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UPPER DEVONIAN OSTRACODA AND ERIDOSTRACA FROM THE BONAPARTE GULF BASIN, NORTHWESTERN AUSTRALIA

by

P. J. JONES

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SUMMARY

Ostracods have been found in the Upper Devonian fauna of the Bonaparte Gulf Basin in the Westwood Member of the Cockatoo Formation (Frasnian), the Buttons Beds (Famennian, toII-toIII), and the Ningbing Limestone (Famennian, toII-toV-Tournaisian?), the ages of which have been established by means of conodonts (Jones & Druce, 1966; Druce, 1968). Twenty-two species of ostracods are described as well as two species belonging to the suborder Eridostraca Adamczak (here excluded from the Ostracoda). The ostracod species (8 new, 8 with open nomenclature, but probably new, and 6 probably previously described) represent 20 genera (1 new, 2 probably new), which are distributed among the ostracod families as follows:-

2 Craspedobolbinidae	4 Geisinidae	1 Krausellidae
1 Pribylitidae	1 Indivisiidae	1 Barychilinidae
1 Hollinidae	1 Beyrichiopsidae	2 Cavellinidae
1 Amphissitidae	1 Lichviniidae	4 Bairdiidae
	2 Paraparchitidae	

Two craspedobolbinid species are assigned to two unnamed genera (probably new) belonging to the subfamily Treposellinae. Antral dimorphism is recognized in *Pribylites* (*Parapribylites*) *hanaicus* Pokorny—the *Parapribylites*-like forms with velar structures are regarded as heteromorphs, and the *Gravia*-like forms in which the velar structure is lacking or reduced to a short spine are regarded as tecnomorphs; a relationship to the superfamily Primitiopsacea is suggested. Species belonging to the genera *Limbatula* and *Amphissites* are described with open nomenclature. *Knoxiella* is regarded as distinct from *Hypotetragona*. The delicate narrow striated marginal structure on the smaller valves of *Geisina* and *Marginia* is considered as a selvage seal. *Indivisia variolata* Zanina is represented, and four species are closely compared with the previously described species *Bairdia nalivkini* Egorov, *B. naumovae* Egorov, *Coeloenellina fabiformis* (Kesling & Kilgore), and *Paraparchites nicklesi* (Ulrich). The differences in shape in individuals of the last species are regarded as due to changes during ontogeny. Species belonging to *Beyrichiopsis?*, *Leptoprimitia*, *Orthobairdia*, *Rectobairdia*, *Cavellina*, *Sulcella* (= *Uchtovia*), and *Krausella?* are also described. A new genus, *Diphyochilina* (Barychilinidae), is proposed to accommodate species close to *Endolophia* Kesling, 1954, but thinner and with a lip-like venter, and without an internal ridge on each valve.

It is suggested that the Eridostraca may represent an extinct suborder of marine branchiopods, and that *Cryptophyllus* Levinson may be a junior synonym of *Rhabdostichus* Raymond.

A provisional zonal scheme is suggested. Within the Westwood Member of the Cockatoo Formation, some of the ostracods of the *hanaicus* zone are related to those of the Frasnian or late Givetian of Europe, e.g. *Amphissites* sp. A, *Indivisia variolata* Zanina, *Limbatula* sp., *Pribylites* (*Parapribylites*) *hanaicus*, *Bairdia* sp. cf. *B. nalivkini* Egorov, and *B.* sp. cf. *B. naumovae* Egorov. Within the Buttons Beds four concurrent-range zones are proposed: *altifrons* zone, *tryphera* zone, *altifrons-ordensis* zone, and *ordensis* zone, which are used for local correlation. These zones are the basis for correlation of the Buttons Beds in the Burt Range area, where conodonts are absent, with the type section in the bed of the Ord River, and with the Ningbing Limestone. Six species from the *altifrons-ordensis* zonal sequence also occur in the northern Canning Basin (Fitzroy sub-basin), but in sediments of late Famennian age.

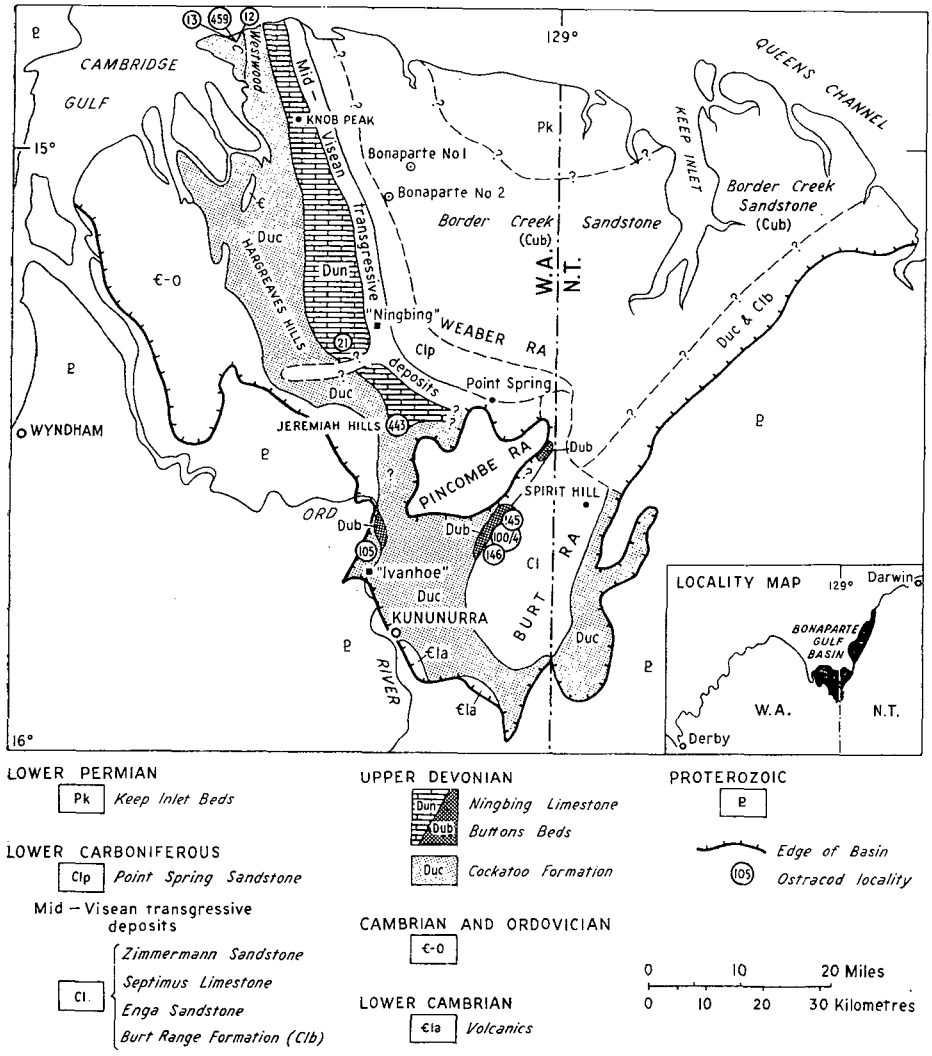

Fig. 1 Distribution of Upper Devonian rocks in the Bonaparte Gulf Basin.

INTRODUCTION

The Bonaparte Gulf Basin contains Palaeozoic rocks covering about 8000 square miles of land around the Joseph Bonaparte Gulf (Fig. 1); the larger part of the basin lies beneath the Timor Sea. Its landward part is truncated by a northeasterly fault zone from Precambrian rocks on the east; the southwestern margin overlaps Precambrian rocks of the Kimberley Block. The estuary of the Victoria River (Queens Channel) separates the landward part of the basin into two areas of outcrop—the southwestern area with Cambrian, Ordovician, and Devonian to lowermost Permian outcrops, and the northern part with Permian, possibly Lower Triassic, and Lower Cretaceous outcrops.

Preliminary studies of the geology of the Bonaparte Gulf Basin have been published by Matheson & Teichert (1948), Reeves (1951), and Traves (1955). McWhae, Playford, Lindner, Glenister, & Balme (1958) included a brief account of the geology, and Drummond (1963) reviewed the geological work up to 1962. Thomas (1962) summarized the Carboniferous stratigraphy up to 1958, and later up to 1963 (Thomas, 1965). Earlier geological investigations have been concisely reviewed by Noakes, Öpik, & Crespin (1952).

In 1963, the Bureau of Mineral Resources began a more detailed study of the geology of the basin. The Upper Devonian and Carboniferous geology of the Bonaparte Gulf Basin is described by Veevers & Roberts (1968). This major work is supported by the following publications: Veevers, Roberts, Kaulback, & Jones (1964) and Guillaume (1966) on the geology; Kaulback & Veevers (1968) on the Lower Palaeozoic geology; Jones & Druce (1966) and Druce (1968) on the conodont stratigraphy; Playford, Veevers, & Roberts (1966) on Upper Devonian (Famennian) reefs in the basin; Roberts, Jones, & Druce (1967) on Upper Devonian palaeontology and correlation; Roberts & Veevers (1967) on the Carboniferous geology; Veevers & Roberts (1966) on Viséan littoral talus breccia and probable beach rock; and Veevers & Roberts (1967) on the Upper Devonian geology.

This Bulletin describes the ostracods in the Upper Devonian fauna of the Bonaparte Gulf Basin, assesses their stratigraphical value, and is a part of the overall study of the Upper Devonian and Lower Carboniferous geology and palaeontology; it also represents the first taxonomic and biostratigraphic study of Upper Devonian Ostracoda from Australia.

ACKNOWLEDGMENTS

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and June 1966, under the supervision of Professor D. A. Brown of the Department of Geology, School of General Studies, Australian National University. The entire thesis has since been revised and additional information has been incorporated.

I wish to thank Professor Brown, Dr I. G. Sohn of the United States Geological Survey, Washington, D.C., and Professor P. C. Sylvester-Bradley of the University of Leicester, who read the entire manuscript of the thesis and offered helpful advice.

It is a pleasure to record my thanks to the following workers for assistance: Professor K. Krömmelbein of the Geologisch-Paläontologisches Institut, University of Kiel; Dr A. Martinsson and Dr V. Jaanusson of the Paleontologiska Institut, Uppsala University; Dr F. Adamczak of the Palaeozoological Institute, Warsaw (temporarily at the University of Stockholm); Dr J. E. Robinson of University College, London; Dr I. G. Sohn and Dr Jean M. Berdan of the United States Geological Survey, Washington, D.C.; and Professor H. W. Scott of the University of Illinois, all of whom freely discussed various aspects of the morphology and taxonomy of many of the fossil ostracods studied, and allowed me to study ostracod collections in their care; Dr H. J. Oertli of the Centre de Recherches (SNPA), Pau; Professor K. Krömmelbein, and Dr A. Martinsson for kind advice on methods of study of Palaeozoic ostracods, laboratory techniques, and photomicrography; Mr J. Le Fevre of the Centre de Recherches (SNPA), Pau, Dr F. Adamczak, and Dr V. Jaanusson for generous co-operation and exchange of material and photographs; Professor H. W. Scott for discussions on palaeocope classification; and Dr M. J. Copeland of the Geological Survey of Canada, Ottawa, for much assistance with Russian publications and translations.

The samples were prepared and picked by Messrs F. Hadzel and A. T. Wilson and Mrs A. Miniotas, all of the Bureau of Mineral Resources, Canberra.

UPPER DEVONIAN STRATIGRAPHY

Undoubted Devonian rocks were first recognized in the Bonaparte Gulf Basin by Matheson & Teichert (1948)[1], who compared them with the Devonian of the Canning Basin. Reeves (1951) and Traves (1955) gave further accounts of the Devonian succession.

The Burt Range Formation, previously regarded as Upper Devonian by Matheson & Teichert (1948), Reeves (1951), and Traves (1955), and

1. The earlier report by Teichert (1943, p. 70) of Devonian fossils in the Bonaparte Gulf Basin is of doubtful validity, as the fossils were collected 15 miles east of Ivanhoe homestead, which according to present stratigraphic concepts is well within the Lower Carboniferous (Tournaisian) Burt Range Formation.

mainly Upper Devonian by Veevers (1959*b*) and Thomas (1962), is now known to be entirely Lower Carboniferous (Jones & Druce, 1966).

The Devonian succession is more than 6000 feet thick, and is divided into a Frasnian terrigenous formation (Cockatoo Formation), Famennian reef-complex (Ningbing Limestone) and lagoonal sediments (Buttons Beds), all of which were deposited on the platform, and Famennian and possibly Frasnian basinal siltstone (the lower part of the Bonaparte Beds; Fig. 2).[1] The platform terrigenous and carbonate sediments are laterally equivalent to the basinal siltstone. Reef growth in the Ningbing Limestone and deposition of basinal siltstone continued into the Lower Carboniferous.

Correlations within the basin are hampered by rapid lateral lithological changes within the Devonian formations, by the restriction of many fossils to a single rock-type (e.g. conodonts and ostracods to the limestones), and by poor preservation of fossils in the sandstones. Despite these limitations, stratigraphical control has been obtained by means of ostracods, brachiopods, and conodonts; the latter being especially useful for intercontinental correlation.

Frasnian

Cockatoo Formation

The Cockatoo Formation crops out on the platform and unconformably overlies Precambrian quartzite and quartz sandstone, Lower Cambrian volcanics, Cambrian dolomite and sandstone, and Lower Ordovician glauconitic sandstone. It is conformably overlain by a Famennian reef-complex (Ningbing Limestone) and lagoonal sediments (Buttons Beds). The Cockatoo Formation consists of about 5000 feet of quartz sandstone, conglomerate, and carbonate, and is divided into eight members (Veevers & Roberts, 1967; and Fig. 2).

Thick wedges of conglomerate and coarse sandstones (Ragged Range Conglomerate Member), deposited close to high fault scarps near the south-eastern margin, pass laterally towards the northwest, along the platform, into thick cross-stratified beds of friable finer-grained quartz sandstones (Kellys Knob, Abney, and Cecil Sandstone Members). The middle part of the sandstone sequence is glauconitic with minor dolomite in the southeast (Kununurra Member), and becomes progressively richer in carbonate towards the northwest (Hargreaves Member), culminating in a small reef, probably fore-reef (Westwood Member).

The richest faunas are found in the middle glauconitic and carbonate members, particularly the Westwood Member, which contains many species of conodonts, ostracods, foraminifers, brachiopods, pelecypods, gastropods, and solitary corals.

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[1] As no ostracods have been found in the Devonian part of the Bonaparte Beds, this unit will not be discussed here.

The sandstones are poorly fossiliferous, by comparison with the carbonate members, but contain pelecypods, plants (mainly *Leptophloeum*), and fish plates. Some pelecypods and plants are even found in the thick conglomerate wedges. Because the pelecypods are commonly associated with marine fossils in the calcareous members of the Cockatoo Formation, their presence elsewhere within the sandstone sequence is taken to indicate marine deposition.

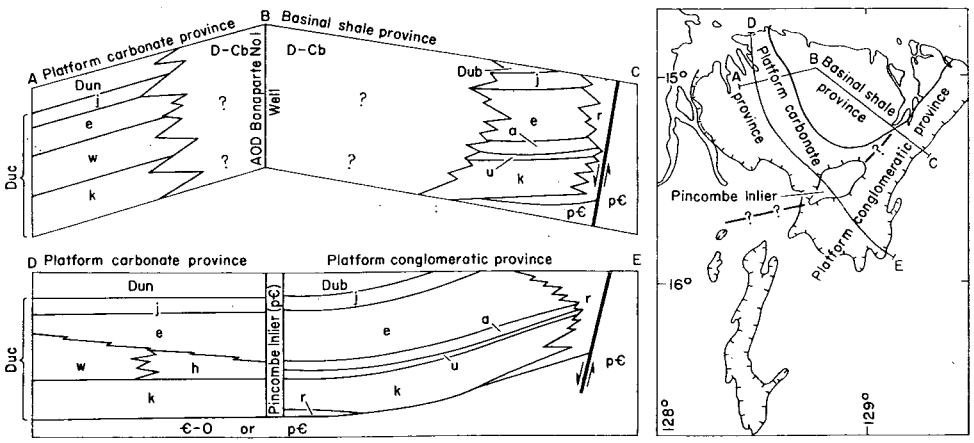

Fig. 2 Relationships of the Upper Devonian stratigraphical units (after Veevers and Roberts, 1967). KEY—Dub = Buttons Beds; Dun = Ningbing Limestone; D-Cb = Bonaparte Beds; Duc = Cockatoo Formation, which consists of eight members—r = Ragged Range Conglomerate Member, k = Kellys Knob Member, u = Kununurra Member, a = Abney Member, h = Hargreaves Member, w = Westwood Member, e = Cecil Sandstone Member, and j = Jeremiah Member.

Faunas indicating a Frasnian age are found only in the middle glauconitic and carbonate members. Jones & Druce (1966) show that the conodonts from the Westwood Member of the Cockatoo Formation are of Frasnian (toI) age; this was later confirmed by Roberts, Jones, & Druce (1967) on the combined evidence from conodonts, ostracods, brachiopods, and foraminifers. The uppermost unit of the Cockatoo Formation (Jeremiah Member) may be uppermost Frasnian to lowermost Famennian in age, because it is conformably overlain by the Famennian Ningbing Limestone, and lies above the Cecil Sandstone Member, which succeeds the Frasnian sediments of the Westwood, Hargreaves, and Abney Members. The lower part of the Cockatoo Formation (Kellys Knob and Ragged Range Members), below the middle fossiliferous members, is undated, and deposition could have started earlier than the Frasnian.

Ostracods were found only in the Westwood Member.

Westwood Member

The Westwood Member, defined by Veevers & Roberts (1968), consists of biogenic limestone, probably fore-reef (600 feet thick), overlain by sandstone

and minor interbedded fossiliferous limestone (1400 feet thick). The lower part contains algae, stromatolites, stromatoporoids, solitary and colonial corals, pelecypods, gastropods, conodonts, foraminifers, and ostracods. The interbedded limestone in the upper arenaceous part of the member is also richly fossiliferous and contains pelecypods, brachiopods, ostracods, conodonts, foraminifers, tentaculitids, fish plates, and plant remains (Roberts, Jones, & Druce, 1967).

FAMENNIAN

Ningbing Limestone

The Ningbing Limestone, a reef complex, crops out in the Ningbing Range and Jeremiah Hills between the Pincombe Inlier and Knob Peak. It is defined by Veevers & Roberts (1968), and partly equivalent to the Burt Range 'Series' of Reeves (1951). Playford, Veevers, & Roberts (1966) recognized in the Ningbing Range a wide back-reef, about 600 feet thick, a narrow reef, and poorly exposed fore-reef. Inter-reef, also poorly exposed, was later recognized by Veevers & Roberts (1967). The back-reef is well exposed in the Jeremiah Hills, where it attains a preserved thickness of 1000 feet.

Ostracods are found only in the back-reef and are rare (in numbers of individuals and species), and associated with abundant brachiopods and sporadic conodonts. Other groups found in the back-reef include corals, stromatoporoids, algae, polyzoans, crinoid ossicles, and plant remains (Roberts, Jones, & Druce, 1967).

Preliminary work on the conodonts from the Ningbing Limestone by Jones & Druce (1966) indicated an early Famennian (upper to$II\beta$-lower to$III\alpha$) age. Later work by Druce (1968) shows that the upper part of the Famennian is also represented. Roberts, Jones, & Druce (1967) note the presence of Tournaisian conodonts and brachiopods from one locality on the eastern or basinward side of the Ningbing Limestone. Although other explanations are possible to account for this Tournaisian age, Veevers & Roberts (1968) favour the suggestion that there was continuous reef deposition from the Frasnian into the Tournaisian, because the limestone containing the Tournaisian faunas is indistinguishable from the Famennian reef limestone.

The Ningbing Limestone conformably overlies the Jeremiah Member of the Cockatoo Formation, and is unconformably overlain by, or faulted against, the Utting Calcarenite, or its top is eroded (Veevers & Roberts, 1968).

Buttons Beds

The Buttons Beds, defined by Veevers & Roberts (1968), consist of 1100 feet of fossiliferous calcarenite with interbedded calcareous sandstone, which were deposited in lagoonal areas south and southeast of the reef-complex (Fig. 1). The best exposed section crops out along the east bank of the Ord

River, at Buttons Crossing, 2 miles north of the Kimberley Research Station; this section was previously referred to the lower part of the Burt Range 'Series' by Matheson & Teichert (1948, p. 14). The base of the Buttons Beds is not exposed and the top is either faulted or eroded; in the Eight-Mile Creek area (Localities 100/4, 145, 146—Fig. 1) at least 270 feet of Buttons Beds are disconformably overlain by the Lower Carboniferous Burt Range Formation. The lower 430 feet of the Buttons Beds exposed in the Ord River section is silty and contains abundant ostracods, fish remains, the alga *Umbellina* sp., and the plant *Leptophloeum australe* (M'Coy). Between 430 feet and 900 feet above the base of the exposed type section, in well bedded limestone, are ostracods, porostrome algae, colonial tabulate corals and solitary corals, stromatoporoids, polyzoans, brachiopods, and gastropods. The uppermost sandy dolomitic part of the section contains only *Leptophloeum australe* (M'Coy).

One of the few conodonts recovered from the Buttons Beds (820 feet above the base of the type section)—*Polylophodonta* sp. nov.—indicates an early Famennian toII-toIII age (Druce, 1968). The ostracods are the only other group which allow detailed local correlation; this subject will be discussed later.

UPPER DEVONIAN OSTRACODA

Previous work

Palaeozoic ostracods were first reported from the Bonaparte Gulf Basin by Teichert (1943, p. 70), who examined fossiliferous limestone samples collected in 1941 by F. G. Forman from about 15 miles east of Ivanhoe homestead (see footnote 1, p. 4). Teichert later reported (*in* Matheson & Teichert, 1948, p. 13, 14) ostracods from the lower fossiliferous beds of his Burt Range 'Series' about 4 miles southeast of Martins Gap, and from the Ord River section. The former locality could possibly be now referred to the Lower Carboniferous (Tournaisian) Burt Range Formation (e.g. Section 100), but the Ord River section is now the type section of the Upper Devonian (early Famennian) Buttons Beds (Section 105).

Content

The Upper Devonian ostracod fauna is small, but diversified. Twenty-two species (8 new, 8 with open nomenclature, but probably new, and 6 probably previously described) representing 20 genera (1 new, 2 probably new), are described and illustrated, along with two species belonging to the suborder Eridostraca Adamczak, which are not Ostracoda. Additional species are indicated by fragmentary specimens, but their preservation is not good enough for adequate description.

Five suborders and thirteen families are represented in the ostracod fauna. The number of families, genera, and species represented in each suborder is shown in Figure 3.

In number of individuals, the Geisiidae and Paraparchitidae predominate, and the Barychilinidae, Cavellinidae, and Bairdiidae are well represented. The number of genera and species represented in each family is shown in Figure 4.

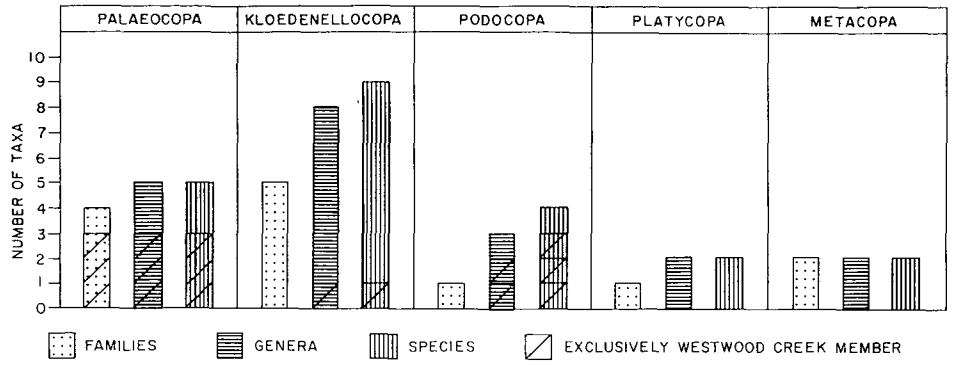

Fig. 3 Histogram showing the number of ostracod families, genera and species in each suborder, represented in the Upper Devonian of the Bonaparte Gulf Basin.

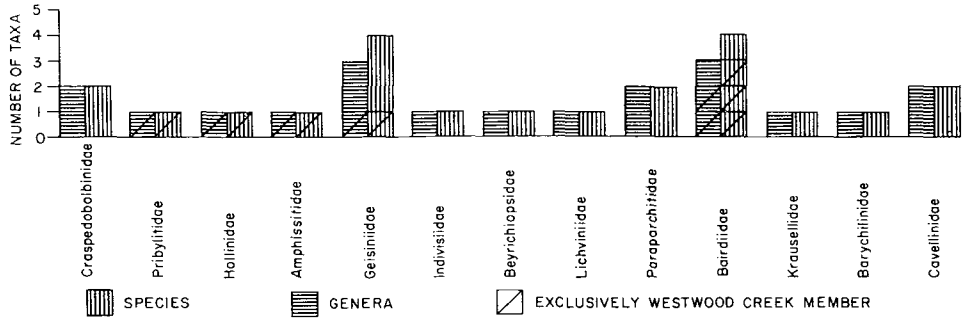

Fig. 4 Histogram showing the number of ostracod genera and species in each family represented in the Upper Devonian of the Bonaparte Gulf Basin.

Geographical distribution

In the Frasnian Cockatoo Formation, ostracods are known only from the Westwood Member, at Westwood Creek, in the northwestern part of the basin. They are not found in the equivalent calcareous members in the south, which appears to reflect the adverse influence of terrigenous deposition near the edge of the basin. Almost the converse relationship holds for the early Famennian biogenous deposition. In the south, the Buttons Beds contain an abundant ostracod fauna, in which the numbers of species and individuals rapidly decrease northwards into the reef-complex (Ningbing Limestone).

Stratigraphical Distribution and Zonation

Westwood Member of the Cockatoo Formation: The stratigraphical distribution of the ostracods within the type section (459) and supplementary sections 12 and 13 is shown in Figure 5. The field relationships have been determined by tracing beds common to all three sections.

