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BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

edited by
S.K. Skwarko



DEPARTMENT OF MINERALS AND ENERGY



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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S.K. Skwarko

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Part 1

The Permian System

Introduction

*by S.K. Skwarko**

Outline of the bulletin

There are perhaps a thousand known species of animal and plant fossils recorded from Permian sedimentary rocks in Western Australia in over 800 publications. This work summarizes the knowledge of Permian fossils in this State: what they look like and how they can be distinguished from each other; their geographical distribution and stratigraphic range; and their use in correlating and dating strata, and recreating past sedimentary environments, climates, and geography.

Our knowledge of Permian fossils in Western Australia is incomplete. Since their discovery in 1861, there was only one period, and then only brief, of truly broadly based palaeontological studies: this took place in the years from 1956 to 1965, following the mapping of the Carnarvon and Canning Basins by the Bureau of Mineral Resources. No less than nine monographs, as well as numerous papers, were published, in which many species of ammonoids, bivalves, brachiopods, bryozoans, foraminifers, and gastropods were systematically described or their previous records revised. These studies were by no means exhaustive. Some groups, such as the abundant trace fossils and worm trails, were completely neglected, while few crinoids and ostracods were described. On the other hand, in other groups, such as brachiopods, ammonoids and palynomorphs, active interest has been maintained to this day.

The approach adopted to the study recorded in this bulletin was firstly an exhaustive literature search and compilation of the available pertinent data on all species, subspecies, and named forms. The second stage involved a preliminary revision of the classification of all taxa (except palynomorphs and fish). The third stage was the actual revision of the groups by the relevant experts. The degree to which each group was revised is not consistent, and was dependent on the number of genera and species represented, the degree to which they had been neglected, and the time available to the individual reviewer(s). The fourth and final stage was the compilation of the appendix, tables, and locality maps. The first, second, and fourth stages were completed by Dr S.K. Skwarko.

For the sake of completeness, a number of chapters are included which briefly describe Permian geography, climate, stratigraphic correlation, and previous studies of the Western Australian fossils.

The Permian System

According to geochronological evidence the Permian Period commenced 286 million years ago (Harland et al., 1982), towards the end of a glacial period which started in the Middle Carboniferous, and ended some 40 million years later with one of the world's greatest biological extinctions. Permian rocks, widespread and in places richly fossiliferous, are important commercially because of the rich coal reserves and oil deposits they contain. However, the study of the Permian Period is particularly frustrating because of the difficulty of establishing the relative ages of widely separated rock units and correlating their boundaries on the world-wide scale.

The Permian System, named after the ancient kingdom of Perm east of Moscow, was established by R.I. Murchison (1841b) on the basis of rocks and fossils in the western flank of the Ural Mountains and in the Russian Platform. The system, as originally defined, included strata now grouped in the Kungurian, Kazanian, and Tatarian Stages of the European USSR. In western Europe the system included the lower New Red Sandstone, and the Kupferschiefer and Magnesian Limestone or Zechstein of the British and German sequences.

The base of the original Permian System was subsequently extended downwards on the basis of the contained ammonoids to include the Artinsk Series (Karpinsky, 1889a), whose lower portion became the Sakmarian Horizon (Frederiks, 1917). The latter, together with the *Schwagerina* Horizon, became the Sakmarian Stage (Ruzhensev, 1936); the *Schwagerina* Horizon subsequently became the Asselian Stage (Ruzhensev, 1934). Throughout most of Europe the upper part of the Permian sequence is non-marine, and one has to look elsewhere to establish Late Permian type sections in marine strata. Furthermore, the study of the contained marine fossils has for a long time concentrated on local ammonoids, which are not numerous and fairly restricted in distribution for regional correlation, and fusulinids, which are entirely absent from large parts of Gondwana and the Boreal Realm.

The base of the Permian System in the Ural Mountains and the Russian Platform (and increasingly outside Europe and the Soviet Union) is placed by most

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authorities at the base of the *Schwagerina* Horizon, i.e. at the base of the Asselian — rather than the base of the Orenburgian or Sakmarian — and this is accepted here.

The provinciality of some European faunas is greatly exceeded by the provinciality of the Australian faunas, particularly from eastern Australia. The eastern Australian assemblages have little in common with the classic Northern Hemisphere faunas. This is in contrast with the less endemic and more diverse Western Australian biota which have similarities with those of India, Pakistan, the Himalayas, and Timor, and, hence, are easier to correlate with the classic Ural sequences.

In Australia, the incoming of the *Eurydesma* fauna and the *Glossopteris* flora is traditionally regarded as marking the base of the Permian (Dickins, 1976, p.7), though there appears to be little independent faunal evidence for this. In eastern Australia, Upper Carboniferous strata appear to be missing and the faunas of the Lower Permian impoverished. In Western Australia, the unconformity at the base of the glacial succession has been traditionally regarded by macropalaeontologists as the lowest Permian horizon. These earliest Permian glacial beds contain the first appearance of a distinctive group of fossil pollen called the *Striatites* microflora, which is abundant throughout the world in association with *Glossopteris* and *Gangamopteris* (Balme, 1964a, p.61). However, recent palynological evidence from the Canning Basin suggests, by comparison with North America, that the onset of glacial conditions there may have taken place in the Late Carboniferous. It is unlikely, however, that the warm climate flora of the Northern Hemisphere would have spread to the Gondwana before the end of the glacial conditions (Archbold, 1982).

The Permian Period closed with a world-wide regression, probably accompanied by abnormal salinity levels and widespread deserts. There were numerous extinctions of both marine and land animals, and plants, and there was a severe drop in the rate of diversification of marine plants. The extinction reductions were probably the most severe known (McAlester, 1973, p.11). However, the faunas that did survive seem to have been affected very little by the regression and were quite similar to the Late Permian ones. Because the uppermost Permian rocks are either red beds or missing and the lowermost Triassic shallow-water faunas are rare, the upper boundary of the Permian System is difficult to define. In the Ural Mountains, the Permian–Triassic boundary is in a non-marine, red-bed sequence defined by vertebrate fossils. Elsewhere, in marine sequences, the boundary has been traditionally placed at the base of the Griesbachian, i.e. at the beginning of a world-wide transgression which followed the Late Permian regression. However, some workers have placed the boundary higher, at the top of the lower Griesbachian (Kozur, 1973a,b, 1974) at the base of the Dienerian (Waterhouse, 1973; Newell, 1973), or even up into Smithian (Waterhouse, 1976a, p.174).

In Western Australia the Permian–Triassic boundary falls within an interval of non-deposition or continental rocks, whilst in eastern Australia the passage from Permian into the Triassic is marked by a pronounced tectonic movement with widespread igneous activity. No marine sections are known in Australia which would shed light on the problem of the Permian–Triassic boundary.

Western Australian stratigraphy

In Western Australia, sedimentary rocks of Permian age occur in the Collie, Perth, Carnarvon, Canning, Browse, Bonaparte, Officer, and Eucla Basins (Fig. 1). In most of these basins, sedimentation followed a similar pattern in which widespread accumulation of glacial deposits in Asselian–Sakmarian times was followed by the deposition of shallow-water marine sandstone and limestone alternating with terrestrial or brackish-water deposits. Sedimentation persisted possibly until the end of the Permian in the Perth Basin, into the Chhidruan (Early Tartarian) in the Canning and Bonaparte Basins, and ceased in the Kazanian or even earlier in the other basins.

The evolution of the Permian stratigraphical nomenclature in the Perth, Carnarvon, Canning, and Bonaparte Basins — the major basins containing Permian rocks — is shown in Tables 1–4. The stratigraphy of each basin is summarized in Geological Survey of Western Australia (1975, 1990) and is not repeated here. Comprehensive accounts of the Permian rocks in each basin are given in the following references: Collie Basin — Lord (1952); Perth Basin — Playford et al. (1976); Carnarvon Basin — Hocking et al. (1987); Canning Basin — Towner and Gibson (1983), Yeates et al. (1984); Browse Basin — Willis (1988); Bonaparte Basin — Mory and Beere (1988), Mory (1991); Officer Basin — Jackson and van der Graaff (1981); and Eucla Basin — Lowry (1970). Localities in the northern Perth Basin and the Canning Basin and major localities in the Carnarvon Basin that are referred to in this publication are shown in Figures 2–4*.

Acknowledgements

I thank all the contributors for giving their time, energy, patience, and perseverance in making this volume possible; also the heads of their institutions for recognizing the value of this project. In particular, I thank Neil Archbold for his outstanding generosity.

* Figures 2–4 are on microfiche in a pocket inside the back cover.

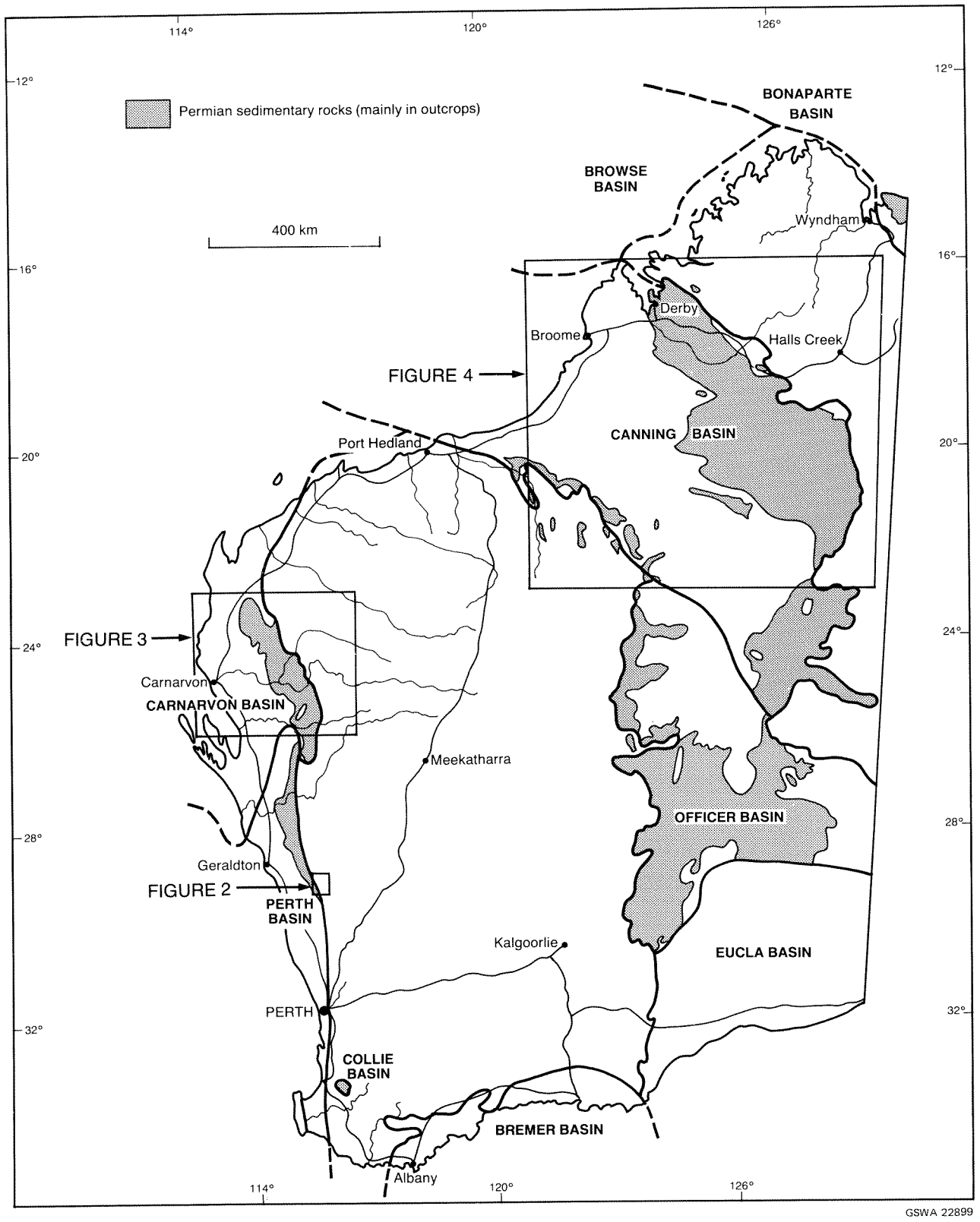

Figure 1. Permian sedimentary rocks in the major sedimentary basins of Western Australia.

Permian geographic and tectonic features — focus on Western Australia

*by P.J. Coleman**

Even those who teach the theory of plate tectonics and the relative movement of continents do not agree on any one map of the Permian world, but most would agree to the existence of Pangaea, a conjugation of supercontinents in the Late Palaeozoic. Pangaea was made up of Gondwana, Laurasia and, very probably, certain east Asian continental masses. Some argue convincingly that Pangaea began its existence in the Devonian (Fig. 5) (Rickard and Belbin, 1980). They show Tethys — the sea between eastern Gondwana (Austro-Gondwana) and the Asian continents — as fairly narrow. Others (Le Pichon and Huchon, 1984) support the Rickard and Belbin reconstruction but point out that the Eurasian part may not have been part of the assembly (Irving, 1983). They stress the relative rotation of continental blocks within Pangaea and show a varying width of Tethys through time. This is a puzzling phenomenon but is supported in reconstructions by authors with very different approaches and methods, e.g. Scotese et al. (1979), Rickard and Belbin (1980) — Devonian only; Morgan (1981), Smith et al. (1981), Le Pichon and Huchon, (1984) — Triassic onwards. The size of Tethys in the Permian has immense relevance to a discussion of the Western Australian Permian faunas. Supporters of the expanding earth hypothesis would argue that Tethys was never a very large ocean (Carey, 1983).



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Figure 5. A version of Rickard and Belbin's (1980) reconstruction of Pangaea as it was in Devonian time, at about 350 million years ago (after Le Pichon and Huchon, 1984, fig. 12). It shows a narrow Tethys, much narrower than it was in the Permian. Africa is assigned its present position, and the pole of projection is at 25°N, 50°E.

Gondwana was made up substantially of the continental masses of South America, Africa, Malagasy, Arabia, parts of Afghanistan, Iran, Turkey, India, parts of Southeast Asia, parts of Indonesia, Australia, Antarctica, Greater New Zealand (including the New Zealand Plateau) (Fig. 6), and the submerged Lord Howe Rise and Norfolk Ridge (Fig. 7). It arose at the end of the Precambrian (Burke and Dewey, 1973) and, as part of Pangaea, was dismembered drastically over a time beginning in the late Early Cretaceous and ending in the Early Tertiary, roughly, 110 to 50 million years ago. In eastern Gondwana (New Guinea area) continental slices were probably rifted off earlier (Audley-Charles, 1983; Pigram and Panggabean, 1984). During its long existence, Gondwana was by no means an enormous expanse of dry land. Of relevance to Permian studies, it was persistently, if intermittently, invaded by marine incursions along the lines of pending dismemberment, or by epeiric or epicratonic seas, or covered by great lake systems.

The Australian scene

In Permian time, the essential Gondwana may have had the configuration shown in Figures 6 and 7. This is a fairly standard reconstruction but is more plausible than others in the area of the southwest Pacific (with special respect to proto-New Guinea and submarine continental masses of the Lord Howe Rise, Norfolk Ridge–New Caledonia, and New Zealand Plateau) (Fig. 7). A debatable item is the placing of the western margin of Western Australia adjoining the northeastern edge of 'Greater India' (Fig. 6), after Veevers et al. (1975) (with supporting references). This placement is preferred because it permits reasonably accurate backtracking of India along the path indicated by the Cretaceous–Tertiary magnetic anomaly patterns (e.g. Johnson et al., 1980; Patriat and Achache, 1984). It should be noted, however, that Hamilton (1979), Sastri et al. (1981), and Archbold (1983a) argue for a more northerly position for India. The Western Australian marginal basins contain faunas and floras, especially the Permian, Triassic and Jurassic ones, which would provide matching tests for possible former neighbours, but so far, convincing species-to-species correlates have not been established, and so the India–Western Australia relationship remains uncertain.

The southern part of the present-day New Guinea and the submerged Queensland Plateau was the active, orogenic, northeastern edge of the Australian craton. There was no Coral Sea. The Lord Howe Rise and the Norfolk Ridge (containing the New Caledonia of the Permian) were also orogenic, either Andean or with a marginal island-arc system (J. Aubouin, pers. comm., *in* Le Pichon and Huchon, 1984). These two merged into Greater New Zealand (New Zealand Plateau, including

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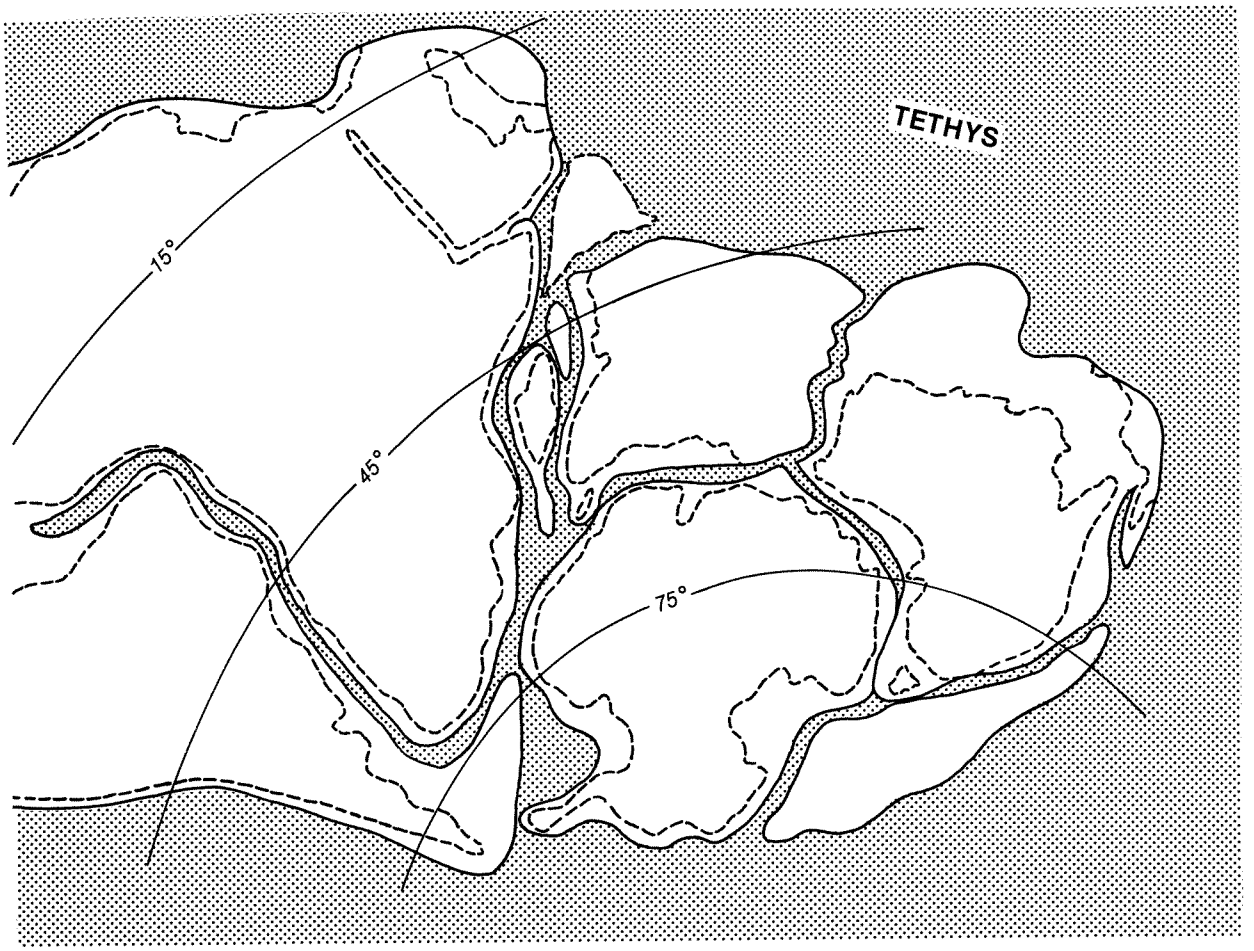

Figure 6. Gondwana as it was in Late Permian time (after Coleman 1980, fig. 1). Eastern Gondwana is made up of Greater India, Antarctica, Australia, and Tasmantis. The lines of pending dismemberment are shown flooded by the surrounding seas. The major marine incursions, such as those that occurred during the Permian in Western and eastern Australia, were much larger than shown here.

the Chatham Rise and the Campbell Plateau). This easternmost part of Gondwana (Lord Howe–Norfolk–New Zealand Plateau) and Australia proper were joined to eastern Antarctica (Fig. 6). There was no Tasman Sea and no New Caledonian Basin.

The lines of future dismemberment were marked by incipient rifts, and the sites of graben were active sediment sinks during the Permian and covered for most of that time by large lake systems. The lakes received glacial sediments, primarily outwash, in the latest Carboniferous to the earliest Permian and were subsequently flooded by several marine incursions. The marine episodes were sporadic but not especially short-lived: some marine formations are hundreds of metres thick. Coal measures occur low down in the sediment pile. There is almost general agreement in placing the Permian south pole within 20 to 25 degrees latitude of southern Australia but this is not supported by the abundant vegetation (the coal seams) nor by the warm- to cool-temperate nature of the faunas. It may have been that climatic belts were not as severely latitudinal as they are today.

Western Australian Permian tectonics

Rift–graben systems similar to those of eastern Australia existed along the western margins of the Australian craton. They were not as expansive as in the east, and glacial sedimentation was much less vigorous and coal measures less developed. They are represented by the major basins — the Perth, Carnarvon, Canning, and Browse Basins. Tectonically, these basins are open at the rifted margins toward the northwest, where their sediment piles give way to younger sea floor. The detached rifted portions will now be found, at least in part, along the east margin of India — following the Hamilton (1979) model — or in the general area northwest of the Bramahputra Bend as mashed-up imbricate slices and/or as underthrust tectonic flakes — following the Veevers et al. (1975) model.

The Western Australian marginal graben system had two preferred elongations, the dominant one trending north-northwest, the other north-northeast (both Yilgarn trends). The eastern margin of this system lay probably along a line marked roughly by the Darling Fault complex

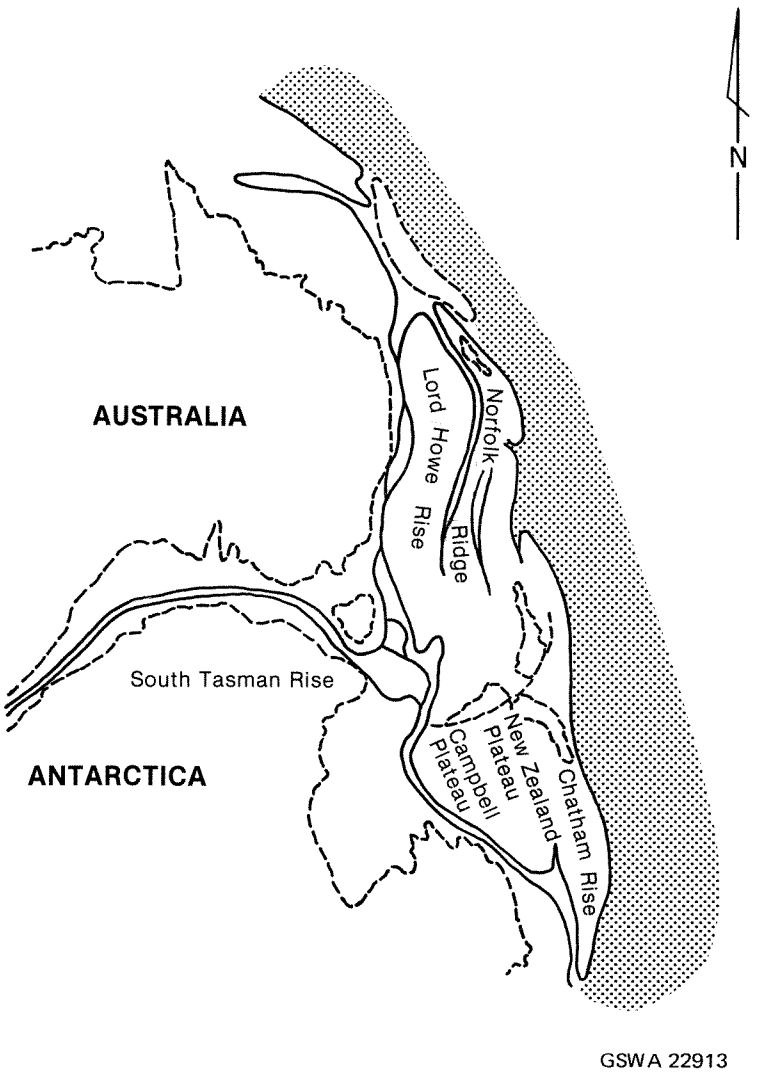

Figure 7. Eastern Gondwana as it was in the Permian (after Coleman 1980, fig. 2). Tasmantis (Lord Howe Rise, Norfolk Ridge, and New Zealand Plateau) was joined to both Australia and Antarctica. This eastern margin was probably orogenic (New Caledonian Orogeny).

and its extension northwards; beyond the southern Carnarvon Basin the eastern margin is obscure. There are also a few intracratonic basins, e.g. the Collie Basin, which is probably a graben.

Northeast of the Exmouth area the north-northeast trend was dominant (Hardabut trend) as far as the Canning Basin which reverted to a dominant north-northwest elongation, exemplified by the Fitzroy Trough. The Canning Basin is both marginal and intracratonic. It penetrates the craton and clearly has structural connection with the much older marginal(?) basin, the Amadeus Basin. This connection is supported by the long sedimentary history of the Canning Basin, which goes back to the Ordovician. The Browse Basin had a similar Permian geography. Both basins lack their northwestern ends, which went off in Jurassic time as part of an unknown slice of continent, its passage marked by the Wharton Basin (Argo Abyssal Plain) magnetic anomalies (Larson, 1975). Timor is probably a remnant of this same rifting event (Audley-Charles et al., 1979; Hamilton, 1979).

The three major basins — Perth, Carnarvon, Canning — fit models of passive margin development, such as those of Falvey (1974), Veevers and Cotterill (1978), and Falvey and Mutter (1981). Even the absence of more than token volcanism can be explained (Veevers and Hansen, 1981). But all three basins have sediment histories ranging from Holocene back past Devonian with rift and pre-spreading features. The sediment piles that mark this Palaeozoic history extend without hiatus or change in sediment style into the Mesozoic–Tertiary sequences, including the post-rift portion. The basins convey a strong sense of stratigraphic continuity and this, in turn, suggests that the siting of at least some rift systems (leading to passive margins) is conditioned by extremely old zones of weakness.

The Permian basins, with their graben and horsts, were not stable, receiving sediment passively until full. Rather, there was vertical jostling between blocks and, as a result, variation occurred in the amount and rates of sedimentation within graben and between graben. The thickness of a particular formation may vary greatly even over small areas within a basin. These movements were co-ordinated early in the Permian, following non-marine (including glacial) sedimentation. A marine incursion occurred, possibly from the north, and reaching as far south as the middle of the Perth Basin. There were several such marine incursions, all of them unified in the sense that all basins, northern, northwestern and western, register them at the same time, illustrated, for example, by the contemporaneous Fossil Cliff (Perth Basin), Callytharra (Carnarvon Basin) and Nura Nura (Canning Basin) faunas of the Early Permian.

This Permian situation endured for nearly forty million years, and seems to have passed without drama into Triassic time, with only minor passage beds marking the transition.

Palaeoclimate

by J.M. Dickins[*]

Some striking features of the Permian have directed attention to the climate of that time. Perhaps the evidence of widespread glaciation (Dickins, 1985a) is the outstanding feature; although indeed in Europe the widespread desert sandstones, evaporites, and other evidence of warm and sometimes arid conditions in latitudes where these do not occur today has aroused curiosity since the birth of the science of geology. In recent years much work has been directed to the late Palaeozoic glaciation which is so prominent in the lower part of the Permian. Descriptions are available in Hambrey and Harland (1981) and a review of the glaciation in Dickins (1985a).

Overall world analysis of Permian climate still remains at an early stage. I have attempted an analysis of the climate of Australia, Gondwana, and the world (Dickins, 1977, 1978, 1985b) and applied the climatic conclusions to understanding the large-scale extinction at the Permian–Triassic boundary and faunal evolution in the late Palaeozoic. Profound world-wide changes in climate are apparent through the Carboniferous and Permian and into the Triassic (Dickins, 1985b). Smaller scale fluctuations can also be discerned but they are still to be studied in detail.

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** Sakmarian as used in earlier papers such as Dickins (1978) is subdivided into Asselian and Sakmarian following current Soviet and world practice. The Asselian is equivalent to the lower part of the Sakmarian as previously used. In the Sakmarian, in the restricted sense, two subdivisions are recognized — the Tastubian and Sterlitamakian.

Criteria for understanding climate are discussed by Dickins (1978, 1985b). For the Permian the evidence available is largely based on the invertebrate faunas and supplemented with physical data from the rocks such as the evidence of glaciation.

Asselian and Sakmarian**

(Stages A and B of Dickins, 1963)

Evidence for glaciation is confined to pre-Tastubian (Asselian) rocks. Glacial features and, in particular terrestrial, moraine are found in the Nangetty Formation of the Perth Basin, the Lyons Group of the Carnarvon Basin, and the Grant Group and Paterson Formation of the Canning Basin (Table 5) (Playford et al., 1975). Evidence for glaciation in the Bonaparte Basin is less clear (Dickins, 1981).

Overlying the well-authenticated glacial deposits is a marine invertebrate fauna in the Holmwood Shale of the Perth Basin, the Carrandibby Formation and the upper part of the Lyons Group of the Carnarvon Basin, and the Wye Worry Member of the Grant Group of the Canning Basin. This fauna is considered to be of Tastubian (Early Sakmarian) age (Archbold et al., this publication) and is regarded as a cold-water fauna on the basis of its close association with glacials and its low diversity (Dickins, 1957a, 1978). I have regarded this fauna as associated with an eustatic post-glacial rise in sea level (Dickins, 1978, 1985a).

Subsequently, no further definite evidence of glaciation is found during the Permian either in Australia or elsewhere (Dickins, 1985a), although cool conditions, probably with seasonal ice, persisted in some areas.

The best evidence for the age of the glaciation in Western Australia (and Australia) is to be found in the Lyons Group where a number of levels of sediment with moraine are interspersed with levels without moraine which contain marine fauna. Marine fossils also occur below the lowermost moraine; some moraine contains marine fossils. This fauna is basically similar throughout (Dickins and Thomas, 1959) and appears to be of Asselian age (Archbold, 1982; Archbold et al., this publication). From sequences in the Cranky Corner and Tasmania Basins (McClung et al., 1972; Calver et al., 1984), the correlates of the Lyons Group below the Carrandibby Formation appear to occur with palynological Stage 2 which is regarded by Kemp et al. (1977) and Balme (1980) as pre-Permian. The palynological evidence for this is unsatisfactory because it is based on the incoming of broad taxonomic groups and lacks stratigraphic precision. It also does not take into account the climatic effect and is contradictory to the invertebrate faunas (Archbold, 1982; Archbold et al., this publication). The conclusion of Kemp et al. and Balme would require a hiatus between the Holmwood Shale and the Nangetty Formation or hiatus within the Holmwood Shale and also similarly between the Carrandibby Formation and the Lyons Group as these

upper units are Tastubian in age and would overlie pre-Permian. There is no evidence of such a hiatus.

Characteristic members of the cold-water fauna are the bivalves *Eurydesma* and *Deltopecten*, the gastropod *Keeneia*, and the brachiopods *Lyonia* and *Brachythyrinella occidentalis*; common also are species of *Myonia*, *Megadesmus* and *Ambikella* (= *Tomiopsis*).

In the Fossil Cliff Member of the Holmwood Shale (Perth Basin), the Callytharra Formation (Carnarvon Basin), and the Nura Nura Member of the Poole Sandstone (Canning Basin), a much more diverse fauna is represented. This fauna is regarded as of Sterlitamakian (Late Sakmarian) age. It is marked by the appearance of many genera of brachiopods not represented below and a much greater diversity of bryozoans, blastoids, and crinoids. A cold-temperate water temperature is, however, suggested by the persistence of a number of forms from below, including *Deltopecten* and *Lyonia*, and the species *Phestia lyonsensis*, *Phestia darwini*, and *Chaenomya? nuraensis*. Some forms, such as *Edmondia*, may suggest warmer conditions (Dickins and Morris, in press), and only a detailed study of the distribution would show whether fluctuations in climate were present. For the Nura Nura Member the apparent absence of *Deltopecten*, a known cold-water form, and the presence of *Straparolus* from my observations on Carboniferous and Timor Permian faunas may suggest warmer water than for the Fossil Cliff Member and Callytharra Formation which occur to the south.

Artinskian and Kungurian

(Stages C and D of Dickins, 1963)

Faunas of Aktastinian (Early Artinskian) age, Stage C, are found only in the High Cliff Sandstone of the Perth Basin and the Cordalia Sandstone, the 'One Gum Formation' (now Moogooloo Sandstone), and, perhaps, the Jimba Jimba Calcarenite Member of the Billidee Formation of the Carnarvon Basin. Many forms, including *Deltopecten*, continue from Stage B (Dickins, 1963; Mercer, 1967). On this basis a similar cold-temperate water temperature might be expected.

A Baigendzhinian (Late Artinskian) age is indicated by the faunas of the Mingenew and Carynginia Formations of the Perth Basin, the Byro Group of the Carnarvon Basin (except for the Baker Formation and possibly the uppermost part of the Nalbia Sandstone), and the Noonkanbah Formation of the Canning Basin. Absent from this part of the sequence are any of the indicators of cold water. On the other hand, indicators of the sub-tropical and tropical Tethyan regions also seem to be absent. Such indicators are colonial corals, algae with a relatively complex morphology, and brachiopods such as the richthofeniids. Also absent are fusulinids and conodonts with the exception of a very limited conodont fauna from the Canning Basin (Nicoll, 1984). Even allowing for widespread clastic sedimentation, the diversity in the brachiopods, the blastoids, and the crinoids is relatively low. The Wandagee Formation and the upper part of the Noonkanbah Formation have, however, a greater diversity than the other formations; whereas the weight of evidence is that overall the water temperature was temperate, the Wandagee Formation was probably laid down in warm-temperate water and the upper part of the Noonkanbah Formation may have even been deposited in sub-tropical water.

No definite Kungurian sedimentary rocks are known from the Perth Basin, but this stage of the Permian is represented in the Carnarvon Basin by, possibly, the uppermost part of the Nalbia Sandstone, the Baker Formation of the Byro Group, and the Coolkilya Sandstone of the Kennedy Group. In the Canning Basin this stage is represented by the Lightjack Formation of the Liveringa Group, and in the Bonaparte Basin by the 'Lower Marine Beds' ('beds at Fossil Head'). No change of climate from that of the underlying part of the sequence is apparent; whether the occurrence of the chamositic oolites in the Lightjack Formation reflects some climatic effect it is not known.

Late Permian

(Stages E and F of Dickins, 1963)

Stage E is best seen in the Canning Basin where it comprises non-marine beds between the marine lower part (Lightjack Formation) and the marine upper part (Hardman Formation) of the Liveringa Group. This stage includes the Condren Sandstone of the Canning Basin; in the Carnarvon Basin, the Binthalya Formation at the top of the Kennedy Group probably belongs here. In the Bonaparte Basin the non-marine beds appear equivalent to the middle part of the Liveringa Group. At present there is little evidence on temperature. The poor occurrence of coal in these beds in the Canning Basin, in contrast to the position in eastern Australia, might suggest an arid climate. Indeed the poor development of coal throughout the Permian sequence in Western Australia might suggest that, in general, the climate was more arid than in eastern Australia.

Stage F is represented by the Hardman Formation of the Canning Basin and the equivalent, upper marine beds of the Bonaparte Basin. The feature of the marine faunas from these beds is their cosmopolitan nature and their close relationships with the Tethyan regions. Many species occur as far away as western Europe, and even Spitzbergen and Greenland, and throughout the intermediate Tethyan Region. This feature has been referred to in many publications, the most recent being Dickins and Shah (1987), and is referred to in other sections in this bulletin.

The cosmopolitan nature of these faunas has been taken to indicate global warming during the Permian (Dickins, 1977, 1983a, 1984, 1985a,b; Kapoor and Tokuoka, 1985; Nakazawa, 1985). Definite sub-tropical or tropical water temperatures are indicated for the Bonaparte Basin by the occurrence of the brachiopod *Leptodus*; the number of species the Hardman Formation

has in common with the sequence in the Bonaparte Basin, as well as Timor, the Salt Range (Pakistan) and other Tethyan warm-water localities, strongly suggests similar water temperatures. The presence of chamositic oolites in the Hardman Formation and the Lightjack Formation may also represent a climatic effect.

In summary, it would seem that in Western Australia during Permian times the initial cold conditions of Asselian and Early Sakmarian became progressively warmer, to cold temperate in the Late Sakmarian and Early Artinskian, to warm temperate in the Late Artinskian to Kazanian, and culminated in tropical or subtropical climate during the Chhidruan.

Correlation and age of Western Australian Permian strata — a review

by S.K. Skwarko[*]

The correlation of the Western Australian Permian biostratigraphic units throughout the State as well as with the rest of Australia and overseas, also referral to the world stages and substages, is summarized in Table 5. This scheme reflects a number of conclusions reached in the course of the current project mainly by Archbold, Dickins and Thomas (this bulletin, Table 6) through the study of bivalves, brachiopods and gastropods, but also by Balme and Backhouse (this bulletin, Table 8; Balme, 1980) through the palynomorphs and by Glenister, Rogers and Skwarko (this bulletin, Table 7) through the ammonoids.

A two-fold subdivision of the Permian System is adopted (Table 5); the boundary between the Lower and the Upper Permian is placed at the top of the Kungurian.

The names of the world stages and substages adopted (Table 5, column 1) are those selected by Archbold et al. (this bulletin) as those arguably most appropriate for Australian conditions. The lowest stage, the Asselian, is followed by the Sakmarian with the distinctive Tastubian and Sterlitamakian ammonoid faunas (Glenister and Rogers, this bulletin). Then Artinskian follows with the lower Aktastinian and the upper, restricted, Baigendzhinian substages — the latter well represented among the Western Australian faunas. The next stage is the Kungurian with distinct Filippovian and Irenian ammonoid faunas. The Kungurian is followed by the Ufimian, a stage difficult to recognize because of the essentially non-marine nature of the type sequence in the Soviet Union (Archbold et al., this bulletin). The Ufimian and the following Kazanian (i.e. Wordian and Capitanian Stages, and the Guadalupian Series) are represented in Western Australia by a non-marine sedimentary episode. Next are the three marine equivalents of the Russian non-marine Tatarian — Chhidruan, Dzhulfian and Dorashamian, of which only the Chhidruan (i.e. Punjabian of Stepanov, 1973) is represented in Western Australia and this strata is readily correlated with the Chhidru Formation of the Salt Range (Pakistan). The Chhidruan includes faunas of the Kalabagh Member of the Wargal Formation (Pakistan) and the fauna of the upper Chhidru Formation.

The base of the Permian System is here regarded as the base of the Asselian Stage, but it is stressed that Balme and Backhouse (this bulletin) follow Balme (1980) and place the boundary higher, at the base of the Unit III (Table 5, column 6) and immediately above the uppermost glacial beds, a horizon marked by a great diversification of gymnosperm pollen. This horizon is equated by Kemp et al. (1977), Balme (1980), and Balme and Backhouse (this bulletin) with a similar diversification in the Northern Hemisphere close to the Carboniferous–Permian boundary (but see Dickins, this bulletin).

The subdivision of the Western Australian Permian marine strata into Australian Stages (Table 5, column 2) on the basis of the contained bivalve–brachiopod–gastropod faunas, rather than on a single fossil group or individual genus and species, is one evolved originally by Thomas and Dickins (1954), but principally by Dickins (1963). This faunal scheme, later corroborated by Archbold's and Thomas's further studies of associated brachiopods, provides one of the surest criteria for correlations with the Asian and generally Gondwanan faunal horizons, including those of eastern Australia. On the other hand the ammonoids, though fairly rare, have been the traditional media which provide the key correlation horizons with the Soviet and other Northern Hemisphere stratotypes (Glenister and Furnish, 1961). With the detailed description of the remaining hitherto undescribed local faunas, the Australian Stages scheme is expected to be further consolidated, and ultimately formalized.

The subdivision of the predominantly non-marine Permian strata of Western Australia on the basis of the contained palynomorphs was established by Kemp et al. (1977), who distinguish eight unnamed units which are followed by *Protohaploxypinus microcorpus* Zone (Table 5, column 6). The boundaries of some of these units correspond to the boundaries of the marine stages, and also to some of the world stages, but correlation with the eastern Australian biostratigraphic units as proposed by Price (1976, 1985) is not overly confident (see Table 5, column 8).

The upper Permian boundary is placed by Balme and Backhouse (this bulletin) at the base of *Kraeuselisporites saeptatus* Zone of Dolby and Balme (1976), in which marine sediments mark the first appearance of floods of spinose acritarchs at a horizon that is probably a little higher than the base of the Griesbachian.

The Collie Basin column (Table 5, column 3) is represented by a palynomorph-bearing section that was

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subdivided by Glikson (1972) into four units of local application only (Table 8), and correlated with the Perth Basin by Balme and Backhouse (this bulletin).

Segroves (1972) recognized five palynomorph assemblages in the Perth Basin (Table 5, column 4). The lowest assemblage, that of *Microbaculispora*, is regarded by Balme and Backhouse (this bulletin) as pre-Permian. Above the level of the *Dulhuntyispora* Assemblage the strata of the Sue Coal Measures probably belongs to *Protohaploxypinus microcorpus* Zone (Truswell, 1980, p.98; earlier defined in the Canning Basin by Kemp et al., 1977).

Part or all of the Nangetty Formation, the lower part of the Lyons Group, and the middle Grant Group are regarded as Asselian (lower part of the Australian Stage A) mainly because of the unequivocal Tastubian age of the overlying beds, and because of the apparently uninterrupted sequence of Permian-like marine macrofossils which continue throughout the Lyons Group upwards into the Tastubian sedimentary rocks. Stage A is correlated with the Lochinvar and Allandale Formations in eastern Australia, and with many important faunas in the Northern Hemisphere (Archbold et al., this bulletin). The Holmwood Shale contains ammonoids in the Beckett Member which, together with the Woolaga Limestone Member, date as Early Sakmarian (Tastubian). The fauna of the lower part of the Holmwood Shale is correlated with those of the Carrandibby Formation in the Carnarvon Basin and the Wye Worry Member of the upper Grant Group in the Canning Basin. This fauna is correlated with the Allandale and Lochinvar Formation in eastern Australia, and with the Tastubian faunas in India, Pakistan, Afghanistan and Tibet (Archbold et al., this bulletin). The ammonoids in the Fossil Cliff Member date it as Late Sakmarian (Sterlitamakian) or upper Tastubian (Glenister et al., this bulletin), and in the Callytharra Formation and the Nura Nura Member of the Poole Sandstone as Sterlitamakian. The particularly distinctive associated faunas of molluscs and brachiopods in these units (Stage B) also provide good correlation between them and with the Arabian Peninsula, peninsular India, and Kashmir (Archbold et al., this bulletin), while the ammonoids allow correlation of Stage B with the Ural International Scale as well as with southern Asia and with many overseas faunas. However, correlations with faunas from eastern Australia are less certain (Archbold et al., this bulletin).

The distinctive marine faunas of the High Cliff Sandstone, the base of the Cordalia Sandstone and the 'One Gum Formation'(now Moogooloo Sandstone), and possibly the Jimba Jimba Calcarenite Member of the Billidee Formation, are placed by Archbold et al. (this bulletin) in the Stage C. Stage C also includes the rest of Wooramel Group of the Carnarvon Basin and the Poole Sandstone (minus the Nura Nura Member) of the Canning Basin. The age of the Wooramel Group, and thereby of Stage C, is regarded as Aktastinian rather than Baigendzhinian based on relationships and similarities of bivalves, brachipods and gastropods above and below (Archbold et al., this bulletin) — but not according to the contained ammonoids, interpretation of which seem to favour a later, Baigendzhinian, age (Glenister et al., this bulletin). Stage C is correlated in eastern Australia with Fauna II in the Bowen Basin, Farley Formation in the Sydney Basin, and Faunizone 5 in Tasmania (Archbold et al., this bulletin).

The Wagina Sandstone appears to be not older than Kungurian (Balme, 1964b; Balme and Backhouse, this bulletin).

In the Carnarvon Basin the whole of the Byro Group is placed in Stage D (Baigendzhinian, Kungurian). The Coyrie Formation at the base of the group marks the probable lower boundary of the Baigendzhinian on the presence of *Neocrimites* sp. similar to *N. fredericksi* in the Baigendzhinian of southern Urals. The ammonoid *Paragastrioceras wandageense* in the Baker Formation marks the top of D_1. Stage D_1 is correlated with the Gebbie Subgroup of the Bowen Basin, Faunas IIIA and IIIB of Dickins (1970), lower Branxton Formation of the Sydney Basin, and Faunizones 6 and 7 of Tasmania. The brachipods of the Wandagee Formation are similar to those of the Amb Formation of the Salt Range (Pakistan), and indicate a Late Artinskian age of the Wandagee assemblages. The position of the Baigendzhinian–Kungurian boundary is placed by Archbold et al. (this bulletin) at the base of the Nalbia Sandstone on the basis of the brachiopod *Svalbardia* taken to be indicative of the earliest Kungurian — this is higher than interpreted through ammonoids (Glenister et al., this bulletin).

The Kungurian faunas of the Baker Formation and the Coolkilya Sandstone are placed in D_2, and are correlated by molluscs and brachiopods with the marine part of the Lightjack Formation and possibly the Triwhite Sandstone in the Canning Basin and the 'Lower Marine Beds' as beds at Fossil Head (Northern Territory) of the Bonaparte Basin. These are correlated with the Catherine Sandstone of the Bowen Basin, the upper part of Fauna III of Dickins (1969) and Faunizones 8 and ?9 in Tasmania, but there is no clear correlation with the Salt Range sequence.

The palynostratigraphic subdivisions of the Canning Basin microfloras are those of Powis (1979) for the lower part of the section, and of Kemp et al. (1977) for the whole column. The latter shows some affinities with the equivalent scheme used in eastern Australia (Table 5, column 5), and some of its boundaries correspond to those of the international stage boundaries, as well as those of the Australian letter stages.

In the southern part of the Canning Basin, the Paterson Formation is mainly a glacial equivalent of all or part of the Grant Group. The Triwhite Sandstone, also in the south, has a marine fauna which could be late Baigendzhinian or early Kungurian in age.

The top, non-marine, beds of the Carnarvon Basin (Table 5, column 5), as well as the equivalent non-marine Condren Sandstone in the Canning Basin and the 'Middle Non-marine Beds' of the Hyland Bay Formation in the Bonaparte Basin, have all been placed in Stage E which, apart from its lower part, is regarded as Kazanian in age

as the overlying beds are already Chhidruan. These units have correlated with the eastern Australian Fauna IV of Dickins (1964a) (Archbold et al., this bulletin).

The fauna of the Hardman Formation and its lateral equivalent in the Bonaparte Basin, the 'Upper Marine Beds', make up the Stage F which, mainly on the basis of the marine macrofossils in the Cherrabun Member, is correlated among others with those of the Kalabagh Member of the Wargal Formation and the Chhidru Formation of the Salt Range, Pakistan, and also those of the Basleo and Amarassi Beds of Timor (Archbold et al., this bulletin). The latter supported by the contained ammonoid (Glenister et al., this bulletin).

In the southern part of the Canning Basin, the Godfrey beds and the Chirup Formation may or may not be the lateral equivalents of the Hardman Formation. Though shallow marine in origin they contain macrofloras and microfloras which do not give a definite correlation and dating.

Correlation and age of Permian marine faunas in Western Australia

by N. W. Archbold [*], *J. M. Dickins* [**], *and G. A. Thomas* [***]

The biostratigraphy of the Western Australian Permian marine succession has traditionally relied on ammonoids to provide key datum levels and correlations with the Soviet stratotypes of the Permian System and other important, overseas stratigraphical sections (Glenister and Furnish, 1961). Correlations with eastern Australia, other Gondwanan regions, and Asia have relied more on the use of such groups as the brachiopods, bivalves, and gastropods (Thomas and Dickins, 1954; Dickins, 1963; Archbold and Dickins, 1991).

For this review, the above groups are again used to summarize the biostratigraphy and correlations of the Western Australian Permian succession because, collectively, they provide the most reliable data at present available. Other groups of marine fossils may also be potentially useful for correlations (e.g. bryozoans), but are frequently rare (e.g. trilobites), or poorly documented (e.g. crinoids) for Western Australia or elsewhere.

This summary of the correlation and age of the faunas is based on the joint efforts of the three authors: Thomas and Archbold investigated the brachiopods, while Dickins studied the bivalves and gastropods; Dickins and Thomas have also extensively studied the field relationships of the stratigraphical units.

For this review we utilize the broad zonal scheme of 'stages' defined by Dickins (1963). We note that these 'stages' in some cases correspond to a single assemblage zone (e.g. Stage B), and, in other cases, they correspond to an evolving group of assemblage zones linked by intermediate faunas (e.g. Stage D, which has three clear assemblages — Coyrie, Wandagee, and Coolkilya — with linking faunas in the Bulgadoo–Cundlego and Nalbia–Baker levels). Although many of the Western Australia faunas are now well known, we postpone proposing a new zonal scheme until further brachiopods, bivalves, and gastropods are described.

Stratigraphy

The Permian stratigraphy of the Perth, Carnarvon, and Canning Basins that we utilize is outlined in Table 5. For the Bonaparte Basin (partly in Western Australia, partly in the Northern Territory) we generally use the informal stratigraphical terminology of Thomas (1957) and Dickins et al. (1972). A number of stratigraphical names have been applied to the Permian sequence of the Bonaparte Basin, some for onshore sequences, and some for subsurface or offshore sections. All these Permian units are included by us in the Port Keats Group, although we note that this name may lapse in the future (Dr A. Mory, pers. comm., 1985). We thank Dr A. Mory (Geological Survey of W.A.) for rationalizing offshore and subsurface stratigraphical units with our onshore units (Table 6).

The Early Permian 'Kulshill Formation' (Caye, 1968; Hughes, 1978), based on the subsurface section in Kulshill 1, is in part equivalent to the onshore outcrops of the 'Keep Inlet Beds' of tillitic sedimentary rocks (Veevers and Roberts, 1968). The Sugarloaf Formation (Guillaume, 1966) was introduced as a general term for outcrops in the Port Keats area. Subsurface occurrences of the formation include marine intervals (Dickins et al., 1972). The Fossil Head Formation (Caye, 1968; Laws and Brown, 1976), of Early Permian age but with no defined stratotype, probably does not include the marine beds that outcrop at Fossil Head (our 'Lower Marine Beds') of Kungurian age, a stratigraphical section of which has been available since early this century (Basedow, 1916). The Hyland Bay Formation (Laws and Brown, 1976; Hughes, 1978) of Late Permian age, based on a subsurface offshore section, probably is partly equivalent to our 'Lower Marine Beds', 'Middle Non-marine Beds', and 'Upper Marine Beds'.

Use of the above names that are based on offshore and subsurface sections for the outcrop sections is only tentative because palaeontological relationships between the sections are either poorly known or unknown. Furthermore we note that Hughes (1978) does not discuss either the 'Sugarloaf Formation' or the Fossil Head Formation or their relationships to the other named units.

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No reliable marine macrofossil data is available from any of the subsurface sections and correlations can only be made indirectly to the marine outcrops by means of palynological data (via other basins) and lithological relationships.

A Permian time scale

Since the recognition of the Permian System by Murchison (1841a), the scope and subdivision of the Permian have changed substantially. Despite the facts that the Carboniferous–Permian boundary, the Permian–Triassic boundary, and even the subdivisions of the Permian are not established as a world standard, considerable consensus has been reached on the first two problems and on several of the stages within the Permian Period. In this paper we provide a brief outline the scheme that we believe is most appropriate to the Western Australian Permian at present. We follow Soviet opinion and, hence, we utilize a two-fold subdivision of the Permian System into: the Lower Permian (Asselian, Sakmarian, Artinskian, and Kungurian), based on sequences and faunas in the Urals and Russian Platform; and the Upper Permian (Kazanian and Tatarian with the marine stages of Chhidruan, Dzhulfian, and Dorashamian), based on sequences and faunas of the Russian Platform, Salt Range (Pakistan), and the Trans-Caucasus.

The base of the Asselian is accepted by us as the base of the Permian, following Soviet (e.g. Stepanov, 1983; Kotlyar and Stepanov, 1984) and other opinions (Glenister et al., this bulletin; Archbold, 1982, 1984c). Above the Asselian is the Sakmarian Stage (which includes the Tastubian and Sterlitamakian Substages), widely recognized because of the distinctive constituent ammonoid faunas (Glenister et al., this bulletin). The Artinskian Stage, above the Sakmarian, is used by us in the sense of Bogoslovskiy and Ruzhentsev (1972) to include the lower Aktastinian Substage and the upper Baigendzhinian Substage. The Baigendzhinian Substage is widely represented and readily identified in Western Australian faunas as discussed later. Opinions on the upper boundary of the Artinskian Stage (Baigendzhinian Substage) have differed. Ruzhentsev (1956), Glenister and Furnish (1961), and Glenister et al. (this bulletin) concluded that the ammonoids of the Kungurian Stage above the Artinskian Stage are so similar to those of the Artinskian that the Kungurian should be considered as the upper part of the Baigendzhinian. However, Bogoslovskaya (1976) redescribed the Kungurian ammonoids and demonstrated their distinctiveness. Subsequently, Chuvashov and Bogoslovskaya (1981) have shown that the Kungurian ammonoids fall into two distinct zones above the Artinskian. As a result we use the Baigendzhinian in a restricted sense, excluding the Kungurian as have other workers (e.g. Grant, 1976), and, hence, our usage is consistent with modern Soviet usage (Kotlyar and Stepanov, 1984; Stepanov, 1984). Nevertheless some confusion does still appear to exist as to the ranges of Late Artinskian ammonoids. For example, *Uraloceras fedorowi* is shown by Chuvashov and Bogoslovskaya (1981) to be characteristic of the latest Artinskian, but Gus'kov et al. (1980) show *U. fedorowi* occurring above Kungurian strata in the Pai-Khoy region of northern USSR.

The Kungurian Stage, as developed in the type region of the Russian Platform, has yielded faunas with distinctive ammonoids (Bogoslovskaya, 1976), fusulinids (Zolotova and Baryshnikov, 1978), diverse other foraminifers (Zolotova and Baryshnikov, 1980), and distinctive brachiopods (Kulikov, 1974). The ammonoids show links with Western Australia as discussed below. As a result, we utilize the name Kungurian as in the recent Soviet sense (Kotlyar and Stepanov, 1984) because the Ufimian of recent Soviet usage appears to be correlative with the upper part of the Roadian of ammonoid specialists (see Stepanov, 1984).

