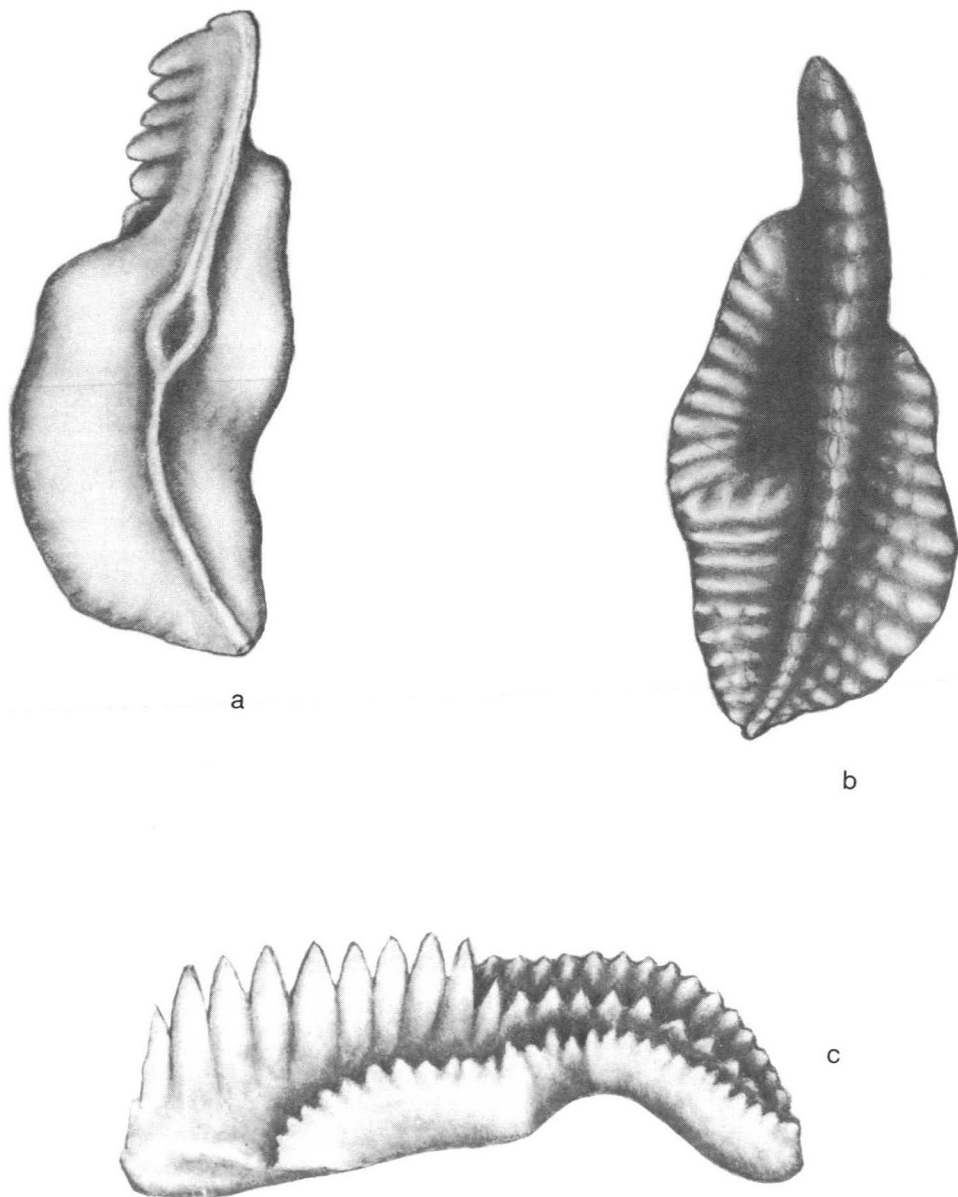


Fig. 25. *Polygnathus seddoni* sp. nov. holotype CPC 12737, (a) aboral view, (b) oral view, (c) lateral view, all x140.

In lateral view the platform is slim and the two levels are distinctive. Aborally, the unit has a narrow low keel. A small elongate basal cavity is present in the anterior quarter of the platform.

Remarks: The peculiar secondary platform is unique amongst described polygnathids. Some specimens of *P. varcus* Stauffer have a secondary expansion which is similar (Orr, 1971, pl. 5, figs 5, 7).

Range: The Canning Basin specimens are from the Upper *Polygnathus asymmetricus* Zone (toI β) and the *Ancyrognathus triangularis* Zone (toI γ), and *P. seddoni* appears to be a good index fossil for the middle Frasnian.

POLYGNATHUS SEMICOSTATUS Branson & Mehl, 1934

(Pl. 80, fig. 5a-c)

- 1934 *Polygnathus semicostata* Branson & Mehl; *Univ. Mo. Stud.*, 8, 247, pl. 21, figs 1, 2.
1949 *Polygnathus semicostata* Branson & Mehl; Thomas, *Bull. geol. Soc. Am.*, 60, 407, pl. 1, fig. 23.
1961 *Polygnathus semicostata* Branson & Mehl; Beach, *Brigham Young Univ., geol. Stud.*, 8, 46, pl. 5, figs 9, 10.
1965 *Polygnathus semicostata* Branson & Mehl; Ethington, *J. Paleont.*, 39, 583, pl. 68, fig. 5.
1968 *Polygnathus semicostata* Branson & Mehl; Mound, *J. Paleont.*, 42, 511, pl. 70, figs 3, 10.

Material: 6 specimens, CPC 12741 figured, from sample BG 19144, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: A polygnathid with a tongue-like posterior projection and a short free blade. The free blade is composed of about 5 fused denticles with free chevron tips; it is tallest at the midpoint.

The platform is large and symmetrical, with crenulate margins and short transverse ridges. Near the carina the platform is smooth and gently trough-like. The posterior termination is extended as a tongue onto which the carina does not extend; it is ornamented by transverse ridges.

Remarks: This species is a homeomorph of the Middle Devonian *Polygnathus linguiformis*, but the tongue-like posterior process is much narrower and less deflected.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934). Other North American occurrences include Iowa (Thomas, 1949), Arizona (Ethington, 1965), New York (Oliver et al., 1967), Utah (Beach, 1961), and Alberta (Mound, 1968). It has also been reported from Germany (Helms, 1961), Belgium (Bouckaert & Ziegler, 1965a), and Morocco (Massa, 1965).

Range: *P. semicostatus* was first described from the Grassy Creek Shale, of toII-lowest toIV age. Oliver et al. (1967) record it from the toII β Zone. Mound (1968) records the species from strata of toII β /toIII α age in Alberta. Helms (1961) records it from the toV Zone. The Belgium specimens are from strata considered by Bouckaert & Ziegler (1965) to be of toII-toIII age. The Moroccan specimens come from a toIII horizon (Massa, 1965, p. 109). The Canning Basin specimens are from the Upper *Scaphignathus veliferus* Zone (toIII β) and Lower *Polygnathus styriacus* Zone (toIV).

POLYGNATHUS SPATULATUS Youngquist, 1947

(Pl. 80, fig. 6a-c)

1947 *Polygnathus spatulata* Youngquist, *J. Paleont.*, 21, 110, pl. 26, fig. 4.

Material: 10 specimens; CPC 12742 figured, from sample BG 19186, McWhae Ridge, Gogo Formation.

Description: A polygnathid with a platform slightly shorter than the free blade. The blade is high, consisting of about 10 fused denticles with free chevron tips, the tallest denticles being towards but not at the front; they slope rapidly posteriorly to merge with the nodose carina, which tends to be widest at its midpoint and disappears before the posterior termination.

The platform is ovate, ornamented with short transverse ridges and with a crenulate platform margin. Smooth troughs which deepen anteriorly are present on either side of the carina.

Remarks: The species can be distinguished from *P. decorosus* by the high blade and from *P. xylus* by the ornamented platform.

Distribution and Range: The species was originally described from a Frasnian shale in Iowa (Youngquist, 1947). The Canning Basin specimens come from the Lower Polygnathus asymmetricus Zone (Frasnian to Ia).

POLYGNATHUS SUBSERRATUS Branson & Mehl, 1934

(Pl. 81, figs 1a-3c)

1934 *Polygnathus subserrata* Branson & Mehl, *Univ. Mo. Stud.*, 8, 248, pl. 20, figs 17-19.

1959 *Polygnathus subserrata* Branson & Mehl; Helms, *Geologie*, 8, 652, pl. 2, fig. 23; pl. 6, fig. 10.

1967 *Polygnathus subserrata* Branson & Mehl; Kotsi, *N. Jb. Paläont. Monatsh.*, 27, 426, pl. 6, figs 9, 10.

1967 *Polygnathus subserrata* Branson & Mehl; Wolska, *Acta palaeont. polon.*, 12, 417, pl. 26, figs 8-10.

1969 *Polygnathus subserratus* Branson & Mehl; Olivieri, *Boll. Soc. paleont. ital.*, 8, 130, pl. 24, figs 3a-c.

Material: 14 specimens; CPC 12743, 12745, 12746 figured, from samples BG 19160 (CPC 12743), 19161 (CPC 12745), 19182 (CPC 12746), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: A polygnathid with a platform and a free blade of equal length. The free blade consists of about 5 laterally compressed denticles with fused bases and posteriorly inclined free tips. The free blade merges with the carina, which is composed of low fused denticles and extends posteriorly beyond the platform termination.

The platform is irregular, especially in juvenile forms, and consists of blunt denticles which diverge from the blade-like carina at between 30° and 45° to the horizontal. The platform margins are crenulate but become less so in adult forms, as the platform denticles become tumid, producing a flatter oral surface.

The basal cavity is narrow and elongate, with thick lips extending along most of the unit. A fine trough runs along the unit, with a pit near the blade-platform junction.

Remarks: The morphology of *P. subserratus* suggests a close relationship to *Spathognathodus*, as noted by Helms (1959). The denticulate carina, the irregular growth of the platform ornament, and the spathognathodid basal cavity are all similar to features found in earliest Carboniferous platform species which have developed from *Spathognathodus*. *Polygnathus* is polyphyletic, as is *Pseudopolygnathus*; the different *Spathognathodus*-*polygnathoid* transitions in the Devonian and Carboniferous may perhaps be traced if the subtle differences in the basal cavity or perhaps in the free blade are studied.

Beinert et al. (1971) suggest that *P. subserratus* should be transferred to *Scaphignathus*; adult specimens closely approach adult specimens of *Scaphignathus veliferus*, although the free blade is usually low in *P. subserratus* and high in *S. veliferus*, a fact noted by Beinert et al. (p. 82). They suggest that *S. veliferus* arose from *P. subserratus*; but the Australian faunas suggest that *P. subserratus* developed separately, later than *Scaphignathus*.

Distribution: The species was originally described from Missouri (Branson & Mehl, 1934). This is the only North American reference. All other occurrences are from Europe, including Austria (Kodsi, 1967), Germany (Helms, 1961; Ziegler, 1962a), Poland (Wolska, 1967), and Portugal (Boogaard, 1963). The specimens compared to *P. subserratus* by Bischoff & Ziegler (1957), although they look very similar to the present forms, are probably homeomorphs, being Middle Devonian in age.

Range: The species was originally described from the Grassy Creek Shale of Missouri, considered by Collinson et al. (1962) as Famennian (toII-basal toIV). Helms (1959) gives the German range as uppermost toIII and toIV. Ziegler (1962a) extends the range from the Middle *Scaphignathus veliferus* Zone (toIII β) as high as the Middle *Polygnathus styriacus* Zone (toV), a range which Wolska (1967) records from Poland. In the Canning Basin the species ranges from the Upper *S. veliferus* Zone (toIII β /toIV boundary) to the Middle *P. styriacus* Zone (toV).

POLYGNATHUS TRIPHYLLATUS (Ziegler, 1960)

(Pl. 81, figs 4a-6c)

- 1960 *Polylophodonta? triphyllata* Ziegler, *Fortschr. Geol. Rheinld West.*, 6, 12, pl. 1, fig. 5; pl. 2, figs 1, 2 (pub. 1962).
1961 *Polygnathus triphyllata* (Ziegler); Helms, *Geologie*, 10, 696, pl. 1, figs 2, 3; pl. 3, figs 12, 15-17.
1965 *Polygnathus nodocostata nodocostata* Branson & Mehl; Bouckaert & Ziegler, *Mém. Expl. Cartes géol. Min. Belg.*, 5, pl. 4, fig. 3 only.
1967 *Polygnathus triphyllata* (Ziegler); Wolska, *Acta palaeont. polon.*, 12, 417, pl. 17, fig. 4.
1969 *Polygnathus triphyllatus* (Ziegler); Olivieri, *Boll. Soc. paleont. ital.*, 8, 130, pl. 23, figs 1a, b.

Material: 8 specimens, CPC 12747-9 figured.

Localities of figured material: Sample BG 19075 (CPC 12747, 12748), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21267 (CPC 12749), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Distribution: *P. triphyllatus* was first described from reworked pebbles in the Triassic of German (Ziegler, 1960). Other records of the species in Europe are

furnished by Bouckaert & Ziegler (1965) from Belgium, Freyer & Zakowa (1967) and Wolska (1967) from Poland, Boyer et al. (1968) from France, Helms (1961) and Bar (1968) from Germany, and Olivieri (1969) from Italy.

Range: The species was first described from *Cheiloceras* Zone (toII) pebbles (Ziegler, 1960); Helms (1961) gives the range as highest toII. Wolska (1967) records the species from the *Palmatolepis quadrantinodosa* Zone (toII β /toIII α) and Freyer & Zakowa (1967) record it from the Lower *P. quadrantinodosa* Zone (toII β) in Poland. In France Boyer et al. (1968) record it from the toII β and lowermost toIII β Zone in France. In the Canning Basin it is confined to the toII β Zones of *Palmatolepis rhomboidea* and Lower *P. quadrantinodosa*.

POLYGNATHUS cf. *P. WEBBI* Stauffer, 1938

(Pl. 82, figs 1a-2c; 5a-c)

cf. 1938 *Polygnathus webbi* Stauffer, *J. Paleont.*, 12, 413, pl. 53, figs 25, 26, 28, 29.

1970 *Polygnathus* sp. cf. *P. webbi* Stauffer; Seddon, *J. geol. Soc. Aust.*, 16, 739, pl. 16, figs 18, 23, 24.

Material: 270 specimens; CPC 12750-2 figured, from samples BG 19533 (CPC 12750), 19534 (CPC 12751), 19546 (CPC 12752), Section 9, McPhee Knoll, Virgin Hills Formation.

Remarks: Seddon (1970a) points out the extreme variability of the Canning Basin forms. He also mentions the *P. webbi*-*P. normalis* transition; it seems that there is also a *P. webbi*-*P. seddoni* transition.

Distribution and Range: *Polygnathus webbi* is an extremely widespread species and very variable. The Canning Basin specimens are from the *Polygnathus asymmetricus* Zone (toI α /toI β).

POLYGNATHUS XYLUS Stauffer, 1938

(Pl. 82, figs 3-4c; 6a-7c)

1940 *Polygnathus xylus* Stauffer, *J. Paleont.*, 14, 430, pl. 60, figs 42, 50, 54, 65-67, 72-74, 78, 79.

1970 *Polygnathus xylus* Stauffer; Seddon, *J. geol. Soc. Aust.*, 12, 740, pl. 12, figs 20, 21; pl. 13, figs 3-5, 11-13.

Material: 740 specimens, CPC 12753-6 figured.

Localities of figured material: Sample BG 19032 (CPC 12753), Section 2, McWhae Ridge, (also BG 19188 (CPC 12754), Sadler Limestone; BG 21242 (CPC 12755, 12756), Section 20, Longs Well Creek, Gogo Formation.

Remarks: Seddon (1970a, p. 738) has discussed in detail the similarities and differences between *P. decorosus* and *P. xylus*, and under *P. decorosus* I have discussed some of the relationships in the present fauna. Some of the forms appear to be transitional to *P. brevilaminus*.

Distribution and Range: It is difficult to determine the geographical distribution of *P. xylus* because of the taxonomic complexity of the *P. decorosus*-*P. xylus* group. The range appears to be at least Middle Devonian to Frasnian. The Canning Basin specimens range from the Lower *Polygnathus asymmetricus* Zone (toI α) as high as the Upper *Palmatolepis gigas* Zone (toI δ).

POLYGNATHUS ZNEPOLENSIS Spasov, 1965

(Pl. 85, figs 1a-3c)

1965 *Polygnathus znepolensis* Spasov, *Trav. géol. Bulg. Sér. paléont.*, 7, 96, pl. 3, figs 1, 2.

1966 *Polygnathus* cf. *P. obliquicostata* Ziegler; Glenister & Klapper, *J. Paleont.*, 40, 830.

1969 *Polygnathus znepolensis* Spasov; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 106, pl. 26, figs 1a-3c.

Material: 44 specimens; CPC 12757-9 figured, from samples BG 19168 (CPC 12757), 19170 (CPC 12758), 19172 (CPC 12759), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: The present specimens are identical with those from the Bonaparte Gulf and I have concluded that the specimens mentioned as *P. cf. P. obliquicostatus* by Glenister & Klapper (1966, p. 830) also belong in *P. znepolensis*.

Distribution and Range: The species was originally described from late Famennian (toV-toVI) strata in Bulgaria (Spasov, 1965). The only other record is from the Bonaparte Gulf Basin in strata presumed to be toV because of the occurrence of *P. znepolensis* and *P. collinsoni* Druce (Druce, 1969). The present specimens range in age from the Upper *Palmatolepis quadrantinodosa* Zone (toIIIa) to the Lower *Polygnathus styriacus* Zone (basal toV).

POLYGNATHUS sp. A Druce, 1969

(Pl. 96, fig. 2a-c)

1969 *Polygnathus* sp. A, Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 107, pl. 21, fig. 3.

Material: Single specimen, CPC 13843, figured, from Sample BG 21574, McWhae Ridge, Virgin Hills Formation.

Remarks: The single specimen recorded agrees closely with the Bonaparte Gulf Basin material. It has deep adcarinal grooves in the anterior part, strong lateral curvature, and strong depression of the platform posterior to the basal cavity. The gyrate ornament on the platform is also distinctive. The specimen illustrated is close to *Ancyrognathus irregularis* Branson & Mehl but lacks the lateral process.

Occurrence and Range: The species was previously recorded from Sample 12/2B, about 65 m above the base of the type section of the Westwood Member of the Cockatoo Formation in the Bonaparte Gulf Basin. The Canning Basin specimen comes from the *Palmatolepis gigas* Zone (Frasnian toI₇/δ).

POLYGNATHUS sp. nov. A

(Pl. 83, fig. 4a, b)

Remarks: A single specimen, CPC 12760, appears to belong to a new species belonging to the *P. germanus* group. The platform is rectangular and is ornamented by a low nodose carina and low isolated nodes arranged in longitudinal lines, the nodes tending to alternate with the nodes in the adjacent row. The free blade is missing. The specimen is from the Lower *Polygnathus styriacus* Zone (toIV), Sample BG 19170, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

POLYGNATHUS sp. nov. B

(Pl. 84, figs 5a-c)

Remarks: A single specimen, CPC 12761, is similar to *Palmatolepis transitans* but lacks an azygous node, and the platform is much slimmer. The platform is asymmetrical, with an upturned nodose margin. The remainder of the platform is ornamented by small, low isolated nodes. The free blade is massive; it merges with the carina, which is also massive, with large, high nodes. The specimen comes from the Upper *Polygnathus asymmetricus* Zone (to I β), Sample BG 19009, (Section 1, McWhae Ridge, Virgin Hills Formation).

POLYGNATHUS sp. nov. C

(Pl. 83, fig. 5a-c)

Remarks: A single specimen, CPC 12762, consists of a tall blade and a lanceolate platform. The platform bears irregular nodose ornament but no recognizable carina. The platform margin is slightly upturned and consists of a series of very fine nodes, giving it a serrated appearance. The specimen is from the *Polygnathus asymmetricus* Zone, Sample BG 21200, Section 19, Kudata Gap, Sadler Limestone.

Genus POLYLOPHODONTA Branson & Mehl, 1934

Type species: *Polygnathus gyratilineatus* Ulrich & Bassler, 1926.

POLYLOPHODONTA CONFLUENS (Ulrich & Bassler, 1926)

(Pl. 88, fig. 1a, b)

- 1926 *Polygnathus confluens* Ulrich & Bassler, *Proc. U.S. nat. Mus.*, 68, 46, pl. 7, figs 14, 15.
1966 *Polylophodonta confluens* (Ulrich & Bassler); Glenister & Klapper, *J. Paleont.*, 40, 831, pl. 94, figs 10, 11. (Synonymy to 1964)
1967 *Polylophodonta confluens* (Ulrich & Bassler); Nehring, *Inst. Geol. Bull.* 209, 153, pl. 3, fig. 9; pl. 5, fig. 2.
1967 *Polylophodonta confluens* (Ulrich & Bassler); Wolska, *Acta palaeont. polon.*, 12, 418, pl. 17, fig. 7.
1968 *Polylophodonta confluens* (Ulrich & Bassler); Huddle, *U.S. geol. Surv. pro. Pap.* 578, 9842, pl. 17, figs 1, 2, 8, 9, 11.
1969 *Polylophodonta confluens* (Ulrich & Bassler); Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 109, pl. 34, figs 3a, b.

Material: 2 specimens; CPC 12784 figured, from sample BG 21014, Section 14, 3 km northwest of Pinnacle Spring, Virgin Hills Formation.

Distribution: The species was originally described from Tennessee (Ulrich & Bassler, 1926), where it was also found by Hass (1956). Elsewhere in North America it is known from Missouri (Branson & Mehl, 1934), New York (Oliver et al., 1967), and Texas (Hass, 1959). In Europe the species has been recorded from Germany (Helms, 1961; Ziegler, 1962a; Bar, 1968; Schneider, 1969) and Poland (Nehring, 1967; Wolska, 1967).

Range: The age of the 'Hardin sandstone' of Tennessee is problematical because the conodont fauna is probably reworked (Huddle, 1968). The only reported

range in North America is by Oliver et al. (1967, fig. 17), who show it restricted to the upper part of the toII β Zone.

In Europe Helms (1961) reports *P. confluens* from the lower toIII Zone. Ziegler (1962a) records the range as confined to the toII β Zone. Wolska gives the range as *P. quadrantinodosa* Zone (upper toII β), whereas Nehring records it from the toIIIa/toIII β Zone in Poland. The Canning Basin specimens range from the *Palmatolepis rhomboidea* Zone to the *P. quadrantinodosa* Zone (toII β).

POLYLOPHODONTA ELONGATA Druce, 1969

(Pl. 88, figs 2a-3, 5a-c)

1969 *Polylophodonta elongata* Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 110, pl. 34, figs 1a-2c; text-fig. 23.

Material: 10 specimens, CPC 12785-7 figured.

Localities of figured material: Sample BG 19019 (CPC 12785), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19111 (CPC 12786), Section 4, northeast of McWhae Ridge, Bugle Gap Formation; BG 21361 (CPC 12787), Section 23, Geikie Gorge, Napier Formation.

Remarks: The specimens are identical with those from the Bonaparte Gulf Basin (Druce, 1969).