Eight species are apparently restricted to the Frasnian Westwood Member: *Pribylites* (*Parapribylites*) *hanaicus* Pokorny, *Limbatula* sp. A, *Amphissites* sp. A, *Knoxiella* sp. A, *Bairdia* sp. cf. *B. nalivkini* Egorov, *Bairdia* sp. cf. *B. naumovae* Egorov, *Rectobairdia* sp. A, and *Eridoconcha* sp. A; these define a zone that I have named the *Pribylites* (*Parapribylites*) *hanaicus* Zone. The Westwood Member also contains the species *Indivisia variolata* Zanina and *Krausella? dubitata* sp. nov., which range into the early Famennian Buttons Beds. Ostracods are common throughout the type section (459—between 40 feet and 440 feet), but only one species has been found in the lower part of Section 12 (*Indivisia variolata* Zanina in localities 12/OA and 12/2A). The eridostracan *Eridoconcha* sp. A first appears in Locality 37/2. Ostracods are more frequent in Section 12 between 385 feet and 470 feet between Localities 12/7 and 12/9. In Section 13, ostracods first appear 535 feet above the base, at Locality 13/9, and range up to 1280 feet above the base, at Locality 13/6. Here, *Eridoconcha* sp. A is absent, and the species *Amphissites* sp. A and *Limbatula* sp. A make their only appearance.

Buttons Beds: The stratigraphical distribution of the ostracods within the type section (105) and other sections (144, 145, and 146) of the early Famennian Buttons Beds is illustrated in Figure 6.

Sixteen species are represented in the Buttons Beds; eight are new (*Geisina monothele, Marginia venula, M. reticulata, Beyrichiopsis? perplexa, Orthobairdia ordensis, Krausella? dubitata, Sulcella altifrons,* and one which belongs to a new genus—*Diphyochilina tryphera*). Four species are probably new, but the nomenclature is left open; these include *Leptoprimitia* sp. A, *Cavellina* sp. A, and two species which possibly represent two new genera, Treposelline Genus A sp. A and Treposelline Genus B sp. A. Three are probably previously described species (*Indivisia variolata* Zanina, *Coeloenellina* sp. cf. *C. fabiformis* (Kesling & Kilgore), and *Paraparchites* sp. cf. *P. nicklesi* (Ulrich); one indeterminable species belongs to the eridostracan genus *Cryptophyllus.*

As previously stated, *Indivisia variolata* Zanina and *Krausella? dubitata* make an earlier appearance in the Frasnian Westwood Member. The species *Paraparchites* sp. cf. *P. nicklesi* (Ulrich) is abundant in the Burt Range Formation of early Carboniferous (Tournaisian) age, and a poorly preserved specimen which possibly belongs to *Orthobairdia ordensis* occurs in the lowermost beds of the Burt Range Formation.

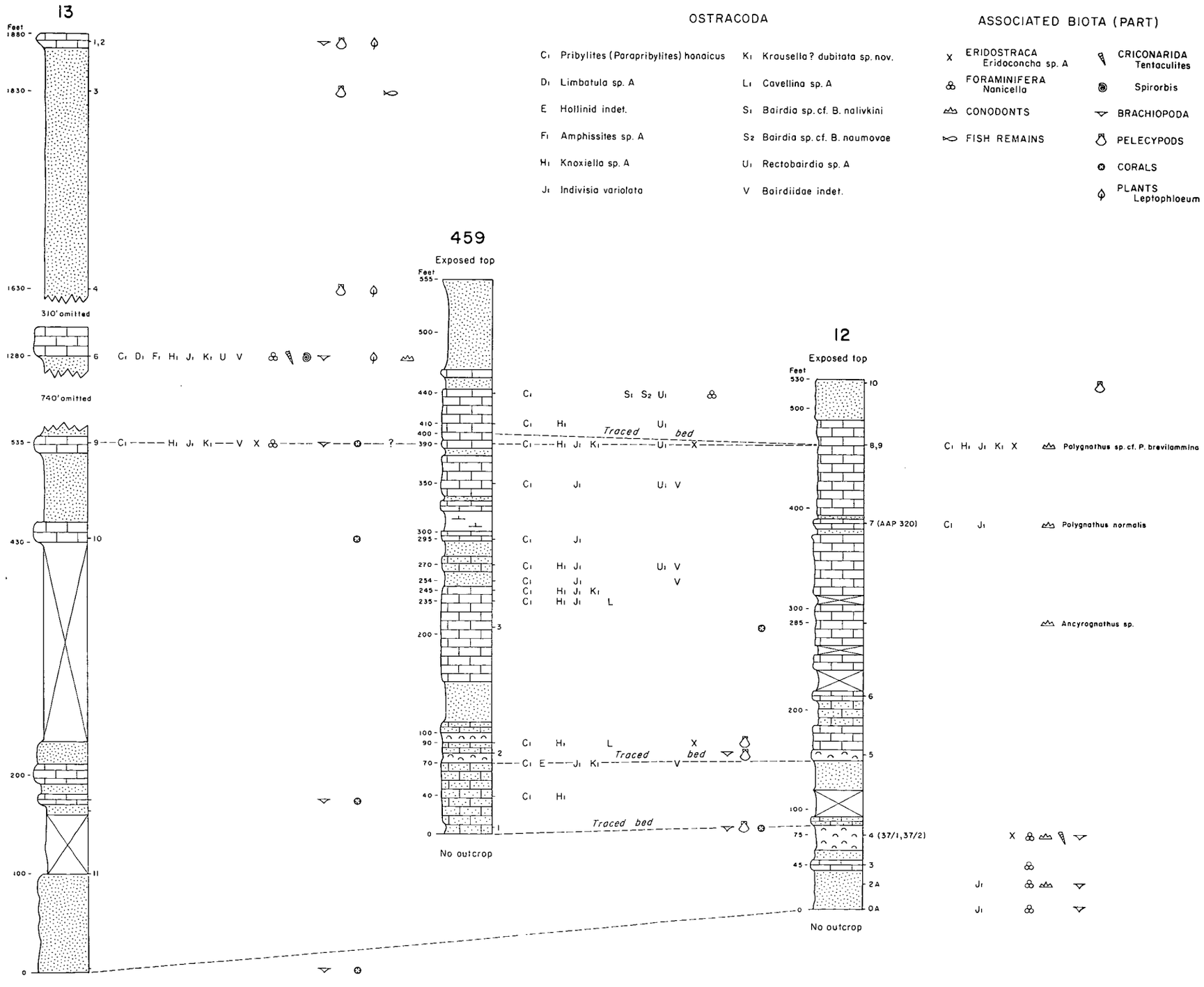

Fig. 5 Distribution of ostracod species and part of associated biota in the Westwood Member of the Cockatoo Formation.

Four provisional concurrent range-zones as defined by the American Code of Stratigraphic Nomenclature (1961) are proposed, based upon the overlapping ranges of *Sulcella altifrons, Diphyochilina tryphera,* and *Orthobairdia ordensis* in section 105. These species are easily identified, are widely distributed within the platform conglomeratic province, and are present in the platform carbonate province. This zonal scheme is, however, based on one thick section only. Other outcrops of the Buttons Beds are of the order of only 100 feet thick and represent only a part of a single zone in the 105 section. Thus, the lateral extent of the complete zonal sequence has yet to be proved. This limitation is fully realized, and the following zonation is suggested as a working scheme, which could only be modified by subsurface investigations in the southeastern platform conglomeratic province.

(i) *Sulcella altifrons* Zone

This zone occupies the lower part of the Buttons Beds between 60 feet and 350 feet above the base of Section 105. Its lower limit is marked by the earliest occurrences of *Sulcella altifrons, Marginia venula, Paraparchites* sp. cf. *P. nicklesi,* and *Cryptophyllus* sp. indet. Its upper limit is defined by the earliest occurrence of *Diphyochilina tryphera.*

(ii) *Diphyochilina tryphera* Zone

This zone coincides with the interval 350 feet to 420 feet of the Buttons Beds in Section 105. Its lower limit is marked by the earliest occurrence of *Diphyochilina tryphera* at 350 feet, and its upper limit is marked by the first appearance of *Orthobairdia ordensis* at 420 feet.

(iii) *Sulcella altifrons-Orthobairdia ordensis* Zone

This zone occupies the interval between 420 feet and 600 feet of the Buttons Beds in Section 105. Its lower limit coincides with the first appearance of *Orthobairdia ordensis,* the sole appearance of Treposelline Genus B sp. A, and the last appearance of *Diphyochilina tryphera.* Its upper limit is marked by the last occurrence of *Geisina monothele, Marginia venula,* and *Sulcella altifrons.*

(iv) *Orthobairdia ordensis* Zone

This zone occupies the interval between 650 feet and 810 feet of the Buttons Beds in Section 105. Its base is characterized by the last occurrence of Treposelline Genus A sp. A, *Krausella? dubitata, Beyrichiopsis? perplexa,* and *Cryptophyllus* sp. indet. *Indivisia variolata* and *Paraparchites* sp. cf. *P. nicklesi* range throughout the *Orthobairdia ordensis* zone. The upper limit is marked by the last occurrence of *Orthobairdia ordensis,* which in Section 105 occurs at 810 feet. No ostracods have been found in the sandy calcarenite at 900 feet, or in the 245 feet of sandy and silty dolomite which overlies the fossiliferous part of the section. Thus, the abrupt cut-off

of the ranges of many of the ostracod species appears to be due to the unfavourable environment. One could speculate that within the same calcareous lithology the *Orthobairdia ordensis* zone may range much higher stratigraphically. If the doubtful occurrence of this species in the basal beds of the Burt Range Formation is substantiated, this would mean that the upper limit of the *Orthobairdia ordensis* zone would have to be extended upwards into the earliest Lower Carboniferous (Tournaisian) strata.

Correlation

Intercontinental correlation is hampered by the endemic nature of the ostracods from the Upper Devonian of the Bonaparte Gulf Basin, and by the fragmentary documentation of Upper Devonian ostracods overseas. Most of the Australian species are either new, or probably new, and there are few studies of Upper Devonian ostracods as compared with those concerned with the Middle Devonian. The pelagic family Entomozoidae, which is extremely important in the micro-stratigraphy of the Upper Devonian of Europe, has not been found in the Bonaparte Gulf Basin. Also, the families Bairdiocyprididae, Pachydomellidae, Quasillitidae, Ropolonellidae, Bufinidae, and Thlipsuridae, which are well represented in the Middle Devonian of North America and Europe, have not been found.

The stratigraphical results of the study of the ostracods, and their value for correlation, are shown schematically in Figure 7.

Ostracods of the hanaicus *zone*

Preliminary conodont studies by Jones & Druce (1966) indicate a late Devonian (Frasnian) age for the Westwood Member of the Cockatoo Formation. This is confirmed by the presence of the ostracods *Amphissites* sp. A, *Bairdia* sp. cf. *B. nalivkini* Egorov, *Bairdia* sp. cf. *B. naumovae* Egorov, *Indivisia variolata* Zanina, and *Limbatula* sp. A, which are all related to species from the Frasnian of the Russian Platform. *Amphissites* sp. A appears to be closely related to some of the specimens figured by Egorov (1953, pl. 1, figs 6, 8; *not* figs 1-3) as *Amphissites irinae* Glebovskaya & Zaspelova. Both species of *Bairdia* appear to be very similar to the illustrations of the species *B. nalivkini* and *B. naumovae* (Egorov, 1953, pl. 4, figs 4a-c; pl. 7, figs 2a-c). *Indivisia variolata* Zanina occurs commonly in the Frasnian Livny Beds, and rarely in the Famennian Zadonsk Beds (Zanina, 1960). All the described species of *Limbatula* come from the Frasnian of the USSR. *Pribylites* (*Parapribylites*) *hanaicus* Pokorny, previously recorded from the uppermost Givetian of Czechoslovakia (Pokorny, 1950), Germany (Becker, 1964), and Canada (McGill, 1966), is now shown to extend into the Frasnian.

Locally, the ostracods of the *hanaicus* zone indicate that Locality 12/9 can be correlated with the locality 390 feet above the base of Section 459, and approximately correlated with Locality 13/9.

ORD RIVER SECTION

105

Exposed top

CONCURRENT RANGE ZONES

ORTHOBAIRDIA ORDENSIS

Base characterized by:
last occurrence of Treposelline gen A
Krausella? dubitata, Beyrichiopsis? perplexa
Cryptophyllus sp. indet.

ORTHOBAIRDIA ORDENSIS - SULCELLA ALTIFRONS

Base characterized by:
first appearance of ordensis
last occurrence of tryphera
occurrence of Treposelline gen B

DIPHYOCHILINA TRYPHERA

Base characterized by:
first appearance of tryphera

SULCELLA ALTIFRONS

Feet
1150
1100
1075
1000
900
860
820
810
800
735
700
650
620
600
525
500
430
420
400
370
350
320
300
280
200
190
170
100
60
10
0

Polylophodonta sp.

No outcrop

146

Feet
200
100
0

No outcrop

EIGHT-MILE CREEK SECTIONS

(Excluding overlying Burt Range Formation)

100 (Base)=144

Feet
200
100
0

← Cockatoo Formation

No outcrop

145

Feet
100
0

No outcrop

OSTRACODA

- A1 Treposelline gen. A sp. A
- B1 Treposelline gen. B sp. A
- G1 Geisina monothele sp. nov.
- I1 Marginia venula sp. nov.
- I2 Marginia reticulata sp. nov.
- J1 Indivisia variolata
- K1 Krausella? dubitata sp. nov.
- L1 Covellina sp. A
- M1 Beyrichiopsis? perplexa sp. nov.
- N1 Leptoprimitia sp. A
- O1 Paraparchites cf. P. nicklesi
- P1 Coeloenellina cf. C. fabiformis
- Q1 Diphyochilina tryphera sp. nov.
- R1 Sulcella altifrons sp. nov.
- T1 Orthobairdia ordensis sp. nov.
- W ERIDOSTRACA Cryptophyllus sp. indet.

ASSOCIATED BIOTA

- PLANTS Leptophloeum
- ALGAE Umbellina
- POLYZOA
- CRICONARIDA Spirorbis
- BRACHIOPODA (articulate)
- Lingula
- CORALS
- CONODONTS (no. of specimens)
- FISH REMAINS
- PELECYPODS

Fig. 6 Distribution of ostracod species and part of associated biota in the Buttons Beds.

Ostracods of the altifrons-ordensis *zonal sequence*

By superposition, the ostracods of the *altifrons-ordensis* zonal sequence must be Frasnian or younger, and Jones & Druce (1966) have provided conodont evidence of an early Famennian (toII-toIII) age for the rock succession which contains these zones. The endemic nature of the ostracod fauna does not permit their use for intercontinental correlation. Only three previously described species have been found: *Indivisia variolata* Zanina, and two tentatively assigned to *Coeloenellina fabiformis* (Kesling & Kilgore) from the Middle Devonian Genshaw formation of Michigan, and *Paraparchites nicklesi* (Ulrich), which is common throughout the Mississippian in North America. Because only broad comparisons may be made, precise correlation is impossible. While the *altifrons-ordensis* zonal sequence contains a fauna which for the most part is typically Devonian, e.g. the Treposellinae, and the genera *Coeloenellina, Indivisia, Leptoprimitia, Marginia,* and *Krausella,* it also includes some genera that suggest a Carboniferous aspect, e.g. *Beyrichiopsis* and *Geisina.* This could suggest that the fauna is of uppermost Devonian or lowermost Carboniferous age, but it most probably reflects the general lack of knowledge of Upper Devonian ostracod faunas.

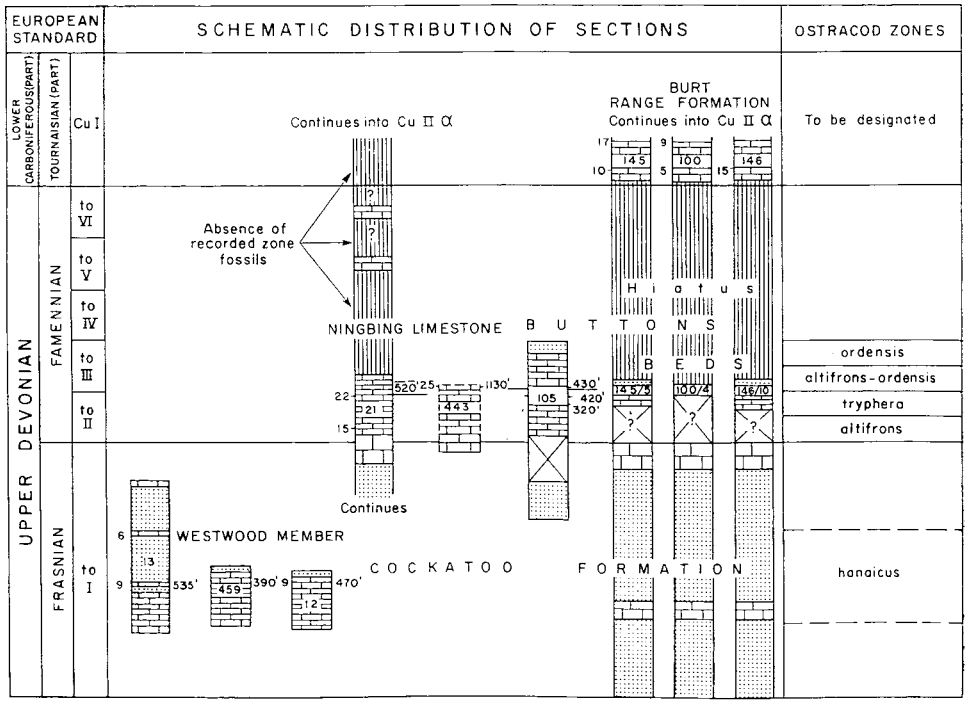

Fig. 7 Correlation chart based on Upper Devonian ostracod zones. KEY—Numbers inside columns = section numbers; numbers on left side of columns = sample numbers; numbers on right side of columns = height above base of section.

The ostracods of the *altifrons-ordensis* zonal sequence are reliable locally as zonal indices, and particularly useful in the absence of conodonts. They have provided the basis for the correlation of isolated outcrops of the Buttons Beds in the Eight Mile Creek area, where conodonts are missing, with the type section at Buttons Crossing. In the Eight Mile Creek area (Loc. 100/4) at the base of Section 100, *Sulcella altifrons, Diphyochilina tryphera,* and *Orthobairdia ordensis* indicate a position at the base of the *altifrons-ordensis* zone (420 feet-430 feet or possibly as high as 500 feet) in Section 105. The same fauna is also present in the Buttons Beds at Localities 145/5 and 146/10. The Burt Range Formation immediately overlies the Buttons Beds in Sections 100, 144, 145, and 146 at Localities 100/6, 144/3, 145/10, and 146/15 respectively. These localities mark a distinct change in the ostracod fauna, which has more of a Lower Carboniferous aspect. This is confirmed by the conodont studies of Jones & Druce (1966). Therefore, the Burt Range Formation is separated from the Buttons Beds by a considerable hiatus: the stages toIV, toV, and toVI appear to be missing in the Burt Range area.

Correlation of the Buttons Beds and the Ningbing Limestone is also based on ostracods. *Diphyochilina tryphera* at Locality 21/22 (520 feet above the base of Section 21) indicates either the *tryphera* zone, or the base of the *altifrons-ordensis* zone. Thus, 21/22 is equivalent to the interval 350 feet to 430 feet above the base of the 105 Section. A poorly preserved specimen possibly belonging to the species *Orthobairdia ordensis* from Locality 21/25, 120 feet above 21/22, may indicate either the *altifrons-ordensis* zone or the higher *ordensis* zone.

The uppermost part of the Ningbing Limestone in the Jeremiah Hills (Locality 443/25), 1130 feet above the base of Section 443, contains the species *Marginia reticulata,* previously known only from the Eight Mile Creek localities 146/10-11-13, 145/8, and 100/4, which indicates either the *tryphera* zone or the base of the *altifrons-ordensis* zone. On this basis, 443/25 is apparently equivalent to the interval 350 feet to 430 feet above the base of Section 105, and by correlation is equivalent to 21/22. The correlation between 443/25 and 21/22, however, is tentative, as it is based on *Marginia reticulata,* whose total range is unknown. It is also at variance with the conodont evidence, as Druce (1968) suggests a late toV-toVI age for a single conodont found at 443/15A, which is 750 feet below 443/25.

Ostracod species common to both the Bonaparte Gulf and Canning Basins

Six of the nineteen species of ostracods described herein are also present in the Upper Devonian (Famennian) sequence of the northern Canning Basin (Fitzroy Sub-basin), as part of ostracod Assemblage A (of Jones, 1961a), viz. *Indivisia variolata, Knoxiella* sp. A, *Marginia venula, Orthobairdia ordensis, Coeloenellina* sp. cf. *C. fabiformis,* and *Cavellina* sp. A. The eridostracan

Eridoconcha sp. A is also present in the Upper Devonian of the Fitzroy Sub-basin, recorded under the name *Rhabdostichus* (Jones, 1959, 1962a). These species occur in outcrops of the Fairfield Beds and its equivalents, and in subsurface sections. Glenister & Klapper (1966), on conodont evidence, correlate this sequence with the German Upper Devonian stages upper toIV-lower toVI. Of the species common to both basins, those in the Bonaparte Gulf Basin occur in the lower Famennian, whereas those of the northern Canning Basin (Fitzroy Sub-basin) occur in the upper Famennian. Therefore, the evidence from both basins shows that in northwestern Australia these six species range almost through the entire Famennian.

TERMINOLOGY

The common terms used in this Bulletin for the description of the fossil ostracod carapaces conform as much as possible to those used in their traditional sense as defined by Kesling (1951). The orientation adopted is that of Bonnema (1913, 1930, 1932), Swartz (1936), Triebel (1941), Hessland (1949), Kesling (1951), Henningsmoen (1953), Jaanusson (1957), Scott (1961), Martinsson (1962), and others—the adductor-muscle scar being in front of the mid-length position.

Kesling (1951) made a comprehensive synopsis of terms used by a number of authors between 1869 and 1948 writing in different languages on different groups of ostracods. This analysis is used as a standard, consistent set of terms. In later papers on palaeocopes, especially those by Henningsmoen (1953, 1965), Jaanusson (1957), Jaanusson & Martinsson (1956), Martinsson (1955, 1962, 1963), and Guber & Jaanusson (1964), new terms have been added.

The following abbreviations are used in the tables.

c	=	carapace
l or LV	=	left valve
r or RV	=	right valve
h	=	heteromorph
t	=	tecnomorph
R/L	=	right valve overlapping left valve
L/R	=	left valve overlapping right valve
L/H	=	length-height ratio
A	=	Adult instar
A-1	=	last pre-adult instar
A-2	=	penultimate pre-adult instar

All measurements are in millimetres.

All type specimens, figured specimens, and thin sections are deposited in the Commonwealth Palaeontological Collection, Canberra, Australia, and are designated by the prefix CPC.

SYSTEMATIC DESCRIPTIONS

Phylum ARTHROPODA Siebold & Stannius, 1845

Class CRUSTACEA Pennant, 1777

Order OSTRACODA Latreille, 1802

Suborder PALAEOCOPA Henningsmoen, 1953, emend. Martinsson, 1962
(= Beyrichiida Pokorny, 1953; = Beyrichicopina Scott, 1961)

Superfamily BEYRICHIACEA Matthew, 1886 (*nom. transl.* Ulrich & Bassler, 1923; *ex* Beyrichiidae Matthew, 1886)

Family CRASPEDOBOLBINIDAE Martinsson, 1962 (*nom. transl.* Martinsson, 1963; *ex* Craspedobolbininae Martinsson, 1962)

Subfamily TREPOSELLINAE Henningsmoen, 1954

Treposelline Genus A sp. A

(Pl. 1, figs 10a-c, 11a, b)

Material: 6 complete and 2 broken heteromorphs, 3 complete tecnomorphs.

Description: Outline subovate, preplete in lateral view, heart-shaped and ventrally swollen in end view. Hinge-line straight, short, less than two-thirds of length of carapace. Lobation weakly developed, consisting of three low broad swellings on the dorsal border which rise slightly above the hinge-line—a preadductorial lobe, a low cusp, and an indistinct anterior lobe. The preadductorial lobe merges into the syllobium, which in turn is widened by the expansion of the crumina in the posteroventral region. The cusp and anterior lobe are spinous in some specimens. Lateral surface delimited by a smooth velar-like ridge, parallel to the free-margin. Crumina ornamented by fine parallel striae on lateral side of velar-like ridge. Subvelar field bordered by a smooth narrow marginal ridge. Surface may be smooth or reticulate.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*Figured on*
CPC 7056 (heteromorph)	0.46	0.35	0.39	Pl. 1, fig. 10a-c
CPC 7057 (tecnomorph)	0.41	0.27	0.29	Pl. 1, fig. 11a, b.

Occurrence: Figured specimens from section 105, Buttons Crossing, east bank of the Ord River—CPC 7056, 430 feet above the base (base of *altifrons-ordensis* Zone), CPC 7057, 660 feet above the base (basal *ordensis* Zone), Buttons Beds, Upper Devonian (lower Famennian toII-toIII). In same section at 100 feet (*altifrons* Zone), 370 feet (*tryphera* Zone), 420 feet (base of *altifrons-ordensis* Zone), 600 feet and 660 feet (base of *ordensis* Zone). Also occurs at locality 100/4 (base of *altifrons-ordensis* Zone), Buttons Beds, at Eight Mile Creek in the Burt Range area.

Remarks: This species probably represents a new genus of Treposellinae, which possesses morphological characters intermediate between the genus *Hibbardia* Kesling, 1953 (with indistinct lobation and a shallow sulcus), and the genus *Phlyctiscapha* Kesling, 1953 (in which lobation is completely effaced and sulci absent). It cannot be properly defined until more specimens are found.

Treposelline Genus B sp. A

(Pl. 1, figs 13a-b; text-fig. 8)

Material: 5 complete heteromorphs.

Description: Outline subovate, preplete in lateral view. Hinge-line straight, long, about three-quarters of the length of the carapace. Lobation moderately developed. Anterior lobe (L1) a low pointed conical cusp projecting above the hinge-line, and connected to a velar-like ridge which surrounds the free border. Preadductorial node (L2) a low broad node in the dorsocentral area. Posterior lobe (L3) a strongly pointed conical cusp, projecting well above the hinge-line. L2 and L3 are both separated from the syllobium by a groove, directed towards the anterocentral region. Syllobium invaded by the crumina, which extends the greatest width from the mid-length position to almost the posterior end. Greatest width extends from ventral position centrally to a mid-height position near the posterior end. Surface may be smooth or finely reticulate.

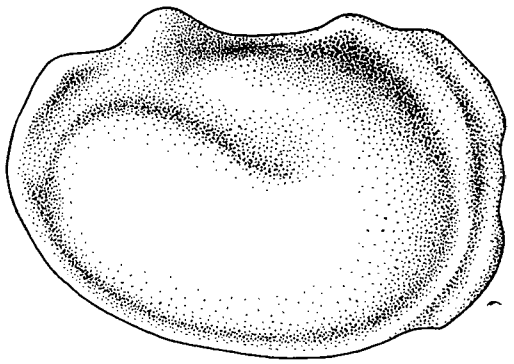

Fig. 8 Treposelline Gen. B sp. A. Diagrammatic drawing illustrating a right valve in lateral view x120.