The Ufimian stage, originally proposed and elaborated on by Nechaev (1915, 1921), was re-established by Likharev (1966). As originally defined, the stage included Kazanian-type brachiopod faunas near the top with such species as *Oriocrassatella plana, Licharewia rugulata*, and *Globiella hemisphaerium* (Nechaev, 1921, p.32). This assemblage from the Kama Beds (west of the central Urals) was included by Frederiks (1925, 1928) in the Kazanian, and marks the incoming of the distinctive Kazanian *Globiella–Licharewia* dominated brachiopod assemblages with advanced *Oriocrassatella*. The Ufimian type sequence, as currently understood, includes two horizons, the lower Solikamsk and the upper Sheminsk (Likharev, 1966; Kotlyar and Stepanov, 1984). The Solikamsk Horizon has an ostracod fauna which is related to that from the Kungurian (Gorsky and Guseva, 1973). A small marine fauna from the fourth subdivision (second from the top) of the Solikamsk Horizon includes *Cancrinella koninckiana*, *Cancrinella cancrini*, *Phricodothyris asiatica*, *Cleiothyridina pectinifera*, and *Schizodus rossicus* (Likharev, 1966, p.74). This undescribed assemblage indicates continuing links with Kungurian assemblages as described by Kulikov (1974) who recorded from the Kungurian both species of *Cancrinella*, a small elythid (as *Torynifer borealis*), and a small non-sulcate athyrid (as *Cleiothyridina royssiana*). Kotlyar and Stepanov (1984, p.61) recorded one *Cancrinella* as *C. cancriniformis* (an Early Permian form), *Phricodothyris rostrata*, the Kazanian *Lingula orientalis*, and a few foraminifers and ostracods. Notably absent from the Solikamsk fauna are true Pinegathyris (distinctly transverse and sulcate athyrids), *Globiella*, and *Licharewia*.

The overall Kungurian affinity of the Solikamsk Horizon has been argued for by such authors as Frederiks (1931, 1934), Gerasimov and Tikhvinskaya (1934), and Gorsky and Guseva (1973). In contrast, Kanev (1983) has argued that non-marine bivalves from the upper three subdivisions of the horizon are distinctive in terms of the evolution of such assemblages.

Also included in the type Ufimian is the Sheminsk Horizon which lacks any known marine fossils but contains the distinctive ostracod assemblage of the *Darwinula angusta* Zone, a species which first appears at the top of the Solikamsk Horizon (Kotlyar and Stepanov, 1984, p.61).

Boreal brachiopod assemblages, such as those from the Kanin Peninsula of European USSR, assigned to the Ufimian, include such genera as *Svalbardia, Muirwoodia, Cancrinella*, the first *Licharewia* and *Kaninospirifer*, but appear to lack *Craspedalosia*, large *Pinegathyris* of the *royssiana* type, and the dominance of *Licharewia* of the *rugulata* group, and *Permospirifer* (Molin et al., 1983). The meagre evidence from the marine fauna of the Solikamsk Horizon may indicate that these Boreal faunas are correlative with the Sheminsk Horizon (i.e. Upper Ufimian).

The long established Kazanian stage, characterized by faunas of distinctive bivalves and brachiopods, appears to be represented in Western Australia by non-marine intervals of sedimentation. The Kazanian appears to be regarded as the equivalent of the Wordian and Capitanian Stages and the Guadalupian Series by ammonoid specialists (Glenister et al., this bulletin). The Guadalupian Series is regarded by ammonoid workers (Glenister et al., this bulletin) as being younger than Roadian but older than Dzhulfian.

We use the Tatarian Stage, based on non-marine strata of the Russian Platform, in deference to history (see also Kotlyar and Stepanov, 1984). Nevertheless for purposes of precise stratigraphical correlations it is used in combination with the three marine stage equivalents of Chhidruan (as used herein), Dzhulfian, and Dorashamian (= Changhsingian of south China, where the Permo-Triassic sequence appears to be more complete than in the Trans-Caucasus). Only the Chhidruan is represented in Western Australia where faunas are readily correlated with faunas of the Chhidru Formation of the Salt Range (Pakistan), and the Himalayas.

Our Chhidruan equals the Punjabian of Stepanov (1973) and Waterhouse (1976). Use of Punjabian is avoided because of an earlier application of the same name for Permian faunas of various ages. Lapparent (1892)'and Munier-Chalmas and Lapparent (1893) used Punjabian for faunas of the Wargal Formation (Salt Range), while Noetling (1901), Schuchert (1928, 1935) and Reed (1936, 1939) used the same term for faunas from the Early Permian sequence beneath the Amb Formation (Salt Range). The Chhidruan, as used herein, includes the faunas of the Kalabagh Member of the Wargal Formation (which appear to overlap with the Kazanian below — Nakazawa, 1978) and of the entire Chhidru Formation.

Faunas high in the Chhidru Formation from the white sandstone unit (Landa Sandstone Member of Waterhouse and Gupta, 1983, p.219) contain no faunal elements 'to indicate an age significantly younger than that of the lower beds of the Chhidru Formation' (Grant, 1970, p.120), although Waterhouse and Gupta (1983, p.221) favoured a Dzhulfian age for the Landa Sandstone brachiopods. Use of the name Chhidruan itself is not satisfactory because, in addition to faunas of the Chhidru Formation being included within it, the term includes the fauna of the Kalabagh Member of the Wargal Formation below the Chiddru Formation. Hence, we use Chhidruan as a temporary expedient. There is considerable agreement that the ammonoid *Cyclolobus* is restricted to pre-Dzhulfian strata (Zhao, 1980; Zakharov, 1983; Gramm and Rostovtsev, 1984; Glenister et al., this bulletin), provided the *Araxilevis–Codonofusiella* beds are excluded from the base of the Dzhulfian (Zakharov, pers. comm., 1986). However, Kotlyar and Stepanov (1984, p.250, 257) record *Cyclolobus* from the Dzhulfian (apparently referring *Godthaabites ruzhencevi* to the genus *Cyclolobus*), and Waterhouse and Gupta (1986) argue that *Cyclolobus* ranges into the Dzhulfian. Nevertheless, the Western Australian *Cyclolobus* is primitive (Glenister et al., this bulletin) indicating a Chhidruan age.

At present, therefore, the basis for the use of Chhidruan for Western Australian faunas is the ready correlation of brachiopods, bivalves, and ammonoids with Chhidru faunas. Correlative terms such as Amarassian (Glenister et al., this bulletin) are based on ammonoids from a poorly known stratigraphic succession from which benthonic faunas are inadequately known, thus reducing the value for correlations based on benthos.

Proposed correlations

Stage A

Stage A includes the faunas of the Nangetty Formation and the Holmwood Shale (but not the Fossil Cliff Member) of the Perth Basin; the Lyons Group, including the Carrandibby Formation, of the Carnarvon Basin; and the Grant Group of the Canning Basin. For the Grant Group it may be noted that a marine fauna has so far been described only from the Wye Worry Member, near the top of the formation (Dickins et al., 1977), and our remarks are limited by this context.

The age and correlation of these faunas has been considered by Dickins (1957a, 1963), Dickins and Thomas (1959), Glenister and Furnish (1961) and Teichert and Glenister (1952), and more recently by Archbold (1982, 1984c).

Reasonable agreement among the students of marine fossils seems to exist on the Tastubian (Lower Sakmarian) age of the Holmwood Shale, the Carrandibby Formation, the upper Lyons Group and the Wye Worry Member, and on the Asselian age of parts or all of the Nangetty Formation, the lower and possibly middle parts of the Lyons Group, and much of the Grant Group. In terms of the palynological subdivisions of the Carboniferous and the Permian of Australia (Kemp et al., 1977) we conclude that the base of the Permian is at, or close to, the base of Stage 2/Unit II microfloras as discussed by Archbold (1982) who highlighted the lack of direct biostratigraphical ties with Soviet sequences. The lower part of the Grant Group, apparently with Stage 1 equivalent microfloras (Kemp et al., 1977), is considered by us to be probably Carboniferous. This is borne out by an apparent lack of any hiatus, together with the continuity of the marine fauna that appears in the lowermost part of the Lyons Group and continues upwards and into the Carrandibby Formation and upper Lyons Group. This was documented on a locality by

locality basis (Dickins and Thomas, 1959) and summarized in this bulletin.

Correlation on faunal grounds can be made with southern Asia. Faunas which appear to be most closely related to those of the upper Lyons Group and its equivalents are found in the Nilawan Group of the Salt Range, Pakistan; peninsular and Himalayan India (including the Talchir Formation, the Umaria Beds, and the lower part, Diamictite Division or Bren Beds, of the Agglomeratic Slate); Afghanistan; and Tibet (Dickins and Thomas, 1959; Dickins and Shah, 1979; Dickins and Shah, 1981; Archbold, 1982, 1984c). These reports seem to support a Tastubian age.

Archbold (1982, Table 3) discussed in detail the faunas and sequences concerned and noted that a range of ages within the Tastubian appeared likely. He also discussed discrepancies between correlations based on faunas and those based on microfloras, particularly in the Indian region, but regarded the faunas as being correlative (Archbold 1982, p.271). Waterhouse (1976), for reasons that are not clear, preferred an Asselian age for most of the faunas including those from the Lyons Group and Carrandibby Formation associated with Stage 3 microfloras (Kemp et al., 1977).

In eastern Australia, Stage A seems to be related to the Lochinvar and Allandale Formations (which also contain Stage 3 microfloras; McClung, 1980), and especially to the upper part of Stage A to the Allandale Formation of the Hunter Valley area of the Sydney Basin. This correlation has long been supported with related species listed by Runnegar (1969a) and Waterhouse (1971; 1976, p.77) who stressed that it was 'the same *Eurydesma* fauna'. Subsequent workers (Archbold, 1982; Waterhouse et al., 1983, p.122; Briggs, 1985; Waterhouse and Gupta, 1982; and Dickins, 1985a) have continued to maintain the correlation of the Lyons–Carrandibby faunas with the Allandale faunas, although Waterhouse and his colleagues have advocated an Asselian age despite the association of both faunas with Stage 3 microfloras (cf. Archbold, 1983b).

The following pairs of species are closely related: *Eurydesma playfordi* from the Carrandibby Formation and the upper Lyons Group, and *E. hobartense* from the Lochinvar, Allandale, and younger formations; *Deltopecten lyonsensis* from the Lyons Group, Carrandibby Formation and Wye Worry Member, and *D. illawarensis* from the Allandale Formation; and *Keeneia carnarvonensis* from the upper Lyons Group, and *Keeneia* sp. from the Allandale Formation (Dickins, 1957a; Dickins and Thomas, 1959). Runnegar (1969a) has in addition also compared *Megadesmus* sp., described by Dickins (1957a) as *Pachydomus?* sp., with *Megadesmus globosus* from the Allandale Formation and *Pachymyonia occidentalis* with *P. morrisi* also from the Allandale Formation. *Schizodus crespinae* from the upper Lyons Group also has a counterpart in *Neoschizodus australis* from the Allandale Formation and the Wasp Head Formation in the southern part of the Sydney Basin which has an Allandale fauna (Runnegar, 1969b).

Stage A brachiopod faunas are distinctive and contain elements not found in eastern Australian equivalent faunas, such as *Lyonia lyoni*, rare *Linoproductus*, *Rhynchopora*, and *Kiangsiella*. Spiriferid brachiopods show some links with eastern faunas and these tend to support the molluscan correlations as summarized by Archbold (1982). *Brachythyrinella* has been reported from the Beckers Formation (Sydney Basin) and Victoria. *Streptorhynchus?* sp. from the Lyons Group resembles a species from the Tasmanian Faunizone 1 (Clarke and Farmer, 1976) — a Lochinvar (= Beckers) time equivalent — and *Punctocyrtella australis* has been recorded from the same faunizone.

A fauna transitional to that of Stage B has been reported from a 2–3 m thick conglomerate band at the base of the Callytharra Formation in the Merlinleigh Subbasin (Thomas, 1976). This basal conglomerate contains a brachiopod-dominated fauna of moderate diversity. Many elements of the fauna are those of the Lyons Group, but rare *Neochonetes* (*Sommeriella*) sp., *Elivina* sp., *Spirelytha* sp. and *Lamnaespina* of *L. papilionata* are also present. This basal unit is a temporal equivalent of the Carrandibby Formation, and was included in that formation by Hocking et al. (1987). However, one of us (G.A.T.) would separate it from the Carrandibby Formation in view of its distinctive fauna, lithology, and depositional environment.

Stage B

In Stage B are included the faunas of the Fossil Cliff Member of the Holmwood Shale, Perth Basin; the Callytharra Formation of the Carnarvon Basin; and the Nura Nura Member of the Poole Sandstone, Canning Basin. These faunas contain distinctive brachiopods, bivalves and gastropods which have been well studied. Their correlation is supported by many common species (see especially Dickins, 1963, for bivalves and gastropods; Thomas and Dickins, 1954, and Archbold et al., this bulletin, for brachiopods), and is indicated by the ammonoids (Glenister et al., this bulletin).

Some reservation is, however, warranted on the detailed relationship in the Perth and Carnarvon Basins where the above listed units are overlain by an erosional unconformity; whereas in the Canning Basin the Nura Nura Member overlies such an unconformity. Fossils found lying on the top of the Callytharra Formation and considered to have been derived from that formation may have come from the base of the Wooramel Group. This matter may need further field study for resolution.

Ammonoids from the Callytharra Formation and the Nura Nura Member are dealt with elsewhere in this bulletin by Glenister et al., who conclude that the Fossil Cliff Member, the Callytharra Formation and the Nura Nura Member are Sterlitamakian (Upper Sakmarian). Nevertheless, Glenister et al. do not rule out an upper Tastubian (Lower Sakmarian) age for the Fossil Cliff

Member and the lower part of the Callytharra Formation on the basis of ammonoids alone. As indicated above, however, the other elements of the fauna allow a firm correlation of the Fossil Cliff Member and the Callytharra Formation.

The fauna from Stage B can be readily correlated with some faunas from the southeastern part of the Arabian Peninsula (Oman), peninsular India (Badhaura), and Kashmir (Agglomeratic Slate) as summarized by Dickins and Shah (1979). This correlation is based on bivalves, gastropods, and brachiopods. The occurrence of the ammonoid *Metalegoceras hudsoni* in Oman, regarded by Glenister et al. (1973, p.1039) as conspecific with *M. clarkei* Miller 1936 from the Nura Nura Member, confirms the correlation of Stage B with the Sterlitamakian Substage of the Ural International Scale.

On the other hand, Stage B can be less readily correlated directly with eastern Australia. It seems to be older than the Farley Formation of the Sydney Basin and Fauna II of the Bowen Basin which in this paper are correlated with Stage C. In this case Stage B could be the time equivalent of the Rutherford Formation which underlies the Farley Formation and Fauna II. Up to the present, however, few fossils have been recognized in the Rutherford Formation (Dickins, 1968) and there seems to be no particularly close relationship between Stage B and Fauna II. Of the detailed faunizones proposed in Tasmania (Clarke and Farmer, 1976), Stage B is probably equivalent to the terrestrial horizons between Faunizones 3 and 4, and Faunizone 4. Faunizone 3 is of Allandale affinities but lacks *Eurydesma cordata*. Elements of Faunizone 5 have also been considered to be Sterlitamakian (e.g. Parfrey, 1983) but overall evidence for correlation between Western Australia and Tasmanian faunas is not pronounced.

Foster et al. (1985) recently described plant microfossils, foraminifers, and ostracods from the Fossil Cliff Member of the Holmwood Shale, Perth Basin. They conclude that on the basis of the ammonoids the formation is Sakmarian in age, and on palynological grounds it appears to be older than the Cattle Creek Formation (and Tiverton Formation) of the Bowen Basin, Queensland. They remark on an apparent discrepancy between correlations based upon palynological, microfaunal, and macrofaunal data. There appears to be no discrepancy, however, with the conclusions made in this paper, nor with those of Dickins (1970, 1976) taking into account that no foraminifers or ostracods are known from the Reids Dome Beds underlying the Cattle Creek Formation, nor the beds overlying the Fossil Cliff Member assigned to Stage C in our paper. There does, however, appear to be a discrepancy with the correlations proposed by Waterhouse et al. (1983).

Waterhouse et al. (1983) do not mention the *Terrakea dickinsi–Tomiopsis plica* Faunal Assemblage (i.e. Fauna IIIA), although it occurs in the Homevale area, Bowen Basin, (Dickins, *in* Malone et al., 1966, p.75). Thus, only the Tiverton Formation (Bowen Basin), as originally used (Malone et al., 1966; Dickins and Malone, 1973), is considered and the conclusion that the higher part of the formation is Tastubian or Sterlitamakian applies. Elsewhere, however, the basal part of the original 'Gebbie Formation' of Malone et al. (1966) containing Fauna IIIA is assigned to the top part of the Tiverton Formation and this top part is considered to be of Aktastinian age (Waterhouse, 1983b; Waterhouse and Jell, 1983).

Stage C

Included in Stage C are: the fauna of the High Cliff Sandstone and the flora of the Irwin River Coal Measures of the Perth Basin, the faunas of most of the Wooramel Group of the Carnarvon Basin, and the flora of the Poole Sandstone (above the Nura Nura Member) of the Canning Basin. The position of the Nura Nura Member which is generally regarded as the lower member of the Poole Sandstone is referred to in the previous section. Distinctive marine faunas have been identified at the base of the High Cliff Sandstone, at the base of the Cordalia Sandstone and the 'One Gum Formation' (now Moogooloo Sandstone), and possibly in the Jimba Jimba Calcarenite Member of the Billidee Formation of the Wooramel Group. However, the marine fauna at the top of the Keogh Formation of the Byro Sub-basin and at the top of the Billidee Formation of the Carnarvon Basin is placed in Stage D; it is the same fauna as that occurring in the overlying Coyrie Formation. The sedimentary rocks represent the coarse transgressive phase (with coarse sand and conglomerate) of the overlying Byro Group sequence. In local exposures they can be separated on lithological grounds from the underlying beds with which they have been included because of mapping expediency. Identifications of the bivalves and gastropods from the High Cliff Sandstone and 'One Gum Formation' are given in Dickins (1963, figs 3 and 4). On this basis and identifications given in Playford (1959) and Mercer (1967), Dickins (1963) concluded that Stage C contained a fauna which is close to that of Stage B, but distinctive. This conclusion was discussed further by Dickins (1968) and Runnegar (1969b). The closer relationship of the faunas from Stage C with Stage B rather than Stage D, together with the distinctiveness of Stages B and C, has been confirmed by the recent work of one of us (N.W.A.) who is describing the brachiopod fauna of the High Cliff Sandstone. Some of the distinctive species of brachiopods are indicated by Archbold et al. (this bulletin).

Although Dickins (1963, 1968, 1976) has suggested that Stage C is Early Artinskian (Aktastinian) on the basis of its intermediate fauna, Cockbain (1980) regards it as Baigendzhinian (Late Artinskian) on the presence of *Pseudoschistoceras*, previously known only from Stage D. Glenister et al. (this bulletin) appear to be inclined to the same point of view.

Because of the strong evidence from the bivalves, gastropods, and brachiopods of the close relationships of the faunas of Stages B and C (see also Runnegar, 1969a; and Waterhouse, 1976) and because of the lack of independent evidence on the range of *Pseudoschistoceras*, we regard Stage C as being Aktastinian, that is Early Artinskian. The authors consider that the Aktastinian is probably rather short when compared with

the Baigendzhinian and that this may be relevant to the problem.

Generalized correlations with eastern Australia probably include Faunizone 5 of Tasmania — with *Taeniothaerus subquadratus*, a species compared with *Taeniothaerus* sp. nov. from the High Cliff Sandstone by Coleman (1957) who considered that the Western Australian specimens were from the Fossil Cliff Member — and elements of Fauna II of the Bowen and Sydney Basins (Clarke and Farmer, 1976).

Waterhouse et al. (1983) assign a pre-Farley Formation age to the lower part of the Tiverton Formation based on the alleged occurrence of *Tomiopsis* (= *Ingelarella*) *elongata* at a lower level and *Tomiopsis* (= *Ingelarella*) *konincki* and *Strophalosia* cf. *subcircularis* at a somewhat higher level. The illustrations of *S.* cf. *subcircularis* and the other species are unsatisfactory, and do not appear to indicate the presence of the species named. The higher part of the Tiverton Formation is said to be Tastubian and Sterlitamakian but the basis for this conclusion is not clear.

Stage D

As previously mentioned, Stage C appears to represent the lower part of the Artinskian (the Aktastinian), whereas Stage D represents the upper part of Artinskian (the Baigendzhinian) and the Kungurian and Stage D may extend into the Ufimian (see below). Stage D is separated from Stage C because of a major change in the fauna at the base of the Byro Group. Throughout Stage D there is a relatively gradual change of faunas until the end of the stage which was marked by marine regression in the Carnarvon, Canning, and Bonaparte Basins. Substages D_1 and D_2 were separated out because of an important, though gradual, change within the stage (Dickins, 1963). Even within D_1 at the species level there is an almost complete change between the lowermost faunas in the Coyrie Formation and the uppermost faunas in the Wandagee Sandstone and Nalbia Formation (Byro Group) as well as the upper part of the Noonkanbah Formation — so that faunal subdivision of D_1 is also warranted. At present, however, such subdivision is regarded as premature pending further taxonomic description. Faunal change is particularly distinctive for the brachiopods, as tabulated by Archbold and Dickins (1991), but, as noted above, linking faunas with a mix of species do occur in units such as Bulgadoo Shale.

Substage D_1

The following units belong in Substage D_1: in the Perth Basin, the Permian Unit 'A' of Dickins and McTavish (1963) (which equals the Carynginia Formation of McTavish, 1965 — text but not Plate 3), and the Mingenew Formation; in the Carnarvon Basin, the upper beds of the Wooramel Group (see discussion in earlier section on this problem) and the Byro Group (with the exception of the Baker Formation); in the Canning Basin, the Noonkanbah Formation and possibly the Triwhite Sandstone; and in the Bonaparte Basin, the limestone member of the Fossil Head Formation from the Kuriyippi Hills, Port Keats area (Dickins et al., 1972).

Although much evidence is indirect, it appears clear that the lower part of this substage is post-Early Artinskian (Aktastinian) and represents the beginning of the Late Artinskian (Baigendzhinian). The most direct evidence is the occurrence of *Neocrimites* sp. from the top of the Billidee Formation and from the Coyrie Formation (Glenister and Furnish, 1961; Cockbain, 1980), which indicates that the lower part of Substage D_1 is Baigendzhinian because of the specimen's similarity to *N. fredericksi* from the Baigendzhinian of the southern Urals (USSR). This is consistent with the occurrence of *N.* cf. *fredericksi* at the base of the Gebbie Subgroup of the Bowen Basin, Queensland (Dickins, 1964b; Armstrong et al., 1967), with a fauna (Fauna IIIA) which is correlated by Dickins (1970) with the Byro Group. The occurrence of *N. meridionalis* in the lower part (below the *Fenestella* Zone) of the Branxton Formation in the Sydney Basin and beds at Gympie, Queensland, and *N.* cf. *meridionalis* from the Lakes Creek Beds, north of Rockhampton in the Bowen Basin (Armstrong et al., 1967) is of relevance here because these units have been regarded as containing Fauna II (Dickins, 1968; Armstrong et al., 1967). Fauna II has been correlated with Stage C (see above).

Recent work suggests that the Sirius Shale of the Springsure area, Bowen Basin, Queensland, may be Fauna III rather than Fauna II (Waterhouse, 1983b; Archbold and Dickins, 1991) in which case the lower part of the Branxton may also be Fauna IIIA, and therefore *N. meridionalis* may be no older than Baigendzhinian. However, in the Lakes Creek Beds of the Bowen Basin the relationship of *N.* cf. *meridionalis* is with Fauna II, and at Gympie *N. meridionalis* underlies a definite Fauna II according to Armstrong et al. (1967).

Because of this evidence *N. meridionalis* would appear to be pre-Baigendzhinian at Gympie, and the statement of Glenister and Furnish (1961) that *Neocrimites* is unknown in beds older than Baigendzhinian Substage apparently needs to be modified. Waterhouse (1983b, p.171) noted that 'it seems difficult to avoid the implication that *Neocrimites*, if correctly identified, entered the Australian Permian sequences before it appeared in Urals'.

The occurrence of *Paragastrioceras wandageense* is important in understanding the age of the upper limit of Substage D_1. *Paragastrioceras wandageense* has been recorded from the Coolkilya Sandstone (Teichert, 1952) (= apparently the Baker Formation of Condon — see Dickins, 1963, p.146). However, Condon (1954) and Cockbain (1980), without giving any field evidence, conclude that *P. wandageense* came from the Nalbia Sandstone. We accept Teichert's view that the species comes from low in his Coolkilya Sandstone (i.e. Baker Formation, in current terms). *Paragastrioceras wandageense* is close morphologically to *P. kungurense* from the Iren Horizon of the Kungurian of the Central

Urals (Bogoslovskaya, 1976). Archbold (1981d, 1984a) had previously accepted the supposed presence of *P. wandageense* in the Nalbia Sandstone and used this as supportive evidence for the Kungurian age of the Nalbia Sandstone. Nevertheless, removal of *P. wandageense* to the Baker Formation does not negate the Nalbia occurrence of the chonetid brachiopod *Svalbardia* as evidence for an earliest Kungurian age for the formation (in general terms probably equivalent to the Filippov Horizon, the lowest horizon of the type Kungurian section). The Nalbia fauna shows many molluscan components in common with the Wandagee fauna below; however, a few bivalves enter such as *Oriocrassatella stokesi* and *Schizodus kennedyensis* (Dickins, 1963). The brachiopods are of much lower diversity than in the Wandagee Formation below, although some species appear to persist (e.g. *Neochonetes (Sommeriella) tenuicapillatus* and *Spirelytha miloradovichi*) while others (e.g. *Svalbardia thomasi*) appear for the first time. As a result we conclude that the top of Substage D_1 (marked by the fauna of the Nalbia Sandstone) is probably earliest Kungurian. Relationships between the Baigendzhinian brachiopods of the Amb Formation of the Salt Range, Pakistan, and those of the Wandagee Formation (see Thomas, 1969a, and Grant, 1970, 1976 — for a general reviews) offer distinct support for the Late Artinskian nature of the Wandagee assemblages.

Of note, as discussed further below, is the supposed co-existence of *P. wandageense* and *Daubichites goochi* in the Nalbia Sandstone (Cockbain, 1980), or as we would understand in the Baker Formation. *Daubichites* is supposed to be post-Kungurian (Glenister et al., this bulletin) or Roadian in age. This has implications and presents problems for the age of Substage D_2 as discussed below.

The base of D_1 in the various basins based on marine faunas is reasonably satisfactory. The marine fossils of the Carynginia Formation and the Mingenew Formation can be correlated with the Coyrie Formation (Dickins *in* McTavish, 1965) and the unnamed limestone of the Bonaparte Basin (Dickins *in* Dickins et al., 1972, p.94). The fauna of the unnamed limestone includes the distinctive Coyrie elements *Neospirifer plicatus* and *Wyndhamia* sp. nov. Correlations with the base of the Noonkanbah Formation are less clear.

In D_1 the faunas change from bottom to top so that very few species persist throughout. Further taxonomic studies will clarify the ranges of some species but the ranges of most of the brachiopods are now reasonably well known (see Archbold et al., this bulletin).

The top of the substage is seen clearly only in the Carnarvon and Canning Basins where it is marked by the upper limit of *Lialosia kimberleyensis* as a common element (the species occurs extremely rarely in the Baker Formation), the persistence of a limited number of Wandagee-type brachiopods, and the entry of *Svalbardia*. Distinctive new faunal elements, such as *Atomodesma exarata,* appear in Substage D_2.

Substage D_1 appears to be entirely younger than Fauna II of the Bowen Basin which is here regarded as the time equivalent of Stage C. Correlation with Faunas IIIA and IIIB seems valid because *Atomodesma exarata* is found in the Catherine Sandstone which is regarded as equivalent to Fauna IIIC (Dickins, 1969; Dickins and Malone, 1973). Of the eastern Australian faunas, once again, the Western Australian faunas are closest to those of Queensland as shown in the occurrence of similar species of *Glyptoleda* and *Platyteichum,* genera which are not known elsewhere in eastern Australia. On the basis of relationships with Queensland, Stage D_1 appears to be equivalent to the Branxton Formation of the Sydney Basin, except possibly for its upper part, and Faunizones 6–7 of Clarke and Banks (1975) in Tasmania.

Substage D_2

Substage D_2 equivalents are not known to occur with certainty in the Perth Basin where there is a hiatus between the Carynginia Formation of lower Substage D_1 and the Wagina Sandstone according to the palynology (Balme, 1964b). The Wagina Sandstone is apparently younger than D_2. Palynological data strongly suggest an Upper Permian age, although a Kungurian age is not entirely out of the question (Balme, 1964b, p.83). In the Carnarvon Basin the Baker Formation and Coolkilya Sandstone of Condon are placed in Substage D_2, and in the Canning Basin the marine part of the Lightjack Formation and possibly the Triwhite Sandstone are also included in the substage (Dickins, 1956a). The 'Lower Marine Beds' or 'beds at Fossil Head' of the Hyland Bay Formation, Bonaparte Basin (Northern Territory), typified by the outcrops at Fossil Head, also contain a D_2 fauna. *Atomodesma exarata* has not been found yet from these beds but the brachiopod *Neochonetes (Sommeriella) afanasyevae* offers a clear correlation with Lightjack and Coolkilya faunas. *Streptorhynchus perfidiabadensis* also offers a distinctive link with Lightjack faunas. The Baker, Coolkilya, and Lightjack faunas contain *Atomodesma exarata* (Dickins, 1956a, 1963). Baker Formation brachiopods form a restricted assemblage which includes *Svalbardia thomasi* and very rare *Lialosia kimberleyensis*. Coolkilya assemblages above are more diverse, and, apart from *N.(S.) afanasyevae*, include rare *Tomiopsis globosus* — another link with the Lightjack faunas. The Baker Formation (as discussed in Substage D_1 above), Coolkilya Sandstone, and Lightjack Formation all contain the ammonoid *Daubichites goochi*, which in recent Soviet studies (e.g. Bogoslovskaya *in* Kotlyar and Stepanov, 1984) has been taken to indicate a Roadian or Ufimian age (i.e. younger than Kungurian). However, we conclude that the Western Australian *Daubichites* is essentially Kungurian (even in the restricted Soviet sense).

No clear correlation of Substage D_2 with the Salt Range sequence is apparent. Non-marine beds and a hiatus may be responsible for this apparent lack of correlation (Pakistani–Japanese Research Group, 1985). On the other hand a fairly clear correlation seems possible with the Bowen Basin, Queensland, where *Atomodesma exarata* occurs in the Catherine Sandstone regarded by Dickins (1969) as belonging to the upper part

of Fauna III. This fits well the conclusion of Dickins (1968) that Fauna IV of the Bowen Basin, directly overlying Fauna III, is immediately younger than Substage D_2. Waterhouse (1976), on the other hand, shows the Baker Formation as older than the Catherine Sandstone, but this appears to be based on a misunderstanding of the occurrence of *A. exarata* in Queensland. Tasmanian equivalents of Substage D_2 include Faunizone 8 and, perhaps, 9 (Clarke and Farmer, 1976) but direct evidence is not clear.

Stage E

In Western Australia, Stage E is represented by non-marine beds with plant fossils of the *Glossopteris* flora. To this stage belong probably: the highest part of the sequence in the Carnarvon Basin, the Condren Sandstone of the Canning Basin, and equivalent beds in the Port Keats area of the Bonaparte Basin. In eastern Australia this stage is represented by various stratigraphic units containing the important Fauna IV of Dickins (1964b). In Queensland, Fauna IV appears to contain some molluscs closely related to, or even conspecific with, those from Substage D_2 of Western Australia, but also include other species which suggest a younger age (Dickins, 1970). Fauna IV appears to be entirely older than Stage F of Western Australia. Additional evidence is available from New Zealand where a sequence with Fauna IV is overlain by the Wairaki Breccia which contains a fauna that has affinities with that from Stage F (Dickins, 1983b); however, Waterhouse (1976, 1982) regards the Wairaki fauna as considerably younger.

Stage F

Stage F is represented by the faunas of the Hardman Formation of the Canning Basin, and the correlative 'Upper Marine Beds' in the Port Keats area of the Bonaparte Basin. The younger age of these beds and the closeness of the fauna to that of the upper part of the 'Middle *Productus* Limestone' (now Kalabagh Member of the Wargal Formation) and the 'Upper *Productus* Limestone' (now Chhidru Formation) of the Salt Range (Pakistan), was first recognized by Thomas and Dickins (1954 — their Assemblage II). The age, correlation, and equivalence of the 'Upper Marine Beds' in the Port Keats area, and the Hardman Formation, was discussed further by Thomas (1957, 1958a), Dickins (1963), and Thomas (1969a). The brachiopods are summarized by Archbold (1988a).

Three members have been recognized in the Hardman Formation, namely the Kirkby Range Member, the Hicks Range Sandstone Member, and the Cherrabun Member (Towner and Gibson, 1983). No marine fossils have been found in the Hicks Range Sandstone Member, and most of the Hardman Formation fossils so far identified have come from the Cherrabun Member. A number of species appear to be common to the Cherrabun and Kirkby Range Members, although *Liveringia magnifica* seems to be confined to the Kirkby Range Member.

The Stage F fauna has close affinities with the faunas of the Kalabagh Member of the Wargal Formation and that of most of the Chhidru Formation, and is also related to correlative faunas of the Himalayas and the Basleo and Amarassi Beds of Timor. There are also links such as *Streptorhynchus* scf. *pelargonatus* with the Magnesian Limestone of England and the Zechstein of Germany. *Cyclolobus* from the Cherrabun Member (Glenister et al., this bulletin) is close to a species from the Amarassi Beds of Timor and thus supports the correlation based on the rest of the fauna. The detailed correlation of these faunas does, however, present considerable problems. For example, the Pakistani–Japanese Research Group (1985) recently concluded that the Kalabagh and Chhidru faunas are, in fact, Dzhulfian, contrary to Waterhouse and Gupta (1983) who gave a pre-Dzhulfian age for most of the Chhidru faunas. Our understanding is outlined in our summary of the Permian time scale but we would prefer to see modern detailed systematic descriptions rather than too many old and often generalized identifications.

Past studies of Western Australian Permian fossils

by S.K. Skwarko[*]

The eminently useful compilation, by Dr P.G. Quilty (1975), entitled 'An annotated bibliography of the palaeontology of Western Australia, 1814–1974', as well as its supplement for the 1975–1982 period (Skwarko and Backhouse, 1983), complement the review of the past palaeontological studies on the Western Australian faunas presented below.

The first fossils of Permian age from Western Australia were described rather late, in 1883, and attracted little attention for the first fifty or so years. However, interest in local fossils gradually grew, accelerated in the 1930s and 1940s, and culminated in the 1950s and 1960s in the publication of a number of monographs in which many fossil groups were described in detail.

The first report of the late Palaeozoic strata in Western Australia was made in 1846 by the Gregory brothers and von Sommer (Archbold, 1981f, p.122); both J.W. Gregory and von Sommer made general observations on 'Carboniferous' fossils in 1849. T. Rupert Jones *in* Gregory (1861) listed brachiopods under generic names from the Irwin River area (Perth Basin) and Lyons River area (Carnarvon Basin).

Permian fossils from Western Australia were described for the first time by Hudleston in 1883. They were mainly corals, echinoderms, bryozoans, and molluscs from the Gascoyne River area; some brachiopods were listed. A year later Hardman (1884) collected 'Carboniferous' fossils in the West Kimberley District. From this collection Foord (1890) subsequently described molluscs, brachiopods, echinoderms and plants, together

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with some additional specimens from the Gascoyne and Irwin River areas collected by H.P. Woodward and F.J. Forrest, while Hinde (1890) described corals and bryozoans, also with additional material from the Gascoyne district. A little earlier, Woodward (1886) described fossil fish remains from the Gascoyne region that were later referred to by Karpinsky (1899a,b) as *Helicoprion*. Etheridge Jnr (1888) discussed several brachiopods, some bivalves, gastropods, and actinozoans from the Fitzroy River area, and described two new brachiopods. He also listed brachiopods and bivalves from the Irwin River area (Etheridge Jnr, 1890). In 1892 Newton described the brachiopod *Chonetes pratti* from the Irwin River district; Howchin (1894a) listed a few foraminifers from the same area. Etheridge Jnr (1897) discussed the relationships of a New South Wales brachiopod with Western Australian specimens. The foraminifers were first described by Howchin (1894b, 1895).

The beginning of this century saw continuation of Etheridge's (1903, 1907a-c, 1914, 1918) work on collections from the Gascoyne River district, the Irwin River area, and the Canning Basin. Chapman (1907) described plants and foraminifers from the Collie Coalfield, and Glauert (1912), a brachiopod and a *Conularia* from the Carnarvon Basin. Lists of fossils were published, both for individual areas (Maitland, 1904; Campbell, 1910; Chapman, 1924) as well as for the whole State (Glauert, 1910, 1926; Maitland, 1919).

In the 1920s, results of only one major palaeontological study appeared — by Bretnall (1926) on the bryozoans. However, Dun and David (1923) wrote on '*Gastrioceras jacksoni*' and Benson (1923) emphasized the Asian affinities of the Western Australian faunas, while Whitehouse (1928) stressed the similarities between the Western Australian and the eastern Australian faunas, similarities which he regarded as greater than with India.

The 1930s saw: the description of the local ammonoids (Miller, 1932, 1936); further descriptions of corals (Hosking, 1931; Hill, 1937); listings and a review (Chapman, 1933) as well as descriptions (Chapman and Parr, 1937) of the foraminifers; and descriptions of many brachiopods (Hosking, 1931, 1933a-c; Prendergast, 1935, 1936), some bivalves (Hosking, 1931, 1933b; Prendergast, 1935), and a bryozoan, a gastropod and a conulariid (Hosking, 1931). Lists of fossils were compiled for the Carnarvon Basin (Raggatt, 1936; Raggatt and Fletcher, 1937), and another attempt was made at correlating the local Permian strata by means of the contained fossils (Hosking, 1933a). There were additional attempts at correlation by Clarke (1937) and Wade (1937, 1939), and Teichert (1940) commenced his contribution to the Western Australian Permian palaeontology and biostratigraphy.

Descriptions of corals continued into the next decade (Hill, 1942), as did those of the brachiopods (Prendergast, 1943) and bivalves (Fletcher, 1945, 1946). The bryozoans also continued to receive attention (Crockford, 1944a-c), and the crinoids were for the first time the subject of a monograph (Teichert, 1949). The foraminifers continued to be studied (Parr, 1942; Crespin, 1945, 1947), and the ammonoids were once again systematically described (Teichert, 1942, 1944a). A few trilobites (Stubblefield, 1944; Teichert, 1944b) and worms (Parr, 1942; Teichert, 1945) were also described.

The listings and the descriptions of both foraminifers (Crespin, 1950, 1956, 1958a,b) and ammonoids (Teichert and Glenister, 1952) continued into the 1950s, a period marked by the appearance of a large number of monographs on fossil faunas collected in the course of mapping of the Carnarvon and Canning Basins by the Bureau of Mineral Resources. Thus, Dickins (1956a-c, 1957a,b) described the gastropods and the bivalves; Coleman (1957) and Thomas (1958b), the brachiopods; and Crockford (1957), the bryozoans. Lists of fossils were drawn up for the Canning Basin (Guppy et al., 1958; Dickins and Thomas, 1959) and the Carnarvon Basin (Dickins and Thomas, 1959), and further attempts were made at correlating the local strata (Thomas and Dickins, 1954). Howell (1956) described putative sponges. The 1950s also marked the beginning of palynological studies in Western Australia. Balme's early work on the Collie Basin (Balme, 1952) was followed by a series of publications that laid the foundations for the systematic study of Permian palynomorphs in Australia (Balme and Hennelly, 1955, 1956a,b). These papers described spores and pollen grains from the Collie Coal Measures, the Irwin River Coal Measures, and eastern Australia.

The accelerated palaeontological activity continued into the 1960s. There were further lists and descriptions of the foraminifers (Belford, 1961, 1965; Crespin, 1961, 1962, 1964, 1965), molluscs (Dickins, 1961; Dickins *in* Veevers and Wells, 1961; Dickins and Shah, 1965; Edgell, 1965), and brachiopods (Thomas, 1962, 1969a; Edgell, 1965). Faunas monographed included the ammonoids (Glenister and Furnish, 1961), gastropods and bivalves (Dickins, 1963), and brachiopods (Campbell, 1965). In addition, the bryozoans were described by Ross (1963) and Wass (1969), and the asteroids by Kesling (1969). Fossil plants from the Canning Basin were listed by White (*in* Veevers and Wells, 1961). Dickins (1964a) continued with attempts at detailed correlation of Permian strata. Balme (1964b) used palynomorphs to date the Wagina Sandstone and to review the biostratigraphy of other units (Balme, 1964a, 1969). In the late 1960s, Segroves undertook a study of the palynomorphs, including an unusual suite of acritarchs, from the northern Perth Basin. Published as a series of papers between 1966 and 1971, this work included the first range charts for Permian palynomorphs in Western Australia (Balme and Segroves, 1966; Segroves 1967, 1969, 1970, 1972). An unpublished thesis covered aspects of the palynology in the Perth Basin (Ingram and Sanders, 1964).

The interest in most local fossil groups seems to have declined in the last fifteen or so years, one of the few exceptions being the brachiopods which continue to be systematically studied mainly by Thomas (1971),

Archbold (1980a,b, 1981a-e, 1983b, 1984a-c, 1985; Archbold and Thomas, 1984a,b, 1985a,b, 1986a,b), and Waterhouse (1970a,b). While preparing this bulletin for publication, work has continued on the brachiopod faunas of Western Australia (Archbold, 1986a,b, 1987, 1988a,b, 1990, 1991; Archbold and Thomas, 1987; Foster and Waterhouse, 1988). The ammonoids received only occasional attention (Glenister et al., 1973, 1990a,b; Cockbain, 1980), and other groups such as foraminifers (Palmieri *in* Foster et al., 1985), the ostracods (Fleming *in* Foster et al., 1985) and molluscs (Archbold and Skwarko, 1988) have also been described. Palynological work is represented by theses on the Carnarvon and Canning Basins (MacLeod, 1973; Powis, 1979), an unpublished report by Glikson (1972) on the Perth and Collie Basins, and papers by Backhouse (1988) on the Collie Basin and Backhouse (1990) on the Perth, Collie and Officer Basins. Balme's extensive work on material from petroleum exploration wells remains largely unpublished, although the main biostratigraphic results of this work were published in a major review by Kemp et al. (1977). Kemp's (1976) paper is the only published record of Permian palynomorphs from the Officer Basin.

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Part 2

Fossil groups

Introduction

*by S.K. Skwarko**

Nearly one thousand genera and species, representing some 22 fossil groups and encompassing all the fossils known from the Permian rocks in this State, are discussed in this chapter. Each major taxonomic group is dealt with in a standard way as far as possible. The introduction to each group will be found in the following printed pages; the systematic documentation of genera and species is on microfiche (in a pocket inside the back cover).

The classification used follows the 'Treatise on Invertebrate Paleontology', except for the foraminifers where Loeblich Jnr and Tappan's (1984) classification, with minor modifications, is adopted.

For each species a reference is given to the article where it was first described, and then to all the literature in which the Western Australian occurrences appear. Only the more important references to occurrences in eastern Australia and overseas are listed. All pertinent data on each named taxon are presented, usually, but not always, under the headings 'Diagnosis', 'Closest species', 'Types', 'Type locality', 'Distribution and range', 'Age', 'Abundance', 'Value in correlation and dating', 'Climate', and 'Sedimentary environment'.

Explanations of some of the headings, conventions followed, and abbreviations used are given below.

(1) After the name of the type species, the abbreviations OD and SD refer to original designation and subsequent designation; M means monotypy.

(2) The following convention is used for the position of the '?' in species names:

Athyris? trilobus Smith
species questionably assigned to genus

Athyris trilobus? Smith
species doubtful but assigned to correct genus

?Athyris trilobus Smith
entire assignment doubtful

(3) Under 'Diagnosis' are listed all the morphological characteristics of a particular species whose combination distinguishes it from other species of the genus.

(4) 'Closest species' names those species morphologically closest to the species discussed and the means of distinguishing them.

(5) 'Types' gives the repository and registered number of type and figured specimens. The following abbreviations are used for the repositories.

AM	Australian Museum, Sydney, New South Wales.
APG	APG Consultants, Kenmore, Queensland.
BM(NH)	British Museum (Natural History), London, United Kingdom.
BPIP	Bernard Price Institute for Palaeontology, Witwatersand University, Johannesburg, South Africa.
BSIP	Birbal Sahni Institute of Palaeobotany, Lucknow, India.
CPC	Commonwealth Palaeontological Collections, Bureau of Mineral Resources, Canberra, ACT.
GSI	Geological Survey of India, Museum, Calcutta, India.
GSN	Geological Survey of New South Wales, Sydney, New South Wales.
GSQ	Geological Survey of Queensland, Brisbane, Queensland.
GSWA	Geological Survey of Western Australia, Perth, Western Australia.
IMP	Imperial Oil Laboratories, Calgary, Alberta, Canada.
LPMA	La Plata Museum, Argentina.
MHN	Musée d'Histoire Naturelle, Paris, France.
MINAD	Mines Administration Laboratories, Brisbane, Queensland.
MP-P	Museu de Paleontologia do Departaments de Paleontologia e Estragrafia do Instituto de Geociencas da Universidado do Rio Grande do Sul, Brasil.
MTHD	Mineralogisch Geologisch Museum Technische Hageschool, Delft, The Netherlands.

* Formerly of the Geological Survey of Western Australia, 100 Plain Street, East Perth, WA, 6004.

MUGD Melbourne University Geology Department, Melbourne, Victoria.

NMV National Museum of Victoria, Melbourne, Victoria.

PU Princeton University, Department of Geological and Geophysical Sciences, Princeton, New Jersey, USA.

SAM South Australian Museum, Adelaide, South Australia.

SM Sedgwick Museum, Cambridge, United Kingdom.

SUGD Sydney University, Geology Department, Sydney, New South Wales.

SUI University of Iowa, Iowa City, Iowa, USA.

UMMP University of Michigan, Museum of Paleontology, Michigan, USA.

UN University of Newcastle, Newcastle, New South Wales.

UQGD University of Queensland, Geology Department, Brisbane, Queensland.

USNM United States National Museum, Washington D.C., USA.

UT University of Tasmania, Geology Department, Hobart, Tasmania.

UWA University of Western Australia, Department of Geology, Perth, Western Australia.

WAM Western Australian Museum, Perth, Western Australia.

YPM Yale Peabody Museum of Natural History, New Haven, Connecticut, USA.

(6) The 'Distribution and range' lists all the known occurrences in Western Australia by locality, basin, and formation; for the rest of Australia, the State and formation are recorded; for overseas occurrences the country is given.

Foraminifers

by V. Palmieri *

The purpose of this mainly nomenclatorial review of Permian Foraminiferida from Western Australia is to present the state of knowledge on the subject current to 1985 and is intended to provide background information for future studies.

It is a compilation of species of foraminifers based mainly on the works of Parr (1942), Crespin and Belford (1957), Crespin (1958b), and Belford (1965). Most of the figures are reproductions of Mr F. Hadzel's drawings that were published in Crespin (1958b); where possible, published figures of holotypes and topotypes are reproduced, and optical or SEM photographs of 11 holotypes from Parr's 1942 collection are also shown.

The suprageneric and generic classification adopted is that of Loeblich Jnr and Tappan (1984), except for the Suborder Lagenina, which includes here the Family Geinitzinidae with the genera *Lunucammina*, *Howchinella* and *Ichthyolaria*, and the Family Nodosariidae, which includes here the genus *Protonodosaria* (see also Foster et al., 1985).

No attempt was made, as part of this study, to produce a stratigraphic distribution of the foraminifers or a correlation chart with eastern Australian Permian Foraminiferida, which could only be at best a repetition of the results achieved by Crespin (1958b). Further studies on Permian foraminifers from western and eastern Australia will undoubtedly provide evidence for a more refined framework of their evolutionary classification. Their usage in biostratigraphy and ecostratigraphy will also be enhanced.

As Crespin (1958b, p.22-27) indicated, some assemblages retrieved from various lithostratigraphic units independently suggest the possibility of broad Australia-wide correlations within the Late Sakmarian and Artinskian (Scheibnerova, 1982; Palmieri, 1983; Foster et al., 1985). When complete stratigraphic sections are available for investigation the difficult task of establishing a foraminiferal biostratigraphic column for the Permian of Australia will hopefully be accomplished.

The ecological and climatic value attributed to Permian foraminifers are derived from three sources: information suggested by other associated fossils, information provided by sedimentological analysis of the rock samples in which they were found, and environmental data from similar recent foraminifers (Crespin, 1958b, p.27-30; Scheibnerova, 1982, p.8-10).

Calcareous foraminifers from the Holmwood Shale and Callytharra Formation suggest that a climatic and environmental change took place during Sakmarian times from cold in Early Sakmarian to cold-temperate and temperate in Late Sakmarian (possible equivalents in eastern Australia are the assemblages from the Pokolbin 'limestone', Hunter River area, northern Sydney Basin, NSW, and the Mostyndale Member of the Cattle Creek Formation, Bowen Basin, Queensland).

Similarly, from the Artinskian the more frequent assemblages of arenaceous agglutinated foraminifers are thought to represent cold climate conditions with a warming to a cold-temperate climate in Late Artinskian times (Byro Group and Noonkanbah Formation in Western Australia, with possible equivalents in the Branxton Formation and the Wandrawandian Siltstone of the Sydney Basin, NSW, and in the Mooroolo Mudstone Member to the Sirius Mudstone Member of the Cattle Creek Formation, Bowen Basin, Queensland).

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In this section on foraminifers, Dr S.K. Skwarko assembled the plates and accompanying captions, and compiled most of the detailed Western Australian locality data; he also incorporated the relevant data from Foster et al. (1985).

Foraminifer genera and species

Systematic descriptions of the foraminifers are on microfiche sheets 1–2 in a pocket inside the back cover.

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Sponges

*by S.K. Skwarko**

No undoubted sponges of Permian age are known from Western Australia. All objects which in the past were described as sponges have, on closer scrutiny, turned out to be something else.

The earliest record of a supposed Western Australian sponge was by Etheridge Jnr (1915), who described isolated plates of an inadunate crinoid as a new genus *Calceolispongia*. The true identity of these plates was subsequently recognized by Gerth (1936). Etheridge Jnr (1918) described as *Anthracosycon* sp. a '... fortuitously shaped piece of sandstone..' (Pickett, 1983, p.104). More recently Howell (1956) described six new species of supposed sponges which he referred to four genera, two of them new: *Stylopegma incerta*, *S. singularis*, *Laubenfelsia australiensis*, *Paramelonella etheridgei*, *P. lata*, and *Paramorphospongia globosa*. Pickett (1983, p.110-111) regarded all these as traces after worms or worm tubes, except for *Paramorphospongia globosa*, which he considered to be non-organic.

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Corals

by John S. Jell **

Both rugose and tabulate corals are present in the Permian of Western Australia. Although they occur sporadically in most Permian sequences in the State, they are usually only represented by relatively few specimens and never form a conspicuous element of a particular fauna. Thus, they have been given scant attention and, in some instances, were not collected during regional mapping program and major palaeontological studies.

During the late 19th and the early 20th centuries, the small collections from some of the regional surveys were described (i.e. Hudleston, 1883; Hinde, 1890; Etheridge Jnr, 1903, 1907, 1914; Glauert, 1910, 1926). Many of the taxa were based on one or only a few specimens, of which a number are now lost. Thus, interpretation of many of these early species is difficult. Dorothy Hill revised this early work in the 1930s and, with limited additional material from other surveys, produced two papers (Hill, 1937a, 1942) bringing the taxonomy of the Rugosa and Tabulata of the Permian of Western Australia up to date for that time. No taxonomic study of these groups has been undertaken since. Similarly, the Permian corals of eastern Australia have been neglected since the work of Dorothy Hill in the 1930s and 1940s.

This review only attempts to bring together the published information on the Permian corals of Western Australia. It has not been possible in the time available to incorporate unpublished information from the regional mapping and petroleum exploration programs of the last 30 years. The taxonomy has been updated in accord with the Treatise of Invertebrate Paleontology, Part F Coelenterata, Supplement 1 Rugosa and Tabulata, by Dorothy Hill (1981). However, especially in the Tabulata, the generic assignments of many of the species are still tentative — firstly, because some of the type species of the Permian genera are in need of revision, and, secondly, more material of many of the Western Australian forms is needed before all their morphological characteristics are known. It is hoped that this review will spotlight the areas where more work is essential for our understanding of these groups.

As a result of these uncertainties in their taxonomy and the lack of attention to their distribution in studied sections, the biostratigraphic usefulness of the rugose and tabulate corals in the Permian of Australia is very limited. However, because of their wide distribution in both eastern and western Australia they may become important biostratigraphically when the deficiencies noted above are rectified. The ages given for the species in the following systematic descriptions are those of the strata in which they are known to occur at present, as established by other fossil groups.

The Australian Permian coral faunas are characterized by small non-dissepimented solitary rugosans and branching tabulatans, and may be ecologically analogous to the ahermatypic scleractinian faunas of today's seas. As such they could have a very wide range of habitat. Associated faunas and sedimentological evidence suggest that the Permian corals inhabited cold to temperate, shallow to moderately deep (up to 200 m) shelf waters which are commonly very turbid and of normal salinity. Comments on climate and sedimentary environment in the accompanying descriptions are omitted, as the data would

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be based on what is known about the formations in which the species occur and not derived from the character of the species themselves.

The Permian corals of Western Australia should be thoroughly revised taxonomically, collected stratigraphically to ascertain the precise range of each taxon, and compared with similar forms from eastern Australia.

Coral genera and species

Systematic descriptions of the coral are on microfiche sheet 2 in a pocket inside the back cover.

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Bryozoa

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Bryozoans are a useful, if somewhat neglected, element of the Permian faunas of Western Australia. There are numerous horizons throughout the Canning, Carnarvon, and Perth Basins where they are a dominant component of the fauna, yet, for various reasons, they have not assumed their full potential as a correlation tool.

Apart from the pioneering efforts of Bretnall (1926), Etheridge Jnr (1888–1914), Foord (1890), Hinde (1890), and Hudleston (1883), most of the existing descriptive taxonomy has been the result of careful studies by Crockford (1941–1957), from which the bryozoan faunal succession for the Canning and Carnarvon Basins has been established. Throughout her later summary publications, Crockford repeatedly noted that there remained substantial faunas requiring further study, but since that time only one paper by Ross (1963) has expanded the number of available taxa. The daunting task which Crockford set for herself, to define the late Palaeozoic bryozoan faunas of

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Western and eastern Australia, needs to be continued if this group is to fulfill its undoubted zonal potential.