Distribution and Range: *P. elongata* is only known from Australia. The Bonaparte Gulf Basin specimens are probably of toII β age; they occur with *P. confluens*. The Canning Basin specimens come from the Lower and Upper *Palmatolepis quadrantinodosa* Zone (upper toII β).

Genus PRIONIODINA Bassler, 1925

Type species: *Prioniodina subcurvata* Ulrich & Bassler, 1926.

PRIONIODINA? SMITHI (Stauffer, 1935)

(Pl. 87, figs 4a-6b)

1938 *Prioniodus smithi* Stauffer, *J. Paleont.*, 12, 441, pl. 50, fig. 26.

1969 *Prioniodina? smithi* Stauffer; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 112, pl. 34, fig. 7; pl. 38, figs 7a, b. (Synonymy).

Material: 52 specimens, CPC 12788-90 figured.

Localities of figured material: Sample BG 19023 (CPC 12788), Section 1, McWhae Ridge, Virgin Hills Formation; BG 19092 (CPC 12789), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21265 (CPC 12790), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Distribution: *P.? smithi* is a very common form in the Famennian and appears to be usually associated with *Palmatodella delicatula*.

Range: Helms (1961) gives the range as Frasnian (toI δ) to Famennian (toIV). Wolska (1967) gives the range as *Palmatolepis triangularis* Zone to *Spathognathodus costatus* Zone (toI δ -toVI).

Genus PSEUDOPOLYGNATHUS Branson & Mehl, 1934

Type species: *Pseudopolygnathus primus* Branson & Mehl, 1934.

PSEUDOPOLYGNATHUS sp. nov. A

(Pl. 22, fig. 11)

Material: 3 specimens; CPC 12791-2 figured, from sample BG 19007, Section 1, McWhae Ridge, Gogo Formation.

Description: The unit consists of a free blade and an asymmetrical platform. The free blade is low, consisting of about 6 denticles which are fused but have very short free tips. The free blade merges with the carina, which is very high and is composed of denticles similar to those of the free blade; they become shorter, stubbier, and better separated posteriorly. The carina does not reach to the posterior termination.

The platform is asymmetrical and is smooth, ornamented by occasional isolated low nodes. In aboral view the basal cavity mirrors the shape of the platform. It is shallow and greatly extended, especially on one side.

Remarks: This appears to be one of the earliest pseudopolygnathids, occurring in the *Polygnathus asymmetricus* Zone.

Genus SCAPHIGNATHUS Helms, 1959

Type species: *Scaphignathus veliferus* Helms, 1959.

SCAPHIGNATHUS VELIFERUS Helms, 1959

(Pl. 86, figs 1a-2c, 4a, b)

- 1959 *Scaphignathus velifera* Helms, *Geologie*, 8, 655, pl. 2, fig. 19; pl. 5, figs 20, 28 (ex Ziegler MS).
- 1961 *Scaphignathus velifera* Ziegler; Freyer, *Freib. Forsch. C95*, 83, pl. 5, fig. 132.
- 1962 *Scaphignathus velifera* Ziegler; Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 102, pl. 11, figs 19-24.
- 1962 *Scaphignathus velifera* Ziegler, *Fortschr. Geol. Rheinld Westf.*, 6, 403, pl. 3, figs 1-6 [preprint 1960].
- non 1965 *Scaphignathus velifera* Helms; Bouckaert & Ziegler, *Mém. Expl. Cartes géol. Min. Belg.*, 5, 27, pl. 5, figs 5-7 [= transitional forms from *Spathognathodus* to *Scaphignathus ziegleri*].
- 1966 *Scaphignathus velifera* Helms; Glenister & Klapper, *J. Paleont.*, 40, 834, pl. 94, figs 1, 2 [non fig. 4 = *S. ziegleri*].
- non 1967 *Scaphignathus velifera* Ziegler; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 232, pl. 23, fig. 1 [= *S. ziegleri*].
- 1967 *Scaphignathus velifera* Ziegler; Freyer & Zakowa, *Acta geol. polon.*, 17, 111, pl. 2, fig. 9.
- non 1967 *Scaphignathus velifera* Ziegler; Boogaert, *Leidse geol. Med.*, 39, 185, pl. 3, fig. 12 [= *S. ziegleri*].
- 1967 *Scaphignathus velifera* Helms; Wolska, *Acta palaeont. polon.*, 12, 423, pl. 16, fig. 4.5.
- 1969 *Scaphignathus velifera* Ziegler; Schönlaub, *Jb. geol. Bundesanst.*, 112, 307, pl. 2, figs 15, 217.
- 1969 *Scaphignathus veliferus* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 138, pl. 23, figs 6a-7.

Material: 24 specimens, CPC 12774-6 figured.

Localities of figured material: Samples BG 19161 (CPC 12774), 19164 (CPC 12775), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 21365 (CPC 12776), Section 23, Geikie Gorge, Napier Formation.

Remarks: I erected a new species, *S. ziegleri*, to include specimens of *Scaphignathus* lacking a medial carina or possessing a carina restricted to the posterior end (Druce, 1969). Some of the specimens figured by other authors are clearly distinguishable as *S. ziegleri* and have been included under that species. Beinert et al. (1971) consider *S. ziegleri* to be a junior synonym of *S. veliferus*, but its earlier occurrence and development from *Spathognathodus* set it apart.

Distribution: The species was originally described from Germany (Helms, 1959), since when it has been extensively reported (Freyer, 1961; Zimmermann, 1960; Ziegler, 1962b, c; Schriel & Stoppel, 1965; Freyer, 1968; Dvorak & Freyer, 1968; Bar, 1968; Schneider, 1969; Meischner & Schneider, 1969). Elsewhere in Europe it occurs in Austria (Schönlaub, 1969a), France (Boyer et al., 1968), Italy (Manzoni, 1965, 1968; Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Wolska, 1967), and Portugal (Boogaard, 1963). The only records of the species outside Europe are from Wyoming (Klapper, 1966) and the Canning Basin (Glenister & Klapper, 1966).

Range: The species was originally described from the highest toIII and ?toIV Zones in Germany (Helms, 1959). Ziegler (1962b) gives the range as *Scaphignathus veliferus* Zone (toIIIa) into the lowest *Polygnathus styriacus* Zone (toIV). This range is also recorded from Poland (Wolska, 1967). The Canning Basin specimens range from the Lower *S. veliferus* (upper toIIIa) Zone into the Lower *P. styriacus* Zone (toIV).

SCAPHIGNATHUS ZIEGLERI Druce, 1969

(Pl. 71, fig. 7; Pl. 86, figs 3a-c, 5a, b)

- 1966 *Scaphignathus velifera* Helms; Glenister & Klapper (part), *J. Paleont.*, 40, pl. 94, fig. 4 only [figs 1, 2 = *S. veliferus*].
1967 *Scaphignathus velifera* Ziegler; Wirth, *N. Jb. Geol. Paläont. Abh.*, 127, 232, pl. 23, fig. 1.
1967 *Scaphignathus velifera* Ziegler; Boogaert, *Leidse geol. Med.*, 39, 185, pl. 3, fig. 12.
1969 *Scaphignathus ziegleri* Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 117, pl. 38, figs 4a-6; text-fig. 25.

Material: 42 specimens, CPC 12777-9 figured.

Localities of figured material: Sample BG 19105 (CPC 12777), 19111 (CPC 12778), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; BG 21061 (CPC 12779), Section 14, 3 km northwest of Pinnacle Spring, Bugle Gap Limestone.

Remarks: One specimen (Pl. 71, fig. 7), is very close to *Spathognathodus*, but differs in having two rows of nodes with no median groove. Specimens illustrated by Bouckaert & Ziegler (1965, pl. 5, figs 5-7) as *S. veliferus* are very similar but are more massive, and the platform is wider but still lacks a median carina or trough. It is probable that *Scaphignathus* developed from *Spathognathodus* by the addition of a row of lateral nodes virtually fused to the bar denticles. This pseudo-platform widened to give forms illustrated by Bouckaert & Ziegler which should be

a new species. The transverse ridges then broke down to give a double row of lateral nodes with a medial trough (*S. zieglerei*), and finally a medial row of nodes was added (*S. veliferus*).

Distribution: *S. zieglerei* was originally described from the Bonaparte Gulf Basin, Australia (Druce, 1969), and has been reported previously from the Canning Basin (Glenister & Klapper, 1966). The only other illustrations of the species are both from Spain (Boogaert, 1967; Wirth, 1967).

Range: The species was originally described from the early Famennian part of the Ningbing Limestone (toII β -toIII α) (Druce, 1969). In the Canning Basin the species ranges from the Lower *Palmatolepis quadrantinodosa* Zone as high as the Lower *Polygnathus styriacus* Zone (toII β -toIV).

Genus SCUTULA Sannemann, 1955

Type species: *Scutula venusta* Sannemann, 1955.

SCUTULA BIPENNATA Sannemann, 1955

(Pl. 87, fig. 1a, b)

- 1955 *Scutula bipennata* Sannemann, *Senck. Leth.*, 36, 154, pl. 4, figs 5, 8, 9.
1967 *Scutula bipennata* Sannemann; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 79, fig. 17, 18.
1967 *Scutula bipennata* Sannemann; Wolska, *Acta paleont. polon.*, 12, 423, pl. 5, figs 11, 12.
1969 *Scutula bipennata* Sannemann; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 118, pl. 38, figs 8a, b. (Synonymy to 1966)
1969 *Scutula bipennata* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 139, pl. 10, figs 6a, b; pl. 24, figs 8-9b.

Material: 24 specimens; CPC 12780 figured, from sample BG 19453, Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

Distribution: The species was originally described from Germany (Sannemann, 1955b) and has been subsequently reported by Bischoff (1956), Ziegler (1958), Helms (1959), Freyer (1961), and Zitzmann (1966). It has also been reported from the following European countries: Austria (Schönlaub, 1969a), Bulgaria (Spasov, 1965), France (Lys & Serre, 1957; Lys et al., 1961; Boyer et al., 1968), Italy (Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1966, 1967), Poland (Wolska, 1967), and Spain (Boogaard, 1965). The only other reports of the species are from the Mississippi Valley (Scott & Collinson, 1961) and Australia (Glenister & Klapper, 1966; Druce, 1969).

Range: Freyer (1961) gives the range of *S. bipennata* as Frasnian (toI δ) up to Famennian (toVI). Wolska (1967) gives the range as *Palmatolepis triangularis* Zone (toI δ) to *Spathognathodus costatus* Zone (toVI). The Canning Basin specimens range from the *Palmatolepis rhomboidea* (lowest toII β) Zone to the Middle *Scaphignathus veliferus* Zone (toIII β).

SCUTULA SINEPENNATA Ziegler, 1958

(Pl. 87, fig. 2a, b)

- 1958 *Scutula sinepennata* Ziegler, *Hess. Landesamt Bodenf., Notizbl.*, 87, 71, pl. 12, figs 29, 25.
1959 *Scutula ? thuringia* Helms, *Geologie*, 8, 656, pl. 5, figs 16a, b; text-fig. 3.

- ?1964 *Scutula* cf. *venusta* Sannemann; Budurov & Tschunев, *Bull. Inst. Sci. Rech. Géol.*, 1, 259, pl. 5, figs 3, 4.
 1967 *Scutula sinepennata* Ziegler; Clark & Ethington, *Geol. Soc. Am. Mem.* 103, 66, pl. 6, fig. 16.
 1968 *Scutula sinepennata* Ziegler; Lange, *Geol. Palaeont.*, 2, 40, pl. 2, fig. Sc.
 1970 *Scutula sinepennata* Ziegler; Seddon, *J. geol. Soc. Aust.*, 16, 752, pl. 14, fig. 6.

Material: 3 specimens; CPC 12782 figured, from sample BG 19106, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Description: Unit arched and flexed. Both bars are of equal length; they are greatly flexed near the apex; the flexure decreases to give a pinched-in apical area. There is no typical apical denticle. The dentition in this area is fine and inclined inward, the inclination being greatest at the point of maximum bar flexure. There is no apparent basal cavity, but a minute break in the aboral margin may represent the cavity.

Remarks: As was pointed out by Clark & Ethington (1967, p. 67) this species is atypical of *Scutula*, having no additional bars. In many respects it resembles *Apatognathus*, but lacks a significant apical denticle. Lange (1968) records *S. sinepennata* in a conodont group (?natural assemblage) which he considers to be a coprolitic association. In the same group are two *Palmatolepis triangularis*, which ranges from toI δ to toII α (Ziegler, 1962a).

Distribution: The species was originally described from the middle *Manticoceras*-Stufe in Germany (Ziegler, 1958) and also from the Saalfelder Upper Devonian under the name *S. ? thuringia* Helms (1959, p. 656). *Scutula* cf. *venusta* of Budurov & Tschunев (1964) resembles *S. sinepennata* from the illustration, but its presence in strata of cuII (Early Carboniferous) age is anomalous. Clark & Ethington (1967) have recorded the species from Utah, and Seddon illustrates specimens from the Canning Basin, Australia. The species has also been reported from Italy (Manzoni, 1965), Poland (Wolska, 1967), and Portugal (Boogaard, 1963).

Range: The species was originally described from the middle *Manticoceras*-Stufe (toI (β) γ) (Ziegler, 1958). *Scutula ? thuringia* has a range of toIII-toIV (Helms, 1959). In North America it has been recovered from strata correlated with upper toI γ . Seddon (1970a) also records it in strata of toI γ age. The Canning Basin specimens are from the Middle *Palmatolepis crepida* Zone (toII α) to the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

SCUTULA VENUSTA Sannemann, 1955

(Pl. 87, fig. 3)

- 1955 *Scutula venusta* Sannemann, *Senck. Leth.*, 36, 155, pl. 4, figs 6, 7.
 1967 *Scutula venusta* Sannemann; Wolska, *Acta palaeont. polon.*, 12, 424, pl. 5, fig. 13.
 1969 *Scutula venusta* Sannemann; Olivieri, *Boll. Soc. paleont. ital.*, 8, 140, pl. 10, figs 8, 9; pl. 24, fig. 10. (Synonymy)

Material: 8 specimens; CPC 12783 figured, from sample BG 19014, Section 1, McWhae Ridge, Virgin Hills Formation.

Distribution: The species was originally described from Germany (Sannemann, 1955b) and has subsequently been reported by Ziegler (1958), Helms (1959), Zimmermann (1960), and Freyer (1961). It has also been reported from Austria

(Schulze, 1968; Schönlaub, 1969a, Bulgaria (Budurov & Tschunev, 1964), France (Serre & Lys, 1958), Italy (Manzoni, 1965; Olivieri, 1969), Poland (Freyer & Zakowa, 1967; Nehring, 1967; Wolska, 1967), and Portugal (Boogaard, 1963). The only other records of the species are from Utah (Clark & Ethington, 1965) and the Canning Basin (Glenister & Klapper, 1966).

Range: Freyer (1961) gives the range as Frasnian (toI δ) to Famennian (toVI). Wolska, 1967) gives the range as *Palmatolepis crepida* Zone (toII α) to *Scaphignathus veliferus* Zone (toIV). The Canning Basin specimens range from the Middle *Palmatolepis triangularis* Zone (toI δ) up to the Lower *Palmatolepis quadrantinodosa* Zone (toII β).

SCUTULA sp. A

Material and Locality: 2 specimens from sample BG 19016, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: Two specimens appear to be intermediate between *Apatognathus* and *Scutula*. The unit is arched, with deep bars and an inclined apical denticle. The bars are short and bear short needle-like denticles. The specimens are from the uppermost *Palmatolepis gigas* Zone.

SCUTULA sp. B

Material and Locality: 3 specimens from sample BG 19019, Section 1, northeast of McWhae Ridge, Virgin Hills Formation.

Remarks: This form is very similar to *Scutula* sp. A, but instead of a definite apical denticle there is a crest of denticles situated asymmetrically on the unit. The specimens range from the *Palmatolepis triangularis* Zone (toI β) to the Upper *Palmatolepis crepida* Zone (toII α).

Genus SPATHOGNATHODUS Branson & Mehl, 1941

Type species: *Spathodus primus* Branson & Mehl, 1933.

SPATHOGNATHODUS BOHLENANUS Helms, 1959

(Pl. 88, fig. 7a, b)

- 1959 *Spathognathodus bohlenanus* Helms, *Geologie*, 8, 658, pl. 6, figs 5-8.
1962 *Spathognathodus bohlenanus* Helms; Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 106, pl. 12, figs 25, 26, 29-35.
1967 *Spathognathodus bohlenanus* Helms; Spasov & Filipovic, *Bull. geol. Inst. Sér. paléont.*, 16, 80, pl. 5, fig. 7, 13; pl. 7, fig. 6.
1967 *Spathognathodus bohlenanus* Helms, Wolska, *Acta Palaeont. polon.*, 12, 426, pl. 18, figs 4-6.
?1968 *Spathognathodus bohlenanus* Helms; Manzoni, *G. Geol.*, 34, 674, pl. 62, fig. 14.
1969 *Spathognathodus bohlenanus* Helms; Olivieri, *Boll. Soc. paleont. ital.*, 8, 143, pl. 12, figs 2a, b; pl. 26, figs 2a-c.

Material: Single specimen, CPC 12793, sample BG 19170, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: The specimen is elongate and shallow, with tall needle-like denticles tallest near the cavity. The basal cavity is conical.

Distribution: The species was originally described from Thuringia, Germany (Helms, 1959). Ziegler (1962a) has also reported it from Germany, as have Bar (1968), Schneider (1969), and Meischner & Schneider, (1970). It has also been reported from Austria (Schulze, 1968; Schönlaub, 1969a), Italy (Manzoni, 1968; Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967), Poland (Wolska, 1967), and Portugal (Boogaard, 1963). This is the first report of the species outside Europe.

Range: Helms (1959) records the species from the toIV/V boundary. Ziegler (1962a) records it from the Middle *Scaphignathus veliferus* Zone (toIII β) to the Upper *Polygnathus styriacus* Zone (toV). Wolska (1967) extends the range down to the *Palmatolepis quadrantinodosa* Zone (toIII α). The Canning Basin specimen is from the Lower *P. styriacus* Zone (toIV).

SPATHOGNATHODUS cf. *S. BREVIS* Bischoff & Ziegler, 1957
(Pl. 88, fig. 6)

cf. 1957 *Spathognathodus brevis* Bischoff & Ziegler, *Hess. Landesamt Bodenf. Abh.*, 22, 116, pl. 19, figs 24, 27-29.

Material: Single specimen, CPC 12794, sample BG 19020, Section 1, McWhae Ridge, Virgin Hills Formation.

Remarks: The specimen consists of a long anterior bar composed of 7 laterally compressed fused denticles with free, posteriorly inclined free tips. There is another denticle over the basal cavity which is more posteriorly inclined than the bar denticles. Anterior to it is a single low denticle. The cavity is asymmetrical and is greatly flared on one side. The short anterior process sets it apart from *S. brevis* (which is probably a pelekysgnathid). It is also similar to some specimens of *Palmatolepis subgracilis* Bischoff. The specimen comes from the Upper *Palmatolepis crepida* Zone.

SPATHOGNATHODUS FITZROYI sp. nov.
(Pl. 88, fig. 8a-c; Pl. 94, fig. 2a, b; text-fig. 26)

Derivation of name: From the Fitzroy River, Western Australia.

Material: 6 specimens, CPC 12795 holotype, CPC 12796 paratype.

Localities of figured material: Holotype, sample BG 19130, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone; paratype, sample 21270 (CPC 12796), Section 21, Margaret River-Needle Eye Rocks, Virgin Hills Formation.

Diagnosis: A flexed spathognathodid characterized by massive denticles on the posterior half.

Description: A spathognathodid with massive denticles. Anterior to the basal cavity there are 5 or 6 denticles which are most massive in the mid-region. The denticles are fused and some are compacted and do not erupt at the surface. Those that do have tall, triangular free tips. The unit is flexed through about 30° and the posterior part bears about 4 denticles, 2 of which, in the mid-region, are massive.

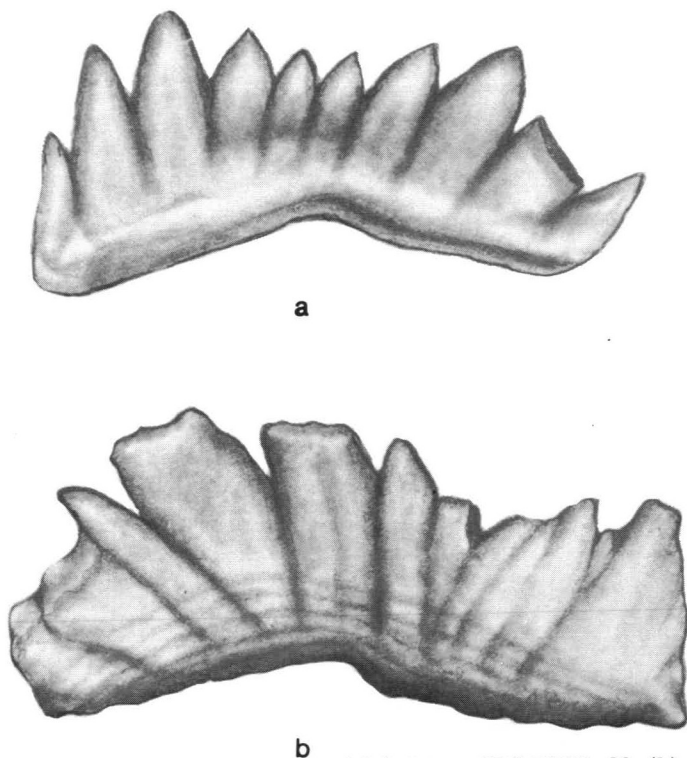


Fig. 26. *Spathognathodus fitzroyi* sp. nov., (a) holotype CPC 12795 x89, (b) paratype CPC 12796 x58.

Aborally, the unit is knife-edged. The basal cavity is situated at the point of flexure and is a narrow slit, widest at the anterior, with narrow but rounded lips.

Remarks: No described species of *Spathognathodus* is similar to this form.

Range: The species ranges from the Lower *Palmatolepis quadrantinodosa* Zone (toII β) to the Lower *Scaphignathus veliferus* Zone (toIII α).

SPATHOGNATHODUS cf. *S. ROBUSTUS* (Branson & Mehl, 1934)
(Pl. 89, fig. 6a, b)

cf. 1934 *Spathodus robustus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 189, pl. 17, fig. 21.

Material: 2 specimens; CPC 12797 figured, from sample BG 19167, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: The specimens appear to be close to *S. robustus*, but they lack the thick aboral edge mentioned by Branson & Mehl (1934, p. 189).

Rhodes et al. (1969) and Druce (1969) have described specimens from the Lower Carboniferous compared by them to *S. robustus*. The original types came from the late Famennian Grassy Creek Shale of Missouri and thus there appear to be two homeomorphic developments of *S. robustus*. The present specimens are

from the Lower *Polygnathus styriacus* Zone (toIV) and thus are probably referable to *S. robustus* s.s.