Dimensions

Figured specimen	*Length*	*Height* (-L2)	(+L2)	*Width*	*Figured on*
CPC 7058	0.55	0.35	0.37	0.45	Pl. 1, fig. 13

Occurrence: Figured specimen (CPC 7058) from section 105, Buttons Crossing, east bank of the Ord River—430 feet above the base (base of *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian (lower Famennian toII-toIII). Also occurs at localities 100/4, 146/10, 146/11 (base of *altifrons-ordensis* Zone), Buttons Beds, Eight Mile Creek, in the Burt Range area.

Remarks: No tecnomorphs have been found. This species probably represents a new genus of Treposellinae related to *Bolbiprimitia* Kay, 1940. The crumina

merges into the syllobium as in *Bolbiprimitia inaequalis* (Jones), as figured by Martinsson (1956, pl. 3, fig. 14; 1962, fig. 96A).

Superfamily PRIMITIOPSACEA Swartz, 1936

(*nom. transl.* Hessland, 1961; *ex* Primitiopsidae Swartz, 1936)

Family PRIBYLITIDAE Pokorny, 1958

Genus PRIBYLITES Pokorny, 1950

Synonyms: *Boucekites* Pribyl, 1953; *Gravia* (*Gravia*) Polenova, 1952; *Gravia* (*Russia*) Polenova, 1952.

Type species: *Pribylites* (*Pribylites*) *moravicus* Pokorny, 1950, p. 589 (by original designation).

Type level: Middle Devonian, Givetian.

Type locality: Celechovice, Czechoslovakia.

Remarks: Pokorny (1950, p. 589) distinguished two subgenera of the genus *Pribylites,* based on the character of the dorsal corners, and the direction of swing in lateral view of the type species:

(i) *Pribylites* (*Pribylites*) *moravicus* Pokorny, 1950, with tuberculate dorsal corners, and slightly postplete outline, and

(ii) *Pribylites* (*Parapribylites*) *hanaicus* Pokorny 1950, without the dorsal swellings at the corners; outline amplete to preplete.

Pokorny (1958, p. 148) has pointed out that forms which are probably congeneric with *Pribylites* have been described from the Middle and Upper Devonian of the USSR as *Gravia* Polenova, 1952. Polenova (1952, p. 83) divided the genus *Gravia* into two subgenera, *G.* (*Gravia*) and *G.* (*Russia*). As she neither figured nor described the type species of *G.* (*Gravia*)—*G.* (*Gravia*) *aculeatus* Polenova, 1952—the name of this subgenus is a *nomen nudum,* and is therefore invalid. Pokorny (loc. cit.) suggested that the type species of *G.* (*Russia*)—*G.* (*Russia*) *unicostatus* Polenova, 1952—belongs to the genus *Pribylites,* a suggestion accepted by Polenova, as she later (1960, p. 299) regarded this subgenus as a subjective synonym of *Pribylites* (*Parapribylites*). He also suggested that *Boucekites* Pribyl, 1952, may be congeneric with *Pribylites.*

Becker (1964, p. 64) drew attention to the fact that *G.* (*Gravia*) was closely related to *Pribylites,* and used *Gravia* as a subgenus of *Pribylites,* designating *G.* (*Gravia*) *volgaensis* Polenova, 1952, as the type species.

According to Becker (1964, p. 63) the presence or absence of a velar structure is of no taxonomic value, as this is a highly variable feature within the same species. In the Australian material, the velar structure is well developed in specimens regarded as heteromorphs, but it is reduced to a spine in tecnomorphs. It is suggested that the subgenus *Pribylites* (*Parapribylites*) is represented by heteromorphs, i.e. *Pribylites* (*Parapribylites*), and tecnomorphs, previously referred to *P.* (*Gravia*). Also the possibility has to be considered that the genus *Boucekites* may represent the tecnomorphs of the subgenus *Pribylites* (*Pribylites*).

Pokorny (1958, p. 147) has pointed out that *Pribylites* and the tecnomorphic forms of *Primitiopsis* are remarkably alike in general shape, which may suggest that the Pribylitidae is related to the Primitiopsacea. This suggestion may have some merit, as the genus *Pribylites* is very similar to the unisulcate genus *Selebratina* Polenova, 1953, which appears to be an intermediate link between *Pribylites* and the Carboniferous genus *Coryellina.* Sohn (1962, p. 1206) has suggested that possibly *Coryellina* might be the end-member of the Primitiopsidae and that (op. cit., p. 1209) '*Selebratina* may well be either a synonym of *Coryellina,* or an ancestral genus'.

Subgenus PRIBYLITES (PARAPRIBYLITES) Pokorny, 1950

? PRIBYLITES (GRAVIA) Polenova, 1952

Type species: *Pribylites* (*Parapribylites*) *hanaicus* Pokorny, 1950 (by original designation) p. 592.

Type level: Middle Devonian, Givetian (probably upper Givetian).

Type locality: Celechovice, Czechoslovakia.

PRIBYLITES (PARAPRIBYLITES) HANAICUS Pokorny, 1950

(Pl. 1, figs 1-5; text-fig. 9)

1950 *Pribylites* (*Parapribylites*) *hanaicus* Pokorny, pp. 592-3, pl. 1, fig. 2-3.
1964 *Pribylites* (*Parapribylites*) *hanaicus* Pokorny; Becker, pp. 58-9, pl. 9, fig. 5.

Type level: Givetian (probably upper Givetian), group of 'red marly coral limestones', with *Calceola sandalina.*

Type locality: Abandoned Ruzicka Quarry, north of Celechovice, less than 15 km SW of Olomouc, north-central Czechoslovakia.

Material: 40 complete carapaces, 2 valves.

Description (*Heteromorphs*): Outline preplete. Dorsum straight, as long as length of domicilium, strongly hypocline with both anterodorsal and posterodorsal ends truncated. Anterocardinal angle about 100°-115°; posterocardinal angle about 80°-90°. Posteroventral margin truncated and merging imperceptibly into a straight or slightly convex ventral margin. Domicilium heart-shaped in cross-section, ventrally swollen. In ventral view outline trapezoidal; greatest width behind mid-length position; anterior end more acute than posterior end. Marginal structure formed by denticulate ridge surrounding free margin of left valve; left valve slightly smaller than right. Denticulate ridge on right valve admarginal in position, and separated from free margin by a smooth area. Velar structure developed as a flange in larger specimens, forming outer antral fence. Antrum concave, bounded distally by marginal denticulate ridge, forming inner antral fence. Ornamentation in some specimens as low acroidal spines at posterior and anterior ends of hinge-line. Non-sulcate. Hinge-structure and contact margin unknown. Surface smooth.

(*Tecnomorphs*): similar to heteromorphs, with same type of inner antral fence, but have convex antra, with outer antral fence reduced to a short raised ridge or spine.

Dimensions

Figured specimens	*Length*	*Height*	*Width*	*Valve*	*Figured on*
CPC 7047	0.64	0.42	0.40	h-c	Plate 1, fig. 1
CPC 7048	0.65	0.45	0.42	h-c	Plate 1, fig. 2
CPC 7049	0.75	0.45	0.25	t-r	Plate 1, fig. 3
CPC 7050	0.66	0.46	0.42	t-c	Plate 1, fig. 4
CPC 7051	0.56	0.36	0.34	t-c	Plate 1, fig. 5

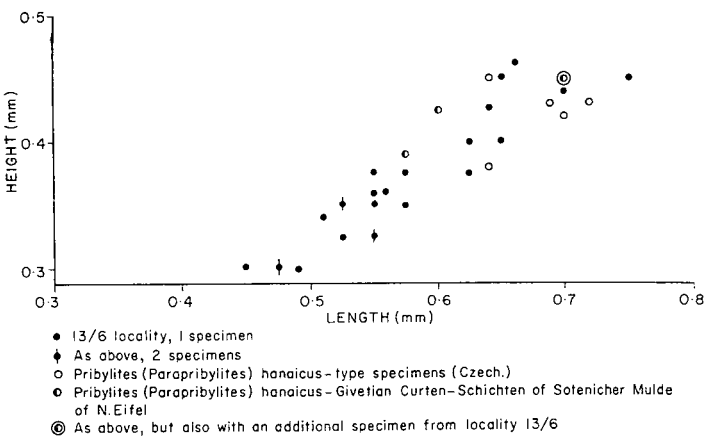

Fig. 9 Size-dispersion diagram for *Pribylites* (*Parapribylites*) *hanaicus* **Pokorny, 1950.**

The measurements of the length and height of 25 specimens collected from locality 13/6 are shown on a graph (Fig. 9). Measurements of the type specimens of *Pribylites (Parapribylites) hanaicus* from Celechovice, Czechoslovakia, and of specimens referred to the same species by Becker (1964) from the Middle Devonian (Givetian) Cürten-Schichten, of the Sötenicher Mulde of North-Eifel, Germany, are also plotted for comparison.

Occurrence: Figured specimens (CPC 7047, 7048, 7049, 7050, and 7051) from BMR section 13, locality 13/6, and AAP section 44, sample AAP 320, which is approximately the stratigraphical equivalent of BMR locality 12/7; also occurs at localities 12/8, 12/9, and 13/9; all localities within the Westwood Member of Cockatoo Formation, Westwood Creek; Upper Devonian (Frasnian).

Remarks: The Australian specimens are very similar to the European species *Pribylites (Parapribylites) hanaicus* Pokorny. Dr F. Adamczak of Stockholm and Dr K. Krömmelbein of Kiel kindly made available to me specimens of this species from the Middle Devonian (Givetian) of the Eifel for comparison with the Westwood Creek specimens. As no distinction could be made between the specimens from the two continents, the name of the European species is applied to the Australian specimens with some confidence.

The posteroventral spine present in the tecnomorphs (CPC 7049, 7050, and 7051) figured on Plate 1, figures 3, 4, and 5 suggests a comparison with the forms assigned to the Russian genera *Selebratina* Polenova, 1953, and *Gravia* Polenova, 1952. This feature however, is regarded as a dimorphic character, and furthermore *Gravia,* as discussed above, is very closely related to, if not synonymous with, *Pribylites (Parapribylites)* Pokorny.

Recently, McGill (1966, p. 111) described *Pribylites* cf. *P. hanaicus* Pokorny from the Slave Point Formation of probable late Givetian age, from Alberta. This species is similar to the type species, and even closer to the specimens described by Becker (1964), in that the outer antral fence ends posteriorly. In my opinion, the European, Canadian, and Australian specimens all belong to the same species-group. It should be noted that the Australian specimens are slightly younger (Frasnian) than those of the northern hemisphere (late Givetian). Magné (1964, pl. 30, fig. 280; chart 7), however, has found a single specimen belonging to an unnamed species of *Pribylites* from the Middle Frasnian Calcaire de Ferques of the Boulonnais, northern France.

Superfamily HOLLINACEA Swartz, 1936

(*nom. transl.* Jaanusson, 1957; *ex* Hollinidae Swartz, 1936)

? Family HOLLINIDAE Swartz, 1936

Subfamily NEODREPANELLINAE Zaspelova, 1952

Genus LIMBATULA Zaspelova, 1952

Type species: *Limbatula symmetrica* Zaspelova, 1952, p. 180 (by original designation).

Type level: Upper Devonian, Frasnian, Evlanov Beds.

Type locality: Bolotskoye, Ivanovskaya Region, USSR.

Diagnosis (translated from Zaspelova, 1952, p. 180): Carapace small, thin-walled, truncate-oval, with a straight dorsal margin, and a large spine or node in the dorsal portion; closer to the anterior end, a small rounded node. Terminal spines connected by a marginal ridge, and projecting above the dorsal border. Surface of valves smooth or alveolar.

LIMBATULA sp. A

(Pl. 1, figs 6-8)

Material: 4 damaged valves, including 1 pre-adult instar.

Description: Outline subovate, preplete to amplete. Hinge-line straight, long. Ventral border slightly convex; convexity increased by truncation of posteroventral border. Anterior end slightly convex. Domicilium swollen in ventrocentral region. Marginal structure appearing as distinct ridge forming inner antral fence, completely surrounding free margin, and separated from the parallel velar ridge by a smooth antrum. Lobation strongly developed. L1 strong, posteriorly inclined, projecting above hinge-line, and attached to the velar ridge. L2 distinct, spinous, low conical shape. L3, the largest lobe, a long robust conical-shaped spine, posteriorly inclined, projecting well above hinge-line. No evidence concerning L4, as the posterodorsal corner is broken in all specimens. Domicilial swelling in ventrocentral region bearing a distinct spinous lobe in posterocentral position, ventral to L3. Surface covered with small, closely spaced pits. Pre-adult instar (Pl. 1, fig. 8) showing ventral border strongly convex, truncated posteriorly, forming a distinctly preplete outline. Lobes well defined, L1 erect.

Dimensions

Figured specimens	*Length*	*Height*	*Width*	*Figured on*
CPC 7052	0.80	0.52	0.25 (excl. lobes)	Pl. 1, fig. 6
CPC 7053	0.80	0.50	0.30 (incl. lobes)	Pl. 1, fig. 7
CPC 7054 (Pre-adult instar)	0.49	0.32	—	Pl. 1, fig. 8

Occurrence: Figured specimens (CPC 7052, 7053, and 7054) from BMR Section 13, locality 13/6; Westwood Member of Cockatoo Formation, Westwood Creek; Upper Devonian (Frasnian).

Remarks: *Limbatula* sp. A probably represents a new species, but as the description is based on only four specimens, it cannot be properly defined

until more material becomes available. Nevertheless, it is of interest to note that this species is related to the genus *Limbatula,* originally described from the Upper Devonian (Frasnian) of the USSR. At present, the Australian material does not provide any information as to whether or not the genus *Limbatula* is dimorphic. The lobes L2, L3, and a lobe in the ventral position below L3 are developed into strong spines, which slightly resembles the lobation of the species *Bicornella tricornis* Coryell & Cuskley, 1934, from the Lower Devonian (Helderbergian) Haragan formation of Oklahoma, as illustrated by Sohn (1961, Q 128, fig. 60, 2a-b).

Superfamily KIRKBYACEA Ulrich & Bassler, 1906

(*nom. transl.* Jaanusson, 1957; = Kirkbyacea *sensu* Martinsson, 1962)

Family AMPHISSITIDAE Knight, 1928

Genus AMPHISSITES Girty, 1910

Type species: *Amphissites rugosus* Girty, 1910, p. 236 (no illus.) (by original designation); also Roundy, 1926, p. 7 (with illus. pl. 1, figs 1a-c).

Type level: Upper Mississippian; Fayetteville shale.

Type locality: Fayetteville, Washington County, Arkansas.

Remarks: Reference is made to the diagnoses of the family Amphissitidae Knight, 1928, and the genus *Amphissites* Girty, 1910, provided by Sohn (1961, pp. 114, 115).

AMPHISSITES sp. A

(Pl. 1, figs 9a-c)

Material: 3 carapaces only.

Description: Outline elongate subquadrate in lateral view, elongate subovate in dorsal view. Right valve slightly larger than left valve. Dorsal border long and slightly concave just anterior of mid-length position, rising at posterior end. Anterior cardinal angle about 120°; posterior cardinal angle about 130°. Anterior border truncated, posterior border rounded. Ventral border straight, merging into anterior and posterior ends. Greatest height in posterior half of carapace. Hinge structure unknown.

Surface ornamented by closely spaced polygonal reticulae. Outer rim present; inner rim in ventral part straight, and gently curved towards dorsal corners. Median node anterior to mid-length, well defined, about one-third of greatest length. Vertical carinae bifurcate at dorsum, forming a delicate dorsal carina.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*Figured on*
CPC 7055	0.85	0.45	0.50 (incl. node)	Plate 1, figs 9a-c

Occurrence: Figured specimen (CPC 7055) from BMR Section 13, locality 13/6; Westwood Member of Cockatoo Formation, Westwood Creek; Upper Devonian (Frasnian).

Remarks: As the description of *Amphissites* sp. A is based on only three specimens, it cannot be properly defined until more material becomes available. The figured specimen, however, appears to be related to some of the specimens figured by Egorov (1953, pl. 1, figs 6, 8; *not* figs 1-3) as *Amphissites irinae* Glebovskaya & Zaspelova from the Frasnian of the Russian Platform. Both have an elongate carapace, the posterior end of which is higher than the anterior end, a slightly concave dorsal border, and a prominent node just anterior to the mid-length position. The holotype (VNIGRI Collection No. 101-28) illustrated by Zaspelova (1959, pl. 13, fig. 7), possesses a much broader inner rim than any of the specimens illustrated by Egorov (1953), which according to Sohn (1961, p. 123) contain representatives of more than one species. It would appear that a revision of Egorov's material is necessary.

The Australian specimens also closely resemble the species figured by Magné (1964, p. 25, figs 190-3) as *Amphissites* sp. F from the lower and middle Frasnian of the Boulonnais, northern France.

Suborder KLOEDENELLOCOPA Scott, 1961

Superfamily KLOEDENELLACEA Ulrich & Bassler, 1908
(*nom. transl.* Swartz, 1945; *ex* Kloedenellidae Ulrich & Bassler, 1908)

Family GEISINIDAE Sohn, 1961

Genus GEISINA Johnson, 1936

Type species: *Beyrichiella gregaria* Ulrich & Bassler, 1908; Johnson, 1936, p. 21 (by original designation).

Type level: Upper Pennsylvanian; Missouri Series.

Type locality: Kansas City, Missouri.

Remarks: Johnson (1936, p. 21) in his diagnosis of *Geisina* referred to 'a second less prominent sulcus in the posterior half', which is inconsistent with

his orientation of the valves; as he figured and described the larger one as the right valve, the weaker sulcus must be in the anterior half of the carapace. In addition, Johnson pointed out that with respect to the overlap of the left valve along its free margin, *Geisina* is similar to *Jonesina* Ulrich & Bassler, 1908, while the hinge structure and sulcation are more nearly like that of *Kirkbyina* Ulrich & Bassler, 1908. Unfortunately, the genotype of *Jonesina* (*Beyrichia fastigiata* Jones & Kirkby, 1886) is only poorly known, and according to Latham (*in* Johnson, 1936, p. 20), the holotype is apparently lost. A study by Johnson (1936, pp. 19-21) of four British Museum specimens identified by Kirkby as *Beyrichia fastigiata,* supplemented by a study of the figures published by Jones & Kirkby, showed that 'the right valve strongly overlaps the left on the ventral and end margins and slightly overlaps the left on the dorsal margin to form the hinge. In the left valve the limit of overlap is marked by a narrow flange which borders the valve on all sides. In a closed carapace this flange is in contact with the thickened edge of the right valve, and the overlap is not visible. The appearance of this contact is well shown in a ventral view of *Jonesina craterigera* (Jones & Kirkby), published by Jones & Kirkby . . . . . '. Thus, according to Johnson's study, the ventral overlap of *Jonesina* closely resembles that of *Geisina,* and Egorov's description of the ventral border of *Knoxiella.* Both *Geisina* and *Knoxiella* apparently differ from *Jonesina* in having a posteriorly depressed hinge-line.

Johnson (1936, p. 21) also pointed out that the overlap along the free margins is well developed in *Geisina,* but only weakly developed in *Kirkbyina.* Furthermore, the left valve overlaps the right valve along the anterodorsal border of *Kirkbyina,* whereas this is reversed in *Geisina.*

Geisina has a similar anterodorsal overlap to that found in *Hypotetragona,* and a ventral overlap similar to that found in *Knoxiella.*

The posterodorsal spine which characterizes *Geisina* may be present in the pre-adult instars of both *Knoxiella cerata* Egorov (1950, p. 101), and *Hypotetragona albertensis* Loranger, 1962 (*nom. nuda* in McGill, 1963 = *H. media* Loranger, 1963), but is absent in the adult stages, although McGill (1963, p. 5) reported a posterodorsal vestigial spine in some of the adult male specimens of the latter.

With respect to the sulcation, the overlap of the valves, and the posteriorly depressed hinge-line, *Knoxites* Egorov, 1950, is very similar to *Geisina,* and Sohn (1961, Q 184) states that this genus 'differs from *Geisina* in having a posterodorsal tubercle'. Egorov (1950, p. 84-85), in his generic description of *Knoxites,* also emphasized the presence of a tubercle in the posteroventral area of the valve. This feature has not been reported in any of the other genera previously mentioned.

GEISINA MONOTHELE sp. nov.

(Pl. 3, figs 8-10)

Derivation of name: Greek *monos,* one, single, alone; *thele,* teat, nipple.

Material: About 80 carapaces.

Diagnosis: A smooth species of *Geisina* with a small nipple-like spine on L3 of the left valve.

Description: Outline subquadrate with anterior swing in lateral view. Right valve larger than left; distinct overlap R/L around free edge. Hinge-line straight, about three-quarters as long as carapace; depressed in shallow channel formed by low swelling of L3 on each valve. Anterior and posterior cardinal angles equal; about 140°. Anterior border broadly rounded; posterior border rounded, truncated on ventral side; axis of greatest length from anteroventral border to posterior corner. Ventral border of right valve considerably thickened, gently rounded, merging smoothly into anterior and posterior borders. Free margin of left valve bears narrow smooth rim, which in turn bears delicate narrow striated marginal structure—probably the selvage seal.

Hinge formed by groove in dorsal border of right valve, with slightly thickened stragulae at anterior and posterior corners; dorsal border of left valve bears a narrow ridge. When valves are closed, ridge of left valve is inserted into groove of right valve, and thickened anterior and posterior stragulae of right valve overlap corners of left valve.

L1 a small, low, indistinct lobe near anterior corner, sloping gently into anterodorsal outline of carapace. L2 a prominent rounded node in dorsal half of valve, diameter about one-quarter of height, steep dorsal anterior and posterior slope, where it is bounded by S2; merges ventrally into main part of carapace. L3 a broad rounded posterior lobe extending slightly above sunken hinge-line, and forms greatest height, slightly behind mid-length position; bears a short nipple-like spine just below dorsal border of left valve, slightly behind position of greatest height; bounded anteriorly by S2, and ventrally merges into main part of carapace.

S1 short, indistinct, less than one-fifth of height of valve. S2 broad, deep, situated about 45 percent of total length of valve from anterior margin, extending ventrally from dorsal border about one-half of distance to ventral border of right valve.

In dorsal view, outline constricted by S2. L3 larger and wider than L2; spine on left valve only. Hinge-line with triangular-shaped stragulae formed

by R/L overlap at the ends; almost sansabelloid, but depression greater in posterior half.

In posterior view, dorsum slightly epicline; sides approximately parallel, overlap distinctly R/L around the free edge; thickened ventral border. Surface smooth.

Dimensions

	Length	*Height*	*Width*	*Figured on*
Holotype (CPC 7072)	0.81	0.54	0.39	Pl. 3, fig. 8
Paratype (CPC 7073)	0.67	0.45	0.35	(Instar) Pl. 3, fig. 9
(CPC 7074)	—	0.54	0.39	Pl. 3, fig. 10

Occurrence: Holotype (CPC 7072), paratype (CPC 7073), and figured specimen (CPC 7074) from Section 105, Buttons Crossing, east bank of Ord River—420 feet above base (base of *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian, early Famennian. In same section at 10 feet (below *altifrons* Zone), 65 feet, 180 feet, and 320 feet (all in *altifrons* Zone); at 350 feet, 370 feet, and 400 feet (in *tryphera* Zone); 420 feet and 430 feet (base of *altifrons-ordensis* Zone); and at 600 feet (*ordensis* Zone). Also occurs in Eight Mile Creek area at localities 100/4, the base of the 100 section (basal *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian (early Famennian).

Remarks: Unlike other species of *Geisina,* this species possesses a low nipple-like spine on the L3 of the left valve, but not on the right valve. *G. meneleyiana* McGill, 1966, from the Middle Devonian (probable late Givetian) of Alberta possesses a single low spine on the L3 of the right valve only. It lacks the distinctive features of *G. victoriana* Krömmelbein, 1954, the only other species of this genus known from Australia (from Middle Devonian Bell Point Limestone, Waratah Bay, Victoria), viz. (1) the pointed corners of the RV, (2) the well developed L1, (3) the flat-tuberculate L3, and (4) a weakly developed ventral ridge. *G. monothele* also lacks the finely corrugated or reticulated surface of the Victorian species; however, this feature may be a function of preservation.

Smaller, immature specimens show a greater anterior swing, deeper sulcation, and a more well developed posterodorsal spine, than the larger specimens. Dimorphic differences are not discernible in the larger specimens, and therefore they are only tentatively assumed to be the adult stage.

Genus KNOXIELLA Egorov, 1950

Type species: *Knoxiella semilukiana* Egorov, 1950, p. 90 (by original designation).

Type level: Upper Devonian, Frasnian, Voronezh beds.

Type locality: Voronezh, Russian Platform.

Remarks: *Knoxiella,* with its bisulcate, subquadrate carapace, and posteriorly depressed hinge-line, appears so closely related to the North American genus *Hypotetragona* Morey, 1936, that Sohn (1961, Q183) regarded *Knoxiella* as a junior synonym. In my opinion, from the available literature, the two genera are distinct. The differences between the genera *Knoxiella* and *Hypotetragona* occur in the nature of the dorsal overlap and the ventral margin. Usually *Knoxiella* possesses well developed anterior and posterior stragulae, about equal in size, which strongly overlap the dorsal corners of the left valve. *Hypotetragona,* however, possesses an anterior stragular process, which slightly overlaps the anterior third of the dorsal margin, and a posterior stragular process, which is almost imperceptible. In *Knoxiella,* the thickened ('bolster-like'; Egorov, 1950, p. 90) border of the right valve strongly overlaps the free edge of the left valve, whereas Morey (1935, p. 326) described the ventral margin of *Hypotetragona* as 'sharp, low ridge parallels free margins, separated from edge by narrow, smooth border'. The slight R/L overlap at the free border of *Hypotetragona* is due to the fact that the ventral ridge of the right valve is slightly more developed than that of the left valve.

The *Hypotetragona* type of dorsal overlap is also present in *Geisina,* but the latter genus lacks the sharp low ridge parallel to the free margins, which is characteristic of *Hypotetragona.* In *Geisina,* however, the thickened free edge of the right valve strongly overlaps the free edge of the left valve, as in *Knoxiella,* and as in Johnson's (1936, p. 21) interpretation of the genus *Jonesina.*

McGill (1966, p. 117) has recently proposed the genus *Ancillacuna* from the Middle Devonian (probable late Givetian) of Alberta; this genus was described as possessing a shallow or almost imperceptible S2, considerable R/L overlap along the anterior half of the hinge, and the posterior half of the hinge-line sharply depressed and flanked by a crest on each valve, essentially continuous with a submarginal velate ridge, which parallels the free edge. From this description, *Ancillacuna* McGill, 1966, appears to be somewhat related to the genus *Hypotetragona* Morey, 1935.