The evaluation of bryozoans collected from the field has become a complex task which the non-specialist palaeontologist finds very difficult. Current procedures require the highly skilled determination of microscopic details and, hence, newly collected material tends to be cited only by open nomenclature, if at all, thus reducing the correlative value of the group. A great number of field studies have been undertaken in Western Australia during the past thirty years but, since the work of Crockford, there has been very little growth in our knowledge of the stratigraphic distribution of approximately one hundred species which were defined at that time. The majority of these species occur in beds of Early Permian age (Sakmarian–Artinskian) with very few having ranges which extend into younger formations. Recent geological studies indicate that there are still many occurrences of bryozoans in these beds which have not been systematically evaluated.

Stratigraphic distribution in Western Australia

Perth Basin

One record of a Permian fenestrate species from the Irwin River area, Perth Basin (Etheridge Jnr, 1907b), has not been evaluated in the absence of the original material. Crockford (1951) reported that major collections of bryozoans from the prolific Fossil Cliff Member in the Irwin River district were sent to North America for description but that no publication of this work has emerged.

Carnarvon Basin

The bryozoan record in this basin is considerably less documented than that of the Canning Basin (see below). Much of the taxonomic work has been based upon older collections for which the locality and stratigraphic control is not always satisfactory.

The Permian sequence commences with the Lyons Group (Asselian, Early Sakmarian) which outcrops in a belt which varies in thickness from 1400 m at the Lyndon River to 800 m near the Wooramel River. Fossils occur sporadically throughout the group with the few bryozoans being found in thin, local, calcareous lenses within tillite, sandstone, and conglomerate beds. Ross (1963) has described three new species of *Pseudobatostomella?* and one of *Polypora*, the scattered record of which ranges laterally and vertically within the Lyons Group. These four taxa show no similarity with the fauna of the overlying Callytharra Formation, and there are many genera in the latter formation which have not been found in the Lyons Group.

The Callytharra Formation (100 m thick) contains fossiliferous, hard and friable, sandy and silty calcarenite and calcilutite, siltstone, and sandstone. Condon (1967) reports that, in the northern Carnarvon Basin, the formation rests disconformably on the Lyons Group and is unconformably overlain with an erosional contact by the Wooramel Group. It has yielded a large bryozoan fauna of some 24 described species of which only five range up into the younger Byro Group. Diagnostic genera include *Pennireteporα, Lyropora, Septopora, Streblocladia*, ribbon-like zoaria of *Hexagonella*, and a large group of fenestellids, some of which are quite distinct from those occurring in adjacent formations. The apparent absence of *Goniocladia* and *Stenopora* and the rarity of *Fistulipora* may be important. However, the fistuliporids and stenoporids have never been fully investigated in this formation and thus it may be premature to make conclusions about their distribution. As noted previously, the Callytharra and Noonkanbah Formations share some nine species, five of which have been reported only from these two formations. In addition, the Callytharra Formation contains a large group of genera that are not found in the Noonkanbah Formation and these taxa support the correlation of the Callytharra Formation with the Nura Nura Member of the Poole Sandstone. Despite the current size of fauna, it is clear that much more material is available for study from this formation.

The Wooramel Group is a predominantly arenaceous sequence which attains a thickness of 70 m (Gascoyne Junction) to 340 m (Mount Madeline). Three formations are recognized in the Merlinleigh Sub-basin namely: Cordalia Sandstone (fragmental bryozoans at base); Moogooloo Sandstone (a few fenestrates); and Jimba Jimba Calcarenite Member (a rich bryozoan assemblage) of the Billidee Formation (minor bryozoans at a few localities). None of these faunas have been described, but Condon (1967) makes the observation that they are superficially comparable with the Callytharra fauna and are dated as Artinskian by the age of the faunas located above and below. Similar faunas are known to exist in the Byro Sub-basin.

The Byro Group is preserved only in the Minilya and Kennedy Range areas where it varies from 700 to 1500 m in thickness. The dominant lithology consists of calcareous to shaly sandstone and siltstone. The sequence was deposited in a moderate to shallow sea and there is increasing evidence of restricted circulation in the depositional environments of the younger formations. The group is subdivided into two parts by a central unconformity in the Merlinleigh Sub-basin, which corresponds to cessation of deposition in the Byro Sub-basin.

Below the erosional level (Coyrie Formation, Mallens Sandstone, and Bulgadoo Shale), there are reports of bryozoans in the first and last formations and, additionally, Crockford has described a number of wide-ranging species from unspecified levels throughout the Byro Group which probably form part of this otherwise undescribed assemblage. Only one species *Hexagonella densa* has been described from the Bulgadoo Shale.

Above the erosional surface, there are five formations (Cundlego Formation, Quinnanie Shale, Wandagee Formation, Nalbia Sandstone, and Baker Formation) of which the Wandagee Formation and Baker Formation

Table 9. Permian bryozoan localities in the Canning Basin

Nura Nura Member of the Poole Sandstone

1, 1A	**1.** Northern end of Lake Josceline, Mt Wynne area (W42B,C); **1A.** 0.40 km west from [2] (W40)
2, 2A	**2.** 1.6 km northeast from Lake Josceline, 6.4 km at 290° from Mt Wynne (W44C); **2A.** 7.2 km west of Mt Wynne Trig. Station (K. Nura 1)
3	0.40 km north from [2] (W36)
4	3.2 km at 40° from Lake Josceline at fence junction (W34B)

Noonkanbah Formation

5A-S	**5A.** 6.4 km due west from Chestnut Bore, Christmas Creek Station; section **A-S** extends over a distance of 4.8 km at 170° from [5A], the horizon of which is near the top of the Noonkanbah Formation (PR284A-S; NH17A-S)
6	6.4 km south from Chestnut Bore, Christmas Creek Station (PR136)
7A, B	**7A.** 4.8 km at 235° from Brutens Yard, Cherrabun Station; **7B.** 180 m northeast from [7A] (PR137G,H)
7C	Approximately 3.2 km at 260° from Brutens Yard and 229 m above base of Noonkanbah Formation (KNF73)
8A	3.2 km at 260° from Brutens Yard, Cherrabun Station (PR288, NK20)
9	Probably near Blue Bush Bore, Cherrabun Station (PR126)
10	5.6 km at 110° from Christmas Creek Homestead (R478)
11	1.6 km south from Melon Waterhole, Gogo Station (GG2)
12	3.2 km at 120° from Tank Bore, Cherrabun Station (PR291)
13	4.8 km at 285° from Brutens Yard, Cherrabun Station (PR302A)
14	0.8 km east from Noonkanbah Homestead (NL32)
15	14.5 km west from Liveringa Homestead, and 1.2 km north of Mt Anderson - Liveringa Road (G51)
16	3.2 km south-southwest from Bohemia Downs Homestead, on a fault line (R422)
17, 17A	Keevies Well, 12.9 km north from Mt Anderson Homestead
18, 18A	**18.** Probably in the vicinity of the Fenton Fault, near Barnes Flow (FL145); **18A.** locality unknown but probably in same area (FL96)
19	4.8 km at 100° from Woods Bore, Christmas Creek Station (PR256)
20	2.4 km at 220° from Brutens Yard, Cherrabun Station (PR113)
21	2.4 km southwest from [5A] (NK15)
22	11.3 km due west from Chestnut Bore, Christmas Creek Station (NK12)
23	On track, 9.7 km east of Ellendale Homestead, Blina Station, on Bells Creek (SP49)
24	9.7 km southeast from Bucknall Pinnacle (SR84)
25	9.7 km at 335° from Pilot Camp, on track to Barnetts Tank from Ellendale Homestead, Blina Station (SP37)
26	On track, 1.6 km at 200° from Barnetts Tank on Sixty-Seven Mile Creek (SP26)
27	Little Flow Bore, 14 km west of Nerrima Homestead
28	On a track as it crosses a ridge (base of Liveringa Group or top of Noonkanbah Formation) 3.2 km at 200° from Barnetts Tank (SP25B)
29, 29A	Mount Marmion, base: top of Noonkanbah Formation
30	1.0 km south from Trig. Station 248, Meeda Station
31	14.5 km east-northeast from Trig. Station G2, St George Ranges
32	Scarp 3.2 km east from Christmas Creek Homestead
33	Just north of Hill C, Grant Range
34	8.9 km south by east from Nerrima Homestead
35	0.8 km east of fence, Duchess Ridge (approx. 8 km southeast of Mt Wynne)

Liveringa Group

36	9.7 km at 140° from Surprise Bore, Cherrabun Station (SR6)
37	12.9 km south from Donkey Gorge Bore, Christmas Creek Station; base of Liveringa Group (PR261)
38	Mt Hardman

SOURCE: Crockford (1957, p.88)

NOTE: Numbers in square brackets refer to other localities listed in this table

contain significant bryozoan assemblages, with only rare occurrences in the remaining units. Crockford has described five or six taxa from each of the Wandagee and Baker Formations and has concluded that they correlate with the upper part of the Noonkanbah Formation.

The Kennedy Group (750 m) contains arenaceous sedimentary rocks which disconformably rest on the Byro Group. *Fenestella disjecta* has been described from the basal Coolkilya Sandstone and this is the only report of bryozoans in this group.

Northern Canning Basin

A review of the stratigraphic record of the Canning Basin is given by Forman and Wales (1981), and Towner and Gibson (1983). Both papers contain summary evaluations of the stratigraphic, palaeoenvironmental, and palaeoclimatic record of Permian strata in the basin. The fossil bryozoan localities are listed in Table 9.

The Permian sequence commenced with the Grant Group (Late Carboniferous–Early Sakmarian). The basal Betty Formation consists of 1654 m thick sequence of coarse- to fine-grained, clastic sedimentary rocks which contain Stages 1–2 microflora. Glacial conditions prevailed during this interval with the probable extension and then initial breakup of the continental ice cap. The overlying 550 m thick Winifred Formation is mainly fine-grained clastics which contain a marine fauna, including bryozoans which have yet to be described. Conditions were probably still very cold at this time but warm enough to permit the influx of shallow-water benthonic faunas. The upper unit, the 562 m thick Carolyn Formation, records the return to colder conditions. A cold-water marine fauna and the presence of diamictites with striated boulders support the concept of re-established glacial conditions at this time.

Unconformably overlying the Grant Group in the northern Canning Basin, the Poole Sandstone (Late Sakmarian–Early Artinskian; 406 m) marks the onset of a marine transgression which inundated the major part of the Canning Basin. The formation contains the Nura Nura Member (110 m), a thin, basal, discontinuous sequence of limestone and calcareous sedimentary rocks in the east which changes to calcareous sandstone, siltstone, and shale elsewhere. In the northwestern areas the member contains a rich marine fauna of Tethyan affinities, suggesting warm to temperate conditions in a moderately shallow, open sea. Marginal to the basin, the facies changes to deltaic, lagoonal or fluvial sedimentation. Ten species of bryozoans have been described from six localities in the Nura Nura Member. These include *Hexagonella australis*, *H. hudlestoni*, *Evactinostella crucialis*, *Dyscritella spinigera*, *Dyscritellina? globosa*, *Fenestella horologia*, *Streblotrypa (Streblascopora) marmionensis*, *Fistulipora nura*, *Stenopora hemispherica*, and *Lyropora joselina*. The first six of these have long ranges which extend up into the overlying Noonkanbah Formation and they also occur in the Carnarvon Basin in the Callytharra, Baker, and Coolkilya Formations. Three of these species, *Dyscritella spinigera*, *Streblotrypa (Streblascopora) marmionensis* [= *S. germana* (Bassler)] and *Fenestella horologia* [= *F. parviuscula* Bassler], have also been recorded from Timor. Of the remaining taxa, *Stenopora hemispherica* provides a stratigraphic link with the Lower *Productus* Limestone of India and locally, the restricted occurrence of *Lyropora–Lyroporella* establishes a strong stratigraphic correlation between the Nura Nura Member and the Callytharra Formation.

The Noonkanbah Formation (Artinskian; 410 m) contains mostly fine-grained clastic sedimentary rocks which fine upwards from coarse-grained transitional beds into the characteristic black shale with minor calcareous sandstone and limestone lenses. Faunal diversity suggests deposition in a warm to sub-tropical, low-energy, marine environment. Dickins and Jell (1974) identified at least three biostratigraphical subdivisions in the formations whilst Thomas (1958b) proposed two associations based on depth criteria, an inner molluscan assemblage (27–34 m) with few bryozoans, and an outer brachiopodal assemblage (34–50 m) which includes a rich bryozoan fauna.

The present review indicates that at least 73 out of a grand total of 107 Permian bryozoan species have been described or listed by Crockford (1957) from 41 localities in the Noonkanbah Formation. As many as 42 of these taxa are restricted in their occurrence to this formation. Further details of this distribution are given in Crockford (1957, table 1). This high concentration of taxonomic studies emphasises the abundant development of bryozoans throughout this formation.

Crockford (1957) further suggests that although there are some species common to the Noonkanbah and Callytharra Formations, there are significant differences in their Fenestellidae, Acanthocladiidae, and Rhabdomesidae to suggest that they should not be correlated. This difference is compounded by further variations evident in the fistuliporids and stenoporids which have yet to be described from the Callytharra Formation. Noonkanbah faunas are best compared with those of the Byro and Kennedy Groups in the Carnarvon Basin where there are a number of diagnostic species common to both areas. Good faunal similarities have also been established with equivalent strata in Timor, the Middle *Productus* Limestone of India, the Urals, and some North American faunas.

The Permian stratigraphic sequence concludes with the Liveringa Group (?890 m) in which eleven bryozoan species have been recorded from three fossil localities. These include *Fistulipora liveringa*, *Etherella porosa*, *Goniocladia timorensis*, *Dyscritella? liveringa*, *D. tenuirama*, *Stenodiscus hardmani*, *S. variabilis*, *Fenestella horologia*, *Rhabdomeson mammillatum* var. nov., *Saffordotaxis elegans*, and *Streblotrypa (Streblascopora) marmionensis*. Material from the first two localities occurs near the base of the group in the Lightjack Formation (180 m) which was deposited in a shallowing, regressive marine environment. Faunal elements belong to the molluscan assemblage (Thomas, 1958b) and have a great deal of similarity with those in the top of the Noonkanbah Formation. The overlying Condren Sandstone (610 m) represents the stratigraphic record of

Table 10. Permian bryozoan species from Western and eastern Australia

Western Australia	eastern Australia
Class STENOLAEMATA Borg 1926	
Order CYSTOPORATA Astrova 1964	
Suborder FISTULIPORINA Astrova 1964	
Family FISTULIPORIDAE Ulrich 1882	
Genus **FISTULIPORA** M'Coy 1850	
Fistulipora compacta Crockford 1944b	*Fistulipora* sp. Wass 1968a
Fistulipora conica Crockford 1944b	
Fistulipora gigantea Crockford 1944b	
Fistulipora liveringa Crockford 1957	
Fistulipora nura Crockford 1957	
Fistulipora stereos Crockford 1957	
Fistulipora vacuolata Crockford 1944b	
Fistulipora wadei Crockford 1944b	
Genus **DYBOWSKIELLA** Waagen & Wentzel 1886	
Dybowskiella arborescens Crockford 1957	
Dybowskiella crescens (Crockford 1944b)	
Dybowskiella geei Etheridge 1907a (North. Terr.)	
Genus **ERIDOPORA** Ulrich 1882	
Eridopora permiana Crockford 1957	
Family HEXAGONELLIDAE Crockford 1947	
Genus **HEXAGONELLA** Waagen & Wentzel 1886	
Hexagonella australis (Bretnall 1926)	
Hexagonella bifida Crockford 1944b	
Hexagonella densa Crockford 1944b	
Hexagonella hudlestoni Crockford 1957	
Hexagonella lineata Crockford 1944b	
Hexagonella nalbia Crockford 1944b	
Hexagonella plana Crockford 1944b	
Hexagonella undulata Crockford 1944b	
Genus **FISTULAMINA** Crockford 1947	
Fistulamina lata Crockford 1957	
Fistulamina sp. Wass 1967a (North. Terr.)	
Genus **PRISMOPORA** Hall 1883	
Prismopora? attenuata Crockford 1957	
Prismopora digitata Crockford 1957	
Prismopora? triradiata Crockford 1957	
Genus **EVACTINOSTELLA** Crockford 1957	
Evactinostella crucialis (Hudleston 1883)	
Family ETHERELLIDAE Crockford 1957	
Genus **ETHERELLA** Crockford 1957	
Etherella irregularis Crockford 1957	
Etherella porosa Crockford 1957	
Etherella porosa var. *minor* Crockford 1957	
Genus **LIGULOCLEMA** Crockford 1957	
Liguloclema meridianus (Etheridge Jnr 1926)	*Liguloclema* sp. Wass 1968a
Liguloclema typicalis Crockford 1957	
Family GONIOCLADIIDAE Waagen & Pichl 1885	
Genus **GONIOCLADIA** Etheridge Jnr 1876	
Goniocladia indica Waagen & Pichl 1885	*Goniocladia immensa* Wass 1968b
Goniocladia timorensis Bassler 1929	

Table 10. Permian bryozoan species from Western and eastern Australia *(continued)*

Western Australia	eastern Australia
	Genus **AETOMACLADIA** Bretnall 1926
Aetomacladia ambrosioides Bretnall 1926	*Aetomacladia ambrosioides* Bretnall 1926
	Order CRYPTOSTOMATA Vine 1884
	Suborder FENESTELLINA Astrova & Morozova 1956
	Family FENESTELLIDAE King 1850
	Genus **FENESTELLA** Lonsdale 1839
Fenestella affluensa Bretnall 1926	*Fenestella affluensa* Bretnall 1926
Fenestella alia (Crockford 1944b)	*Fenestella altcarinata* (Crockford 1941b)
Fenestella amplia (Crockford 1944b)	*Fenestella amplia* (Crockford 1944b)
Fenestella basleoensis Bassler 1929	*Fenestella aspratilis* Bassler 1929
Fenestella cacuminatis (Crockford 1944a)	*Fenestella bituberculata* (Crockford 1941b)
Fenestella chapmani (Crockford 1944b)	*Fenestella bownenesis* Wass 1968a
Fenestella columnaris (Crockford 1944a)	*Fenestella cantharifórmis* (Crockford 1941b)
Fenestella disjecta (Crockford 1944a)	*Fenestella* cf. *columnaris* (Crockford 1944a)
Fenestella hindei Crockford 1957	*Fenestella dispersa* (Crockford 1943a)
Fenestella horologia Bretnall 1926	*Fenestella (Levifenestella?) expansa* (Crockford 1945b)
Fenestella lennardi (Crockford 1944a)	*Fenestella expansa* var. *nodulifera* (Crockford 1945b)
Fenestella princeps (Crockford 1944a)	*Fenestella exserta* Laseron 1918
Fenestella ruidacarinata (Crockford 1944a)	*Fenestella fossula* Lonsdale 1844
Fenestella sparsigemmata (Crockford 1944b)	*Fenestella granulifera* (Crockford 1941b)
Fenestella valentis (Crockford 1944a)	*Fenestella horologia* Bretnall 1926
	Fenestella? ignota (Etheridge 1921) Wass 1967b
	Fenestella quinquecella (Crockford 1941b)
	Fenestella rockhamptonensis (Crockford 1945b)
	Fenestella simulatrix (Crockford 1945b)
	Fenestella sparsa (Crockford 1945b)
	Fenestella sparsinodata (Crockford 1945b)
	Fenestella spinifera (Crockford 1945b)
	Fenestella springsurensis Wass 1968a
	Fenestella (Parafenstella) sp. Wass 1968a
	Genus **HEMITRYPA** Phillips 1841
	Hemitrypa sexangula Lonsdale 1844
	Genus **PENNIRETEPORA** d'Orbigny 1849
Penniretepora fossata Crockford 1944b	*Penniretepora* sp. Wass 1968a
Penniretepora granulata Crockford 1944b	*Penniretepora triporosa* Crockford 1944b
Penniretepora triporosa Crockford 1944b	
	Genus **LYROPORELLA** Simpson 1895
Lyroporella erkosoides (Etheridge Jnr 1926)	
	Family POLYPORIDAE Vine 1883
	Genus **LYROPORA** Hall 1857
Lyropora joselina Crockford 1957	
	Genus **POLYPORA** M'Coy 1844
Polypora australis (Hinde 1890)	*Polypora dichtoma* Crockford 1941b
Polypora bruteni Wass 1967a	*Polypora keppelensis* Crockford 1962
Polypora kimberleyensis Crockford 1957	*Polypora linea* Crockford 1941b
Polypora lyndoni Ross 1963	*Polypora magnafenestrata* Crockford 1941b
Polypora megastoma (de Koninck 1863)	*Polypora montuosa* (Laseron 1918)
Polypora multiporifera Crockford 1944a	*Polypora multinodata* Crockford 1941b
Polypora natalis Crockford 1957	*Polypora pertinax* Laseron 1918
Polypora obesa Crockford 1957	*Polypora smithii* Etheridge 1892
Polypora retificis Crockford 1944a	*Polypora triseriata* Crockford 1941b
Polypora wadei Crockford 1957	*Polypora virga* Laseron 1918
Polypora woodsi (Etheridge Jnr 1892)	*Polypora woodsi* (Etheridge Jnr 1892)

Table 10. Permian bryozoan species from Western and eastern Australia *(continued)*

Western Australia	eastern Australia
	Genus **AUSTRALOPOLYPORA** Engel 1979
Australopolypora fovea (Crockford 1944a)	
	Genus **PROTORETEPORA** de Koninck 1876
Protoretepora ampla (Lonsdale 1844)	*Protoretepora ampla* (Lonsdale 1844)
Protoretepora flexuosa Crockford 1957	*Protoretepora konincki* (Etheridge Jnr 1892)
Protoretepora robusta (Bassler 1929)	
	Family ACANTHOCLADIIDAE Zittel 1880
	Genus **PTYLOPORA** M'Coy 1844
	Ptylopora carinata (Crockford 1941b)
	Ptylopora sp. Wass 1968a
	Family SEPTOPORIDAE Morozova 1962
	Genus **SEPTOPORA** Prout 1859
Septopora ornata Crockford 1944b	
	Genus **SYNOCLADIA** King 1849
Synocladia spinosa Crockford 1944b	
Synocladia teicherti Crockford 1957	
	Genus **DIPLOPORARIA** Nickles & Bassler 1900
	Diploporaria sp. Wass 1968a
	Suborder RHABDOMESINA Astrova & Morozova 1956
	Family RHABDOMESIDAE Vine 1884
	Genus **RHABDOMESON** Young & Young 1874
Rhabdomeson bispinosum Crockford 1944b	
Rhabdomeson bretnalli Crockford 1957	
Rhabdomeson grande Bassler 1929	
Rhabdomeson mammillatum (Bretnall 1926)	
Rhabdomeson mammillatum var. nov. Crockford 1957	
Rhabdomeson? ramosa (Crockford 1957)	
	Family RHOMBOPORIDAE Simpson 1895
	Genus **RHOMBOPORA** Meek 1872
Rhombopora? tenuis Hinde 1890	*Rhombopora filiformis* Crockford 1941b
Rhombopora? hindei Etheridge 1907a (North. Terr.)	*Rhombopora laxa* (Etheridge Snr 1872)
	Rhombopora sp. Wass 1968a
	Genus **SAFFORDOTAXIS** Bassler 1952
Saffordotaxis castanea Crockford 1957	*Saffordotaxis multinodata* Wass 1968a
Saffordotaxis elegans Crockford 1957	
Saffordotaxis multigranulata (Bretnall 1926)	
Saffordotaxis sp. cf. *S. wanneri* (Bassler 1929)	
	Genus **MEGACANTHOPORA** Moore 1929
Megacanthopora? scalariformis Crockford 1957	
	Family HYPHASMOPORIDAE Vine 1886
	Genus **OGBINOPORA** Shishova 1965
Ogbinopora? etheridgei (Bretnall 1926)	
	Genus **STREBLOTRYPA** Vine 1885
Streblotrypa sp. cf. *S. minutula* Bassler 1929	*Streblotrypa (Streblascopora) marmionensis*
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)	(Etheridge Jnr 1926)
Streblotrypa brownei Etheridge Jnr 1907a (North. Terr.)	

Table 10. Permian bryozoan species from Western and eastern Australia *(continued)*

Western Australia	eastern Australia
UNCERTAIN PLACING	
Genus **RHOMBOCLADIA** Rodgers 1900	
Rhombocladia minor Crockford 1944b	
Rhombocladia spinulifera Crockford 1944b	
Genus **STREBLOCLADIA** Crockford 1944	
Streblocladia excavata Crockford 1944b	
Order TREPOSTOMATA Ulrich 1882	
Family ULRICHOTRYPELLIDAE Romanchuk 1967	
Genus **HINGANELLA** Romanchuk 1967	
Hinganella? bella (Crockford 1957)	
Family DYSCRITELLIDAE Dunaeva & Morozova 1967	
Genus **DYSCRITELLA** Girty 1911	
Dyscritella adnascens Bassler 1929	*Dyscritella corella* Wass 1968b
Dyscritella? liveringa Crockford 1957	*Dyscritella porosa* Crockford 1943a
Dyscritella macrostoma Crockford 1957	*Dyscritella restis* Crockford 1943a
Dyscritella spinigera (Bassler 1929)	
Dyscritella tenuirama Crockford 1957	
Genus **DYSCRITELLINA** Morozova 1967	
Dyscritellina? globosa (Crockford 1957)	*Dyscritellina?* sp. (Wass 1968a)
Genus **PSEUDOBATOSTOMELLA** Morozova 1960	
Pseudobatostomella bruteni (Crockford 1957)	*Pseudobatostomella cylindrica* (Crockford 1941b)
Pseudobatostomella? dickinsi (Ross 1963)	
Pseudobatostomella? fisheri (Ross 1963)	
Pseudobatostomella? lyndoni (Ross 1963)	
Family STENOPORIDAE Waagen & Wentzel 1886	
Genus **STENOPORA** Lonsdale 1844	
Stenopora hemispherica Waagen & Wentzel 1886	*Stenopora australis* Nicholson & Etheridge 1886
Stenopora lineata Crockford 1957	*Stenopora contigua* Crockford 1945a
Stenopora punctata Crockford 1957	*Stenopora crinita* Lonsdale 1845
Stenopora spicata var. *obtusa* Crockford 1957	*Stenopora etheridgei* Crockford 1945a
Stenopora? sp. A Etheridge Jnr 1914	*Stenopora frondescens* Crockford 1943a
	Stenopora gimpiensis Etheridge Jnr 1892
	Stenopora gracilis (Dana 1849)
	Stenopora grantonensis Crockford 1943a
	Stenopora hirsuta Crockford 1945a
	Stenopora jackii Nicholson & Etheridge 1886
	Stenopora johnstoni Etheridge Jnr 1891
	Stenopora leichhardtii Nicholson & Etheridge 1886
	Stenopora nigris Crockford 1943a
	Stenopora ovata Lonsdale 1844
	Stenopora parallela Crockford 1945a
	Stenopora pustulosa Crockford 1945a
	Stenopora rugosa Crockford 1945a
	Stenopora spiculata Crockford 1945a
	Stenopora tasmaniensis Lonsdale 1844
Genus **STENODISCUS** Crockford 1945	
Stenodiscus hardmani Crockford 1957	*Stenodiscus moniliformis* Crockford 1945a
Stenodiscus variabilis Crockford 1957	*Stenodiscus* sp. Wass 1968a
Genus **TABULIPORA** Young 1883	
Tabulipora scissa Crockford 1957	

NOTE: North. Terr. = Northern Territory

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a complex fluvial, estuarine, deltaic and shallow-marine environment. This formation is overlain by the Hardman Formation (100 m) which contains evidence of a further marine transgression of Early Tatarian age. The third fossil horizon with three species, namely *Dyscritella tenuirama, D. liveringa* and *Stenodiscus hardmani*, is found at this level.

A comparison with eastern Australian faunas

David (1950) expressed the view that there existed little relationship between eastern and western Permian faunas and that most likely there was no direct link between the two depositional areas. This suggestion was qualified by the reservation that a better knowledge of the faunas could reverse this opinion.

Subsequently, Crockford (1951) confirmed that there were a few species of bryozoans common to both regions. These include *Fenestella horologia, Polypora woodsi,* and *Protoretepora ampla* with the latter supporting a correlation of the Noonkanbah Formation with the Muree Sandstone in the Hunter Valley, NSW. Some similarity of stenoporids from the Bowen Basin, Queensland, with those of Western Australia was also noted. The discovery by Banks (*in* Hill, 1955) of Tasmanian faunas with Western Australian affinities considerably strengthened the concept of a southern link between east and west.

Studies by Wass (1968a,b, 1969, 1971) on the Permian faunas of eastern Australia have extended our knowledge of the limited similarity which exists between bryozoan faunas of the two regions. In addition to the species mentioned by Crockford (1951), Wass (1971) reported a further ten genera which are known to occur in both regions, namely *Stenodiscus, Dyscritellina?, Fistulipora, Pennirétepora, Goniocladia, Streblascopora, Saffordotaxis, Rhombopora, Aetomacladia,* and *Liguloclema*, with equivalent species from each area showing considerable similarities. However, further study and a tabulation (Table 10) of the available species in the two regions highlights some interesting differences:

(a) Bryozoans of the Order Cystoporata (principally *Fistulipora, Dybowskiella, Hexagonella, Prismopora,* and *Etherella*) are a major component (32 species) of the Western Australian Permian fauna. This is in stark contrast to their occurrence in the eastern states where the order is almost unrecorded, being known by rare specimens of *Goniocladia, Aetomacladia, Fistulipora,* and *Liguloclema*.

(b) The situation is reversed in the Order Trepostomata. In this group there are several species of *Dyscritella, Pseudobatostomella,* and *Stenopora* in both areas of the continent but the record of this order in Western Australia is very sparse compared with the overwhelming abundance of species and material in the eastern states.

(c) In the Order Cryptostomata, there are numerous species of *Fenestella, Polypora, Pennirétepora,* and *Protoretepora* found in both regions. Species overlap between the two regions is insignificant. Some rarer distinctive taxa, such as *Septopora, Synocladia* and *Ptylopora*, have also been found but occur in only one of the two regions.

Table 10 emphasises that there are few common species and some taxonomic groups have little or no representatives in either the eastern or western region. The implication from this comparison is that there are significant differences between the Permian bryozoan faunas occurring on either side of the Australian continent which have not been bridged by existing taxonomic studies, notwithstanding the existence of some cosmopolitan taxa in both regions.

Bryozoa genera and species

Systematic descriptions of the bryozoa are on microfiche sheets 2-3 in a pocket inside the back cover.

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Brachiopods

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In Western Australia, members of the phylum Brachiopoda are abundant and valuable in correlation, biostratigraphy, and the recognition of faunal provinces. The majority of available collections have now been monographed, with the remaining groups being investigated by us. New species will undoubtedly be recognized in future collections but aspects of species diversity and generic make-up of the faunas are now known in some detail. The concept of a distinct Western Australian Permian faunal province, mentioned by Schuchert (1935) and progressively amplified by such reviews as those of Teichert (1951), Thomas (1969) and Archbold (1983a) — the last one formally naming the Westralian Province, can now be approached in an analytical manner down to the level of relative species diversity for most genera (Archbold, 1983a). It is significant that the knowledge of the Western Australian Permian Brachiopoda has reached this stage of analysis, considering the remoteness of the outcrops. By comparison, the eastern Australian Permian brachiopods are collectively less well known, despite progressive documentation since 1825.

General review of the faunas

Westralian faunas fall into three main groups. The first group consists of the Early Sakmarian (Tastubian) faunas which were impoverished and include representatives of *Streptorhynchus, Permorthotetes, Kiangsiella;* the productids *Lyonia* and rare *Linoproductus*; and the spiriferids *Brachythyrinella, Trigonotreta, Punctocyrtella,* and *Tomiopsis*. Undetermined terebratulid and athyridid species are also present, as is a poorly known *Rhynchopora*. *Lyonia, Linoproductus, Rhynchopora,* and *Brachythyrinella* are restricted to the Tastubian faunas (which may range down into the Asselian). *Lyonia* is now known to be restricted to the Lyons Group of the Carnarvon Basin. The described occurrence of the species *L. lyoni* from the Fossil Cliff Member of the Perth Basin by Coleman (1957), a report accepted by Archbold (1983b), can now be disproved; the specimens are, in fact, from the High Cliff Sandstone and belong to a new species of *Cancrinella*.

These Early Sakmarian faunas, indicative of cold water (Dickins, 1978), exhibit a strong Gondwanan affinity and are associated with the bivalve *Eurydesma*. Links with the Austrazean Province include *Streptorhynchus (Grumantia?), Brachythyrinella*, and *Trigonotreta*.

The second group is made up of a series of faunas which range from Late Sakmarian (Sterlitamakian) to Middle Kungurian in age, and are rich and varied (over 180 species), with many genera demonstrating links with Cimmerian (= Southern Tethyan), Uralian, and Boreal faunas. Links with the Austrazean Province are relatively minor, particularly considering the geographical proximity. Many genera are represented by more than one species indicating that evolving plexi existed at that time within or close to the Western Australian basins. Water temperatures varied from cool to warm temperate for these faunas (Dickins, 1978).

Genera present include *Semilingula* (one species), the strophomenid *Streptorhynchus*, the Boreal genus *Arctitreta, Kiangsiella, Permorthotetes* (apparently endemic to Western Australia), and poorly known *Derbyia*. Within the Productida, the chonetids are represented by *Tornquistia, Demonedys, Neochonetes (Sommeriella)* (an abundant subgenus), *Chonetinella* (poorly known genus), the Boreal genus *Svalbardia* (also known from the Cimmerian Province), and *Quinquenella*.

Strophalosiids include true *Strophalosia* and *Heteralosia, Wyndhamia* and *Echinalosia* (both genera characteristic of the Austrazean Province), and *Lialosia* (possibly present in the Himalayas). The anomalous *Mingenewia*, represented by one species, is only known from Western Australia.

The Aulostegacea are represented by species attributed to *Aulosteges* and *Taeniothaerus*, the latter also present in the Austrazean Province. The Productellacea are represented by *Stictozoster*, a genus of the Cimmerian Province and the Boreal Realm. Overtoniids include *Comuquia* (one species), a Cimmerian–Western Tethyan–Uralian genus; a probable species of *Lethamia*, an Austrazean genus; and *Dyschrestia*. The marginiferid *Retimarginifera*, a genus of the Cimmerian Province, is represented by two species.

Callytharrella and *Costiferina* of the Dictyoclostidae each have one species. Both genera are known from the Cimmerian Province, the latter being widespread throughout southern Tethyan faunas and rare in the Northern Province of China. Of the Linoproductidae, the cosmopolitan *Cancrinella* is an abundant genus and *Globiella*, a Cimmerian–Uralian–Boreal genus, is represented by two species.

Rhynchonellida are rather sparsely represented by two stenoscismatacean genera. *Stenoscisma* has several species, one of Cimmerian affinity, and a species of *Camerisma?* shows cosmopolitan affinities.

The Syringothyridacean spiriferids include *Myodelthyrium* (previously referred to *Pseudosyringothyris*), *Punctocyrtella, ?Pseudosyrinx*, and several new punctate genera. *Myodelthyrium* characterizes the Sterlitamakian faunas and may have Boreal affinities. *Punctocyrtella* carries over from the Tastubian faunas. The new genera are less common and are found only in the Baigendzhinian faunas. They appear to be endemic.

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A rare, undescribed species of *Spiriferinaella* sparsely represents the Paeckelmanellacea.

Of the Spiriferidae, *Neospirifer* is an abundant genus with species that show affinities to plexi of the genus that are characteristic of the Cimmerian Province. *Trigonotreta* is a subordinate element of the Westralian faunas with the species not being close to the Austrazean species. The striking genera *Latispirifer* and *Crassispirifer* may also be present in the Cimmerian Province. *Costatispirifer* and *Cratispirifer* (each known from one species) are endemic to Western Australia. *Fusispirifer*, widespread in these faunas, is also known from the Cimmerian Province, eastern Boreal faunas (Kolyma region), and the Austrazean Province. An additional large genus, possibly related to *Pondospirifer*, is also present in these faunas and is represented by three undescribed species from the Callytharra, Wandagee–Noonkanbah, and Baker–Coolkilya levels. *Pondospirifer* is known from the Himalayan region of the Cimmerian Province. *Spiriferella*, *Elivina*, and *Spirelytha* are known from specific levels and represent genera that migrated into the Westralian Province from warmer faunas (the latter genera not being present in Austrazean faunas). *Phricodothyris* is represented by one rare species. *Tomiopsis* is represented by numerous relatively rare species. All species are distinct from Austrazean *Ingelarella*. The Boreal *Fredericksia* appears to be represented by two extremely rare species.

The Spiriferinida are represented by the genera *Gjelispinifera, Lamnaespina, Callispirina;* and by *Hustedia*. The first three characterize the Callytharra Formation faunas. *Gjelispinifera* has affinities with Cimmerian (Timor) species. *Callispirina* has widespread Cimmerian affinities. *Lamnaespina* has links with New Zealand faunas. There are two species referable to *Hustedia*: one is a small species from the Callytharra Formation; another from the Baigendzhinian faunas is an endemic form, possibly belonging to a new genus.

The athyrids are represented by several species of the *Cleiothyridina* type. All species require modern analysis and will be described by us elsewhere.

Terebratulids occur sporadically and are represented by the genera *Fletcherithyris, Hoskingia, Yochelsonia, Gilledia*, and a possible *Hemiptychina*. Three of the genera are present in the Austrazean Province.

The third group is a distinctive Chhidruan (Early Tatarian) fauna known from the Canning and Bonaparte Basins. Genera present include *Streptorhynchus, Derbyia, Neochonetes (Sommeriella), Liveringia, Echinalosia (Notolosia), Aulosteges, Taeniothaerus, Megasteges, Waagenoconcha, Costiferina, Leptodus, Latispirifer, Neospirifer, Tomiopsis, Hustedia, Cleiothyridina, Fletcherithyris*, and *Hoskingia*. Many of the forms are close to Himalayan and Salt Range (Pakistan) species and reflect a subtropical to tropical water temperature (Dickins, 1978).

Classification

For groups that have been studied by us recently we follow the classification schemes utilized in those studies. The Orthotetacea have been comprehensively reviewed by Cooper and Grant (1974) and their classification has been followed. The schema of Manankov (1984) has not been adopted.

The taxon Productida is used at the ordinal level following Soviet authors, as is the taxon Athyridida (Sarycheva and Sokolskaya, 1959; Dagis, 1974).

The punctate syringothyridacean genera *Myodelthyrium, Punctocyrtella*, and *Pseudosyrinx* have been placed in the Licharewiidae (Slyusareva, 1958), adopting the usage of Grigoryeva (1977).

The spiriferinid genera have been classified in the general groupings proposed by Cooper and Grant (1976) but with the incorporation of Gjelispiniferinae (Ivanova, 1975) and Punctospiriferidae (Waterhouse, 1975).

Palaeoecology

Based on the analysis by Elias (1937) of the Early Permian of Kansas, USA, Thomas (1958b) recognized three broad fossil assemblages in the Western Australian Permian. Arranged in order from relatively shallow to relatively deep water, the three assemblages are:

(1) 'Molluscan assemblage' — largely bivalves with very subordinate calcareous brachiopods. This assemblage is commonly found in the Coolkilya Sandstone, Lightjack Formation, and 'Lower Marine Beds' of the Port Keats Group.

(2) 'Mixed assemblage' — bivalves, calcareous brachiopods, bryozoans, and crinoids. This is a typical assemblage of intervals within the Callytharra Formation, Byro Group, and Noonkanbah Formation. These stratigraphical sequences also exhibit the third assemblage at times.

(3) 'Brachiopod assemblage' — predominantly calcareous brachiopods, with bryozoans, corals and crinoids; molluscs are rare. In addition to intervals within the Callytharra Formation and the Noonkanbah Formation, this assemblage is typical of such units as the 'Madeline Formation' and Wandagee Formation.

Archbold (1981d) noted that chonetid brachiopods occur in two types of coquinites: those where individuals are disarticulated and invariably worn, and those where individuals are conjoined with excellent preservation of fine surface ornament. Based on work of Elias (1966), the former coquinite type probably indicates deposition in agitated water above wave base, while the latter coquinite type indicates deposition in quieter deeper water.

Palaeoecological studies have been subordinate to the descriptive and biostratigraphical studies carried out to date. Comments on the palaeoecology are invariably 'buried' within such works. Nevertheless, now that the

basic composition of the Western Australian marine Permian faunas is largely known, a wealth of potential exists for palaeocological investigations. Such detailed studies are hampered by the distance of outcrops from settled areas.

Brachiopod genera and species

Systematic descriptions of the brachiopods are on microfiche sheets 3–5 in a pocket inside the back cover.

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Bivalves

by J.M. Dickins [*] and S.K. Skwarko [**]

The bivalves are a prominent constituent of the Western Australian Permian fauna and, arguably, are more conspicuous than any other marine group with the exception of the brachiopods. They tended to be especially plentiful in the littoral and the immediate sublittoral zone, whereas the brachiopods were more common in slightly deeper water (Thomas, 1958; Dickins, 1963). No deep shelf or deeper water faunas have been identified.

As can readily be seen from inspecting the bivalve range charts (Dickins, 1963) there is a rapid change in species from level to level. Because of this they are particularly useful in correlation both in different parts of a single basin and between basins. For the Early Permian (see below), because of the provincialism due to temperature, correlation using bivalves is less readily undertaken between different provinces. Not withstanding this, reliable correlation of relatively short time intervals can be undertaken between Western and eastern Australia as well as other parts of the world such as South Africa, southern and central Asia, South America, and even farther afield. When bivalves are used together with other groups, especially brachiopods and gastropods, an even more satisfactory result can be obtained. Because the Late Permian faunas are more cosmopolitan, with some single species very widespread, faunal correlation is easier. However, the world-wide regression in the Late Permian, which culminated at the Permian–Triassic boundary (Dickins, 1983), causes difficulties. Because of the faunal relationships outlined here and of the completeness of the Western Australian marine sequence (except for the uppermost Permian), it can serve as a scale for South America, India, and South Africa, and possibly for other parts of the world.

The relationship between water temperature and bivalves is discussed under 'Palaeoclimate'. Some differences between Western and eastern Australia bivalve faunas are of interest. *Vacunella, Pyramus,* and *Myonia* (and *Pachymyonia*) are poorly developed in Western Australia. On the other hand, *Edmondia, Glyptoleda, Praeundulomya, Undulomya*, and *Oriocrassatella* are poorly developed or absent from eastern Australia, as are *Parallelodon, Pseudomyalina, Cosmomya, Euchondria, Acanthopecten*, and *Girtypecten;* of these, *Glyptoleda, Parallelodon, Pseudomyalina*, and *Oriocrassatella* have been found only in Queensland.

Since this volume has been prepared the following paper has been published:

MORRIS, N.J., DICKINS, J.M., and ASTAFIEVA-URBAITIS, K., 1991, Upper Palaeozoic Anomalodesmatan Bivalvia: Bulletin of the British Museum of Natural History (Geology), v.47, pt 1, p.51-100.

This publication should be consulted for possible modification of some generic names used in the bivalves section of this volume and for some aspects of the classification.

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Bivalves genera and species

Systematic descriptions of the bivalves are on microfiche sheets 5–6 in a pocket inside the back cover.

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Ammonoids

by Brian F. Glenister, Frederick S. Rogers*, and S.K. Skwarko***

Historically, ammonoids have played a pivotal part in intercontinental correlation of the Western Australian Permian. Early inability to differentiate Australian Carboniferous biotas from Permian ones resulted in use of the term 'Permo-Carboniferous' and introduction of the provincial 'Kamilaroi System' (David, 1950). Many early workers speculated on the affinities and age of Australian Late Palaeozoic ammonoids (Glenister and Furnish, 1961), but Miller (1932) made the first detailed investigation in attempting to identify the systemic boundary. He was able to establish that *Gastrioceras jacksoni* Etheridge Jnr 1907 from the Holmwood Shale in the Irwin River area of the Perth Basin, Western Australia, is related to '... the Permian forms of Timor, the Artinsk Region of European Russia, and Texas', thereby identifying the Early Permian (Middle Permian of Miller) of Western Australia. New occurrences of Permian ammonoids have been added sporadically in objective, stratigraphic succession above the horizon of *Juresanites jacksoni* (Miller, 1936; Teichert, 1942, 1944; Teichert and Glenister, 1952; Glenister and Furnish, 1961). Eighteen ammonoid species are now known from the Permian of Western Australia, thirteen of them named. Although most of these ammonoids are extremely rare, the successions span almost the entire Permian. With the recent addition of *Cyclolobus*, Western Australia, thus, becomes one of the most useful reference regions for Permian biostratigraphy. International correlations in current use (Archbold, 1981) are largely those presented by Glenister and Furnish (1961), although stage terminology has changed significantly (e.g. Furnish, 1973) through both refinement and addition.

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The manuscript of the present paper was submitted in June 1985, and only editorial alterations have been made since that time. In the interim, the following two publications have appeared:

GLENISTER, B.F., BAKER, C., FURNISH, W.M., and THOMAS, G.A., 1990, Additional Early Permian Ammonoid Cephalopods from Western Australia: Jour. Paleontology, v.64, p.392-399.

GLENISTER, B.F., BAKER, C., FURNISH, W.M., and DICKINS, J.M., 1990, Late Permian Ammonoid Cephalopod *Cyclolobus* from Western Australia: Jour. Paleontology, v.64, p.399-402.

Stage nomenclature is considered briefly in these studies (p.399). Our current understanding is that the Amarassi assemblage of Timor does not warrant separate stage designation, and should be considered as lower Dzhulfian. This conclusion should be noted in reading the present study (B.F. Glenister, December 1990).

Reference assemblages of Permian ammonoids

No single stratigraphic sequence provides a satisfactory reference for the entire Permian ammonoid succession. However, a functional composite is available by combination of data from three or four areas, the southern Ural Mountains of the USSR, southwestern United States, south China, and/or Iran (Glenister, 1981). Three of the Lower Permian stages (Asselian, Sakmarian, Artinskian) are based on fairly adequate stratigraphic sequences in the southern Ural Mountains (Ruzhentsev, 1952; 1956), and this same general area affords promise for selection of a Carboniferous–Permian boundary stratotype. Comparable successions are available in west Texas, but there are profound provincial differences between the ammonoid faunas of the two areas. In particular, the American Lower Permian is characterized by, and zoned primarily by reference to, the Perrinitidae, whereas no representatives of that family are known from the Urals. However, enough cosmopolitan families are common to the two areas to permit confident correlation (Glenister, 1981). Progressive chemical restriction and eventual non-marine character of the post-Artinskian sequences of the Urals and

the Russian Platform render these areas unsuitable as references for the younger Permian stages. In fact, ammonoid evidence from the type Kungurian (Bogoslovskaya, 1976), supposedly the reference for highest Lower Permian, suggests that this interval correlates with the Upper Artinskian Baigendzhinian Substage. Post-Artinskian, pre-Upper Permian ammonoid sequences occur in objective stratigraphic succession in the American Southwest, and provide the reference type for the uppermost Lower Permian Roadian Stage (Nassichuk et al., 1966; Furnish, 1966). Bogoslovskaya (1976) has demonstrated that ammonoids from the type Kungurian are pre-Roadian. Ammonoids from type and correlative Roadian sequences were listed by Furnish (1973).

The American Southwest provides sequences that could serve effectively for definition of the Lower–Upper Permian series boundary and stratotypes for the basal Upper Permian (Guadalupian) Wordian and Capitanian stages. Diverse ammonoid faunas occur throughout, and zonation is based firmly on the Cyclolobidae (Furnish, 1966; Furnish and Glenister, 1970). However, a problem remains in attempting to relate the top of the Guadalupian to those successions in Iran and Transcaucasia, Kashmir, and south China that afford references for the higher Upper Permian stages, Abadehian (Amarassian), Dzhulfian, and Changhsingian.

A possible key to Upper Permian correlation between the two hemispheres is the occurrence in the post-Capitanian La Colorada Beds of Coahuila, Mexico (Spinosa et al., 1970) and the lower Dzhulfian of Iran (Spinosa et al., 1970; Taraz et al., 1981) of ancestral araxoceratins, especially *Eoaraxoceras*. Both ammonoid and fusulinacean successions in these sequences as well as physical stratigraphy suggest a significant interval of time between the Capitanian and Dzhulfian. This interval has been termed Abadehian (Taraz, 1971), with the pre-Dzhulfian of Abadeh, central Iran, serving as reference. Ammonoids are relatively rare in the type Abadehian, although an indeterminate species of *Cyclolobus* occurs in association with *Xenodiscus* at 280 m beneath the base of the Dzhulfian (Taraz et al., 1981). More prolific ammonoid sequences occurring in objective stratigraphic succession beneath Dzhulfian (araxoceratin) faunas are known from Coahuila (Spinosa et al., 1975) and the Soviet Far-Eastern Maritime Province. A most significant sequence in the latter area, from the Lyudyanza Formation of Neizvestnaya Bay and the Artemovka River, Primor'ye Region, is under current study by Yu. Zakharov and colleagues (Zakharov, 1983; pers. comm., 1985) report an araxoceratin fauna underlain by strata in which the cyclolobid ammonoids *Timorites* and *Cyclolobus* occur in direct association. Such cyclolobid associations characterize the extremely diverse Amarassi ammonoid fauna of Timor (Spinosa et al., 1970), and it seems that the Abadehian corresponds approximately to the Amarassian.

Stratotype designations for these and, in fact, all Upper Permian stages are needed to stabilize nomenclature. For practical current purposes, Amarassian is used for ammonoid faunas comparable with those of Amarassi Province, especially for association of *Cyclolobus* and its direct progenitor *Timorites*.

Prolific ammonoid assemblages of the highest Permian stages, Dzhulfian and Changhsingian, occur in objective stratigraphic succession in both Iran (Taraz et al., 1981) and south China (Zhao et al., 1978). Precise correlation between these two areas has been established, and either could serve for designation as stratotypes. However, Iran has the advantage of objective succession of Dzhulfian upon Abadehian (Amarassian), and we, therefore, base the stage on the Transcaucasian Dzhulfa Beds from the *Araxilevis* Beds below through the *Vedioceras–Haydenella* Beds (Ruzhentsev and Sarycheva, 1965). This interval is the range zone of the otoceratid Subfamily Araxoceratinae and corresponds to the Wujipinian (Wujapingian) of south China. A profound change in ammonoid faunas occurs above the Dzhulfian, otoceratid (i.e. araxoceratin) dominance being replaced by that of the xenodiscaceans. These uppermost Permian sequences comprise the Dorasham Beds (Dorashamian; Rostovtsev and Azaryan, 1973) of Transcaucasia, from the *Phisonites* Beds below through the *Paratirolites* Beds (Ruzhentsev and Sarycheva, 1965). They correlate with the Chang-hsing Formation (Changhsingian; Furnish and Glenister, 1970) of south China (Zhao et al., 1981). No significant break in continuity of sedimentation occurred in south China, where 'Permian-type' brachiopods extend across the erathem boundary into the 'mixed faunas' of the basal Chinglung Group in association with the last of the characteristically Late Permian Family Otoceratidae (i.e. Subfamily Araxoceratinae), the definitively Triassic genus *Otoceras* (Sheng et al., 1984). By contrast, the boundary is marked by an unconformity in both Transcaucasia and central Iran. Consequently, south China is more suitable as stratotype for uppermost Permian and, perhaps, the erathem boundary, and Changhsingian is therefore used as designation for the terminal Permian stage.

Correlations based on ammonoids

In the following paragraphs, ammonoid evidence will be used exclusively to formulate and evaluate correlation hypotheses. Only in this manner can the maximum biostratigraphic potential of the group be realized. It will remain for others to add occurrence data derived from different biologic groups and independent sedimentologic and stratigraphic sources to effect the most plausible correlations. Suggested age assignments (Table 7) are basically those of Glenister and Furnish (1961), with the exception that Roadian, Amarassian and Changhsingian are now recognized as independent stages, thereby necessitating restriction of the Artinskian and Dzhulfian stages.

The oldest Australian Permian ammonoid sequence is from the Holmwood Shale of the Perth Basin (Table 7). Specific affinities of abundant *Juresanites jacksoni* in the Beckett (lower) Member of the Holmwood Shale suggest correlation with the Lower Sakmarian Tastubian Substage. Possibility of an Asselian age cannot be rejected completely, but *Juresanites* is not known to extend into the Upper Sakmarian Sterlitamakian Substage of the southern Urals. *Juresanites jacksoni* occurs higher, in the Woolaga Limestone (middle) Member of the Holmwood

Shale, in association with *Svetlanoceras irwinense*. Type *Svetlanoceras* and closely related forms are confined to the Asselian and Tastubian Substage, although advanced species similar to *S. irwinense* are also known from the Sterlitamakian. There is, therefore, no compelling ammonoid evidence for a post-Tastubian age for the lower and middle part of the Holmwood Shale. The genus *Metalegoceras*, which is represented in the Fossil Cliff (upper) Member of the Holmwood Shale by *M. kayi*, appeared in the late Tastubian but was abundant first in the Sterlitamakian. Numerical considerations, as well as the primitive suture of *M. kayi*, therefore, suggest a Sterlitamakian assignment for the Fossil Cliff Member; although late Tastubian cannot be precluded. For practical purposes, the Tastubian–Sterlitamakian boundary is considered to lie at the base of the Fossil Cliff Member.

The Callytharra Formation of the Carnarvon Basin can be assigned to the Sterlitamakian, and correlated with the Fossil Cliff Member of the Holmwood Shale, Perth Basin, and the Nura Nura Member of the Poole Sandstone, Canning Basin, on the presence in each of comparable metalegoceratids. Location near the base of the Callytharra Formation, Perth Basin, of the species *Svetlanoceras irwinense* indicates the possibility that the unit ranges down into the upper Tastubian, but the significance of this occurrence is equivocal. *Propopanoceras* is confined to the Sakmarian, and the presence in the Nura Nura Member of a species with advanced sutures strongly supports reference to the Upper Sakmarian Sterlitamakian Substage.

The distinctive adrianitid *Neocrimites* appeared first in the Baigendzhinian Substage of the Upper Artinskian, and recovery of this genus at the base of the Byro Group (Coyrie Formation), Carnarvon Basin, and in the top of the Wooramel Group (Billidee Formation) establishes a maximum age for parent strata. An advanced metalegoceratid, *Pseudoschistoceras simile,* is associated with *Neocrimites* in the Coyrie Formation and occurs also in the Cordalia Sandstone near the base of the Wooramel Group. The range of *Pseudoschistoceras* has not been determined precisely outside Western Australia, but occurrence of the Coyrie species in the Cordalia Sandstone lends at least weak support to the possibility that both units are of comparable age, Baigendzhinian. If this is the case, there is no ammonoid evidence for representation in the Carnarvon Basin section of the Lower Artinskian — Aktastinian Substage, a unit that is, however, poorly delineated outside the Urals (Glenister and Furnish, 1961). Physical stratigraphy lends support to the possibility that the Aktastinian record is missing at the unconformity above the Callytharra Formation.