SPATHOGNATHODUS STABILIS (Branson & Mehl, 1934)

(Pl. 89, figs 3a, b, 5a, b, 7a, b, 10a, b)

- 1934 *Spathodus stabilis* Branson & Mehl, *Univ. Mo. Stud.*, 8, 188, pl. 17, fig. 20.
1956 *Spathognathodus stabilis* (Branson & Mehl); Bischoff & Ziegler, *Hess. Landesamt Bodenf., Notizb.*, 84, 167, pl. 13, fig. 11.
1959 *Spathognathodus stabilis* (Branson & Mehl); Helms, *Geologie*, 8, 658, pl. 3, fig. 5; pl. 5, fig. 1; pl. 6, figs 12, 13.
1961 *Spathognathodus stabilis* (Branson & Mehl); Freyer, *Freib. Forsch.*, C95, 88, text-fig. 148.
1962 *Spathognathodus stabilis* (Branson & Mehl); Ziegler, *Hess. Landesamt Bodenf. Abh.*, 38, 112, pl. 13, figs 1-10.
1966 *Spathognathodus stabilis* (Branson & Mehl); Klapper, *Univ. Kansas paleont. Inst. Pap.* 3, 23, pl. 5, fig. 7 [non fig. 6].
1967 *Spathognathodus stabilis* (Branson & Mehl); Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 81, pl. 5, figs 8, 11, 16, 17.
1967 *Spathognathodus stabilis* (Branson & Mehl); Wolska, *Acta paleont. polon.*, 12, 428, pl. 19, figs 1-3.
?1968 *Spathognathodus stabilis* (Branson & Mehl); Mound, *J. Paleont.*, 42, 514, pl. 70, figs 19, 23.
1969 *Spathognathodus stabilis* (Branson & Mehl); Olivieri, *Boll. Soc. paleont. ital.*, 8, 145, pl. 12, figs 3a-c; pl. 26, figs 3-6b.

Material: Six specimens; CPC 12798-801 figured, from samples BG 19454A (CPC 12801), BG 19092 (CPC 12798), BG 19107 (CPC 12709, 12800), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Remarks: The figured specimens are very similar to illustrated specimens of *S. stabilis* except that the cavity is not greatly flared in the smaller specimens. The species appears to arise from the same stock as *S. strigosus*.

Occurrence: The species was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Elsewhere in North America it has been recorded from Wyoming (Klapper, 1966) and Alberta (Mound, 1968). In Europe the species has been reported from Germany (Bischoff & Ziegler, 1956; Helms, 1959; Freyer, 1961, 1968; Ziegler, 1962a; Henningsen, 1965), Austria (Schönlaub, 1969a), France (Boyer et al., 1968), Italy (Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1967, Poland (Wolska, 1967), and Portugal (Boogaard, 1963).

Range: The age of the Grassy Creek Shale is late Famennian (Collinson et al., 1962). Bischoff & Ziegler (1956) give the European range as toIII to Lower Carboniferous. Ziegler (1962a) gives the range as Middle *Scaphignathus veliferus* Zone (toIII β) as high as the Upper *Spathognathodus costatus* Zone (toVI). Wolska (1967) extends the range down to the *Palmatolepis quadrantinodosa* Zone (toII β). The Canning Basin specimens range from the Middle *Palmatolepis triangularis* Zone (basal Famennian) (an even earlier first occurrence) as high as the basal part of the Upper *P. quadrantinodosa* Zone.

SPATHOGNATHODUS STRIGOSUS (Branson & Mehl, 1934)

(Pl. 89, figs 4a, b, 8a-9b, 11a, b)

- 1934 *Spathodus strigosus* Branson & Mehl, *Univ. Mo. Stud.*, 8, 187, pl. 17, fig. 17.
1956 *Spathognathodus strigosus* (Branson & Mehl); Bischoff & Ziegler, *Hess. Landesamt Bodenf. Notizbl.*, 84, 167, pl. 13, fig. 15.
1961 *Spathognathodus strigosus* (Branson & Mehl); Freyer, *Freib. Forsch.*, C95, 88, text-fig. 14.9.
1962 *Spathognathodus strigosus* (Branson & Mehl); Ziegler, *Hess. Landesamt Bodenf., Abh.*, 38, 111, pl. 12, figs 21-23.
1967 *Spathognathodus strigosus* (Branson & Mehl); Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 81, pl. 5, figs 14, 15; pl. 7, figs 7, 8.
1967 *Spathognathodus strigosus* (Branson & Mehl); Wolska, *Acta palaeont. polon.*, 12, 428, pl. 18 figs 9-15.

Material: 50 specimens; CPC 12802-8 figured, from samples BG 19087 (CPC 12802), 19089 (CPC 12805), 19133 (CPC 12804), 19147 (CPC 12805), 19160 (CPC 12806), 19173 (CPC 12807), 19174 (CPC 12808), Section 4, northeast of McWhae Ridge, Virgin Hills Formation and Bugle Gap Limestone.

Remarks: In the Canning Basin *S. strigosus* is represented in most faunas by a single specimen, but it ranges over enough time to show some evolutionary development. In the earliest part of the Lower *Palmatolepis quadrantinodosa* Zone the specimens are small and the anterior denticles are of the same order of height as the remainder. The denticles tend to be needle-like and the cavity is in the posterior half. The cavity tends to move to a more medial position and the 'step' in the aboral margin tends to flatten out. The anterior denticles tend to become about twice as massive as the bar denticles and to form a blade, and the denticles themselves are laterally compressed and fused with free tips. The specimens in the Lower *Polygnathus styriacus* Zone exhibit all these characters. The two end members of the sequence are easily distinguished, but in the middle part of the range the characters are all intermediate.

Another feature is that the earliest specimens tend to be small, whereas the later specimens are more massive.

S. strigosus appears to have developed from an *S. stabilis* type form which may be ancestral to both *S. strigosus* and *S. stabilis*. *S. strigosus* appears to be ancestral to most of the Carboniferous spathognathids.

Distribution: *S. strigosus* was originally described from the Grassy Creek Shale of Missouri (Branson & Mehl, 1934). The only other North American report of the species is by Thomas (1949) from Iowa. However, Mound (1968) places *S. strigosus* in synonymy with *S. gradatus* (Youngquist), and this appears to be substantially correct, particularly for the early forms. This extends the occurrence in North America to Alberta (Mound) and a second occurrence in Iowa (Youngquist, 1945), and possibly Minnesota (Stauffer, 1940) if *S. gratiosus* (Stauffer) is placed in synonymy.

In Europe the species is known from Germany (Bischoff & Ziegler, 1956; Freyer, 1961, 1968; Ziegler, 1962a; Henningsen, 1965; Bar, 1968). It has also been recorded from Austria (Schönlaub, 1969a), Yugoslavia (Spasov & Filipovic, 1967), and Poland (Wolska, 1967).

Range: The species was originally described from the late Famennian Grassy Creek Shale of Missouri (Branson & Mehl, 1934). Ziegler (1962a) gives a range of Lower *Palmatolepis quadrantinodosa* Zone to Upper *Spathognathodus costatus*

Zone. However, if *S. gradatus* is a senior synonym, then the range is extended into the Frasnian, the fauna including *Ancyrodella* and *Ancyrognathus triangularis*. The Canning Basin specimens range from Lower *P. quadratinodosa* Zone (to II β) up to the Lower *Polygnathus styriacus* Zone (to IV), but ancestral forms are present in the Middle *Palmatolepis triangularis* Zone.

SPATHOGNATHODUS sp. nov. A

(Pl. 90, fig. 4a, b)

Material: 2 specimens; CPC 12809 figured, from sample BG 19007, Section 1, McWhae Ridge, Gogo Formation.

Remarks: A small spathognathodid somewhat similar to *S. stabilis* in having a flaring posterior cavity. However, the dentition is characteristic; the blade is formed by denticles of equal height, fused, with very short free tips. In the posterior the bar is depressed and the denticles become lower and isolated.

This species appears to develop into *Pseudopolygnathus* sp. nov. A, which occurs in the same sample. This is probably the earliest development of *Pseudopolygnathus* from *Spathognathodus*. The specimens come from the Middle *Polygnathus asymmetricus* Zone.

SPATHOGNATHODUS sp. nov. B

(Pl. 90, fig. 5a, b)

Remarks: A single specimen, CPC 12810, from sample BG 19129, Section 4, northeast of McWhae Ridge, is unusual. It is extremely short and tall. It is composed of 13 denticles which are tallest and most massive in the mid-part of the anterior half. They decrease rapidly in height both anteriorly and posteriorly. The cavity is elongate and is confined to the posterior half. The specimen resembles a foreshortened *S. stabilis*, and comes from the Lower *Scaphignathus veliferus* Zone (to IIIa).

SPATHOGNATHODUS sp. nov. C

(Pl. 90, fig. 6a-c; Pl. 91, fig. 1a-c)

Remarks: Two specimens, CPC 12811, 12812, are characterized by their tall free blade and the development of lateral dentition. Although both specimens display these characters, they differ in detail. In one specimen (Pl. 91, fig. 1a, b) the blade is highest at its midpoint, whereas in the other it is highest at the posterior end (Pl. 90, fig. 6c). The first specimen also possesses a fairly deep bar with laterally compressed denticles with free chevron tips; the second has a lower bar with isolated denticle tips. In both specimens the denticles erupt from the slightly tumid bar.

The basal cavity is narrow and elongate, situated at the midpoint at the point of flexure of the aboral margin.

Laterally nodose spathognathodids are known from the late Famennian (*S. aculeatus*), but *aculeatus* is characterized by a flaring basal cavity and peg-like lateral denticles connected by a low ridge to the main bar.

The specimens are from the Middle *Scaphignathus veliferus* Zone (toIII β) and the Lower *Polygnathus styriacus* Zone (toIV), samples BG 19145, 19170, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

SPATHOGNATHODUS sp. nov. D

(Pl. 90, fig. 7a, b)

Remarks: One specimen, CPC 12813, is a small spathognathodid with 15 denticles of nearly equal height, fused bases, and tall triangular free tips. One of the denticles above the basal cavity is slightly larger than the others, and posterior to it the bar denticles are slightly smaller than the other bar denticles. The basal cavity is situated in the posterior to the midpoint of the unit and is elongate with gently flared lips. The aboral margin is virtually straight. The general form of the unit suggests an ozarkodinid ancestor. The specimen is from the Middle *Palmatolepis triangularis* Zone (basal Famennian), sample BG 19453E from Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

SPATHOGNATHODUS sp. E

(Pl. 91, fig. 5a, b, c)

Remarks: A single specimen, CPC 12814, is distinguished by its extremely tall denticles with fused bases but with long discrete tips and a tumid bar at the unit midpoint. The tumid part bears a few small low nodes on the oral surface. The specimen bears some resemblance to *Polygnathellus*. It is from the Middle *Palmatolepis triangularis* Zone (basal Famennian), sample BG 19453E, from Section 4, northeast of McWhae Ridge, Virgin Hills Formation.

SPATHOGNATHODUS sp. nov. F

(Pl. 90, fig. 8a, b)

Remarks: Two specimens, CPC 12815 figured, are characterized by a massive denticle situated over the basal cavity. The two denticles at the anterior end are also massive and are separated from the median denticle by 5 smaller and narrower denticles. Behind the median denticle there are about 5 more small denticles. The basal cavity is relatively small and situated at the point of downward flexure of the aboral margin. The presence of a well developed denticle over the basal cavity is reminiscent of *S. steinhornensis* and *S. primus* from the Lower Devonian and Upper Silurian respectively. The present specimens are from the Lower *Polygnathus asymmetricus* Zone (toIa); the figured specimen is from sample BG 19180 at the base of Section 1 immediately southwest of McWhae Ridge, Gogo Formation.

SPATHOGNATHODUS sp. G

(Pl. 91, fig. 2a, b)

Remarks: A single specimen, CPC 12816, is characterized by a deep bar and minute needle-like free denticle tips. The unit is comparatively small, but the series of 17 isolated, needle-like denticle tips is unusual. The anterior and posterior

margins are convex and the aboral margin is straight, with a small basal cavity at the midpoint. The specimen is from the Lower *Polygnathus asymmetricus* Zone (toIa), from sample BG 19188 at the base of the section immediately southwest of McWhae Ridge in Sadler Limestone interfingering with Gogo Formation.

SPATHOGNATHODUS sp. H.

(Pl. 91, fig. 4a, b)

Remarks: Four specimens, CPC 12817 figured, are distinctive because of their convex aboral margin and apparent lack of a basal cavity. The denticles are approximately equidimensional and are characteristically elongate and needle-like. They number about 9. The specimens range from the *Ancyrognathus triangularis* Zone (toIδ) up to the Lower *Scaphignathus veliferus* Zone (toIIIa). The figured specimen is from sample BG 19061, Section 4, northeast of McWhae Ridge, Sadler Limestone.

SPATHOGNATHODUS sp. I

(Pl. 91, fig. 3a, b)

Remarks: A small simple spathognathodid with equidimensional denticle consisting of about 11 denticles which are slightly taller in the mid-region. The posterior inclination of the denticles gradually increases toward the posterior. The basal cavity is elongate with slightly flared lips and is situated in the posterior half, extending to the posterior termination. The species appears to be a development of *S. stabilis* and could be ancestral to both the protognathodids and the *S. cf. S. cristulus* group of spathognathodids of the earliest Carboniferous. The specimen is from the Lower *Polygnathus styriacus* Zone (toIV), from sample BG 19173, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone (CPC 12818).

Genus SYNPRIONIODINA Bassler, 1925

Type species: *Synprioniodina alternata* Ulrich & Bassler, 1926.

SYNPRIONIODINA cf. *S. ALTERNATA* Bassler, 1925

(Pl. 92, figs 1a-5)

Material: 65 specimens, CPC 12819-23 figured.

Localities of figured material: Sample BG 19049 (CPC 12819), Section 3, McWhae Ridge, Sadler Limestone; BG 19453B (CPC 12820), E (CPC 12821), Section 4, northeast of McWhae Ridge, Virgin Hills Formation; BG 21234 (CPC 12823), Section 20, Longs Well Creek, Gogo Formation; BG 19498 (CPC 12822), Section 7, Paddy's Valley, Gogo Formation.

Remarks: Clark & Ethington (1967, p. 64) note that the genera *Euprioniodina*, *Neoprioniodus*, *Prioniodina*, and *Synprioniodina* are linked by transitional species and that the existing species also intergrade. They state that 'a careful revision of the entire group is desirable as well as necessary'. The present specimens are not abundant enough even to attempt any rationalization of this complex. The fauna

contains forms referable to *S. alternata* and to *S. prona*, but the two intergrade. I have included all these forms under the present heading. The earlier forms are mostly referable to *S. alternata*, whereas the later forms are mostly of *S. prona* type. They range in age from the Upper *Polygnathus asymmetricus* Zone as high as the Lower *Palmatolepis quadrantinodosa* Zone.

SYNPRIONIODINA sp. A

(Pl. 93, figs 1a-2b)

Material: 5 specimens; CPC 12824, 12825 figured, from samples BG 19107 (CPC 12824), 19147 (CPC 12825), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: A synprioniodid with a short posterior bar and a relatively long anterior bar. The anterior bar is depressed through about 70° and bears about 7 needle-like denticles which decrease in height anteriorly and are fused for most of their length. The apical denticle is massive, about 3 times as wide and twice as long as the largest bar denticle. The posterior bar is twice as deep as the anterior bar and bears about 12 denticles which are needle-like, basally fused, with long free tips. The basal cavity opens at the junction of the bar and the apical denticle. The species ranges from the Lower *Palmatolepis quadrantinodosa* Zone (toIIβ) probably as high as the Middle *Scaphignathus veliferus* Zone (toIIIβ). An unnamed specimen figured by Bond (1947, pl. 1, fig. 13) is very close and is probably the same species.

SYNPRIONIODINA sp. B

(Pl. 93, figs 3a-4b)

Remarks: Two specimens, CPC 12826 from sample BG 19107 and CPC 12827 from BG 19108, from Section 4, northeast of McWhae Ridge (Bugle Gap Limestone), are distinctive in having long posterior bars and a small apical denticle. The posterior bar bears about 30 denticles which are needle-like and tall; in the posterior half the dentition tends to be cyclic. The apical denticle is small and is only just wider than the bar denticles, which are fused to either face. The anterior bar is short and bears about 5 needle-like denticles which decrease in height rapidly anteriorly. The basal cavity is small and subapical. These specimens are close to *Synprioniodina newalbalyensis* Huddle; they are from the lower part of the Upper *Palmatolepis quadrantinodosa* Zone.

Genus *TRIPODELLUS* Sannemann, 1955

Type species: *Tripodellus flexuosus* Sannemann, 1955.

TRIPODELLUS ROBUSTUS Bischoff, 1957

(Pl. 93, figs 5a-6b)

1957 *Tripodellus robustus* Bischoff, *Hess. Landesamt Bodenf., Abh.*, 19, 58, pl. 6, fig. 40.

1967 *Tripodellus robustus* Bischoff; Spasov & Filipovic, *Bull. geol. Inst., Sér. paléont.*, 16, 82, pl. 6, fig. 18, 20.

- 1967 *Tripodellus robustus* Bischoff; Wolska, *Acta palaeont. polon.*, 12, 430, pl. 5, fig. 7.
 1969 *Tripodellus robustus* Bischoff; Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 139, pl. 41, figs 2a-3. (Synonymy to 1966)
 1969 *Tripodellus robustus* Bischoff; Olivieri, *Boll. Soc. paleont. ital.*, 8, 146, pl. 8, figs 11, 12; pl. 26, figs 11, 12.

Material: 40 specimens; CPC 12828, 12829 figured, from samples BG 19107 (CPC 12828), 19108 (CPC 12829), Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

Remarks: Some of the specimens have tumid bars, giving distinct shoulders at the base of the denticles, especially on the anterior bar.

Distribution: The species was originally described from Germany (Bischoff, 1957) and has been reported from there by Helms (1959), Freyer (1961, 1968), Schneider (1969), and Meischner & Schneider (1970). It has also been reported from Austria (Schönlaub, 1969a), France (Boyer et al., 1968), Italy (Olivieri, 1969), Yugoslavia (Spasov & Filipovic, 1965, 1967), Poland (Freyer & Zakowa, 1967), and Portugal (Boogaard, 1963).

Range: Bischoff (1957) gives the range as uppermost Devonian, but this is the bottom of his section. Wolska (1967) gives the range as *Palmatolepis quadrantinodosa* Zone to *Scaphignathus veliferus* Zone. The Canning Basin specimens range from the *Palmatolepis rhomboidea* Zone to the Upper *Scaphignathus veliferus* Zone.

gen. nov. et sp. nov. Druce, 1969
 (Pl. 24, fig. 5)

- 1969 gen. nov. et sp. nov. Druce, *Bur. Miner. Resour. Aust. Bull.* 98, 140, pl. 41, figs 4a, b.

Remarks: Two specimens, CPC 12830 figured, are very similar to that illustrated from the Bonaparte Gulf Basin. However, they are slightly more asymmetrical, with one bar reduced and the other extended; although the unit is twisted, the twisting is less. There is also a certain resemblance to *Neoprioniodus? tortus* Druce. The specimens are from the Middle *Palmatolepis crepida* (toIIa) and the Lower *Polygnathus styriacus* Zones (toIV) and the illustrated specimen is from sample BG 19172, Section 4, northeast of McWhae Ridge, Bugle Gap Limestone.

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APPENDIX 1

LOCALITY AND FAUNAL REGISTER

Key to Conodont Zones		
24	Upper	<i>Polygnathus styriacus</i>
23	Middle	
22	Lower	
21	Upper	<i>Scaphignathus veliferus</i>
20	Middle	
19	Lower	
18	Upper	<i>Palmatolepis quadrantinodosa</i>
17	Lower	
16		
15	Upper	<i>Palmatolepis crepida</i>
14	Middle	
13	Lower	
12	Upper	<i>Palmatolepis triangularis</i>
11	Middle	
10	Lower	
9	Uppermost	<i>Palmatolepis gigas</i>
8	Upper	
7	Lower	
6		<i>Ancyrognathus triangularis</i>
5	Upper	<i>Polygnathus asymmetricus</i>
4	Middle	
3	Lower	

APPENDIX 1—LOCALITY AND FAUNAL REGISTER

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19001	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19002	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19003	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19004	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19005	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19006	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19007	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	—	see Fig. 19
19008	0.30 m 6.60 m gap	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills	—	see Fig. 19
19009	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19010	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19011	1.50 m gap 1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19012	1.50 m gap 1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19013	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19014	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19015	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19016	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19017	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Virgin Hills (goniatite bed)	—	see Fig. 19
19018	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19
19019	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19
19020	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19021	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19
19022	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19
19023	1.50 m gap	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)	—	see Fig. 19
19024	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	(stromatolite horizon)		see Fig. 19
19025	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	None
19026	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	None
19027	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	None
19028	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	None
19029	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	Fragments
19030	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	L. Frasnian	<i>Polygnathus xylus</i>
19031	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	L. Frasnian	<i>P. xylus</i> <i>Ozarkodina immersa</i>
19032	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	L. Frasnian	<i>P. xylus</i>
19033	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	L. Frasnian	<i>Enantiognathus lipperti</i> <i>Hibbardella (Diplodella) alternata</i> <i>Polygnathus decorosus</i> <i>P. normalis</i> <i>P. xylus</i>
19034	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	4-7	<i>Polygnathus decorosus</i> <i>P. normalis</i> <i>P. pollocki</i>
19035	1.51 m	McWhae Ridge	126°04'30'' 18°43'50''	5 5133	Sadler	?	None
19036	1.50 m gap 1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Sadler	L. Frasnian	<i>Belodella erecta</i> <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i>
19037	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Sadler	L. Frasnian	<i>Hindeodella compressa</i> <i>Polygnathus decorosus</i>
19038	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Sadler	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.		Formation	Age	Conodont Fauna
19039	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?	None
19040	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	L. Frasnian	Fragments
19041	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?	None
19042	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?L. Frasnian	Fragments
19043	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Windjana	L. Frasnian	<i>Hindeodella compressa</i> <i>H. subtilis</i> <i>Icriodus brevis brevis</i> <i>Lonchodina typicalis</i> <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>P. xylus</i>
19044	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	L. Frasnian	<i>Hindeodella compressa</i> <i>H. subtilis</i> <i>Ozarkodina?</i> sp. <i>Polygnathus xylus</i> <i>Ozarkodina immersa</i> <i>Polygnathus xylus</i> <i>P. xylus</i>
19045	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	L. Frasnian	
19046	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	L. Frasnian	
19047	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?	None
19048	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?	<i>Acodina</i> sp. <i>Enantiognathus lipperti</i> <i>Hindeodella subtilis</i> <i>Icriodus brevis brevis</i> <i>Lonchodina typicalis</i> <i>Polygnathus</i> sp. A <i>Hindeodella</i> sp. nov. D <i>Icriodus alternatus alternatus</i> <i>Lonchodina typicalis</i> <i>Neoprioniodus</i> sp.
19049	1.51 m	McWhae Ridge	126°04'30'' 18°43'55''	5	5133	Sadler	?	<i>Acodina inopinata</i> <i>Hibbardella</i> (<i>Diplododella</i>) <i>plana</i> <i>H. (Hibbardella) angulata</i> <i>Icriodus alternatus curvirostratus</i> <i>I. alternatus cymbiformis</i> <i>I. brevis darbyensis</i> <i>I. symmetricus symmetricus</i> <i>Lonchodina</i> sp.
19050	1.51 m	McWhae Ridge	126°04'30''	5	5133	Sadler	?	<i>Ozarkodina?</i> sp. <i>Ozarkodina immersa</i> <i>Polygnathus xylus</i>