KNOXIELLA sp. A

(Pl. 7, figs 4-6; text-fig. 10)

Material: 46 poorly preserved carapaces; mostly pre-adult instars.

Description: *Adult ? tecnomorph*—Outline subquadrate, elongate, with anterior swing in lateral view. Hinge-line straight, about two-thirds of length, very slightly depressed between L2 and posterodorsal corner. Anterior cardinal angle

about 140°, posterior cardinal angle 90° or slightly more. Anterodorsal border truncated, forming anterior swing; anterior end rounded, posterior end truncated. Ventral border straight. R/L overlap weak (probably due to poor preservation).

Hinge structure not known; stragular processes weakly developed.

L1 and S1 absent. L2 a small rounded node in dorsal half of valve. S2 deep, situated about two-fifths distance from anterior end, extending ventrally about two-fifths of distance to ventral margin. L3 low, indistinct. Surface reticulate with closely-spaced polygonal ornament.

Pre-adult instars—become successively more elongate as the adult stage is approached, and are not accompanied by a comparable increase in growth of the hinge-line; that is, the hinge-line becomes relatively shorter as the adult stage is approached.

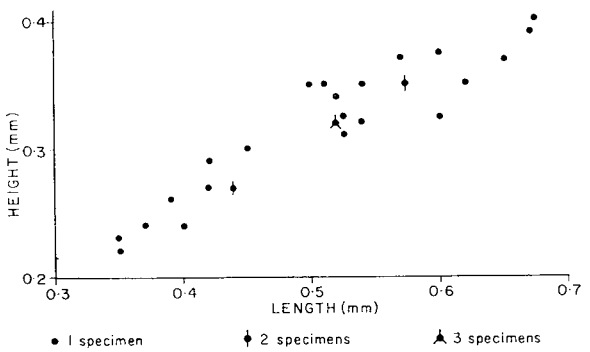

Fig. 10 Size-dispersion diagram for *Knoxiella* sp. A based on 30 specimens from localities 12/8, 13/6 and 13/9.

Dimensions

Figured specimens	*Length*	*Height*	*Width*	*Figured on*
CPC 7183	0.92	0.52	0.32	Pl. 7, fig. 4
CPC 7184	0.67	0.39	0.27	Pl. 7, fig. 5
CPC 7185	0.45	0.30	0.18	Pl. 7, fig. 6

The measurements of the length and height of 29 specimens from localities 12/8 and 13/6 are shown on a graph (Fig. 10).

Occurrence: Figured specimens (CPC 7183, 7184) from locality 12/8, (CPC 7185) from locality 13/6—Westwood Creek; Westwood Member of Cockatoo Formation; Upper Devonian (Frasnian). Also found at localities 12/9 and 13/9, Westwood Creek.

Remarks: The nomenclature of *Knoxiella* sp. A is left open at present, as the material on which it is based is too badly preserved to warrant a proper description. It appears, however, to be conspecific with the species listed by Jones (1962a, p. 36) as *Knoxiella* sp. in the well completion report of Frome Rocks No. 2 well, northern Canning Basin.

Genus MARGINIA Polenova, 1952

Type species: *Marginia sculpta* Polenova, 1952, p. 96 (by original designation).

Type level: Middle Devonian; upper Givetian.

Type locality: Syzran, Samara Bend region, USSR.

Remarks: Sohn (1961b, Q186) has suggested that *Marginia* is a possible junior synonym of *Tambovia* Samoilova, 1951—a monotypic genus, the type species of which (*T. prima* Samoilova, 1951), according to Sohn, is 'probably based on juvenile instars'. However, the juvenile instars of all species of *Marginia* would have to be described and compared with *Tambovia prima* in order to demonstrate the validity of Sohn's hypothesis.

Pokorny (1958, p. 204) noted that the type species of *Marginia* appears to be closely related to the genus *Beyrichiopsis* Jones & Kirkby, 1886. In my opinion, the marginal 'frill' of *Marginia* is probably a type of selvage seal (see discussion of the genus *Beyrichiopsis,* p. 39), and is not homologous with the fimbriate or spinous admarginal structure of *Beyrichiopsis*. Moreover, *Marginia* lacks the strongly inflated L3, L2, and ventral part of the carapace, which is characteristic of *Beyrichiopsis*. In this Bulletin, the genus *Marginia* is assigned to the family Geisinidae Sohn, 1961.

MARGINIA VENULA sp. nov.

(Pl. 2, figs 1-3; text-fig. 11)

Derivation of name: Latin, *vena*—vein; referring to the vein-like ridges which ornament the surface.

Material: 2 heteromorphs, and about 70 immature moults.

Diagnosis: Lateral surface ornamented by distinct vein-like ridges, and surrounded by a smooth ridge along ventral border of each valve, parallel to free margin; this ridge extends anteriorly as far as L1. L2 and S1 well developed, and dorsal border of L3 bears a crest.

Description: *Heteromorphs*—Outline subquadrate with anterior swing in lateral view; axis of greatest length inclined about 9° to straight hinge-line. Right valve larger than left; distinct R/L overlap along ventral margin. Hinge-line straight, about three-quarters as long as carapace, depressed in a channel extending from above L2 to posterodorsal corners of valves. Anterior cardinal angle about 125°; posterior cardinal angle about 130°. Posterior border merges imperceptibly into straight ventral border; anterior border broadly rounded. Selvage seal preserved as narrow striated frill along posteroventral margin of right valve.

Hinge structure not known; stragular processes well developed, about equal in size, and overlap corners of left valve.

L1 distinct, formed by narrow ridge whose axis is parallel to anterodorsal border. L2 a rounded node in dorsal half of the valve, sloping gently into S1, anterior side of L2 parallel to S1 and top anterior corner; side facing S2 steep and approximately perpendicular to straight hinge-line. L3 represented by a crest, which rises above straight hinge-line in posterocentral part of dorsal border, but dies out before reaching posterior corners of valves. S1 short, distinct, parallel to L1, steep on L1 side, gradually rises to form L2. S2 deep, situated about one-third distance from anterior corner, extending ventrally about two-fifths of distance to ventral margin.

In dorsal view outline elongate oval; L3 bears ridges which flank depressed dorsum; greatest width in posterior half of carapace.

In posterior view, dorsum epicline; R/L overlap distinct around free edge; thickened ventral border.

Surface ornamented by distinct vein-like ridges which are absent in S1 and S2, and a strong ridge along ventral border of each valve, parallel to marginal structure and extending anteriorly, terminating in L1.

Tecnomorphs—Lack posterior swelling of heteromorphs, and very juvenile tecnomorphs possess a distinct posterodorsal spine.

Dimensions

		Length	*Height*	*Width*	*Figured on*
Holotype	(CPC 7060)	1.17	0.75	0.49	Pl. 2, figs 1a-c
	(CPC 7061)	1.00	0.65	0.37	Pl. 2, figs 2
	(CPC 7062)	0.91	0.60	0.40	Pl. 2, figs 3a-b

The measurements of the length and height of 28 specimens from locality 100/4 are shown on a graph (Fig. 11).

Occurrence: Holotype (CPC 7060) and figured specimen CPC 7062 from locality 100/4, the base of Section 100, Buttons Beds, Burt Range (basal *altifrons-ordensis* Zone); figured specimen CPC 7061 from section 105, Buttons Crossing, east bank of the Ord River, 430 feet above the base, Buttons Beds (basal *altifrons-ordensis* Zone)—Upper Devonian, early Famennian. Also occurs in localities 145/5, 146/10 and 146/11—Buttons Beds (basal *altifrons-ordensis* Zone), Upper Devonian, early Famennian.

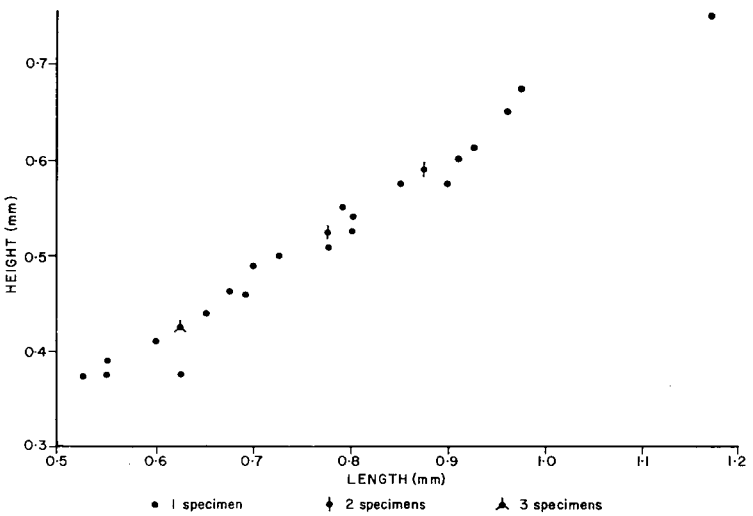

Fig. 11 Size-dispersion diagram for *Marginia venula* sp. nov. based on 28 specimens from locality 100/4.

Remarks: The vein-like ridges are much finer than those on *Marginia sculpta multicostata* Polenova, 1952, and the presence of a distinct S2 clearly distinguishes *M. venula* from *M. lobanovoensis* Polenova, 1955.

MARGINIA RETICULATA sp. nov.

(Pl. 2, figs 4a-f, 5a-c; text-fig. 12)

Derivation of name: Latin, *reticulatus*—net-like, netted.

Material: 6 heteromorphs and 15 pre-adult instars.

Diagnosis: Like *M. venula,* but lateral surface ornamented by coarse polygonal reticulae of constant size, replaced by smooth area at posterior end.

Description: *Heteromorphs*—Outline subquadrate in lateral view; axis of greatest length inclined about 19° to straight hinge-line. Right valve larger than left; distinct R/L overlap around free edge. Hinge-line straight, slightly more than three-quarters as long as carapace, depressed in a channel extending from above S2 to posterodorsal corners of valves. Anterior cardinal angle about 135°; posterior cardinal angle about 130°. Ventral border long, straight, slightly inclined towards anterior end; anterior and posterior ends truncated and parallel to form a slight anterior swing.

Hinge structure not known; stragular processes well developed, about equal in size, and overlap corners of left valve.

L1 indistinct, appears to be formed by a narrow ridge whose axis is parallel to anterodorsal border. L2 a rounded node in dorsal half of valve, sloping gently into S1; this side parallel to S1 and top anterior corner; side facing S2 steep and approximately perpendicular to straight hinge-line. L3 a hump, which rises above hinge-line in posterocentral part of dorsal border, higher on left valve than on right. S1 short, distinct, parallel to anterodorsal border, gradually rises to form L2. S2 deep, situated about two-fifths distance from anterior corner, extending ventrally about same distance to ventral margin.

In dorsal view outline elongate oval; L3 of left valve bears a crest, and rises above hump on right valve; dorsum depressed in posterior half; greatest width in posterior half of carapace.

In posterior view, dorsum asymmetrically epicline; sides approximately parallel; R/L overlap distinct around free edge; thickened ventral border.

Surface ornamented by coarse polygonal reticulae of constant size, covering both valves, excluding smooth area at posterior end, which extends around ventral border to anterior corner, and is separated from reticulated surface by narrow ridge parallel to free margin of each valve.

Tecnomorphs—Lack the posterior swelling of heteromorphs.

Pre-adult instars—Hinge-line relatively longer than in adult form, dorsal corners more distinct; anterior cardinal angle about 100°. Marked preplete outline. L3 bears a distinct node.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*Remarks*
Holotype, CPC 7063	1.14	0.71	0.50	Adult, pl. 2, fig. 4
CPC 7064	0.90	0.56	0.42	A-1, pl. 2, fig. 5

The measurements of the length and height of 11 specimens collected from locality 100/4 are shown on a graph (Fig. 12).

Occurrence: Holotype (CPC 7063) and figured specimen (CPC 7064) from localities in the Eight Mile Creek area, Burt Range, 100/4 base of 100 section, 146/10, 146/11, 146/13, and possibly 145/8, Buttons Beds—all within the basal *altifrons-ordensis* Zone, Upper Devonian, early Famennian. It is also found in the Ningbing Limestone at localities 21/22 and 443/25.

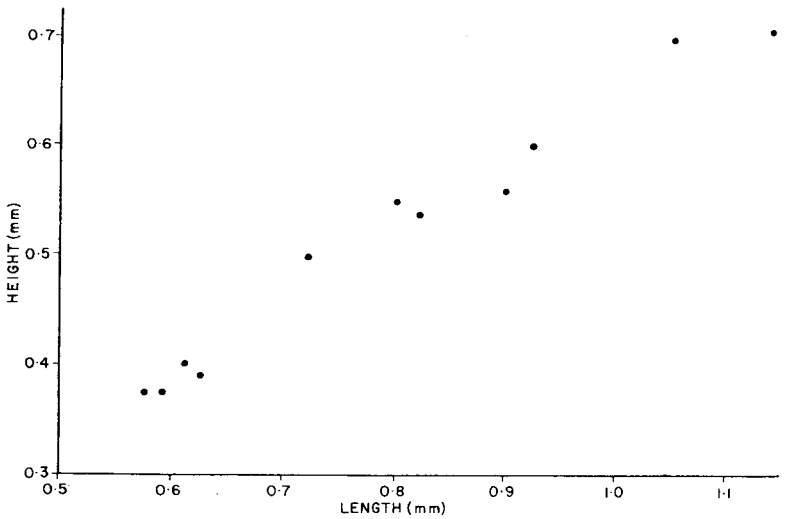

Fig. 12 Size-dispersion diagram for *Marginia reticulata* sp. nov. based on 11 specimens from locality 100/4.

Remarks: *Marginia reticulata* is similar to *M. venula* in outline, lobation, and sulcation, but differs in ornamentation. *M. reticulata* possesses coarse polygonal reticulae of constant size, which are replaced by a smooth area at the posterior end, whereas *M. venula* is ornamented by distinct vein-like ridges. This difference does not appear to be due to intraspecific variation, as no transitional forms have been found.

Family INDIVISIIDAE Egorov, 1954

(*nom. transl.* Polenova, 1960; *ex* Indivisiinae Egorov, 1954)

Diagnosis (translated from Polenova, 1960, p. 327-8): 'Carapace truncate-oval, dorsal edge nearly straight, usually higher at the posterior end, almost equivalved; usually one distinct sulcus or pit or two smooth sulci; sometimes the edges are slightly flattened; surface smooth. Carapaces of females with internal partitions located from the posteroventral angle towards the anterodorsal angle; carapaces of immature moults flatter than carapaces of males. The hinge is formed by the groove of the right valve and the sharpened edge of the left valve. Devonian-Carboniferous. Five genera.'

Genus INDIVISIA Zaspelova, in Egorov, 1954

Type species: *Indivisia indistincta* Glebovskaya & Zaspelova in Egorov, 1954, p. 12, pl. 4, figs 5-8, 13-14.

Type level: Upper Devonian, Frasnian, Svinord Beds.

Type locality: Village of Krivets, Russian Platform.

Diagnosis (after Polenova, 1960, p. 328): 'Carapace with dorsal edge weakly bent over, unsegmented.'

Remarks: Presumably, Polenova's diagnosis refers to an epiclinal dorsum, and the lack of distinct sulcation. The genus *Indivisia* appears to be very similar to the North American genera *Ellipsella* Coryell & Rogatz, 1932, *Neokloedenella* Croneis & Funkhouser, 1939, and *Lochriella* Scott, 1942. Further morphological investigations of these genera are required, particularly of the interior of the carapace, before their mutual relationships can be understood.

Some confusion exists concerning the authorship of the genus *Indivisia* and the type species. Egorov (1954) referred to *'Indivisia* (Gleb. et Zasp., in litt.)' on page 8, and to *'Indivisia* Zasp. in litt.' (genotype—*'Indivisia indistincta* Zasp. in litt'.) on page 9, in what appears to be the first published reference to this genus. Presumably Egorov (1954) had access to Zaspelova's rough manuscript, but there was no evidence that it was ever published. An explanation appeared some five years later, when Zaspelova (1959, p. 8) stated that of the 75 ostracod species which she described at this time, '20 species were established in 1941 by E. M. Glebovskaya, but not described. These species are described in the present work under two names—E. M. Glebovskaya and V. S. Zaspelova.' Zaspelova (1959, p. 44) credited the genus *Indivisia* to herself alone, but she credited the genotype—*Indivisia indistincta*—to Glebovskaya and herself.

From this, I conclude that the correct generic designation is *'Indivisia* Zaspelova, in Egorov 1954', and acknowledging the fact that Zaspelova wished to share the credit of establishing the species *I. indistincta* with Glebovskaya, which was first published in Egorov (1954, p. 12-13), the correct designation of the genotype is *'Indivisia indistincta* Glebovskaya & Zaspelova, in Egorov, 1954.'

INDIVISIA VARIOLATA Zanina, 1960

(Pl. 4, figs 1-5; text-fig. 13)

1960 *Indivisia variolata* Zanina, p. 85, Pl. 7, figs 5-6.

Type level: Upper Devonian, Frasnian, Livny beds.

Type locality: Quarry along left bank of the Livenka River, 5 km from Livny; Russian Platform.

Material: About 180 carapaces.

Diagnosis (After Zanina, 1960, p. 85): 'Carapace roundly rectangular in outline, uniformly but weakly inflated, with a pitted sculpture at the ends.'

Description: Outline subquadrate, elongate, with anterior swing in lateral view. Hinge-line straight, slightly more than one-half of length, depressed in shallow channel formed by low hump on posterodorsal border. Anterodorsal corner smooth, passing imperceptibly into rounded anterior border; posterior cardinal angle 140°. Right valve overlaps left at posterodorsal corner, free margin, and anterior third of dorsal border. Free border of each valve bears low ridge which makes smooth, shallow, inverted V-shaped depression at contact margin. Contact margin of each valve bears a narrow, smooth rim. Ventral border of left valve straight; right valve straight or slightly concave. Median sulcus (S2) shallow or absent. Greatest height in posterior half of heteromorphs, medial or in anterior half of tecnomorphs.

In dorsal view, outline elongate-oval, with subparallel sides; greatest width in posterior half of heteromorphs; anterior third of dorsum of right valve overlaps left; posterior half depressed.

In posterior view outline ovate with greatest width in mid-height position; dorsum epicline.

In ventral view, contact margin of each valve with narrow smooth rim, depressed between parallel ridges.

Surface smooth.

Dimensions and morphogenesis

Figured specimen	*Length*	*Height*	*Width*	*Valve*	*Remarks*
CPC 7075	1.175	0.725	0.575	h-c	Adult figured on Pl. 4, fig. 1
CPC 7076	1.075	0.65	0.50	h-c	Adult figured on Pl. 4, fig. 2
CPC 7077	0.90	0.55	0.40	t-c	Instar A-1 figured on Pl. 4, fig. 3
CPC 7078	0.675	0.40	0.30	t-c	Instar A-2 figured on Pl. 4, fig. 4
CPC 7079	0.45	0.287		t-c	Instar A-4 figured on Pl. 4, fig. 5

The measurements of the length and height of 76 specimens collected from locality 105/170 are shown on a graph (Fig. 13), which suggests that the

pre-adult stages are represented by four instars, A-1, A-2, A-3, and A-4. In the adult stage, the differences between the heteromorphs and the tecnomorphs appear to be differences of degree, and do not suggest a distinct division. Measurements of the holotype of *Indivisia variolata* (No. 18/9286; Central Geological Museum, Leningrad) from the Upper Devonian (Frasnian) of Livny, Russian Platform, are also plotted for comparison.

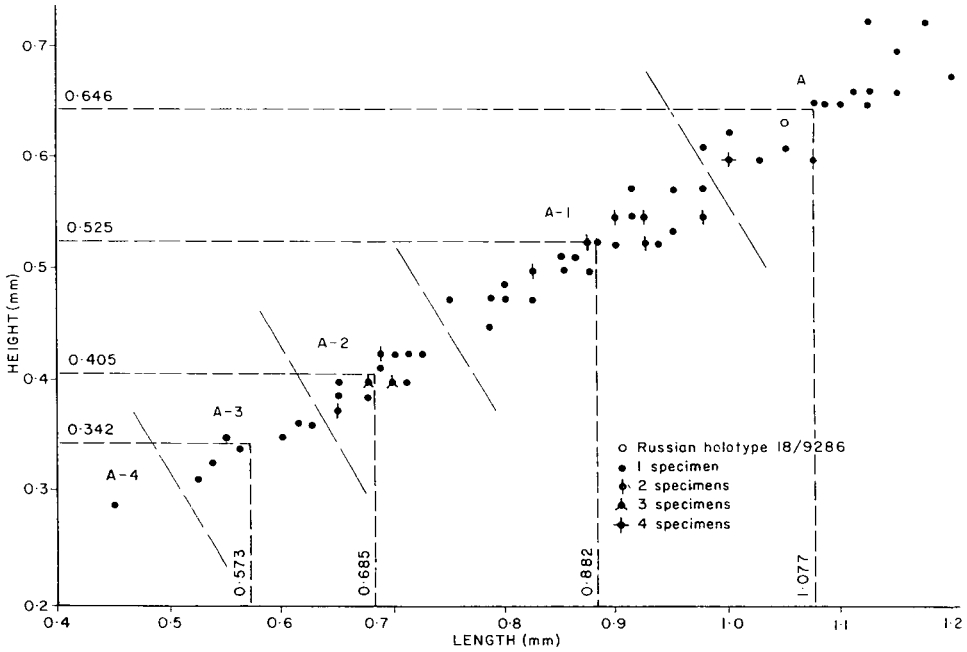

Fig. 13 Size-dispersion diagram for *Indivisia variolata* Zanina, 1960, based on 76 specimens from Section 105 (170 feet).

TABLE 1

Moult-Stage	No. of Spec.	Length		Height		L/H Ratio
		Range	Mean	Range	Mean	
ADULT INSTAR	20	0.975-1.20	1.077	0.60 -0.725	0.646	1.67
A-1	30	0.75 -0.975	0.882	0.45 -0.575	0.525	1.68
A-2	18	0.65 -0.725	0.685	0.375-0.425	0.405	1.69
A-3	7	0.525-0.625	0.573	0.312-0.362	0.342	1.67
A-4	1	nil	0.45	nil	0.287	1.58

Table 1 shows that the mean values of the L/H ratio remains more or less constant for the pre-adult and adult stages. The growth factors for length and height vary considerably from Przibram's (1931) theoretical value of 1.26, as shown by Table 2.

TABLE 2

	Growth Factors	
	Length	Height
A-1 to Adult	1.22	1.23
A-2 to A-1	1.29	1.29
A-3 to A-2	1.20	1.18

Occurrence: Figured specimens (CPC 7075, 7076, 7077, 7078, 7079) from section 105, Buttons Crossing, east bank of the Ord River, 170 feet above the base (*altifrons* Zone), Buttons Beds, Upper Devonian (early Famennian). Also in the same section at 10 feet (below *altifrons* Zone); 100 feet, 180 feet (*altifrons* Zone); 370 feet, 400 feet (*tryphera* Zone); 420 feet, 430 feet (basal *altifrons-ordensis* Zone); 525 feet, 600 feet (*altifrons-ordensis* Zone); 735 feet, 820 feet (*ordensis* Zone). Other occurrences in the Eight Mile Creek area at localities 100/4 (also = 144/1), the base of the 100 section, and 145/5 (basal *altifrons-ordensis* Zone)—Buttons Beds, Upper Devonian (early Famennian); locality 21/22, Ningbing Limestone, Ningbing area (*tryphera* Zone), Upper Devonian (early Famennian); localities 13/6, 13/9, 12/2A, 12/9, possibly 12/0A, and AAP section 44, sample 320, which is approximately the stratigraphical equivalent of BMR locality 12/7—all within the Westwood Member of the Cockatoo Formation (*hanaicus* Zone, Upper Devonian, Frasnian), Westwood Creek.

Indivisia variolata also occurs in the Fitzroy Sub-basin of the northern Canning Basin at Oscar Hill in the Fairfield Beds (*Avonia proteus* Zone of Veevers, 1959), and in subsurface Upper Devonian (Famennian) rocks penetrated by BMR No 2 Laurel Downs (core 18—1775 feet to core 34—3013 feet), Frome Rocks No. 2 Well (core 15—4471 feet to core 22—6653 feet) and Babrongan No. 1 Well (core 3—2445 feet).

Zanina (1960, p. 85) also recorded the species *Indivisia variolata* from both the Frasnian (Livny Beds) and the Famennian (Zadonsk Beds).

Remarks: Comparison of the descriptions and figures of the Australian specimens with those of the Russian species *Indivisia variolata* Zanina shows that the two are morphologically very similar. Both possess identical characters in outline, dorsal and ventral overlap, almost imperceptible median sulcus, and a rounded inflation along the free margins of the valves, the right being raised above the left. The latter feature, together with the marked anterodorsal overlap, is diagnostic of the genus *Hypotetragona* Morey. *Indivisia variolata* differs from the type species of *Hypotetragona* (*H. impolita* Morey, 1935), however, by the lack of reticulation and a well developed median sulcus. Generically, it is closer to the *Ellipsella, Neokloedenella, Lochriella* group, but as noted above, this group is poorly understood.

The surface of the carapace of both *I. variolata* and the Australian specimens is smooth, but according to Zanina (1960, p. 85) the ends of the carapace of the Russian species are 'covered by relatively large, round pits reminiscent of smallpox'. This appears to be the only difference between the specimens from the two continents. In my opinion, the texture of the valve surface is subject to the chances of preservation, and may not have any diagnostic significance within this genus. Thus, I regard the Russian and the Australian specimens as belonging to the same species-group.

Family BEYRICHIOPSIDAE Henningsmoen, 1953

(*nom. transl.* Sohn, 1961; *ex* Beyrichiopsiinae Henningsmoen, 1953)

Genus BEYRICHIOPSIS Jones & Kirkby, 1886

Type species: *Beyrichiopsis fimbriata* Jones & Kirkby, 1886; subsequently designated by Ulrich & Bassler, 1908, p. 323.

Type level: Lower Carboniferous, 'Calciferous Sandstone series'.

Type locality: Not designated. Localities given—*Scotland,* Roxburghshire, Tweeden Burn and Staneshiel Burn, Liddlesdale; Fifeshire, Billow Ness and Sunnybank Quarry; Linlithgowshire (West Lothian), Murrayfield Pit; *England,* Northumberland, Plashetts; *Northern Ireland,* Co. Down, Cultra.