Bamyaniceras, a medlicottiid that extends through the Artinskian and Roadian stages of the Lower Permian into the Wordian Stage of the Upper Permian, ranges from the basal Byro Group (Coyrie Formation) of the Carnarvon Basin up into the upper Byro Group (Nalbia Sandstone). It has also been recorded in the basal Liveringa Group of the Canning Basin. All Australian occurrences belong in a group of species that is restricted to the Artinskian and Roadian stages. *Bamyaniceras* is associated in the Nalbia Sandstone with the paragastrioceratid genera *Paragastrioceras* and *Daubichites*. The former characterizes the Baigendzhinian but ranges from the Asselian and extends as a rare element into the Roadian; *Daubichites* is confined to the Roadian. Overlap of these two paragastrioceratids establishes a Roadian age for the Nalbia Sandstone. *Daubichites* also confirms the Roadian age of the basal unit of the Kennedy Group of the Carnarvon Basin, the Coolkilya Sandstone, and the Lightjack Formation of the basal Liveringa Group in the Canning Basin.

Ammonoids of demonstrably Guadalupian age are unknown from Australia. However, the recent discovery of primitive *Cyclolobus* in the Cherrabun Member of the Hardman Formation, Canning Basin, confirms the presence of Upper Permian sedimentary rocks. The most plausible assignment is to the post-Guadalupian Amarassian Stage. Neither of the uppermost Permian stages (Dzhulfian and Changhsingian) is represented in ammonoid facies, and sedimentologic considerations suggest that much of latest Permian time is represented in Western Australia by unconformities and non-marine facies.

Ammonoid provincialism

Early Permian ammonoid faunas are strikingly provincial, whereas those of the Late Permian tend to be cosmopolitan (Nassichuk et al., 1966). The Western Australian Early Permian ammonoids clearly represent the Boreal Realm, in resembling those from the Urals and Arctic Canada in dominance of Metalegoceratidae and Paragastrioceratidae, and lacking the Tethyan Perrinitidae.

Systematics

'Into each life some rain must fall ...' Longfellow, The Rainy Day, 1842.

Several tentative conclusions presented by Glenister and Furnish (1961) were based on inadequate data, and reinterpretation is warranted. The first involves figured specimen UWA 35778 (Glenister and Furnish, 1961, p.731-732, pl. 80 figs 8, 9; text fig. 17), identified as 'Ammonitiform, family and gen. indet.' With a limonitized internal mould of 19 mm diameter, this form was labelled as having come from Nura Nura Ridge in the northern Canning Basin in association with a similarly preserved collection of invertebrates recognizable as having been derived from the Nura Nura Member of the Poole Sandstone. The authors realized that the specimen is '... a Mesozoic type ... not related to any known Permian form'. However, they described it because there was no geologic reason to suspect contamination. After 25 additional years of accumulation of data on Permian ammonoids it becomes increasingly improbable that the specimen belongs with the Nura Nura collection. It is best regarded as an indeterminate generalized Mesozoic ammonoid, probably a contamination from the Cretaceous.

Specimens UWA 45246 and UWA 45249 were described briefly in an addendum (Glenister and Furnish, 1961, p.732-733). The former, a well-preserved specimen from the type Fossil Cliff Member of the Holmwood

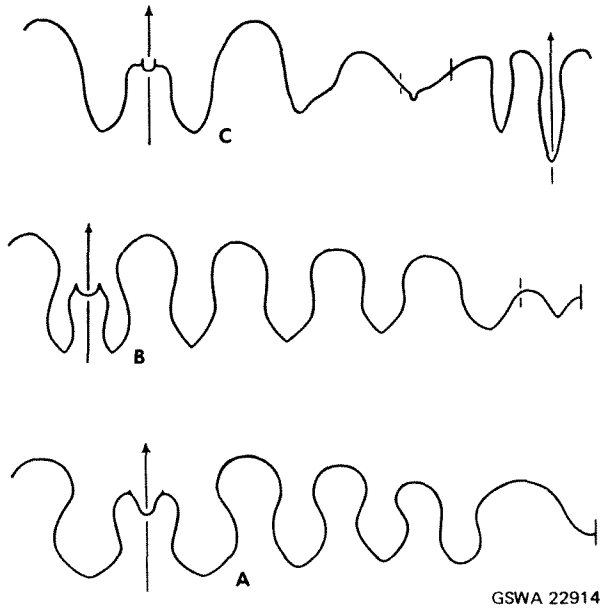

Figure 8. A, *Agathiceras applanatum* Teichert 1944: based on holotype UWA 21451 from Coolkilya Sandstone, Carnarvon Basin, at a conch diameter of 15mm.
B, *Neocrimites* sp.: based on figured specimen CPC 1776 from Coyrie Formation, Carnarvon Basin, at a conch diameter of approximately 14 mm, whorl width of approximately 14 mm, and whorl height of approximately 7 mm.
C, *Svetlanoceras irwinense* (Teichert & Glenister 1952): based on paratypes UWA 32037 (external suture) and UWA 32038 (internal suture) from Holmwood Shale, Perth Basin, at a conch diameter of approximately 9 mm, and whorl height of approximately 3.5 mm.

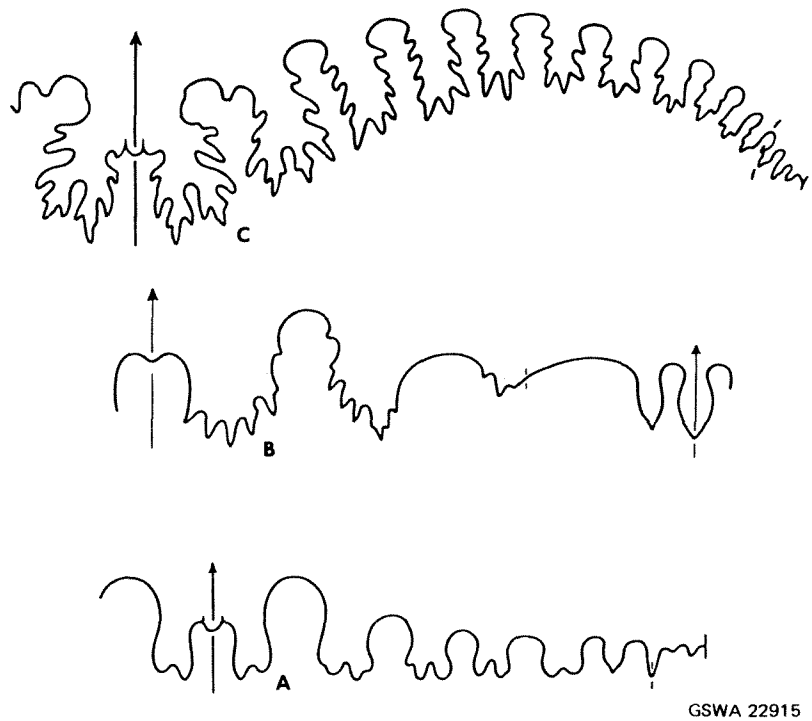

Figure 9. A, *Propopanoceras ruzhencevi* Glenister & Furnish 1961: based on holotype CPC 1773 from Nura Nura Member of the Poole Sandstone, northern Canning Basin, at a conch diameter of 12 mm, and whorl height of 5.5 mm.
B, *Thalassoceras wadei* Miller 1936: based on paralectotype UWA 19987 and lectotype UWA 19988 from Nura Nura Member of the Poole Sandstone, northern Canning Basin, at a conch diameter of approximately 11 mm.
C, *Cyclolobus persulcatus* Rothpletz 1892: based on hypotype CPC 25340 from Cherrabun Member of the Hardman Formation, northern Canning Basin, at a conch diameter of 30 mm.

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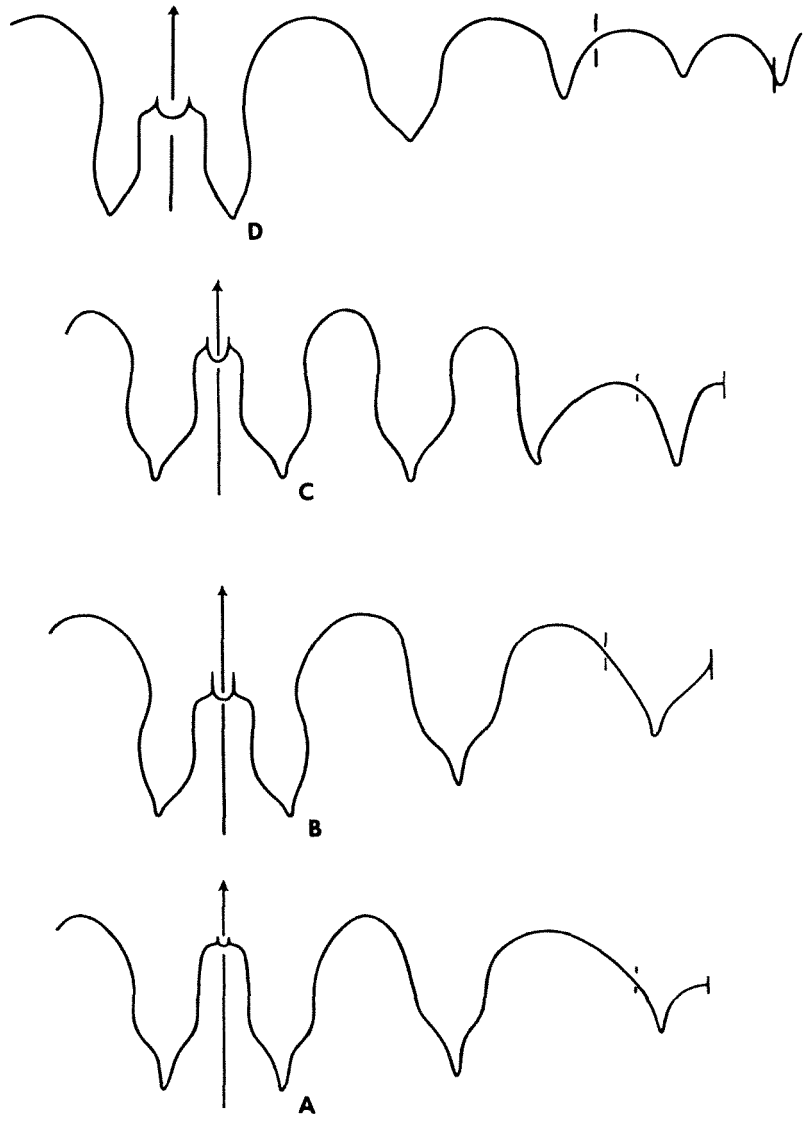

Figure 10. A, *Daubichites goochi* (Teichert 1942): based on holotype UWA 20504 from Coolkilya Sandstone, Carnarvon Basin, at a conch diameter of 90 mm.
B, *Paragastrioceras wandageense* Teichert 1942: based on holotype UWA 20142 from Nalbia Sandstone, Carnarvon Basin, at a conch diameter of 19 mm and whorl width of 13 mm.
C, *Metalegoceras* sp. nov. Glenister & Furnish 1961: based on figured specimen CPC 1770 from Callytharra Formation, Carnarvon Basin, at a conch diameter of approximately 85 mm.
D, *Metalegoceras kayi* Glenister, Windle & Furnish 1973: based on holotype UWA 45246 from Fossil Cliff Member of the Holmwood Shale, Perth Basin, at a conch diameter of 22 mm.

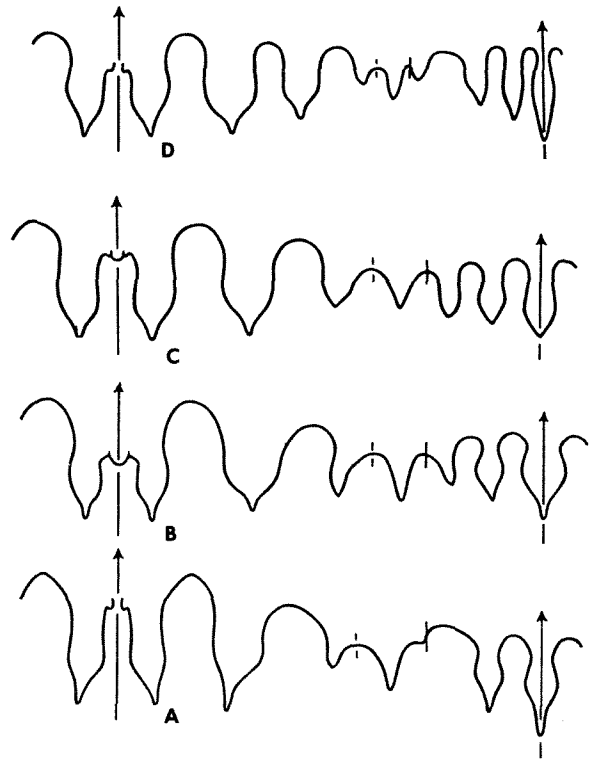

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Figure 11. A, *Juresanites jacksoni* (Etheridge Jnr 1907): based on hypotype UWA 37512 from Beckett Member of the Holmwood Shale, Perth Basin, at a conch diameter of 95 mm.
B, *Metalegoceras striatum* Teichert 1942: based on holotype UWA 20508 (internal suture), at a conch diameter of approximately 22 mm, and on hypotype CPC 1769 (external suture), at a slightly smaller diameter; both specimens from Nura Nura Member of the Poole Sandstone, northern Canning Basin.
C, *Metalegoceras australe* (Smith 1927): based on UWA 19985 (cotype of *M. clarkei)* from Nura Nura Member of the Poole Sandstone, northern Canning Basin, at a conch diameter of 25 mm.
D, *Pseudoschistoceras simile* Teichert 1944: based on paratype UWA 21440 from Coyrie Formation, Carnarvon Basin, at a conch diameter of approximately 80 mm.

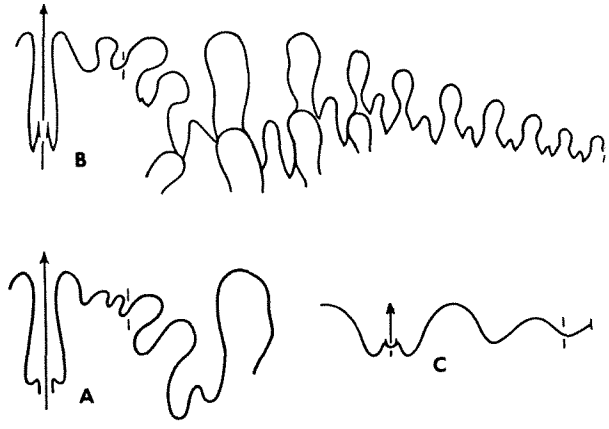

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Figure 12. A, *Bamyaniceras* sp. nov. Glenister & Furnish 1961: partial suture based on figured specimen CPC 1765 from Coyrie Formation, Carnarvon Basin, at a conch diameter of approximately 12 mm.
B, *Bamyaniceras australe* (Teichert 1942): based on hypotype CPC 1763 from Wandagee Formation, Carnarvon Basin, at a conch diameter of 55 mm.
C, cf. *Mescalites* sp.: based on figured specimen MUGD F6667 from Callytharra Formation, Carnarvon Basin, at a conch diameter of 7.5 mm.

Shale, was referred to the ancestral metalegoceratid genus *Juresanites*. Subsequent removal of matrix revealed sutural asymmetry with advanced development on one side that justified assignment to *Metalegoceras* and description as the holotype of *M. kayi* Glenister et al. (1973, p.1040-1043).

Specimen UWA 45249 is a poorly preserved discoidal ammonoid from Enanty Hill in the Irwin River District that was reputed to have been derived from the Permian Mingenew Formation. Based upon a conch form that is unusually evolute for Permian ammonoids, it was compared with the Late Permian ceratite *Xenaspis* Waagen (1895). This ammonoid was subsequently found to be associated with Jurassic species, and identified as *Fontannesia clarkei* (Crick 1894), by Coleman and Skwarko (1968).

Ammonoid genera and species

Systematic descriptions of the ammonoids are on microfiche sheets 6—7 in a pocket inside the back cover. Ammonoid sutures illustrated in Figures 8-12 are referred to in the systematics.

Acknowledgements

University of Iowa colleague W. M. Furnish participated in an earlier comprehensive study of Australian Permian ammonoids (Glenister and Furnish, 1961) and has collaborated in all subsequent investigations. Cathy Baker, University of Iowa student of Permian ammonoids, assisted in preparation of Figures 9C and 12C.

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Nautiloids

by Curt Teichert and S.K. Skwarko***

Although representatives of the Orthoceratoidea and Nautiloidea occur not uncommonly in the Permian of Western Australia, not a single species has so far been described.

In the Perth Basin, the stratigraphic distribution of nautiloids has been summarized by Playford et al., (1976), and appears to be limited to the three members of the Sakmarian Holmwood Shale. An orthoceroid nautiloid has been identified from the Beckett Member; an indeterminate nautiloid was found in the Woolaga Limestone Member; and *Domatoceras* sp., *Euloxoceras* sp., *Pseudorthoceras* sp., and *Stearoceras* sp. have been identified from the richly fossiliferous Fossil Cliff Member (Playford et al., 1976, p.94-96).

In the Carnarvon Basin, the nautiloids occur mainly in the north. The Late Sakmarian (Sterlitamakian) Callytharra Formation contains the well-preserved *Pseudorthoceras*, *Mooreoceras*, *Brachycycloceras*, *Domatoceras*, and *Stearoceras* (Teichert, 1951, p.83; Condon, 1954, p.71); and the Late Artinskian (Baigendzhinian) Wandagee Formation and Coolkilya Sandstone (in the old sense, Teichert, 1947) have yielded *Stearoceras* (or *Permonautilus*), *Titanoceras*, and *Phacoceras* (Condon, 1954, p.61, 67, 71, 78, 82; 1967, p.170), in addition to orthoconic forms which occur more rarely (Condon, 1954, p.61). The affinities of these faunas are with those of the Salt Range, Pakistan, and North America. It should, however, be remembered that these are preliminary identifications made by Teichert in the early 1940s, which have not been confirmed by detailed studies.

To the above statements, paraphrased from Teichert (1951, p.83) by McWhae et al. (1958, p.67-69), can be added: *Permonautilus* sp. from the Early Artinskian (Aktastinian) Billidee Formation and also from near Mount Sandiman Woolshed (Condon, 1967); and 'coiled nautiloids' from the Aktastinian 'Congo Formation' (now Moogooloo Sandstone), and unspecified 'nautiloids' from unknown localities in the Late Artinskian Coyrie Formation, Bulgadoo Shale, and Cundlego Formation (Condon, 1967, p.97, 102, 131, 142, 161).

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Gastropods

by J.M. Dickins and S.K. Skwarko***

Although descriptions of Western Australian Permian gastropods have been undertaken by R. Etheridge Jnr. and J.M. Dickins, much of the fauna still remains undescribed; for example, none of the gastropods from the Hardman Formation have been described. However, the limited descriptions available may be supplemented by the comprehensive lists of identifications included in Dickins (1963), Condon (1954, 1967), and Guppy et al. (1958).

Palaeoecology

Depth and type of bottom

From the close association of the gastropods with other faunal elements and clastic sedimentary rocks, there seems little doubt that most, if not all, of the gastropods recorded lived in relatively shallow water. There is no indication of any deep-water fauna such as might be suggested by a distinctive specialized association. Gastropods are common in clastic sedimentary rocks but perhaps they are

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more common in the bioclastic calcareous beds. This would not be surprising as the pleurotomariids and bellerophontids are filter feeders and turbid water would not likely be favourable for them. Probably some or many of them grazed on seaweeds and were able to move over muddy bottoms. Rocky shore and hard bottoms are almost unrecognized in the sequence.

Water temperature

Three broad water-temperature associations are recognized within the Permian bivalve fauna, and are discussed below in ascending stratigraphic sequence.

The lower cold-water association (Stage A)*

The lower cold-water association found with the *Eurydesma* fauna contains *Keeneia* and distinctive species of *Peruvispira* and *Mourlonia*. Bellerophontids — such *Bellerophon, Euphemites, Stachella* and *Retispira* — are absent. Although the bellerophontid *Warthia* has not been recorded, from its occurrence in eastern Australia in cold-water faunas, it might also be expected. *Warthia, Peruvispira*, and *Mourlonia* appear to have a rather wide temperature tolerance; although due to the absence of other genera they are more prominent in the cold-water faunas.

The higher temperate-water association (Stages B–D)*

As well as the genera occurring in the sequence below, pleurotomariids and bellerophontids are found in the higher temperate-water association. Other genera, such as *Straparolus, Macrochilina*, and *Naticopsis?* are also present. The bellerophontids include *Bellerophon, Euphemites, Stachella* and *Retispira*, and the pleurotomariids include the subgenera *Pseudobaylea* and *Woolnoughia* and the genera *Ptychomphalina, Platyteichum*, and *Baylea*. This fauna, which persisted for a long time (Late Sakmarian to Kungurian), contrasts with warmer water faunas, such as those in Timor and southern Asia, not only in its lower generic diversity but also in the poor representation of *Straparolus*-like forms and in the complete absence of high-spired gastropods. On the other hand it contrasts with the faunas of eastern Australia which are on the whole regarded as remaining under a cold-water regime for longer (Dickins, 1978). In eastern Australia, apart from *Warthia* which is common, no other bellerophontids have so far been recorded, except a single species of *Stachella* in the Upper Permian of Queensland; high-spired gastropods and *Straparolus*-like forms are also entirely absent.

The upper warmer-water association (Stage F)*

The upper warmer-water association is not apparently more diverse than the underlying one and also lacks high-spired gastropods. The close specific resemblance to other faunas which appear to be of warm water in origin, (particularly to the Upper Permian fauna of the Salt Range, Pakistan) suggests that the fauna must be warm-temperate or even sub-tropical (even though, for example, high-spired gastropods occur in the Salt Range fauna).

Use in correlation

The value of Permian gastropods in correlation seems to have been under-rated. An inspection of figure 5 in Dickins (1963) will show that there is a change of species to be found at different levels probably, in general, more rapid than of either ammonoids or spores and pollen. There can be little doubt that when taxonomic description is further advanced, the gastropods will be more useful for correlation, especially in conjunction with other elements of the fauna.

Gastropod genera and species

Systematic descriptions of the gastropods are on microfiche sheet 7 in a pocket inside the back cover.

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* See 'Correlation and age of the Western Australian Permian strata'.

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Scaphopods

*by S.K. Skwarko**

Scaphopods are rare in the Western Australian Permian and little is known of them. Single specimens have been recorded from the Late Sakmarian–Late Artinskian Poole Sandstone, Canning Basin (McWhae et al., 1958, p.56), and from the Asselian–Early Sakmarian Lyons Group and the Late Artinskian 'Madeline Formation' (now Coyrie Formation)(Condon, 1967, p.48, 149) in the Carnarvon Basin. No studies have been carried out on these few specimens, and their repository is unknown.

Scaphopods were collected by the author in 1985 to the north-northwest of the Birdrong Bore, Middalya Station, Carnarvon Basin, in what is probably the Late Artinskian Wandagee Formation.

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Conulariids

*by G.A. Thomas***

Representatives of the enigmatic group Conulata are found sporadically in many Western Australian Permian sequences from a wide variety of marine environments of both cold and warmer waters. The group is in need of detailed study; collections are known to be housed in various Australian museums and university departments. Apparently only one genus *Paraconularia* Sinclair 1940 is represented. The characteristic eastern Australian genus *Notoconularia* Thomas (1969) does not appear to be present in the Permian rocks of Western Australia.

Until recently only one species, *P. warthi* (Waagen), had been named and described, from the Wooramel River area (Hosking, 1931, 1933). This was subsequently identified from various levels by Raggatt (1936), Raggatt and Fletcher (1937), Fletcher (1938), and Teichert (1951). *Paraconularia warthi* is a distinctive species from the cold-water Talchir Boulder Beds of the Salt Range, Pakistan. Its presence in Western Australia cannot be confirmed on available evidence. Other species are undoubtedly present and were recorded variously as *Conularia* sp. or *Conularia* from various formations.

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A new species, *Paraconularia* sp. nov., is yet to be described from the 'Upper Marine Beds' of the Port Keats Group, Northern Territory. A specimen from the 'Norton Formation' (now the Nalbia Sandstone), Carnarvon Basin, possibly belongs to this species but more collections are needed for confirmation.

Conulariid genera and species

Systematic descriptions of the conulariids are on microfiche sheet 7 in a pocket inside the back cover.

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Ostracods

by P.J.G. Fleming and S.K. Skwarko***

Little is known of the distribution and abundance of the ostracods in the Permian strata of Western Australia. Only one systematic study of the local ostracods (Foster et al., 1985) has ever been attempted (by P.J.G. Fleming), and its results are incorporated below.

Review of past literature shows that ostracods have been encountered in the Fossil Cliff Member of the Holmwood Shale, Perth Basin (McWhae et al., 1958; Clarke et al., 1951), in the Bulgadoo Shale, Carnarvon Basin (Condon, 1967), and in the Nura Nura Member of the Poole Sandstone (Guppy et al., 1952, 1958) and the Noonkanbah Formation (Guppy et al., 1958) in the Canning Basin. Only generic determinations are available.

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There is no published record of the abundance of ostracods, except for the Freney-Kimberley Nerrima 1 bore and another which states that 'the Bulgadoo Shale has many ... ostracods throughout ...' (Condon, 1967, p.142). The lack of data on the group need not indicate their paucity; in the above-mentioned recent study some 17 forms have been distinguished from two small samples in the Fossil Cliff Member of the Holmwood Shale.

Ostracod genera and species

Systematic descriptions of the ostracods are on microfiche sheets 7–8 in a pocket inside the back cover.

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Trilobites

*by Brian A. Engel * and L. Noreen Morris **

Trilobites are a rare element of the Permian marine faunas of the Australian continent. Western Australian taxonomic studies are limited to those of Teichert (1944) where the material has been assigned to *Ditomopyge* Newell. In eastern Australia, Wass and Banks (1971) and Engel and Laurie (1978) have described various species of *Doublatia* Wass and Banks. From time to time isolated pygidia have been recorded in field studies but these have seldom been preserved for later, detailed investigation.

Apart from indicating a general Early Permian age, the Western Australian species are too rare to provide any useful stratigraphic control.

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Trilobite genera and species

Systematic descriptions of the trilobites are on microfiche sheet 8 in a pocket inside the back cover.

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Asteroids

by Robert V. Kesling[*]

Asteroids seem to be rare in Permian rocks in Western Australia. Four starfish from the Wandagee Formation belong to at least three distinct species. They are exceptionally well preserved with both oral and aboral surfaces exposed. They have in common robust plates and prominent coronets. The large plates apparently had restricted movement, and the presence of short spines associated with the adambulacrals of *Permaster grandis* suggests that this species, at least, raked through bottom debris. The mouth-angle structures are, in all three species, composed of closely associated plates, so that the mouth apparently could not be opened widely or used in effective biting.

Asteroid genera and species

Systematic descriptions of the asteroids are on microfiche sheet 8 in a pocket inside the back cover.

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Blastoids

by S.K. Skwarko[**]

Blastoids are rare in the Western Australian Permian rocks, and only five taxa have been hitherto described (Breimer and Macurda Jnr, 1972; Macurda Jnr, 1973). All are from virtually a single locality in the Late Sakmarian Callytharra Formation, and although their preservation is generally good, only three out of five taxa have been specifically identified.

Blastoid genera and species

Systematic descriptions of the blastoids are on microfiche sheet 8 in a pocket inside the back cover.

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Crinoids

by Curt Teichert [*] *and G. D. Webster* [**]

Permian crinoid faunas have been described from Timor (Wanner, numerous papers between 1910 and 1949), the Himalayas (Waagen, 1885), southern Ural Mountains, USSR(Yakovlev and Ivanov, 1956), Tunisia (Valette, 1934; Lane, 1979 — among others), Bolivia (Branisia, 1965), the midcontinent USA (Moore and Plummer, 1940; Pabian and Strimple, 1974 — among others), southern Nevada, USA (Lane and Webster, 1966; Webster and Lane, 1967), and eastern Australia (Willink, 1978, 1979a,b, 1980). A large fauna has been reported from the Callytharra Formation of Western Australia (Webster, 1977, 1987). All of these faunas are dominated by the inadunate crinoids. Only in three faunas, Timorese, Bolivian and Western Australian, are camerate or flexible crinoids of significant percentages. Both the camerates and flexibles became extinct in the Permian while the inadunates continued into the Triassic. As may be noted, several of the Permian faunas have been documented within the past 25 years. Synthesis studies have not been made, although some general correlations have been discussed (Lane and Webster, 1966).

In general, Permian crinoid genera and species, like earlier forms, are short ranging (Lane and Webster, 1980). Most species are reported from only one epoch, and genera are commonly confined to one or two epochs, sometimes ranging into the underlying Late Carboniferous and very rarely extending back into the Early Carboniferous or Late Devonian. Crinoids have not been used to define stage boundaries. Most genera and species are geographically restricted with few cosmopolitan forms (Lane and Webster, 1980). Insufficient study of the Permian crinoids has been made to be able to fully document their stratigraphic and geographic value.

The first Permian crinoid described from Western Australia was *Calceolispongia hindei* Etheridge 1915. *Calceolispongia* and its species were fully documented by Teichert (1949) when he demonstrated that *Calceolispongia* is widespread in the Permian of Western Australia and that the species are good index fossils. Willink (1979b) further enhanced their value when he described the eastern Australian species. Teichert (1991) summarized the geographic and stratigraphic distribution of the Calceolispongiidae in Western Australia (see Table 11).

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Table 11. Distribution of Calceolispongidae in the Permain strata of the Carnarvon Basin

SERIES	STAGE	SUB-STAGE	GROUP	FORMATION	
UPPER PERMIAN	Kaz.		KENNEDY	Binthalya	
				Mungadan	
LOWER PERMIAN	Uf.			Coolkilya	*C. hindei, C. robusta, C.* sp. indet. B, *C.* sp. indet. C
	Kungurian		BYRO	Baker	*C.* sp. indet. D
				Nalbia	*C.* sp. indet. A, *C.* sp. indet. L
	Artinskian	Baigendzhinian		Wandagee	60-145 m *C. spectabilis* 50-56 m *C. multiformis* 45-55 m *C. rubra* 25-35 m *C. abundans* 0-50 m *C. rotundata* 0-25 m *C. elegantula* — *J.minilyaensis* from unrecorded horizon
				Quinnanie	*C.* sp. indet. E, *C.* sp. indet. K
				Cundlego	*C. truncata, J. bostocki*
				Bulgadoo	*C. acuminata,*
				Mallens	*?C. acuminata, C.* sp. indet. J *C.* spp. nov.
				Coyrie	*C. barrabiddiensis, C.* sp. indet. F
		Akt.	WOORAMEL	Billidee	*C.* sp. indet. I
				Moogooloo	
				Cordalia	
	Sakmarian	Ster.		Callytharra	*C. digitata, C. spinosa,* Calceolispongiidae? gen. et sp. indet. A
		Tast.	LYONS	Carrandibby	Calceolispongiidae gen. et sp. nov. A
	Asselian			undivided	Calceolispongiidae gen. indet. sp. nov. A, Calceolispongiidae gen. et sp. nov. B, *C.* sp. indet. G, *C.* sp. indet. H

C. = Calceolispongia, J. = Jimbacrinus

Akt. = Aktastian, Kaz. = Kazanian, Ster. = Sterlitamakian, Tast. = Tastubian, Uf. = Ufimian

The largest and most diverse crinoid fauna reported in Australia occurs in the type section of the Callytharra Formation west of Callytharra Spring along the Wooramel River in the Carnarvon Basin (Webster, 1977, 1987). This fauna contains more than forty species, many of which are unidentified but recognizable on morphologic characters of disarticulated plates. The Callytharra fauna is dominated by inadunate crinoids, mostly unornamented. In addition, it has seven long-ranging genera, four camerates and three inadunates. The fauna is interpreted to be of Late Sakmarian (Sterlitamakian) age which is based on the palaeontologic and stratigraphic studies of Dickins (1964) and Thomas (1976), among others.

Some correlations can be made between the eastern and Western Australian crinoid faunas, although no species are known to be common to both areas. Eastern Australian faunas were reported from several horizons and localities in Queensland, New South Wales and Tasmania (Willink, 1978, 1979a,b, 1980), whereas the Callytharra fauna is from one locality. Two genera, *Notiocatillocrinus* and *Calceolispongia*, are common in Permian rocks from both regions. Also, a dichocrinid, *Neocamptocrinus*, described by Willink (1980) from eastern Australia, is related to *Camptocrinus* sp. cf. *C. indoaustralicus* from the Callytharra fauna. *Notiocatillocrinus nerimbrae* (McKellar 1969), an Artinskian form found in eastern Australia, is quite similar to *N. callytharraensis* from the Callytharra fauna. Currently, the species of *Calceolispongia* offer the highest potential for a crinoid zonation for the Permian of Western Australia and correlation with eastern Australia.

The Callytharra fauna is most closely related to the Basleo Beds fauna of Timor, the largest known Permian crinoid fauna. There are seven species common to both faunas and four other species present in the Callytharra fauna are referred with reservation to species known from the Basleo fauna (Webster, 1987). Similarities within these faunas cause one to question the middle Permian age (Wanner, 1924) assigned to the Basleo fauna. Differences between these faunas probably reflect environmental conditions.

The Callytharra fauna contains few genera in common with the known Permian warmer water faunas of North America, South America, North Africa, or the USSR. This is believed to reflect the cooler water environment that the Australian faunas existed in. *Calceolispongia* appears to have been the most successful crinoid genus in adapting and evolving under the cooler water conditions.

Additional Permian crinoids have been found in strata other than the Callytharra Formation in Western Australia and more will undoubtedly be found in the future. Also, the abundance of disarticulated stem and cup plates in some strata offers additional biostratigraphic potential with future studies.

In the current review of the Western Australian Permian crinoids, C. Teichert takes responsibility for the treatment of the Calceolispongiidae, and the chapter on the history of research. G. D. Webster wrote the introduction, described all genera and species other than those of the Calceolispongiidae (but contributed data on *C. digitata* and *C. spinosa*) and prepared Plates 64 and 65. Plates 66–70 and the accompanying captions were prepared by S.K. Skwarko.

History of research

The first mention of the occurrence of Permian crinoids in Western Australia is found in a paper by Gregory (1849) who lists '*Encrinites*' among fossils from limestone beds on the Irwin River. This is without doubt the formation now known as Fossil Cliff Member of the Holmwood Shale in the northern part of the Perth Basin.

Next, an occurrence of crinoid stems was reported by Foord (1890) who mentioned 'numerous weathered fragments' of which he figured one. These came from an unspecified locality on the Gascoyne River in the Carnarvon Basin from rocks which Foord believed to be Early Carboniferous; they could have come from any one of the numerous fossiliferous Permian beds which are crossed by the Gascoyne River.

Of greater interest is a publication by Etheridge Jnr, who described in some detail 'enlarged crinoid stems' which he believed to have been infested by an 'endophytic fungus' (Etheridge Jnr, 1903, p.25-30, pl. 4). They had been collected by A. G. Maitland in the Minilya River on Williambury Station, Carnarvon Basin. These stems show characteristic, somewhat irregular swellings, always near more or less circular holes (which Etheridge called 'cicatrix') with a diameter of 2 to 5 mm. In these swollen parts, the stems are enlarged from their normal diameter of 10–12 mm to as much as 20 mm, and the columnals show distorted growth, apparently in response to the disturbance created by an invading organism which Etheridge believed to have been thallophytes. Similarly deformed crinoid stems are known in Palaeozoic crinoids of all ages and are, by many authors, believed to have been caused by borings of the polychaete *Myzostomum*. Brett (1985) has reviewed these structures which rightly have to be interpreted as trace fossils made by unknown makers and for which Brett proposed the name *Tremichnus*.

Presence of crinoid remains in the Fossil Cliff Member of the Holmwood Shale, Irwin River area, was again reported by Glauert (*in* Campbell, 1910, p.52).

Somewhat paradoxically, the first Permian crinoid from Western Australia to be formally named was misinterpreted as a sponge and named *Calceolispongia* by Etheridge Jnr (1915). Its true nature as a crinoid was not cleared up until 1936, when Gerth recognized it as a senior synonym of the Timor genus *Dinocrinus* Wanner 1916. Teichert (1949) described numerous species of this genus from several Permian formations in the Perth, Carnarvon, and Canning Basins and in 1954 he established the family Calceolispongiidae, at the same time adding a new Permian genus, *Jimbacrinus* Teichert 1954.

In 1951, Teichert reported presence of about 15 genera of crinoids (in addition to *Calceolispongia*) in Permian rocks of Western Australia, including representatives of the Poteriocrinitidae, Catillocrinidae, and Allagecrinidae. Unfortunately, this fauna has never been described.

More recent reports on Permian crinoid faunas are reviewed in more detail in Teichert (1991) and in the systematic contributions by Teichert and Webster in this bulletin.

Crinoid genera and species

Systematic descriptions of the crinoids are on microfiche sheet 8 in a pocket inside the back cover.

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Conodonts

by S.K. Skwarko[*]

Conodonts are extremely rare in rocks of Permian age in Australia. In Western Australia the only reports of their occurrence are by Reeves (1949) who listed 'Fragment of a ?Conodont' from the Late Sakmarian (Sterlitamakian) Nura Nura Member of the Poole Sandstone, Canning Basin (Guppy et al., 1958, p.47; Towner and Gibson, 1983, p.20). Nicoll's (1976) initial attempt at collecting conodonts, mainly in the Carnarvon Basin, was unsuccessful. However, subsequently he reported a very limited, and hitherto specifically unidentified, fauna from the Late Artinskian (Baigendzhinian) Noonkanbah Formation, Canning Basin, both in outcrop north of the Short Range and from subsurface in Tappers Inlet 1 (Nicoll, 1984, p.442).

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Palynomorphs

by B.E. Balme[**] *and J. Backhouse*[*]

Palynology has been extensively used in the stratigraphic analysis of Permian sequences in Western

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Australia, but the volume of formally published documentation is not great. Palynostratigraphy in the State was initiated by a preliminary investigation of coals from the Collie Basin (Balme, 1952) employing techniques and informal systematics that were pioneered by Raistrick in England and followed by Dulhunty (1945, 1946) in New South Wales and de Jersey (1946) in Queensland. Balme's study demonstrated the presence of distinctive common palynomorphs in coeval strata in eastern and Western Australia. It was also clear, from the comprehensive account of Virkki (1946), that essentially similar assemblages were present in Indian Permian sedimentary rocks. Apart from their phytogeographic implications, results from Collie indicated the biostratigraphic potential of plant microfossils. The Ewington Member of the Collie Coal Measures was clearly differentiated from the Collieburn and Cardiff Members on the basis of the occurrence and relative frequencies of certain palynomorphs. Balme, therefore, proposed two loosely defined biozones within the Collie Coal Measures, informally designated MC1 and MC2.

A few samples from the Collie, Wilga, Perth, Carnarvon, and Canning Basins were included in the collection used by Balme and Hennelly (1955, 1956a,b) in their papers on Australian Permian spores and pollen grains. The main purpose of these accounts was to provide a systematic basis for biostratigraphic studies, using formal binomial nomenclature. Secondarily, however, they further emphasized the essential unity of Permian palynomorph associations throughout the Australian continent. As information on Late Palaeozoic palynology increased from other Gondwana countries, particularly India, it became clear that the phytogeographic province defined by macroscopic remains of the plants of the '*Glossopteris* Flora' was characterized, for some purposes more effectively, by intrinsically homogeneous plant microfossil assemblages. Balme (1964) discussed the principal characteristics of these assemblages and speculated on their phytogeographic and gross evolutionary implications. Saccate pollen, especially disaccate taeniate forms, are the most distinctive, abundant, and varied elements. They appear first in Late Palaeozoic glacial sequences, diversify sharply in strata immediately overlying the ultimate glacigene sedimentary rocks, and decline sharply in the basal Triassic units. These distributional patterns, in conjunction with the occurrence of certain other spore and pollen taxa with restricted stratigraphic ranges, were used by Balme (1964) as the basis for defining three palynostratigraphic units that could be recognized throughout Australia. These were named, in ascending order, the *Nuskoisporites, Vittatina,* and *Dulhuntyispora* Assemblages.

Ingram (*in* Sanders and Ingram, 1964) carried out the first detailed palynological studies of Permian strata in the Perth Basin with an investigation of seams of the Irwin River Coal Measures. His work was continued and expanded by Segroves, who published a series of significant papers dealing with palynological systematics (Segroves, 1969, 1970a; Balme and Segroves, 1966). Segroves's most important contribution was possibly his recognition of a number of unusual palynomorphs of non-vascular origin, which he described in a well-illustrated account (Segroves, 1967). In addition, he refined Balme's three-fold biostratigraphic scheme by subdividing the sequence in the northern Perth Basin into five biostratigraphic 'Assemblages' (Segroves, 1970b). The nomenclature applied to these and their relationship to lithostratigraphic and other palynostratigraphic units are summarized in Table 8 (on microfiche).

Documentation of Western Australian plant microfossils is urgently required, especially from the Canning Basin where the assemblages are, in general, best preserved and most diverse. Apart from a contribution by Price (1983), dealing mainly with the genus *Dulhuntyispora*, no systematic accounts subsequent to those of Segroves have been published. There exist, however, a number of unpublished dissertations that encompass both taxonomy and biostratigraphy. Glikson (1972) studied borehole sequences in the Collie and southern Perth Basins and recognized a similar biostratigraphic succession to that proposed by Segroves. Subsequently, Robertson (1979) investigated the palynology of the Ceres Seam in the Muja Sub-basin in relation to its microscopic petrography. He found pronounced variations in the relative frequencies of several palynomorph taxa within the seam and explained these in terms of developing plant succession in deepening swamp environment. The work of MacLeod (1973) remains the only readily accessible illustrated account dealing with the palynology of Permian sequences in the Carnarvon Basin. It is based on the examination of two stratigraphic wells that were drilled in the Byro Basin by the Bureau of Mineral Resources (BMR). They were spudded near the base of the Byro Group, passed through the Wooramel Group and Callytharra Formation, and terminated in the Lyons Group. MacLeod related this part of the succession to Lower Permian palynostratigraphic units in the Perth Basin, but little is known of the palynology of the upper Byro Group and the Kennedy Group.

Sedimentary rocks associated with glacial sequences in the Canning Basin, unlike those in the Perth and Carnarvon Basins, often contain diverse, well-preserved, palynomorph assemblages. These provided the material for a comprehensive thesis by Powis (1979), some aspects of which have been published (Playford and Powis, 1979; Powis, 1984). Four Oppel-zones were defined by Powis (1979) in the stratigraphic interval which is encompassed by the Grant Group and Nura Nura Member of the Poole Sandstone. The upper three of these are shown in Table 8, but only the highest is regarded as Permian in the present review.

Limits of the Permian System in Western Australia

The base of the Permian System, in all Western Australian sedimentary basins, lies within a thick sequence of glacigene sedimentary rocks that are older than early Sakmarian and younger than about early Namurian, an interval representing nearly 40 million years. Except in the Carnarvon Basin, no significant invertebrate fossils have yet been described from the glacial sequences. Plant

microfossils, on the other hand, occur throughout the successions and for this reason Balme (1980) proposed that the base of the Australian Permian be defined on palynological criteria. The horizon selected was the base of Unit III of Kemp et al. (1977), which corresponds in a general way to the base of Stage 3a in eastern Australia. At this horizon there is a sharp increase in the abundance and diversity of gymnosperm pollen, which reflects, presumably, colonization of the 'Australian' region by new plant alliances, following post-glacial climatic amelioration. A similar dramatic expansion of gymnosperm elements occurs at horizons close to the Carboniferous–Permian boundary in many places in the world, including the type sequences in the USSR. It was not suggested that the base of Unit III corresponded precisely to that of the type Asselian; the lower part of that Stage may undoubtedly correlate with the upper portion of Unit II. For present practical purposes, however, such a margin of discrepancy is considered inevitable and acceptable. The choice of this datum has been opposed (Archbold, 1982; Dickins, 1985), mainly on the grounds that it requires almost total compression of all or part of the Asselian Stage. Although this is true, the alternative adopted by critics is to regard all the Gondwanan glacial sequences as entirely Asselian (Dickins, 1985). There is virtually no palaeontological evidence to support this conclusion. It requires the deposition of 2500 m of clastic sediments in the Fitzroy Graben over about 6 million years. This is almost the same thickness as that deposited in the same graben during the main period of rift fill, in the Tournaisian–Namurian interval of some 40 million years. In this review the base of Unit III is therefore taken as marking the beginning of the Permian, recognizing at the same time that this entails a degree of pragmatism.

By comparison, the upper limit of the Permian, or at least the base of the Triassic, is adequately defined, in most Western Australian basins, by the earliest occurrence of lower Scythian marine deposits. An exception is the Bunbury Trough in the Perth Basin, where the Upper Permian section of the Sue Coal Measures is overlain by the predominantly continental lower Triassic Sabina Sandstone. Here, the Upper Permian section is probably more complete than any known from the onshore areas of any other sedimentary basins in the State. The base of the Triassic is taken to coincide with the lower limit of the *Kraeuselisporites saeptatus* Zone of Dolby and Balme (1976) or its equivalent. This horizon is probably a little higher than the base of the Griesbachian stage. At Kap Stosch, east Greenland (Balme, 1979), strata containing a palynomorph association closely similar to that of the *Kraeuselisporites saeptatus* Zone overlie beds with *Otoceras*, 'Permian' brachiopods, and a plant microfossil assemblage which resembles in some respects the assemblage that characterizes the *Protohaploxypinus reticulatus* Zone in Western Australia. This lends support to the view of Waterhouse (1976), that at least some faunas containing *Otoceras* should be assigned to the Permian. The problem remains a difficult and, to some extent, a subjective one, depending on the relative chronostratigraphic emphasis placed on various invertebrate groups. The most readily applied stratigraphic datum in marine successions is undoubtedly the first appearance of the floods of poorly diversified, small spinose acritarchs, which characterize Early Triassic marine deposits in all parts of the world where they have been investigated. Such an event defines the beginning of the *Kraeuselisporites saeptatus* Zone and for this reason the unit is assigned to the Triassic in its entirety.

Selection of taxa for inclusion

The review embraces all those species that have been formally described in published papers up to 1985. Forms attributed to a genus but without a specific epithet (e.g. *Leiosphaeridia* sp.) have not been included, unless they have been explicitly compared to a previously published species (e.g. *Alisporites* sp. cf. *A. plicatus* Jizba). The only exceptions to this are several forms compared to previously published species listed in a recent paper by Foster et al. (1985).

Subsequent to the completion of this review in 1985, one of the authors (J. Backhouse) has published two papers on systematic and biostratigraphic aspects of Permian palynomorphs (Backhouse, 1988, 1991). The reader is referred to these papers for further information on Permian palynomorphs from Western Australia.

Synonymies: The synonymy lists are brief and intended only to indicate the nomenclatural history of the taxon and the published source of its first record from Western Australia. They, therefore, include the original published name of the species, the authority for the name adopted in the present review, and the earliest reference to its occurrence in Western Australia. For more detailed synonymies of many of the species listed, readers are referred to the systematic accounts of Foster (1975, 1979).

Synopses: These summarize the principal morphological characteristics of each species, without attempting to fulfil a complete diagnostic purpose. Species are categorized as *small* if their maximum dimension is less than 45 μm, *medium* between 45–85 μm, and *large* when it is greater than 85 μm. When polarity is determinable, the shape cited is that in polar view: shapes of acritarchs are expressed in terms of the most frequently preserved orientation. The outer layer of the exine in cavate spores and pollen grains is referred to as the exoexine and the inner as the intexine. Pollen grains described as saccate may be protosaccate but are not so described unless ultrastructural evidence is available.

Types: Many of the species listed lacked designated type specimens in their original diagnoses. Most are not invalidated for this reason, as they were published before 1 January, 1958, when indication of a type became mandatory under the International Code of Botanical Nomenclature. Some confusion has been created by later authors in their attempts to remedy early deficiencies and, for some species, two or more different specimens have been subsequently designated as lectotypes or syntypes of the same taxon. Only the earliest traceable designation has been included in this review. Repositories are indicated for types that are represented by objective specimens and not solely by illustrations. These repositories are abbreviated as shown in 'Introduction' to this bulletin.

Distributions: Unpublished petroleum company reports and a few unillustrated publications list palynomorph species from many parts of the State. It is usually impossible to verify these determinations and, in order to avoid duplication of errors in systematics and identification lists, they have not been considered. The species present in some lithological units have been fully reported in the literature, while for some other units they have been partially reported. There are other units with virtually no palynological data, although they almost certainly contain many species. Therefore, in order not to present a potentially misleading picture of the geographic ranges of almost all species, their distribution by lithologic unit has been omitted.

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Palynomorph genera and species

Systematic descriptions of the palynomorphs are on microfiche sheet 9 in a pocket inside the back cover.

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Plants

by John Rigby[*]

Permian plant fossils have been known from Western Australia since the last century. Collections have been meagre and frequently reported in geological reports as a list of names without accompanying figures; often the whereabouts of the specimens is unknown.

Collie Basin

The first record of a Permian flora from Western Australia was attributed to Etheridge Snr (1892) by Etheridge Jnr (1907) who quoted: 'Portions of *Glossopteris* or *Noeggerathia* occur in this coal'. M'Coy (1898) identified a specimen as *Glossopteris browniana* from a collection submitted to him by Sir John Forrest, then the Premier of Western Australia. Chapman (1907) subsequently described and figured the fossils that were present in the collection, which included *Glossopteris browniana, G. indica, G. angustifolia, ?G. gangamopteroides*, and *Vertebraria*. Some of these determinations have been revised. Other authors (Maitland, 1907; Glauert, 1910; Lord, 1952) added species to this list but they neither described, nor figured, additional specimens until Rigby (1966) reviewed and revised Permian floras of the Perth and Collie Basins. In both Rigby (1966) and the current review, all available specimens have been re-examined either as original specimens or as photographs.

Perth Basin

The first report of the occurrence of Permian plants from the Perth Basin was by Glauert (1923). Later authors (Teichert, 1939, 1943; Clarke and et al., 1951; Johnson et al., 1954; Balme, 1964) recorded plants at various stratigraphic horizons. Although Glauert described his specimens, neither he nor the other authors figured examples. Rigby (1966) described and figured specimens including many of those mentioned by earlier authors.

Collections from the Irwin River area of the northern Perth Basin are the only systematically collected Permian floras from Western Australia.

Carnarvon Basin

A few specimens have been described and figured from the Carnarvon Basin: a glossopterid leaf (Teichert 1942); lycopods (White 1959; White and Condon 1959). No other significant recordings have been published.

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Table 12. Distribution of identifiable Permian plant species from Western Australia.

	SAKMARIAN		*ARTINSKIAN*			*KUNGURIAN*	*KAZANIAN*			*TATARIAN*	*AGE UNKNOWN*
	Carnarvon Basin	*Canning Basin*	*Collie Basin*	*Perth Basin*	*Canning Basin*	*Canning Basin*	*Collle Basin*	*Perth Basin*	*Canning Basin*	*Collie Basin*	*Collie Basin*
Cyclodendron leslii		0		0							
Cyclodendron sp.	*	0		0							
?Brasilodendron pedroanum									0		
Lepidodendron sp.					*						
Bothrodendron sp.					*				*		
Stigmaria sp.					*						
lycopod gen. et sp. indet.	0										
Sphenophyllum rhodesii				0							
Sphenophyllum sp.				*							
Raniganjia minima								0			
Raniganjia sp.									0		
Paracalamites australis		0		0	0	0		0	0		0
Phyllotheca australis				0					0		
Neomariopteris lobifolia				0					0		
Neomariopteris polymorpha									*		
Alethopteris lindleyana				0					0		
Glossopteris angustifolia		*						*	*		*
Glossopteris browniana		*		*				*	*		*
Glossopteris communis									*		*
Glossopteris condrenensis		0		0					0		
Glossopteris sp. cf. *G. decipiens*				0							0
Glossopteris erregullanus				0							
Glossopteris gangamopteroides											*
Glossopteris gregoryi			0	0				0			
Glossopteris sp. cf. *G. hispida*			?								
Glossopteris indica	*			*				*	*		
Glossopteris irwinensis				0							

| | | |

Table 13. Age and occurrence of Permian plants found in Western Australia and elsewhere in Gondwana

	Age and occurrence				
	in W.A.	*in eastern Australia*	*in India*	*in South America*	*in southern Africa*
Cyclodendron leslii	S-A	B	L		E
Brasilodendron pedroanum	K-T			E	
Phyllotheca australis	P	P			L
Neomariopteris lobifolia	P	P			
Alethopteris lindleyana	P		L		
Glossopteris linearis	K-T	B			E-L
Glossopteris spathulato-cordata	S-A	L			
Gangamopteris clarkeana	K-T		E		
Gangamopteris cyclopteroides	P		E		
Gangamopteris spatulata	P	E			
Botrychiopsis valida	K-T		E	E	E
Liknopetalon enigmata	S-A				E
Ginkgophyllum diazii	S-A			C-P	
Samaropsis milleri	S-A	P	E-L		

Note: Species of doubtful identity in Western Australia, and endemic and long-ranging species have been omitted.

Abbreviations: S-A Sakmarian - Artinskian in Western Australia; K-T Kazanian - Tatarian in Western Australia; C-P latest Carboniferous or basal Permian; P throughout most of the Permian; B basal Permian = Talchir Series of India; E Early Permian = Karharbari and/or Barakar Stages of India; L Late Permian = Raniganj Stage of India

Canning Basin

Kidston (*in* Foord, 1890) described a small collection of plants, including lycopods, from the Canning Basin. These were redescribed and refigured by Edwards (1952). Walkom (1938) and Guppy et al. (1958) listed, but did not figure, species. White (1961) described and figured a number of species. The most comprehensive collection from the basin was described by White and Yeates (1976) in an unpublished record.

Current review

Specimens held by various institutions were examined, or in some cases where transportation was a problem, specimens were photographed, and the photos examined. Specimens were no longer available from some of the older collections, these have been marked with an asterisk in the text to signify that the identification has not been confirmed, e.g. all specimens attributed to *Glossopteris browniana* that were examined were found to belong to other species; specimens listed under **Glossopteris browniana* may not belong to this species, although this identification cannot be discounted.

Table 12 shows the distribution of identifiable specimens under basins and epochs. Records such as 'silicified wood' have been omitted as they have no biostratigraphic significance.