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19051	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	3-6	see Fig. 20
19052	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	?	see Fig. 20
19053	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	?	see Fig. 20
19054	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	?	see Fig. 20
19055	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	?	see Fig. 20
19056	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Windjana	3-6	see Fig. 20
19057	6.04 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Sadler	?6	see Fig. 20
19058	6.04 m	McWhae Ridge	126°04'40'' 18°43'55''	5 5133	Sadler	?6	see Fig. 20
19059	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	Virgin Hills	6	see Fig. 20
19060	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	Virgin Hills	6	see Fig. 20
19061	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	Virgin Hills	6	see Fig. 20
19062	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	6	see Fig. 20
19063	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	6	see Fig. 20
19064	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	6	see Fig. 20
19065	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	7-13	see Fig. 20
19066	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	7-13	see Fig. 20
19067	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	7-13	see Fig. 20
19068	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	7-13	see Fig. 20
19069	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'55''	5 5133	(goniatite bed)	7-13	see Fig. 20
19070	1.51 m	E of McWhae Ridge	126°04'40'' 18°43'40''	5 5133	(goniatite bed)	7-13	see Fig. 20
19071	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5 5133	Virgin Hills	7-13	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run</i>	<i>No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19072	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	7-13	see Fig. 20
19073	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	14-15	see Fig. 20
19074	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	16	see Fig. 20
19075	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	16	see Fig. 20
19076	1.51 m	E of Kellys Pass	126°05'00'' 18°43'55''	5	5133	Virgin Hills	16	see Fig. 20
19077	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	16	see Fig. 20
19078	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	(2nd sromato- lite bed)	17	see Fig. 20
19079	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19080	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19081	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19082	1.51 m	E of Kellys Pass	126°05'00'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19083	13.60 m gap 1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19084	4.50 m gap 1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19085	1.51 m gap 1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19086	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19087	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19088	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19089	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19090	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19091	1.51 m 1.51 m gap	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19092	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run</i>	<i>No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19093	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19094	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19095	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19096	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19097	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19098	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19099	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19100	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19101	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19102	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19103	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19104	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Virgin Hills	17	see Fig. 20
19105	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	17	see Fig. 20
19106	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	17	see Fig. 20
19107	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	18	see Fig. 20
19108	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	18	see Fig. 20
19109	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	18	see Fig. 20
19110	1.51 m	E of Kellys Pass	126°05'10'' 18°43'40''	5	5133	Bugle Gap	18	see Fig. 20
19111	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19112	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19113	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run</i>	<i>No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19114	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19115	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19116	1.51 m gap 1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19117	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19118	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19119	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19120	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	18	see Fig. 20
19121	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19122	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19123	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19124	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19125	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19126	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19127	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19128	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19129	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19130	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19131	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19132	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19133	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19134	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run</i>	<i>No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19135	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19136	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19137	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19138	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19039	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19140	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19141	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	19	see Fig. 20
19142	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19143	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19144	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19145	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19146	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19147	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	20	see Fig. 20
19148	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?20	see Fig. 20
19149	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?20	see Fig. 20
19150	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?20	see Fig. 20
19151	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?21	see Fig. 20
19152	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?21	see Fig. 20
19153	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	?21	see Fig. 20
19154	1.51 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19155	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>		<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19156	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19157	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19158	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19159	3.02 m	NE of Kellys Pass	126°05'10'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19160	3.02 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	21	see Fig. 20
19161	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19162	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19163	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19164	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19165	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19166	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19167	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19168	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19169	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19170	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19171	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19172	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19173	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19174	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19175	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20
19176	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5	5133	Bugle Gap	22	see Fig. 20

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19177	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	Bugle Gap	22	see Fig. 20
19178	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	Bugle Gap	22	see Fig. 20
19179	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	Bugle Gap	22	see Fig. 20
19180	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	Bugle Gap	22	see Fig. 20
19181	6.04 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	Bugle Gap	22	see Fig. 20
19182	3.02 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	(very thin bedded)	22/23	see Fig. 20
19183	3.02 m	Mimbi Creek Headwaters	126°05'20'' 18°42'30''	5 5133	(very thin bedded)	22/23	see Fig. 20
19184	Spot	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	3	<i>Icriodus alternatus curvirostratus</i> <i>I. brevis brevis</i> <i>Polygnathus xylus</i>
19185	Spot 1 m above 19184	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	3	<i>Icriodus alternatus alternatus</i> <i>Polygnathus asymmetricus ovalis</i>
19186	1.50 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	3	<i>Acodina</i> sp. <i>Ancyrodella rotundiloba rotundiloba</i> <i>Hibbardella</i> sp. <i>Icriodus alternatus curvirostratus</i> <i>I. alternatus cymbiformis</i> <i>Lonchodina</i> sp. <i>Ozarkodina immersa</i> <i>O.?</i> sp. <i>O.</i> sp. <i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. spatulatus</i> <i>P. xylus</i>
19187	1.50 m	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Gogo	?	None
19188	Spot = 19186	McWhae Ridge	126°04'30'' 18°43'55''	5 5133	Sadler	?3	<i>Bryantodus typicus</i> <i>Hindeodella subtilis</i> <i>Icriodus brevis brevis</i> <i>I. brevis spicatus</i> <i>Ligonodina magnidens</i> <i>Lonchodina</i> sp. <i>Neoprioniodus armatus</i> <i>Polygnathus xylus</i> <i>Spathognathodus</i> sp. nov. G

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
19189	3.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	3-4	<i>Ancyrodella rotundiloba alata</i> <i>Bryantodus typicus</i> <i>Icriodus alternatus curvirostratus</i> <i>Ligonodina magnidens</i> <i>Lonchodina typicalis</i> <i>Neoprioniodus</i> sp. <i>Polygnathus decorosus</i> <i>P. spatulatus</i> <i>P. xylus</i> <i>P. xylus</i>
19190	3.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	L. Frasnian	<i>P. xylus</i>
19191	3.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	L. Frasnian	<i>P. xylus</i>
19192	3.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?L. Frasnian	<i>Hibbardella aurita</i> <i>Hindeodella</i> sp. <i>Neoprioniodus</i> sp. <i>Polygnathus normalis</i> <i>P. xylus</i> None
19193	Spot	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Windjana	?	None
19194	Spot	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?	None
19195	Spot 6.04 m above 19194	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	None
19196	6.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	<i>Polygnathus normalis</i>
19197	6.04 m	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	None
19198	Spot = 19194	Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?	None
19199	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?L. Frasnian	<i>Polygnathus xylus</i>
19200	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?L. Frasnian	Fragments
19401	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?L. Frasnian	Fragments
19402	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Pillara	?L. Frasnian	? <i>Polygnathus normalis</i> <i>P. xylus</i> None
19403	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	None
19404	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	None
19405	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5	5133	Sadler	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19406	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Pillara	?	None
19407	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Pillara	?	None
19408	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Pillara	?	None
19409	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Pillara	?	None
19410	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Pillara	?	None
19411	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Sadler	?	<i>Neoprioniodus</i> sp.
19412	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Virgin Hills	?	Fragments
19413	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Virgin Hills	?	<i>Hindeodella</i> sp.
19414	1.51 m	E entrance Kellys Pass	126°04'20'' 18°43'30''	5 5133	Virgin Hills	?	Fragments
19415	Spot	Nr Cave Spring	126°03'55'' 18°43'40''	5 5133	Sadler	?	None
19416	6.04 m 19415	Nr Cave Spring	126°03'55'' 18°43'40''	5 5133	Sadler	?	None
19417	1.50 m above 19416	Nr Cave Spring	126°03'55'' 18°43'40''	5 5133	Sadler	?L. Frasnian	<i>Polygnathus xylus</i>
19418	Spot 6 m above 19417	Nr Cave Spring	126°03'55'' 18°43'40''	5 5133	Sadler	?L. Frasnian	<i>Icriodus alternatus alternatus</i> <i>I. alternatus curvirostratus</i> <i>I. symmetricus symmetricus</i>
19419	Spot 6 m above 19418	Nr Cave Spring	126°03'55'' 18°43'40''	5 5133	Sadler	?L. Frasnian	<i>Hindeodella corpulenta</i> <i>Hibbardella (Hibbardella) angulata</i> <i>I. brevis brevis</i> <i>Polygnathus xylus</i>
19420	Spot 1.5 m above 19419	Nr Cave Spring	126°03'55'' 18°43'40''	5 5135	Sadler	3/4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Hindeodella corpulenta</i> <i>Polygnathus xylus</i>
19421	Spot	E Cave Spring	126°03'50'' 18°43'45''	5 5135	Sadler	3/4	<i>Enantiognathus lipperti</i> <i>Hindeodella corpulenta</i> <i>H. subtilis</i> <i>Hibbardella</i> sp. <i>Icriodus brevis brevis</i> <i>Ligonodina magnidens</i> <i>Ozarkodina immersa</i> <i>O.?</i> sp. <i>Polygnathus xylus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19422	Spot	E Cave Spring	126°03'50'' 18°43'45''	5 5135	Sadler	?	None
19423	Spot	W Cave Spring	126°03'35'' 18°43'35''	5 5135	Sadler	?	None
19424	3.02 m	NE Jones Spring	126°03'10'' 18°42'30''	5 5135	Sadler	?L. Frasnian	<i>Polygnathus foliatus</i>
19425	3.02 m	NE Jones Spring	126°03'10'' 18°42'30''	5 5135	Sadler	4-6	<i>Polygnathus australis</i>
19426	3.02 m	NE Jones Spring	126°03'10'' 18°42'30''	5 5135	Sadler	?	None
19427	Spot	NE Jones Spring	126°03'10'' 18°42'30''	5 5135	Windjana	?	None
19428	Spot	NE Jones Spring	126°03'10'' 18°42'30''	5 5135	Windjana	?	None
19429	6.04 m	NE Jones Spring	126°42'10'' 18°42'30''	5 5135	Pillara	?	None
19430	6.04 m	NE Jones Spring	126°42'10'' 18°42'30''	5 5135	Pillara	?	None
19431	Spot	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Gogo	3/4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Palmatolepis transitans</i> (?) <i>Polygnathus asymmetricus</i> <i>asymmetricus</i>
19432	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Sadler	3/5	<i>P. cf. P. webbi</i> <i>Hindeodella subtilis</i> <i>Polygnathus asymmetricus</i> <i>asymmetricus</i>
19433	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Windjana	?	<i>P. xylus</i> None
19434	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	?	None
19435	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	?	None
19436	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	?	None
19437	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	4-7	<i>Polygnathus pollocki</i>
19438	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	?	None
19439	3.02 m	Nr Boggy Crossing	126°03'10'' 18°41'15''	4 5119	Pillara	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19440	3.02 m	Nr Boggy Crossing	126°03'10" 18°41'15"	4 5119	Pillara	?	None
19441	3.02 m	Nr Boggy Crossing	126°03'10" 18°41'15"	4 5119	Pillara	?	None
19442	3.02 m	Nr Boggy Crossing	126°03'10" 18°41'15"	4 5119	Pillara	?	None
19443	3.02 m	Nr Boggy Crossing	126°03'10" 18°42'30"	4 5199	Pillara	?	None
19444	3.02 m	Nr Boggy Crossing	126°03'10" 18°42'30"	4 5199	Pillara	?	None
19445	3.02 m	Nr Boggy Crossing	126°03'10" 18°42'30"	4 5199	Pillara	?	None
19446	Spot	Road N of Jones Spring	126°03'10" 18°42'00"	4 5119	'Calcrete'	—	None
19447	Spot	Daves Falls	126°03'10" 18°42'30"	5 5135	Gogo	3-5	<i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. spatulatus</i> Youngquist <i>P. xylus</i>
19448A	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	7	see Fig. 20
19448B	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	7	see Fig. 20
19448C	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	7	see Fig. 20
19448D	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	7	see Fig. 20
19448E	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19449A	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19449B	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19449C	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19449D	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19449E	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19450A	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20
19450B	0.30 m	Nr Casey Falls	126°05'00" 18°43'55"	5 5133	Virgin Hills	8	see Fig. 20

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
19450C	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	8	see Fig. 20
19450D	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	8	see Fig. 20
19450E	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	8	see Fig. 20
19451A	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	?9	see Fig. 20
19451B	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	?9	see Fig. 20
19451C	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	?9	see Fig. 20
19451D	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19451E	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19452A	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19452B	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19452C	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19452D	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19452E	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19453A	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	9	see Fig. 20
19453B	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	10	see Fig. 20
19453C	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	10	see Fig. 20
19453D	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	10	see Fig. 20
19453E	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	11	see Fig. 20
19454A	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	11	see Fig. 20
19454B	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	11	see Fig. 20
19454C	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	11	see Fig. 20
19454D	0.30 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	12	see Fig. 20

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19455	1.51 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	13	see Fig. 20
19456	0.05 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	13	see Fig. 20
19457	0.05 m	Nr Casey Falls	126°05'00'' 18°43'55''	5 5133	Virgin Hills	13-14	see Fig. 20
19458	Spot	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Windjana	?	None
19459	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Pillara	?	None
19460	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Pillara	?	None
19461	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Pillara	?	None
19462	Spot	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Windjana	?L. Frasnian	<i>Belodella resima</i> <i>Drepanodus</i> sp.
19463	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Drepanodus</i> sp. <i>Hindeodella compressa</i> <i>H. subtilis</i> <i>Ozarkodina immersa</i> <i>Polygnathus xylus</i>
19464	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	?	None
19465	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Drepanodus</i> sp. <i>Hindeodella</i> sp. <i>Ozarkodina immersa</i> <i>O.?</i> sp.
19466	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	?	None
19467	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Acodina</i> sp. <i>Belodella costata</i> <i>B. resima</i> <i>Hindeodella</i> sp. <i>Polygnathus xylus</i> <i>Hindeodella</i> sp.
19468	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	
19469	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella devonica</i>
19470	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>B. costata</i>
19471	1.51 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19472	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Drepanodus</i> sp. <i>Ozarkodina immersa</i> <i>Polygnathus xylus</i>
19473	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella triangularis</i> <i>B. resima</i> <i>Drepanodus</i> sp. <i>Hindeodella compressa</i> <i>Polygnathus foliatus</i>
19474	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella costata</i> <i>B. resima</i> <i>Drepanodus</i> sp. <i>Hibbardella</i> sp. <i>Hindeodella</i> sp. <i>Neoprioniodus</i> sp. <i>Polygnathus foliatus</i>
19475	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Polygnathus xylus</i>
19476	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Drepanodus</i> sp. <i>Polygnathus xylus</i>
19477	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Drepanodus</i> sp. <i>Polygnathus xylus</i>
19478	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Icriodus brevis brevis</i> Stauffer <i>Ozarkodina immersa</i> <i>Polygnathus pollocki</i> sp. nov. <i>Polygnathus xylus</i>
19479	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	None
19480	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	None
19481	3.02 m	Lloyd Hill	126°00'45'' 18°40'25''	4 5117	Sadler	L. Frasnian	<i>Belodella triangularis</i> <i>Hindeodella subtilis</i> <i>Polygnathus xylus</i>
19482	Spot	Lloyd Hill- Laidlaw Range	126°01'15'' 18°40'25''	4 5117	Gogo	4	<i>Ancyrodella rotundiloba alata</i> <i>Bryantodus nitidus</i> <i>Hibbardella</i> (<i>Hibbardella</i>) <i>multidens</i> <i>H. (Diplododella) aurita</i> <i>Hindeodella</i> sp. <i>Icriodus symmetricus symmetricus</i> <i>Lonchodina arcuata</i> <i>Ozarkodina macra</i> <i>Polygnathus asymmetricus ovalis</i> <i>P. brevilaminus</i> <i>P. janetae</i> <i>P. xylus</i> <i>Synprioniodina alternata</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19483	Spot	Lloyd Hill- Laidlaw Range	126°01'15'' 18°40'25''	4 5117	Gogo	3/4	<i>Bryantodus</i> sp. <i>Hibbardella</i> (<i>Diplodella</i>) <i>aurita</i> <i>H. subtilis</i> <i>Icriodus alternatus alternatus</i> <i>Polygnathus janetae</i> <i>P. xylus</i> None
19484	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	?	None
19485	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	3/4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Bryantodus typicalis</i> <i>Ozarkodina immersa</i> <i>Polygnathus foliatus</i> <i>P. xylus</i> None
19486	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	?	None
19487	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	?L. Frasnian	<i>Ozarkodina immersa</i>
19488	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	?L. Frasnian	<i>Belodella devonica</i> <i>Hindeodella subtilis</i> <i>Ligonodina magnidens</i> <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i> <i>P. xylus</i>
19489	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	3/4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>A. rotundiloba binodosa</i> <i>Belodella resima</i> <i>Hindeodella compressa</i> <i>Ligonodina magnidens</i> <i>Lonchodina</i> sp. nov. A <i>Polygnathus xylus</i> <i>Synprioniodina alternata</i>
19490	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Sadler	L. Frasnian	<i>Belodella resima</i> <i>Hibbardella</i> (<i>Diplodella</i>) <i>alternata</i> <i>Hindeodella compressa</i> <i>Ligonodina</i> sp. <i>Ozarkodina immersa</i> <i>Polygnathus foliatus</i> <i>P. xylus</i>
19491	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Windjana	?	None
19492	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Pillara	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19493	Spot	Laidlaw Range	126°01'60'' 18°40'10''	4 5117	Pillara	?	None
19494	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo	3/4	see Fig. 21
19495	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo	4	see Fig. 21
19496	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo	?L. Frasnian	see Fig. 21
19497	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo/Sadler	4-7	see Fig. 21
19498	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo	?L. Frasnian	see Fig. 21
19499	Spot every 160 m	Between Laidlaw & Emanuel Range	126°01'00'' 18°40'10''	4 5117	Gogo	?	see Fig. 21
19500	400 m	Between Laidlaw & Emanuel Range	126°00'00'' 18°40'30''	4 5117	Gogo	?L. Frasnian	see Fig. 21
19501	SW of 19498 Spot every 160 m	Between Laidlaw & Emanuel Range	126°00'00'' 18°40'30''	4 5117	Gogo	3/4	see Fig. 21
19502	Spot every 160 m	Between Laidlaw & Emanuel Range	126°00'00'' 18°40'30''	4 5117	Gogo	?L. Frasnian	see Fig. 21
19503	Spot every 160 m	Between Laidlaw & Emanuel Range	126°00'00'' 18°40'30''	4 5117	Gogo	?L. Frasnian	see Fig. 21
19504	3.02 m	Between Laidlaw & Emanuel Range	125°59'40'' 18°40'20''	4 5117	Sadler	?	see Fig. 21
19505	3.02 m	Between Laidlaw & Emanuel Range	125°59'40'' 18°40'20''	4 5117	Sadler	?L. Frasnian	see Fig. 21
19506	3.02 m	Between Laidlaw & Emanuel Range	125°59'40'' 18°40'20''	4 5117	Sadler	?	None
19507	3.02 m	Between Laidlaw & Emanuel Range	125°59'40'' 18°40'20''	4 5117	Pillara	?	None
19508	Spot	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Windjana	?	None
19509	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Sadler	L. Frasnian	<i>Hindeodella subtilis</i> <i>Polygnathus xylus</i>
19510	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Sadler	L. Frasnian	<i>Synprioniodina alternata</i> <i>Icriodus alternatus alternatus</i> <i>I. alternatus elegantulus</i> <i>I. brevis</i> subsp. nov. b <i>Neoprioniodus armatus</i> <i>Ozarkodina immersa</i> <i>Polygnathus xylus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19511	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Sadler	?	None
19512	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	3/4	<i>Polygnathus janetae</i> <i>P. xylus</i>
19513	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	?	None
19514	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	?L. Frasnian	<i>Hindeodella compressa</i> <i>Synprioniodina alternata</i>
19515	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	?	None
19516	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	4-7	<i>Polygnathus pollocki</i> <i>P. xylus</i>
19517	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	?	None
19518	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	4-7	<i>Hindeodella subtilis</i> <i>Polygnathus pollocki</i> <i>P. xylus</i>
19519	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	4-7	<i>Polygnathus xylus</i>
19520	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	4-7	<i>Polygnathus decorosus</i>
19521	1.51 m	Wade Knoll	125°59'55'' 18°39'30''	3 5110	Gogo	4-7	<i>Icriodus alternatus alternatus</i> <i>Ligonodina</i> sp. <i>Polygnathus</i> sp.
19522	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	'11 rolled reef block'	?	None
19523	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	Virgin Hills	6-8	<i>Ancyrodella buckeyensis</i> <i>Ancyrodella nodosa</i> <i>Icriodus alternatus elegantulus</i> <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>P. foliatus</i>
19524	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	'rolled block'	?	None
19525	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	'rolled block'	?	None
19526	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	'rolled block'	?	None
19527	1.51 m	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	Virgin Hills	?	None
19528	1.51 m	McIntyre Knolls	126°06'10'' 18°37'50''	2 5095	Virgin Hills	6	<i>Ancyrodella lobata</i> <i>Icriodus alternatus alternatus</i> <i>Nothognathella iowensis</i> <i>Polygnathus decorosus</i> <i>P. normalis</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
19529	1.51 m	McIntyre Knolls	126°06'10'' 18°37'50''	2	5095	Virgin Hills	6-8/9	<i>Ancyrodella gigas</i> <i>Icriodus alternatus cymbiformis</i> <i>Lonchodina</i> sp. <i>Polygnathus decorosus</i> <i>Ancyrodella rugosa</i> <i>Ligonodina magnidens</i> <i>Palmatolepis</i> sp. <i>Polygnathus decorosus</i> <i>P. cf. P. webbi</i> None
19530	Spot	McIntyre Knolls	126°06'10'' 18°37'50''	2	5095	Virgin Hills	?L. Frasnian	
19531	Spot	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	'rolled block'	?	
19532	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	?L. Frasnian	see Fig. 22
19533	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	3/4	see Fig. 22
19534	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	4/?5	see Fig. 22
19535	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	?	see Fig. 22
19536	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	4-7	see Fig. 22
19537	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19538	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19539	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19540	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19541	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19542	3.02 m	McPhee Knoll	126°05'50'' 18°38'00''	3	5105	Virgin Hills	5	see Fig. 22
19543	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3	5105	Gogo	4/5	see Fig. 22
19544	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3	5105	Virgin Hills	5	see Fig. 22
19545	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3	5105	Virgin Hills	5	see Fig. 22
19546	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3	5105	Virgin Hills	5	see Fig. 22