Remarks: Jones & Kirkby's original description and figures of *Beyrichiopsis fimbriata* (Jones & Kirkby 1886, pl. 11, figs 6a, 9a, c) and of other species related to the genus *Beyrichiopsis—B. fortis* var. *glabra* (op. cit., pl. 12, fig. 1c), *B. fortis* var. *granulata* (op. cit., pl. 12, fig. 3b)—clearly shows that the 'fimbriate' or spinous fringe is, in modern terminology, an admarginal structure. This should not be confused with a more delicate but superficially similar structure present, for example, on the smaller left valve of species belonging to the genera *Glyptopleura, Geisina,* and *Marginia.*

In the type species of *Glyptopleura* (*G. inopinata* Girty, 1910), Girty (1910, p. 237) described 'a smooth, finely striated border which surrounds the shell everywhere save along the hinge'. Dr I. G. Sohn of the United States Geological Survey kindly permitted me to examine the type specimens of *G. inopinata,* in which I observed the structure that Girty described, and noted that it was a delicate striated marginal structure, which is present on the smaller valve only. Dr Sohn suggested that this structure is, in effect, a selvage seal. If so, the carapace must have had an inner lamella. The genus *Glyptopleura* needs to be investigated to determine whether or not an inner lamella exists. Dr J. E. Robinson, of University College, London, kindly allowed me to examine topotype material of species of *Beyrichiopsis* (*B. fimbriata* Jones &

Kirkby, 1886; *B. fortis* Jones & Kirkby, 1886) from the Lower Carboniferous rocks of Great Britain. These specimens are characterized by a fimbriate or spinous admarginal structure, and a strong inflation of L3, L2, and the ventral part of the carapace, which often results in a bifurcation of the proximal end of S2.

BEYRICHIOPSIS? PERPLEXA sp. nov.

(Pl. 3, figs 1-7; text-fig. 14)

Derivation of name: Latin *perplexus*—intricate, involved, puzzling; referring to the questionable generic assignment.

Material: 16 carapaces (7 heteromorphs, 9 tecnomorphs), and 1 tecnomorphic left valve.

Diagnosis: Lateral surface ornamented by a single crest in a ventral position. Position of frill marginal, not admarginal.

Description: *Heteromorph*: Outline subquadrate-elongate in lateral view. Right valve slightly larger than left; R/L overlap along ventral margin. Hinge-line straight, about three-quarters as long as carapace, posterior half obscured by swelling of L3. Anterior cardinal angle about 130°, posterior cardinal angle about 140°. Posterior end broadly rounded; anterodorsal end obliquely truncated; ventral border straight. Marginal structure developed as a moderately broad striated frill on smaller valve.

Hinge structure not known; stragular processes present, poorly developed, slightly overlapping corners of left valve.

L1 low, indistinct. L2 prominent, rounded node in dorsal half of valve, sloping steeply into S1 and S2. L3 a distinct swelling rising above hinge-line in posterocentral part of dorsal border. S1 short, indistinct. S2 broad, deep, extending proximally about one-half of distance to ventral margin.

In dorsal view outline elongate oval, with posterior inflation; L3 swollen and rises above hinge-line; stragular processes weakly developed.

Surface ornamented by fine polygonal reticulae, covering both valves, and a ventral crest consisting of a row of small tubercles.

Tecnomorph: Similar to heteromorph, but lacking posterior swelling. Immature moults have a more rounded ventral margin.

Dimensions

	Length	*Height* (excl. L3)	*Width* (Incl. L3)	*Valve*	*Figured on*
Holotype CPC 7065	0.76	0.45	0.39	h-c	Pl. 3, fig. 1
Paratype A CPC 7066	0.76	0.47	0.32	t-c	Pl. 3, fig. 2
Paratype B CPC 7067	0.74	0.45	0.34	h-c	Pl. 3, fig. 3
Figured specimens					
CPC 7068	0.66	0.40	0.30	t-c	Pl. 3, fig. 4
CPC 7069	0.60	0.37	0.27	t-c	Pl. 3, fig. 5
CPC 7070	0.75	0.43	—	t-l	Pl. 3, fig. 6
CPC 7071	0.72	0.44	0.27	t-c	Pl. 3, fig. 7

The measurements of the length and height of 16 specimens collected from locality 100/4 are shown on a graph (Fig. 14).

Occurrence: Holotype (CPC 7065), paratypes (CPC 7066, 7067), and figured specimens CPC 7068, 7069 from locality 100/4, the base of the 100 section (base of *altifrons-ordensis* Zone), Button Beds, Upper Devonian (lower Famenian); figured specimens CPC 7070, 7071 from localities 105/170 and 105/600 respectively. Other localities include 145/5 and 146/10 from the Eight Mile Creek area, Burt Range.

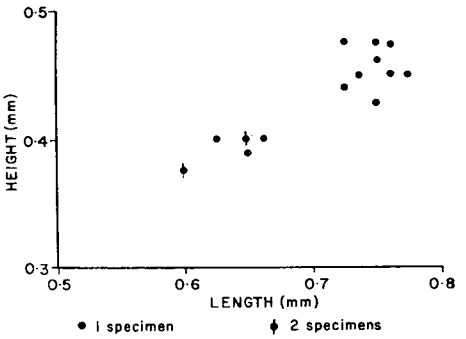

Fig. 14 Size-dispersion diagram for *Beyrichiopsis? perplexa* sp. nov. based on 16 specimens from locality 100/4.

Remarks: The strongly inflated lobation of the heteromorphic form, the presence of a moderately broad marginal frill, and a ventral crest, indicate that this species may belong to *Beyrichiopsis*. On the other hand, the position of the frill is marginal as in *Geisina monothele* (Pl. 3, fig. 8e), and not admarginal as in the type species of *Beyrichiopsis*.

Family LICHVINIIDAE Posner in Egorov, 1950

(*nom. transl.* Sohn, 1961; *ex* Lichvininae Posner in Egorov, 1950)

Diagnosis (after Egorov, 1950, p. 61; translation): 'Kloedenellidae with well defined partition separating the brood chamber from the cavity of the carapace. Immature moults without partition in posterior part of carapace. Right valve always larger than the left. Hinge-line in both valves more or less straight, posterior half of hinge-line of right valve is occupied by a lamellar tooth (= bar). In many cases a spiral ridge is developed, the internal loop of which surrounds the pit (or pits if there is more than one)'.

Remarks: A concise definition of the family Lichviniidae is also given by Sohn (1961, Q186).

Genus LEPTOPRIMITIA Kummerow, 1953

Type species: *Leptoprimitia compressa* Kummerow, 1953, p. 31 (by original designation).

Type level: Middle Devonian, lower part (K_3) at the contact with the Brachiopodenkalk (K_{3a}).

Type locality: Quarry at Pecza, Wolhynia, Ukrainian SSR (formerly eastern Poland).

Diagnosis (translated from Kummerow, 1953, p. 31): 'Very flat, elongate, elliptical or ovate shell bordered by a thin ridge around the entire margin, with small pits (= *Grübchen*) below the middle part of the dorsal border and flat punctae (= *Siebpunkten*) on the surface'.

Remarks: There is a translation difficulty with regard to Kummerow's use of the word *Grübchen* (= punctate surface ornamentation, Kesling 1951, p. 133). Kummerow states that below the middle part of the dorsal border are *Grübchen,* but according to his illustrations (pl. 4, figs 5, 7a, pl. 6, fig. 1a) a sulcus is shown in this position. His use of the word *Grübchen* in this context makes the next statement concerning *Siebpunkten* (= punctae) repetitive. In order to make Kummerow's terminology consistent with current usage, the word *Grübchen* as used in the above diagnosis should be interpreted as a sulcus.

The genus *Leptoprimitia* includes the species *L. compressa* Kummerow, 1953, *L. circumvallata* Kummerow, 1953, and *L. plana* (Gürich, 1866) (originally described as belonging to the genus *Primitia*). The species *Euglyphella? polonica* Pribyl, 1953, from the figures (Pribyl, 1953, pl. 4, figs 6-9) appears to be similar to *L. circumvallata,* and examination of specimens of *Euglyphella? polonica,* through the kindness of Dr F. Adamczak, shows that this species should be assigned to *Leptoprimitia.*

LEPTOPRIMITIA sp. A

(Pl. 5, figs 5a-b; text-fig. 15)

Material: 3 specimens (1 heteromorphic right valve, 2 tecnomorphic carapaces).

Description: *Heteromorph*—Outline elongate, subquadrate in lateral view; anterior end broadly rounded, merging imperceptibly into convex ventral border; posteroventral border obliquely truncated. Hinge-line straight, about 0.7 as long as carapace. Lateromarginal bend bears a ridge completely surrounding lateral

surface; dorsal part of ridge flanged and obscures hinge-line; central dorsal and central ventral parts of lateromarginal ridge concave. Posterodorsal area of lateral surface swollen, posteroventral area depressed. Faint sulcal depression present.

In dorsal view posterior end swollen, outline constricted behind mid-length position. Dorsum wide, epiclinal, bordered by dorsal part of lateromarginal ridge (= dorsal plica of Jaanusson, 1957, p. 188), widest in posterior part, tapering towards anterior end.

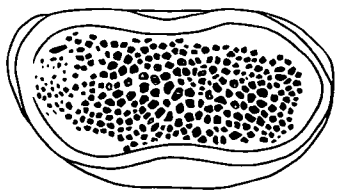

Fig. 15 *Leptoprimitia* **sp. A. Diagrammatic drawing illustrating a right valve in lateral view x 60.**

Hinge structure and contact margin unknown. Surface reticulate.

Tecnomorph—Lacks posterodorsal swelling.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*Valve*
CPC 7087	0.71	0.40	0.17	h-r

Occurrence: Figured specimen (CPC 7087) from locality 100/4 the base of the 100 section (basal *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian, early Famennian. Also occurs at 105/10 (below *altifrons* Zone).

Remarks: *Leptoprimitia* sp. A probably represents a new species, but as the description is based on only three specimens, it cannot be properly defined until more material becomes available.

Superfamily PARAPARCHITACEA Scott, 1959

Family PARAPARCHITIDAE Scott, 1959

Genus PARAPARCHITES Ulrich & Bassler, 1906

Type species: *Paraparchites humerosus* Ulrich & Bassler, 1906, p. 150 (by original designation).

Type level: Elmdale Formation, Council Grove Group, Lower Permian.

Type locality: Manhattan, Kansas.

Remarks: The orientation followed here is the one proposed by Scott (1959, p. 672), and opposite to that proposed by Kellett (1933, p. 645), and Kesling (1958, p. 192-3), and used by Cooper (1941; 1946). Scott (1959, p. 672) considered the end possessing the greatest height as anterior. Thus, in Scott's

words 'the swing is forward, the thickest end is posterior, spines when present are posterodorsal, and the faint muscle scar, rarely preserved, is anterior. This results in the left valve overlapping the right along the free margin, and right valve slightly overreaching the left (in adults) along a portion of the dorsum'.

Scott (1959, p. 673) noted that many species with a well developed truncated posteroventral margin have been referred to *Paraparchites;* however, as they do not conform in outline to the genotype, he considered that they should be placed in one or more new genera. The younger instars of species belonging to *Paraparchites* commonly possess a posteroventrally truncated outline (cf. *Paraparchites humerosus* Ulrich & Bassler as figured by Kellett, 1933, pl. 13, figs 1-7), which becomes more amplete in older instars and the adult. Thus, in my opinion, differences in outline would be an unstable character on which to base new genera.

PARAPARCHITES sp. cf. P. NICKLESI (Ulrich, 1891)

(Pl. 5, figs 1-4)

cf.

1891 *Leperditia nicklesi* Ulrich, p. 200, pl. 18, fig. 1a-e.
1910 *Paraparchites nicklesi* (Ulrich); Grabau & Shimer, p. 343, fig. 1657c-f.
1911 ——— ———; Girty, p. 105, pl. 9, fig. 2-5.
1915 ——— ———; Girty, p. 134, pl. 11, fig. 2.
1929 ——— ———; Harlton, p. 255, pl. 1, fig. 1.
1930 ——— ———; Croneis, p. 63, pl. 15, fig. 11.
1935*a* ——— ———; Morey, p. 317, pl. 28, fig. 26.
1935*b* ——— ———; Morey, p. 475, pl. 54, fig. 8.
1939 ——— ———; Coryell & Johnson, p. 214, pl. 25, fig. 1.
1941 ——— ———; Cooper, p. 62, pl. 14, figs 5-7.
1955 ——— ———; Benson, p. 1038, pl. 108, figs 8, 14.
1958 ——— ———; Benson & Collinson, p. 7, pl. 1, fig. 9.
1963 ——— ———; Green, p. 127-8, pl. 8, figs 10, 11.

Material: About 150 specimens.

Description: *Adults?*—Large, subovate, amplete to slightly preplete in lateral view; hinge-line of variable length depending upon degree of elongation of carapace (about $\frac{1}{2}$ of length for specimens with L/H ratio of 1.36; about $\frac{3}{4}$ of length for more elongated specimens with L/H ratio of 1.6), straight, obscured by anterodorsal hump on right valve. Greatest height slightly anterior to mid-length position; greatest width slightly posterior to mid-length. Surface smooth to punctate. Hingement and contact margin not seen.

Pre-adult instars—Subcircular, preplete in lateral view; hinge-line about $\frac{2}{3}$ of length of carapace, straight, partly obscured by anterodorsal hump on right valve. Greatest height in anterior part of carapace; greatest width slightly posterior to mid-length position. Small spine present on posterodorsal area of right valve. Surface smooth.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*L/H ratio*	*Figured on*
CPC 7083	1.92	1.41	0.92	1.36	Pl. 5, fig. 1
CPC 7084	2.00	1.37	0.42	1.60	Pl. 5, fig. 2
CPC 7085	1.45	1.10	0.72	1.32	Pl. 5, fig. 3
CPC 7086	1.15	0.87	0.57	1.32	Pl. 5, fig. 4

Occurrence: Figured specimens (CPC 7083, 7084, 7085, 7086) from section 105, Buttons Crossing, east bank of the Ord River—430 feet above the base (basal *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian (lower Famennian toII-toIII). Also in section 105 at 60 feet, 100 feet, and 280 feet (in *altifrons* Zone), at 350 feet, 370 feet, and 400 feet (in *tryphera* Zone), and at 420 feet, 430 feet, 600 feet, 650 feet, and 860 feet (in *ordensis* Zone). Other occurrences include localities in the Eight Mile Creek area, Burt Range, 100/4, the base of Section 100 (basal *altifrons-ordensis* Zone), and 145/5, 145/7, 146/10, 146/11, and 146/13 (basal *altifrons-ordensis* Zone). All localities within the Buttons Beds, Upper Devonian (early Famennian).

Remarks: The specimens figured on Plate 5, figures 1-4, are referred to a single species; the differences in outline, and length of hinge-line relative to the length of the carapace, are interpreted as ontogenetic changes—the smaller, subcircular forms are considered as pre-adult instars, and the larger, more elongate, suboval forms are regarded as adults. Among the larger forms, the hinge-line is longer in the more elongated specimens (e.g. Pl. 5, fig. 2), and the posterodorsal spine appears to be absent. The smaller, subcircular form of this species appears to be related to the North American species *Paraparchites nicklesi* (Ulrich, 1891), as figured by Morey (1935a, pl. 28, fig. 26), and Cooper (1941, pl. 14, figs 5-7), and the larger, more elongate, suboval forms are similar to the figures of Benson (1955, pl. 108, figs 8, 11) and Benson & Collinson (1958, pl. 1, fig. 9).

Ulrich (1891, p. 200) described a posterodorsal spine on the right valve of the holotype of *P. nicklesi,* but Girty (1911, p. 105) subsequently noted from the specimens which he assigned to this species that 'in some specimens the spine is very distinct, and in others it is obsolete, or at least its presence cannot be determined'. Other workers, e.g. Morey (1935a, p. 317), Coryell & Johnson (1939, p. 214), have also referred specimens without 'tubercles' to *P. nicklesi* (Ulrich). This concept could be regarded as being too broad, but until a complete revision of *P. nicklesi* (Ulrich) has been undertaken, it is the one which I prefer to follow.

Genus COELOENELLINA Polenova, 1952

Type species: *Coeloenellina parva* Polenova, 1952, p. 67 (by original designation).

Type level: Middle Devonian; upper Givetian; Starooskol beds.

Type locality: Yulovo-Ishim, in Penza Region, Russian Platform.

Diagnosis (as amended by Polenova, 1960, p. 13): 'Truncated-ovate carapace; right valve is larger than the left valve. Edges of the valves bent towards the line of commissure. Greatest convexity median or closer to the posterior end, sometimes located asymmetrically. Hinge-line depressed, hingement formed by a groove in the right valve which receives the dorsal edge of the left valve. Small round adductor muscle scar subcentral or near anterior end'.

Remarks: In the discussion of her revised diagnosis of the genus *Coeloenellina,* Polenova (1960, p. 13) stated that the structure of the contact margin remains the principal difference from the genus *Coeloenella* Stewart, 1936 (= junior synonym of *Paraparchites* Ulrich & Bassler, 1906, according to Scott, 1959, p. 673). In the genus *Coeloenellina,* the edges of the valves are bent towards the line of commissure, and in lateral outline the valves are subamplete in shape (this last feature is in common with the genus *Paraparchites*). Both in Polenova (1960, p. 13) and in the original description (Polenova, 1952, p. 67) the orientation of *Coeloenellina* in the illustration is contrary to that given in the text. Polenova's original orientation has been quoted in the diagnosis, although as Pokorny (1958; translation Allen, 1965, p. 212) pointed out, the correct orientation is probably the opposite, i.e. the end possessing the greatest height is anterior. As *Coeloenellina* is close to the genus *Paraparchites,* it is reasonable to assume that both genera should be oriented the same way. Scott (1959, p. 672) in discussing the genus *Paraparchites* has given good reasons as to why he regards the position of greatest height as the anterior end. Thus, Pokorny's orientation of this genus is adopted in the following description.

COELOENELLINA sp. cf. C. FABIFORMIS (Kesling & Kilgore, 1952)

(Pl. 1, figs 12a-d; text-fig. 16)

cf. 1952 *Schmidtella fabiformis* Kesling & Kilgore, pp. 2, 3, pl. II, figs 1-7.

Material: 35 complete carapaces.

Description: Subovate, preplete outline. Inequivalved, left valve overlapping right along ventral border. Hinge-line straight, long, about three-quarters length of carapace, depressed between slightly convex dorsal border of each valve. Anterior and ventral borders broadly rounded; posterior border obliquely truncated ventrally. Greatest height anterior of mid-length position. Hinge-structure unknown. Surface nonlobate, smooth.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*L/H ratio*	*Figured on*
CPC 7059	0.64	0.47	0.37	1.36	Pl. 1, fig. 12

The measurements of the length and height of 15 specimens collected from locality 100/4 are shown on a graph (Fig. 16).

If the larger specimens (length 0.72 and 0.74 mm) are considered as adults, then the figured specimen (Pl. 1, fig. 12a-d) probably belongs to the adult-1 stage. The average L/H ratio varies between 1.32 for the smaller specimens, 1.35 for the specimens in which the length falls within the 0.54-0.65 mm size range, and 1.39 for the larger specimens more than 0.7 mm long.

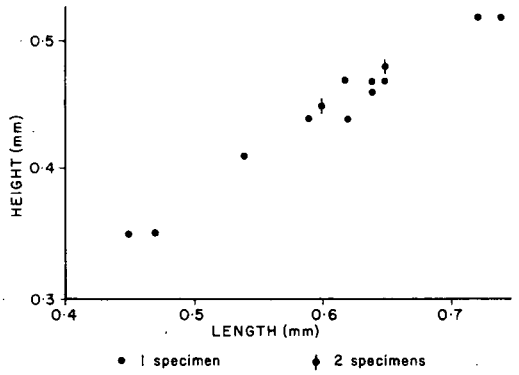

Fig. 16 Size-dispersion diagram for *Coeloenellina* cf. *C. fabiformis* (Kesling & Kilgore, 1952) based on 15 specimens from locality 100/4.

Occurrence: Figured specimen (CPC 7059) from locality 100/4 (also =144/1), the base of Section 100; other specimens from 145/5, 145/8, 145/9, 146/10 and 146/13 (base of *altifrons-ordensis* Zone), Buttons Beds, Eight Mile Creek area, Burt Range, Upper Devonian (early Famennian).

Remarks: This species closely resembles the illustrations of *Schmidtella fabiformis* Kesling & Kilgore, 1952 (pl. II, figs 1-7), originally described from the Middle Devonian Genshaw Formation of Michigan. The dimensions of the holotype (length 0.47 mm, height 0.37 mm, width 0.27 mm) are comparable with those of the smaller Australian specimens, which may represent the adult–2 instar. This species is only tentatively assigned to the North American form as it does not show the reversal of overlap, which is suggested by an examination of Kesling & Kilgore's figures.

Polenova (1960, p. 13) has pointed out that *Schmidtella fabiformis* Kesling & Kilgore is incorrectly assigned generically, and that it probably belongs in the genus *Coeloenellina* Polenova, 1952. It may be added that the figures of the species of *Microcoeloenella optata* Polenova, 1955 (Polenova, 1955, pl. X, figs 8a-c), from the Middle Devonian of the Volga-Ural region, are so similar to those of *Coeloenellina fabiformis* (Kesling & Kilgore) and the Australian species that it is possible to suggest that all three forms may be conspecific.

The species which Krömmelbein (1954, p. 197) described as *Schmidtella subfabiformis* from the Buchan Caves Limestone (late Lower Devonian—Philip,

1966) of Victoria must be assigned to the genus *Coeloenellina*. The Victorian species is more elongate than *Coeloenellina* sp. cf. *C. fabiformis* (Kesling & Kilgore), and lacks the strong preplete *Paraparchites*-like outline.

Coeloenellina sp. cf. *C. fabiformis* superficially resembles the German Middle Devonian (Givetian) species *C. minima* (Kummerow, 1953), as redescribed and refigured by Becker (1965b, p. 173, pl. 5, figs 3-4). The latter species, however, is distinguished from the Australian species by its truncated postero-ventral margin, its highly convex dorsal border, and its larger size.

Suborder METACOPA Sylvester-Bradley, 1961

? Family KRAUSELLIDAE Berdan, 1961

Remarks: McGill (1963, p. 9) emended the definition of Krausellidae to include the fusiform ostracods previously assigned to *Acratia* Delo, 1930, by Egorov (1953), for which he proposed the new genus *Egorovia*. Berdan's definition was emended by the addition of (i) 'LV may or may not be distinctly different from RV', and (ii) 'either both ends acuminate or only posterior end produced as spine'.

Genus KRAUSELLA Ulrich, 1894

Type species: *Krausella inaequalis* Ulrich, 1894, p. 691 (by original designation).

Type level: Middle Ordovician, Platteville Formation, *Vanuxemia* Zone.

Type locality: Dixon, Lee County, Illinois.

Remarks: Triebel (1941, p. 371) compared *Krausella inaequalis* Ulrich with the Recent freshwater species *Strandesia centrura* Klie (Pl. 15, fig. 173a-b) and *Cypricerus episphaena* G. W. Müller (Pl. 15, fig. 171a-b), and showed that there is a close similarity in the form of the carapace, and the presence of a posterior spine on the smaller right valve. He quoted this comparison as 'a case of extensive and striking convergence'. Triebel also noted that both of the Recent species belong to genera having species in which the posterior spine is lacking. The two Recent species show that marked divergences of form occur within the genus, and homeomorphic similarities in form may occur between completely unrelated species. Triebel therefore doubted whether the genus *Krausella* represents a natural unit in present classification. He concluded (p. 372) that a character which is not constant even within genera among living species can scarcely be used as a basis for distinguishing fossil genera.

Triebel's view does not allow for the possibility that the fossil forms may not have been as variable as the Recent forms. *Krausella* is still recognized as a valid genus in current literature, with *Rayella* Teichert, 1939 (*pro Basslerites* Teichert, 1937, *non* Howe, 1937) as a junior synonym.

KRAUSELLA? DUBITATA sp. nov.

(Pl. 5, figs 6a-d, 7a-c)

Derivation of name: Latin, *dubitatus,* hesitant, doubtful; referring to the uncertain generic assignment.

Material: 12 specimens.

Description: Outline elongate-subelliptical. Greatest height median. Posterodorsal border strongly and broadly curved, meeting posteroventral border well below mid-height position. Anterodorsal border straight or gently curved, more than one-third of length of carapace. Ventral border straight in centre, gently curved towards ends. Anterior end at about mid-height position. Left valve overlapping right strongly along anterodorsal and ventral borders, and slightly along posterodorsal and anteroventral borders. Hinge-line straight, slightly depressed. In dorsal view outline ovate, greatest width slightly posterior to mid-length position. In posterior view sides slope gently away from dorsum; greatest width in mid-height position; small but well defined spine at posterior end of right valve. Hinge structure and contact margin not seen. Surface smooth.

Dimensions

	Length	*Height*	*Width*	*Figured on*
Holotype CPC 7088	0.92	0.50	0.45	Pl. 5, figs 6a-d
Paratype CPC 7089	0.85	0.45	0.42	Pl. 5, figs 7a-c

Occurrence: Holotype (CPC 7087) from section 105, Buttons Crossing, east bank of the Ord River, 350 feet above the base, Buttons Beds (*altifrons-ordensis* Zone), and paratype (CPC 7088) from the same section 170 feet above the base (*altifrons* Zone). Also occurs in same section at 350 feet, 370 feet (*tryphera* Zone), and 650 feet (*ordensis* Zone); also at locality 100/4 (= 144/1), the base of section 100 (*altifrons-ordensis* Zone); all localities lower Famennian. Small specimens which could be young instars belonging to this species occur in the Westwood Member of the Cockatoo Formation at localities 13/9 (535 feet), 13/6 (1280 feet), 12/9 (470 feet), and 459 (70, 245 feet) Westwood Creek; *hanaicus* Zone, Frasnian.

Remarks: This species is assigned to the genus *Krausella* with some hesitation, as it appears similar in ventral and dorsal view to the genus *Acratia* Delo, 1930. *Acratia,* however, is characterized by acuminate ends in lateral view,

especially the posterior, which lacks a posteroventral spine. The small specimens found at Westwood Creek may have to be subsequently referred to a species belonging to *Acratia*.

Egorovia McGill, 1963, and *Coryellites* Kellett, 1936, may be also mentioned for comparison with *Krausella? dubitata;* the Australian species lacks the smoothly convex ventral border of *Egorovia,* and the greatest height and width is situated medially, unlike that of *Coryellites,* which is in the posterior half of the carapace.

Family BARYCHILINIDAE Ulrich, 1894

Genus DIPHYOCHILINA nov.

Derivation of name: Greek, *diphyes,* of double nature, twofold, and *cheilos,* lip, referring to the lip-like venter and dorsum.

Type species: *Diphyochilina tryphera* sp. nov.

Diagnosis: Like *Endolophia* Kesling, 1954, but thinner and with a lip-like venter; without an internal ridge on each valve. Dimorphism unknown.