The significance of the Permian floras of Western Australia

In Western Australia, the greatest diversity of Permian flora occurs in the Irwin River–Mingenew area of the northern Perth Basin, with a lesser diversity in the northeastern part of the Canning Basin. However, when one compares the diversity in the two regions with other parts of the Permian Gondwana, the significance of the diversity is not as great. However, palynologically, an extensive and diverse flora is indicated from these Western Australian regions (Balme and Backhouse, this bulletin). The discrepancy may be due either to inadequate collecting or to conditions unsuitable for the preservation of plant megafossils during the Permian.

Non-marine Permian strata outcrop over very large areas in Western Australia. One can only conclude that there must be many areas where suitable conditions for preservation existed. Therefore, the paucity of sites and collections must, at least in part, reflect inadequate collecting.

The floras are typically of Gondwanan affinities indicated by species of *Glossopteris, Gangamopteris, Vertebraria, Raniganjia, Neomariopteris*, and others. The few non-Gondwanan species present are all based on specimens which are not available to the reviewer, and so they will be disregarded here. A number of the species listed in Table 12 are endemic to Western Australia; the remaining species also occur elsewhere (Table 13).

Further collecting throughout most of Gondwana will refine biostratigraphic data.

It should be noted that the common, widely distributed Gondwana species *Paracalamites australis, Vertebraria indica*, and *Cordaites spatulata* (formerly *Noeggerathiopsis hislopii*) have been omitted from Table 13.

Plant genera and species

Systematic descriptions of the plants are on microfiche sheets 9–10 in a pocket inside the back cover.

Addendum

The new species *Gondwanophyton daymondii* is described here (and repeated in the microfiche section) to satisfy the requirement of the International code for Botanical Nomenclature.

Genus **GONDWANOPHYTON** Maithy 1974

Type species: *Gondwanophyton indicum* Maithy 1974.

Gondwanophyton daymondii Rigby sp. nov.
(Plate 91 fig. 5)

Diagnosis: Leaf elliptical, of unknown affinities, apparently peltate but having very pronounced auriculate base, attachment typically ^-notched, stem-clasping. Venation in upper part of the leaf, radial, dichotomizing forking generally three times; venation in lower part of leaf arising from a vein along the inner margin, the vein is no thicker than other veins. Veins thin slightly towards the margin.

Holotype: WAM P86.58.

Distribution and range: Perth Basin — Irwin River Coal Measures.

Age: Artinskian.

Abundance: Two leaves of the holotype.

Value in correlation and dating: The only other species occurs in the Early Permian Barakar Coal Measures of India. The genus may be restricted to the Early Permian. Specimens are easily identifiable; hence, the species may prove to be of biostratigraphic value.

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Fish

A contribution to IGCP 328: Palaeozoic microvertebrates

by Susan Turner *

All the fossil fish found in the Permian of Western Australia come from marine limestones and most are shark teeth. Only Archbold (1981) has reported in detail on the presence of actinopterygian scales, although the dearth of information probably reflects the few microfossil studies made to date.

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New information from the Lower Permian (Sakmarian) from the Fossil Cliff Member, Holmwood Shale, indicate useful microvertebrate assemblages, including eugeneodont shark teeth and palaeonisicoid scales and teeth, which indicate links with the southern USA (Fernandino, 1992). Actinopterygian microremains are also being found in samples from the type section of the Callytharra Formation (Artinskian), Carnarvon Basin (Condon, 1967).

Hills (1958) first reviewed the records of Permian fish from Australia, most of which were from Western Australia. Long (1982, 1991) briefly updated our knowledge of Permian marine and freshwater fish faunas around Australia, and Turner (1982) catalogued Queensland records. A checklist of Australian fossil fish was subsequently produced (Long and Turner, 1984).

The first Permian fish found in Western Australia was a specimen of *Helicoprion* described by Woodward (1886) as *Edestus davisi*. Teichert (1940) described three further specimens of *Helicoprion* from the Wandagee Formation in the Carnarvon Basin. On the basis of the overseas distribution of *Helicoprion* in the Urals, Indo-China, Japan, and North America it became possible for the first time to resolve the age problem of at least the upper part ('Wandagee beds') of the 'Carboniferous' or the 'Permo-Carboniferous' sequence of the Carnarvon Basin and date it as Early Permian, Artinskian, rather than Late Carboniferous, Uralian (Teichert, 1939, p.6; 1940, p.142). Hills (1958) and Condon (1967) reported further specimens (still undescribed) from the underlying Bulgadoo Shale. Young (*in* Yeates et al., 1975a,b; pers. comm., 1985) reported additional material that still awaits study.

The helicoprionids have been classified in various ways and their relationships are still not satisfactorily known. Traditionally they have been allied with the edestids, and regarded either as hybodontiform selachians (Long and Turner, 1984: following Romer, 1966), or holocephalians. Obruchev (1964, 1967) retained *Helicoprion* as a 'bradyodont' holocephalian in Karpinsky's family Helicoprionidae, but separated it from the Edestidae. Moy-Thomas and Miles (1971), however, followed Bendix-Almgreen (1966) in separating helicoprionids and edestids, regarding the former as an order of elasmobranchs *incertae sedis*. In a recent review, Zangerl (1981) has united the two groups in a new order of elasmobranchs, the Eugeneodontida, placing *Helicoprion* in the Family Agassizondontidae.

Helicoprionids are widespread in Permian limestones throughout the world, being recorded from western North America, Greenland, Spitsbergen, the Urals region of USSR, Iran?, Laos, Japan, China, and Western Australia, often associated with fusulinids. Undoubtedly, they were among the top predators of their day, and probably lived mostly in deep water. The genus *Helicoprion* is known from Early Permian (Asselian to Artinskian) rocks only.

Teichert (1943) described the first definite Permian 'bradyodont' teeth from Australia when he named *Crassidonta subcrenulata* and *Helodus* species from the Artinskian Wandagee Formation.

Comparison with other Australian faunas

Our knowledge of Permian fish faunas in Australia is poor. Only in the last few years has a major research program been undertaken on the fauna from the Late Permian (Late Kazanian) Rangal Coal Measures of Blackwater, central Queensland (Duy Phuoc, 1981). Leu (1989, 1990) discovered an unusual freshwater euselachian shark *Surcaudalis rostratus*; one endemic genus and species of bobasatraniform palaeoniscoid fish, *Ebanaqua ritchei,* has been described (Campbell and Duy Phuoc, 1983) and at least seven distinct types of palaeonisciforms are present. It may be possible to match up some of the Rangal Coal Measure scales with those recorded from the Coyrie Formation of the Carnarvon Basin.

Other actinopterygian fish records include *Urosthenes* species and '*Elonichthys davidi*' from the Newcastle Coal Measures of New South Wales (Dana, 1848; Woodward, 1931, 1940); 'fish scales' mentioned in some geological survey publications (e.g. Turner, 1982 for Queensland citations); and palaeoniscoid and *Acrolepis* fish scales from the Parmeener Supergroup of Tasmania (S. Forsyth, pers. comm., 1990; Long, 1991).

Western Australian fish fauna in a worldwide context

The Permian fish faunas of the world are impoverished in numbers of taxa (Romer, 1966), and are transitional between the typical Palaeozoic faunas, which are rich in all bony and cartilaginous fish groups, and the Mesozoic faunas, which are dominated by actinopterygian bony fishes and hybodont and, later, neoselachian sharks. The Western Australian fauna only includes representatives of an open marine environment: *Helicoprion* and *Helodus* has worldwide distribution; *Crassidonta* is found in western USA and central USSR. While the few Western Australian occurrences provide clear links with cosmopolitan marine Early Permian fish faunas, it is premature to consider them representative of the Australian faunas as a whole.

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Fish genera and species

Systematic descriptions of the fish are on microfiche sheet 10 in a pocket inside the back cover.

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Annelids

*by S.K. Skwarko**

No remnants of worm borings and tubes are known from the Permian sedimentary rocks of Western Australia. Worm burrows, however, have been found, and a few have been described, but they are rare, if the meagre record in the literature is any guide. Tracks and trails — some probably made by worms — are abundant at some horizons, but because of the uncertainty of their origin, they are reviewed in the chapter on 'Trace fossils and proble-matica'.

Annelid genera and species

Systematic descriptions of the annelids are on micro-fiche sheet 10 in a pocket inside the back cover.

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Trace fossils and problematica

by S.K. Skwarko and A. Seilacher ***

Despite the relative abundance of trace fossils in some Permian strata in Western Australia, there has been little interest shown in them in the past. However, their usefulness in the interpretation of the depositional environment has resulted in more attention being given to them in the recent literature.

The first trace fossils to be described from Permian strata in Western Australia were by Etheridge Jnr (1903), who illustrated as 'Crustacean? tracks' a specimen of *?Scalarituba* from the Coolkilya Pool area on Wandagee Station, Carnarvon Basin. Almost forty years later other '*Scalarituba*' were illustrated by Teichert (1941), as 'Large gastropod trails' from the 'Upper Ferruginous series' in the Moulamen Hill area, Canning Basin — as well as a 'Segmented trail, probably made by large mud-eating worm' from the Coolkilya Pool area.

More recently, Moore et al. (1980a) recorded from the Carnarvon Basin Baker Formation a *Chondrites* and *Planolites*, and *Lophoctenium* from the upper Bulgadoo Shale; *Zoophycos*, *Scalarituba* (i.e. *Margaritichnus*), *Rhizocorallium* and *Cosmorhaphe* from the middle Nalbia Sandstone; and rare *Scalarituba* and *Skolithos* from the Mallens Sandstone, and Cundlego and Coyrie Formations. In the Late Permian Kennedy Group, Moore et al. (1980b) recognized *Zoophycos* in the middle Coolkilya Sandstone, *Scalarituba* (i.e. *Margaritichnus*), *Rhizocorallium* and *Cosmorphaie* (i.e. *Cosmorhaphe*) in the Mungadan Sandstone and Binthalya Formation, and *Skolithos* mainly in the lower Coolkilya Sandstone.

Bhatia et al. (1984) recorded *Diplocraterion*, *Asterosoma*, *Cylindrichnus*, *Teichichnus*, *Skolithos*, and *?Ophiomorpha* from the subsurface Tern Member of the Hyland Bay Formation in the Bonaparte Basin. From the Canning Basin, Yeates et al. (1984) illustrated an unnamed trace fossil from the Lightjack Formation, other trace fossils (probably *Cruziana*) from the Condren Sandstone, and *Rhizocorallium* from the Godfrey beds.

Brief descriptions and illustrations of some representative Permian trace fossils from this State comprise the systematic section; with one exception, open nomenclature is used. Seilacher is responsible for many of the identifications and for the discussions on the mode of formation and the nature of the individual traces; the figures on Plate 102 are his own.

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Trace fossil and problematica genera and species

Systematic descriptions of the trace fossils and problematica are on microfiche sheet 10 in a pocket inside the back cover.

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Appendix

A list of Permian fossils from the Collie, Perth, Carnarvon, and Canning Basins

by S.K. Skwarko

Palynomorphs are present in many Permian stratigraphic units in the State. However, because of the uneven coverage in published literature and the unreliability of unpublished records they are omitted from the following lists. The fossil names in inverted commas have not had their presence and identity confirmed in the current project.

Collie Basin

Collie Coal Measures

Plants

Paracalamites australis Rigby 1966
?Paracalamites sp.
?rhizome of a fern probably allied to *Rhizomopteris*
Glossopteris angustifolia Brongniart 1831
Glossopteris browniana Brongniart 1828
Glossopteris communis Feistmantel 1876
Glossopteris sp. cf. *G. decipiens* Feistmantel
Glossopteris gangamopteroides Feistmantel 1870
Glossopteris sp. cf. *G. hispida* Pant 1966
Glossopteris indica Schimper 1869
Glossopteris sp. D
Glossopteris waginanus (Rigby 1966) Rigby, Chandra & Surange 1988
Glossopteris woolaganus Rigby, Chandra & Surange 1988
Gangamopteris sp. cf. *G. angustifolia* (M'Coy 1847) M'Coy 1847
Gangamopteris spp.
Vertebraria indica Royle 1834
Cordaites spatulata (Dana 1849) Rigby, Maheshwari & Schopf 1980
Cordaites sp.
Cordaicladus sp.
?gymnosperm stems
Samaropsis sp.

Ewington Member

Plants

Glossopteris condrenensis Rigby, Chandra & Surange 1988
Glossopteris gregoryi Rigby, Chandra & Surange 1988
Glossopteris sp. cf. *G. hispida* Pant 1966
Gangamopteris spatulata M'Coy 1875
Gingkophyllum diazii Archangelsky & Arrondo 1975

Collieburn Member

Plants

Gangamopteris clarkeana Feistmantel 1878
Gangamopteris cyclopteroides Feistmantel 1876

Cardiff Member

Plants

Glossopteris linearis M'Coy 1847
Gangamopteris cyclopteroides Feistmantel 1876

Perth Basin

Nangetty Formation

Foraminifers

Hyperammina elegantissima Plummer 1945
Hemigordius schlumbergeri (Howchin 1895)
'Chlorophytes (Segroves, 1971)'
'*Botryococcus* sp.'

Holmwood Shale

Foraminifers

Psammosphaera pusilla Parr 1942
Saccammina ampulla (Crespin 1958)
Thurammina phialaeformis Crespin 1958

10436—7

Thuramminoides sphaeroidalis Plummer 1945
Hyperammina callytharraensis Crespin 1958
Hyperamminoides hadzeli (Crespin 1958)
Ammodiscus nitidus Parr 1942
Glomospirella nyei Crespin 1958
Trochammina subobtusa Parr 1942

Bryozoans

'*Fenestella* sp.'

Bivalves

'*Solemya*' *holmwoodensis* Dickins 1963
'*Conocardium* sp.'

Gastropods

Bellerophon sp.

Ostracods

Bairdia sp.
Healdia sp.

Annelids

'serpulids'

Conulariids

Paraconularia sp. E

Beckett Member

Ammonoids

Juresanites jacksoni (Etheridge Jnr 1907)

Nautiloids

'orthoceroid'

Crinoids

'crinoid stem fragment'

Woolaga Limestone Member

Brachiopods

Neochonetes (Sommeriella) pratti (Davidson 1859)
'*?Fletcherithyris* sp. cf. *F. hardmani* Campbell 1965'

Bivalves

'*Sanguinolites*' sp.

Ammonoids

Juresanites jacksoni (Etheridge Jnr 1907)
Svetlanoceras irwinense (Teichert & Glenister 1952)

Nautiloids

not identified

Gastropods

not identified

Conulariids

'conularid sp. indet.'

Annelids

Serpulites spp.

Fossil Cliff Member

Foraminifers

Saccammina arenosa (Crespin 1958)
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina callytharraensis Crespin 1958
Hyperamminoides elegans (Cushman & Waters 1928)
Hyperamminoides hadzeli (Crespin 1958)
'*Ammodiscus incertus* d'Orbigny'
'*Ammodiscus milletianus* Chapman'
Ammodiscus multicinctus Crespin & Parr 1941
Ammodiscus nitidus Parr 1942
Glomospirella nyei Crespin 1958
'*Reophax* sp. nov.'
Ammobaculites woolnoughi Crespin & Parr 1941
Trochammina subobtusa Parr 1942
Tetrataxis conica Ehrenberg 1854
Tetrataxis sp.
Orthovertella protea Cushman & Waters 1928
Hemigordius schlumbergeri (Howchin 1895)
Hemigordius volutus Palmieri 1985
Calcitornella dickinsi (Crespin 1958)
Calcitornella elongata Cushman & Waters 1928
Calcitornella heathi Cushman & Waters 1928
Calcitornella stephensi (Howchin 1894)
Trepeilopsis australiensis Crespin 1958
'*Trepeilopsis* sp. cf. *grandis* (Cushman & Waters)'
Lunucammina triangularis (Chapman & Howchin 1905)
Howchinella woodwardi (Howchin 1895)
Protonodosaria irwinensis (Howchin 1895)
Protonodosaria tereta (Crespin 1958)
'*Nodosaria* sp.'
'*Endothyra* sp. cf. *E. media* Waters'
'*Tristix* sp.'

Corals

'*Amplexus*' sp.
Euryphyllum trizonatum Hill 1937
?Gerthia sulcata (Hinde 1890)
?Plerophyllum australe Hinde 1890
Cladochonus striatus Hill 1942

Bryozoans

'*Hexagonella* sp.'
'*Stenopora leichhardtii* Nicholson & Etheridge Jnr'
'*Fenestella* sp.'
'*Polypora* sp.'
'*Rhombopora* sp.'

Brachiopods

Neochonetes (Sommeriella) pratti (Davidson 1859)
Strophalosia irwinensis Coleman 1957
Heteralosia etheridgei (Prendergast 1943)
Aulosteges baracoodensis Etheridge Jnr 1903
Aulosteges spinosus Hosking 1931
Taeniothaerus irwinensis Coleman 1957
Callytharrella callytharrensis (Prendergast 1943)
Cancrinella irwinensis Archbold 1983
Stenoscisma? sp. nov. A
Globiella foordi (Etheridge Jnr 1903)
Neospirifer hardmani (Foord 1890)
Trigonotreta neoaustralis Archbold & Thomas 1986
Elivina hoskingae Archbold & Thomas 1985

Spirelytha fredericksi Archbold & Thomas 1984
Phricodothyris occidentalis Archbold & Thomas 1984
Tomiopsis woodwardi Archbold & Thomas 1986
Cleiothyridina baracoodensis (Etheridge Jnr 1903)
Fletcherithyris sp. cf. *F. hardmani* Campbell 1965

Bivalves

Nuculopsis bangarraensis Dickins 1963
Nuculopsis darlingensis Dickins 1963
Palaeoneilo sp. nov.
Quadratonucula australiensis Dickins 1963
Phestia lyonsensis (Dickins 1956)
Cypricardinia? elegantula Dickins 1963
Parallelodon bimodoliratus Dickins 1963
Modiolus koneckii Dickins 1963
Pseudomyalina sp. A
Atomodesma (Atomodesma) mytiloides Beyrich 1864
Acanthopecten? sp.
Etheripecten sp. cf. *E. subquinquelinatus* Etheridge Jnr 1907
Etheripecten sp. A
Etheripecten tenuicollis (Dana 1847)
Girtypecten ovalis Dickins 1963
Heteropecten comptus (Dana 1847)
Streblopteria sp.
Streblopteria? sp.
Euchondria callytharraensis Dickins 1963
Deltopecten sp.
?Deltopecten waterfordi Dickins 1963
Palaeolima sp. nov.
Plagiostoma? sp. nov.
Schizodus sandimanensis Dickins 1963
Astartella obliqua Dickins 1963
Edmondia prichardi Dickins 1963
Palaeosolen? badgeraensis Dickins 1963
'*?Megadesmus carinatus* (Morris 1845)'
Astartila? tumida Dickins 1963
?Myonia carinata (Morris 1845)
Myonia sp. nov.
Pachymyonia sp. cf. *P. occidentalis* Dickins 1957
Chaenomya sp. B
Myofossa subarbitrata (Dickins 1963)
Cosmomya (Palaeocosmomya) sp.
Cosmomya (Palaeocosmomya) sp. nov.
Praeundulomya subelongata Dickins 1963
Stutchburia hoskingae Dickins 1957
Stutchburia variabilis Dickins 1957
Conocardium sp. A

Ammonoids

Metalegoceras kayi Glenister, Windle & Furnish 1973

Nautiloids

'*Pseudorthoceras* sp.'
'*Euloxoceras* sp.'
'*Domatoceras* sp.'
'*Stearoceras* sp.'

Gastropods

Warthia sp. B
Stachella crucilirata Dickins 1963
?Bellerophon costatus Sowerby 1834
Bellerophon? decussatus Fleming 1828
Bellerophon sp. cf. *B. formani* Dickins 1963
Bellerophon sp. nov. A
'*Retispira*' *clarkei* Dickins 1963
Retispira irwinensis Dickins 1963
Keeneia? sp. nov.
Baylea perthensis Dickins 1963
Mourlonia (Pseudobaylea) freneyensis Dickins 1963
Mourlonia (Woolnoughia) angulata Dickins 1963
Mourlonia? obscura Dickins 1963
Ptychomphalina talboti Dickins 1963
Peruvispira sp. cf. *P. umariensis* (Reed 1928)
Pleuromaria sp.
Platyceras sp. cf. *P. abundans* (Wanner 1922)
Macrochilina winensis Dickins 1963
Naticopsis? sp. nov.

Ostracods

Hollinella? sp.
Bairdia sp. A
Bairdia sp. B
'*Bairdia* sp. C'
Kirkbyacean? indet. sp. A
Kirkbyacean? indet. sp. B
Roundyella ludbrookae Fleming 1985
Healdia chapmani Crespin 1945
Healdia grayi (Crespin 1945)
Healdia irwinensis Fleming 1985
Healdia spp. A & B
Healdioides sp.
Healdiacean indet.
Bairdiocyprinidae indet.
Healdianella? sp.
Cavellinidae indet.
Graphiadactyllis alveiformis Fleming 1985
Zarinia ludbrookae Fleming 1985
Ostracods indet.

Trilobites

Ditomopyge sp. Teichert 1944

Crinoids

'*?Actinocrinus* sp.'
Calceolispongia digitata Teichert 1949
'*Platycrinus* sp.'

High Cliff Sandstone

Foraminifers

Saccammina arenosa (Crespin 1958)
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina callytharraensis Crespin 1958
Ammodiscus nitidus Parr 1942

Bryozoans

'fenestrate bryozoans'

Brachiopods

Neochonetes (Sommeriella) sp. nov. A
Aulosteges ingens Hosking 1931
Taeniothaerus sp. nov.
Cancrinella sp. C
Neospirifer sp. nov.

Tomiopsis rarus Archbold & Thomas 1986
Cleiothyridina sp.
Gilledia woolagensis Campbell 1965

Bivalves

?Cypricardinia sp. B
Parallelodon sp. cf. *P. bimodoliratus* Dickins 1963
Etheripecten tenuicollis (Dana 1847)
Etheripecten sp. cf. *E. tenuicollis* (Dana 1847)
Streblopteria sp.
Schizodus sp. cf. *S. fitzroyensis* Dickins 1963
Oriocrassatella spp.
Palaeosolen? sp. B
Astartila? sp. A
Stutchburia sp. cf. *S. variabilis* Dickins 1957

Gastropods

Bellerophon sp. cf. *B. formani* Dickins 1963
Bellerophon sp. nov. A
Mourlonia (Pseudobaylea) sp. cf. *M.(P.) freneyensis* Dickins 1963
Naticopsis? sp. nov.

Irwin River Coal Measures

Plants

Cyclodendron leslii (Seward) Kraüsel 1928
Cyclodendron sp.
Bothrodendron sp.
lycopod or sphenopsid leaves
Sphenophyllum rhodesii Rigby 1966
Sphenophyllum sp.
Phyllotheca australis Brongniart 1828
Paracalamites australis Rigby 1966
Neomariopteris lobifolia (Morris 1845) Maithy 1974
?Neomariopteris sp.
Alethopteris lindleyana (Royle 1833) Schimper 1869
Glossopteris browniana Brongniart 1828
Glossopteris condrenensis Rigby, Chandra & Surange 1988
Glossopteris sp. cf. *G. decipiens* Feistmantel 1879
Glossopteris erregullanus? Rigby, Chandra & Surange 1988
Glossopteris gregoryi Rigby, Chandra & Surange 1988
Glossopteris indica Schimper 1869
Glossopteris irwinensis Rigby, Chandra & Surange 1988
Glossopteris spathulato-cordata Feistmantel *ex* Walkom 1928
Glossopteris sp. A
Glossopteris sp. C
Gangamopteris cyclopteroides Feistmantel 1876
Gangamopteris spp.
Liknopetalon enigmata Smithies *ex* Anderson & Anderson 1985
Vertebraria indica Royle 1834
Eretmonia balmei (Rigby 1966) Rigby, Chandra & Surange 1988
scale leaf
Cordaites spatulata (Dana 1847) Rigby, Maheshwari & Schopf 1980
Cordaites sp.
Senia? sp.
Gondwanophyton daymondii Rigby sp. nov.
Cordaicladus sp.
conifer cone
seed

Carynginia Formation

Foraminifers

'Hippocrepinella sp.'
Saccammina arenosa (Crespin 1958)
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina callytharraensis Crespin 1958
Hyperammina fusta Crespin 1958
Hyperamminoides elegans (Cushman & Waters 1928)
Hyperamminoides expansus Plummer 1945
Ammodiscus nitidus Parr 1942
Spiroplectammina carnarvonensis Crespin 1958

Brachiopod

Permorthotetes? spp.
Neochonetes (Sommeriella) robustus Archbold 1981
'?Strophalosiid gen. et sp. indet.'

Conulariids

'conularid'

Wagina Sandstone

Plants

Raniganjia minima (Rigby 1966) Rigby comb. nov.
Paracalamites australis Rigby 1966
Glossopteris browniana Brongniart 1828
Glossopteris gregoryi Rigby, Chandra & Surange 1988
Glossopteris indica Schimper 1869
Glossopteris waginanus (Rigby 1966) Rigby, Chandra & Surange 1988
Glossopteris sp. A
Gangamopteris spatulata M'Coy 1875
Gangamopteris spp.
Vertebraria indica Royle 1834
Cordaites spatulata (Dana) Rigby, Maheshwari & Schopf 1980
?Cordaites sp.
Botrychiopsis valida (Feistmantel 1876) Archangelsky & Arrondo 1971
Senia? sp.
'gymnosperm wood'
Samaropsis sp.

Mingenew Formation

Brachiopods

Neochonetes (Sommeriella) robustus Archbold 1981
Wyndhamia? sp.
Mingenewia anomala Archbold 1980
Aulosteges lyndonensis Coleman 1957
?Cancrinella spp.
Licharewiid gen. nov. A et sp. nov.
Licharewiid gen. nov. B sp. nov. A
Fusispirifer byroensis (Glauert 1912)
?Spiriferella sp.
Cleiothyridina spp.

Hoskingia nobilis (Etheridge Jnr 1907)
Gilledia sp. cf. *G. homevalensis* Campbell 1965
Gilledia woolagensis Campbell 1965

Bivalves

'*Modiolus*' sp. B
Pseudomyalina mingenewensis (Etheridge Jnr 1907)
Pseudomyalina sp. A
Etheripecten sp. cf. *E. subquinquelineatus* Etheridge Jnr 1907
Heteropecten comptus Dana 1847
Chaenomya? nuraensis Dickins 1903

Gastropods

Ptychomphalina maitlandi Etheridge Jnr 1903

Plants

Glossopteris erregullanus Rigby, Chandra & Surange sp. nov.
Glossopteris sp. A

Carnarvon Basin

Lyons Group

Hocking et al. (1986) recognized only two named formations(Harris Sandstone and Carrandibby Formation) in the Lyons Group. The distribution of fossils throughout the group is presented below under the names of Condon's (1967) formations, which are not recognized as valid as they lack lateral persistence and, hence, cannot be mapped.

Undifferentiated

Bryozoans

Pseudobatostomella? dickinsi (Ross 1963)
Pseudobatostomella? fisheri (Ross 1963)
Pseudobatostomella? lyndoni (Ross 1963)
Polypora lyndoni Ross 1963

Brachiopods

Permorthotetes crespinae Thomas 1958
Kiangsiella sp. A
Streptorhynchus? sp. nov.
Linoproductus sp.
Lyonia lyoni (Prendergast 1943)
Rhynchopora sp. nov.
Punctocyrtella australis (Thomas 1971)
Trigonotreta lyonsensis Archbold & Thomas 1986
Brachythyrinella occidentalis (Thomas 1971)
Tomiopsis notoplicatus Archbold & Thomas 1986

Bivalves

Phestia lyonsensis (Dickins 1956)
Leiopteria? carrandibbiensis Dickins 1957
Eurydesma sp.
Etheripecten sp. indet. B
Megadesmus sp. B
Pachymyonia occidentalis Dickins 1957
Praeundulomya elongata Dickins 1957

Crinoids

Calceolispongia sp. indet. H
Calceolispongiidae gen. et sp. nov. B

Plants

Cyclodendron sp.
Lycopodiopsis sp. cf. *L. derbyi* Renault 1890
'*Stigmaria* sp.'

'Coyango Greywacke'

Plants

'*Lepidodendron* sp.'

'Dumbardo Siltstone'

Bryozoans

'Fenestellidae'

Brachiopods

Kiangsiella sp. A
Streptorhynchus? sp. nov.
Lyonia lyoni (Prendergast 1943)
Rhynchopora sp. nov.
Punctocyrtella australis (Thomas 1971)
Trigonotreta lyonsensis Archbold & Thomas 1986
?Brachythyrinella occidentalis (Thomas 1971)
Tomiopsis notoplicatus Archbold & Thomas 1986
'Terebratulid indet.'
'*Athyridid* indet.'

Bivalves

'*Aviculopecten* sp. cf. *A. tenuicollis* (Dana 1847)'
Deltopecten lyonsensis Dickins 1957

Crinoids

Calceolispongia sp. indet. G

'Koomberan Greywacke'

Corals

not identified

Bryozoans

not identified

Brachiopods

'spiriferids'

Bivalves

'pectinids'
'new pectinids'

Crinoids

'crinoid stem ossicles'

'Mundarie Siltstone'

Foraminifers

'*Hyperamminoides* sp.'
Reophax tricameratus Parr 1942

Bryozoans

not identified

Brachiopods

'*Permorthotetes* sp.'
Lyonia lyoni (Prendergast 1943)
Punctocyrtella australis (Thomas 1971)
'*Trigonotreta* sp. indet.'

Bivalves

Deltopecten lyonsensis Dickins 1957

Gastropods

Keeneia carnarvonensis Dickins 1957
'cf. *Omphalotrochus*'
Platyschisma? sp. nov.

Crinoids

'echinoderm spines'
'*Calceolispongia* sp.'
'crinoid ossicles and plates'

'Thambrong Formation'

Foraminifers

'*Calcitornella stephensi* (Howchin 1894)'

Bryozoans

'Fenestellidae'
'Batostomellidae'

Brachiopods

Lyonia lyoni (Prendergast 1943)
Punctocyrtella australis (Thomas 1971)
Trigonotreta lyonsensis Archbold & Thomas 1986
Brachythyrinella occidentalis (Thomas 1971)
'Spiriferacea gen. et sp. indet.'
'orthotetids' indet.

Bivalves

'*Nuculana lyonsensis* Dickins 1956'
Eurydesma sp. indet.
'*Aviculopecten tenuicollis* (Dana 1847)'
'*Aviculopecten* sp. indet.'
Deltopecten lyonsensis Dickins 1957
Schizodus crespinae Dickins 1957
'*Cleobis* sp.'
Astartila condoni Dickins 1957
'*?Parallelodon* sp. indet.'
Stutchburia variabilis Dickins 1957

Gastropods

Keeneia carnarvonensis Dickins 1957
Mourlonia (Mourlonia) lyndonensis Dickins 1957
Peruvispira umariensis (Reed 1928)

Scaphopods

not identified

Conulariids

Paraconularia sp. cf. *P. warthi* (Waagen 1889)
Paraconularia sp. B
Paraconularia spp.

Crinoids

Calceolispongiidae gen. indet. sp. nov. A

Plants

wood fragments — not identified

'Weedarra Shale'

Foraminifers

'*Hyperammina callytharraensis* Crespin 1958'

Bryozoans

'Fenestellidae'
'Batostomellidae'

Brachiopods

'Spiriferid' indet.
'*Lyonia lyoni* (Prendergast 1943)'
'*Permorthotetes crespinae* Thomas 1958'

Bivalves

Deltopecten lyonsensis Dickins 1957
Stutchburia variabilis Dickins 1957

Carrandibby Formation

Foraminifers

'*Hyperamminoides* sp. cf. *H. hadzeli* (Crespin 1958)'

Bryozoans

'Fenestellidae'
'Batostomellidae'

Brachiopods

Tomiopsis notoplicatus Archbold & Thomas 1986

Bivalves

Phestia darwini (de Koninck 1877)
Leiopteria? carrandibbiensis Dickins 1957
Eurydesma playfordi Dickins 1957
Etheripecten tenuicollis (Dana 1847)
Deltopecten lyonsensis Dickins 1957)
Astartila condoni Dickins 1957
Astartila? obscura Dickins 1957
Pachymyonia occidentalis Dickins 1957
Chaenomya? nuraensis Dickins 1963
Praeundulomya elongata Dickins 1957
Stutchburia variabilis Dickins 1957

Gastropods

Keeneia carnarvonensis Dickins 1957
Mourlonia (Mourlonia) lyndonensis Dickins 1957
'*Mourlonia (Mourlonia)* sp. nov. A'

Peruvispira umariensis (Reed 1928)

Echinoderms

'Crinoidea'
Calceolispongiidae gen. et sp. nov. A
'Blastoidea'
'cup ossicles'

Callytharra Formation

Foraminifers

Hyperamminita rudis (Parr 1942)
Thurammina phialaeformis Crespin 1958
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina callytharraensis Crespin 1958
Hyperammina coleyi Parr 1942
Hyperammina elegantissima Plummer 1945
?Hyperammina fusta Crespin 1958
Giraliarella angulata Crespin 1958
Giraliarella triloba Belford 1961
Hyperamminoides elegans (Cushman & Waters 1928)
Hyperamminoides expansus Plummer 1945
Hyperamminoides hadzeli (Crespin 1958)
'*Ammodiscus incertus* d'Orbigny'
'*Ammodiscus milletianus* Chapman'
Ammodiscus multicinctus Crespin & Parr 1941
Ammodiscus nitidus Parr 1942
'*Ammodiscus* sp. cf. *A. nitidus* Parr'
'*Ammodiscus* sp.'
'*Glomospira* sp.'
Glomospirella nyei Crespin 1958
Tolypammina adhaerens (Parr 1942)
Ammovertella inclusa (Cushman & Waters 1927)
Reophax tricameratus Parr 1942
Ammobaculites eccentrica Crespin 1958
Ammobaculites sp. cf. *A. eccentrica* Crespin 1958
Ammobaculites wandageeensis Crespin 1958
Placopsilina wooramelensis Crespin 1958
'*Spiroplectammina* sp.'
Trochammina subobtusa Parr 1942
Earlandia condoni Crespin 1958
Tetrataxis conica Ehrenberg 1843
Orthovertella protea Cushman & Waters 1928
Hemigordius harltoni Cushman & Waters 1928
Hemigordius schlumbergeri (Howchin 1895)
Meandrospira australis (Crespin & Belford 1957)
Meandrospira meandrina (Crespin & Belford 1957)
Calcitornella dickinsi (Crespin 1958)
Calcitornella elongata (Cushman & Waters 1928)
Calcitornella heathi Cushman & Waters 1928
Calcitornella sp.
Calcitornella stephensi (Howchin 1894)
Calcivertella palata Crespin 1958
Trepeilopsis australiensis Crespin 1958
'*Trepeilopsis grandis* (Cushman & Waters)'
'*Trepeilopsis* sp. cf. *grandis* (Cushman & Waters)'
Spirillina papillodentata Crespin 1958
Lunucammina triangularis (Chapman & Howchin 1905)
Howchinella hillae (Crespin 1958)
Howchinella striatosulcata (Crespin 1958)
Howchinella woodwardi (Howchin 1895)
Ichthyolaria limpida (Crespin 1958)
'*Dentalina labiata*'
'*Dentalina* sp.'
Protonodosaria irwinensis (Howchin 1895)
Protonodosaria tereta (Crespin 1958)
'*Nodosaria* sp.'
'*Bigenerina* sp.'
'*Palaeobigenerina* sp.'
'*Haplophragmoides* sp. 2'
'*Ruditaxis rudis* Brady'
'*Spandelinoides striatoclavata* (Spandel)'
'*Stacheia marginulinoides*'
'*Stacheia pupoides*'
'*Stacheia* sp.'

Corals

'*Amplexus pustulosus* Hudleston 1883'
Euryphyllum minutum Hill 1937
Plerophyllum australe Hinde 1890
Tachylasma sp.
Verbeekiella talboti (Hosking 1931)
Gertholites insculpta (Hill 1942)
Gertholites? sp.
Cladochonus striatus Hill 1942

Bryozoans

Hexagonella australis (Bretnall 1926)
Hexagonella hudlestoni Crockford 1957
Evactinostella crucialis (Hudleston 1883)
Liguloclema meridianus (Etheridge Jnr 1926)
Aetomacladia ambrosioides Bretnall 1926
Dyscritella adnascens Bassler 1929
Dyscritella spinigera (Bassler 1929)
Fenestella affluensa Bretnall 1926
Fenestella alia (Crockford 1944)
Fenestella amplia (Crockford 1944)
Fenestella chapmani (Crockford 1944)
Fenestella horologia Bretnall 1926
Fenestella sparsigemmata (Crockford 1944)
Pennirepora fossata Crockford 1944
Pennirepora granulata Crockford 1944
Pennirepora triporosa Crockford 1944
Lyroporella erkosoides (Etheridge Jnr 1926)
Lyropora joselina Crockford 1957
Polypora australis Hinde 1890
Polypora woodsi (Etheridge Jnr 1892)
Septopora ornata Crockford 1944
Rhabdomeson bispinosum (Crockford 1944)
Rhombopora? tenuis Hinde 1890
Saffordotaxis multigranulata (Bretnall 1926)
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)
Rhombocladia minor Crockford 1944
Rhombocladia spinulifera Crockford 1944
Streblocladia excavata Crockford 1944
'Batostomellidae'

Brachiopods

Permorthotetes callytharrensis Thomas 1958
Permorthotetes camerata Thomas 1958
Permorthotetes? sp.
Streptorhynchus? sp. nov.
Arctitreta? plicatilis (Hosking 1933)
Tornquistia occidentalis Archbold 1980
Neochonetes (Sommeriella) pratti (Davidson 1859)

Strophalosia irwinensis Coleman 1957
Heteralosia etheridgei (Prendergast 1943)
Aulosteges baracoodensis Etheridge Jnr 1903
Aulosteges spinosus Hosking 1931
Stictozoster senticosa (Hosking 1933)
Comuquia australis Archbold 1984
Lethamia? obscurus Archbold 1984
Dyschrestia micracantha (Hosking 1933)
Callytharrella callytharrensis (Prendergast 1943)
Cancrinella irwinensis Archbold 1983
Globiella foordi (Etheridge Jnr 1903)
Stenoscisma sp. nov.
Camerisma? callytharrensis (Hosking 1933)
Myodelthyrium dickinsi (Thomas 1971)
Punctocyrtella australis (Thomas 1971)
Latispirifer callytharrensis Archbold & Thomas 1985
Neospirifer foordi Archbold & Thomas 1986
Neospirifer hardmani (Foord 1890)
Neospirifer sp. A
Fusispirifer carnarvonensis Archbold & Thomas 1987
Trigonotreta neoaustralis Archbold & Thomas 1986
Elivina hoskingae Archbold & Thomas 1985
Spirelytha fredericksi Archbold & Thomas 1984
Phricodothyris occidentalis Archbold & Thomas 1984
Tomiopsis notoplicatus Archbold & Thomas 1986
Tomiopsis? sp.
Tomiopsis woodwardi Archbold & Thomas 1986
Fredericksia? sp. nov. A
Gjelispinifera decipiens (Hosking 1933)
Lamnaespina papilionata (Hosking 1933)
Callispirina sp. nov.
Hustedia? sp. nov.
Cleiothyridina baracoodensis (Etheridge Jnr 1903)
Cleiothyridina spp.
Fletcherithyris sp. cf. *F. hardmani* Campbell 1965

Bivalves

'*Glyptoleda* sp. A'
Cypricardinia? elegantula Dickins 1963
Parallelodon bimodoliratus Dickins 1963
Parallelodon sp. A
Modiolus koneckii Dickins 1963
Pseudomyalina sp. A
Atomodesma (Atomodesma) mytiloides Beyrich 1894
Atomodesma (Atomodesma) mytiloides Beyrich 1894 var. nov.
Atomodesma (Atomodesma) sp. cf. *A.(A.) timorense* (Wanner 1922)
Acanthopecten? sp.
Etheripecten sp. cf. *E. subquinquelineatus* Etheridge Jnr 1907
'*?Etheripecten* sp. indet. A'
Etheripecten tenuicollis (Dana 1847)
Girtypecten ovalis Dickins 1963
'*Heteropecten comptus* (Dana 1847)'
Streblopteria sp.
Euchondria callytharraensis Dickins 1963
Deltopecten waterfordi Dickins 1963
Plagiostoma? sp. nov.
Schizodus sandimanensis Dickins 1963
Astartella obliqua Dickins 1963
Oriocrassatella sp.
Edmondia prichardi Dickins 1963
Megadesmus sp.
Myonia sp. nov.
Chaenomya sp. B
Praeundulomya sp.

Ammonoids

cf. *Mescalites* sp.
Metalegoceras sp. nov. Glenister & Furnish 1961
Svetlanoceras irwinense (Teichert & Glenister 1952)

Nautiloids

'*Brachycycloceras*'
'*Mooreoceras*'
'*Pseudorthoceras*'
'*Domatoceras*'
'*Stearoceras*'

Gastropods

Mourlonia (Mourlonia) sp. nov. A
Platyceras sp. cf. *P. abundans* (Wanner 1922)
Platyceras sp. nov.

Conulariids

Paraconularia sp. cf. *P. warthi* (Waagen 1889)

Blastoids

Neoschisma australe Breimer & Macurda 1972
Notoblastus stellaris Breimer & Macurda 1972
Notoblastus sp.
Thaumatoblastus sp.
Rhopaloblastus sp.

Crinoids

Actinocrinites sp. cf. *A. brouweri* (Wanner 1924)
Camptocrinus sp. cf. *C. indoaustralicus* (Wanner 1924)
Platycrinites wrighti (Marez-Oyens 1940)
Notiocatillocrinus callytharraensis Webster 1987
Synbathocrinus campanulatus (Wanner 1916)
Synbathocrinus constrictus (Wanner 1916)
Tapinocrinus ingrami Webster 1987
Tapinocrinus macurdai Webster 1987
Cydonocrinus sp. cf.*C. turbinatus* (Wanner 1916)
Apographiocrinus pumilus (Wanner 1916)
Parabursacrinus granulatus (Wanner 1916)
Parabursacrinus magnificus (Wanner 1916)
Calceolispongia digitata Teichert 1949
Calceolispongia spinosa Teichert 1949
Calceolispongiidae gen. et sp. indet. A
'numerous stem and cup ossicles'

Plants

Gangamopteris cyclopteroides Feistmantel 1876
calcareous algae

Annelids

Spirorbis ambiguus Fleming 1825

Wooramel Group

Cordalia Sandstone

Bryozoans

fragments of fenestellids

Brachiopods
fragments only

Ammonoids
Pseudoschistoceras simile Teichert 1944

Trace fossils
Scalarituba

Moogooloo Sandstone

Bryozoans
'fenestellids'

Brachiopods
Permorthotetes? spp.
Streptorhynchus spp.
'Strophalosiid gen. et sp. indet.'
Aulosteges spp.
Cancrinella sp.
'*Spirelytha* spp.'

Bivalves
'*Atomodesma* sp.'
'*Pseudomyalina* sp.'
Parallelodon sp. B
Astartila? sp. B
Undulomya sp. B

Nautiloids
'coiled nautiloid'

Gastropods
'trochid'

Fish
'Elasmobranchii undet.'

Billidee Formation

Bivalves
'*Nuculana*' sp.

Ammonoids
Neocrimites sp.

Gastropods
Warthia sp. A
bellerophontids

Trace fossils
Margaritichnus sp.

Jimba Jimba Calcarenite Member

Bryozoans
not identified

Brachiopods
Neochonetes (Sommeriella) pratti (Davidson 1859)
Strophalosia jimbaensis Archbold 1986
?Cancrinella spp.
Globiella flexuosa (Waterhouse 1970)
Neospirifer hardmani (Foord 1890)
Trigonotreta neoaustralis Archbold & Thomas 1986
Spirelytha spp.
Cleiothyridina spp.
Derbyia? sp. B

Bivalves
Nuculopsis (Nuculopsis) sp. B
Etheripecten sp. B
Schizodus sp. cf. *S. kennedyensis* Dickins 1956
Stutchburia sp. nov.

Ammonoids
'*Propinococeras* sp.' [*?Bamyaniceras australe* Teichert 1942]

Nautiloids
'*Permonautilus* sp.'

Gastropods
Warthia sp. A
bellerophontids
'*Mourlonia (Mourlonia)* sp. nov. B'
Mourlonia (Pseudobaylea?) sp. nov.
'*Pleurotomaria* sp.'
Macrochilina sp.

Crinoids
Calceolispongia sp. indet. I

Keogh Formation

Bryozoans
not identified

Brachiopods
Neochonetes sp.
'*Fusispirifer* sp.'

Bivalves
'*Atomodesma* sp.'
'pectinids'
'*Undulomya* sp.'
'*Astartila* sp.'

Gastropods
not identified

Conulariids
Paraconularia spp.

Byro Group

Undifferentiated

Bryozoans
Aetomacladia ambrosioides (Bretnall 1926)
Fenestella affluensa Bretnall 1926
Fenestella horologia Bretnall 1926
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)

Foraminifers

'Textularia sp.'
'Nodosinella sp.'

Trilobites

Trilobite (genus & species unknown) Etheridge 1892

Coyrie Formation

Foraminifers

Sacculinella australis (Crespin 1958)
Hyperamminita rudis (Parr 1942)
Thurammina phialaeformis Crespin 1958
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina coleyi Parr 1942
'Hyperammina sp. cf. H. elegantissima Plummer'
Hyperammina fusta Crespin 1958
Hyperamminoides acicula Parr 1942
Hyperamminoides elegans (Cushman & Waters 1928)
'Hyperamminoides sp.'
Ammodiscus nitidus Parr 1942
Reophax ellipsiformis Crespin 1958
Reophax emaciatus Plummer 1945
Reophax fittsi (Warthin 1930)
Reophax minutissimus Plummer 1945
Reophax tricameratus Parr 1942
Ammobaculites wandageeensis Crespin 1958
'Ammobaculites sp.'
Spiroplectammina carnarvonensis Crespin 1958
Textularia improcera Crespin 1958
'Frondicularia sp.'
'Haplophragmoides sp. 1'

Bryozoans

'Fenestellidae'
'Batostomellidae'
'Streblotrypa sp.'

Brachiopods

Permorthotetes spp.
Kiangsiella condoni Thomas 1958
Streptorhynchus spp.
Tornquistia magna Archbold 1980
Neochonetes (Sommeriella) robustus Archbold 1981
Heteralosia spp.
Wyndhamia colemani Archbold 1987
Echinalosia prideri (Coleman 1957)
Aulosteges ingens Hosking 1931
Aulosteges lyndonensis Coleman 1957
Cancrinella sp. A
Pseudosyrinx? sinuosa Thomas 1971
Neospirifer plicatus Archbold & Thomas 1986
Crassispirifer rostalinus (Hosking 1931)
Spirelytha sp. A
Tomiopsis pauciplicatus Archbold & Thomas 1986
Cleiothyridina spp.
Fletcherithyris? sp.
Hoskingia sp. cf. *H. wandageensis* Campbell 1965
Gilledia sp. cf. *G. homevalensis* Campbell 1965
Hoskingia trigonopsis (Hosking 1933)

Bivalves

Nuculopsis (Nuculopsis) sp. A
Nuculopsis (Nuculanella) sp.
Palaeoneilo sp.
Glyptoleda sp. nov.
Pseudomyalina sp. B
Atomodesma (Atomodesma) mytiloides Beyrich 1864
'?Etheripecten spp.'
Etheripecten sp. cf. *E. subquinquelineatus* Etheridge Jnr 1907
Heteropecten comptus (Dana 1847)
'Heteropecten sp. cf. *H. subquinquelineatus* Etheridge Jnr 1907'
'Heteropecten sp.'
Streblochondria sp.
'Pectinid gen. et sp. A'
Pseudomonotis sp.
?Schizodus kennedyensis Dickins 1956
Schizodus sp. B
'Selonomorpha sp.'
'Oriocrassatella sp.'
Palaeosolen? sp. A
Astartila blatchfordi (Hosking 1933)
Praeundulomya concentrica Dickins 1957
'Stutchburia sp.'
Stutchburia sp. nov.
Chaenomya sp. A
'Teredo sp.'

Ammonoids

Neocrimites sp.
Pseudoschistoceras simile Teichert 1944
Bamyaniceras sp. nov. Glenister & Furnish 1961

Nautiloids

'nautiloids indet.'

Gastropods

Euphemites sp.
Warthia sp. A
Stachella sp.
Stachella sp. nov.
Bellerophon sp.
Straparolus (Leptomphalus) sp.
Baylea? sp.
Mourlonia (Mourlonia) sp. nov. B
Mourlonia (Pseudobaylea?) sp. nov.
Ptychomphalina maitlandi Etheridge Jnr 1903
Ptychomphalina sp.
Platyteichum sp.
Macrochilina sp.
Naticopsis? sp.

Conulariids

Paraconularia spp.
Paraconularia sp. cf. *P. warthi* (Waagen 1889)

Trilobites

Ditomopyge? sp.

Scaphopods

not identified

Crinoids

Calceolispongia barrabiddiensis Teichert 1949
Calceolispongia sp. indet. F
'stem ossicles'

Plants
'?Araucaria'

Fish
Cryphiolepidid? gen. et sp. indet. (Archbold 1981)

Annelids
'Vermes'
not identified

Trace fossils
Skolithos sp.
not identified

Mallens Sandstone

Foraminifers
Thuramminoides sphaeroidalis Plummer 1945
Hyperamminoides acicula (Parr 1942)
Ammodiscus nitidus Parr 1942

Brachiopods
Aulosteges spp.
Fusispirifer byroensis (Glauert 1912)
Crassispirifer rostalinus (Hosking 1931)
Hoskingia trigonopsis (Hosking 1933)

Bivalves
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.
Etheripecten sp. nov.
Pseudomonotis sp.
Schizodus sp. B
Oriocrassatella sp. cf. *O. stokesi* Etheridge Jnr 1907
Astartila blatchfordi (Hosking 1931)
Vacunella sp. nov.
Stutchburia sp. nov.

Ammonoids
?Bamyaniceras australe (Teichert 1942)

Gastropods
Ptychomphalina maitlandi (Etheridge Jnr 1903)

Conulariids
Paraconularia spp.

Crinoids
?Calceolispongia acuminata Teichert 1949
Calceolispongia sp. indet. J
Calceolispongia spp. nov.

Trace fossils
Skolithos sp.
not identified

Plants
wood

Bulgadoo Shale

Foraminifers
Sacculinella australis (Crespin 1958)
Hyperamminita rudis (Parr 1942)
Saccammina ampulla (Crespin 1958)
Saccammina hemisphaerica (Chapman & Howchin 1905)
Thurammina phialaeformis Crespin 1958
Thuramminoides sphaeroidalis Plummer 1945
Hyperammina coleyi Parr 1942
Pseudohyperammina radiostoma Crespin 1958
Hyperamminoides acicula Parr 1942
Hyperamminoides elegans (Cushman & Waters 1928)
Hyperamminoides expansus Plummer 1945
Ammodiscus nitidus Parr 1942
Tolypammina undulata Parr 1942
Reophax ellipsiformis Crespin 1958
Reophax emaciatus Plummer 1945
Reophax? thomasi (Crespin 1958)
Ammobaculites eccentrica Crespin 1958
Ammobaculites wandageeensis Crespin 1958
Ammobaculites woolnoughi Crespin & Parr 1941
Spiroplectammina carnarvonensis Crespin 1958
Trochammina subobtusa Parr 1942
Hemigordius harltoni Cushman & Waters 1928
Nodosaria raggatti Crespin 1958
Pseudonodosaria serocoldensis (Crespin 1945)

Corals
Gertholites immensa (Hill 1937)
'?Gertholites sp.' (=*Thamnopora* sp. of Condon, 1967)

Bryozoans
Hexagonella densa Crockford 1944

Brachiopods
Tornquistia magna Archbold 1980
Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
Fredericksia? sp. nov. B
Hoskingia kennediensis Campbell 1965

Bivalves
Nucundata undulostriata (Fletcher 1945)
Phestia basedowi (Etheridge Jnr 1907)
Praeundulomya concentrica Dickins 1957

Ammonoids
Bamyaniceras australe (Teichert 1942)

Nautiloids
not identified

Gastropods
Platyteichum johnstonei Dickins 1961
Ptychomphalina maitlandi (Etheridge Jnr 1903)

Conulariids
Paraconularia sp.

Ostracods
ostracods indet.

Crinoids
Calceolispongia acuminata Teichert 1949

Fish

Helicoprion davisi (H. Woodward 1886)

Annelids

Serpulites indicus Waagen

Trace fossils

'Lophoctenium' sp. 1

Cundlego Formation

Foraminifers

Oryctoderma teicherti (Parr 1942)
Hyperammina coleyi Parr 1942
Pseudohyperammina radiostoma Crespin 1958
Hyperamminoides acicula (Parr 1942)
Hyperamminoides expansus (Plummer 1945)
Ammodiscus nitidus Parr 1942
Glomospirella nyei Crespin 1958
Reophax ellipsiformis Crespin 1958
Reophax subasper Parr 1942
Reophax? thomasi (Crespin 1958)
Ammobaculites wandageeensis Crespin 1958
Spiroplectammina carnarvonensis Crespin 1958
Trochammina subobtusa Parr 1942
Hemigordius harltoni Cushman & Waters 1928
Meandrospira meandrina (Crespin & Belford 1957)
Nodosaria raggatti Crespin 1958

Corals

Pleurophyllum sp.
Verbeekiella mersa Hill 1942

Bryozoans

Synocladia spinosa Crockford 1944

Brachiopods

Permorthotetes spp.
Streptorhynchus hoskingae Thomas 1958
Tornquistia sp. aff. *T. tropicalis* Grant 1976
Demonedys granti Archbold 1980
Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
Quinquenella australis Archbold 1981
Heteralosia prendergastae (Coleman 1927)
Wyndhamia multispinifera (Prendergast 1943)
Retimarginifera perforata Waterhouse 1970
'Fusispirifer sp. nov.'
Spiriferella cundlegoensis Archbold & Thomas 1985
Hoskingia kennediensis Campbell 1965
Gilledia sp. cf. *G. homevalensis* Campbell 1965

Bivalves

Glyptoleda coleyi Fletcher 1945

Nautiloids

not identified

Gastropods

Platyteichum johnstonei Dickins 1961
Ptychomphalina maitlandi (Etheridge Jnr 1903)

Conulariids

Paraconularia spp.

Crinoids

'Calceolispongia spp.'
Calceolispongia truncata Teichert 1949
Jimbacrinus bostocki Teichert 1954

Trace fossils

Scolicia sp. 1
Scolicia sp. 2
Margaritichnus sp. 1?
helicoidal backfill burrow
Didymaulichnus? sp. 1
Didymaulichnus? sp. 2
Didymaulichnus? gen. and sp. 1
Skolithos sp.