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19547	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3 5105	Virgin Hills	5-7	see Fig. 22
19548	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3 5105	Virgin Hills	5/6	see Fig. 22
19549	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3 5105	Virgin Hills	5-8	see Fig. 22
19550	3.02 m	Waggon Creek to McPhee Knoll	126°05'20'' 18°38'10''	3 5105	Virgin Hills	5-8	see Fig. 22
19551	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	?L. Frasnian	<i>Hindeodella subtilis</i> <i>Icriodus alternatus alternatus</i> <i>Polygnathus normalis</i> <i>P. xylus</i> <i>Synprioniodina alternata</i> <i>Ancyrodella</i> sp. <i>P. xylus</i>
19552	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	Frasnian	<i>Belodella triangularis</i> <i>Bryantodus macrodentus</i> <i>Ligonodina magnidens</i> <i>Lonchodina</i> sp. <i>Polygnathus xylus</i> <i>Hindeodella subtilis</i> <i>Ozarkodina immersa</i> <i>Polygnathus pollocki</i> <i>P. cf. P. webbi</i> <i>P. xylus</i>
19553	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	Frasnian	<i>Ligonodina magnidens</i> <i>Lonchodina typicalis</i> <i>Polygnathus decorosus</i> <i>Spathognathodus</i> sp. None
19554	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	4-7	None
19555	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	Frasnian	None
19556	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	?	None
19557	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	?	None
19558	Spot	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Windjana	?	None
19559	Spot	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Sadler	?	None
19560	Spot	Waggon Pass	126°05'00'' 18°38'15''	3 5106	?Sadler	L. Frasnian	<i>Polygnathus xylus</i> <i>P. decorosus</i> <i>Ancyrodella</i> sp. <i>Bryantodus nitidus</i> <i>Icriodus</i> sp. <i>Polygnathus foliatus</i>
19561	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3 5106	Virgin Hills	Frasnian	

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
19562	3.02 m	Waggon Pass	126°05'00'' 18°38'15''	3	5106	Virgin Hills	4-6	<i>Polygnathus australis</i> sp. nov.
19563	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	?	None
19564	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	Windjana	3-4	<i>Polygnathus spatulatus</i> <i>P. xylus</i>
19565	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	?	None
19566	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	6-9	<i>Ancyrodella nodosa</i> <i>Palmatolepis</i> sp. <i>Polygnathus normalis</i> <i>Polygnathus decorosus</i>
19567	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	Frasnian	
19568	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	?	None
19569	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	?	None
19570	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	Frasnian	<i>Hindeodella</i> sp. <i>Polygnathus decorosus</i> <i>Ancyrodella buckeyensis</i>
19571	Spot	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	7	<i>A. curvata</i> <i>A. nodosa</i> <i>Hibbardella</i> (<i>Diplododella</i>) <i>alternata</i> <i>H. (Diplododella) aurita</i> <i>Hindeodella subtilis</i> <i>Ligonodina panderi</i> <i>Nothognathella typicalis</i> <i>Ancyrodella nodosa</i> <i>Ancyrodella altus</i> <i>Polygnathus decorosus</i> <i>P. normalis</i>
19572	3.02 m	NW corner Lawford Range	126°06'00'' 18°36'50''	2	5094	?Virgin Hills	8-9	None
19573	Spot	Lawford Range nr McIntyre Knolls	126°06'05'' 18°36'45''	2	5095	Pillara	?	
19574	Spot	Lawford Range nr McIntyre Knolls	126°06'05'' 18°36'45''	2	5095	Windjana	?	None
19575	3.02 m	Lawford Range nr McIntyre Knolls	126°06'05'' 18°36'45''	2	5095	Virgin Hills	5-7	<i>Ancyrodella curvata</i> <i>A. lobata</i> <i>Bryantodus nitidus</i> <i>Icriodus</i> sp. <i>Palmatolepis proversa</i> <i>Polygnathus decorosus</i> <i>P. cf. P. webbi</i> <i>P. xylus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19576	3.02 m	Lawford Range nr McIntyre Knolls	126°06'05'' 18°36'45''	2 5095	Virgin Hills	5-7	<i>Icriodus alternatus curvirostratus</i> <i>I. alternatus cymbiormis</i> <i>Palmatolepis</i> sp. <i>Polygnathus foliatus</i> <i>P. normalis</i> see Fig. 23
19577	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Gogo	4-6	see Fig. 23
19578	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Gogo	?5	see Fig. 23
19579	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	?5	see Fig. 23
19580	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	5-8	see Fig. 23
19581	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	6-9	see Fig. 23
19582	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	6-7	see Fig. 23
19583	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	6-7	see Fig. 23
19584	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	7	see Fig. 23
19585	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	7	see Fig. 23
19586	3.02 m	Nr W entrance to Waggon Pass	126°04'00'' 18°39'00''	3 5106	Virgin Hills	?	None
19587	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Windjana	?	None
19588	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	?Gogo	L. Frasnian	<i>Belodella devonica</i> <i>B. resima</i> <i>B. triangularis</i> <i>Hindeodella subtilis</i> <i>Ozarkodina?</i> sp. <i>Polygnathus xylus</i> None
19589	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	?Gogo	?	None
19590	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	?Gogo	?	None
19591	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Sadler	?	None
19592	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	3-5	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Bryantodus</i> sp. <i>Polygnathus xylus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
19593	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	L. Frasnian	<i>Hindeodella compressa</i> <i>Icriodus brevis brevis</i> <i>Synprioniodina alternata</i> <i>Enantiognathus lipperti</i> <i>Icriodus brevis spicatus</i> <i>I. incrassatus</i> subsp. nov. c. <i>Ligonodina</i> sp. nov. A <i>Lonchodina typicalis</i> <i>Polygnathus foliatus</i> <i>P. xylus</i>
19594	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	L. Frasnian	<i>Enantiognathus lipperti</i> <i>Lonchodina typicalis</i> <i>Neoproniodus</i> sp. <i>Nothognathella typicalis</i> <i>Ozarkodina?</i> sp. <i>Polygnathus xylus</i> None
19595	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	Frasnian	<i>Enantiognathus lipperti</i> <i>Lonchodina typicalis</i> <i>Neoproniodus</i> sp. <i>Nothognathella typicalis</i> <i>Ozarkodina?</i> sp. <i>Polygnathus xylus</i> None
19596	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	?	
19597	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	3-5	<i>Icriodus alternatus curvirostratus</i> <i>Nothognathella typicalis</i> <i>Ozarkodina?</i> sp. <i>Polygnathus decorosus</i> <i>P. janetae</i> <i>P. normalis</i> <i>P. cf. P. webbi</i>
19598	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Bryantodus macrodentus</i> <i>Hindeodella subtilis</i> <i>Ligonodina panderi</i> <i>Nothognathella polynathoidea</i> <i>Polygnathus decorosus</i> <i>Icriodus alternatus alternatus</i> <i>Neoproniodus</i> sp. <i>Polygnathus decorosus</i> <i>P. foliatus</i>
19599	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	Frasnian	<i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. foliatus</i>
19600	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	3-4	<i>P. foliatus</i> None
21001	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	?	None
21002	3.02 m	Glenister Knolls	126°02'00'' 18°41'45''	4 5118	Gogo	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21003	Spot	Timanites Hill	126°02'25'' 18°40'35''	4 5118	Gogo	3-4	<i>Ancyrodella</i> sp. nov. A <i>Hindeodella subtilis</i> <i>Lonchodina typicalis</i> <i>Nothognathella klapperi</i> <i>N. typicalis</i> <i>Ozarkodina immersa</i> <i>O.?</i> sp. <i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. foliatus</i> None
21004	3.02 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	?Pillara	?	None
21005	3.02 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	Virgin Hills	?	None
21006	3.02 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	Virgin Hills	?	None
21007	3.02 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	Virgin Hills	10	<i>Ancyrodella curvata</i> <i>Nothagnathella abnormis</i> <i>Ozarkodina immersa</i> <i>Palmatolepis subrecta</i>
21008	3.02 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	Virgin Hills	Frasnian	<i>Ancyrodella</i> sp.
21009	6.04 m	Cudgebut Fault	126°01'20'' 18°43'50''	5 5137	Virgin Hills	?	<i>Ozarkodina</i> sp. None
21010	Spot	Below 21005	126°01'20'' 18°43'50''	5 5137	Virgin Hills	6-9	<i>Ancyrodella nodosa</i>
21011	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	12-15	see Fig. 24
21012	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	14+	see Fig. 24
21013	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	15	see Fig. 24
21014	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	16	see Fig. 24
21015	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	16	see Fig. 24
21016	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	16	see Fig. 24
21017	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	16	see Fig. 24
21018	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	Famennian	see Fig. 24

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
21019	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	Famennian	see Fig. 24
21020	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	?Virgin Hills	17+	see Fig. 24
21021	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137		17+	see Fig. 24
21022	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137		?	see Fig. 24
21023	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	17+	see Fig. 24
21024	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21025	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21026	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	17+	see Fig. 24
21027	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	17+	see Fig. 24
21028	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	17+	see Fig. 24
21029	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	17-18	see Fig. 24
21030	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21031	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21032	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21033	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21034	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21035	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21036	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21037	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21038	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21039	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
21040	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21041	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21042	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21043	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21044	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21045	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21046	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21047	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21048	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21049	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18	see Fig. 24
21050	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18	see Fig. 24
21051	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21052	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	18+	see Fig. 24
21053	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	20	see Fig. 24
21054	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	20+	see Fig. 24
21055	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	20+	see Fig. 24
21056	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	20+	see Fig. 24
21057	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	20-21	see Fig. 24
21058	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	?	see Fig. 24
21059	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	22	see Fig. 24
21060	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	22	see Fig. 24

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21061	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	22	see Fig. 24
21062	3.02 m	½ km SE of 21005	126°01'55'' 18°44'40''	5 5137	Bugle Gap	22	see Fig. 24
21063	Spot	Cave Spring	126°03'35'' 18°43'35''	5 5135	Sadler	?	None
21064	Spot	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Virgin Hills	4-7	<i>Polygnathus</i> cf. <i>P. webbi</i>
21065	Spot	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Gogo	3-7	<i>Falcodus guntharii</i>
21066	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Hibbardella (Hibbardella) angulata</i> <i>Polygnathus asymmetricus</i> <i>asymmetricus</i>
21067	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	?	None
21068	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	?	None
21069	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	?	None
21070	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	?	None
21071	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Sadler	?	None
21072	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Pillara	?	None
21073	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Pillara	?	None
21074	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Pillara	?	None
21075	3.02 m	E face of Lawford Range	126°04'45'' 18°42'00''	4 5120	Pillara	?	None
21076	3.02 m	E face of Lawford Range	126°04'45'' 18°41'00''	4 5120	Pillara	?	None
21077	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4 5121	Virgin Hills	?	None
21078	3.02 m	SW corner Teichert Hills	126°05'25'' 18°42'00''	4 5121	Virgin Hills	?	None
21079	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4 5121	Sadler	?	None
21080	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4 5121	Sadler	Frasnian	<i>Polygnathus foliatus</i>
21081	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4 5121	Sadler	3-5	<i>Polygnathus asymmetricus</i> <i>asymmetricus</i>
21082	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4 5121	Sadler	Frasnian	<i>Icriodus incrassatus</i> subsp. c <i>Ligonodina panderi</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo		Formation	Age	Conodont Fauna
				Run	No.			
21083	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Windjana	?Frasnian	<i>Icriodus</i> sp. <i>Polygnathus</i> sp.
21084	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Pillara	?	None
21085	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Pillara	?	None
21086	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Pillara	?	None
21087	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Pillara	?	None
21088	3.02 m	SW corner Teichert Hills	126°05'25'' 18°41'00''	4	5121	Pillara	?	None
21089	Spot	½ km E of Cave Spring	126°04'10'' 18°43'20''	5	5135	Virgin Hills	?	None
21090	Spot	½ km E of Cave Spring	126°04'10'' 18°43'20''	5	5135	Nautiloid bed Sadler	L. Frasnian	<i>Hindeodella</i> sp. <i>Icriodus alternatus alternatus</i> <i>I. alternatus curvirostratus</i> <i>I. incrassatus incrassatus</i> <i>Ozarkodina?</i> sp. <i>Polygnathus foliatus</i> <i>P. xylus</i> <i>Hindeodella brevis</i> <i>H.</i> sp. <i>Icriodus brevis spicatus</i> <i>I. symmetricus symmetricus</i> <i>Lonchodina</i> sp. nov. A <i>Neoprioniodus armatus</i> <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i> <i>P. xylus</i>
21091	Spot	½ km E of Cave Spring	126°04'10'' 18°43'20''	5	5135	Oncolite bed Sadler	3-5	<i>Hibbardella</i> sp. <i>Hindeodella compressa</i> <i>H. corpulenta</i> <i>Icriodus alternatus alternatus</i> <i>I. alternatus curvirostratus</i> <i>I. brevis brevis</i> <i>I. brevis darbyensis</i> <i>Lonchodina typicalis</i> <i>Neoprioniodus</i> sp. <i>Ozarkodina immersa</i> <i>O.?</i> sp. <i>Pelekyognathus elevatus</i> <i>Polygnathus decorosus</i> <i>P. foliatus</i> <i>P. janetae</i> <i>P. xylus</i>
21092	Spot	½ km E of Cave Spring	126°04'10'' 18°43'20''	5	5135	Oncolite bed Sadler	4-6	

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21093	3.02 m	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	17	<i>Ozarkodina?</i> <i>lacera</i> <i>Palmatolepis glabra glabra</i> <i>P. minuta minuta</i> <i>P. perlobata perlobata</i> <i>P. tenuipunctata</i> <i>Polygnathus brevilaminus</i> <i>P. fallax</i> <i>P. germanus</i> <i>P. normalis</i> None
21094	Spot	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	?	None
21095	Spot	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	?	None
21096	Spot	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	17+	<i>Icriodus alternatus alternatus</i> <i>Palmatolepis minuta minuta</i> <i>Polygnathus normalis</i> <i>Scaphignathus ziegleri</i> <i>Palmatolepis glabra</i> subsp. indet. <i>P. minuta minuta</i> <i>Polygnathus normalis</i>
21097	Spot	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	17+	None
21098	Spot	Ngumban Cliff	126°03'00'' 18°45'30''	6	5145	Virgin Hills	?	None
21099	3.02 m	1.5 km E of Pinnacle Spring	126°03'25'' 18°45'30''	6	5145	Bugle Gap	18	<i>Palmatolepis glabra acuta</i>
21100	3.02 m	1.5 km E of Pinnacle Spring	126°03'25'' 18°45'30''	6	5145	Bugle Gap	18	<i>Hibbardella (Hassognathus) franca</i> <i>Hindeodella subtilis</i> <i>Ozarkodina homoarcuata</i> <i>Synprioniodina alternata</i> None
21101	Spot	1.5 km E of Pinnacle Spring	126°03'25'' 18°45'30''	6	5145	Bugle Gap	?	None
21102	3.02 m	1.5 km E of Pinnacle Spring	126°03'25'' 18°45'30''	6	5145	Bugle Gap	?	None
21103	Spot	N margin Lawford Range	126°06'00'' 18°35'30''	1	5081	Virgin Hills	?Frasnian	<i>Polygnathus normalis</i>
21104	Spot	N margin Lawford Range	126°06'00'' 18°35'30''	1	5081	Virgin Hills	7	<i>Lonchodina</i> sp. nov. A. <i>Ozarkodina immersa</i> <i>Palmatolepis foliacea</i> <i>P. gigas</i> <i>Polygnathus normalis</i> <i>Polygnathus decorosus</i>
21105	Spot	N margin Lawford Range	126°06'05'' 18°35'30''	1	5081	Virgin Hills	?Frasnian	

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21106	Spot	N margin Lawford Range	126°06'05'' 18°35'30''	1 5081	Virgin Hills	?	None
21107	Spot	N margin Lawford Range	126°06'05'' 18°35'30''	1 5081	Virgin Hills	4-7	<i>Lonchodina</i> sp. nov. A <i>Ozarkodina</i> sp. <i>Polygnathus normalis</i> <i>Hibbardella</i> sp.
21108	Spot	N margin Lawford Range	126°06'05'' 18°35'30''	1 5081	Virgin Hills	7	<i>Lonchodina</i> sp. nov. A <i>Palmatolepis foliacea</i> <i>P. gigas</i> <i>Polygnathus pollocki</i>
21109	Spot	N margin Lawford Range	126°06'05'' 18°35'30''	1 5081	Virgin Hills	?	None
21110	Spot	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Virgin Hills	?11	<i>Ozarkodella homoarcuata</i> <i>Palmatolepis</i> sp. cf. <i>P. triangularis</i> <i>Polygnathus decorosus</i>
21111	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Windjana	?	None
21112	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Pillara	?	None
21113	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Pillara	?	None
21114	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Pillara	?Frasnian	<i>Polygnathus decorosus</i>
21115	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Pillara	?	None
21116	3.02 m	N margin Lawford Range	126°06'20'' 18°35'30''	1 5081	Pillara	?	None
21117	Spot	Above 2110	126°06'20'' 18°35'30''	1 5081	Virgin Hills	?	None
21118	Spot	N margin Lawford Range	126°07'00'' 18°35'40''	1 5080	Virgin Hills	?	None
21119	Spot	N margin Lawford Range	126°07'00'' 18°35'40''	1 5080	Virgin Hills	?	None
21120	Spot	N margin Lawford Range	126°07'00'' 18°35'40''	1 5080	Virgin Hills	3-9	<i>Ancyrodella buckeyensis</i> <i>Palmatolepis</i> sp. <i>Polygnathus xylus</i>
21121	Spot	N margin Lawford Range	126°07'10'' 18°35'40''	1 5080	Virgin Hills	?	None
21122	Spot	N margin Lawford Range	126°07'10'' 18°35'40''	1 5080	Virgin Hills	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21123	Spot	N margin Lawford Range	126°07'40'' 18°35'30''	1	5080	Virgin Hills	5-6	<i>Ancyrodella buckeyensis</i> <i>A. curvata</i> <i>Icriodus alternatus alternatus</i> <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i>
21124	Spot	N margin Lawford Range	126°07'40'' 18°35'30''	1	5080	Virgin Hills	5-10	<i>Ancyrodella lobata</i> <i>Polygnathus decorosus</i> <i>P. normalis</i>
21125	Spot	N margin Lawford Range	126°08'50'' 18°35'00''	1	5079	Windjana	?	None
21126	Spot	N margin Lawford Range	126°08'50'' 18°35'00''	1	5079	Virgin Hills	?	None
21127	Spot		126°09'30'' 18°35'00''	1	5079	Pillara	?	None
21128	Spot	4 km section in N Lawford Range ending at Lawford Spring	126°08'00'' 18°37'00''	1	5079	Pillara	?	None
21129	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21130	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21131	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21132	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21133	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21134	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21135	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21136	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None
21137	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1	5079	Pillara	?	None