Relationships: *Diphyochilina* is assigned to the family Barychilinidae because of its strong resemblance to the genera *Endolophia* Kesling, 1954, and *Barychilina* Ulrich, 1891. These genera have the following features in common: (a) ornamentation of distinct low ridges, which are oriented more or less parallel to the axis of the valve, (b) subrhomboidal outline, (c) smooth epiclinal dorsum, which in Ulrich's (1891, p. 198) words '- - - resemble a pair of thick lips' (presumably this is the origin of the name *Barychilina*).

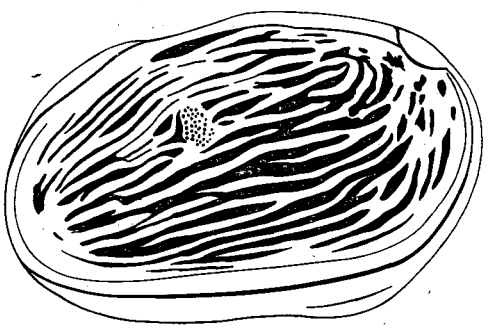

Fig. 17 *Diphyochilina tryphera* **sp. nov. Diagrammatic drawing illustrating the main features in left lateral view x 67.**

Diphyochilina, like *Endolophia,* lacks the deep pit of *Barychilina,* but differs from *Endolophia* as it lacks an internal ridge. Unlike both of these genera, *Diphyochilina* is thin, and the ventral border of each valve overhangs the contact margin, in much the same manner as the epiclinal dorsum extends above the hinge-line. In this respect, *Diphyochilina* somewhat resembles the Rhaetic genus *Rhombocythere* Anderson, 1964; compare, for example, the anterior view of *D. tryphera* (Pl. 6, fig. 2c) with those of Anderson's species *R. wicheri* and *R. penarthensis* (Anderson, 1964, pl. 9, fig. 5, pl. 10, fig. 22).

The ornamentation of *Diphyochilina* superficially resembles that found in *Glyptopleura* Girty, 1910, and *Venula* Cooper, 1941. The Australian genus, however, possesses neither the kloedenellid dimorphism, nor the deep pit found in *Glyptopleura.* It differs from *Venula* in features of overlap, and lacks the swollen posterior end of the North American genus.

DIPHYOCHILINA TRYPHERA sp. nov.

(Pl. 6, figs 2-4; text-figs 17, 18)

Derivation of name: Greek *trypheros,* dainty, delicate; referring to the surface ornamentation.

Material: Over 90 specimens.

Description: Outline subrhomboidal, elongate, with anterior swing in lateral view. Right valve considerably larger than left; strongly overlapping left valve around free edge. Hinge-line straight, about one-half as long as carapace, depressed in a deep channel formed by convex dorsal border, which bears a sharp ridge on each valve. Anterior border rounded, truncated on dorsal side; posterior border rounded, truncated on ventral side; axis of greatest length extends from anteroventral border to posterior corner, inclined at about 75° to the height. Free border of each valve bears a strong, smooth ridge, whose inner side makes a deeply inverted V-shaped depression at ventral margin. Contact margin of each valve bears a narrow, smooth rim. Ventral border of left valve straight to slightly concave; right valve concave. Median sulcus or pit absent, represented by weak adductor muscle scar of a healdiid type (Pl. 6, fig. 2f), slightly anterior of mid-length position. Surface ornamented by inosculating distinct low ridges, oriented more or less parallel to axis of valve. Grooves between ridges set with rows of punctae.

In dorsal view, outline elongate-oval, with greatest width in central part of carapace; dorsum epiclinal, smooth area defined by sharp ridge on each valve; R/L overlap at ends of hinge-line.

Hinge structure unknown. Apart from the absence of an internal ridge, revealed by a thin section cut parallel to the width of the carapace (Pl. 6, fig. 3), internal structures are unknown. Dimorphism unknown.

Dimensions

	Length	*Height*	*Width*	*L/H ratio*	*Figured on*
Holotype (CPC 7091)	0.937	0.60	0.375	1.56	Pl. 6, fig. 2
Paratype (CPC 7093)	0.80	0.50	0.30	1.60	Pl. 6, fig. 4
Figured specimen (CPC 7092)	1.20	—	0.475	—	Pl. 6, fig. 3

The measurements of the length and height of 30 specimens collected from locality 105/420 are shown on a graph (Fig. 18).

Occurrence: Holotype (CPC 7091), paratype (CPC 7093), and figured specimen (CPC 7092) from section 105, Buttons Crossing, east bank of the Ord River, 420 feet above the base, Buttons Beds (basal *altifrons-ordensis* Zone)—Upper Devonian, early Famennian. Also in the same section at 350 feet, 370 feet, 400 feet (*tryphera* Zone), and 430 feet (basal *altifrons-ordensis* Zone). Other occurrences at 100/4, the base of section 100, 146/11, 146/13 Burt Range (basal *altifrons-ordensis* Zone), and at 21/22 (*tryphera* Zone), Ningbing Limestone in the Ningbing area.

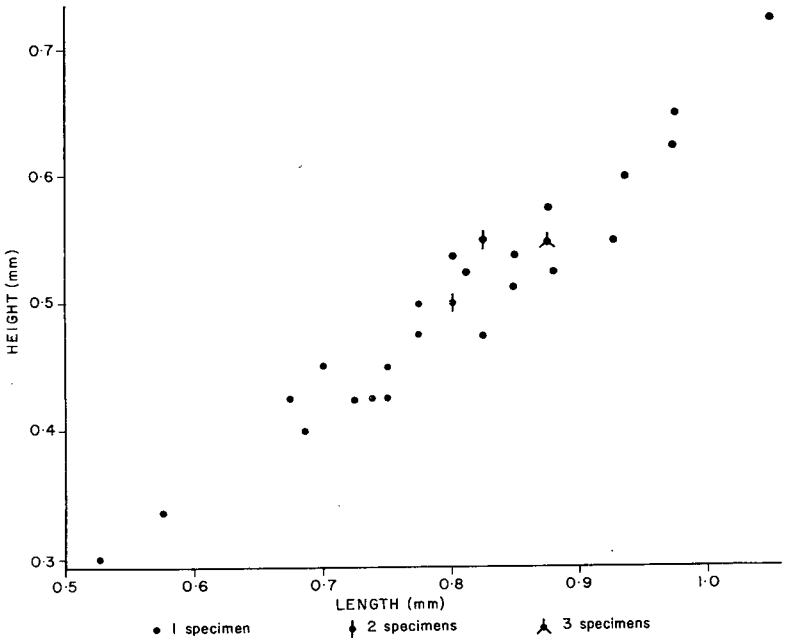

Fig. 18 Size-dispersion diagram for *Diphyochilina tryphera* **sp. nov. based on 30 specimens from section 105 (420 feet).**

Remarks: *Diphyochilina tryphera* appears to be closely related to *Evlanella? scrobiculata* Polenova, 1952 from the upper Givetian of the Russian Platform. The Russian species, however, is ornamented by fine concentric reticulae, instead of the *Glyptopleura*-type ridges of *D. tryphera*. This difference is probably of specific rank, and not sufficiently significant to separate the two species generically. Thus, I consider *Evlanella? scrobiculata* Polenova, 1952 also belongs to the genus *Diphyochilina*.

Suborder PLATYCOPA Sars, 1866

Family CAVELLINIDAE Egorov, 1950

(*nom. transl.* Polenova, 1960; *ex* Cavellininae Egorov, 1950)

Genus CAVELLINA Coryell, 1928

Type species: *Cavellina pulchella* Coryell, 1928, p. 89 (by original designation).

Type level: Not designated; levels given—Pennsylvanian, Desmoinesian, Holdenville formation, and Missourian, Seminole formation.

Type locality: Oklahoma (exact locality not given).

Remarks: Pokorny (1958, p. 210) adds that the inner ridge separating the brood chamber is much larger than in *Cytherella,* so that it extends from the ventral to the dorsal margin.

CAVELLINA sp. A

(Pl. 6, fig. 1a-b)

Material: 8 carapaces (mainly broken).

Description: Oval outline in lateral view; greatest height in mid-length position. Anterodorsal border more steeply inclined than posterodorsal border; posterior border broadly rounded, anterior border slightly asymmetrically rounded, with axis of greatest length inclined at about 82° to height. Posterior end above mid-height position, anterior end below mid-height position. Right valve larger than left valve, with complete overlap; maximum overlap along anterodorsal border. Left valve bears ridge along anterior margin. Hinge structure, contact margin, and muscle-scars not seen. In dorsal view outline ovate, with greatest width in posterior half of carapace. Surface smooth.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*Figured on*
CPC 7090	0.94	0.67	0.45	Pl. 6, fig. 1

Occurrence: Figured specimen from locality 100/4, the base of section 100, and other specimens from 145/5 and 145/7 (basal *altifrons-ordensis* Zone), Buttons Beds, Eight-Mile Creek area, Burt Range, Upper Devonian (early Famennian).

Remarks: This species occurs in the northern Canning Basin, in the subsurface Upper Devonian sequence penetrated by BMR No. 2 Laurel Downs (1775-3013 feet cores, and 4000 feet in cuttings), and Frome Rocks No. 2 Well (3640-5596

feet). A proper definition of the species must await a detailed study of abundant specimens from the northern Canning Basin.

In lateral outline *Cavellina* sp. A resembles the Middle Devonian species *C. buchanensis* Krömmelbein, 1954, from Victoria; also a comparison may be made with the Middle Devonian species *C. mesodevonica* Pokorny, 1950, from Czechoslovakia, and *C. accurata* Polenova, 1952, from the USSR.

Genus SULCELLA Coryell & Sample, 1932

(= ?UCHTOVIA Egorov, 1950)

Type species: *Sulcella sulcata* Coryell & Sample, 1932, p. 274 (by original designation).

Type level: Middle Pennsylvanian, upper Desmoinesian, Lone Camp group, East Mountain formation.

Type locality: Mineral Wells shale pit, Mineral Wells, Palo Pinto County, Texas.

Remarks: The diagnosis of *Sulcella* is given by Coryell & Sample (1932, p. 275) and Benson et al. (1961, Q370). The stratigraphical range and geographic distribution of the genus are given by Benson et al. as Mississippian-Pennsylvanian, North America. *Sulcella* is known to occur, however, in the Middle Devonian rocks of North America (*S. emicatusa* Stover, 1956—Hamilton group, New York State), Europe (*S. refrathensis* Krömmelbein, 1954—Givetian, Germany), and Australia (*S. australis* Krömmelbein, 1954—Eifelian or Emsian of Victoria). It probably occurs in the Middle and Upper Devonian of the USSR, recorded under the name *Uchtovia* Egorov, 1950. From Egorov's (1950, p. 40-2) description of the type species (*Uchtovia polenovae* Egorov, 1950), and the description and figures of the type species in the 'Osnovy' (Polenova, 1960, p. 322), there appears to be no significant difference between *Uchtovia* and *Sulcella.*

SULCELLA ALTIFRONS sp. nov.

(Pl. 4, figs 6-8; text-fig. 19)

Derivation of name: Latin, *altus*—high; *frons*—brow, fore part; referring to the position of greatest height in anterior half of carapace.

Material: 15 complete carapaces, and 3 damaged specimens.

Diagnosis: Greatest height in anterior half, valves smooth, sulcus weakly expressed; posterior ridge absent.

Description: Outline elongate, subelliptical, defined by larger right valve. Greatest height in anterior half of carapace. Dorsal border broadly convex in anterior half, almost straight in posterior half, and gently inclined towards posterior end. Anterior border broadly rounded and curving smoothly into a very gently concave ventral border. Posterior border asymmetrically curved, with posterior end slightly above mid-height position. Right valve overlapping left all round, well developed on dorsal and ventral borders, weakly developed on anterior border. Posterior end of right valve, in some specimens, bears a low blunt spine. Hinge-line slightly depressed in posterior half of dorsum, between inflated posterodorsal borders of both valves; gently inclined towards posterior end. Ventral margin of left valve strongly concave, bearing a narrow smooth rim which extends towards the anterior and posterior margins.

In dorsal view, outline of tecnomorphs elongate-oval with greatest width in middle; in heteromorphs greatest width confined to posterior half; median sulcus (S2) weakly expressed, position located only by slight constriction of carapace outline of heteromorphs.

In posterior view, outline ovate with greatest width in mid-height position. Surface smooth.

Dimensions

	Length	*Height*	*Width*	*Valve*	*Figured on*
Holotype CPC 7080	1.00	0.525	0.425	h-c	Pl. 4, fig. 6
Paratype CPC 7081	0.875	0.45	0.325	t-c	Pl. 4, fig. 7
Paratype CPC 7082	0.755	0.387	0.262	t-c	Pl. 4, fig. 8

The measurements of the length and height of 15 specimens collected from localities 105/100, 105/420, 105/430, and 100/4 are shown on a graph (Fig. 19).

The group of specimens approximately 1.00 mm in length is accepted as adult, as it contains heteromorphs. The mean values of the length and height of this group are 1.00 mm and 0.516 mm respectively.

Occurrence: Holotype (CPC 7080) from section 105, Buttons Crossing, east bank of Ord River, 420 feet above the base, and paratypes (CPC 7081, 7082) from the same section at 430 feet (basal *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian; early

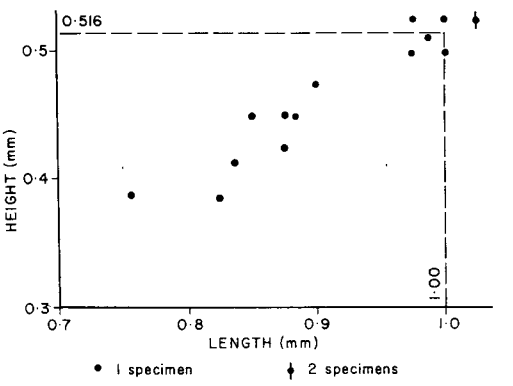

Fig. 19 Size-dispersion diagram for *Sulcella altifrons* sp. nov. based on 15 specimens from section 105 (100, 420, and 430 feet) and locality 100/4.

Famennian. Also in the same section at 60 feet, 100 feet, and 170 feet (*altifrons* Zone), and at 600 feet (top of *altifrons-ordensis* Zone). Other occurrence at 100/4, the base of section 100, Buttons Beds, Burt Range (*altifrons-ordensis* Zone).

Remarks: This species appears to be closely related to *Cavellina abundans* Pokorny, 1950, which Rozhdestvenskaya (1959, p. 145) assigned to the genus *Uchtovia* Egorov, 1950. *Sulcella abundans* (Pokorny) has been recorded from the Middle Devonian (late Givetian) of Czechoslovakia (Pokorny, 1950, p. 626), Germany (Krömmelbein, 1954, p. 252; Becker, 1965a, p. 395), and the Bashkirian ASSR (Rozhdestvenskaya, 1959, p. 144). *S. altifrons* lacks the almost level dorsal border of *S. abundans,* which is approximately parallel with the ventral border; the dorsal border of *S. altifrons* is distinctly convex, with the maximum height situated in the anterior half, and the posterior part is gently inclined towards the posterior end. Moreover, tecnomorphs of the Australian species lack the posterior ledge or step which according to Rozhdestvenskaya is present in the males of *S. abundans*.

Suborder PODOCOPA Sars, 1866

Superfamily BAIRDACEA Sars, 1888

(*nom. transl.* Sylvester-Bradley, 1948; *ex* Bairdiidae Sars, 1888)

Family BAIRDIIDAE Sars, 1888

A diagnosis of the Bairdiidae has been given by Shaver (1961, Q201). Van Morkhoven (1962, p. 113) has prepared a more complete diagnosis, which includes definitions based upon both the carapace morphology and the appendages.

The carapace morphology of many 'bairdioid'-shaped species lacks the distinct characters which are used for generic classification in other ostracod groups. Hence, many ostracod workers consider that *Bairdia* has an extremely long time range from Ordovician to Recent (e.g. Sylvester-Bradley, 1961, Q201). Sohn (1960, p. 13), on the other hand, suggested that the living species and the post-Palaeozoic fossil species now assigned to *Bairdia* are probably not congeneric with the Palaeozoic species of *Bairdia* M'Coy, 1844, and require one or more new genera for their reception; he rejected the use of the genus *Nesidea* Costa, 1849, for the younger species (cf. Doeglas, 1931; Tressler, 1949, 1954). As redefined, the stratigraphical range of *Bairdia* s.s. was restricted to rocks of Middle Devonian to Permian age. Sohn proposed three new genera—*Cryptobairdia, Orthobairdia,* and *Rectobairdia*—for many smooth species previously assigned to *Bairdia,* based on slight changes in the outline of the carapace.

Becker (1965a, p. 415), however, used the taxa erected by Sohn at the subgeneric rank only. He stated that many of Sohn's doubts (particularly with

Cryptobairdia) indicate the transition of one group into another, and that with a large number of specimens from the one locality, continuous variation may be seen within the characteristics which Sohn accepted as diagnostic of genera.

The generic classification by Sohn, based on slight changes in carapace outline, is followed in this study, as it appears to have the support of Kornicker's (1961) work on the taxonomy of living Bairdiinae. Kornicker studied both the carapace and the body morphology of thirteen species, and has provided evidence to suggest that carapace differences between genera belonging to the Bairdiinae will be more subtle than those normally found between ostracod genera.

Not all subfamilies of the Bairdiidae are as conservative as the Bairdiinae. Kollmann (1960, 1963) has described an extremely diverse fauna of Bairdiidae from rocks of Middle Triassic to early Jurassic age from the Austrian Alps. He proposed nine new genera, which he assigned to five subfamilies—the smooth genera to Bairdiinae Sars, 1923, and Alanellinae Boucek, 1936, and the strongly sculptured genera to his new subfamilies Nodobairdiinae, Triebelininae, and Carinobairdiinae.

Compared with other groups of ostracods, the subfamily Bairdiinae shows little evolutionary change in carapace morphology; this has hitherto obscured the generic relationships. Probably many smooth Bairdiinae in present-day seas are masked under the name *Bairdia,* whereas the exotically sculptured subfamilies of the Triassic are represented today by only one genus—*Triebelina.*

Subfamily BAIRDIINAE Sars, 1923, emend. Kollmann, 1963

Diagnosis: Kollmann (1963, p. 163) emended the concept of the subfamily Bairdiinae to include 'a group of genera, which are distinguished by their "bairdioid" outline, in which the posterior end is always placed on the level of the ventral margin or half way between the ventral margin and the mid-height position, but never placed on the extension of the dorsal margin above the mid-height position. In dorsal and lateral views the carapace is compressed or acuminate. Spines on the anterodorsal margin of the larger valve are absent. Strong sculpture is absent'. (Translation).

Genus BAIRDIA M'Coy, 1844

Type species: *Bairdia curta* M'Coy, 1844; subsequently designated by Miller, 1892, p. 704.

Type level: Lower Carboniferous, 'Yellow Sandstone group'.

Type locality: near Granard, County Longford, Ireland.

Diagnosis: Sohn (1960, p. 12) in his generic diagnosis states: 'Smooth asymmetrical ostracodes; end margins acuminate, posterior more pointed. Dorsal margin convex; ventral margin curved to straight; dorsoanterior and dorsoposterior margins straight to curved. Dorsal outline subelliptical, ends always narrow. Left valve larger, overlaps along dorsum, posterodorsal margin, and venter where "lip" may be present. Duplicature broad, adductor muscle scar slightly anterior and below center of valve, circular, consists of rosette of individual scars'.

BAIRDIA sp. cf. B. NALIVKINI Egorov, 1953

(Pl. 7, figs 3a-c)

cf. 1953 *Bairdia nalivkini* Egorov, p. 8, pl. 4, figs 4a-c.
? 1955 *Bairdia rockfordensis* Gibson, p. 17, pl. 1, fig. 8.

Material: 1 specimen.

Description: Outline bairdioid, subreniform, subelongate. Left valve strongly overlapping right on dorsal and central ventral borders, where it forms a lip in front of the mid-length position on the ventral border. Hinge-line slightly curved. Overlap very slight along anteroventral and posteroventral borders. Dorsal border slightly convex, broadly symmetrical. Posterodorsal border of left valve about one-third of length; anterodorsal border more than one-third of length. Ventral border slightly concave. Anterior end slightly below mid-height position; bluntly truncated. Posterior end well below mid-height position; broadly pointed. Greatest height central; greatest width slightly posterior to mid-length position.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*L/H ratio*	*Figured on*
CPC 7734	1.32	0.71	0.50	1.86	Pl. 7, fig. 3

Occurrence: Figured specimen (CPC 7734) from locality 459/440—Westwood Creek; Westwood Member of Cockatoo Formation; Upper Devonian (Frasnian).

Remarks: This species resembles, in outline and overlap features, the illustrations of *Bairdia nalivkini* Egorov, 1953 (pl. 4, figs 4a-c), originally described from the Upper Devonian (Frasnian) of the Russian Platform. It also resembles, even more closely, *Bairdia rockfordensis* Gibson, 1955 (pl. 1, fig. 8), from the Upper Devonian Cerro Gordo member of the Lime Creek Formation, Iowa, which according to Anderson (1966) is Frasnian (toI_{γ}). Examination of topotype material of *B. rockfordensis* Gibson is necessary, as

Sohn (1960, p. 41) has pointed out that 'the holotype (USNM 123088) of this species is a damaged steinkern of an undeterminate genus'.

The Australian specimen is slightly more elongate than either of the Russian and American species, and it is tentatively referred to the senior species—*B. nalivkini* Egorov, 1953.

BAIRDIA sp. cf. B. NAUMOVAE Egorov, 1953

(Pl. 7; figs 2a-c; text-fig. 20)

cf. 1953	*Bairdia naumovae* Egorov, p. 23, pl. 11, figs 1-2.
? 1953	*Bairdia birinae* Egorov, p. 25, pl. 12, figs 3, 4.
? 1954*a*	*Bairdia singularis* Krömmelbein, p. 248, pl. 1, fig. 1.
? 1960	*Cryptobairdia ? singularis;* Sohn, pp. 37, 46, 48, 51.
? 1965*a*	*Bairdia (Cryptobairdia) singularis;* Becker, p. 420.
? 1965*a*	*Bairdia (Cryptobairdia)* cf. *singularis;* Becker, p. 421, pl. 35, fig. 6.

Material: 1 specimen.

Description: Outline bairdioid, subreniform, elongate. Left valve overlapping right on dorsal and central ventral borders, where it forms a lip just in front of mid-length position on ventral border. Hinge-line straight, slightly inclined posteriorly. Overlap very slight along anteroventral and posteroventral borders. Dorsal slightly convex, asymmetrical. Posterodorsal border of left valve slightly more than one-third of length; anterodorsal border long, nearly one-half of length, merging gently into central dorsal border. Ventral border concave. Anterior end slightly below mid-height position; rounded. Posterior end slightly below mid-height position; broadly pointed. Greatest height central.

In dorsal view, anterior and posterior ends subacuminate; greatest width central.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*L/H ratio*	*Figured on*
CPC 7733	1.35	0.65	0.47	2.07	Pl. 7, fig. 2

Occurrence: Figured specimen (CPC 7733) from locality 459/440—Westwood Creek; Westwood Member of Cockatoo Formation; Upper Devonian (Frasnian).

Remarks: This species resembles in outline and overlap features the illustrations of *Bairdia naumovae* Egorov, 1953 (pl. 11, figs 1, 2) and the smaller species *Bairdia birinae* Egorov, 1953 (pl. 12, figs 3, 4), both from the Upper Devonian (Frasnian) of the Russian Platform. Egorov (1953, p. 25) doubted whether the holotype (length 0.82 mm, height 0.39 mm) of *B. birinae* Egorov was an adult specimen, and according to Sohn (1960, p. 7), discussing the growth stages of Bairdiinae, 'it appears reasonable to assume that specimens

less than 1 millimeter in greatest length are young stages of growth'. In my opinion, from the illustrations, *B. birinae* Egorov appears to be an immature moult stage of *B. naumovae* Egorov (probably A-2 stage).

The Australian species also resembles *Bairdia singularis* Krömmelbein, 1954 (pl. 1, fig. 1) and *B.* (*Cryptobairdia*) cf. *singularis,* Becker, 1965a (pl. 35, fig. 6), both from the Middle Devonian (Givetian) of Germany. Both German species are similar to *B. naumovae* Egorov, and are in the same size range as *B. birinae* Egorov. Thus it is possible that the German species are also immature moult stages belonging to *B. naumovae* Egorov. All of these species are here tentatively regarded as junior synonyms of *B. naumovae* Egorov. The Australian species, however, is also tentatively referred to *B. naumovae* Egorov, as at present only one specimen is available for study.

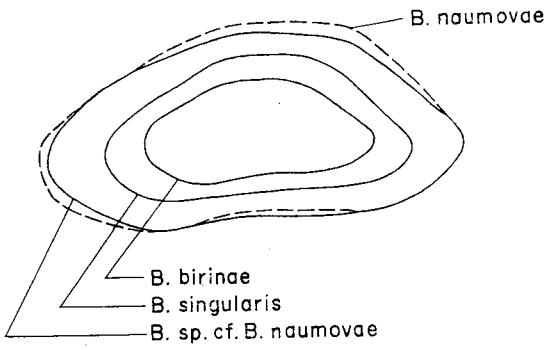

Fig. 20 Diagrammatic drawing illustrating the differences between the outline of the left valves of (a) *Bairdia* **sp. cf.** *B. naumovae,* **(b)** *B. naumovae* **Egorov 1953, (c)** *B. singularis* **Krömmelbein 1954, and (d)** *B. birinae* **Egorov 1953.**

Two other species may be mentioned for comparison with the Australian material—*B. fabaeformis* Polenova, 1953, from the Upper Devonian (Frasnian) of the Russian Platform, and *B. extenda* Gibson, 1955, from the Upper Devonian Cerro Gordo member of the Lime Creek Formation, Iowa. Polenova (1953, p. 69) noted that *B. fabaeformis* is distinguished from *B. birinae* Egorov by the more uniform slope of the dorsal margin to the ends, the more rounded posterior end, and the smaller(?) size. These are also the differences between *B. fabaeformis* and the Australian species.

B. extenda Gibson has the same outline as the Australian species, but is considerably more elongated (L/H ratio = 2.35).

Genus ORTHOBAIRDIA Sohn, 1960

Type species: *Bairdia cestriensis* Ulrich, 1891, p. 210, pl. 17, figs 6a-c; originally designated by Sohn, 1960, p. 65.

Type level: Upper Mississippian, Chester Series; shale.

Type locality: Near Grayson Springs, Grayson County, Kentucky.

Diagnosis: Bairdiinae with parallel sides in dorsal outline.