Quinnanie Shale

Foraminifers

Psammosphaera pusilla Parr 1942
Thurammina phialaeformis Crespin 1958
Oryctoderma teicherti (Parr 1942)
Hyperammina coleyi Parr 1942
Hyperamminoides acicula (Parr 1942)
Ammodiscus nitidus Parr 1942
Tolypammina adhaerens (Parr 1942)
Tolypammina undulata Parr 1942
Reophax subasper Parr 1942
Reophax tricameratus Parr 1942
Ammodiscus wandageeensis Parr 1942
Ammobaculites woolnoughi Crespin & Parr 1941
Trochammina subobtusa Parr 1942

Corals

solitary corals

Brachiopods

Semilingula occidentalis (Archbold 1981)
Streptorhynchus hoskingae Thomas 1958
Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
'Fusispirifer sp. nov.'
Spiriferella cundlegoensis Archbold & Thomas 1985
Spirelytha sp. B

Bivalves

'Aviculopectinidae'
Cosmomya (Palaeocosmomya) aplatum Fletcher 1946
Cosmomya (Palaeocosmomya) teicherti Fletcher 1946
Cosmomya (Palaeocosmomya) sp. cf. *C. (P.) teicherti* Fletcher 1946
'Undulomya sp.'

Ammonoids

Bamyaniceras australe (Teichert 1942).

Nautiloids

'Permonautilus'

Gastropods

'Bellerophontidae'

Crinoids

Calceolispongia sp. indet. E

Calceolispongia sp. indet. K

Wandagee Formation

Foraminifers

Hyperamminita rudis (Parr 1942)
Saccammina arenosa (Crespin 1958)
Thurammina phialaeformis Crespin 1958
Thuramminoides sphaeroidalis Plummer 1945
Oryctoderma teicherti (Parr 1942)
Hyperammina coleyi Parr 1942
Giraliarella rhomboidalis Crespin 1958
Pseudohyperammina radiostoma Crespin 1958
Hyperamminoides acicula Parr 1942
Hyperamminoides elegans (Cushman & Waters 1928)
'*Ammodiscus incertus* d'Orbigny'
'*Ammodiscus milletianus* Chapman'
Ammodiscus multicinctus Crespin & Parr 1941
Ammodiscus nitidus Parr 1942
Ammodiscus wandageeensis Parr 1942
Tolypammina adhaerens (Parr 1942)
Tolypammina undulata Parr 1942
Reophax emaciatus Plummer 1945
Reophax subasper Parr 1942
Reophax tricameratus Parr 1942
Ammobaculites wandageeensis Crespin 1958
'*Spiroplectammina* sp.'
Trochammina pulvilla Crespin & Parr 1941
Trochammina subobtusa Parr 1942
Digitina recurvata Crespin & Parr 1941
Flectospira prima Crespin & Belford 1957
Hemigordius harltoni Cushman & Waters 1928
Howchinella parri (Crespin 1948)
Nodosaria raggatti Crespin 1958
Pseudonodosaria serocoldensis (Crespin 1945)
'*Nodosaria* sp.'

Corals

Allotropiophyllum sp.
Euryphyllum reidi Hill 1937
Euryphyllum ?sp.
Verbeekiella mersa Hill 1942
Gertholites immensa (Hill 1937)
Gertholites marmionensis (Etheridge Jnr 1914)
Gertholites sp. aff. *G. marmionensis* (Etheridge Jnr 1914)
favositoid fragments

Bryozoans

Fistulipora compacta Crockford 1944
Fistulipora conica Crockford 1944
Fenestella columnaris (Crockford 1944)
Polypora multiporifera Crockford 1944
Polypora retificis Crockford 1944
Australopolypora fovea Crockford 1944
'*Minilya* sp.'
'*Polypora* sp.'

Brachiopods

Streptorhynchus hoskingae Thomas 1958
Tornquistia gregoryi Archbold 1981
Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
Heteralosia complectens (Etheridge Jnr 1918)
Wyndhamia multispinifera (Prendergast 1943)
Lialosia kimberleyensis (Prendergast 1943)
Taeniothaerus coolkiliensis Coleman 1957
Taeniothaerus miniliensis Coleman 1957
Taeniothaerus teicherti Coleman 1957
Dyschrestia colemani Archbold 1984
Retimarginifera perforata Waterhouse 1970
Cancrinella bella (Etheridge Jnr 1918)
Neospirifer amplus Archbold & Thomas 1986
Neospirifer postplicatus Archbold & Thomas 1986
'*Fusispirifer* sp. nov.'
Crassispirifer pinguis Archbold & Thomas 1985
Trigonotreta dickinsi Archbold & Thomas 1986
Spiriferella australasica (Etheridge Jnr 1889)
Spirelytha miloradovichi Archbold & Thomas 1984
Tomiopsis teicherti Archbold & Thomas 1986
Hustedia? basedowi (Etheridge Jnr 1918)
Cleiothyridina macleayana (Etheridge Jnr 1889)
Yochelsonia thomasi Stehli 1961
Hoskingia wandageensis Campbell 1965
Hoskingia sp. cf. *H. wandageensis* Campbell 1965
Gilledia sp. cf. *G. homevalensis* Campbell 1965

Bivalves

Glyptoleda sp. cf. *G. glomerata* Fletcher 1945
Glyptoleda sp.
'*Phestia basedowi* (Etheridge Jnr 1907)'
Cypricardinia? sp. A
'*Modiolus*' sp. A
'*?Leiopteria* sp.'
'*Pseudomyalina mingenewensis* (Etheridge Jnr 1907)'
Atomodesma (Atomodesma) mytiloides Beyrich 1864
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.
'*Etheripecten* sp.'
Etheripecten sp. C
Etheripecten sp. nov.
Girtypecten? sp.
'pectinid gen. et. sp. nov.'
Streblopteria sp.
Streblopteria? sp. nov. B
'*Euchondria* sp. nov.'
'*Deltopecten*' sp. nov.
Pseudomonotis (Trematiconcha) wandageensis Newell & Boyd 1970
'*Pseudomonotis* sp. nov.'
Schizodus kennedyensis Dickins 1956
Schizodus sp. cf. *S. kennedyensis* Dickins 1956
Schizodus sp. nov. B
Palaeosolen? sp. A
Astartila blatchfordi (Hosking 1931)
Astartila fletcheri Dickins 1956
Cosmomya (Palaeocosmomya) aplatum Fletcher 1946
Cosmomya (Palaeocosmomya) sp. cf. *C. (P.) aplatum* Fletcher 1946
Cosmomya (Palaeocosmomya) teicherti Fletcher 1946
Undulomya pleiopleura Fletcher 1946
Undulomya rugulata Fletcher 1946
Stutchburia sp. nov.

Ammonoids

Bamyaniceras australe (Teichert 1942)

Nautiloids

'Titanoceras sp.'

Gastropods

Euphemites sp. nov.
Stachella sp. nov.
Bellerophon sp. nov. B
Retispira sp. cf. *R. emerii* (Etheridge Jnr 1907)
Straparolus (Euomphalus) sp.
Mourlonia (Mourlonia) sp. nov. B
Ptychomphalina maitlandi Etheridge Jnr 1903
Platyteichum johnstonei Dickins 1961
'Peruvispira sp. nov.'

Conulariids

Paraconularia spp.
Paraconularia sp. cf. *P. warthi* (Waagen 1889)

Trilobites

Ditomopyge meridionalis Teichert 1944

Scaphopods

not identified

Asteroids

Monaster carnarvonensis Kesling 1969
Monaster wandageensis Kesling 1969
?Monaster wandageensis Kesling 1969
Permaster grandis Kesling 1969

Blastoids

not identified

Crinoids

Calceolispongia abundans Teichert 1949
Calceolispongia elegantula Teichert 1949
Calceolispongia multiformis Teichert 1949
Calceolispongia rotundata Teichert 1949
Calceolispongia rubra Teichert 1949
Calceolispongia spectabilis Teichert 1949
Jimbacrinus minilyaensis Teichert 1954
Family et gen. indet.

Fish

Helicoprion davisi (H. Woodward 1886)
Crassidonta? subcrenulata Teichert 1943
Helodus? sp.

Annelids

Amphictene permiana Parr 1942
Conchotrema tennuis Teichert 1945
Conchotrema tubulosa Teichert 1945
Paramelonella etheridgei Howell 1956
Gen. et sp. indet.

Nalbia Sandstone

Bryozoans

Evactinostella crucialis (Hudleston 1883)

Brachiopods

Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
Svalbardia thomasi Archbold 1981
Wyndhamia multispinifera (Prendergast 1943)
Lialosia kimberleyensis (Prendergast 1943)
Cancrinella sp. B
Spirelytha miloradovichi Archbold & Thomas 1984
?Hoskingia sp. cf. *H. wandageensis* Campbell 1965

Bivalves

Phestia thomasi (Dickins 1956)
Cypricardinia? sp. A
'Allorisma sp.'
'Modiolus sp. A'
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.
'Streblopteria sp.'
'?Streblopteria sp. nov.'
'Euchondria sp.'
'Pseudomonotis spp. nov.'
'Plagiostoma sp.'
Schizodus kennedyensis Dickins 1956
'Schizodus sp. nov.'
Oriocrassatella stokesi Etheridge Jnr 1907
Palaeosolen? sp. A
'Megadesmus sp. nov.'
Astartila blatchfordi (Hosking 1931)
'Chaenomya sp.'
Stutchburia muderongensis Dickins 1956
Stutchburia sp. nov.

Ammonoids

Bamyaniceras australe (Teichert 1942
Paragastrioceras wandageense Teichert 1942
Dauchites goochi (Teichert 1942)

Gastropods

'Warthia sp. B cf. *W. micromphala* (Morris 1845)'
'Stachella sp.'
'Bellerophon sp. cf. *B.* pennatus'
Retispira sp. cf. *R. emerii* (Etheridge Jnr 1907)
Mourlonia (Mourlonia) sp. nov. B
Platyteichum johnstonei Dickins 1961
Platyteichum? sp. nov.

Conulariids

?Paraconularia fletcheri Thomas 1986
?Paraconularia sp. nov.

Crinoids

Calceolispongia sp. indet. A
Calceolispongia sp. indet. L

Fish

Helicoprion davisi (H. Woodward 1886)

Trace fossils

Margaritichnus sp. 1
Zoophycos sp.
Pelecypodichnus sp.
Cosmoharphe sp.
Cylindricum? sp.
Rhizocorallium sp.
Skolithos sp.

Baker Formation

Bryozoans

Fistulipora gigantea Crockford 1944
Dybowskiella arborescens Crockford 1957
Hexagonella nalbia Crockford 1944
Hexagonella undulata Crockford 1944
Evactinostella crucialis (Hudleston 1883)

Brachiopods

?Permorthotetes teicherti Thomas 1958
Svalbardia thomasi Archbold 1981
Lialosia kimberleyensis (Prendergast 1943)
?Aulosteges sp. indet. A
'*Fusispirifer* spp.'
Cleiothyridina macleayana (Etheridge Jnr 1889)

Bivalves

Atomodesma exarata Beyrich 1864
Cosmomya (Palaeocosmomya) teicherti Fletcher 1946
Undulomya pleiopleura Fletcher 1946

Ammonoids

'*Paragastrioceras wandageense* Teichert 1942'
'*Daubichites goochi* (Teichert 1942)'

Crinoids

Calceolispongia sp. indet. D

Trace fossils

Chondrites sp.
Planolites sp.

Kennedy Group

Coolkilya Sandstone

Foraminifers

Hyperamminoides acicula Parr 1942

Bryozoans

Fenestella disjecta (Crockford 1944)

Brachiopods

Permorthotetes teicherti Thomas 1958
Streptorhynchus johnstonei Thomas 1958
Derbyia? sp. A
Neochonetes (Sommeriella) afanasyevae Archbold 1981
Chonetinella sp.
Aulosteges sp. indet. A
Dyschrestia sp.
Retimarginifera waterhousei Archbold 1984
Cancrinella coolkilyaensis Archbold 1983
'*Fusispirifer* spp.'
Spiriferella etheridgei Archbold & Thomas 1985
Spirelytha stepanoviana Archbold & Thomas 1984
Tomiopsis globosus Archbold & Thomas 1986
Cleiothyridina macleayana (Etheridge Jnr 1889)
Yochelsonia thomasi Stehli 1961

Bivalves

Phestia thomasi (Dickins 1956)
Parallelodon subtilistriatus Wanner 1922
Pseudomyalina obliqua Dickins 1956
Atomodesma exarata Beyrich 1864
Streblopteria sp.
'*Pseudomonotis* sp. nov.'
Schizodus kennedyensis Dickins 1956
Neoschizodus johnstonei Dickins 1956
Oriocrassatella stokesi Etheridge Jnr 1907
Astartila fletcheri Dickins 1956
?Undulomya pleiopleura (Fletcher 1946)
Stutchburia muderongensis Dickins 1956

Ammonoids

Agathiceras applanatum Teichert 1944
Daubichites goochi (Teichert 1942)
Popanoceras sp. indet.

Gastropods

Euphemites sp. nov.
Warthia sp. B. cf. *W. micromphala* (Morris 1845)
Straparolus? sp.
Mourlonia (Mourlonia) sp.
Mourlonia sp.
Ptychomphalina sp.
?Platyteichum johnstonei Dickins 1961
?Platyteichum sp. nov.

Conulariids

Paraconularia sp. C

Trilobites

Ditomopyge meridionalis Teichert 1944
Ditomopyge? sp.

Crinoids

Calceolispongia hindei Etheridge Jnr 1915
Calceolispongia robusta Teichert 1949
Calceolispongia sp. indet. B
Calceolispongia sp. indet. C

Trace fossils

Palaeodictyon? sp.
Palaeodictyon? (Squamodictyon?) sp.
Margaritichnus sp. 1
'*Lophoctenium*' sp. 2
Zoophycos sp.
Imbrichnus sp.
Gen. and sp. 5
Gen. and sp. 6
Gen. and sp. 7

Mungadan Sandstone

Bivalves

'rare bivalves not identified'

Annelids

Serpulites spp.

Trace fossils and problematica

Palaeodictyon? sp.
Palaeodictyon? (Squamodictyon?) sp.
Scolicia sp. 4
Curvolithus sp.
Margaritichnus sp. 1
Macaronichnus sp. 1

'*Lophoctenium*' sp. 2
'*Lophoctenium*' sp. 3
Phycosiphon incertum von Fischer-Ooster 1858
Imbrichnus sp.
Cosmoharphe sp.
Gen. and sp. 2
Gen. and sp. 5
Gen. and sp. 6
Rhizocorallium sp.
Problematicum 1

Binthalya Formation

Brachiopods

'large neospiriferids'

Bivalves

'large bivalves'

Trace fossils

Margaritichnus sp. 1
Cosmoharphe sp.
Rhizocorallium sp.
trails and burrows

Canning Basin

Grant Group

Undifferentiated

Foraminifers

'*Reophax* sp. nov. aff. *R. expatiatus* Plummer'
'*Reophax* sp.'

Betty Formation

unspecified marine macrofossils

Winifred Formation

unidentified crinoids, bryozoans, and echinoid fragments

Carolyn Formation

Wye Worry Member

Bryozoans

'*Fenestella*' sp.

Brachiopods

unidentifiable dielasmids and spiriferids

Bivalves

'*?Eurydesma* sp. indet.'
Etheripecten sp. cf. *E. tenuicollis* (Dana 1847)
Streblopteria sp.
Deltopecten lyonsensis Dickins 1957

Gastropods

'*?Keeneia* sp. indet.'

Crinoids

'Calceolispongidae sp. nov.'

Plants

'*Glossopteris*'

Millajjiddee Member

Crinoids

Calceolispongiidae gen. indet. sp. nov. B

Plants

Paracalamites australis Rigby 1966
Glossopteris indica Schimper 1869
Vertebraria indica Royle 1834
Cordaites spatulata (Dana 1849) Rigby, Maheshwari & Schopf 1980
silicified wood
Samaropsis sp.

Trace fossils

not identified

Poole Sandstone

Ostracods

Ostracods indet.

Scaphopods

not identified

Bivalves

Parallelodon sp. indet.
Lithopaga? sp.
Modiolus koneckii Dickins 1963
Stutchburia variabilis Dickins 1957

Plants

Cyclodendron? sp.
Lepidodendron sp.
Bothrodendron sp.
Stigmaria sp.
Glossopteris angustifolia Brogniart 1831
Glossopteris sp. cf. *G. angustifolia* Brongniart 1831
Glossopteris browniana Brongniart 1828
Glossopteris indica Schimper 1869
'*Glossopteris* sp.'
Gangamopteris spp.
Cordaites spatulata (Dana 1849) Rigby, Maheshwari & Schopf 1980
cf. *Taeniopteris spatulata* McClelland 1850
?Brachyphyllum sp.
silicified wood
Cardiocarpus sp.
?Cordaicarpon emarginatum Walkom 1935
Samaropsis milleri (Feistmantel 1879) Seward 1917

Nura Nura Member

Foraminifers

Saccammina hemisphaerica (Chapman & Howchin 1905)
Hyperamminoides expansus Plummer 1945
Ammodiscus nitidus Parr 1942

Glomospirella nyei Crespin 1958
Tetrataxis sp.
Hemigordius schlumbergeri Howchin 1895
Calcitornella stephensi (Howchin 1894)
Trepeilopsis australiensis Crespin 1958
Protonodosaria irwinensis (Howchin 1895)
Protonodosaria tereta (Crespin 1958)
'*Nodosaria* sp.'

Bryozoans

Fistulipora nura Crockford 1957
Hexagonella australis (Bretnall 1926)
Hexagonella hudlestoni Crockford 1957
Evactinostella crucialis (Hudleston 1883)
Dyscritella spinigera (Bassler 1929)
Dyscritellina? globosa (Crockford 1957)
Stenopora hemispherica Waagen & Wentzel 1886
Fenestella horologia Bretnall 1926
Lyropora joselina Crockford 1957
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)

Brachiopods

Permorthotetes lindneri Thomas 1958
Streptorhynchus spp.
Neochonetes (Sommeriella) pratti (Davidson 1859)
'*?Aulosteges* sp. cf. *A. spinosus* Hosking 1931'
'*?Callytharrella callytharrensis* (Prendergast 1943)'
?Cancrinella spp.
Stenoscisma? sp. nov.
Myodelthyrium dickinsi (Thomas 1971)
Neospirifer foordi Archbold & Thomas 1986
'*Neospirifer* sp. indet.'
Cratispirifer nuraensis Archbold & Thomas 1985
Tomiopsis woodwardi Archbold & Thomas 1986
Fletcherithyris sp. cf. *F. hardmani* Campbell 1965
'Terebratulid indet.'

Bivalves

Nuculopsis bangarraensis Dickins 1963
Nuculopsis darlingensis Dickins 1963
Quadratonucula australiensis Dickins 1963
'*Glyptoleda* sp. A'
Phestia darwini (de Koninck 1877)
Phestia lyonsensis (Dickins 1956)
Cypricardinia? elegantula Dickins 1963
Pseudomyalina sp. A
Atomodesma (Atomodesma) mytiloides Beyrich 1864
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var nov.
Atomodesma (Atomodesma) sp. cf. *A. timorense* (Wanner 1922)
Etheripecten sp. cf. *E. subquinquelineatus* Etheridge Jnr 1907
Etheripecten tenuicollis (Dana 1847)
Etheripecten sp. cf. *E. tenuicollis* (Dana 1847)
Etheripecten? sp. indet. A
'*Heteropecten subquinquelineatus* M'Coy var. *comptus* Dana 1847'
Streblochondria sp. nov.
Euchondria callytharraensis Dickins 1963
Elimata guppyi Dickins 1963
Schizodus fitzroyensis Dickins 1963
Schizodus sandimanensis Dickins 1963
Astartella? sp. nov.
Astartella obliqua Dickins 1963
Oriocrassatella sp.
Edmondia prichardi Dickins 1963
Palaeosolen? badgeraensis Dickins 1963
Megadesmus? sp. B
Astartila sp. cf. *A. danai* (de Koninck 1877)
Chaenomya? nuraensis Dickins 1963
Chaenomya sp. B
Myofossa subarbitrata (Dickins 1963)
Cosmomya (Palaeocosmomya) sp. nov.
Stutchburia sp. cf. *S. variabilis* Dickins 1957

Ammonoids

Metalegoceras australe (Smith 1927)
Metalegoceras striatum Teichert 1942
Propopanoceras ruzhencevi Glenister & Furnish 1961
Thalassoceras wadei Miller 1936

Gastropods

Euphemites wynnensis Dickins 1963
Warthia? carinata Dickins 1963
Warthia intermedia Dickins 1963
Warthia? sp. indet.
Stachella crucilirata Dickins 1963
Bellerophon formani Dickins 1963
Bellerophon sp. indet.
Bellerophontidae gen. indet.
Straparolus (Leptomphalus) besselensis Dickins 1963
Mourlonia (Pseudobaylea) freneyensis Dickins 1963
Mourlonia (Pseudobaylea) sp. cf. *M.(P.) freneyensis* Dickins 1963
Mourlonia? obscura Dickins 1963
Ptychomphalina sp. nov.
Pleurotomariidae gen. indet.
?Platyceras sp. nov.

Conulariids

Paraconularia sp. A

Ostracods

Bairdia sp.
Healdia sp.

Crinoids

crinoid ossicles

Conodonts

'?conodont fragments'

Plants

Cyclodendron leslii (Seward 1903) Kraüsel 1928
Cyclodendron sp.
Glossopteris browniana Brogniart 1828
Vertebraria indica Royle 1834
Samaropsis sp. cf. *S. milleri* (Feistmantel 1879) Seward 1917

Noonkanbah Formation

Foraminifers

Hippocrepinella biaperta Crespin 1958
Psammosphaera pusilla Parr 1942
Hyperamminita rudis (Parr 1942)

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Sacculinella australis (Crespin 1958)
Saccammina ampulla (Crespin 1958)
Saccammina hemisphaerica (Chapman & Howchin 1905)
Thurammina phialaeformis Crespin 1958
Thuramminoides sphaeroidalis Plummer 1945
'*Thuramminoides* sp. cf. *T. teicherti* (Parr)'
Oryctoderma teicherti (Parr 1942)
Hyperammina coleyi Parr 1942
Hyperammina fusta Crespin 1958
Hyperammina sp.
Giraliarella rhomboidalis Crespin 1958
Giraliarella travesi Crespin 1958
Pseudohyperammina radiostoma Crespin 1958
Hyperamminoides acicula (Parr 1942)
Hyperamminoides elegans (Cushman & Waters 1928)
Hyperamminoides expansus Plummer 1945
'*Hyperamminoides* sp. cf. *H. expansus* (Plummer)'
'*Hyperamminoides* sp.'
Ammodiscus erugatus Crespin 1958
Ammodiscus nitidus Parr 1942
Glomospirella nyei Crespin 1958
'*Tolypammina* sp.'
Tolypammina undulata Parr 1942
Reophax ellipsiformis Crespin 1958
Reophax emaciatus Plummer 1945
Reophax subasper Parr 1942
Reophax tricameratus Parr 1942
Ammobaculites wandageeensis Crespin 1958
'*Ammobaculites* sp. cf. *A. woolnoughi* Crespin & Parr'
Trochammina subobtusa Parr 1942
'*Trochammina* sp. cf. *T. subobtusa* Parr 1942'
Digitina recurvata Crespin & Parr 1940
'*Digitina* sp. cf. *D. recurvata* Crespin & Parr'
Flectospira prima Crespin & Belford 1957
Orthovertella protea Cushman & Waters 1928
Hemigordius harltoni Cushman & Waters 1928
Meandrospira kimberleyensis (Crespin & Belford 1957)
Meandrospira meandrina (Crespin & Belford 1957)
Calcitornella heathi Cushman & Waters 1928
Calcitornella sp.
Calcitornella stephensi (Howchin 1894)
Calcivertella palata Crespin 1958
Calcivertella sp. cf. *C. palata* Crespin 1958
Plummerinella kimberleyensis Crespin 1958
Lunucammina triangularis (Chapman & Howchin 1905)
Howchinella parri (Crespin 1945)
Howchinella semicostula (Crespin 1958)
Howchinella striatosulcata (Crespin 1958)
Howchinella woodwardi (Howchin 1895)
Ichthyolaria impolita (Crespin 1958)
Pachyphloia caseyi (Crespin 1958)
Protonodosaria tereta (Crespin 1958)
Nodosaria conicodensestriata Paalzow 1935
Nodosaria fisheri Crespin 1958
Nodosaria raggatti Crespin 1958
Nodosaria spiculata Crespin 1958
'*Nodosaria* sp.'
'*Nodosaria* sp. nov.'
Dentalina grayi Crespin 1985
Dentalina habra Crespin 1958
Dentalina nerrimaensis Crespin 1958
Pseudonodosaria serocoldensis (Crespin 1945)
'*Frondicularia* sp. nov.'
'*Orthovertella* sp.'

Corals

Plerophyllum australe Hinde 1890
Gertholites marmionensis (Etheridge Jnr 1914)
Cladochonus nicholsoni (Etheridge Jnr 1914)

Bryozoans

Fistulipora stereos Crockford 1957
Fistulipora vacuolata Crockford 1944
Fistulipora wadei Crockford 1944
Dybowskiella arborescens Crockford 1957
Dybowskiella crescens (Crockford 1944)
Eridopora permiana Crockford 1957
Hexagonella australis (Bretnall 1926)
Hexagonella bifida Crockford 1944
Hexagonella hudlestoni Crockford 1957
Hexagonella lineata Crockford 1944
Hexagonella plana Crockford 1944
Fistulamina lata Crockford 1957
Prismopora? attenuata Crockford 1957
Prismopora digitata Crockford 1957
Prismopora? triradiata Crockford 1957
Evactinostella crucialis (Hudleston 1883)
Etherella irregularis Crockford 1957
Etherella porosa Crockford 1957
Etherella porosa var. *minor* Crockford 1957
Liguloclema meridianus Etheridge Jnr 1926
Liguloclema typicalis Crockford 1957
Goniocladia indica Waagen & Pichl 1885
Goniocladia timorensis Bassler 1929
Aetomacladia ambrosioides Bretnall 1926
Hinganella? bella (Crockford 1957)
Dyscritella adnascens Bassler 1929
Dyscritella macrostoma Crockford 1957
Dyscritella spinigera (Bassler 1929)
Dyscritella tenuirama Crockford 1957
Dyscritellina? globosa (Crockford 1957)
Pseudobatostomella bruteni (Crockford 1957)
Stenopora lineata Crockford 1957
Stenopora punctata Crockford 1957
Stenopora? sp. A Etheridge Jnr 1914
Stenopora spicata var. *obtusa* Crockford 1957
Stenodiscus hardmani Crockford 1957
Stenodiscus variabilis Crockford 1957
Tabulipora scissa Crockford 1957
Fenestella basleoensis Bassler 1929
Fenestella cacuminatis (Crockford 1944)
Fenestella columnaris (Crockford 1944)
Fenestella disjecta (Crockford 1944)
Fenestella hindei Crockford 1957
Fenestella horologia Bretnall 1926
Fenestella lennardi (Crockford 1944)
Fenestella princeps (Crockford 1944)
Fenestella rudiacarinata (Crockford 1944)
Fenestella valentis (Crockford 1944)
Polypora bruteni Wass 1967
Polypora kimberleyensis Crockford 1957
Polypora megastoma (de Koninck 1863)
Polypora multiporifera Crockford 1944
Polypora natalis Crockford 1957
Polypora obesa Crockford 1957
Polypora wadei Crockford 1957

Polypora woodsi (Etheridge Jnr 1892)
Australopolypora fovea (Crockford 1944)
Protoretepora ampla (Lonsdale 1844)
Protoretepora flexuosa Crockford 1957
Protoretepora robusta (Bassler 1929)
Synocladia teicherti Crockford 1957
Rhabdomeson bispinosum Crockford 1944
Rhabdomeson bretnalli Crockford 1957
Rhabdomeson grande Crockford 1944
Rhabdomeson mammillatum (Bretnall 1926)
Rhabdomeson mammillatum var. nov. Crockford 1957
Rhabdomeson? ramosa (Crockford 1957)
Rhombopora? tenuis Hinde 1890
Saffordotaxis castanea Crockford 1957
Saffordotaxis elegans Crockford 1957
Saffordotaxis multigranulata (Bretnall 1926)
Saffordotaxis sp. cf. *S. wanneri* (Bassler 1929)
Megacanthopora? scalariformis Crockford 1957
Ogbinopora? etheridgei (Bretnall 1926)
Streblotrypa sp. cf. *S. minutula* Bassler 1929
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)
Rhombocladia spinulifera Crockford 1944

Brachiopods

Permorthotetes sp. aff. *P. camerata* Thomas 1958
Permorthotetes guppyi Thomas 1958
Permorthotetes sp. aff. *P?. guppyi* Thomas 1958
Kiangsiella sp. cf. *K. condoni* Thomas 1958
Kiangsiella sp. B
Streptorhynchus costatus Thomas 1958
Streptorhynchus spp.
Streptorhynchus variabilis Thomas 1958
Arctitreta? crassimurus (Thomas 1958)
Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
Svalbardia narelliensis Archbold 1981
Heteralosia complectens (Etheridge Jnr 1918)
Wyndhamia multispinifera (Prendergast 1943)
Lialosia kimberleyensis (Prendergast 1943)
Taeniothaerus miniliensis Coleman 1957
Retimarginifera perforata Waterhouse 1970
Costiferina wadei (Prendergast 1943)
Cancrinella bella (Etheridge Jnr 1918)
Stenoscisma? sp. nov. B
Licharewiid gen. nov. B et sp. nov. B
Neospirifer amplus Archbold & Thomas 1986
Neospirifer postplicatus Archbold & Thomas 1986
Crassispirifer pinguis Archbold & Thomas 1985
Trigonotreta dickinsi Archbold & Thomas 1986
Spiriferella australasica (Etheridge Jnr 1889)
Spirelytha miloradovichi Archbold & Thomas 1984
Tomiopsis teicherti Archbold & Thomas 1986
Hustedia? basedowi (Etheridge Jnr 1918)
Cleiothyridina macleayana (Etheridge Jnr 1889)
Fletcherithyris sp. cf. *F. hardmani* Campbell 1965
Yochelsonia thomasi Stehli 1961
Hoskingia sp. cf. *H. grandis* Campbell 1965
Hoskingia sp. cf. *H. wandageensis* Campbell 1965
Gilledia sp. cf. *G. homevalensis* Campbell 1965
Hemiptychina? sp. Campbell 1965

Bivalves

'*Pseudomyalina* sp. cf. *P. mingenewensis* (Etheridge Jnr 1907)'
Atomodesma (Atomodesma) mytiloides Beyrich 1864
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.
'*Myalina* sp. nov. af. *M. congeneris* Wallcott'
Etheripecten spp.
'*Streblochondria* sp.'
Streblopteria? sp. nov. A
'*Pseudomonotis* sp. nov. A'
?Astartila blatchfordi (Hosking 1931)
Astartila sp.
Undulomya rugulata Fletcher 1946
Undulomya sp. A

Gastropods

Warthia sp. A cf. *W. micromphala* (Morris 1845)
Bellerophon costatus Sowerby 1834

Bellerophontids

Baylea? sp. nov.
Ptychomphalina maitlandi Etheridge Jnr 1903
Ptychomphalina sp. nov.

Ostracods

Hollina sp.
Hollinella sp.
Kirkbya sp.
Amphissites sp.
Bairdia sp.
Bythocypris sp.
Cypris sp.
Healdia sp.
Cavellina sp.
Cytherella sp.
cf. *Jonesina*
Ostracoda gen. indet.

Crinoids

Calceolispongia hindei Etheridge Jnr 1915
Calceolispongia multiformis Teichert 1949
Calceolispongia rotundata Teichert 1949
Calceolispongia rubra Teichert 1949
?Calceolispongia spectabilis Teichert 1949
Calceolispongia sp. indet. M

Conodonts

not identified

Plants

Paracalamites australis Rigby 1966

Fish

'Elasmobranchii undet.'
Actinopterygian? undet.

Annelids

Serpulites spp.
Conchotrema tubulosa Teichert 1945

Triwhite Sandstone

Brachiopods

'Productid indet.'

'*?Neospirifer* sp. nov.'

Bivalves

'*Modiolus*' sp.
Atomodesma (Atomodesma) mytiloides Beyrich 1864
Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.
Etheripecten sp. D
'*Merismopteria* sp.'
?Schizodus kennedyensis Dickins 1956
Astartila blatchfordi (Hosking 1931)
Astartila sp. cf. *A. blatchfordi* (Hosking 1931)

Gastropods

Warthia sp. A cf. *W. micromphala* (Morris 1845)
Stachella sp.
Mourlonia (Mourlonia) sp.
Ptychomphalina maitlandi Etheridge Jnr 1903

Plants

wood fragments

Vertebrates

bony plate

Liveringa Group

Undifferentiated

Foraminifers

Reophax tricameratus Parr 1942
Howchinella woodwardi (Howchin 1895)

Lightjack Formation

Foraminifers

'*Hyperammina fusta* Crespin 1958'
'*Hyperamminoides* spp.'
Ammodiscus erugatus Crespin 1958
Reophax subasper Parr 1942

Corals

Tachylasma densum Hill 1937

Bryozoans

Fistulipora liveringa Crockford 1957
Etherella porosa Crockford 1957
Goniocladia timorensis Bassler 1929
Dyscritella tenuirama Crockford 1957
Dyscritella? liveringa Crockford 1957
Stenodiscus hardmani Crockford 1957
Stenodiscus variabilis Crockford 1957
Fenestella horologia Bretnall 1926
Rhabdomeson mammillatum var. nov. Crockford 1957
Staffordotaxis elegans Crockford 1957
Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)

Brachiopods

Permorthotetes guppyi Thomas 1958
Streptorhynchus perfidiabadensis (Etheridge Jnr 1907)
Neochonetes (Sommeriella) afanasyevae Archbold 1981
Heteralosia spp.
?Cancrinella spp.
Costatispirifer gracilis Archbold & Thomas 1985
Trigonotreta lightjacki Archbold & Thomas 1986
Tomiopsis balgoensis Archbold & Thomas 1986
Tomiopsis globosus Archbold & Thomas 1986
Yochelsonia stehlii Campbell 1965

Bivalves

Phestia basedowi (Etheridge Jnr 1907)
Parallelodon subtilistriatus Wanner 1922
Atomodesma exarata Beyrich 1864
Schizodus kennedyensis Dickins 1956
'*?Aviculopecten hardmani* Etheridge Jnr'
'*Streblochondria* sp.'
Oriocrassatella stokesi Etheridge Jnr 1907
Astartila fletcheri Dickins 1956
Stutchburia muderongensis Dickins 1956

Ammonoids

Daubichites goochi (Teichert 1942)
Bamyaniceras australe (Teichert 1942)

Gastropods

Warthia sp. A cf. *W. micromphala* (Morris 1845)
'Bellerophontidae gen. et sp. nov.'
'*Retispira bellireticulata* (Etheridge Jnr 1907)'
Retispira emerii (Etheridge Jnr 1907)
'*?Hantonia* sp. nov.'

Conulariids

'*Conularia warthi Waagen*'
Paraconularia sp. D

Crinoids

crinoid ossicles

Annelids

Serpulites spp.

Plants

Paracalamites australis Rigby 1966
equisetalean stem

Trace fossils and problematica

Scolicia sp. 1?
Scolicia sp. 3
Margaritichnus sp. 1
Margaritichnus sp. 1?
Macaronichnus sp. 1
Gyrochorte? sp.
Problematicum 2

Condren Sandstone

Plants

?Brasilodendron pedroanum (Carruthers 1969)
'*?Bothrodendron* sp.'
Phyllotheca australis Brongniart 1828
Phyllotheca sp.
Raniganjia sp.
Paracalamites australis Rigby 1966
Neomariopteris lobifolia (Morris 1845) Maithy 1974
Neomariopteris polymorpha (Feistmantel 1876) Maithy 1974

Alethopteris lindleyana (Royle 1833) Schimper 1869
Glossopteris browniana Brongniart 1828
Glossopteris communis Feistmantel 1876
Glossopteris condrenensis Rigby, Chandra & Surange 1988
Glossopteris indica Schimper
Glossopteris sp. B
Gangamopteris sp. cf. *G. angustifolia* M'Coy 1847
Gangamopteris cyclopteroides Feistmantel 1876
Gangamopteris spp.
?Palaeovittaria kurzii Feistmantel 1876
Vertebraria indica Royle 1834
scale leaves
Cordaites spatulata (Dana 1849) Rigby, Maheshwari & Schopf 1980
?Cordaites sp.
Artisia alternans Lignier 1895
Araucarites cutchensis Feistmantel 1876
cycad pith casts
Carpolithes sp.
Samaropsis milleri (Feistmantel 1879) Seward 1917
'*Samaropsis moravica* (Helmhacher) Zeiller 1892'
Samaropsis sp.

Hardman Formation

Foraminifers

Hyperammina fusta Crespin 1958

Gastropods

Bellerophontids
Pleutomariids

Trace fossils and problematica

Scolicia sp. 2
Cruziana? sp. 4
Cylindricum? sp.
Problematicum 3

Cherrabun Member

Corals

'*Tachylasma densum* Hill 1937'

Bryozoans

Dyscritella tenuirama Crockford 1957
'*Dyscritella? liveringa* Crockford 1957'
'*Stenodiscus hardmani* Crockford 1957'

Brachiopods

Streptorhynchus luluigui Hosking 1933
Streptorhynchus sp. cf. *S. pelargonatus* (Schlotheim 1816)
Derbyia hardmani Thomas 1958
Neochonetes (Sommeriella) sp. nov. B
'*?Heteralosia* sp. nov.'
'Strophalosiid gen. et sp. nov.'
Aulosteges reclinis Coleman 1957
Taeniothaerus fletcheri Coleman 1957
Megasteges fairbridgei (Coleman 1957)
Megasteges septentrionalis (Etheridge Jnr 1907)
Waagenoconcha imperfecta Prendergast 1935
Latispirifer amplissimus Archbold & Thomas 1985
Neospirifer grandis Archbold & Thomas 1986
Tomiopsis hardmani Archbold & Thomas 1986
Hustedia sp. nov. cf. *H. grandicosta* Davidson 1862
Cleiothyridina penta (Prendergast 1935)
Cleiothyridina sp. nov.
Fletcherithyris hardmani Campbell 1965
Hoskingia grandis Campbell 1965

Bivalves

'*Phestia* sp. cf. *P. acuta* (Waagen 1881)'
Modiolus sp. nov.
Atomodesma (Atomodesma) sp. cf. *A. (A.) semiplicata* Reed 1944
'*Atomodesma* sp. nov.'
'Large pectinid'
Pseudomonotis (Trematiconcha) wandageensis Newell & Boyd 1970.
'cf. *Pseudomonotis deplanata* Waagen 1881'
'*Acanthopecten* sp.'
'*Streblopteria* sp. nov.'
'*Cyrtorostra* sp. nov.'
'*Stutchburia* cf. *S. dubius* (Wanner 1940)'
'*?Triaphorus* sp. nov.'
Schizodus cf. *S. obscurus* (King)
'*Oriocrassatella* sp. nov.'
Astartella sp. nov.
'*Megadesmus* sp. nov.'
Astartila? sp. nov.
'*?Vacunella* sp. nov.'
'*Wilkingia* cf. *W. elegans* (King 1850)'
'*?Wilkingia* sp. nov.'
Sanguinolitidae gen. et sp. nov.

Ammonoids

Cyclolobus persulcatus Rothpletz 1892

Gastropods

Warthia sp. C
'*Bellerophon* cf. *B. politus* and *B. triangularis* Waagen 1880'
'*Mogulia* sp. nov.'
'*Stachella* or *Retispira* sp. nov.'
'*Mourlonia* sp.'
'*Platyteichum* sp. nov.'
'*Bellerophon* cf. *B. blanfordianus* Waagen 1880'
'*Bembexia* sp. nov.'
'*Peruvispira* sp. nov.'
'*?Naticopsis* sp.'

Kirkby Range Member

Trace fossils

Scolicia sp. 5

Godfrey beds

Plants

'*Cyclodendron leslii* (Seward 1903) Kraüsel 1928'
'*Glossopteris* sp.'
Cordaites spatulata (Dana 1849) Rigby, Maheshwari & Schopf 1980

Trace fossils

Rhizocorallium

Plates

Plate 1

Specimens are figured in frontal view, unless otherwise stated.

Figures 5, 6, 12, 29 and 33 were photographed by Dr J. Backhouse (Geological Survey of W.A.). Figures 45–47 have been reproduced from Contributions to Cushman Foundation for Foraminiferal Research (Belford, 1961) with the permission of the Cushman Foundation, USA. The rest of the figures are from BMR Bulletin 48 (Crespin, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Figs 1–4 *Hippocrepinella biaperta* Crespin 1958

1. **Paratype**, CPC 2354; x22.
2, 3. **Holotype**, CPC 2351; typical distorted test; x27.
4. **Paratype**, CPC 2355; x22.
Road cutting near Oonah, northwest Tasmania, 37 km west of Waratah on main Somerset–Waratah Road; Quamby Mudstone; Sakmarian–Artinskian.

Figs 5–8 *Psammosphaera pusilla* Parr 1942

5. **Holotype**, UWA 20680; x50.
6. **Topotype**, CPC 2357; internal view; x50.
7. **Topotype**, CPC 2357; x30.
South side of Minilya River near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

8. **Hypotype**, CPC 2358; slightly compressed; x40.
At 45.7 m in AFO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 9–11 *Sacculinella australis* Crespin 1958

9. **Holotype**, CPC 2375; x22.
Minilya River, 0.4 km upstream from Wandagee Homestead, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

10. **Paratype**, CPC 2376; slightly compressed with fine horizontal bands of carbonaceous material; x22.
7.4 km southwest of Moogooree Homestead, Carnarvon Basin; 97.5 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

11. **Paratype**, CPC 2379; x23.
At 198–201 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian).

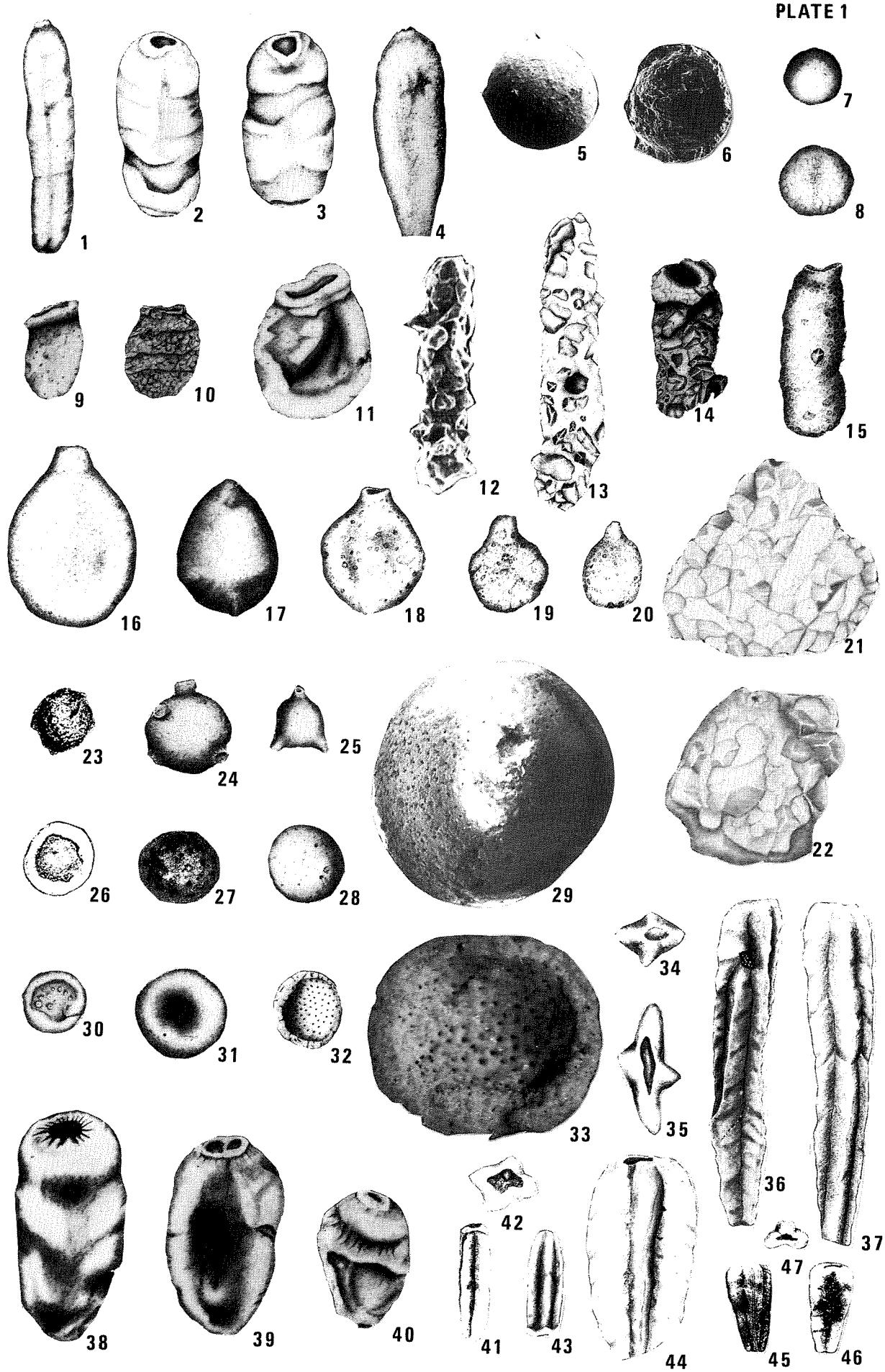
Figs 12–15 *Hyperamminita rudis* (Parr 1942)

12. **Holotype**, UWA 20677; x30.
East of Coolkilya Paddock, 173 m east of Teichert, Higgins and Uttings Station 52, May 1939, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

13. **Hypotype**, CPC 2419; x20.
25.6 km north-northwest of Bidgemia Homestead, Carnarvon Basin; top of Wandagee Formation; Late Artinskian (Baigendzhinian).

14. **Hypotype**, CPC 2420; x16.
Wooramel River, 4 km west of junction with Madeline Creek, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

PLATE 1



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GSWA 22919

15. **Hypotype**, CPC 2534; x13.
At 9.1–15.2 m in Jurgarra Creek, BMR water bore, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 16–17 *Saccammina ampulla* (Crespin 1958)

16. **Paratype**, CPC 2374; x18.
17. **Holotype**, CPC 2372; x19.
Oonah, 36.8 km north of Waratah, on main Somerset–Waratah Road, northwestern Tasmania; Quamby Mudstone; Artinskian.

Figs 18–20 *Saccammina hemisphaerica* (Chapman & Howchin 1905)

18. **Hypotype**, CPC 2371; irregularly compressed; x19.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Arkinskian (Baigendzhinian).

19. **Hypotype**, CPC 2369; x15.
Ninnigo Dam, Middalya Station, Carnarvon Basin; top of Bulgadoo Shale; Late Artinskian (Baigendzhinian).

20. **Hypotype**, CPC 2370; x18.
At 7.9–15.2 m in BMR Bore 11(T), Ponds Creek, Sydney Basin, NSW; Mulbring Siltstone; Kazanian.

Figs 21, 22 *Saccammina arenosa* (Crespin 1958)

21. **Holotype**, CPC 2359; x33.
22. **Paratype**, CPC 2360; x29.
Wooramel River, 3.6 km west of junction with Madeline Creek, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 23–25 *Thurammina phialaeformis* Crespin 1958

23. **Hypotype**, UWA 20681; x22.
Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

24. **Holotype**, CPC 2361; x14.
25. **Paratype**, CPC 2362; x10.
Minilya River, 0.4 km upstream from Wandagee Homestead, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 26, 27, 30, 31 *Thuramminoides sphaeroidalis* Plummer 1945

26. **Hypotype**, CPC 2366; test deflated in middle; x5.
At 118.9–121.9 m in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

27. **Hypotype**, CPC 2365; compressed; x12.
Minilya River, 5.6 km northwest of Wandagee Homestead, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

30. **Hypotype**, CPC 2886; x40.
Mount Sandiman Station, 4.8 km east-southeast of Merlinleigh Homestead, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

31. **Hypotype**, CPC 2364; moderately compressed; x13.
3.6 km southeast of Donnellys Well, Williambury Station, Carnarvon Basin; Mallens Sandstone; Late Artinskian (Baigendzhinian).

Figs 28, 29, 32, 33 *Oryctoderma teicherti* (Parr 1942)

28. **Hypotype**, CPC 2367; x7.5.
29. **Holotype**, UWA 20674; x20.
32. **Hypotype**, CPC 2368; interior of broken test; x6.5.
33. **Hypotype**, UWA 20674; internal view; x10.

South side of Minilya River, near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 34, 36, 37 *Giraliarella angulata* Crespin 1958

Holotype, CPC 2428; in apertural (x63) and lateral (x38) views.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 35, 44 *Giraliarella rhomboidalis* Crespin 1958

Holotype, CPC 2432; in apertural (x61) and lateral (x36) views.
3.4 km west of south of Merlinleigh Homestead, Carnarvon Basin; uppermost part of Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 38–40 *Pseudohyperammina radiostoma* Crespin 1958

38. **Holotype**, CPC 2421; x34.
39. **Paratype**, CPC 2425; x29.
40. **Paratype**, CPC 2422; x31.

At 143 m (for CPC 2421, 2425) and 39.3 m (CPC 2422) in AFO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 41–43 *Giraliarella travesi* Crespin 1958

Holotype, CPC 2431; in apertural (x125) and lateral (x48) views.
At 652.3–653.8 m in Myroodah 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 45–47 *Giraliarella triloba* Belford 1961

Holotype, CPC 3856; in apertural and lateral views; x30 (after Belford, 1961, pl. 3 figs 9-11).
Core no. 11 (330.1–333.2 m) in BMR 9 bore, Daurie Creek, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Plate 2

Specimens are figured in frontal view, unless stated otherwise.

Figures 13, 26, 27, 33 and 35 were photographed by Dr J. Backhouse (Geological Survey of W.A.). The rest of the figures are from BMR Bulletin 48 (Crespin, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Figs 1, 2 *Hyperammina callytharraensis* Crespin 1958

1. **Paratype**, CPC 2383; slightly flattened; x26.
Section near Salt Gully, Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

2. **Holotype**, CPC 2382; x19.
Callytharra Spring, Carnarvon Basin; 6.1–10.7 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3–5 *Hyperammina fusta* Crespin 1958

3. **Holotype**, CPC 2407; x32.
4. **Paratype**, CPC 2409; x29.
5. **Paratype**, CPC 2408; x33.
7.4 km southwest of Moogooree Homestead, Carnarvon Basin; 97.5 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 6–8 *Hyperammina elegantissima* Plummer 1945

6. **Hypotype**, CPC 2399; x30.
7. **Hypotype**, CPC 2398; x28.
8. **Hypotype**, CPC 2397; x15.
Core 66 (949.5–951.0 m for CPC 2399), Core 67 (980.4–986.5 m for CPC 2397, 2398) in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 9–13 *Hyperammina coleyi* Parr 1942

9. **Topotype**, CPC 2388; x6.5.
South side of Minilya River, near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

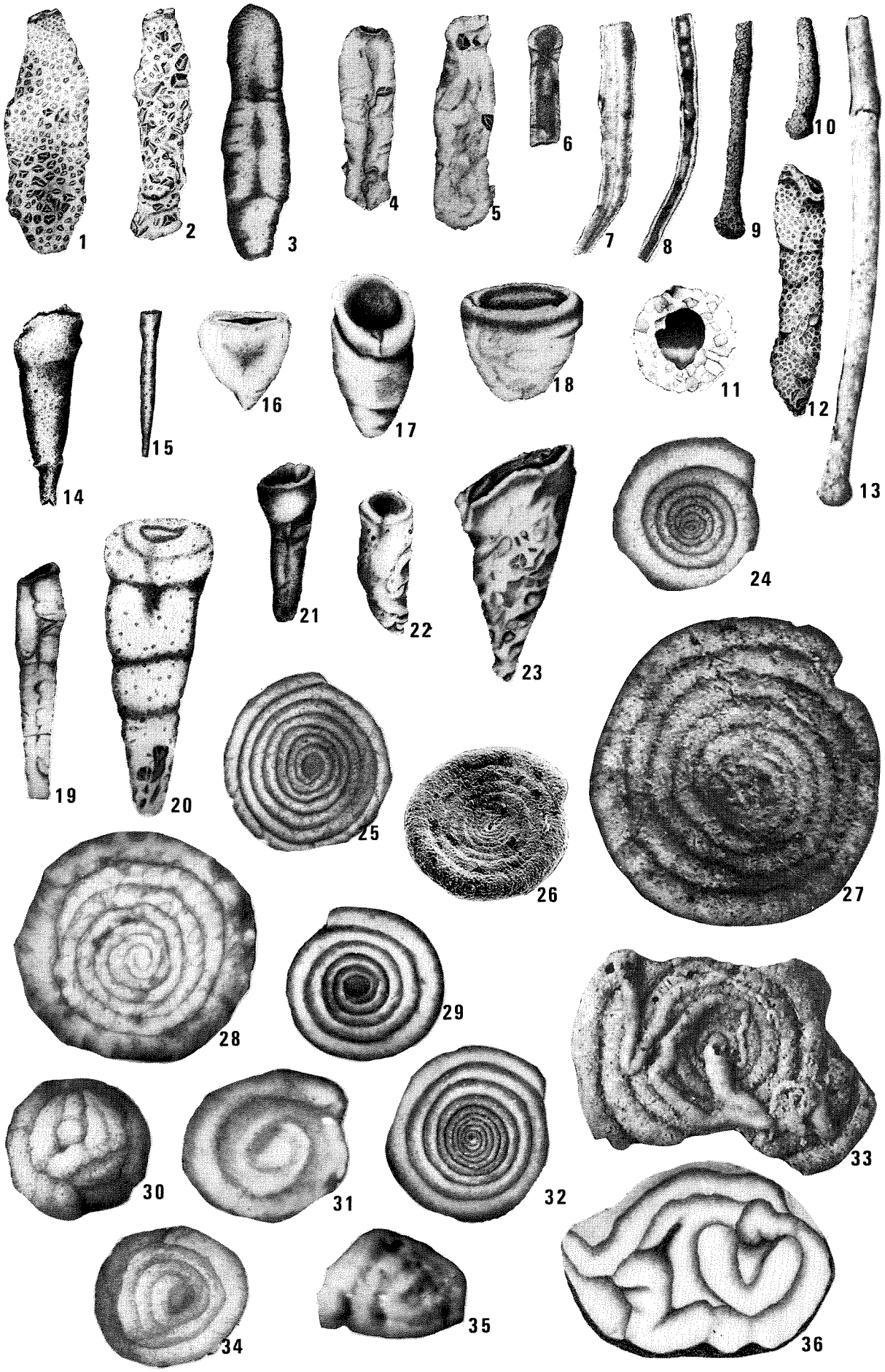
10. **Hypotype**, CPC 2389; x6.5
7.7 km southwest of Moogooree Homestead, Carnarvon Basin; 123.4 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

11. **Hypotype**, CPC 2392; horizontal section; x25.
12. **Hypotype**, CPC 2391; x16.
Callytharra Spring, Carnarvon Basin; 54.9–70.1 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

13. **Holotype**, UWA 20676; x10.
South side of Minilya River, near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 14, 15 *Hyperamminoides acicula* Parr 1942

14. **Hypotype**, CPC 2381; x13.
7.7 km southwest of Moogooree Homestead, Carnarvon Basin; 123.4 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).