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
21138	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21139	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21140	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21141	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21142	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21143	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21144	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21145	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21146	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21147	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21148	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21149	Spot	4 km section in N Lawford Range ending at Lawford Spring	to 126°08'40'' 18°35'30''	1 5079	Pillara	?	None
21150	Spot	3 km NE of Old Bohemia	126°10'30'' 18°38'30''	3 5102	Pillara	?	None
21151	Spot	3 km NE of Old Bohemia	126°10'30'' 18°38'30''	3 5102	Windjara	?	None
21152	Spot	3 km NE of Old Bohemia	126°10'30'' 18°38'30''	3 5102	Virgin Hills	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21153	Spot	3 km NE of Old Bohemia	126°10'30'' 18°38'30''	3 5102	Virgin Hills	3-5	<i>Polygnathus asymmetricus ovalis(?)</i>
21154	Spot	3 km NE of Old Bohemia	126°10'30'' 18°38'30''	3 5102	Virgin Hills	?Frasnian	<i>Polygnathus normalis</i>
21155	Spot	3 km NE of Old Bohemia	126°10'05'' 18°38'35''	3 5102	Virgin Hills	?Frasnian	<i>Hindeodella</i> sp. <i>Icriodus alternatus alternatus</i> <i>Polygnathus normalis</i> None
21156	3.02 m	Immediately S of Old Bohemia	126°08'30'' 18°40'00''	3 5103	Virgin Hills	?	None
21157	3.02 m	Immediately S of Old Bohemia	126°08'30'' 18°40'00''	3 5103	Virgin Hills	?	None
21158	3.02 m	Immediately S of Old Bohemia	126°08'30'' 18°40'00''	3 5103	Virgin Hills	13	<i>Acodina formosa</i> <i>Hindeodella subtilis</i> <i>I. alternatus alternatus</i> <i>I. alternatus cymbiformis</i> <i>Palmatolepis minuta loba</i> <i>P. quadrantinodosolobata</i> <i>P. cf. P. regularis</i> <i>P. tenuipunctata</i> <i>Polygnathus brevilaminus</i> <i>P. decorosus</i> <i>Palmatodella delicatula</i> <i>Palmatolepis minuta minuta</i> <i>P. quadrantinodosa marginifera</i> <i>Spathognathodus strigosus</i> None
21159	Spot	Immediately S of Old Bohemia	126°08'30'' 18°40'00''	3 5103	Virgin Hills	17+	
21160	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Virgin Hills	?	
21161	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Virgin Hills	?	None
21162	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Bugle Gap	14+	<i>Belodella resima</i> <i>Hindeodella subtilis</i> <i>Ligonodina</i> sp. <i>Palmatolepis minuta minuta</i> <i>Synprioniodina alternata</i> gen. et sp. nov. None
21163	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Bugle Gap	?	None
21164	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Bugle Gap	?	None
21165	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Bugle Gap	?	None
21166	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3 5103	Bugle Gap	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo		Formation	Age	Conodont Fauna
				Run	No.			
21167	Spot	1.5 km S of Old Bohemia	126°08'30'' 18°40'35''	3	5103	Bugle Gap	?	None
21168	Spot	Mt Pierre Gorge	126°05'00'' 18°36'45''	3	5107	Pillara	?	None
21169	Spot	Mt Pierre Gorge	126°05'00'' 18°36'45''	3	5107	Windjara	?	None
21170	Spot	Mt Pierre Gorge	126°05'00'' 18°36'45''	3	5107	Pillara	?	None
21171	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21172	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21173	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21174	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21175	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21176	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21177	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21178	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21179	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21180	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21181	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21182	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21183	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21184	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21185	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21186	6.04 m	Gap Spring- Kunian Gap	125°54'35'' 18°37'10''	2	5088	Pillara	?	None
21187	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Pillara	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21188	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Pillara	?	None
21189	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21190	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	3-5	<i>Icriodus brevis brevis</i> <i>I. brevis darbyensis</i> <i>I. brevis spicatus</i>
21191	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	3-5	<i>Icriodus brevis spicatus</i> <i>I. symmetricus circularis</i>
21192	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	3-5	<i>Icriodus brevis brevis</i> <i>I. symmetricus circularis</i>
21193	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21194	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	4-7	<i>Polygnathus pollocki</i> <i>Spathognathodus</i> sp.
21195	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21196	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21197	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	4-7	<i>Hindeodella subtilis</i> <i>Icriodus alternatus alternatus</i> <i>Ozarkodina</i> sp. <i>Polygnathus pollocki</i> <i>P. xylus</i> <i>Synprioniodina alternata</i>
21198	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21199	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21200	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	4-7	<i>Polygnathus pollocki</i> <i>P. sp. nov. B</i> <i>Synprioniodina alternata</i>
21201	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21202	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21203	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21204	6.04 m	Kudata Gap	125°54'35'' 18°36'00''	2	5088	Sadler	?	None
21205	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2	5088	Sadler	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21206	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	4-7	<i>Belodella resima</i> <i>Hibbardella</i> (<i>Diplododella</i>) <i>aurita</i> <i>Hindeodella</i> sp. <i>Ozarkodina</i> sp. <i>Polygnathus pollocki</i>
21207	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	4-7	<i>Belodella resima</i> <i>Icriodus brevis darbyensis</i> <i>Polygnathus pollocki</i>
21208	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	4-7	<i>Belodella triangularis</i> <i>Hindeodella</i> sp. <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i> <i>P. pollocki</i>
21209	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?	None
21210	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>A. rotundiloba alata</i> <i>Hibbardella</i> sp. <i>Icriodus alternatus alternatus</i> <i>Lonchodina</i> sp. nov. A <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>P. normalis</i>
21211	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?	None
21212	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i>
21213	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Polygnathus decorosus</i>
21214	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?	None
21215	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Belodella triangularis</i> <i>Hindeodella subtilis</i> <i>P. decorosus</i>
21216	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Polygnathus decorosus</i>
21217	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Hindeodoella subtilis</i> <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i> <i>P. pollocki</i> <i>Synproniodina alternata</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21218	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	4-7	<i>Belodella resima</i> <i>Drepanodus</i> sp. <i>Hindeodella subtilis</i> <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>P. pollocki</i> <i>Synprioniodina alternata</i>
21219	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Belodella</i> sp. <i>Polygnathus decorosus</i> <i>P. foliatus</i>
21220	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i>
21221	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Polygnathus decorosus</i>
21222	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba</i> <i>A. rotundiloba alata</i> <i>Icriodus alternatus alternatus</i> <i>Polygnathus foliatus</i> <i>P. pollocki</i>
21223	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-5	<i>Belodella resima</i> <i>Icriodus alternatus cymbiformis</i> <i>I. brevis spicatus</i> <i>Polygnathus decorosus</i>
21224	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-6	<i>Icriodus alternatus cymbiformis</i> <i>Lonchodina</i> sp. nov. A <i>Ozarkodina</i> sp. nov. B <i>Polygnathus decorosus</i> <i>P. foliatus</i>
21225	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba</i> subsp. indet. <i>Icriodus alternatus curvirostratus</i> <i>I. alternatus elegantulus</i> <i>Neoproniodus</i> sp. C <i>Ozarkodina versa</i>
21226	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Polygnathus decorosus</i> <i>Hindeodella compressa</i> <i>Ligonodina spiculata</i> <i>Polygnathus decorosus</i> <i>P. foliatus</i>
21227	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Icriodus symmetricus symmetricus</i> <i>Lonchodina arcuata</i> <i>Polygnathus decorosus</i> <i>P. foliatus</i> <i>P. pollocki</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21228	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Belodella costatus</i> <i>Hindeodella brevis</i> <i>Icriodus symmetricus symmetricus</i> <i>Ozarkodina immersa</i> <i>Polygnathus brevilaminus</i> <i>P. decorosus</i> <i>P. pollocki</i>
21229	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Belodella costata</i> <i>Hibbardella (Diplododella) alternata</i> <i>Hindeodella compressa</i> <i>Icriodus alternatus cymbiformis</i> <i>I. alternatus</i> subsp. a <i>I. brevis darbyensis</i> <i>I. symmetricus symmetricus</i> <i>Lonchodina typicalis</i> <i>Neoprioniodus armatus</i> <i>Ozarkodina macra</i> <i>O.?</i> sp. <i>Polygnathus decorosus</i> <i>P. foliatus</i> <i>P. cf. P. webbi</i>
21230	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Lonchodina</i> sp.
21231	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Polygnathus foliatus</i> <i>Ancyrodella rotundiloba rotundiloba</i> <i>Icriodus alternatus alternatus</i> <i>I. symmetricus symmetricus</i> <i>Polygnathus decorosus</i> <i>P. normalis</i>
21232	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	4-7	<i>Hindeodella subtilis</i> <i>Icriodus alternatus elegantulus</i> <i>I. symmetricus circularis</i> <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i> <i>P. foliatus</i>
21233	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Hindeodella</i> sp. <i>Ozarkodina</i> sp.
21234	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Polygnathus decorosus</i> <i>Ancyrodella rotundiloba rotundiloba</i> <i>A. rotundiloba alata</i> <i>Hindeodella corpulenta</i> <i>H.</i> sp. <i>Ozarkodina</i> sp. <i>Polygnathus foliatus</i> <i>Synprioniodina alternata</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21235	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba alata</i> <i>Hindeodella</i> sp. <i>Icriodus alternatus alternatus</i> <i>I. symmetricus circularis</i> <i>Lonchodina perlonga</i> <i>Ozarkodina immersa</i> <i>Polygnathus brevilaminus</i> <i>P. decorosus</i> <i>P. foliatus</i> <i>P. normalis</i>
21236	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?L. Frasnian	<i>Drepanodus</i> sp. <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i>
21237	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>A. rotundiloba alata</i> <i>Icriodus alternatus alternatus</i> <i>I. incrassatus incrassatus</i> <i>I. symmetricus circularis</i> <i>Lonchodina</i> sp. <i>Ozarkodina immersa</i> <i>Polygnathus decorosus</i>
21238	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	?	None
21239	3.02 m	Sadler Ridge	125°56'30'' 18°36'40''	2 5088	Sadler	3-4	<i>Ancyrodella rotundiloba rotundiloba</i> <i>Polygnathus decorosus</i>
21240	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?	None
21241	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Lonchodina typicalis</i> <i>Polygnathus decorosus</i>
21242	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Enantiognathus lipperti</i> <i>Hindeodella</i> sp. <i>Icriodus alternatus costatus</i> <i>I. alternatus curvirostratus</i> <i>I. alternatus elegantulus</i> <i>I. brevis brevis</i> <i>I. brevis</i> subsp. a <i>I. incrassatus</i> subsp. c <i>I. symmetricus circularis</i> <i>Ligonodina</i> sp. <i>Lonchodina typicalis</i> <i>Ozarkodina?</i> sp. <i>Pelekyognathus elevatus</i> <i>Polygnathus decorosus</i> <i>P. xylus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21243	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Hindeodella subtilis</i> <i>Icriodus brevis brevis</i> <i>Polygnathus brevilaminus</i> <i>P. decorosus</i> <i>P. xylus</i>
21244	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Polygnathus decorosus</i>
21245	3.02 m	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	None
21246	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Bryantodus</i> sp. <i>Hindeodella subtilis</i> <i>Icriodus alternatus cymbiformis</i> <i>I. brevis spicatus</i> <i>Polygnathus decorosus</i>
21247	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	2-4	<i>Ancyrodella buckeyensis</i> <i>A. rugosa</i> <i>A. rotundiloba rotundiloba</i> <i>Icriodus alternatus elegantulus</i> <i>Ozarkodina</i> sp. <i>Polygnathus decorosus</i> <i>P. xylus</i>
21248	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?	None
21249	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?	None
21250	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?	None
21251	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?	None
21252	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2 5089	Gogo	?L. Frasnian	<i>Enantiognathus lipperti</i> <i>Hibbardella (Diplododella) aurita</i> <i>Icriodus alternatus curvirostratus</i> <i>Neoproniodus</i> sp. <i>Ozarkodina?</i> sp. <i>Polygnathus decorosus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21253	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2	5089	Gogo	3-4	<i>Ancyrodella gigas</i> <i>Camptognathus conus</i> <i>Hindeodella subtilis</i> <i>Icriodus symmetricus circularis</i> <i>Ligonodina panderi</i> <i>Lonchodina</i> sp. nov. A <i>Ozarkodina immersa</i> <i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. australis</i> <i>P. decorosus</i> <i>P. foliatus</i> <i>P. cf. P. webbi</i>
21254	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2	5089	Gogo	?	None
21255	Spot	Longs Well Ck	125°57'00'' 18°36'40''	2	5089	Gogo	?	None
21256	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	15	see Fig. 25
21257	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	Famennian	see Fig. 25
21258	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	13-15	see Fig. 25
21259	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	Famennian	see Fig. 25
21260	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	13+	see Fig. 25
21261	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	13+	see Fig. 25
21262	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	14-15	see Fig. 25
21263	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	14-17	see Fig. 25
21264	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	Famennian	see Fig. 25
21265	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	Famennian	see Fig. 25
21266	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	16	see Fig. 25
21267	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	—	—	Virgin Hills	17-18	see Fig. 25

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
21268	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	?18	see Fig. 25
21269	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	?18	see Fig. 25
21270	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	18-19	see Fig. 25
21271	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	18	see Fig. 25
21272	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	18	see Fig. 25
21273	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	Famennian	see Fig. 25
21274	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	— —	Virgin Hills	?	see Fig. 25
21275	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	18	see Fig. ??
21276	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	?	see Fig. ??
21277	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	?	see Fig. ??
21278	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	18	see Fig. ??
21279	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	?	see Fig. ??
21280	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Virgin Hills	18-19	see Fig. ??
21281	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Piker Hills	?Famennian	see Fig. ??
21282	3.02 m	Margaret River to Needle Eye Rocks	125°52'15'' 18°15'40''	2 5089	Piker Hills	18	see Fig. ??
21283	3.02 m	S end of Home Range	125°55'00'' 18°30'40''	— —	Sadler	?	None
21284	3.02 m	S end of Home Range	125°55'00'' 18°30'40''	— —	Sadler	?	None
21285	3.02 m	S end of Home Range	125°55'00'' 18°30'40''	— —	Pillara	?	None
21286	3.02 m	S end of Home Range	125°55'00'' 18°30'40''	— —	Pillara	?	None
21287	3.02 m	S end of Home Range	125°55'00'' 18°30'40''	— —	Pillara	?	None
21288	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21289	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21290	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21291	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?Pamennian	Hibbardella sp.
21292	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21293	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21294	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21295	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21296	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21297	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21298	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21299	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	— —	Pillara	?	None
21300	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21301	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21302	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21303	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21304	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	Fragment
21305	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21306	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21307	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21308	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21309	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None

<i>Sample No. (BG)</i>	<i>Collecting interval</i>	<i>Locality</i>	<i>Co-ordinates</i>	<i>Photo Run No.</i>	<i>Formation</i>	<i>Age</i>	<i>Conodont Fauna</i>
21310	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21311	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	Fragment
21312	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21313	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21314	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21315	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21316	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21317	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21318	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21319	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21320	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21321	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21322	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21323	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21324	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21325	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21326	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21327	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21328	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21329	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None
21330	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2 5089	Pillara	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo		Formation	Age	Conodont Fauna
				Run	No.			
21331	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21332	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21333	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21334	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21335	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21336	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21337	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21338	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Pillara	?	None
21339	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Windjana	?	None
21340	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Sadler	?11	None
21341	6.04 m	Menyous Gap	125°50'00'' 18°24'00''	2	5089	Sadler	?	None
21342	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21343	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21344	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21345	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21346	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21347	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21348	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21349	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21350	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None
21351	3.02 m	E side of Horseshoe Range	126°14'10'' 18°11'00''	—	—	Fairfield	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21352	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	18+	<i>Apatognathus varians varians</i> <i>Hibbardella (Hassognathus) separata</i> <i>Hindeodella subtilis</i> <i>Icriodus alternatus</i> subsp. a <i>Polygnathus collinsoni</i> <i>P. znepolensis</i> <i>Spathognathus strigosus</i> None
21353	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	?	None
21354	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	18+	<i>Icriodus alternatus curvirostratus</i>
21355	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	22	<i>Acodina formosa</i> <i>Hibbardella (Hassognathus) separata</i> <i>Hindeodella corpulenta</i> <i>Lonchodina</i> sp. nov. A <i>Ozarkodina</i> sp. <i>Polygnathus irregularis</i> <i>P. perplexus</i> None
21356	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	?	None
21357	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	?	None
21358	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	23	<i>Hibbardella</i> sp. <i>Hindeodella compressa</i> <i>Ozarkodina</i> sp. <i>Polygnathus collinsoni</i> <i>P. perplexus</i>
21359	3.02 m	Piker Hills	126°04'00'' 18°05'00''	2 5089	Piker Hills	23	<i>Apatognathus varians ethingtoni</i> <i>Ozarkodina</i> sp. <i>Polygnathus</i> sp.
21360	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2 5089	Napier	?	None
21361	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2 5089	Napier	17/18	<i>Hindeodella corpulenta</i> <i>H. subtilis</i> <i>Neoprioniodus</i> sp. nov. A <i>Ozarkodina</i> sp. <i>Palmatolepis glabra pectinata</i> <i>P. minuta minuta</i> <i>Polygnathus nodoundatus</i> <i>P. cf. P. normalis</i> <i>Polylophodonta elongata</i> <i>Scutula bipennata</i> <i>Spathognathodus fitzroyi</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21362	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2	5089	Napier	17/18	<i>Palmatolepis glabra pectinata</i> <i>Polygnathus nodoundata</i>
21363	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2	5089	Napier	17/18	<i>Hindeodella corpulenta</i> <i>Falcodus aculeatus</i>
21364	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2	5089	Napier	17/18	<i>Scaphignathus zieglerti</i>
21365	3.02 m	Geikie Gorge	125°40'00'' 18°06'00''	2	5089	Napier	17/18	<i>Ozarkodina</i> sp. <i>Scaphignathus veliferus</i> <i>Scutula bipennata</i> None
21366	Spot	Windjana Gorge	124°58'00'' 17°25'00''	—	—	Pillara	?	
21367	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4	5121	Pillara	L. Frasnian	<i>Hibbardella</i> sp. <i>Hindeodella subtilis</i> <i>Scutula bipennata</i> <i>Lonchodina</i> sp.
21368	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4	5121	Windjana	?	
21369	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4	5121	Sadler	?	None
21370	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4	5121	Sadler	?	None
21371	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4	5121	Sadler	6	<i>Ancyrodella buckeyensis</i> <i>Ancyrodella lobata</i> <i>Ancyrodella nodosa</i> <i>Bryantodus</i> sp. <i>Enantiognathus lipperti</i> <i>Falcodus variabilis</i> <i>Hibbardella (Hibbardella) multidentis</i> <i>H. (Diplodella) aurita</i> <i>Hindeodella compressa</i> <i>H. subtilis</i> <i>Ligonodina panderi</i> <i>Lonchodina perlonga</i> <i>Nothognathella abbreviata</i> <i>N. sublaevis</i> <i>Ozarkodina immersa</i> <i>O. sp. nov. B</i> <i>Palmatolepis subrecta</i> <i>Polygnathus foliatus</i> <i>P. normalis</i> <i>Synprioniodina alternata</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21372	3.02 m	E side of Teichert Hills	126°06'00'' 18°41'00''	4 5121	Sadler	?	<i>Hindeodella</i> sp.
1362	Spot	Geikie Gorge	125°40'00'' 18°06'00''	4 5121	Napier	17-18	<i>Hindeodella corpulenta</i> <i>Lonchodina</i> sp. <i>Ozarkodina homoarcuata</i> <i>Palmatolepis glabra pectinata</i> <i>P. minuta minuta</i> <i>P. perlobata perlobata</i> <i>Polygnathus delicatulus</i> <i>P. germanus germanus</i> <i>P. normalis</i> <i>Tripodellus robustus</i>
1365	Spot	Geikie Gorge	125°40'00'' 18°06'00''	4 5121	Napier	19+	<i>Palmatodeella delicatula</i> <i>P. minuta minuta</i> <i>Scaphignathus veliferus</i>
19963	Spot	Geikie Hill	126°39'03'' 18°04'14''	Noonkanbah 1A D5055	Pillara	?	None
19965	Spot	Geikie Gorge	125°40'00'' 18°06'00''	— —	Napier	22	<i>Ozarkodina homoarcuata</i> <i>Palmatolepis gracilis gracilis</i> <i>Polygnathus collinsoni</i> <i>P. irregularis</i> <i>P. znepolensis</i>
21414	Spot	Elimberrie	125°02'40'' 17°40'10''	— —	algal bioherm ?Napier	15-18	<i>Hibbardella (Diplododella) aurita</i> <i>Polygnathus normalis</i> <i>Prioniodina? smithi</i> <i>Tripodellus robustus?</i>
21415	Spot	Elimberrie	125°02'40'' 17°40'10''	— —	algal bioherm ?Napier	14+	<i>Palmatolepis minuta minuta</i> <i>Hindeodella</i> sp.
21416	Spot	Elimberrie	125°02'40'' 17°40'10''	— —	algal bioherm ?Napier	17-18	<i>Hibbardella</i> sp. <i>Hindeodella corpulenta</i> <i>H. subtilis</i> <i>Ozarkodina macra</i> <i>Palmatolepis minuta minuta</i> <i>Polygnathus delicatulus</i> <i>P. germanus germanus</i> <i>P. normalis</i>
21418	Spot	Elimberrie	125°02'40'' 17°40'10''	— —	highest Napier	22-23	<i>Apatognathus varians varians</i> <i>Hindeodella</i> sp. <i>Palmatolepis gracilis gracilis</i> <i>Polygnathus collinsoni</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21422-1	3.02 m	Narlarla	124°40'22'' no copy for second line	— —	Napier	?	<i>Ozarkodina</i> sp.
21422-2	3.02 m	Narlarla	124°40'22'' no copy for second line	— —	Napier	?	<i>Polygnathus normalis</i>
21422-3	3.02 m	Narlarla	124°40'22'' no copy for second line	— —	Napier	?	<i>Icriodus alternatus elegantulus</i> <i>Ozarkodina immersa</i> <i>Polygnathus</i> sp. Fragments
21422-4	3.02 m	Narlarla	124°43'30'' 17°15'30''	— —	Napier	?	None
21422-5	3.02 m	Narlarla	124°43'30'' 17°15'30''	— —	Napier	?	None
21422-6	3.02 m	Narlarla	124°43'30'' 17°15'30''	— —	Napier	?	None
21422-7	3.02 m	Narlarla	124°43'30'' 17°15'30''	— —	Napier	13	<i>Icriodus arkonensis</i> subsp. c
21422-8	3.02 m	Narlarla	124°43'30'' 17°15'30''	— —	Napier	?	None
21511-pt. 6	Spot	Windjana Gorge	124°57'08'' 17°24'20''	— —	Pillara	?	None
21520	Spot	1.5 km N of Waggon Pass	126°04'40'' 18°37'38''	— —	Globular Virgin Hills stromatolite bed longitudinal bed	9-10	<i>Ancyrodella ioides</i> <i>A. nodosa</i> <i>Hindeodella subtilis</i> <i>Ligonodina panderi</i> <i>Lonchodina typicalis</i> <i>L. sp. nov. A</i> <i>Neoprioniodus</i> cf. <i>N. armatus</i> <i>Palmatolepis delicatulus</i> <i>P. gigas</i> <i>Polygnathus</i> sp.
21522	Spot	Waggon Pass	126°04'40'' 18°37'38''	— —	stromatolite bed within and below Virgin Hills	8-9	<i>Ancyrodella buckeyensis</i> <i>Ancyrognathus triangularis</i> <i>Bryantodus nitidus</i> <i>Hibbardella</i> (<i>Diplododella</i>) <i>aurita</i> <i>Hindeodella subtilis</i> <i>Nothognathella abnormis</i> <i>Palmatolepis subrecta</i> <i>Polygnathus decorosus</i> <i>Synprioniodina alternata</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21526	Spot	3.0 km NNW of Pinnacle Spring	126°01'40'' 18°44'10''	— —	stromatolites	8	<i>Ancyrodella curvata</i> <i>Ancyrognathus altus</i> <i>Bryantodus nitidus</i> <i>Ligonodina panderi</i> <i>Lonchodina</i> sp. nov. A <i>Palmatolepis subrecta</i> <i>Polygnathus decorosus</i>
21527	Spot	3.0 km NNW of Pinnacle Spring	126°01'40'' 18°44'10''	— —	abutting stromatolites	16-17	<i>Acodina</i> sp. <i>Hindeodella brevis</i> <i>H. subtilis</i> <i>Nothognathella</i> sp. <i>Ozarkodina immersa</i> <i>O. macra</i> <i>Palmatodella delicata</i> <i>Palmatolepis glabra elongata</i> <i>P. minuta minuta</i> <i>P. minuta loba</i> <i>P. minuta schleizia</i> <i>P. quadrantinodosa marginifera</i> <i>Polygnathus brevilaminus</i> <i>P. normalis</i> <i>P. triphyllatus</i> <i>Prioniodina? smithi</i> <i>Scutula bipennata</i> <i>Scutula venusta</i> <i>Tripodella robustus</i>
21530	Spot	2.4 km S of Teichert Hills	126°06'15'' 18°42'07''	— —	stromatolites	13	<i>Icriodus incrassatus incrassatus</i> <i>I. incrassatus</i> subsp. b <i>I. incrassatus</i> subsp. c <i>I. incrassatus</i> subsp. d <i>Ligonodina magnidens</i> <i>Neoprionodus armatus</i> <i>Palmatolepis triangularis</i> <i>P. quadrantinodosolobata</i> <i>P. cf. P. regularis</i>
21532	Spot	McWhae Ridge S of pt D8	126°04'30'' 18°43'55''	5 5133	Sadler-Virgin Hills transition	4	<i>Hindeodella</i> sp. nov. A <i>Palmatolepis</i> cf. <i>P. punctata</i> <i>Polygnathus asymmetricus</i> <i>asymmetricus</i> <i>P. decorosus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21546	Spot	McWhae Ridge pt A18	126°04'30'' 18°43'55''	5 5133	bulbous stroma- tolite bed	15	<i>Falcodus variabilis</i> <i>Hibbardella</i> (<i>Diplododella</i>) <i>alternata</i> <i>Hindeodella subtilis</i> <i>Icriodus incrassatus</i> subsp. a <i>Nothognathella falcata</i> <i>N. palmatoformis</i> <i>N. typicalis</i> <i>Ozarkodina immersa</i> <i>Palmatodella delicatula</i> <i>Palmatolepis glabra glabra</i> <i>P. glabra elongata</i> <i>P. minuta minuta</i> <i>P. minuta loba</i> <i>P. quadrantinodosolobata</i> <i>P. subperlobata</i> subsp. A <i>P. subgracilis</i> <i>Polygnathus germanus germanus</i> <i>P. glaber glaber</i> <i>P. normalis</i> <i>Prioniodina? smithi</i> <i>Scutula sinepennata</i> <i>Tripodellus robustus</i> Fragments
21547	Spot	McWhae Ridge pt A16	126°04'30'' 18°43'55''	— —	domal stroma- tolites Virgin Hills	?	
21548	Spot	McWhae Ridge pt A18 to pt A19	126°04'30'' 18°43'55''	— —	abutting unconformity Virgin Hills	15	<i>Hibbardella</i> sp. <i>Hindeodella subtilis</i> <i>Neoprioniodus armatus</i> <i>Nothognathella falcata</i> <i>N. typicalis</i> <i>Ozarkodina homoarcuata</i> <i>Palmatolepis glabra glabra</i> <i>P. glabra elongata</i> <i>P. minuta minuta</i> <i>P. tenuipunctata</i> <i>Polygnathus germanus germanus</i> <i>P. normalis</i>
21549	3.02 m	McWhae Ridge pt A18 to pt A19	126°04'30'' 18°43'55''	— —	abutting unconformity Virgin Hills	15-18	<i>Hindeodella</i> sp. <i>Palmatolepis glabra elongata</i> <i>P. minuta minuta</i> <i>Polygnathus germanus germanus</i> <i>P. normalis</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21550	Spot	Immediately S of pt A17	126°04'30'' 18°43'55''	— —	stromatolites	15	<i>Acodina formosa</i> <i>A. sannemanni</i> <i>Hindeodella compressa</i> <i>Icriodus alternatus alternatus</i> <i>I. incrassatus incrassatus</i> <i>I. incrassatus</i> subsp. b <i>I. incrassatus</i> subsp. c <i>Palmatodella delicatula</i> <i>Palmatolepis glabra elongata</i> <i>P. minuta minuta</i> <i>P. quadrantinodosolobata</i> <i>P. cf. P. regularis</i> <i>P. subperlobata</i> <i>P. sp. nov. B</i> <i>Polygnathus brevilaminus</i> None
21555	Spot	3.02 m below A26	126°04'30'' 18°43'55''	— —	Virgin Hills	?	
21556	Spot	3.02 m above A26	126°04'30'' 18°43'55''	— —	Virgin Hills	11-13	<i>Icriodus alternatus elegantulus</i> <i>I. arkonensis</i> subsp. b <i>I. arkonensis</i> subsp. c <i>Ligonodina magnidens</i> <i>Nothognathella abnormis</i> <i>N. typicalis</i> <i>Ozarkodina macra</i> <i>Palmatolepis triangularis</i> <i>Polygnathus brevilaminus</i> <i>P. sp. nov. D</i>
21566	Spot	McWhae Ridge between A27/A7	126°04'30'' 18°43'55''	— —	stromatolites 1st unit	6-7	<i>Bryantodus nitidus</i> <i>Lonchodina</i> sp. nov. A <i>Nothognathella brevidonta</i> <i>Ozarkodina macra</i> <i>Polygnathus foliatus</i>
21567	Spot	McWhae Ridge between A27/A7	126°04'30'' 18°43'55''	— —	stromatolites 3rd unit	7	<i>Nothognathella typicalis</i> <i>Palmatolepis subrecta</i> <i>Polygnathus foliatus</i>
21568	Spot	McWhae Ridge between A27/A7	126°04'30'' 18°43'55''	— —	stromatolites 4th unit	6-8	<i>Synprioniodina alternata</i> <i>Ancyrodella curvata</i> <i>A. nodosa</i> <i>Bryantodus nitidus</i>
21569	Spot	McWhae Ridge between A27/A7	126°04'30'' 18°43'55''	— —	stromatolites 5th unit	11+	<i>Polygnathus normalis</i> <i>Palmatolepis triangularis?</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21570	Spot	McWhae Ridge pt A6	126°04'30'' 18°43'55''	— —	Virgin Hills 1 m below <i>Frutexit</i> s	Frasnian	<i>Hindeodella</i> sp. <i>Icriodus incrassatus incrassatus</i> <i>Neoproniodus armatus</i>
21571	Spot	McWhae Ridge pt A41	126°04'30'' 18°43'55''	— —	stromatolites 6th unit	15	<i>Apatognathus</i> sp. <i>Icriodus incrassatus incrassatus</i> <i>I. incrassatus</i> subsp. b <i>I. incrassatus</i> subsp. c <i>I. incrassatus</i> subsp. d <i>Neoproniodus</i> sp. <i>Palmatolepis glabra pectinata</i> <i>P. minuta minuta</i> <i>P. minuta loba</i> <i>P. cf. P. regularis</i> <i>Polygnathus germanus incurvus</i> <i>P. glaber glaber</i> gen. et sp. nov. B....
21572	Spot	McWhae Ridge pt A41	126°04'30'' 18°43'55''	— —	massive algal limestone	?	None
21573	Spot	McWhae Ridge pt A41	126°04'30'' 18°43'55''	— —	Virgin Hills E side of fault	5-7	<i>Palmatolepis subrecta</i> <i>Polygnathus foliatus</i>
21574	Spot	McWhae Ridge pt A41	126°04'30'' 18°43'55''	— —	Virgin Hills	6-8	<i>Ancyrodella nodosa</i> <i>Ancyrognathus irregularis</i> <i>Bryantodus nitidus</i> <i>Ligonodina</i> sp. <i>Palmatolepis subrecta</i> <i>Polygnathus</i> sp. A <i>Polygnathus</i> sp.
21577	Spot	N Laidlaw Range. pt 14	126°02'27'' 18°38'05''	— —	Pillara	Frasnian	
21578-1	1.51 m	Mimbi Creek	Sample BG 19181 126°04'40'' 18°43'48''	— —	Bugle Gap?	22	<i>Hindeodella compressa</i> <i>Neoproniodus armatus</i> <i>Polygnathus collinsoni</i> <i>P. irregularis</i>
21578-2	1.51 m	Mimbi Creek	Sample BG 19181 126°04'40'' 18°43'48''	— —	Bugle Gap?	22/23	<i>Spathognathodus bohlenanus</i> <i>Hindeodella compressa</i> <i>H. sp.</i> <i>Ozarkodina macra</i> <i>Palmatolepis gracilis gracilis</i> <i>Pelekysgnathus</i> sp. nov. A <i>Polygnathus collinsoni</i> <i>Prioniodina? smithi</i> <i>Spathognathodus crassidentatus</i>