Discussion: Sohn (1960, p. 65) states that 'the fact that very young instars as well as adults have parallel sides indicates that this feature is not due to dimorphism and ontogeny'.

ORTHOBAIRDIA ORDENSIS sp. nov.

(Pl. 6, figs 5-7; text-fig. 21)

Derivation of name: After the Ord River.

Material: About 70 specimens, mostly broken.

Diagnosis: A species of *Orthobairdia* with posterodorsal border of left valve concave, slightly more than one-third of greatest length; central dorsal border about one-third of greatest length, inclined posteriorly.

Description: Outline bairdioid, subovate. Left valve strongly overlapping right on anterodorsal and central ventral borders, where it forms a distinct lip in front of mid-length position on ventral border. Hinge-line straight, slightly inclined posteriorly. Overlap very slight along posterodorsal, posteroventral, and anteroventral borders. Dorsal border convex, asymmetrical, inclined posteriorly. Posterodorsal border of left valve slightly more than one-third of length; anterodorsal border about one-third of length. Ventral border straight. Anterior end above mid-height position; rounded. Posterior end below mid-height; pointed. Greatest height in front of mid-length; greatest width central. Adductor muscle-scar consists of 10 discrete spots. Lower 4 scars grouped together as 2 pairs, upper 4 scars in line, and 2 remaining scars located in centre of pattern. Surface smooth, and sometimes shows punctae.

Dimensions

	Length	*Height*	*Width*	*L/H ratio*	*Figured on*
Holotype (CPC 7094)	1.32	0.75	0.57	1.76	Pl. 6, fig. 5
Paratype A (CPC 7095)	1.32	0.74	0.57	1.77	Pl. 6, fig. 6
Paratype B (CPC 7096)	1.35	0.77	0.57 (est.)	1.72	Pl. 6, fig. 7

Occurrence: Holotype (CPC 7094) and paratypes (CPC 7095, 7096) from section 105, Buttons Crossing, east bank of Ord River—420 feet above the base (basal *altifrons-ordensis* Zone), Buttons Beds, Upper Devonian (early Famennian). In same section at 430 feet (basal *altifrons-ordensis* Zone), and 600 feet (top of *altifrons-ordensis* Zone), 650 feet, 735 feet, and 810 feet (*ordensis* Zone). Also occurs at localities 100/4, 146/10, and 146/13, Buttons

Beds (basal *altifrons-ordensis* Zone), and may possibly range upwards into the base of the Burt Range Formation at locality 144/3 (Lower Carboniferous, basal Tournaisian).

Remarks: *Orthobairdia ordensis* is similar in lateral outline to the Pennsylvanian species *Orthobairdia powersi* Kellett, 1934; it lacks, however, the horizontal ridge on the left valve near the dorsal margin of *O. powersi,* the central part of the dorsal border is longer, the anterodorsal border is shorter, and the posterior end is more pointed than the American species. It is instructive to compare the muscle-scar pattern of *Orthobairdia ordensis* with that figured

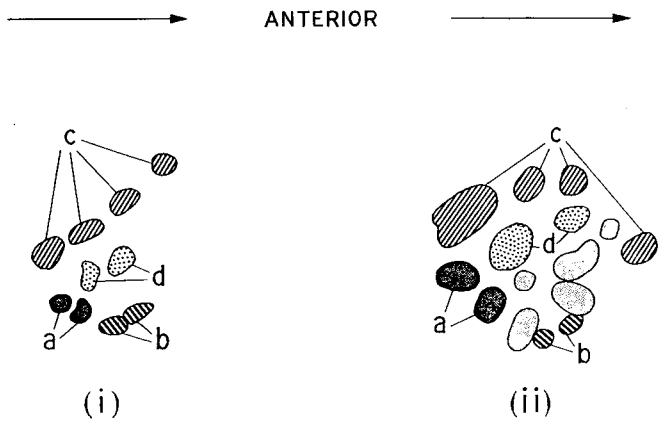

Fig. 21 Suggested homology of muscle scar patterns. A comparison between the muscle scar pattern of *Orthobairdia ordensis* sp. nov. (fig. i), and that figured by Shaver (1961, Q202, fig. 139, 3b; fig. ii herein) as belonging to *Bairdia golcondensis* Croneis & Gale (= *?Orthobairdia cestriensis* (Ulrich), according to Sohn, 1960, p. 66).

by Shaver (1961, Q202) for *Bairdia golcondensis* Croneis & Gale, an Upper Mississippian species which Sohn (1960, p. 66) tentatively referred to *Orthobairdia cestriensis* (Ulrich). Although the number of individual scars increases from 10 in *O. ordensis* to 15 in *O. cestriensis?,* the same basic pattern exists in both species (Fig. 21). This pattern consists of:

(a) 2 posterior scars in the medial position;

(b) 2 ventral scars close together, but with a slight gap in the younger species; these may represent the mandibular scars;

(c) 4 dorsal scars in a straight line in *O. ordensis*—the anterior one may be a frontal scar; only 3 dorsal scars occur in a straight line in the younger species; the fourth (the frontal scar?) appears lower, in a medial position;

(d) 2 central scars in *O. ordensis,* the precise equivalents of which are difficult to determine in the younger species.

Five extra scars appear in the younger species—2 just above the mandibular? scars, 2 just below the central scars, and 1 between the frontal? scar and the anteriormost central scar.

Genus RECTOBAIRDIA Sohn, 1960

Type species: *Bairdia distressa* Geis, 1940; originally designated by Sohn, 1960, p. 52; new name in Sohn, 1940, for *Bairdia depressa* Geis, 1932 (*not* Kafka, 1885).

Type level: Salem limestone, lower Meramecian, Middle Mississippian.

Type locality: Not designated; Indiana.

Diagnosis: Sohn (1960, p. 52) in his generic diagnosis states: 'Differs from *Bairdia* s.s. by having a straight to very gently curved dorsal margin'.

Remarks: This genus is defined as having a straight dorsal margin, and a pointed posterior.

RECTOBAIRDIA sp. A

(Pl. 7, figs 1a-c)

Material: 12 specimens, several corroded.

Description: Outline bairdioid, subquadrate, elongate. Left valve overlapping right on anterior and posterior parts of dorsal border, and central ventral border, where it forms a lip in front of mid-length position. Hinge-line and dorsal border straight, both either parallel with ventral border, or slightly inclined anteriorly. Posterodorsal border of left valve one-third of length, anterodorsal border short, one-quarter of length. Ventral border concave; posteroventral border truncated. Anterior end slightly above mid-height position, upturned. Posterior end slightly below mid-height position, strongly pointed.

Greatest height central to posterior half.

In dorsal view, anterior and posterior ends acuminate; greatest width central.

Dimensions

Figured specimen	*Length*	*Height*	*Width*	*L/H ratio*	*Figured on*
CPC 7732	1.09	0.47	0.37	2.30	Pl. 7, fig. 1

Occurrence: Figured specimen (CPC 7732) from Section 459, 440 feet above the base, Westwood Creek; Westwood Member of Cockatoo Formation; Upper Devonian (Frasnian). Other localities within the same section at 270 feet, 350 feet, 390 feet, and 410 feet above the base, and at 1280 feet above base of section 13 (= locality 13/6).

Remarks: Some of the specimens show a slight resemblance to *Bairdiacypris? quarziana* (Egorov, 1953). This elongate Australian species, however, cannot be properly defined until better preserved material is found.

Subclass BRANCHIOPODA ?

Suborder ERIDOSTRACA Adamczak, 1961

(= subfamily Eridoconchinae, Henningsmoen, 1953)

Diagnosis: Small; shell thick, well calcified, multilamellar; hinge-line short, straight; dorsal margin convex, umbonate. Lamellae may be exfoliated and reduced in number, sometimes to a single lamella; sulcus may be present in umbonal region of exfoliated shells. Animal unknown.

Remarks: The biological position of the Eridostraca is uncertain. The group includes multilamellar genera, e.g. *Eridoconcha* Ulrich & Bassler, 1923, *Cryptophyllus* Levinson, 1951, and *Aberroconcha* Adamczak, 1961, in which the growth of the shell differs from the normal moulting habit of ostracods. Nevertheless, genera belonging to the Eridostraca have been traditionally regarded as ostracods by most ostracod workers (see discussion—Jones, 1962b, p. 17), with the exception of Schmidt (1941, p. 18) and Le Fevre (1963; p. 156), who assigned them to the Conchostraca. Recently, Zagora (1966, p. 231) assigned three species of *Eridoconcha* (*sensu* Adamczak) to the suborder Eridostraca, without reference to the higher taxa, but mentioned Hartmann's (1963) opinion that the Eridostraca may be more closely related to the Conchostraca than to the Ostracoda. Authorities on the Conchostraca, however, regard the *Eridoconcha*-group as ostracods (e.g. Tasch, 1963, p. 146).

The multilamellar condition of the genera which belong to the Eridostraca has been interpreted as:

(i) *moult-retention* by Levinson (1951, p. 554), 'as being due to incomplete shedding of moults accompanied by later cementation'.

(ii) *moult-initiation* by Adamczak (1961, p. 55), in which shells with seven or more lamellae represent the original condition inherited from conchostracan ancestors, while the shells with less than seven lamellae are attempting to initiate moulting.

(iii) *normal growth* by Jones (1962b, p. 18), in contrast to the rare cases of moult retention of abnormal individuals of ostracod species. In these cases the process of moulting is inhibited by possibly a biochemical change in the body, e.g. perhaps if the enzyme responsible for ecdysis is absent due to some genetic abnormality.

Adamczak (1961, p. 53) suggested that the Eridostraca are related to the Conchostraca for three reasons: (1) a multilamellar carapace is common to both groups; (2) the minute reticulation in his new species *'Eridoconcha' granulifera* resembles analogous structures between the grooves of living conchostracans; and (3) the minute pores at the boundary of the growth bands of partly decalcified valves, which he referred to *'E. rugosa'*, resemble the pores which contain setae in the chitinous mantle of recent Conchostraca. In addition, another reason can be cited for this relationship: (4) a small umbonal spine is present in the Ordovician species *Cryptophyllus simpsoni, C. magnus,* and *C. nuculopsis* (Harris, 1957, p. 182-3), which is similar to the umbonal spine present in the conchostracan genera *Vertexia* and *Echinestheria.*

The carapace of the Conchostraca, however, is chitinous, and only very slightly calcified, whereas the Eridostraca are well calcified. Moreover, the Conchostraca are a non-marine group, which make their first appearance in the Lower Devonian. The Eridostraca, on the other hand, are a marine group, which range from Middle Ordovician to Carboniferous.

Adamczak (1961) assigned his suborder Eridostraca to the Ostracoda. In this Bulletin the Eridostraca is assigned to the class Crustacea, but no definite evidence is available regarding the intermediate taxa. The Eridostraca may represent a new extinct order of marine branchiopods, but at present this opinion is extremely speculative.

Family ERIDOCONCHIDAE Henningsmoen, 1953

(*nom. transl.* Adamczak, 1961; *ex* Eridoconchinae Henningsmoen, 1953)

Diagnosis: Identical with the diagnosis of the suborder Eridostraca, p. 64.

Remarks: Adamczak (1961) redefined the present generic concepts of *Eridoconcha* Ulrich & Bassler, 1923, and *Cryptophyllus* Levinson, 1951, on the basis of the number of lamellae they possessed. Species with seven to eleven lamellae were referred to *Eridoconcha,* for which Adamczak emended and raised the Eridoconchinae to familial rank, and species with one to six lamellae were referred to *Cryptophyllus,* for which a new family—the Cryptophyllidae—was proposed. In my opinion (Jones, 1962b, p. 37) 'the number of lamellae appears to be an unstable character on which to define either a species or a genus of the extinct Eridostraca', and for this reason I prefer to continue

to follow Levinson's definitions of these genera. Thus, I regard the family Cryptophyllidae Adamczak, 1961, as a junior synonym of the family Eridoconchidae Henningsmoen, 1953.

Genus ERIDOCONCHA Ulrich & Bassler, 1923

Type species: *Eridoconcha rugosa* Ulrich & Bassler, 1923, p. 297 (by original designation).

Type level: Upper Ordovician, Cincinnatian, Maysville Group, McMillan Formation, Corryville member.

Type locality: Cincinnati, Ohio.

Remarks: The French species *Estheria* (*Euestheria*) *buchoti* Peneau, 1937, from the schists of Moulin de Regereau in the Armorican Massif (Devonian, or doubtfully Silurian), probably belongs to the genus *Eridoconcha.* Raymond (1946, p. 277) redescribed and produced the original figures of this species, which he assigned to his genus *Rhabdostichus* (which may possibly be a synonym of *Cryptophyllus* Levinson, 1951). Like the type species of *Rhabdostichus*—*R. pulex* (Clarke, 1882)—it is associated with a marine fauna. The ridges of *Estheria buchoti,* however, are more strongly developed than those of *R. pulex,* and form U-shaped grooves as in *Eridoconcha.* Moreover, the carapace is much larger. The finely reticulate surface between the ridges of *buchoti* is not an exclusively conchostracan feature, as it has been reported by Adamczak (1961, p. 85) to occur in his species *'Eridoconcha' granulifera.*

ERIDOCONCHA sp. A

(Pl. 7, figs 6, 7)

Material: 6 specimens.

Description: Small, equivalved; ovate to slightly asymmetrical in lateral view; umbo well developed, sharply pointed towards anterior end. Axis of greatest length intersects height at angles between 80° and 90°. Greatest height coincides with position of umbo, within anterior half of carapace; greatest width in dorso-central region. Hinge-line straight, about three-quarters of total length. Posterior cardinal angle greater than anterior cardinal angle; ventral border convex. At least 4 to 7 flange-like ridges present, separated by U-shaped grooves.

Dimensions

Figured specimens	*Length*	*Height*	*Width*	*Figured on*
CPC 7188	0.52	0.45	—	Pl. 7, fig. 6
CPC 7189	0.44	0.36	0.17	Pl. 7, fig. 7

Occurrence: Figured specimen CPC 7188 from locality 37/2, figured specimen CPC 7189 from locality 13/9; also occurs in localities 12/8 and 12/9. All localities within the Westwood Member of the Cockatoo Formation, Westwood Creek; Upper Devonian (Frasnian).

Remarks: *Eridoconcha* sp. A probably represents a new species, but as only six specimens are available, no adequate description can be given at present. It bears a superficial resemblance to *E. buchoti* (Peneau), but is much smaller than the French species (length 4.7 mm).

Eridoconcha sp. A resembles the forms listed as *'Rhabdostichus'* found in the northern Canning Basin in the Upper Devonian subsurface sequence penetrated by the wells BMR 2 Laurel Downs (Jones, 1959, p. 50), and Frome Rocks No. 2 (Jones, 1962a, p. 36). The Canning Basin forms are much more elongated than *Eridoconcha* sp. A.

Genus CRYPTOPHYLLUS Levinson, 1951

Type species: *Eridoconcha oboloides* Ulrich & Bassler, 1923, pp. 296-7, by original designation of Levinson, 1951, p. 558.

Type level: Middle Ordovician, Decorah Shale.

Type locality: St Paul, Minnesota.

Remarks: The possibility that the genus *Cryptophyllus* may be congeneric with the genus *Rhabdostichus* Raymond, 1946, has been discussed by Rome & Goreux (1960, p. 191), and Jones (1962b, p. 5). The type specimen of the genotype of *Rhabdostichus—R. pulex* (Clarke, 1882)—needs to be re-described together with additional collections of topotype material, before one can be sure that the two taxa are congeneric.

Devonian species of *Cryptophyllus* (*sensu* Levinson, *non* Adamczak) have been previously described from Belgium (Matern, 1929), Russia (Egorov, 1954), North America (Stover, 1956; Wilson, 1956—described as *Rhabdostichus* Raymond), Poland (Adamczak, 1961), Australia (Jones, 1962b), Algerian Sahara (Le Fevre, 1963), and Germany (Zagora, 1966).

CRYPTOPHYLLUS sp. indet.

(Pl. 7, figs 4, 5)

Material: 12 broken carapaces.

Description: Large, equivalved; ovate in lateral view, umbo low, poorly defined, projecting slightly above hinge-line. Hinge straight; ventral border slightly convex or parallel to hinge-line. At least eleven shell layers present.

Dimensions

Figured specimens	*Length*	*Height*	*Figured on*
CPC 7186	1.25	1.05	Pl. 7, fig. 4
CPC 7187	1.32	0.97	Pl. 7, fig. 5

Occurrence: Figured specimens (CPC 7186, 7187) from section 105, Buttons Crossing, east bank of Ord River, 600 feet above the base (*ordensis* Zone), Buttons Beds, Upper Devonian (lower Famennian toII-toIII). Also in same section at 60 feet, 65 feet, 170 feet (*altifrons* Zone), 400 feet, 420 feet, 430 feet (*altifrons-ordensis* Zone), 525 feet, and 650 feet (*ordensis* Zone).

Remarks: This description is based upon broken and poorly preserved specimens, which could lead to erroneous morphological observations; for instance, the anterior part of figured specimen CPC 7186 is broken, and the outline is therefore apparently asymmetrical, whereas, in actual fact, the marginal ridges should be projected anteriorly, which would make the outline more amplete, and the umbo would not rise so prominently above the hinge-line. Figured specimen CPC 7187 (Pl. 7, fig. 5) possesses the ovate outline of *Cryptophyllus* sp. A from the Gneudna Formation (middle Frasnian) of the Carnarvon Basin, Western Australia (Jones, 1962b), but more material would need to be examined before the two species could be regarded as conspecific.

LIST OF LOCALITIES WITH DETERMINATIONS OF OSTRACODA

Most of the localities listed are in measured sections: an expression such as 12/9 indicates locality 9 within measured section 12.

Details of the localities within the sections are shown graphically in Figures 5 and 6. The geological sketch-map (Fig. 1) shows the geographical distribution of all the sections from which Upper Devonian ostracods are described.

Westwood Member of the Cockatoo Formation

Section 459—TYPE SECTION—Westwood Creek, about 3 miles east-southeast of Shakespeare Hill, at Lat. 14°52'S, Long. 128°30'E; eastern limb of anticline, measured by J. J. Veevers, collected by E. C. Druce, 10th August 1965.

459/40 (40 feet)—*hanaicus* Zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A

459/70 (70 feet)—*hanaicus* Zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Hollinid indet.
Indivisia variolata Zanina
Krausella? dubitata sp. nov.
Bairdiidae indet.

459/90 (90 feet)—*hanaicus* Zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Cavellina sp. A

459/235 (235 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Cavellina sp. A

459/245 (245 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Krausella? dubitata sp. nov.

459/254 (254 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Indivisia variolata Zanina

459/270 (270 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Rectobairdia sp. A
Bairdiidae indet.

459/295 (295 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Indivisia variolata Zanina

459/350 (350 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Indivisia variolata Zanina
Rectobairdia sp. A
Bairdiidae indet.

459/390 (390 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Krausella? dubitata sp. nov.
Rectobairdia sp. A
Eridoconcha sp. A (Eridostraca)

459/410 (410 feet)—*hanaicus* zone

Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Rectobairdia sp. A

459/440 (440 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Bairdia sp. cf. *B. nalivkini* Egorov
Bairdia sp. cf. *B. naumovae* Egorov
Rectobairdia sp. A

Section 12—Complementary section, Westwood Creek, about ¼ mile E. of Section 459; eastern limb of anticline, measured by J. J. Veevers, collected by P. J. Jones, 8th-11th July 1963.

12/0A (0 feet)—? zone
Indivisia variolata Zanina ?

12/2A (25 feet)—? zone
Indivisia variolata Zanina

12/4 = 37/1 & 37/2 (75 feet)—? zone
Eridoconcha sp. A (Eridostraca)
Indivisia variolata Zanina

12/7 (385 feet) = AAP 320—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Indivisia variolata Zanina

12/8 and 12/9 (470 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Krausella? dubitata sp. nov.
Paraparchites sp. indet.
Eridoconcha sp. A (Eridostraca)

Section 13—Complementary section Westwood Creek, W. of Section 459 western limb of anticline, measured by J. J. Veevers, collected by P. J. Jones, 8th-11th July 1963.

13/9 (535 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina

Krausella? dubitata sp. nov.
Bairdiidae sp. indet.
Eridoconcha sp. A (Eridostraca)

13/6 (1280 feet)—*hanaicus* zone
Pribylites (*Parapribylites*) *hanaicus* Pokorny
Knoxiella sp. A
Indivisia variolata Zanina
Krausella? dubitata sp. nov.
Rectobairdia sp. A
Bairdiidae sp. indet.

Buttons Beds

Section 105—TYPE SECTION, base 2 miles north of Buttons Crossing, north of Kimberley Research Station on east bank of Ord River, at Lat. 15°38'S, Long. 128°42'E; measured by J. Roberts and collected by P. J. Jones, 1st-4th July 1963.

105/10 (10 feet)—below *altifrons* zone
Leptoprimitia sp. A
Geisina monothele sp. nov.
Indivisia variolata Zanina

105/60 (60 feet)—base of *altifrons* zone
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/100 (100 feet)—*altifrons* zone
Indivisia variolata Zanina
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Treposelline gen. A sp. A

105/170 (170 feet)—*altifrons* zone
Indivisia variolata Zanina
Marginia venula sp. nov.
Sulcella altifrons sp. nov.
Krausella? dubitata sp. nov.
Beyrichiopsis? perplexa sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/180 (180 feet)—*altifrons* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Beyrichiopsis? perplexa sp. nov.

105/280 (280 feet)—*altifrons* zone
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

105/320 (320 feet)—*altifrons* zone
Geisina monothele sp. nov.
Beyrichiopsis? perplexa sp. nov.

105/350 (350 feet)—*tryphera* zone
Geisina monothele sp. nov.

Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Krausella? dubitata sp. nov.
Beyrichiopsis? perplexa sp. nov.
Diphyochilina tryphera gen. et sp. nov.

105/370 (370 feet)—*tryphera* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Treposelline gen. A sp. A
Krausella? dubitata sp. nov.
Diphyochilina tryphera gen. et sp. nov.

105/400 (400 feet)—*tryphera* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Diphyochilina tryphera gen. et sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/420 (420 feet)—base of *altifrons-ordensis* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Treposelline gen. A sp. A
Diphyochilina tryphera gen. et sp. nov.
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/430 (430 feet)—lower *altifrons-ordensis* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Treposelline gen. A sp. A
Treposelline gen. B sp. A
Diphyochilina tryphera gen. et sp. nov.
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/525 (525 feet)—*altifrons-ordensis* zone
Indivisia variolata Zanina
Cryptophyllus sp. indet. (Eridostraca)

105/600 (600 feet)—*altifrons-ordensis* zone
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Treposelline gen. A sp. A
Beyrichiopsis? perplexa sp. nov.
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/620 (620 feet)—*ordensis* zone
Indivisia variolata Zanina
Beyrichiopsis? perplexa sp. nov.
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/660 (660 feet)—*ordensis* zone
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Treposelline gen. A sp. A
Krausella? dubitata sp. nov.
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

105/735 (735 feet)—*ordensis* zone
Indivisia variolata Zanina
Orthobairdia ordensis sp. nov.

105/820 (820 feet)—*ordensis* zone
Indivisia variolata Zanina
Orthobairdia ordensis sp. nov.

105/860 (860 feet)—? zone
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

Section 100—Eight Mile Creek, Burt Range area, Buttons Beds disconformably overlain by Burt Range Formation, base of section at Lat. 15°38'S, Long. 128°55'E; measured by J. Roberts, collected by P. J. Jones, 7th July 1965.

100/4 Buttons Beds, base of *altifrons-ordensis* zone
Leptoprimitia sp. A
Indivisia variolata Zanina
Geisina monothele sp. nov.
Marginia venula sp. nov.
Marginia reticulata sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Sulcella altifrons sp. nov.
Cavellina sp. A
Treposelline gen. A sp. A
Treposelline gen. B sp. A
Krausella? dubitata sp. nov.
Beyrichiopsis? perplexa sp. nov.
Diphyochilina tryphera gen. et sp. nov.
Orthobairdia ordensis sp. nov.
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)

Section 144 (duplication of base of Section 100); measured by J. Roberts, collected by P. J. Jones, 7th July 1965.

144/1 (= 100/4)—base of *altifrons-ordensis* zone
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)
Indivisia variolata Zanina
Krausella? dubitata sp. nov.
Geisina monothele sp. nov.
Marginia venula sp. nov.
Beyrichiopsis? perplexa sp. nov.
Orthobairdia ordensis sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

144/2 (= 100/5)—? zone
Ostracoda indeterminable

144/3 (= 100/6)—base of Lower Carboniferous Burt Range Formation—lower Tournaisian.
Coryellina sp.
Hastacypris sp.
Paraparchites sp.
?Orthobairdia ordensis sp. nov.

Section 145—1 mile north of Section 100; measured by J. Roberts, collected by P. J. Jones, 14th July 1965.

145/5 (35 feet)—?base of *altifrons-ordensis* zone
Indivisia variolata Zanina
Marginia venula sp. nov.
Beyrichiopsis? perplexa sp. nov.
Cavellina sp. A
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

145/7 (60 feet)—?lower *altifrons-ordensis* zone
Cavellina sp. A
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

145/8 (80 feet)—?lower *altifrons-ordensis* zone
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)
Marginia reticulata sp. nov.

145/9 (90 feet)—?lower *altifrons-ordensis* zone
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)

Section 146—1 mile south of Section 100; measured by J. Roberts, collected by P. J. Jones, 15th July 1965.

146/10 (125 feet)—basal *altifrons-ordensis* zone
Krausella? dubitata sp. nov.
Beyrichiopsis? perplexa sp. nov.
Marginia venula sp. nov.
Marginia reticulata sp. nov.
Treposelline gen. B sp. A
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)
Orthobairdia ordensis sp. nov.
Cryptophyllus sp. indet. (Eridostraca)

146/11 (135 feet)—lower *altifrons-ordensis* zone
Marginia venula sp. nov.
Marginia reticulata sp. nov.
Treposelline gen. B sp. A
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Diphyochilina tryphera gen. et sp. nov.

146/13 (162 feet)—lower *altifrons-ordensis* zone
Marginia reticulata sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)
Coeloenellina sp. cf. *C. fabiformis* (Kesling & Kilgore)
Orthobairdia ordensis sp. nov.
Diphyochilina tryphera gen. et sp. nov.

Ningbing Limestone (back-reef)

Section 21—TYPE SECTION, base 6 miles west-southwest of Ningbing at Lat. 15°18'S., Long. 120°37½' E.; measured by J. J. Veevers, collected by P. J. Jones, 19th July 1963.

21/15 (30 feet)
Ostracoda indeterminable.