FORAMINIFERS

15. Hypotype, CPC 2380; x4.5.
South side of Minilya River, near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 16–18 *Hyperamminoides expansus* Plummer 1945

16. **Hypotype**, CPC 2400; x30.
18. **Hypotype**, CPC 2401; x30.
2.4 km east-southeast of Cundlego Crossing, Minilya River, Carnarvon Basin; 19.8 m below top of Bulgadoo Shale; Late Artinskian (Baigendzhinian).

17. **Hypotype**, CPC 2402; x34.
Brutens Yard area, northern Canning Basin; 3.1 m below top of Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 19, 20 *Hyperamminoides elegans* (Cushman & Waters 1928)

19. **Hypotype**, CPC 2393; x5.
20. **Hypotype**, CPC 2396; x18.
76.8 km southeast of Moogooree Homestead, Carnarvon Basin; 97.5 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 21–23 *Hyperamminoides hadzeli* (Crespin 1958)

21. **Holotype**, CPC 2410; x16.
22. **Paratype**, CPC 2412; x17.
23. **Paratype**, CPC 2414; second chamber excessively expanded; x28.
Callytharra Spring area, Carnarvon Basin; 54.9–70.1 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 24 *Ammodiscus erugatus* Crespin 1958

Holotype, CPC 2462; microspheric form; x49.
At 265.2–272.8 m in Myroodah 1, northern Canning Basin; Liveringa Group; Late Artinskian–Chhidruan.

Figs 25, 28 *Ammodiscus multicinctus* Crespin & Parr 1941

25. **Hypotype**, CPC 2466; x89.
At 16.2–22.9 m in BMR 14 bore, Ponds Creek, NSW; Mulbring Siltstone; Kazanian.

28. **Holotype**, CPC 149; x44.
Railway cutting west of Farley Station, Hunter River area, NSW; Farley Formation; Sakmarian–Artinskian.

Figs 26, 29, 32 *Ammodiscus nitidus* Parr 1942

26. **Holotype**, UWA 20670; x50.
East of Coolkilya Paddock, 173 m east of Teichert, Higgins and Uttings Station 52, May 1939, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

29. **Hypotype**, CPC 2468; megalospheric form; x61.
3.0 km west of south of Merlinleigh Homestead, Carnarvon Basin; upper part of Wandagee Formation; Late Artinskian (Baigendzhinian).

32. **Topotype**, CPC 2467; microspheric form; x61.
East of Coolkilya Paddock, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 27 *Ammodiscus wandageeensis* Parr 1942

Holotype, UWA 20671; x10.
South side of Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 30, 34 *Glomospirella nyei* Crespin 1958

30. **Holotype**, CPC 2475; x67.
Cundlego Crossing, Minilya River, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

34. **Paratype**, CPC 2476; x135.
Callytharra Spring area, Carnarvon Basin; 54.9–70.1 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 31, 35 *Tolypammina adhaerens* (Parr 1942)

31. **Hypotype**, CPC 2473; x33.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

35. **Holotype**, UWA 20675; x20.
South side of Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 33, 36 *Tolypammina undulata* Parr 1942

33. **Holotype**, UWA 20682; x10.
South side of Minilya River, near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

36. **Hypotype**, CPC 2481; x54.
Gully at Hebden, Portion 148, Parish Liddell, County Durham, NSW; Mulbring Siltstone; Kazanian.

Plate 3

Specimens are figured in frontal view, unless stated otherwise.

Figures 8 and 11 were photographed by Dr J. Backhouse (Geological Survey of W.A.). The rest of the figures are from BMR Bulletin 48 (Crespin, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Fig. 1 *Ammovertella inclusa* (Cushman & Waters 1927)

Hypotype, CPC 2480; x44.
Callytharra Spring area, Carnarvon Basin; 0–3.7 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 2, 3 *Reophax emaciatus* Plummer 1945

2. **Hypotype**, CPC 2449; x52.
At 170.7–173.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian).

3. **Hypotype**, CPC 2448; x36.
Section south of Grant Range, northern Canning Basin; 114.3 m below top of Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4, 5 *Reophax belfordi* Crespin 1958

4. **Holotype**, CPC 2440; x74.
5. **Paratype**, CPC 2443; x77.
At 167.6–170.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian)–?Kungurian.

Fig. 6 *Reophax ellipsiformis* Crespin 1958

Holotype, CPC 2444; x30.
7.36 km southwest of Moogooree Homestead, Carnarvon Basin; 97.5 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

Fig. 7 *Reophax fittsi* (Warthin 1930)

Hypotype, CPC 2450; x27.
At 775.1–778.8 m (Core no. 31) in Roebuck Bay 1, southern Canning Basin; ?Grant Group; ?Asselian–Early Sakmarian (Tastubian).

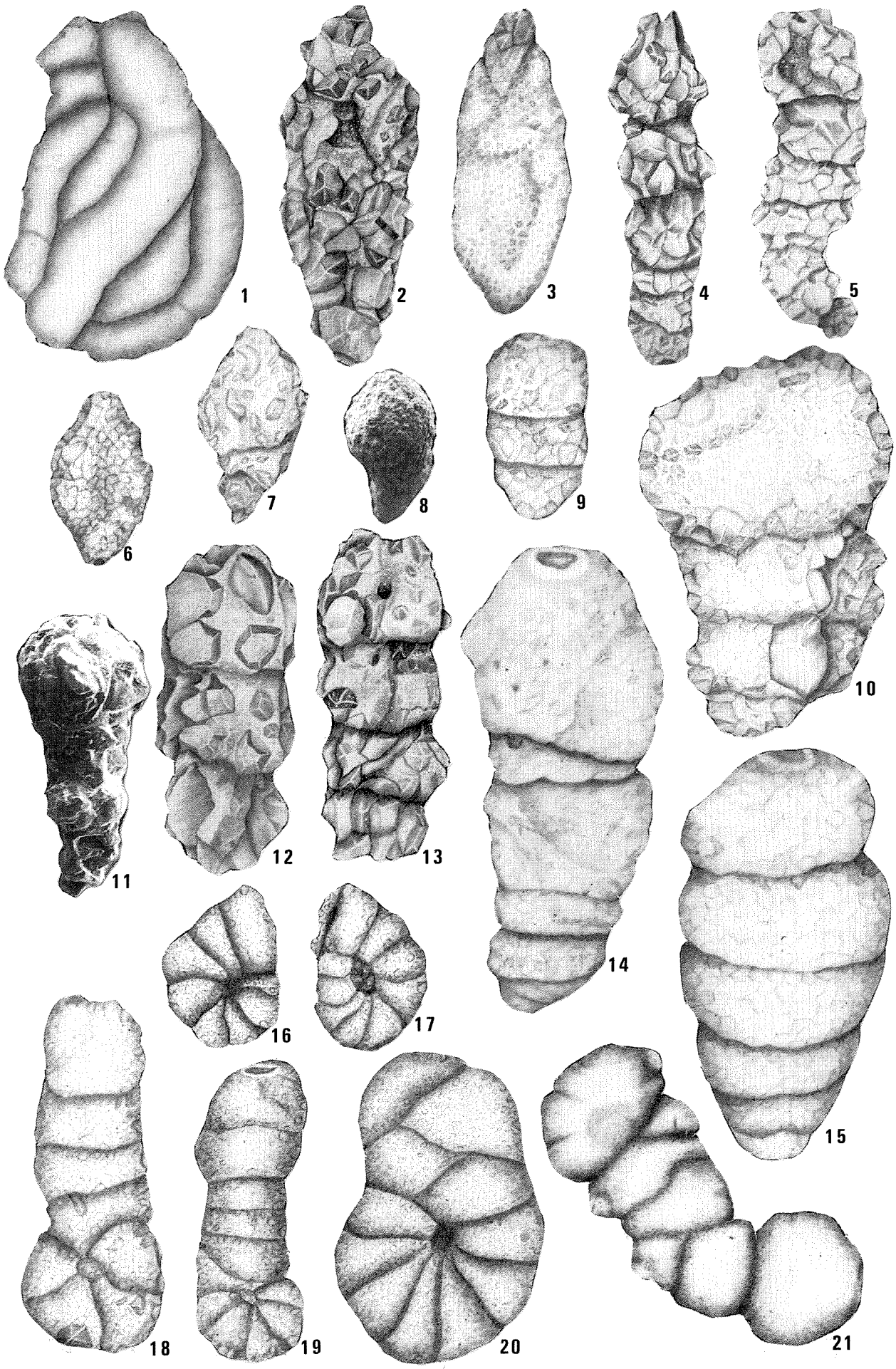
Figs 8–10 *Reophax tricameratus* Parr 1942

8. **Holotype**, UWA 20684; x20.
South side of Minilya River near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

9. **Hypotype**, CPC 2458; x23.
7.2 km southwest of Moogooree Homestead, Carnarvon Basin; 123.4 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

10. **Hypotype**, CPC 2459; x54.
Right bank of creek flowing into Gascoyne River, 3.2 km east of K39 Trig. Point, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

PLATE 3



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Figs 11, 12 *Reophax subasper* Parr 1942

11. **Holotype**, UWA 20685; x50.
East of Coolkilya Paddock, 173 m east of Teichert, Higgins and Uttings Station 52, May 1939, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

12. **Hypotype**, CPC 2457; x54.
West bank of railway cutting, west of Minimbah, northern Sydney Basin, NSW; Mulbring Siltstone; Kazanian.

Fig. 13 *Reophax minutissimus* Plummer 1945

Hypotype, CPC 2455; x70.
Aldebaran Creek, 6.4 km northeast of Mount Catherine, Bowen Basin, Qld; Ingelara Formation; Kungurian.

Figs 14, 15 *Reophax? thomasi* (Crespin 1958)

14. **Holotype**, CPC 2460; x39.
15. **Paratype**, CPC 2461; x37.
2.0 km southwest of Nalbia Dam, Wandagee Station, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 16, 17, 20 *Ammobaculites eccentrica* Crespin 1958

16, 17. **Holotype**, CPC 2482; x100.
20. **Paratype**, CPC 2484; x290.
Callytharra Spring area, Carnarvon Basin; 50.9–70.1 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 18 *Ammobaculites wandageeensis* Crespin 1958

Holotype, CPC 2485; x93.
Cundlego Crossing, Minilya River, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Fig. 19 *Ammobaculites woolnoughi* Crespin & Parr 1941

Hypotype, CPC 2489; x31.
At 234.4 m in bore at Stanford Main Colliery No. 2, Coongewai, northern Sydney Basin, NSW; Cessnock Sandstone Member, Branxton Formation; Late Artinskian (Baigendzhinian).

Fig. 21 *Placopsilina wooramelensis* Crespin 1958

Holotype, CPC 2530; x78.
Callytharra Spring area, Carnarvon Basin; 6.7–7.6 m above base of type section of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Plate 4

Specimens are figured in lateral view, unless stated otherwise.

Figures 5 and 6 are reproduced from the Royal Society of New South Wales Proceedings and Journal (Crespin and Parr, 1941) with the permission of the Royal Society of New South Wales. Figure 9 was photographed by Dr J. Backhouse (Geological Survey of W.A.). The rest of the figures are from BMR Bulletin 48 (Crespin, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Fig. 1 *Textularia bookeri* Crespin 1958

Holotype, CPC 153; x41.
Large railway cutting west of Farley Station, Hunter River District, northern Sydney Basin, NSW; Rutherford or Farley Formation; Sakmarian or Artinskian.

Figs 2, 3 *Textularia improcera* Crespin 1958

2. **Paratype**, CPC 2497; x75.
3. **Holotype**, CPC 2498; x86.
7.7 km southwest of Moogooree Homestead, Carnarvon Basin; 123.4 m above base of Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 4, 8 *Spiroplectammina carnarvonensis* Crespin 1958

4. **Paratype**, CPC 2492; x81.
At 128.0–134.1 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

8. **Holotype**, CPC 2490; x95.
Minilya River, 0.4 km upstream from Garden Outcamp, Wandagee Station, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 5, 6 *Trochammina pulvilla* Crespin & Parr 1941

Holotype, CPC 156; dorsal and ventral views; x100 (after Crespin & Parr, 1941, pl. 12 figs 6a, b).
Foot of Victoria Pass, Mitchell Highway, southern Sydney Basin, NSW; Berry Formation; Kazanian.

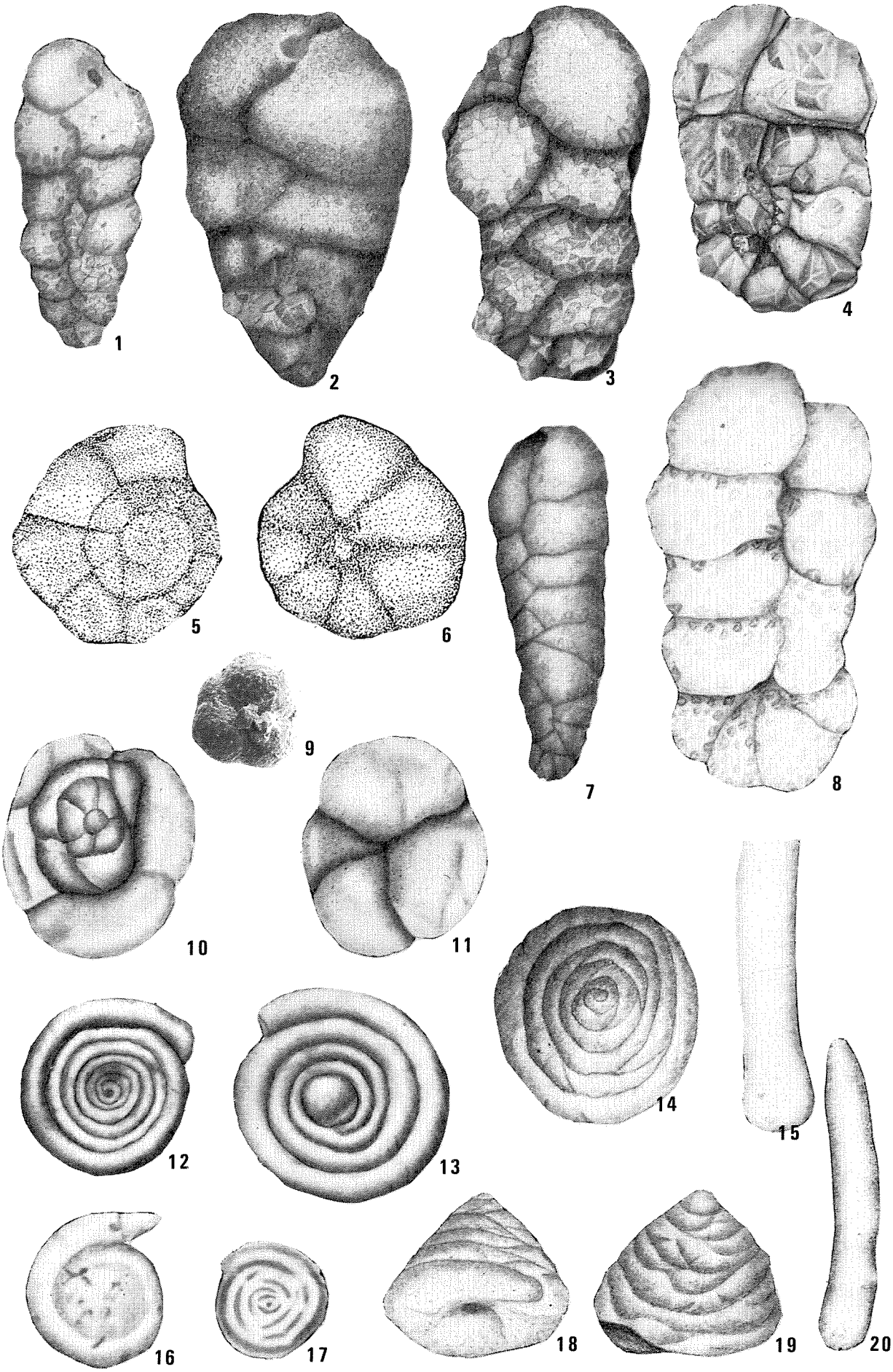
Fig. 7 *Digitina recurvata* Crespin & Parr 1941

Topotype, CPC 2499; x37.
Foot of Victoria Pass, Mitchell Highway, southern Sydney Basin, NSW; Berry Formation; Kazanian.

Figs 9–11 *Trochammina subobtusa* Parr 1942

9. **Holotype**, UWA 20683; ventral view; x50.
South side of Minilya River near Coolkilya Pool, Carnarvon Basin; Quinnanie Shale; Late Arkinskian (Baigendzhinian).

10, 11. **Hypotype**, CPC 2527; dorsal and ventral views; x97.
Cundlego Crossing, Minilya River, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).



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Figs 12, 13 *Hemigordius harltoni* Cushman & Waters 1928

12. **Hypotype**, CPC 2502; x58.
13. **Hypotype**, CPC 2501; x55.
At 189.0–192.0 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian)–?Kungurian.

Figs 14, 18, 19 *Tetrataxis conica* Ehrenberg 1854

Hypotype, CPC 2528; in three views; x77.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 15, 20 *Earlandia condoni* Crespin 1958

15. **Paratype**, CPC 2435; x58.
Callytharra Spring, Carnarvon Basin; 6.7 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

20. **Holotype**, CPC 2433; x51.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 16, 17 *Hemigordius schlumbergeri* (Howchin 1895)

16. **Hypotype**, CPC 2506; x20.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

17. **Hypotype**, CPC 2507; x34.
Section near mouth of Salt Gully, Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Plate 5

Specimens are figured in frontal view, unless stated otherwise.

The figures are from BMR Bulletin 48 (Crespin, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Figs 1–3 *Meandrospira kimberleyensis* (Crespin & Belford 1957)

1, 2. **Holotype**, CPC 2296; dorsal and lateral views; x50.
3. **Holotype**, vertical section; x88.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4, 5 *Flectospira prima* Crespin & Belford 1957

Holotype, CPC 2275; dorsal and lateral views; x77.
At 170.7–173.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian)–?Kungurian.

Figs 6, 7, 12, 13 *Meandrospira meandrina* (Crespin & Belford 1957)

6, 7, 13. **Holotype**, CPC 2289; dorsal, ventral, and lateral views; x5312.
Holotype, CPC 2289; horizontal section; about x85.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 8–11 *Meandrospira australis* (Crespin & Belford 1957)

8, 11. **Holotype**, CPC 2268; two horizontal sections; x107.
9, 10. **Holotype**, CPC 2268; lateral and ventral views; x70.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 14, 18 *Calcitornella stephensi* (Howchin 1894)

Hypotype, CPC 2517; external and attached side views; x61.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 15 *Calcivertella palata* Crespin 1958

Holotype, CPC 2520; x111.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

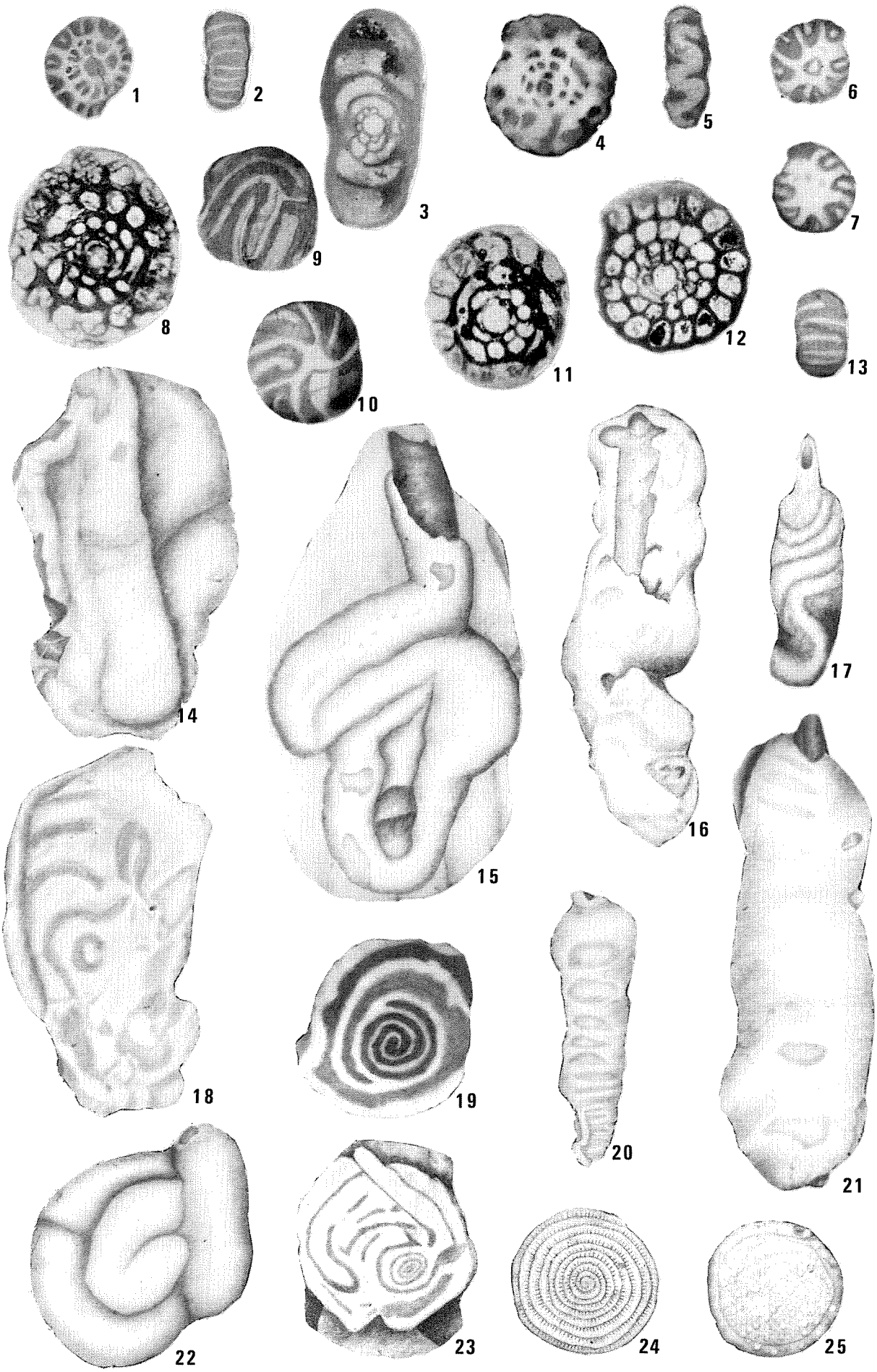
Figs 16, 17 *Calcitornella dickinsi* (Crespin 1958)

16. **Holotype**, CPC 2531; x41.
At 983.0–981.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

17. **Paratype**, CPC 2532; x73.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 19, 23 *Calcitornella heathi* Cushman & Waters 1928
19. **Hypotype**, CPC 2515; attached side view; x46.

PLATE 5



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23. **Hypotype**, CPC 2613; attached side view; x60.
At 150 m in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 20, 21 *Trepeilopsis? australiensis* Crespin 1958

20. **Paratype**, CPC 2608; ?microspheric form; x31.
Section near mouth of Salt Gully, Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

21. **Holotype**, CPC 2606; x65.
Callytharra Spring area, Carnarvon Basin; 6.7–12.5 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 22 *Orthovertella protea* Cushman & Waters 1928

Hypotype, CPC 2509; x66.
Callytharra Spring area, Carnarvon Basin; 3.1 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 24, 25 *Spirillina papillodentata* Crespin 1958

Holotype, CPC 2605; ventral (x47) and dorsal (x50) views.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Plate 6

Specimens are figured in frontal view, unless stated otherwise.

Figures 9, 11, and 16 are from BMR Bulletin 80 (Belford, 1968) and the rest of the figures are from BMR Bulletin 48 (Crespin, 1958b); all figures are reproduced with the permission of the Director, Bureau of Mineral Resources.

Figs 1, 2 *Calcitornella elongata* Cushman & Waters 1928

Hypotype, CPC 2511; x46.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 3, 7 *Plummerinella kimberleyensis* Crespin 1958

3. **Holotype**, CPC 2521; attached side view; x66.
7. **Paratype**, CPC 2604; attached side view; x58.
At 150.6 m in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4, 5 *Lunucammina triangularis* (Chapman & Howchin 1905)

4. **Hypotype**, CPC 2602; x56.
At 981.5–987.6 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

5. **Hypotype**, CPC 2601; x51.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 6, 12 *Howchinella striatosulcata* (Crespin 1958)

6. **Holotype**, CPC 2596; x42.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

12. **Paratype**, CPC 2599; x42.
At 150.6 m in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 8, 9 *Howchinella woodwardi* (Howchin 1895)

8. **Topotype**, CPC 2589; x42.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

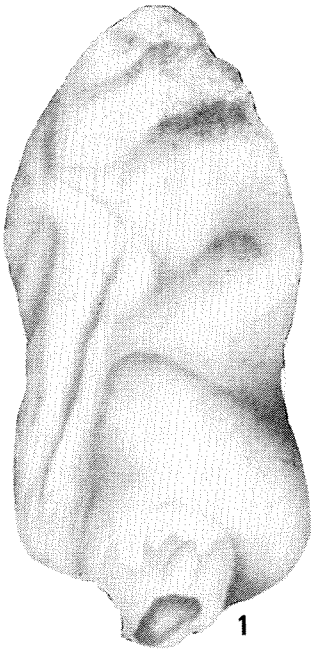
9. **Hypotype**, CPC 6875; x35 (after Belford, 1968, pl. 3 fig. 16).
At 120.8–122.7 m in BMR 7 bore, Middalya Station, Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian)–?Kungurian.

Figs 10, 11 *Howchinella aulax* (Crespin 1945)

10. **Holotype**, CPC 2571; megalospheric form; x33.
North bank of Cattle Creek, below waterfall, southeast of Springsure, Bowen Basin, Qld; Cattle Creek Formation; Artinskian.

11. **Hypotype**, CPC 6871; x57 (after Belford, 1968, pl. 3 fig. 12).
At 330.9–333.4 m in BMR 7 bore, Middalya Station, Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian)–?Kungurian.

PLATE 6



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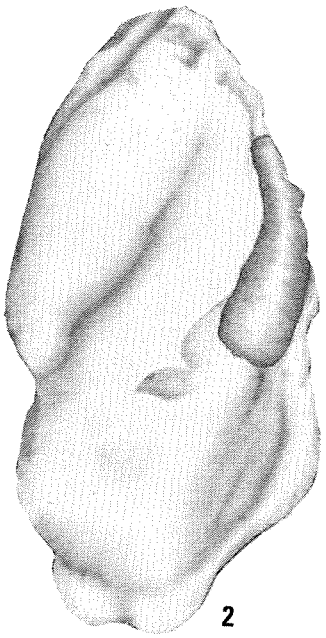

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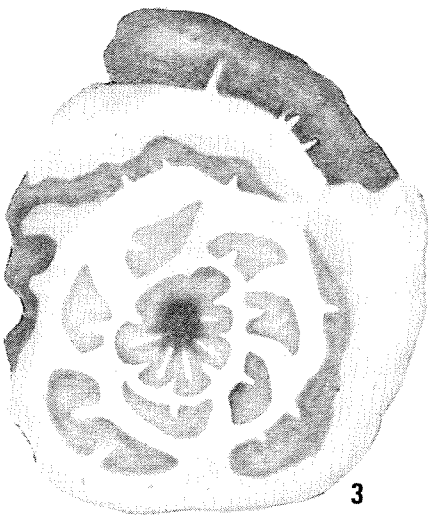

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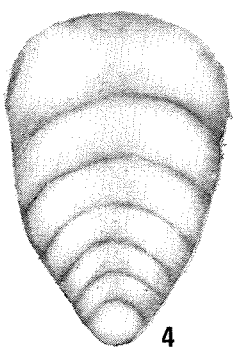

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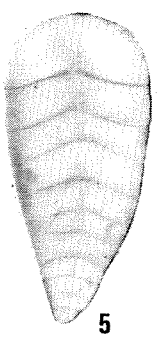

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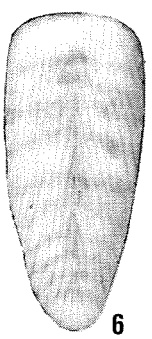

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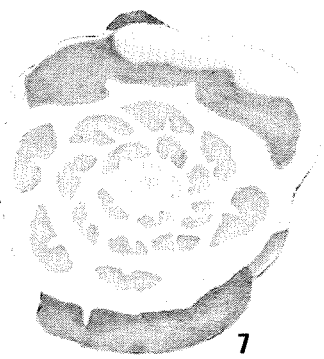

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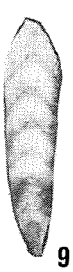

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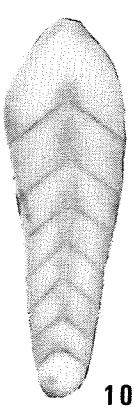

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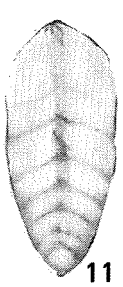

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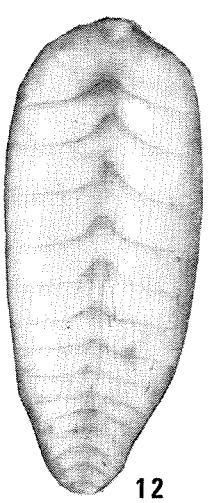

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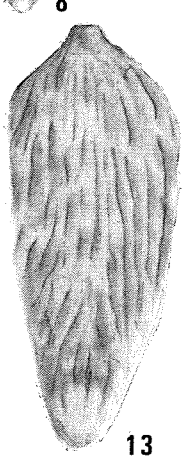

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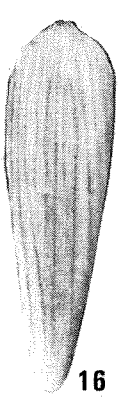

16



17

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Figs 13, 14 *Howchinella hillae* (Crespin 1945)

13. **Holotype**, CPC 2575; megalospheric form; x60.
North bank of Cattle Creek, below waterfall, southeast of Springsure, Bowen Basin, Qld; Cattle Creek Formation; Artinskian.

14. **Paratype**, CPC 2577; x33.
2.4 km west-northwest of Coordewandy Homestead, Carnarvon Basin; 40.2 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 15, 16 *Howchinella parri* (Crespin 1945)

15. **Holotype**, CPC 279; x45.
Kulnura Bore at 1281.1 m, 1.2 km south of Kooree Trig. Station, northern Sydney Basin, NSW; Branxton Formation; Kungurian.

16. **Hypotype**, CPC 6874; x38 (after Belford, 1968, pl. 3 fig. 15).
At 89.2–92.2 m in BMR 7 bore, Middalya Station, Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 17 *Howchinella semicostula* (Crespin 1958)

Holotype, CPC 2587; x58.
At 483.1–484.6 m in Myroodah 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 7

Specimens figured in frontal view, unless stated otherwise.

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Fig. 1 *Pachyphloia caseyi* (Crespin 1958)

Holotype, CPC 2593; x80.
At 150.6 m in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian)

Figs 2, 3 *Ichthyolaria impolita* (Crespin 1958)

2. **Holotype**, CPC 2578; megalospheric form; x112.
3. **Paratype**, CPC 2592; microspheric form; x71.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4, 5 *Ichthyolaria limpida* (Crespin 1958)

4. **Holotype**, CPC 2581; x58.
North bank of Cattle Creek, below waterfall, southeast of Springsure, Bowen Basin, Qld; Cattle Creek Formation; Artinskian.

5. **Paratype**, CPC 2582; x67.
At 949.5–951.0 m in Giralia 1, northern Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 6, 7 *Protonodosaria tereta* (Crespin 1958)

6. **Holotype**, CPC 2542; megalospheric form; x62.
Callytharra Spring area, Carnarvon Basin; 0–3.7 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

7. **Paratype**, CPC 2898; nearly axial section; x60.
Pokolbin, Hunter River area, northern Sydney Basin, NSW; Rutherford or Farley Formation; Sakmarian or Artinskian.

Figs 8, 9 *Protonodosaria irwinensis* (Howchin 1895)

8. **Hypotype**, CPC 2557; with striated globular initial chamber; x58.
Callytharra Spring area, Carnarvon Basin; 6.7–10.67 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

9. **Hypotype**, CPC 2556 (topotype); with smooth globular initial chamber; x62.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 10, 11 *Nodosaria fisheri* Crespin 1958

10. **Paratype**, CPC 2553; microspheric form; x75.
11. **Holotype**, CPC 2552; macrospheric form; x87.
At 39.3 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

PLATE 7

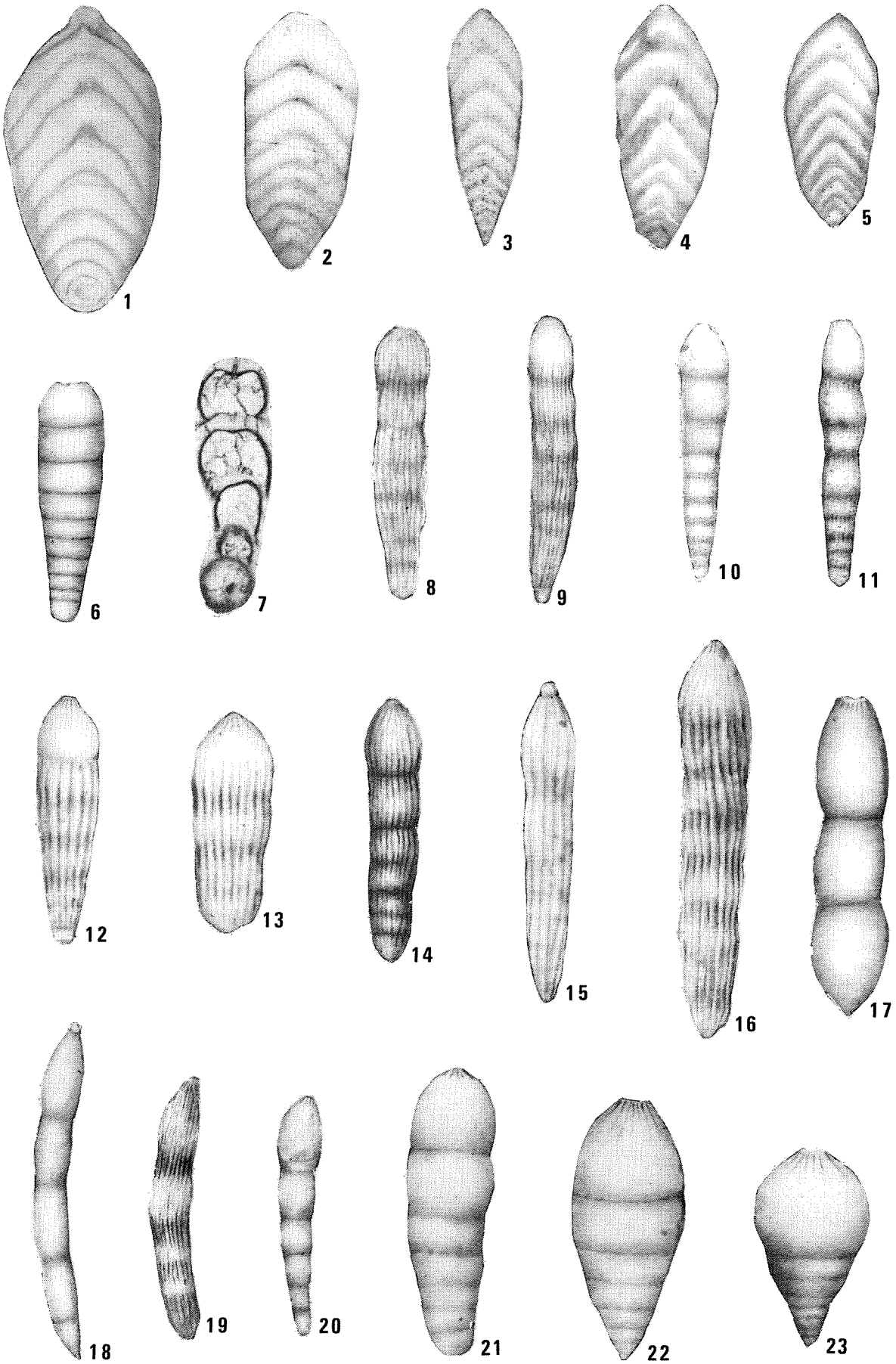

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Fig. 12 *Nodosaria conicodensestriata* Paalzow 1935

Hypotype, CPC 2546; x32.
At 189.0–192.0 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 13 *Nodosaria crassula* Crespin 1958

Holotype, CPC 2548; x33.
At 204 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 14 *Nodosaria striatella* (Paalzow 1935)

Hypotype, CPC 2568; x45.
At 170.7–173.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 15 *Nodosaria decoris* Crespin 1958

Holotype, CPC 2550; x54.
At 170.7–173.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 16 *Nodosaria springsurensis* Crespin 1945

Hypotype, CPC 2567; x44.
At 170.7–173.7 m in Giralia 1, northern Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), ?Kungurian.

Fig. 17 *Nodosaria spiculata* Crespin 1958

Holotype, CPC 2543; x106.
Upper 3.7 m of Core 5 (146.3–152.4 m) in Jurgurra Creek BMR 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 18 *Dentalina habra* Crespin 1958

Holotype, CPC 2538; x46.
At 21.0 m FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian)

Fig. 19 *Dentalina nerrimaensis* Crespin 1958

Holotype, CPC 2540; x66.
At 21.0 m in FKO Nerrima 1, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 20 *Dentalina grayi* Crespin 1945

Holotype, CPC 278; x61.
Lower part of exposure in Argus's Selection, Springsure area, Bowen Basin, Qld; Ingelara Formation; Kungurian.

Fig. 21 *Nodosaria raggatti* Crespin 1958

Holotype, CPC 2560; x62.
Minilya River, 0.4 km upstream from Wandagee Homestead, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 22, 23 *Pseudonodosaria serocoldensis* (Crespin 1945)

22. **Holotype**, CPC 276; x45.
Cattle Creek below waterfall, southeast of Springsure, Bowen Basin, Qld; Cattle Creek Formation; Artinskian.

23. **Hypotype**, CPC 2566; x44.
At 262.1–263.7 m in Myroodah 1, northern Canning Basin; Liveringa Group; Artinskian–?Chhidruan.

Plate 8

Figs 1, 2 *'Amplexus' pustulosus* Hudleston 1883

1. **Hypotype**, UWA 41071; transverse section; x2.
Near Trig. Station K52, Kennedy Range, near Williambury–Middalya road, Carnarvon Basin; ?Callytharra Formation; ?Late Sakmarian (Sterlitamakian).

2. **Lectotype**, BM(NH) R2275; x0.75.
Fossil Range, near junction of Gascoyne and Lyons Rivers, Carnarvon Basin; ?Callytharra Formation; ?Late Sakmarian (Sterlitamakian).

Fig. 3 *Gerthia sulcata* (Hinde 1890)

3. **Topotype**, GSWA F514; transverse section; x2.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 4–8 *Plerophyllum australe* Hinde 1890

4. **Topotype**, UQGD F12531; transverse section; x2.
5. **Topotype**, UQGD F12534; transverse section close to proximal tip; x5.
6. **Topotype**, UQGD F12534; transverse section towards the middle of the corallite; x5.
7. **Hypotype**, UWA 19979; transverse section towards the calyx; x2.
Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

8. **Hypotype**, UWA 8491; x1.
Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 9, 10 *Plerophyllum* sp.

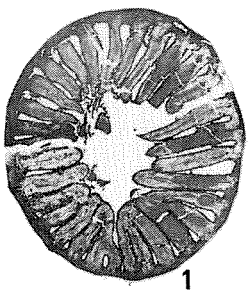
9. **Hypotype**, UWA 20214; transverse section; x5.
10. **Hypotype**, UWA 20214; x2.
Coolkilya Pool area on Minilya River, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Figs 11, 12 *Euryphyllum trizonatum* Hill 1937

11. **Holotype**, slide UWA 40962; transverse section; x4.
12. **Holotype**, UWA 19976; x1.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 13–16 *Euryphyllum minutum* Hill 1937

13. **Hypotype**, slide UWA 40967; transverse section; x5.
14. **Hypotype**, slide UWA 40967; transverse section; x5.
15. **Holotype**, UWA 19983; x1.
16. **Hypotype**, slide UWA 40967; longitudinal section; x5.
The creek 0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; ?Callytharra Formation; ?Late Sakmarian (Sterlitamakian).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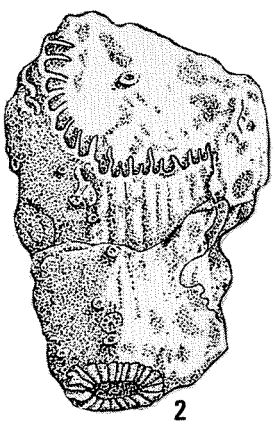
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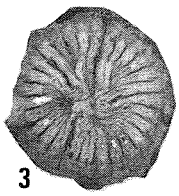
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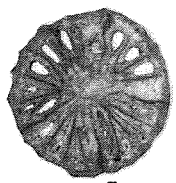
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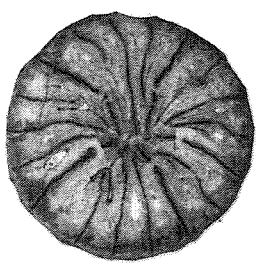
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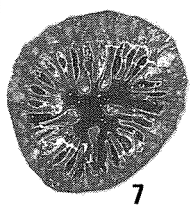
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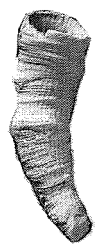
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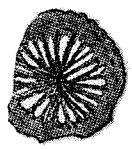
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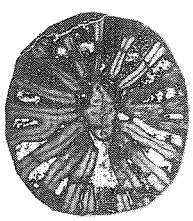
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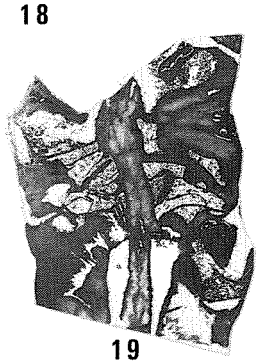
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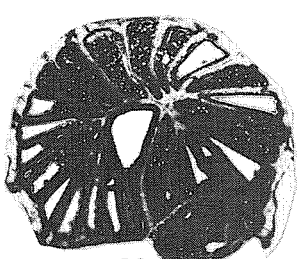
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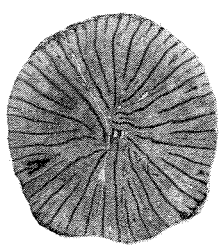
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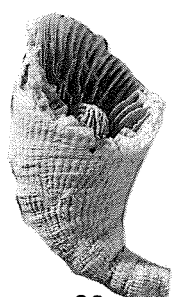
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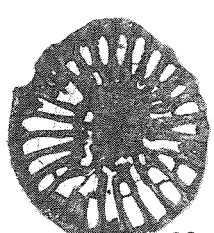
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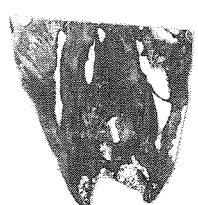
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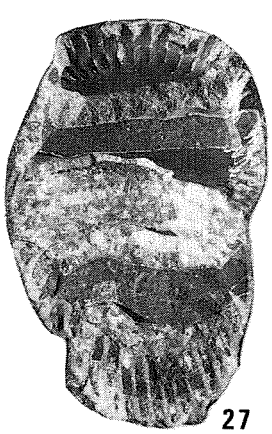
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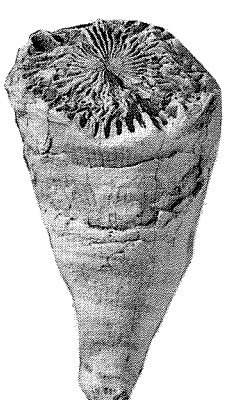
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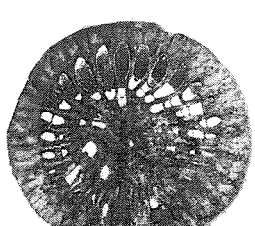
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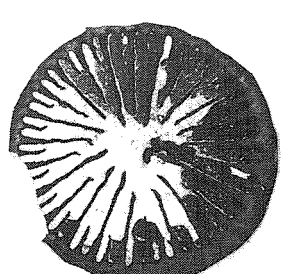
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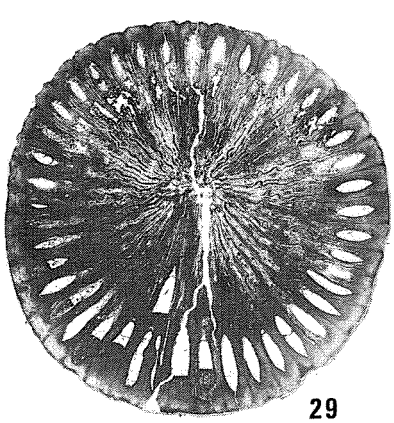
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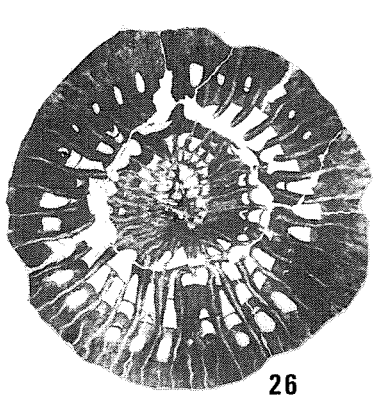
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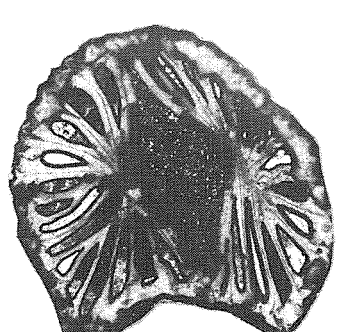
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CORALS

Figs 17–19 *Verbeekiella mersa* Hill 1942

17. **Paratype**, UWA 20215; x1.
North side of Minilya River, west of Coolkilya Pool, Carnarvon Basin; lower part of the Wandagee Formation; Late Artinskian (Baigendzhinian).

18. **Holotype**, slide UWA 41075; transverse section; x2.
19. **Paratype**, slide UWA 41076; longitudinal section; x2.
North side of Minilya River, west of Coolkilya Pool, Carnarvon Basin; lower part of Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 20 *Allotropiophyllum* sp.

Hypotype, slide UWA 41072; transverse section; x4.
North side of Minilya River, west of Coolkilya Pool, Carnarvon Basin; middle part of Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 21 *Tachylasma densum* Hill 1937

Holotype, slide UWA 40961; transverse section; x2.
North of Hill C, Freney Oil area, Kimberley, northern Canning Basin; Liveringa Group; Kungurian–Chhidruan.

Figs 22–26 *Verbeekiella talboti* (Hosking 1931)

22. **Syntype**, GSWA F515; x1.
23. **Hypotype**, slide UWA 40959; transverse section; x2.
24. **Hypotype**, slide UWA 40960; longitudinal section; x2.
25. **Syntype**, GSWA F516; transverse section; x2.
26. **Hypotype**, slide UWA 41077; transverse section; x2.
The creek 0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 27 *'Amplexus'* sp.

Hypotype, UWA 20212; external view; x1.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 28, 29 *Euryphyllum reidi* Hill 1938

28. **Hypotype**, UWA 20213; x1.
North side of Minilya River, west of Coolkilya Pool, Carnarvon Basin; middle part of Wandagee Formation; Late Artinskian (Baigendzhinian).

29. **Hypotype**, slide UWA 41071; transverse section; x2.
Locality as for fig. 28; upper part of Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 30 *Tachylasma* sp.

Hypotype, GSWA F517; transverse section; x4.
0.8 km west of Callytharra Spring, Wooramel River area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 31 *Euryphyllum?* sp.

Hypotype, slide UWA 41074; transverse section; x4.
North side of Minilya River, west of Coolkilya Pool, Carnarvon Basin; middle part of Wandagee Formation; Late Artinskian (Baigendzhinian).

Plate 9

Figs 1–4 *Gertholites marmionensis* (Etheridge Jnr 1914)

1. **Lectotype**, GSWA F492; x2.
2. **Syntype**, GSWA 10930; transverse section; x2.
3. **Syntype**, GSWA 10930; tangential section; x2.
4. **Syntype**, GSWA 10930; longitudinal section; x2.

Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 5–11 *Gertholites insculpta* (Hill 1942)

5. **Lectotype**, slide UWA 41078(d); longitudinal section; x2.
6. **Lectotype**, slide UWA 41078(c); tangential section; x2.
7. **Lectotype**, slide UWA 41078(a); transverse section of tip; x2.
8. **Lectotype**, slide UWA 41078(b); transverse section; x2.
9. **Lectotype**, UWA 20218(e); fragment of branch; x1.
10. **Lectotype**, UWA 20218(f); tip of branch; x1.
11. **Lectotype**, UWA 20217; base of branch; x1.

Near Callytharra Spring on Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 12, 13 *Cladochonus striatus* (Hill 1942)

12. **Paratype**, UWA 19980a; x2.
13. **Hypotype**, UWA 20220; x2.5.

The creek 0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 14–18 *Gertholites immensa* (Hill 1937)

14. **Hypotype**, UWA 20204; x1.
15. **Hypotype**, slide UWA 41068; transverse section; x2.
16. **Hypotype**, slide UWA 41069; longitudinal section; x2.

Bulgadoo Pool, Minilya River, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

17. **Holotype**, GSWA F518; longitudinal section; x2.
18. **Holotype**, GSWA F518; tangential section; x2.

3.2 km east of Christmas Creek Homestead, south of Rough Range; northern Canning Basin; Late Artinskian (Baigendzhinian).

Fig. 19 *Gertholites* sp. aff. *G. marmionensis* (Etheridge Jnr 1914)

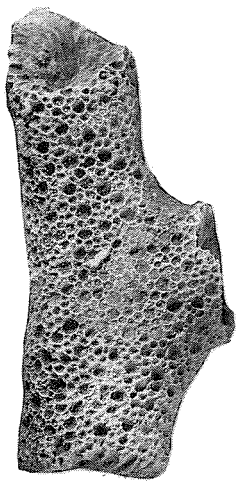
Hypotype, UWA 20217; x1.

Northwest of Station 23, Minilya River, Carnarvon Basin; Wandagee Formation; ?Late Artinskian (Baigendzhinian).

Figs 20–22 *Cladochonus nicholsoni* (Etheridge Jnr 1914)

20. GSWA F508; x1.
21. GSWA F507; x1.

Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).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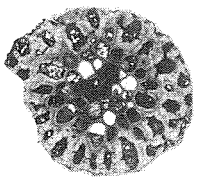
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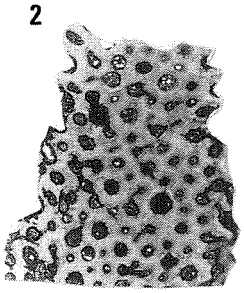
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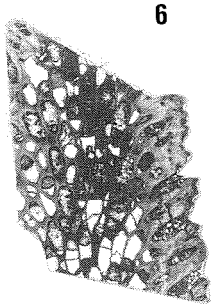
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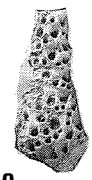
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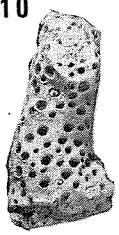
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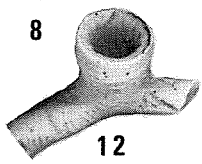
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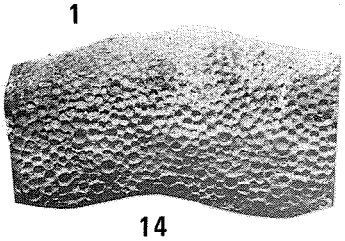
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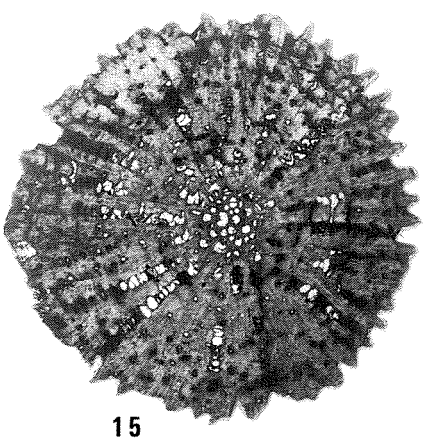
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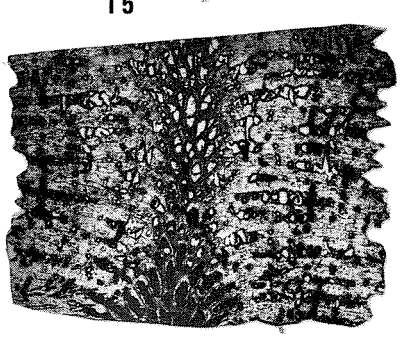
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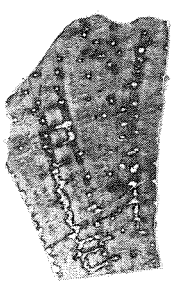
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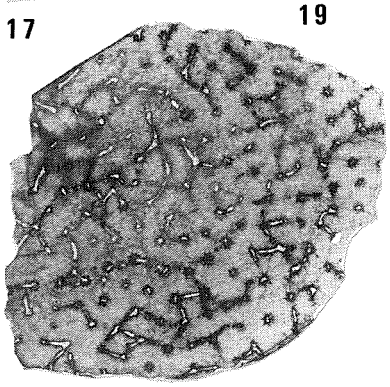
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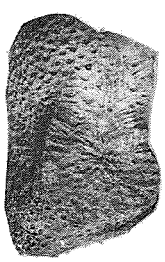
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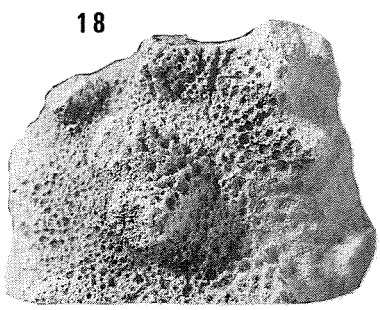
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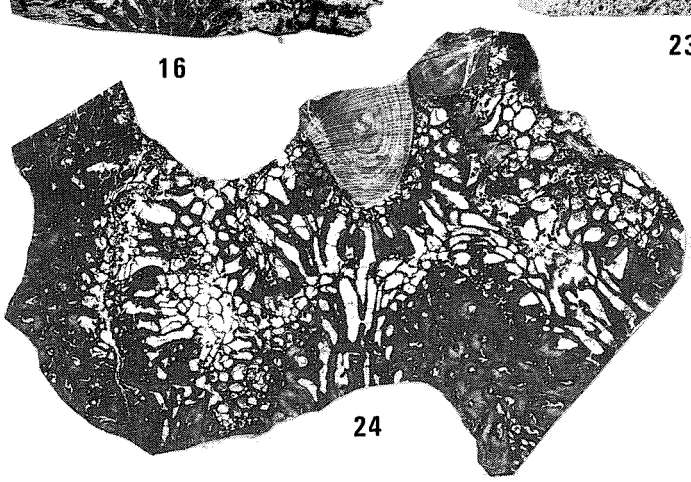
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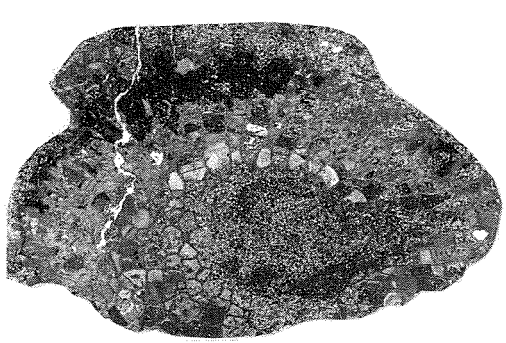
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CORALS

22. GSWA F519; x1.
0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 23, 24 *Gertholites?* sp.

23. **Hypotype**, UWA 20211; x1.
24. **Hypotype**, UWA 20211; thin section; x2.
Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 25, 26 Favositoid fragment

25. Weathered surface, UWA 20216; x1.
26. Thin section, UWA 20216; x2.
Coolkilya Pool area on Minilya River, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Plate 10

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Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Figs 1, 2 *Fistulipora compacta* Crockford 1944

1. Tangential section of **holotype**, UWA 22129 (slide 41190); x10.
2. Longitudinal section of **holotype** (slide 41191); x10.