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run	No.	Formation	Age	Conodont Fauna
21578-3	1.51 m	Mimbi Creek	Sample BG 19182	—	—	Bugle Gap?	?23	<i>Hibbardella</i> (<i>Hassognathus</i>) <i>separata</i> <i>Hindeodella brevis</i> <i>H. compressa</i> <i>H. corpulenta</i> <i>H. sp.</i> <i>Polygnathus collinsoni</i> <i>Spathognathus crassidentatus</i> <i>Spathognathus strigosus</i> None
21583	Spot	NE of Old Bohemia pt 20	126°09'47'' 18°42'07''	—	—	Pillara	?	
21612	1.51 m	pt 1015	126°03'00''	6	5145	Virgin Hills	?5	see Fig. 26
21613	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	?5	see Fig. 26
21614	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	6	see Fig. 26
21615	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	6	see Fig. 26
21616	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	6/7	see Fig. 26
21617	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	7/9	see Fig. 26
21618	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	9/10	see Fig. 26
21619	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	11/12	see Fig. 26
21620	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	12	see Fig. 26
21621	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	12/13	see Fig. 26
21622	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	Virgin Hills	13/14	see Fig. 26
21623	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	1st stromatolite	15	see Fig. 26
21624	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	1st stromatolite	15	see Fig. 26
21625	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	1st stromatolite	15/16	see Fig. 26
21626	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	1st stromatolite	17	see Fig. 26
21627	1.51 m	Pinnacle Spring pt 1015	18°45'30'' 126°03'00''	6	5145	main stromatolite Virgin Hills	17	see Fig. 26

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo Run No.	Formation	Age	Conodont Fauna
21628	1.51 m	pt 1015 Pinnacle Spring	126°03'00'' 18°45'30''	6 5145	Virgin Hills	18	see Fig. 26
21629	1.51 m	pt 1015 Pinnacle Spring	126°03'00'' 18°45'30''	6 5145	Virgin Hills	18	see Fig. 26
21630	Spot	N of Pinnacle Spring, pt 1018	125°59'20'' 18°43'50''	— —	Bugle Gap	17	<i>Icriodus</i> sp. <i>Palmatolepis distorta</i> <i>P. marginifera</i> <i>P. minuta minuta</i> <i>Polygnathus germanus germanus</i> <i>P. glaber glaber</i> <i>P. normalis</i>
21633	Spot	N of Pinnacle Spring, pt 1019	125°59'12'' 18°43'25''	— —	?	17-18	<i>Spathognathodus strigosus</i> <i>Ozarkodina? lacera</i> <i>O. macra</i> <i>Palmatolepis distorta</i> <i>P. minuta minuta</i> <i>Polygnathus glaber glaber</i> <i>Prioniodina? smithi</i> <i>Polygnathus normalis</i>
21635	Spot	N of Pinnacle Spring, pt 1026	125°59'28'' 18°43'50''	— —	Bugle Gap	?	
21647	Spot	Virgin Hills pt 1035	125°52'48'' 18°31'08''	— —	Virgin Hills	17-18	<i>Falcodus</i> sp. nov. A <i>Hindeodella</i> sp. <i>Nothognathella</i> sp. <i>Ozarkodina immersa</i> <i>Palmatodella delicatula</i> <i>Palmatolepis glabra elongata</i> <i>P. glabra pectinata</i> <i>P. minuta minuta</i> <i>Polygnathus normalis</i> <i>Prioniodina? smithi</i>
21658	Spot	Elimberrie pt 1040	125°02'47'' 17°40'08''	— —	Napier	?	None
21667	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	— —	Napier	18+	<i>Polygnathus znepolensis</i>
21668	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	— —	Napier		Fragments
21669	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	— —	Napier		None
21670	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	— —	Napier	?	None

Sample No. (BG)	Collecting interval	Locality	Co-ordinates	Photo		Formation	Age	Conodont Fauna
				Run	No.			
21671	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	—	—	Napier	?	None
21672	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	—	—	Napier	17+	<i>Rhodalepis inornata</i> <i>Spathognathodus strigosus</i>
21673	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	—	—	Napier	17+	<i>Rhodalepis inornata</i> <i>Spathognathodus strigosus</i>
21674	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	—	—	Napier	?	None
21675	6.00 m	Windjana Gorge	124°56'30'' 17°24'30''	—	—	Napier	?	None
21678	Spot	Narlarla	124°43'30'' 17°15'30''	—	—	Napier	5-10	<i>Palmatolepis subrecta</i>
21679	Spot	Narlarla	124°43'30'' 17°15'30''	—	—	Napier	?	None
21680	Spot	Narlarla	124°43'30'' 17°15'30''	—	—	Napier	10-15	<i>Palmatolepis subperlobata</i> <i>Polygnathus</i> sp. <i>Ieriodus</i> sp.

APPENDIX 2

INDEX AND REGISTER OF FIGURED SPECIMENS

Name of conodont species	Page	Slide numbers of figured specimens	Sample Number (BG)	Formation
<i>Acodina formosa</i> Stauffer	49	CPC 12849	21158	Virgin Hills
<i>Acodina inopinata</i> (Stauffer)	49	CPC 12850	19018	Virgin Hills
<i>Acodina</i> sp. nov. A	50	CPC 12851 Holotype CPC 12852 Paratype	21264 21265	Virgin Hills Virgin Hills
<i>Ancyrodella buckeyensis</i> Stauffer	53	CPC 12353 CPC 12354 CPC 12355 CPC 12356 CPC 12357 CPC 12358 CPC 12359	19001 19537 19584 21371 21371 21371 21371	Gogo Virgin Hills Virgin Hills Sadler Sadler Sadler Sadler
<i>Ancyrodella curvata</i> (Branson & Mehl)	55	CPC 12360	19014	Virgin Hills
<i>Ancyrodella gigas</i> Youngquist	57	CPC 12361 CPC 12362 CPC 12363	19544 19544 19544	Gogo Gogo Gogo
<i>Ancyrodella ioides</i> Ziegler	58	CPC 12364 CPC 12365 CPC 12366 CPC 12367	19013 19013 19013 19013	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Ancyrodella lobata</i> Branson & Mehl	59	CPC 12368 CPC 12369 CPC 12370 CPC 12371 CPC 12372	19580 19534 19548 19575 21371	Virgin Hills Virgin Hills Virgin Hills Virgin Hills Sadler
<i>Ancyrodella nodosa</i> Ulrich & Bassler	61	CPC 12373 CPC 12374 CPC 12375 CPC 12376 CPC 12377 CPC 12378	19009 19581 19582 19582 19582 19582	Virgin Hills Virgin Hills Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Ancyrodella rotundiloba rotundiloba</i> (Bryant)	62	CPC 12379 CPC 12380 CPC 12381 CPC 12382 CPC 12383 CPC 12384 CPC 12385 CPC 12386 CPC 12387 CPC 12388 CPC 12389 CPC 12390	19186 19189 19189 19482 19482 19534 19598 21222 21228 21228 21229 21237	Gogo Gogo Gogo Gogo Gogo Virgin Hills Gogo Sadler Sadler Sadler Sadler Sadler
<i>Ancyrodella rotundiloba alata</i> Glenister & Klapper	64	CPC 12391 CPC 12392 CPC 12393 CPC 12394	19001 19482 19482 21234	Gogo Gogo Gogo Sadler
<i>Ancyrodella rugosa</i> Branson & Mehl	66	CPC 12395	21247	Gogo
<i>Ancyrodella</i> sp. nov. A	67	CPC 12353	21003	Gogo
<i>Ancyrognathus altus</i> Müller & Müller	67	CPC 12397	19572	Virgin Hills

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Ancyrognathus asymmetricus</i> (Ulrich & Bassler)	68	CPC 12396	21614	Virgin Hills
<i>Ancyrognathus irregularis</i> Branson & Mehl	69	CPC 13805 CPC 13806	21522 21574	Virgin Hills Virgin Hills
<i>Angulodus</i> sp. cf. <i>A. pergracilis</i> (Ulrich & Bassler)	70	CPC 12398	19019	Virgin Hills
<i>Angulodus</i> sp.	70	CPC 12399 CPC 12400	19115 19534	Bugle Gap Virgin Hills
<i>Apatognathus varians varians</i> Branson & Mehl	71	CPC 12681 CPC 12613 CPC 12573 CPC 12719	19105 19158 19152 19138	Bugle Gap Bugle Gap Bugle Gap Bugle Gap
<i>Apatognathus varians klapperi</i> Druce	73	CPC 12681 CPC 12744	19113 19160	Bugle Gap Bugle Gap
<i>Apatognathus</i> sp. nov. B	74	CPC 12781 CPC 13807	19072 21270	Virgin Hills Virgin Hills
<i>Belodella devonica</i> (Stauffer)	75	CPC 12723	19588	Gogo
<i>Belodella resima</i> (Philip)	76	CPC 12720 CPC 13808 CPC 13809 CPC 13810 CPC 13811	19462 19463 19465 19474 19490	Sadler Sadler Sadler Sadler Sadler
<i>Belodella triangularis</i> (Stauffer)	77	CPC 13812 CPC 13813 CPC 13814 CPC 13815	19467 19473 19481 19533	Sadler Sadler Sadler Virgin Hills
<i>Bryantodus macrodentus</i> (Bryant)	78	CPC 12905 CPC 13816 CPC 13817 CPC 13818	19104 19105 19543 19598	Virgin Hills Bugle Gap Gogo Gogo
<i>Bryantodus nitidus</i> Ulrich & Bassler	79	CPC 12906 CPC 13819 CPC 13820 CPC 13821 CPC 12575 CPC 13822	19072 19482 19495 19547 19584 19582	Virgin Hills Gogo Sadler Virgin Hills Virgin Hills Virgin Hills
<i>Bryantodus typicus</i> Bassler	80	CPC 12907 CPC 13823 CPC 13824	19547 19580 19584	Virgin Hills Virgin Hills Virgin Hills
<i>Campognathus conus</i> Pollock	81	CPC 12908 CPC 13825 CPC 13826	19547 19547 21253	Virgin Hills Virgin Hills Gogo
<i>Campognathus</i> sp. nov. A	82	CPC 12909 CPC 13827	12547 12547	Virgin Hills Virgin Hills
<i>Drepanodus</i> sp.	83	CPC 12853 CPC 12854	19462 21218	Sadler Sadler
<i>Elsonella</i> sp.	83	CPC 12913 CPC 13828 CPC 13829	19062 19105 19107	Virgin Hills Bugle Gap Bugle Gap
<i>Enantiognathus lipperti</i> (Bischoff)	84	CPC 12911 CPC 13830 CPC 13831 CPC 13832 CPC 13833	19411 19585 19595 21242 21371	Sadler Virgin Hills Gogo Gogo Virgin Hills

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Enantiognathus</i> cf. <i>E. inversus</i> (Sannemann)	85	CPC 12912	19450C	Virgin Hills
<i>Falcodus aculeatus</i> Sannemann	85	CPC 12916 CPC 13834	19113 19105	Bugle Gap Bugle Gap
<i>Falcodus guntharii</i> Ziegler	86	CPC 12910	21065	Gogo
<i>Falcodus variabilis</i> Sannemann	86	CPC 12914 CPC 13835 CPC 13836 CPC 13837 CPC 13838	19079 19105 19130 19151 21014	Virgin Hills Bugle Gap Bugle Gap Bugle Gap Virgin Hills
<i>Falcodus</i> cf. <i>F. variabilis</i> Sannemann	87	CPC 12915	19023	Virgin Hills
<i>Falcodus</i> sp. nov. A	88	CPC 12416 CPC 12417 CPC 12418 CPC 12419	19109 19113 19130 19134	Bugle Gap Bugle Gap Bugle Gap Bugle Gap
<i>Hibbardella</i> (<i>Diplododella</i>) <i>alternata</i> Branson & Mehl	89	CPC 12401 CPC 12402 CPC 12403 CPC 12404	19001 19019 19534 19571	Gogo Virgin Hills Virgin Hills Virgin Hills
<i>Hibbardella</i> (<i>Diplododella</i>) <i>aurita</i> Sannemann	89	CPC 12408 CPC 12409	21015 21206	Virgin Hills Sadler
<i>Hibbardella</i> (<i>Diplododella</i>) <i>plana</i> Thomas	90	CPC 12413	19050	Sadler
<i>Hibbardella</i> (<i>Hassognathus</i>) <i>franca</i> Sannemann	91	CPC 12410	21100	Bugle Gap
<i>Hibbardella</i> (<i>Hassognathus</i>) <i>separata</i> Branson & Mehl	92	CPC 12414 CPC 12415	19080 19538	Virgin Hills Virgin Hills
<i>Hibbardella</i> (<i>Hibbardella</i>) <i>angulata</i> Hinde	93	CPC 12405 CPC 12406	19419 19534	Sadler Virgin Hills
<i>Hibbardella</i> (<i>Hibbardella</i>) <i>multidens</i> Ulrich & Bassler	93	CPC 12411 CPC 12412	19061 21371	Virgin Hills Virgin Hills
<i>Hindeodella brevis</i> Branson & Mehl	94	CPC 12420 CPC 12421	19115 19023	Bugle Gap Virgin Hills
<i>Hindeodella compressa</i> Huddle	95	CPC 12432 CPC 12433 CPC 12434 CPC 12435 CPC 12436	19049 21229 19119 19007 19108	Sadler Sadler Bugle Gap Gogo Bugle Gap
<i>Hindeodella corpulenta</i> Branson & Mehl	96	CPC 19422	19422	Sadler
<i>Hindeodella subtilis</i> Ulrich & Bassler	97	CPC 12423 CPC 12424 CPC 12425 CPC 12426 CPC 12427 CPC 12428 CPC 12429	19167 19188 19019 21215 19014 21216 19448A	Bugle Gap Sadler Virgin Hills Sadler Virgin Hills Sadler Virgin Hills
<i>Hindeodella uncata</i> (Hass)	98	CPC 12430 CPC 12431	19072 19109	Virgin Hills Bugle Gap
<i>Hindeodella</i> cf. <i>H. moweri</i> Stauffer	99	CPC 12437	19105	Bugle Gap
<i>Hindeodella</i> sp. nov. A	99	CPC 12438 CPC 12439	19001 19007	Gogo Gogo

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Hindeodella</i> sp. nov. B	100	CPC 12440	19102	Virgin Hills
<i>Hindeodella</i> sp. nov. C	100	CPC 12441	19468	Sadler
<i>Hindeodella</i> sp. nov. D	100	CPC 12442	19543	Gogo
<i>Hindeodella</i> sp. nov. E	100	CPC 12443 CPC 12444	21232 19482	Sadler Gogo
<i>Icriodus alternatus alternatus</i> Branson & Mehl	105	CPC 12445 CPC 12446 CPC 12447 CPC 12448	19114 19113 19111 19105	Bugle Gap Bugle Gap Bugle Gap Bugle Gap
<i>Icriodus alternatus costatus</i> (Thomas)	106	CPC 12449 CPC 12450 CPC 12451	21222 21242 21246	Gogo Gogo Gogo
<i>Icriodus alternatus curvirostratus</i> Bultynck	107	CPC 12453 CPC 12454 CPC 12455 CPC 12456	19112 21242 21242 19454A	Bugle Gap Gogo Gogo Virgin Hills
<i>Icriodus alternatus cymbiformis</i> Branson & Mehl	108	CPC 12457 CPC 12458 CPC 12459	19529 19576 21229	Virgin Hills Virgin Hills Sadler
<i>Icriodus alternatus elegantulus</i> Stauffer	108	CPC 12460 CPC 12461 CPC 12462	21242 21242 21242	Gogo Gogo Gogo
<i>Icriodus alternatus</i> subsp. nov. a	109	CPC 12463 CPC 12464 CPC 12465 CPC 12466	19117 19539 19534 19576	Bugle Gap Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus arkonensis arkonensis</i> Stauffer	110	CPC 12467 CPC 12468	19016 19454B	Virgin Hills Virgin Hills
<i>Icriodus arkonensis</i> subsp. nov. a	111	CPC 12469 CPC 12470 CPC 12471 CPC 12472	19453D 19454B 19454B 19454B	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus arkonensis</i> subsp. nov. b	111	CPC 12473 CPC 12474 CPC 12475 CPC 12476	19017 19454B 19453E 19453B	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus arkonensis</i> subsp. nov. c	111	CPC 12477 CPC 12478 CPC 12479 CPC 12480	19453B 19454B 19454B 19454B	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus brevis brevis</i> Stauffer	112	CPC 12481 CPC 12482	19057 21242	Sadler Gogo
<i>Icriodus brevis darbyensis</i> Klapper	112	CPC 12483 CPC 12484 CPC 12485 CPC 12486	19050 19050 19050 21242	Sadler Sadler Sadler Gogo
<i>Icriodus brevis spicatus</i> Youngquist & Peterson	113	CPC 12487 CPC 12488	21246 19594	Gogo Gogo
<i>Icriodus brevis</i> subsp. a	114	CPC 12489	21242	Gogo
<i>Icriodus brevis</i> subsp. b	114	CPC 12490 CPC 12491 CPC 12492	19058 19117 19117	Sadler Bugle Gap Bugle Gap