21/22 (520 feet)—*tryphera* zone, or base of *altifrons-ordensis* zone.
Diphyochilina tryphera gen. et sp. nov.
Marginia reticulata sp. nov.
Indivisia variolata Zanina

21/25 (640 feet)—*altifrons-ordensis* zone or *ordensis* zone.
?Orthobairdia ordensis sp. nov.

Section 443—Jeremiah Hills; measured by J. J. Veevers, collected by P. J. Jones, 20th July 1965.

443/25 (1130 feet—at top of section)—*?tryphera* zone, or base of *altifrons-ordensis* zone.
Marginia reticulata sp. nov.
Paraparchites sp. cf. *P. nicklesi* (Ulrich)

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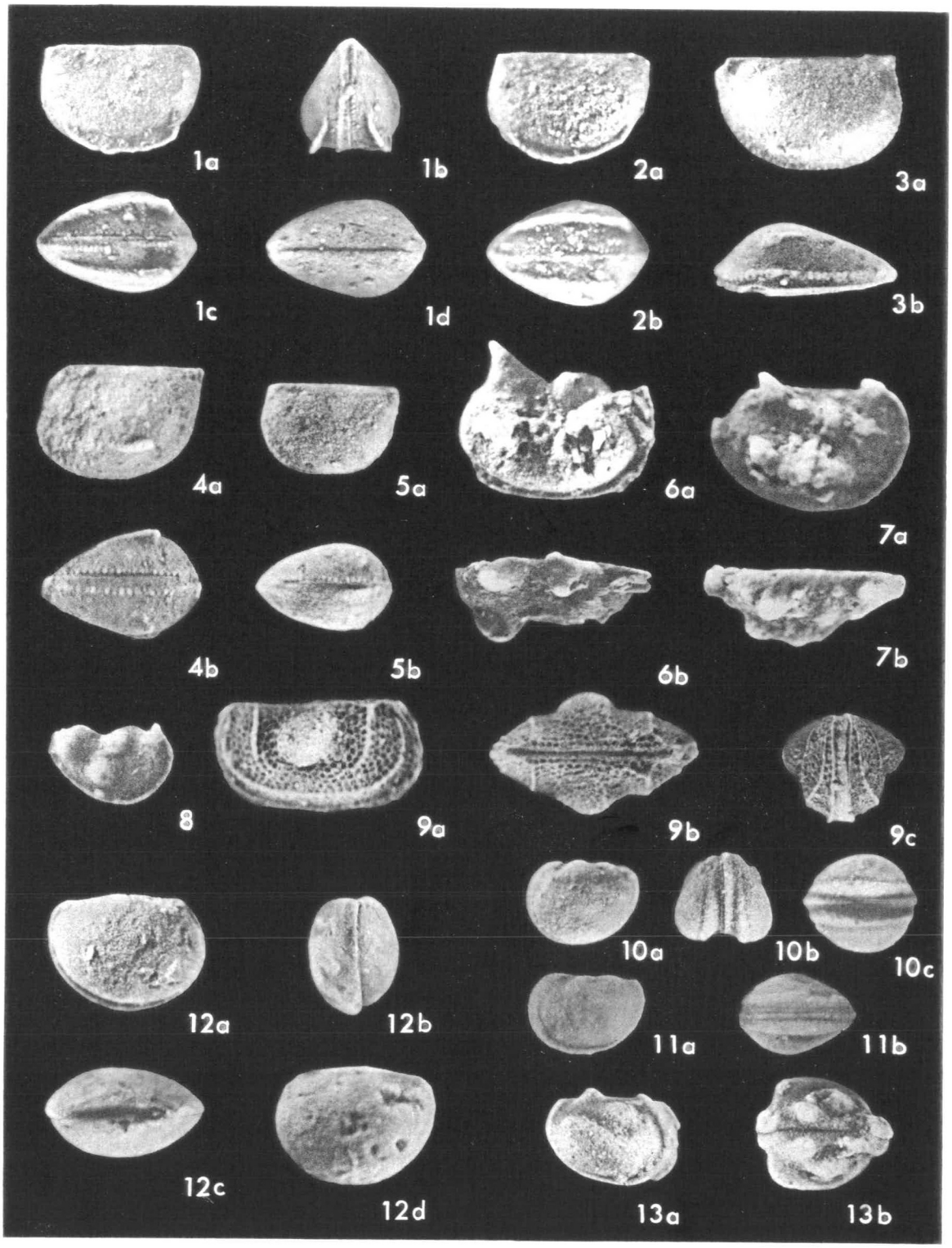
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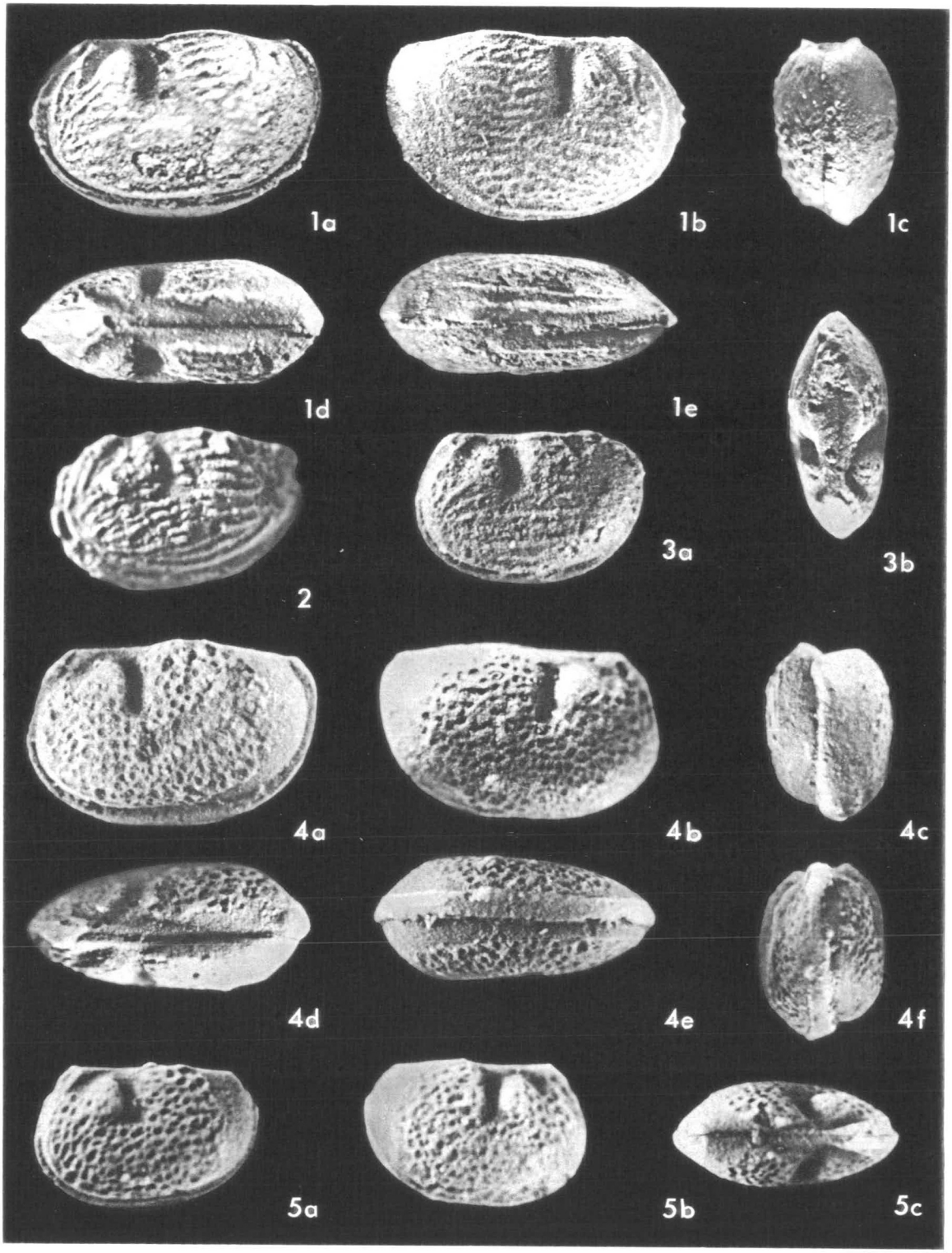
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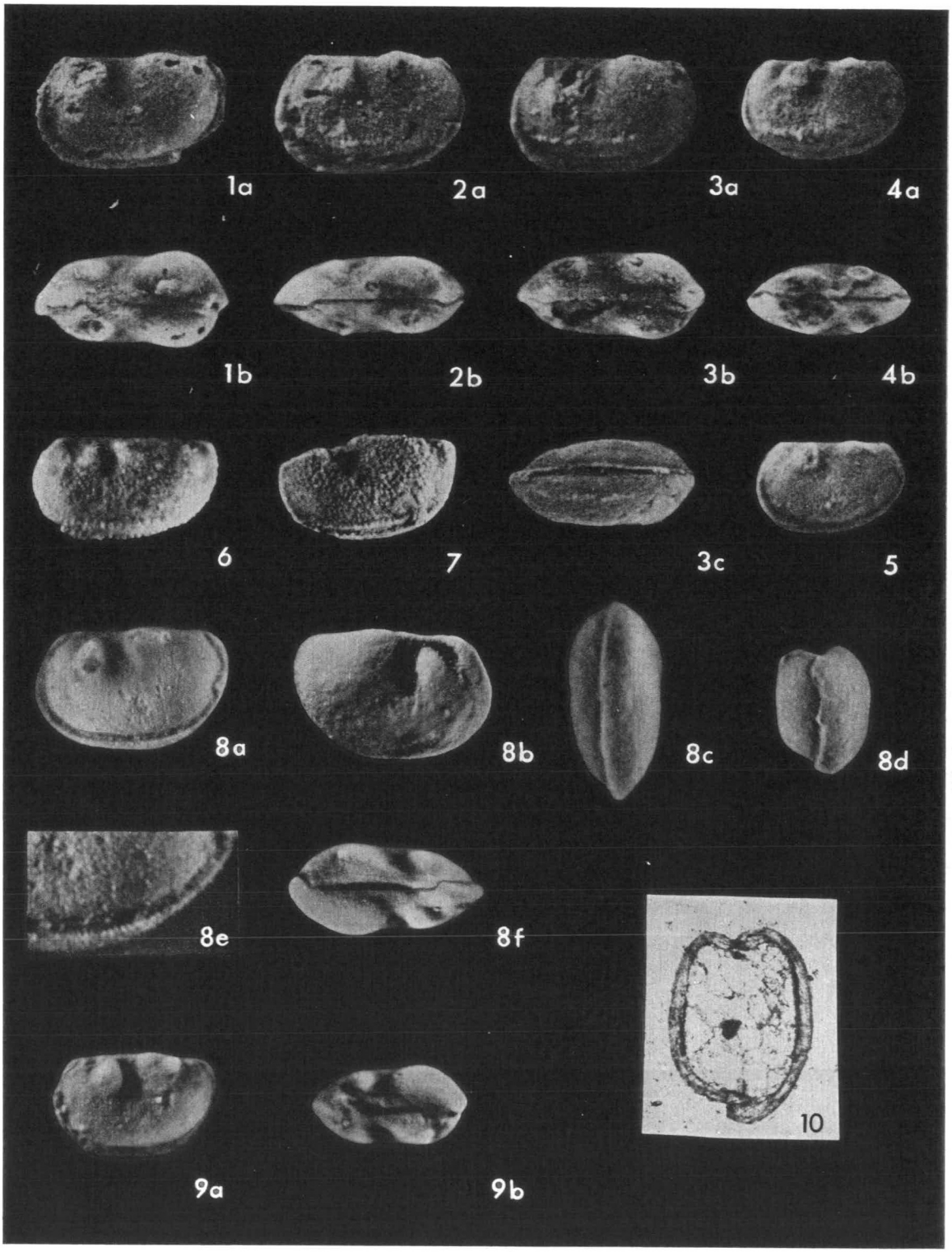
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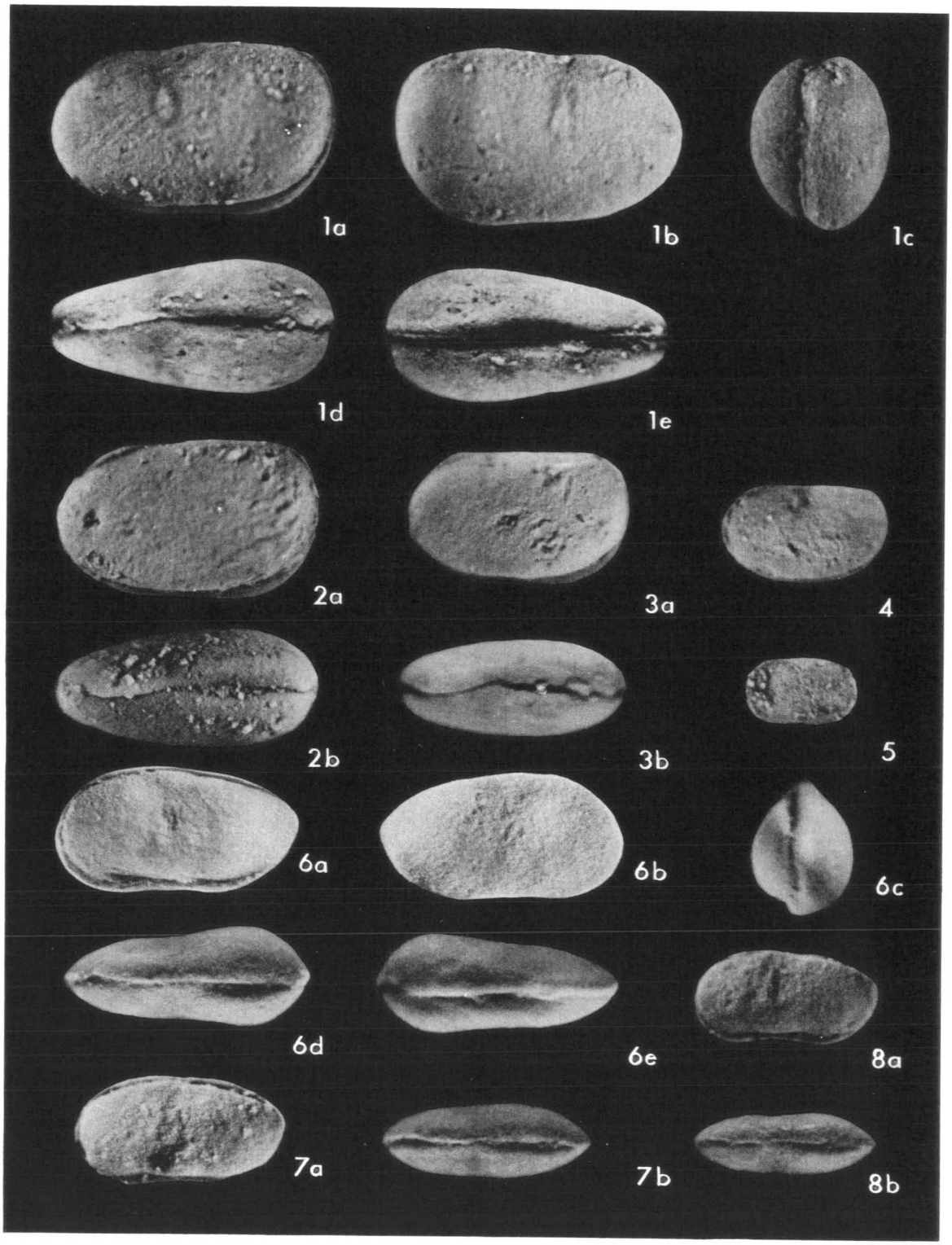
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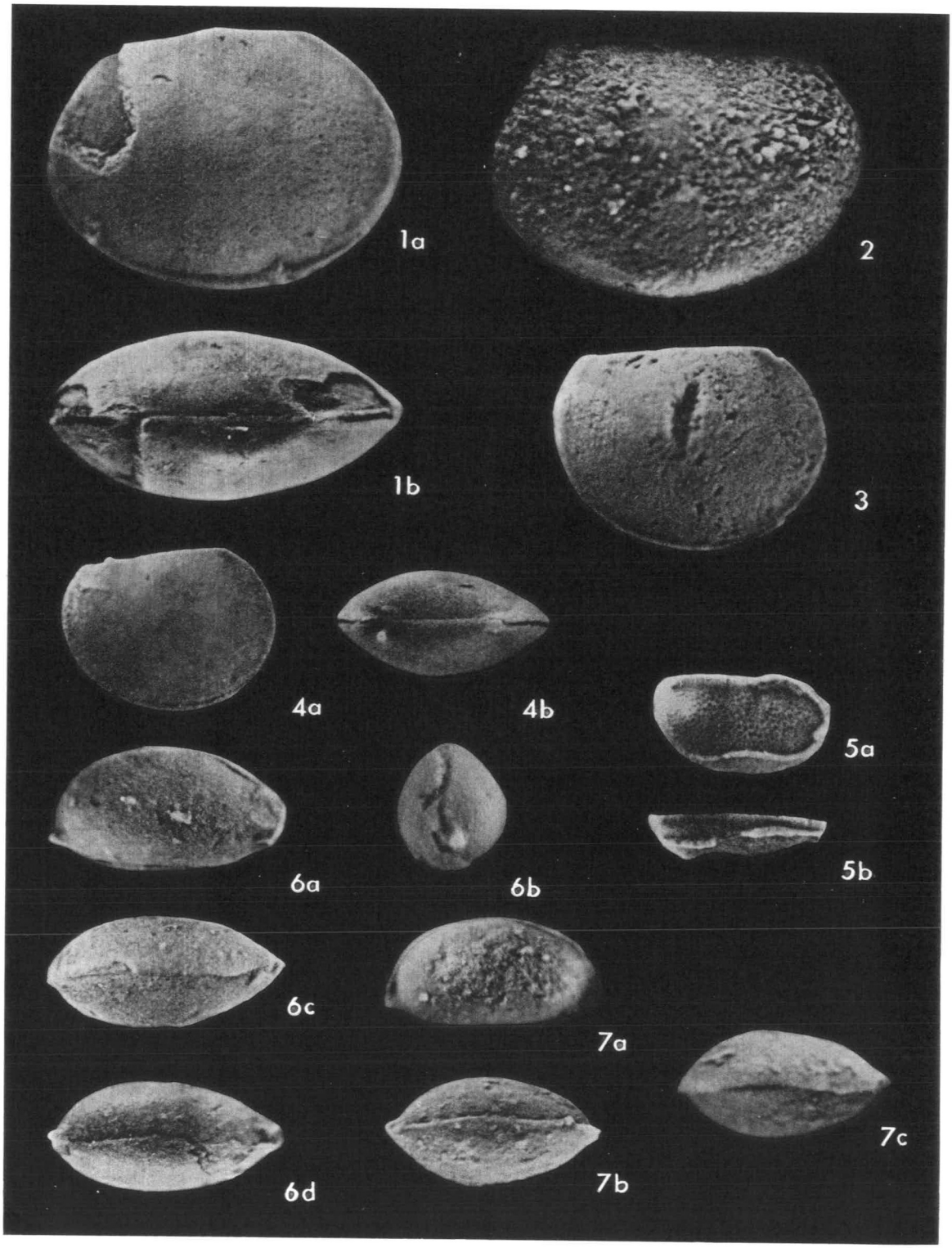
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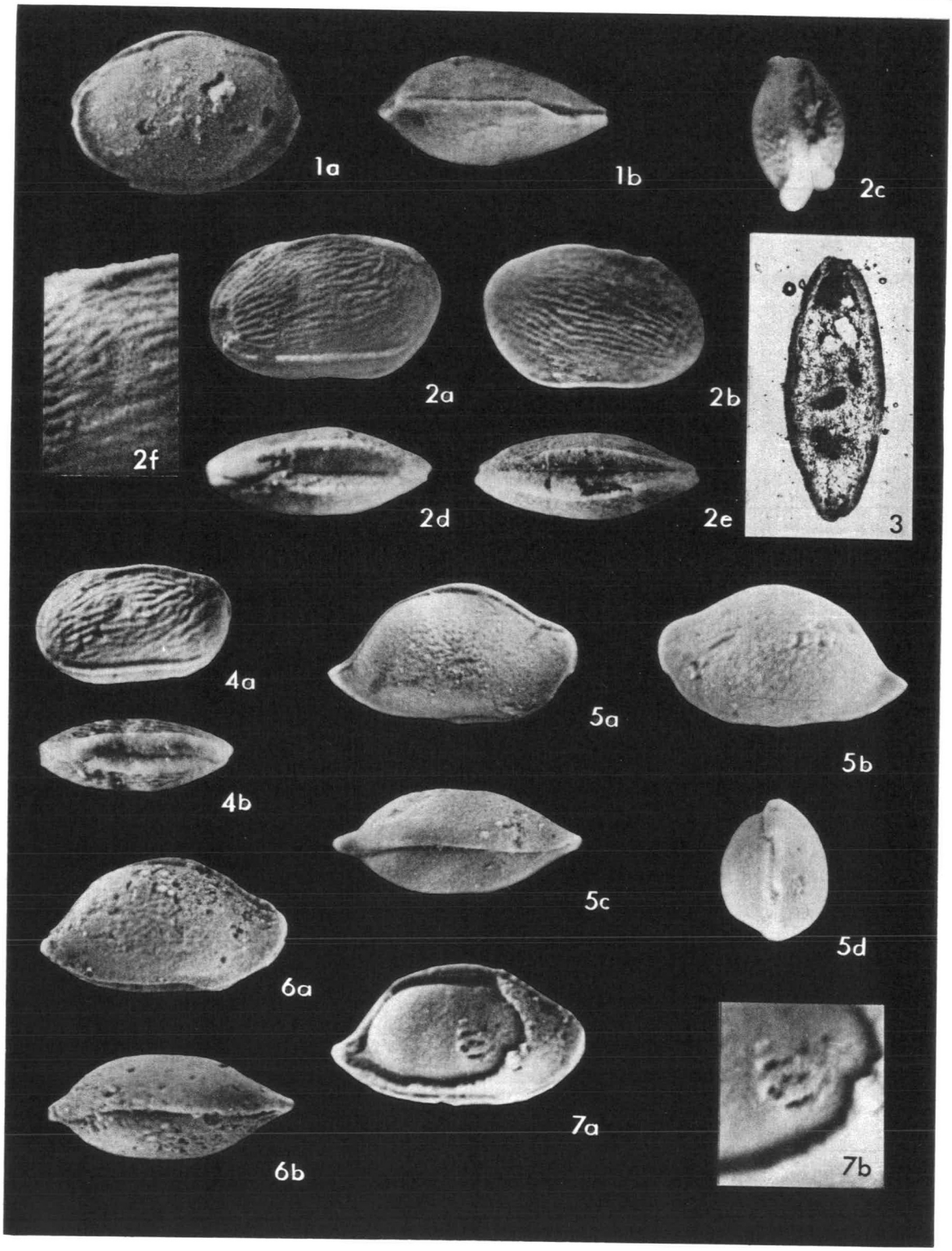
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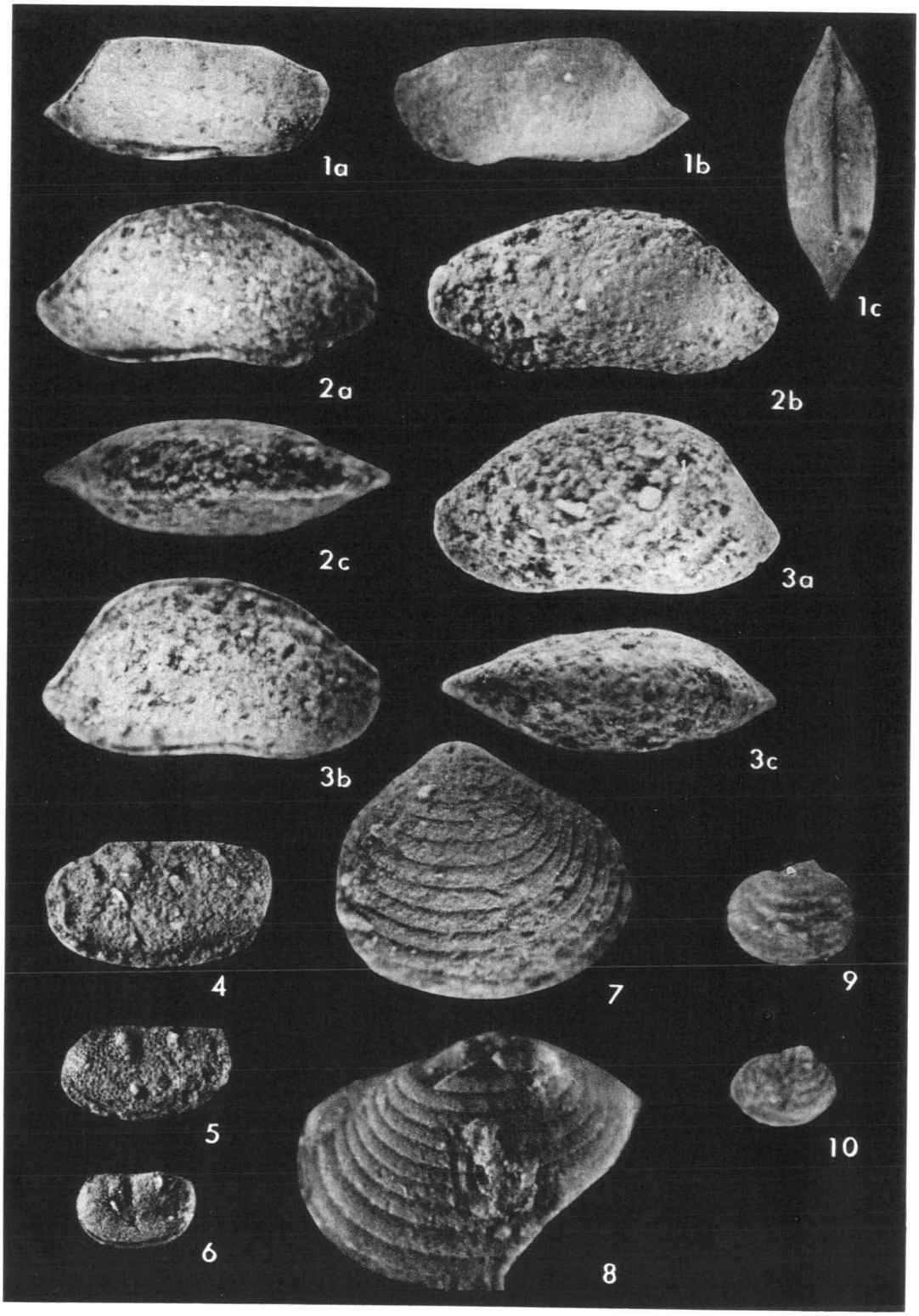
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