Name of conodont species	Page	Slide numbers of figured specimens	Sample Number (BG)	Formation
<i>Icriodus incrassatus incrassatus</i> Youngquist & Peterson	114	CPC 12493	21090	Sadler
<i>Icriodus incrassatus</i> subsp. nov. a	115	CPC 12494 CPC 12495 CPC 12452 CPC 12496 CPC 12497 CPC 12498	19018 19454D 21257 21011 21011 19016	Virgin Hills Virgin Hills Gogo Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus incrassatus</i> subsp. nov. b	115	CPC 12499	19018	Virgin Hills
<i>Icriodus incrassatus</i> subsp. nov. c	116	CPC 12500 CPC 12501 CPC 12502 CPC 12503	19106 19115 19594 21242	Bugle Gap Bugle Gap Gogo Gogo
<i>Icriodus incrassatus</i> subsp. nov. d	116	CPC 13839 CPC 13840 CPC 13841	21530 21571 21571	Virgin Hills Virgin Hills Virgin Hills
<i>Icriodus symmetricus symmetricus</i> Branson & Mehl	116	CPC 12504 CPC 12505 CPC 12506 CPC 12507	19534 19537 21229 21229	Virgin Hills Virgin Hills Sadler Sadler
<i>Icriodus symmetricus circularis</i> Youngquist & Peterson	117	CPC 12508 CPC 12509 CPC 12510 CPC 12511	19534 19534 19534 21235	Virgin Hills Virgin Hills Virgin Hills Sadler
<i>Icriodus symmetricus expansus</i> Branson & Mehl	118	CPC 12512 CPC 12513 CPC 12514 CPC 12515	19537 21191 21231 21232	Virgin Hills Sadler Sadler Sadler
<i>Icriodus symmetricus</i> subsp. nov. a	118	CPC 12516 CPC 12517	19534 19534	Virgin Hills Virgin Hills
? <i>Kladognathus</i> sp.	122	CPC 12522 CPC 12523	19001 19019	Gogo Virgin Hills
<i>Ligonodina magnidens</i> Ulrich & Bassler	122	CPC 12524 CPC 12525	19016 19081	Virgin Hills Virgin Hills
<i>Ligonodina panderi</i> (Hinde)	123	CPC 12526 CPC 12527	19583 19583	Virgin Hills Virgin Hills
<i>Ligonodina spiculata</i> (Ulrich & Bassler)	124	CPC 12528	21226	Sadler
<i>Ligonodina</i> sp. nov. A	124	CPC 12529	19005	Gogo
<i>Ligonodina</i> sp. nov. B	124	CPC 12530	19113	Bugle Gap
<i>Ligonodina</i> sp.	124	CPC 12531	19061	Virgin Hills
? <i>Ligonodina</i> sp.	125	CPC 12532	19166	Bugle Gap
<i>Lonchodina arcuata</i> Ulrich & Bassler	125	CPC 12831 CPC 12832 CPC 12833 CPC 12834	19502 19534 19582 19585	Gogo Gogo Virgin Hills Virgin Hills
<i>Lonchodina perlonga</i> Ulrich & Bassler	126	CPC 12835 CPC 12836	19583 21371	Virgin Hills Sadler
<i>Lonchodina typicalis</i> Bassler	126	CPC 12837 CPC 12838 CPC 12839	19543 19594 21003	Gogo Gogo Gogo

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Lonchodina</i> sp. nov. A	126	CPC 12840 CPC 12841 CPC 12842 CPC 12843	19538 21107 21210 21371	Virgin Hills Virgin Hills Sadler Sadler
<i>Neoprioniodus armatus-alatus</i> group	127	CPC 12533 CPC 12534 CPC 12535 CPC 12536 CPC 12537 CPC 12538	19583 19583 19170 19072 19001 21361	Gogo Gogo Bugle Gap Virgin Hills Gogo Napier
<i>Neoprioniodus semiseparatus</i> (Branson & Mehl)	128	CPC 12540 CPC 12541	19104 21225	Virgin Hills Sadler
<i>Neoprioniodus</i> sp. nov. A	128	CPC 12539	21278	Virgin Hills
<i>Nothognathella abbreviata</i> Branson & Mehl	130	CPC 12542	19454B	Virgin Hills
<i>Nothognathella abnormis</i> Branson & Mehl	131	CPC 12543 CPC 12544 CPC 12545 CPC 12546	19583 19583 19583 19583	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Nothognathella brevidonta</i> Youngquist	132	CPC 12547 CPC 12548 CPC 12549 CPC 12550	19014 19583 19584 21371	Virgin Hills Virgin Hills Virgin Hills Sadler
<i>Nothognathella falcata</i> Helms	133	CPC 12551 CPC 12552 CPC 12553 CPC 12554	19018 19451B 21267 21267	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Nothognathella iowaensis</i> Youngquist	134	CPC 12555 CPC 12556	19528 19547	Virgin Hills Virgin Hills
<i>Nothognathella klapperi</i> Uyeno	135	CPC 12557	19548	Virgin Hills
<i>Nothognathella palmatoformis</i> sp. nov.	135	CPC 12558 Holotype CPC 12559 Paratype CPC 12560 Paratype CPC 12561 Paratype	19019 19019 19023 19130	Virgin Hills Virgin Hills Virgin Hills Bugle Gap
<i>Nothognathella polygnathoidea</i> Branson & Mehl	137	CPC 12562	19018	Virgin Hills
<i>Nothognathella typicalis</i> Branson & Mehl	138	CPC 12563 CPC 12564 CPC 12565 CPC 12566	19014 19016 19018 21011	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Nothognathella</i> sp. nov. A	139	CPC 12567 CPC 12568	19082 19106	Virgin Hills Bugle Gap
<i>Ozarkodina homoarcuata</i> Helms	139	CPC 12569 CPC 12570	19104 19117	Virgin Hills Bugle Gap
<i>Ozarkodina immersa</i> (Hinde)	140	CPC 12571 CPC 12572	19023 19108	Virgin Hills Bugle Gap
cf. <i>Ozarkodina</i> ? <i>lacera</i> Helms	141	CPC 12518 CPC 12519 CPC 12520 CPC 12521	19105 19140 21093 21271	Bugle Gap Bugle Gap Virgin Hills Virgin Hills
<i>Ozarkodina macra</i> Branson & Mehl	142	CPC 12574 CPC 12575	19016 19584	Virgin Hills Virgin Hills
<i>Ozarkodina versa</i> (Stauffer)	143	CPC 12577	19170	Bugle Gap

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Ozarkodina</i> ? sp. Seddon	145	CPC 12844 CPC 12845 CPC 12846 CPC 12847 CPC 12848	19050 19001 19050 19421 19123	Sadler Gogo Sadler Sadler Bugle Gap
<i>Ozarkodina</i> sp. nov. A	143	CPC 12578	19008	Virgin Hills
<i>Ozarkodina</i> sp. nov. B	143	CPC 12579 CPC 12580	19534 19538	Virgin Hills Virgin Hills
<i>Ozarkodina</i> sp. nov. C	144	CPC 12581	19421	Sadler
<i>Ozarkodina</i> sp. nov. D	144	CPC 12582	19014	Virgin Hills
<i>Ozarkodina</i> sp. nov. E	144	CYC 12583	21354	Piker Hills
<i>Ozarkodina</i> sp. nov. F	144	CPC 12584	19101	Virgin Hills
<i>Palmatodella unca</i> Sannemann	146	CPC 12585	21269	Virgin Hills
<i>Palmatodella</i> sp. nov. A	147	CPC 12586	19104	Virgin Hills
<i>Palmatolepis delicatula delicatula</i> Branson & Mehl	147	CPC 12587 CPC 12588 CPC 12589 CPC 12590	19018 19018 19018 19018	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis distorta</i> Branson & Mehl	148	CPC 12591	19095	Virgin Hills
<i>Palmatolepis foliacea</i> Youngquist	150	CPC 12592 CPC 12593 CPC 12594 CPC 12595	21108 21108 21108 21104	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis gigas</i> Miller & Youngquist	151	CPC 12612 CPC 12615	19451A 21108	Virgin Hills Virgin Hills
<i>Palmatolepis</i> cf. <i>P. gigas</i> Miller & Youngquist	152	CPC 12614	19016	Virgin Hills
<i>Palmatolepis glabra glabra</i> Ulrich & Bassler	152	CPC 12596 CPC 12597 CPC 12598 CPC 12599	19019 19019 19072 21261	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis glabra acuta</i> Helms	154	CPC 12602 CPC 12607	21267 21267	Virgin Hills Virgin Hills
<i>Palmatolepis glabra elongata</i> Holmes	155	CPC 12600 CPC 12601	21014 21267	Virgin Hills Virgin Hills
<i>Palmatolepis glabra pectinata</i> Ziegler	156	CPC 12603 CPC 12604 CPC 12605 CPC 12606 CPC 12639	19083 19102 19108 21361 21267	Virgin Hills Virgin Hills Bugle Gap Napier Virgin Hills
<i>Palmatolepis gracilis gracilis</i> Branson & Mehl	157	CPC 12609 CPC 12610 CPC 12611	19171 19173 19182	Bugle Gap Bugle Gap Bugle Gap
<i>Palmatolepis hassi</i> Müller & Müller	158	CPC 12616 CPC 12617 CPC 12618	19009 19009 19012	Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis linguiformis</i> Müller	158	CPC 12619	19448E	Virgin Hills
<i>Palmatolepis minuta minuta</i> Branson & Mehl	159	CPC 12620 CPC 12621 CPC 12622	19019 21267 21271	Virgin Hills Virgin Hills Virgin Hills

Name of conodont species	Page	Slide numbers of figured specimens	Sample Number (BG)	Formation
<i>Palmatolepis minuta loba</i> Helms	160	CPC 12623 CPC 12624	19019 21262	Virgin Hills Virgin Hills
<i>Palmatolepis minuta schleizia</i> Helms	161	CPC 12625 CPC 12626	19081 19116	Virgin Hills Bugle Gap
<i>Palmatolepis perlobata perlobata</i> Ulrich & Bassler	161	CPC 12627 CPC 12628 CPC 12629 CPC 12630	19083 19100 19183 21093	Virgin Hills Virgin Hills Bugle Gap Virgin Hills
<i>Palmatolepis perlobata sigmoidea</i> Ziegler	163	CPC 12631	19105	Bugle Gap
<i>Palmatolepis proversa</i> Ziegler	163	CPC 12632 CPC 12633	19548 19548	Virgin Hills Virgin Hills
<i>Palmatolepis punctata</i> (Hinde)	164	CPC 12634 CPC 12635 CPC 12636	19548 19548 19548	Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis quadrantinodosa</i> <i>inflexoidea</i> Ziegler	165	CPC 12641 CPC 12642	19080 19080	Virgin Hills Virgin Hills
<i>Palmatolepis quadrantinodosa</i> <i>marginifera</i> Helms	165	CPC 12637 CPC 12638 CPC 12640	19089 19130 21275	Virgin Hills Bugle Gap Virgin Hills
<i>Palmatolepis quadrantinodosalobata</i> Sannemann	166	CPC 12643 CPC 12644	19018 19455	Virgin Hills Virgin Hills
<i>Palmatolepis</i> cf. <i>P. regularis</i> Cooper	167	CPC 12645 CPC 12646	19455 19455	Virgin Hills Virgin Hills
<i>Palmatolepis rugosa ampla</i> Ziegler	168	CPC 12648	19119	Bugle Gap
<i>Palmatolepis rugosa grossi</i> Ziegler	169	CPC 12647	19163	Bugle Gap
<i>Palmatolepis</i> cf. <i>P. subgracilis</i> Bischoff	169	CPC 12649	19023	Virgin Hills
<i>Palmatolepis subperlobata</i> Branson & Mehl	170	CPC 12651 CPC 12654 CPC 12662 CPC 12663	19454D 21011 19455 19455	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis subperlobata</i> subsp. a Helms	171	CPC 12655 CPC 12656 CPC 12657	19019 19020 19455	Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis subrecta</i> Miller & Youngquist	171	CPC 12658 CPC 12659 CPC 12660 CPC 12661	19448A 19451B 19581 19585	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis tenuipunctata</i> Sannemann	173	CPC 12652 CPC 12655 CPC 12664 CPC 12665	19455 19455 19455 19455	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis transitans</i> Müller	173	CPC 12666 CPC 12667	19534 19544	Virgin Hills Gogo
<i>Palmatolepis triangularis</i> Sannemann	174	CPC 12668 CPC 12669 CPC 12670 CPC 12671	19453E 19454A 19454B 19454B	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis unicornis</i> Miller & Youngquist	175	CPC 12672 CPC 12673 CPC 12674	19583 19583 19584	Virgin Hills Virgin Hills Virgin Hills
<i>Palmatolepis</i> sp. nov. A	176	CPC 12650	19092	Virgin Hills

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<i>Palmatolepis</i> sp. nov. B	176	CPC 13842	21550	Virgin Hills
<i>Pelekysgnathus elevatus</i> (Branson & Mehl)	177	CPC 12763 CPC 12764 CPC 12765 CPC 12766	19056 21092 21092 21242	Sadler Sadler Sadler Gogo
<i>Pelekysgnathus</i> sp.	178	CPC 12767	19183	Bugle Gap
<i>Polygnathellus multidentis</i> (Ulrich & Bassler	178	CPC 12769 CPC 12770 CPC 12771 CPC 12772	19001 19543 19585 19598	Gogo Gogo Virgin Hills Gogo
<i>Polygnathellus</i> cf. <i>P. typicalis</i> Bassler	179	CPC 12773	19541	Virgin Hills
<i>Polygnathus asymmetricus asymmetricus</i> Bischoff & Ziegler	180	CPC 12676 CPC 12677 CPC 12678 CPC 12679	19186 19544 19544 21253	Gogo Gogo Gogo Gogo
<i>Polygnathus asymmetricus ovalis</i> Ziegler & Klapper	180	CPC 12680 CPC 12683	19001 19482	Gogo Gogo
<i>Polygnathus australis</i> sp. nov.	181	CPC 12685 Holotype CPC 12684 Paratype CPC 12686 Paratype	19425 19412 19577	Sadler Virgin Hills Gogo
<i>Polygnathus brevilaminus</i> Branson & Mehl	183	CPC 12687 CPC 12688 CPC 12689	19452D 19453D 19454B	Virgin Hills Virgin Hills Virgin Hills
<i>Polygnathus collinsoni</i> Druce	184	CPC 12690 CPC 12691	19183 19183	?Bugle Gap ?Bugle Gap
<i>Polygnathus decorosus</i> Stauffer	184	CPC 12692 CPC 12693 CPC 12694	19007 19449B 19449B	Gogo Virgin Hills Virgin Hills
<i>Polygnathus delicatulus</i> Ulrich & Bassler	185	CPC 12695 CPC 12696 CPC 12697	19107 19097 19109	Bugle Gap Virgin Hills Bugle Gap
<i>Polygnathus fallax</i> Helms & Wolska	186	CPC 12698 CPC 12699	19080 21093	Virgin Hills Virgin Hills
<i>Polygnathus foliatus</i> Bryant	187	CPC 12700 CPC 12701 CPC 12702 CPC 12703	19561 19594 21197 21234	Sadler Gogo Sadler Sadler
<i>Polygnathus germanus germanus</i> Ulrich & Bassler	188	CPC 12704 CPC 12705 CPC 12706 CPC 12707	19024 21014 21262 21263	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Polygnathus germanus</i> subsp. nov. a	189	CPC 12708	19082	Virgin Hills
<i>Polygnathus germanus</i> subsp. nov. b	190	CPC 12709	19164	Bugle Gap
<i>Polygnathus glaber glaber</i> Ulrich & Bassler	190	CPC 12710 CPC 12711 CPC 12712 CPC 12713	19007 19077 19082 21015	Virgin Hills Virgin Hills Virgin Hills Virgin Hills
<i>Polygnathus irregularis</i> (Thomas)	191	CPC 12714 CPC 12715 CPC 12716	19170 21059 21355	Bugle Gap Bugle Gap Piker Hills
<i>Polygnathus janetae</i> sp. nov.	192	CPC 12717 Holotype CPC 12718 Paratype	19418 19482	Sadler Gogo
<i>Polygnathus nodoundatus</i> Helms	192	CPC 12721	21362	Napier

Name of conodont species	Page	Slide numbers of figured specimens	Sample Number (BG)	Formation
<i>Polygnathus normalis</i> Miller & Youngquist	194	CPC 12722	19014	Virgin Hills
		CPC 12724	19071	Virgin Hills
		CPC 12725	19548	Virgin Hills
<i>Polygnathus</i> cf. <i>P. norrisi</i> Uyeno	195	CPC 12726	19117	Bugle Gap
		CPC 12727	19109	Bugle Gap
		CPC 12728	19147	Bugle Gap
		CPC 12768	19108	Bugle Gap
<i>Polygnathus obliquicostatus</i> Ziegler	196	CPC 12729	21015	Virgin Hills
<i>Polygnathus</i> cf. <i>P. pennatus</i> Hinde	196	CPC 12730	19454D	Virgin Hills
		CPC 12731	19453B	Virgin Hills
<i>Polygnathus perplexus</i> Thomas	197	CPC 12732	19114	Bugle Gap
		CPC 12733	21355	Piker Hills
<i>Polygnathus pollocki</i> sp. nov.	198	CPC 12734 Holotype	19543	Gogo
		CPC 12735 Paratype	19554	Sadler
		CPC 12736 Paratype	21207	Sadler
<i>Polygnathus seddoni</i> sp. nov.	198	CPC 12737 Holotype	19543	Gogo
		CPC 12738 Paratype	19543	Gogo
		CPC 12739 Paratype	19543	Gogo
		CPC 12740 Paratype	19543	Gogo
<i>Polygnathus semicostatus</i> Branson & Mehl	201	CPC 12741	19144	Bugle Gap
<i>Polygnathus spatulatus</i> Youngquist	202	CPC 12742	19186	Gogo
<i>Polygnathus suberratus</i> Branson & Mehl	202	CPC 12743	19160	Bugle Gap
		CPC 12745	19161	Bugle Gap
		CPC 12746	19182	?Bugle Gap
<i>Polygnathus triphyllatus</i> (Ziegler)	203	CPC 12747	19075	Virgin Hills
		CPC 12748	19075	Virgin Hills
		CPC 12749	21267	Virgin Hills
<i>Polygnathus</i> cf. <i>P. webbi</i>	204	CPC 12750	19533	Virgin Hills
		CPC 12751	19534	Virgin Hills
		CPC 12752	19546	Virgin Hills
<i>Polygnathus xylus</i> Stauffer	204	CPC 12753	19032	Sadler
		CPC 12754	19188	Sadler
		CPC 12755	21242	Gogo
		CPC 12756	21242	Gogo
<i>Polygnathus znepolensis</i> Spasov	205	CPC 12757	19168	Bugle Gap
		CPC 12758	19170	Bugle Gap
		CPC 12759	19172	Bugle Gap
<i>Polygnathus</i> sp. A Druce	205	CPC 13843	21574	Virgin Hills
<i>Polygnathus</i> sp. nov. A	205	CPC 12760	19170	Bugle Gap
<i>Polygnathus</i> sp. nov. B	206	CPC 12761	19009	Virgin Hills
<i>Polygnathus</i> sp. nov. C	206	CPC 12762	21014	Virgin Hills
<i>Polylophodonta confluens</i> (Ulrich & Bassler)	206	CPC 12784	21014	Virgin Hills
<i>Polylophodonta elongata</i> Druce	207	CPC 12785	19019	Virgin Hills
		CPC 12786	19111	Bugle Gap
		CPC 12787	21361	Napier
<i>Prioniodina</i> ? <i>smithi</i> (Stauffer)	207	CPC 12788	19023	Virgin Hills
		CPC 12789	19092	Virgin Hills
		CPC 12790	21265	Virgin Hills
<i>Pseudopolygnathus</i> sp. nov. A	208	CPC 12791	19007	Gogo
		CPC 12792	19007	Gogo

<i>Name of conodont species</i>	<i>Page</i>	<i>Slide numbers of figured specimens</i>	<i>Sample Number (BG)</i>	<i>Formation</i>
<i>Scaphignathus veliferus</i> Helms	208	CPC 12774 CPC 12775 CPC 12776	19161 19164 21365	Bugle Gap Bugle Gap Napier
<i>Scaphignathus ziegleri</i> Druce	209	CPC 12777 CPC 12778 CPC 12779	19105 19111 21061	Bugle Gap Bugle Gap Bugle Gap
<i>Scutula bipennata</i> Sannemann	210	CPC 12780	19453E	Virgin Hills
<i>Scutula sinepennata</i> Ziegler	210	CPC 12782	19106	Bugle Gap
<i>Scutula venusta</i> Sannemann	211	CPC 12783	19014	Virgin Hills
<i>Spathognathodus bohlenanus</i> Helms	212	CPC 12793	19170	Bugle Gap
<i>Spathognathodus</i> cf. <i>S. brevis</i> Bischoff & Ziegler	213	CPC 12794	19020	Virgin Hills
<i>Spathognathodus fitzroyi</i> sp. nov.	213	CPC 12795 Holotype CPC 12796 Paratype	19130 21270	Bugle Gap Virgin Hills
<i>Spathognathodus</i> cf. <i>S. robustus</i> (Branson & Mehl)	214	CPC 12797	19167	Bugle Gap
<i>Spathognathodus stabilis</i> (Branson & Mehl)	215	CPC 12798 CPC 12799 CPC 12800 CPC 12801	19092 19107 19107 19454A	Virgin Hills Bugle Gap Bugle Gap Virgin Hills
<i>Spathognathodus strigosus</i> (Branson & Mehl)	216	CPC 12802 CPC 12803 CPC 12804 CPC 12805 CPC 12806 CPC 12807 CPC 12808	19087 19089 19133 19147 19160 19173 19174	Virgin Hills Virgin Hills Bugle Gap Bugle Gap Bugle Gap Bugle Gap Bugle Gap
<i>Spathognathodus</i> sp. nov. A	217	CPC 12809	19007	Gogo
<i>Spathognathodus</i> sp. nov. B	217	CPC 12810	19129	Bugle Gap
<i>Spathognathodus</i> sp. nov. C	217	CPC 12811 CPC 12812	19145 19170	Bugle Gap Bugle Gap
<i>Spathognathodus</i> sp. nov. D	218	CPC 12813	19453E	Virgin Hills
<i>Spathognathodus</i> sp. nov. E	218	CPC 12814	19453E	Virgin Hills
<i>Spathognathodus</i> sp. nov. F	218	CPC 12815	19186	Gogo
<i>Spathognathodus</i> sp. nov. G	218	CPC 12816	19188	Gogo
<i>Spathognathodus</i> sp. nov. H	219	CPC 12817	19061	Sadler
<i>Spathognathodus</i> sp. nov. I	219	CPC 12818	19173	Bugle Gap
<i>Synprioniodina</i> cf. <i>S. alternata</i> Bassler	219	CPC 12819 CPC 12820 CPC 12821 CPC 12822 CPC 12823	19049 19453B 19453E 21234 19498	Sadler Virgin Hills Virgin Hills Gogo Gogo
<i>Synprioniodina</i> sp. nov. A	220	CPC 12824 CPC 12825	19107 19147	Bugle Gap Bugle Gap
<i>Synprioniodina</i> sp. nov. B	220	CPC 12826 CPC 12827	19107 19108	Bugle Gap Bugle Gap
<i>Tripodellus robustus</i> Bischoff	220	CPC 12828 CPC 12829	19107 19108	Bugle Gap Bugle Gap
gen nov. et sp. nov. Druce	221	CPC 12830	19172	Bugle Gap