Minilya River area, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 3, 4 *Fistulipora conica* Crockford 1944

3. Tangential section of **holotype**, UWA 22130 (slide 41192); x10.
4. Longitudinal section of **holotype** (slide 41193); x10.

Minilya River area, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 5, 6 *Fistulipora gigantea* Crockford 1944

5. Tangential section of **holotype**, UWA 22127A (slide 41186); x10.
6. Longitudinal section of **holotype** (slide 41187); x10.

Wandagee Hill, Carnarvon Basin; Baker Formation; Kungurian.

Figs 7, 8 *Fistulipora liveringa* Crockford 1957

7. Tangential section of **holotype**, CPC 1057; x10.
8. Longitudinal section of **holotype**; x10.

Locality [37], northern Canning Basin; Lightjack Formation; Kungurian.

Figs 9, 10 *Fistulipora nura* Crockford 1957

9. Tangential section of **holotype**, CPC 1054; x10.
10. Longitudinal section of **holotype**; x10.

Locality [1], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 11, 12 *Fistulipora stereos* Crockford 1957

11. Tangential section of **holotype**, CPC 1058, showing enlarged zooecial tubes and thickened lunaria at top of photograph; x10.
12. Longitudinal section of **holotype**; x10.

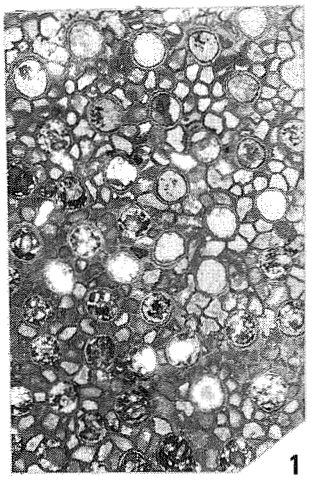
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 13, 14 *Fistulipora vacuolata* Crockford 1944

13. Tangential view of specimen CPC 1053; x10.

Locality [13], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

14. Longitudinal section of **holotype**, UWA 22126 (slide 41185); x10.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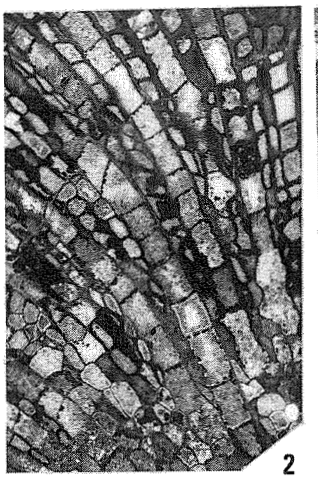
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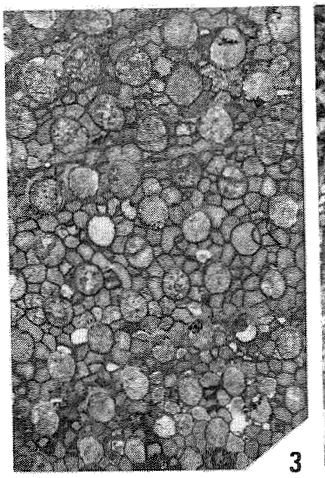
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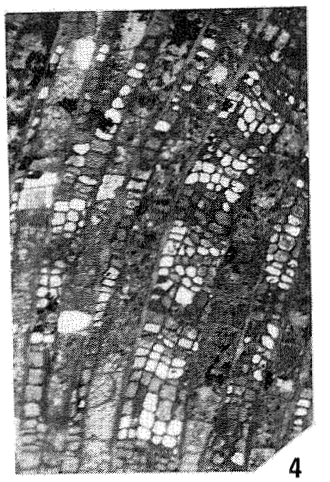
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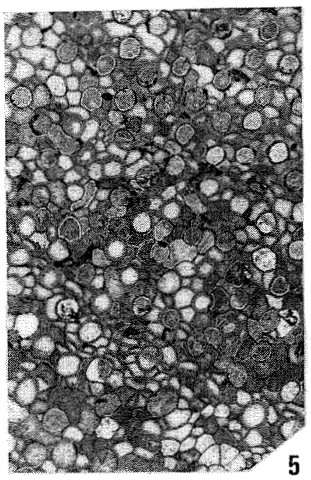
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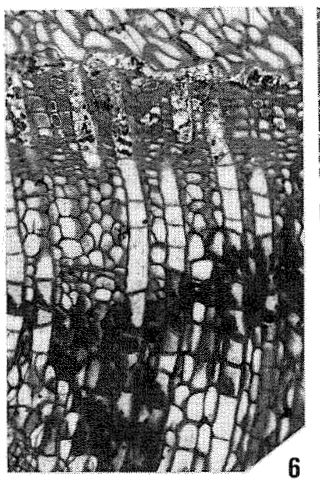
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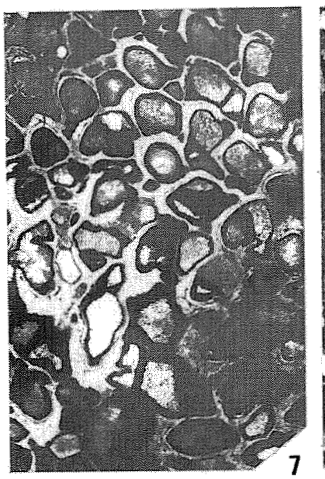
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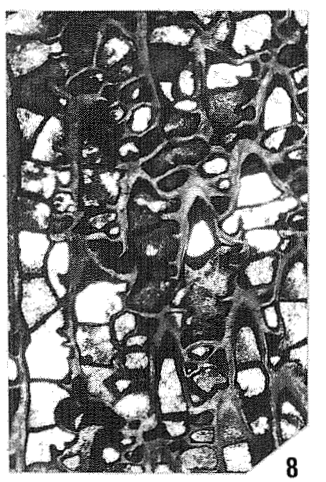
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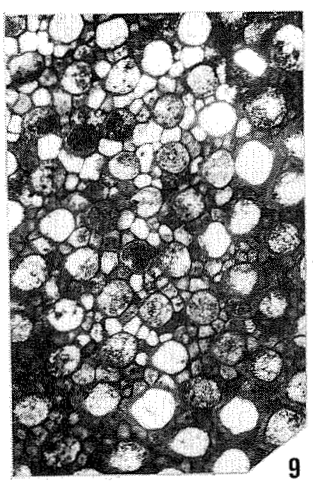
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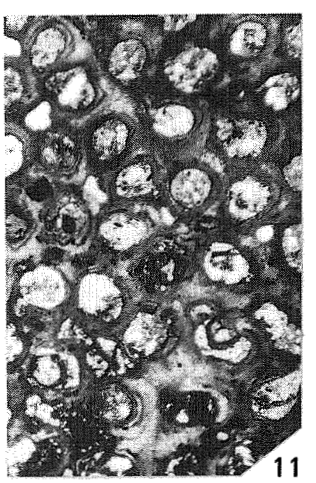
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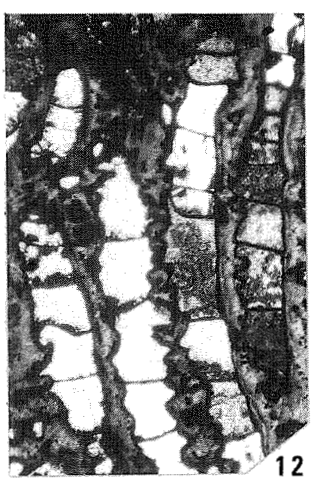
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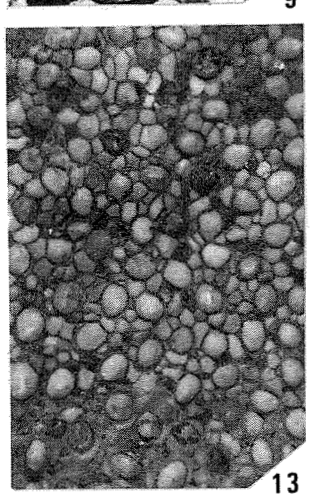
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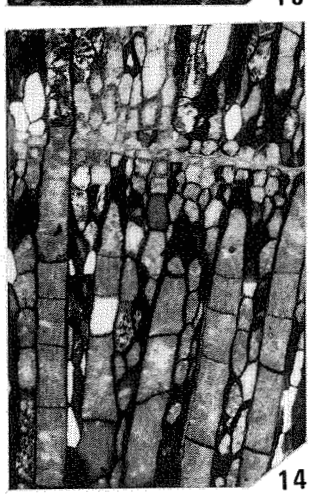
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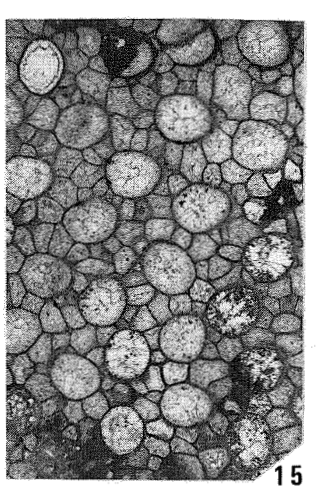
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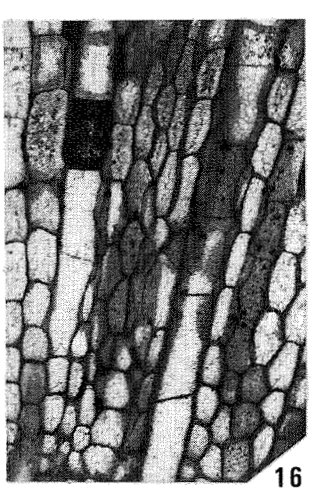
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BRYOZOANS

GSWA 22928

Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 15, 16 *Fistulipora wadei* Crockford 1944

15. Tangential section of **holotype**, UWA 22124 (slide 41179); x15.
16. Longitudinal section of **holotype** (slide 41180); x15.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 11

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Figs 1, 2 *Hexagonella australis* (Bretnall 1926)

1. View of **holotype**, GSWA 6 (2/2405G); x2.
2. View of **paratype**, (part of **holotype**), AM F36572; x4.

Fossil Hill, Wyndham River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3–5 *Hexagonella densa* Crockford 1944

3. Tangential section of **holotype**, UWA 22131, cut near centre (slide UWA 41201); x7.
4. Longitudinal section of **holotype** (slide UWA 41199); x5.
5. Longitudinal section of **holotype** (slide UWA 22131); x5.

Wandagee Station, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 6, 7 *Hexagonella bifida* Crockford 1944

6. Tangential section of **holotype**, UWA 22132 (slide UWA 41195); x8.
7. Longitudinal section of **holotype** (slide UWA 41194); x8.

Locality [33], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 8–10 *Hexagonella plana* Crockford 1944

8. Tangential section of **holotype**, UWA 22125 (slide UWA 41182); x7.
9. Oblique tangential section of **holotype** (slide UWA 41183); x7.
10. Longitudinal section of **holotype** (slide UWA 41181); x7.

Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 11, 12 *Hexagonella hudlestoni* Crockford 1957

11. View of **holotype**, CPC 1074; x2.

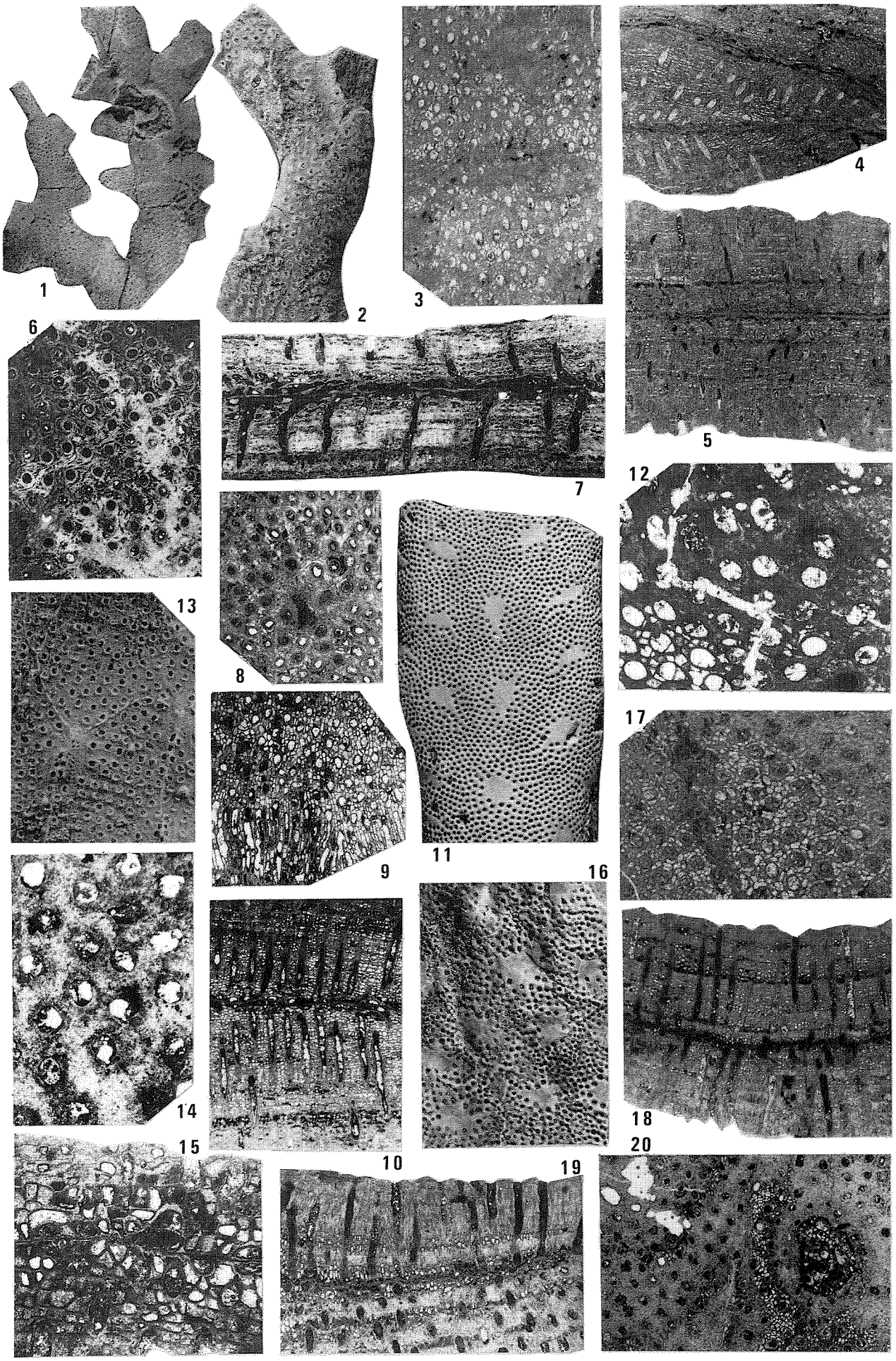
Locality [5C], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

12. Tangential section of specimen CPC 1071A, passing from vesicular tissue near the mesotheca (bottom) to dense stereom (top) near surface; x10.

Locality [2], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 13–15 *Hexagonella lineata* Crockford 1944

13. Surface of **holotype**, AM F17567; x5.
14. Tangential section of **holotype** (slide AM 3584); x20.
15. Longitudinal section of **paratype**, AM F17569 (slide AM 3586); x20.



BRYOZOANS

Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 16–18 *Hexagonella nalbia* Crockford 1944

16. Surface of **holotype**, UWA 22133; x3.
17. Tangential section of **holotype** (slide UWA 41197); x7.
18. Longitudinal section of **holotype** (slide UWA 41198); x7.
Between Wandagee and Middalya Stations, Carnarvon Basin; Baker Formation; Kungurian.

Figs 19, 20 *Hexagonella undulata* Crockford 1944

19. Longitudinal section of **holotype**, UWA 22128 (slide UWA 41188); x7.
20. Tangential section of **holotype** (slide UWA 41189); x7.
Coolkilya Paddock, Wandagee Station, Carnarvon Basin; Baker Formation; Kungurian.

Plate 12

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Figs 1, 2 *Dybowskiella crescens* (Crockford 1944)

1. Tangential section of **holotype**, UWA 22123A (slide UWA 41177); x20.
2. Longitudinal section of **holotype** (slide UWA 41178); x15.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 3–5 *Dybowskiella arborescens* Crockford 1957

3. Longitudinal section from outer axial to peripheral zone, **paratype**, CPC 1055; x15.
4. Tangential polished section of **paratype**, CPC 1055; x3.
5. Oblique tangential section through peripheral zone of **paratype**, CPC 1055; x15.
Locality [12], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 6, 7 *Eridopora permiana* Crockford 1957

6. Side view of **holotype**, CPC 1065A; x2.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

7. Tangential section of **paratype**, CPC 1063A; x15.
Locality [15], northern Canning Basin; Noonkanbah Formation; Artinskian.

Figs 8–10 *Fistulamina lata* Crockford 1957

8. Eroded view of **paratype**, CPC 1077A; x2.
Locality [12], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

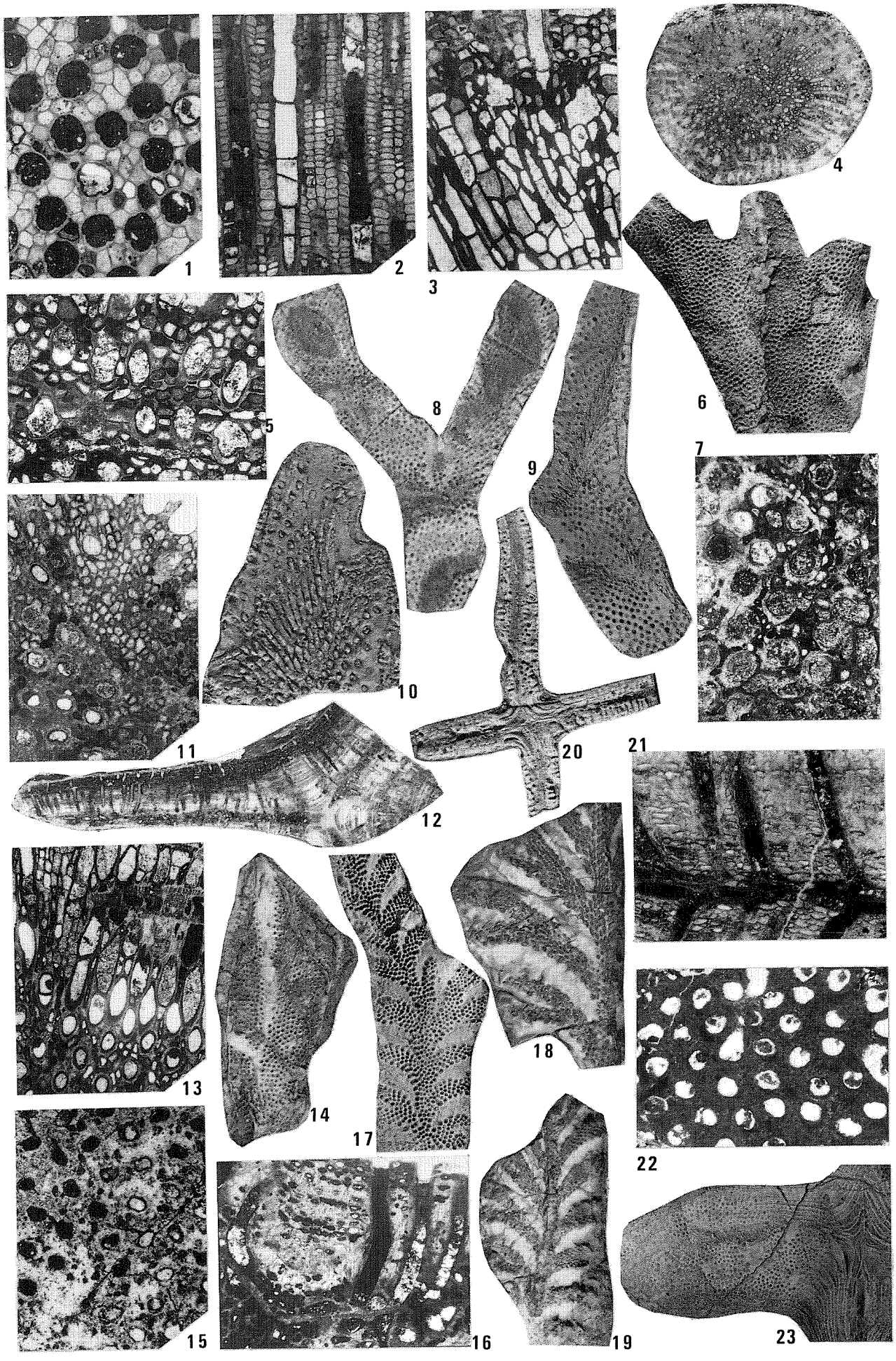
9. Side view of **paratype**, UWA 22337; x3.
Locality [30], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

10. Weathered surface of **paratype**, CPC 1077B, showing long zooecial tubes near mesotheca, and stereom separating apertures near surface; x6.
Locality [12], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 11–14 *Prismopora? triradiata* Crockford 1957

11. Tangential section of **holotype**, CPC 1088, from near surface to a level where spaces between zooecial tubes and maculae are occupied by vesicles; x15.
12. Transverse section of **holotype**, showing three-rayed mesotheca and the layering of vesicles and stereom between the tubes; x3.
13. Oblique tangential section of **holotype**; x15.

PLATE 12



BRYOZOANS

GSWA 22930

Locality [8], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

14. Side view of **paratype**, CPC 1091; x2.
Locality [10], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 15–17 *Prismopora digitata* Crockford 1957

15. Tangential section of **paratype**, CPC 1086, through outer zoarium where stereom separates zooecial tubes; x15.
16. Transverse section of **paratype**, CPC 1086; x15.
17. View of **holotype**, CPC 1073B; x3.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 18, 19 *Prismopora? attenuata* Crockford 1957

18. Side views of one ray of **holotype**, CPC 1087; x3.
19. Side view of two rays of **holotype**; x2.
Locality [5C], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 20–23 *Evactinostella crucialis* (Hudleston 1883)

20. Eroded view of four rays, CPC 1230A; x2.
Locality [15], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

21. Longitudinal section of part of one bifoliate ray, UWA 22339B; x15.
Locality [29A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

22. Tangential thin section, CPC 1096C; x15.
Locality [1], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

23. Oblique, eroded view of four rays, one of which exposes a surface bearing zooecial openings, CPC 1100; x1.5.
Locality [18A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 13

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Figs 1–3 *Liguloclema meridianus* (Etheridge Jnr 1926).

1. Surface view of **holotype**, GSWA 15/10930A; x4.
2. Transverse section of **holotype**; x20.
3. Oblique tangential section of **holotype**, showing hook-shaped zooecial outlines in sections cut parallel to the surface; x20.

Locality [29A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 4 *Liguloclema typicalis* Crockford 1957

View of **holotype**, CPC 1106A; x2.5.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 5 *Goniocladia indica* Waagen & Pichl 1885

Eroded surface of specimen, UWA 22336C; x3.
Locality [35], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 6 *Goniocladia timorensis* Bassler 1929

View of base and reverse surface of the colony, UWA 2757E; x3.
Locality [31], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 7–9 *Etherella irregularis* Crockford 1957

7. Transverse section of **holotype**, CPC 1073H, with two tubes showing partial division corresponding to the hook-shape shown in the tangential section; x15.
8. Surface view of **holotype**; x2.5.
9. Surface of **paratype**, CPC 1073G, etched to near the level of the mesotheca to show the characteristic shape of the initial portion of the zooecial tubes; x10.

Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

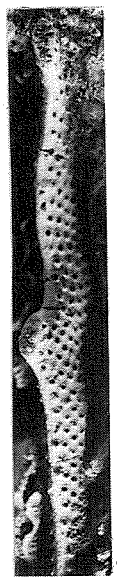
Fig. 10 *Etherella porosa* var. *minor* Crockford 1957

Surface of **holotype**, CPC 1073D; x3.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 11, 12 *Etherella porosa* Crockford 1957

11. Surface view of specimen, GSWA F5815; x2.

3.2 km east of Christmas Creek Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).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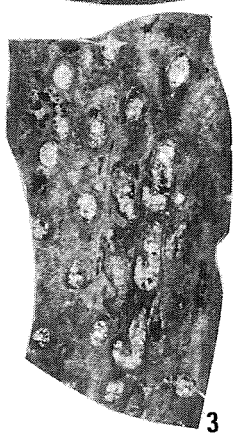
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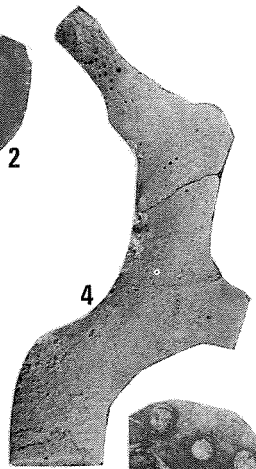
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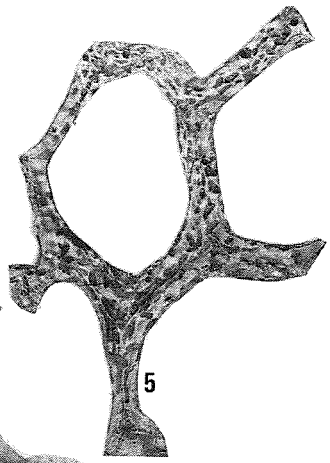
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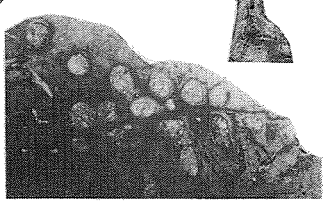
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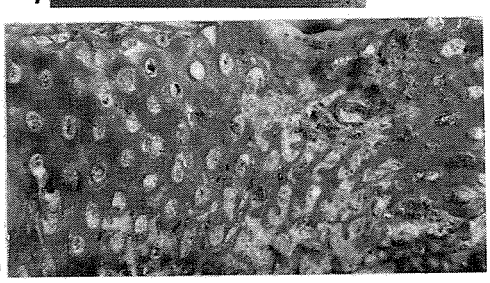
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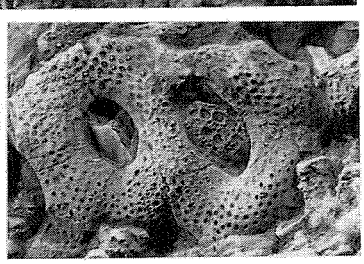
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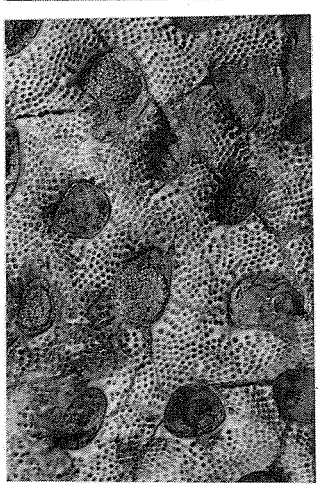
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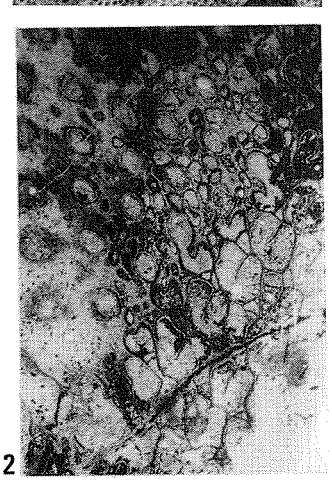
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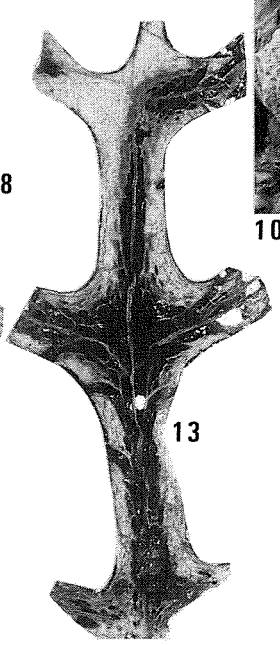
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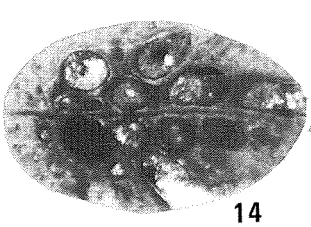
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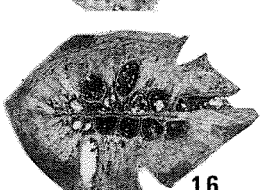
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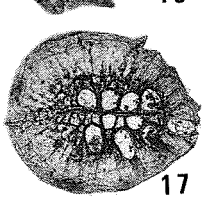
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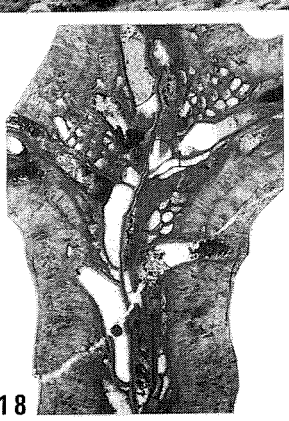
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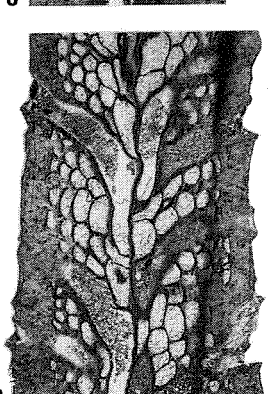
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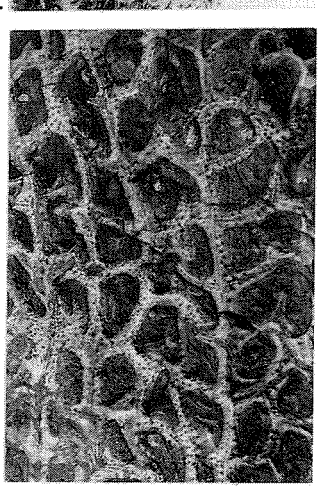
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BRYOZOANS

12. Oblique tangential section of **holotype**, CPC 1102A, showing the hook-shaped portion of the zooecial tubes; x15.
Locality [5B], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 13–20 *Aetomacladia ambrosioides* Bretnall 1926

13. Longitudinal section cut close to the reverse surface, slide UWA 41210; x5.
14. Vertical section through mesial lamina, slide UWA 41209; x35.
10.5 km north of Mount Anderson Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

15. Surface of **lectotype**, GSWA 2/2405B; x5.
Fossil Hill, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

16, 17. Vertical sections showing fibrous arrangement of stereom, unnumbered slides; x15.
18, 19. Longitudinal sections cut closer to obverse surface, showing vesicular and zooecial arrangement, unnumbered slides; x15.
Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

20. View of an extensive colony, GSWA F5813; x2.
3.2 km east of Christmas Creek Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 14

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Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Figs 1, 2 *Dyscritella adnascens* Bassler 1929

1, 2. Encrusting specimen, CPC 1172; x20, x8 respectively.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 3, 4 *Dyscritella spinigera* (Bassler 1929)

3. View of specimen, CPC 1079B; x4.
Locality [15], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

4. Etched zoarium, CPC 1148; x8.
Locality [1], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 5–7 *Pseudobatostomella bruteni* (Crockford 1957)

5. Thin section of **holotype**, CPC 1168A; x15.
Locality [5N], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

6, 7. **Paratypes**, CPC 1175A and 1175B; side view of two specimens; x8.
Locality [5], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 8 *Dyscritella? liveringa* Crockford 1957

Surface of the **holotype**, CPC 1181, a thin encrusting zoarium; x16.
Locality [38], northern Canning Basin; Liveringa Group; Kungurian–Chhidruan.

Figs 9, 10 *Dyscritella macrostoma* Crockford 1957

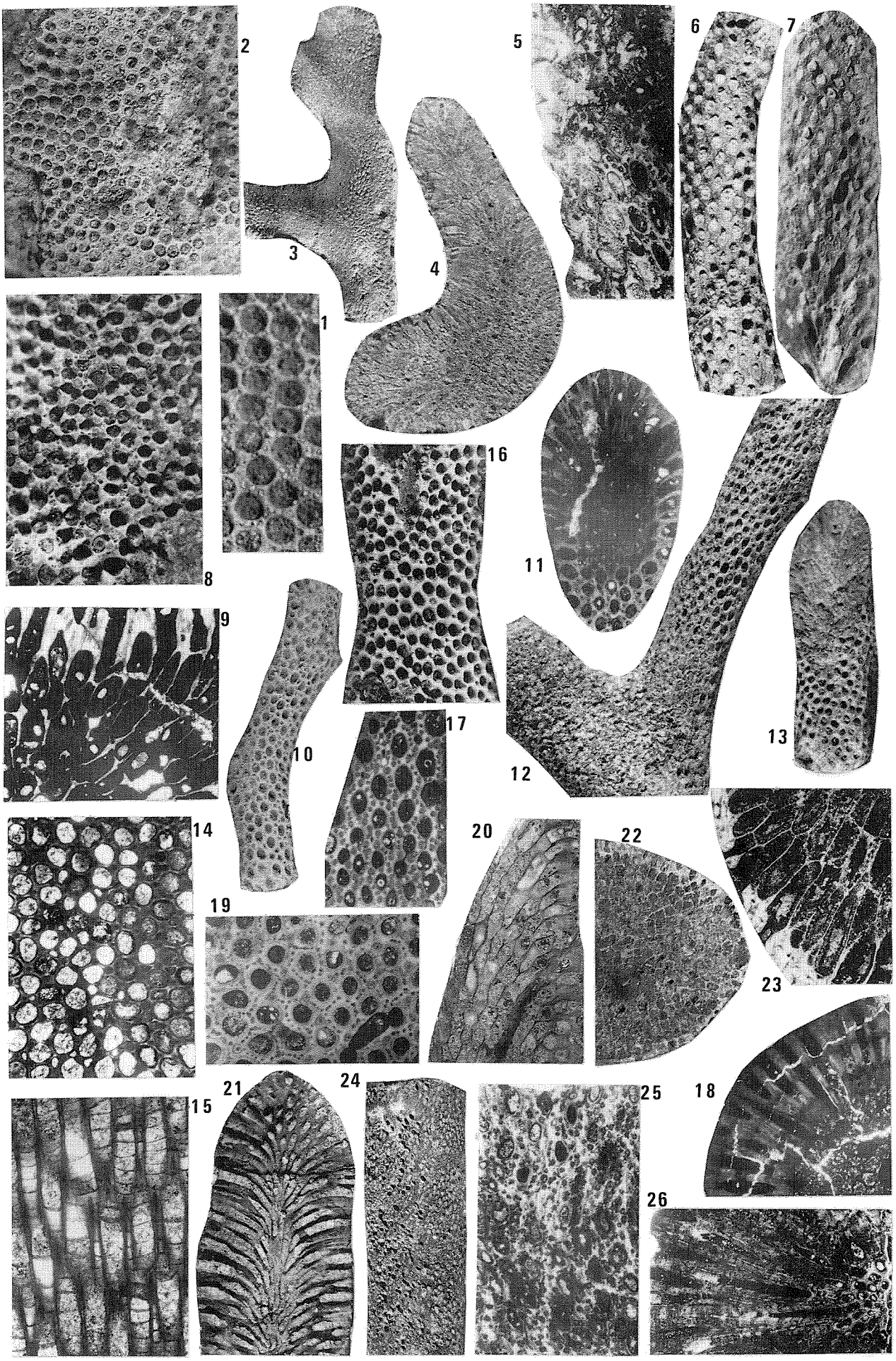
9. Portion of a thin section passing obliquely through the zoarium, **paratype**, CPC 1178; x15.
Locality [5S], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

10. Surface of the **holotype**, CPC 1116C; x6.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 11–13 *Dyscritella tenuirama* Crockford 1957

11. Oblique transverse section of **paratype**, CPC 1165A; x15.
Locality [8], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

12. Surface of **paratype**, CPC 1159; x8.
Locality [38], northern Canning Basin; Liveringa Group; Kungurian–Chhidruan.



BRYOZOA

13. Surface of **holotype**, CPC 1161; x8.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 14, 15 *Dyscritellina? globosa* (Crockford 1957)

14. Tangential section of the **holotype**, CPC 1138; x15.
15. Longitudinal oblique section of the **holotype**; x15.
Locality [3], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 16–18, 21 *Stenodiscus hardmani* Crockford 1957

16. Surface of the **holotype**, CPC 1139A; x10.
17. Tangential section, close to surface of **paratype**, CPC 1139E, showing acanthopores; x15.
18. Transverse section of **paratype**, CPC 1139E, with slightly moniliform walls; x15.
Locality [38], northern Canning Basin; Liveringa Group; Kungurian–Chhidruan.

21. Eroded cross-section of CPC 1140; x10.
Locality [24], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 19, 20 *Stenodiscus variabilis* Crockford 1957

19. Tangential section of **paratype**, CPC 1141, with acanthopores of two sizes and mesopores rarely developed; x15.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

20. Oblique longitudinal section of **paratype**, CPC 1143; x15.
Locality [5H], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 22, 23 *Tabulipora scissa* Crockford 1957

22. Tangential cross-section of **holotype**, CPC 1133; x7.
23. Oblique transverse section of **holotype**, showing narrow peripheral zone and occasional diaphragms; x15.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 24–26 *Megacanthopora? scalariformis* Crockford 1957

24. Surface of **holotype**, CPC 1129; x3.
25. Tangential section of **holotype**; x15.
26. Transverse section of **holotype**, crossing wide peripheral and narrow axial zones; x15.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 15

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Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Figs 1–3 *Pseudobatostomella? fisheri* (Ross 1963)

1. Tangential section showing numerous mesopores and acanthopores around zooecial openings, **holotype**, CPC ML107-4; x20 (after Ross, 1963, pl. 10 fig. 6).
2. Part of longitudinal section showing moniliform zooecial walls in peripheral and subperipheral regions, **holotype**; x20 (after Ross, 1963, pl. 8 fig. 4).
3. External zoarial fragment, **paratype**, CPC ML107-8; x5 (after Ross, 1963, pl. 10 fig.3)
Locality ML107, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

Figs 4, 5 *Stenopora hemispherica* Waagen & Wentzel 1886

4. Portion of zoarium in longitudinal section showing angular tubes, CPC 1291; x3.
5. Part of expanding zoarium showing transverse and longitudinal views of zooecial tubes, CPC 1291; x3.
Locality [2A], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 6–9 *Pseudobatostomella? dickinsi* (Ross 1963)

6. Longitudinal section showing slender walls in axial region and thickened, slightly moniliform walls in peripheral region, **holotype**, CPC ML109-2; x20 (after Ross, 1963, pl. 9 fig. 5).
7. Tangential section showing longitudinal alignment of zooecial openings, **holotype**; x20 (after Ross, 1963, pl. 8 fig 7).
Locality ML109, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

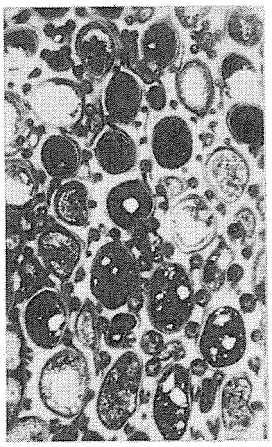
8. External view of fragment of colony, **paratype**, CPC ML106-3; x5 (after Ross, 1963, pl. 9 fig. 2).
Locality ML106, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

9. Part of transverse section showing thin-walled polygonal zooecia in the axial region, and thickened zooecial walls in the peripheral region, **paratype**, CPC ML90-2; x20 (after Ross, 1963, pl. 9 fig. 9).
Locality ML90, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

Figs 10–12 *Hinganella? bella* (Crockford 1957)

10. Transverse section of **paratype**, CPC 1128B; x15.
11. **Holotype**, CPC 1128A; x2.
12. Tangential section with numerous micranthopores and fairly abundant mesopores, **paratype**, CPC 1128B; x15.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

PLATE 15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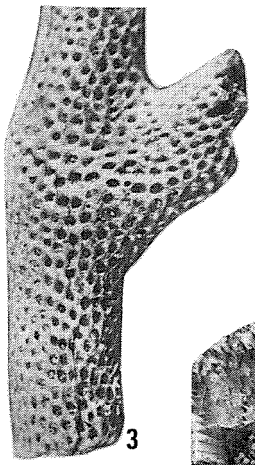
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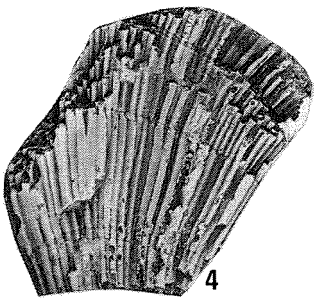
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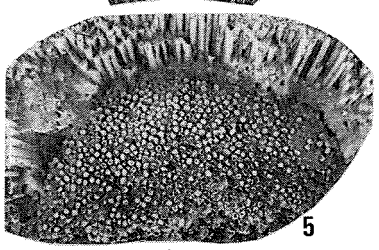
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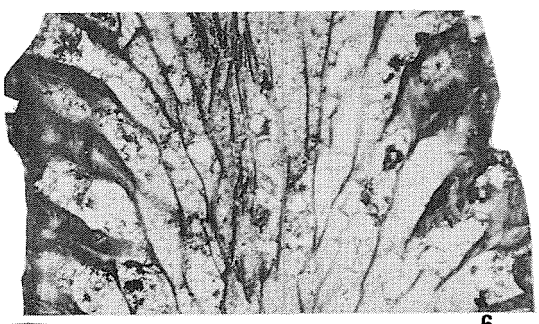
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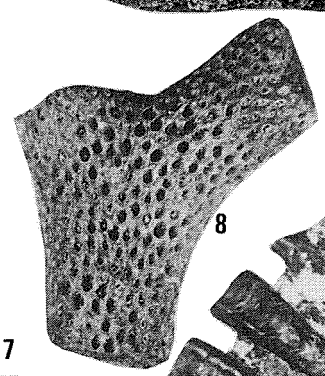
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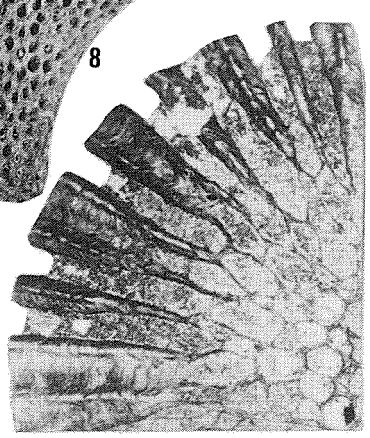
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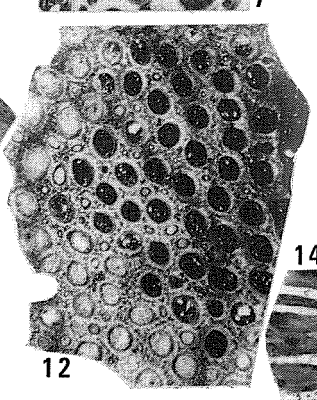
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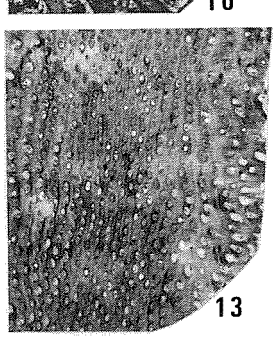
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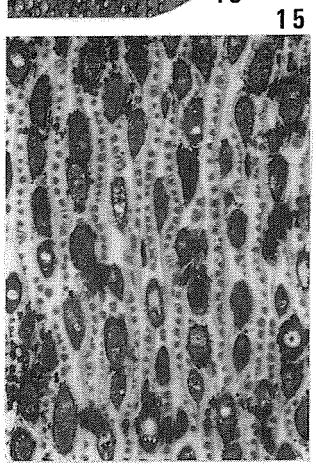
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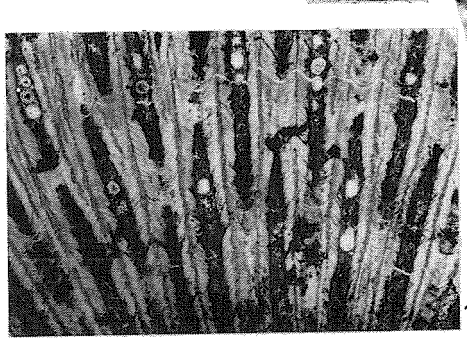
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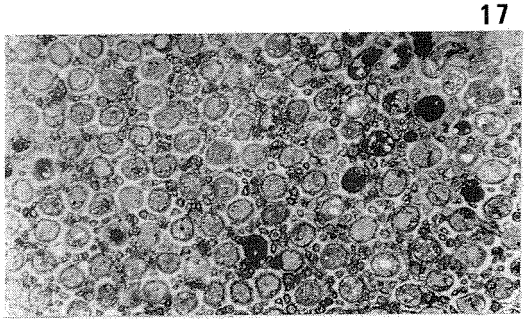

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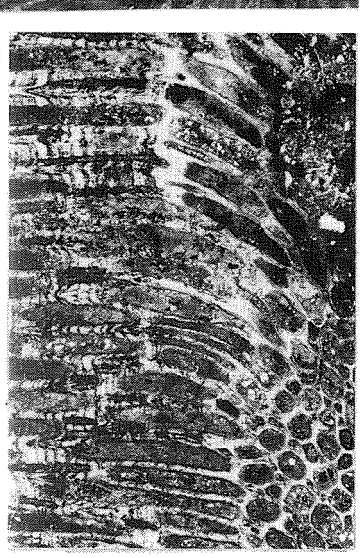

BRYOZOANS

Figs 13–16 *Stenopora lineata* Crockford 1957

13. **Holotype**, CPC 1127; polished longitudinal section located 2 mm below external surface; x3.
14. Portion of polished transverse section of **holotype**; x8.
15. Tangential thin section of **holotype**; x15.
16. Longitudinal section of **holotype**; x15.

Locality [5C], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 17, 18 *Stenopora punctata* Crockford 1957

17. Tangential section of **holotype**, CPC 1130, near surface of zoarium, showing mesopores and acanthopores of two sizes; x15.
18. Longitudinal section of **holotype**; x15.

Locality [19], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 16

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Figs 1–3 *Stenopora spicata* var. *obtusa* Crockford 1957

1. **Holotype**, CPC 1121; tangential section, showing normal arrangement of zooecia, mesopores and acanthopores; x15.
2. Partial transverse section of **holotype** with tube walls showing indistinct moniliform structure in peripheral regions and prominent acanthopores; x15.
3. Portion of **holotype**; x2.
Locality [5C], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4–6 *Pseudobatostomella? lyndoni* (Ross 1963)

4. **Holotype**, CPC ML90-1; partial transverse section showing outer edge of axial region and thick, laminate zooecial walls in peripheral region; x20 (after Ross, 1963, pl. 11 fig. 4).
5. External zoarial fragment, **holotype**; x50 (after Ross, 1963, pl. 11 fig. 8).
6. Tangential section of **holotype**, showing regular arrangement of large zooecial openings, distinct acanthopores and small mesopores; x50 (after Ross, 1963, pl. 11 fig. 3).
Locality ML90, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

Figs 7, 8 *Stenopora?* sp. A Etheridge Jnr 1914

7. External view of part zoarium, **hypotype**, GSWA F466; x2.
8. Enlarged portion of external surface of **hypotype**, showing structural details; x12.5.
Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 9 *Fenestella amplia* (Crockford 1944)

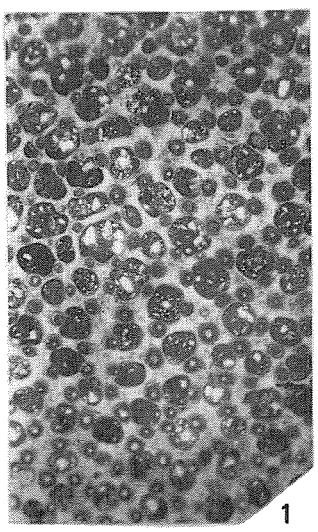
Obverse surface of **holotype**, CPC 309 (formerly 792); x5.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 10, 11 *Fenestella affluensa* Bretnall 1926

10. Obverse surface of CPC 302 (formerly 782); x5.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

11. Enlarged view of obverse features of **lectotype**, GSWA 2/2405E; x10.
East of Gascoyne–Wyndham River junction, Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian), Kungurian.

PLATE 16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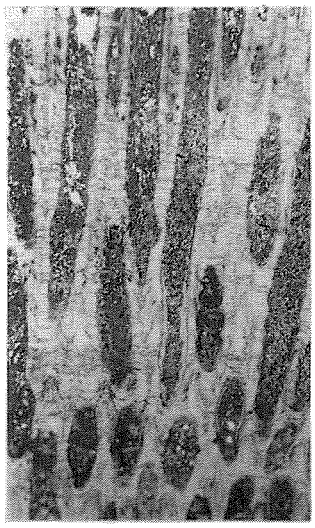
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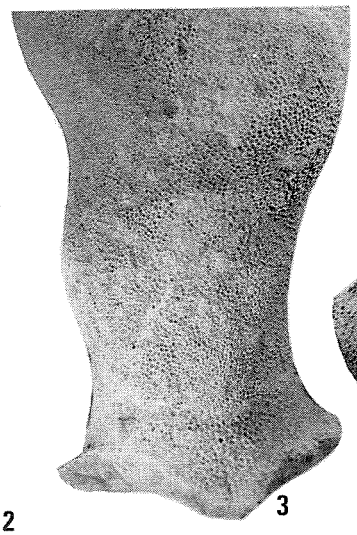
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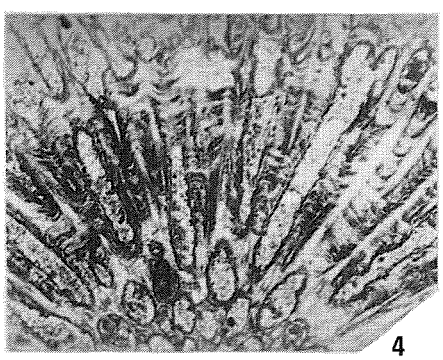
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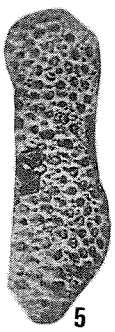
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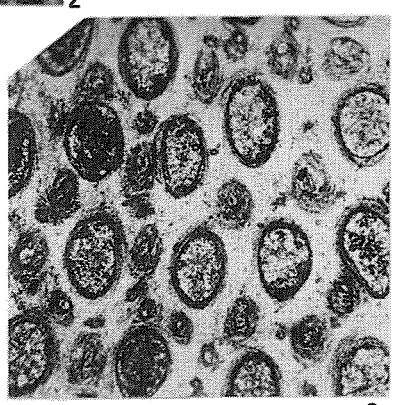
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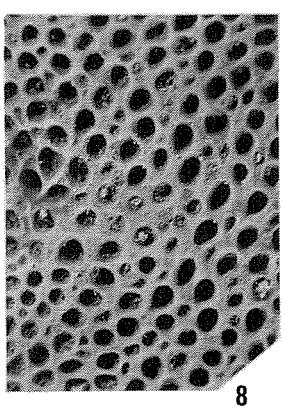
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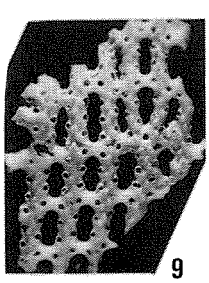
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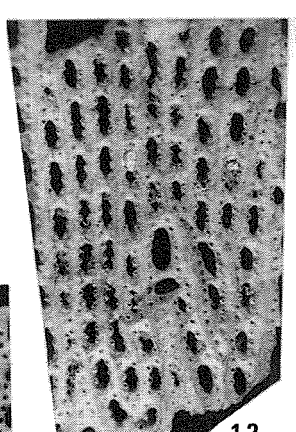
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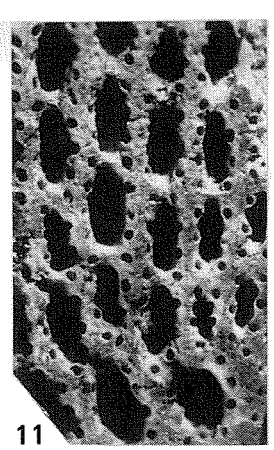
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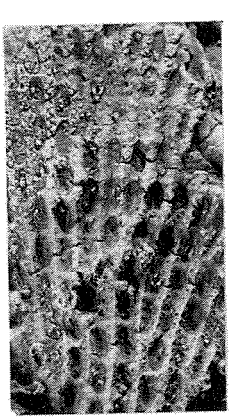
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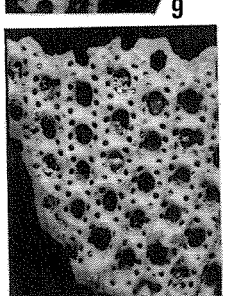
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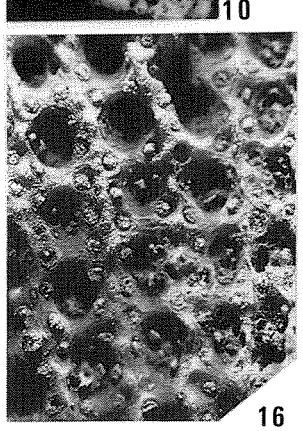
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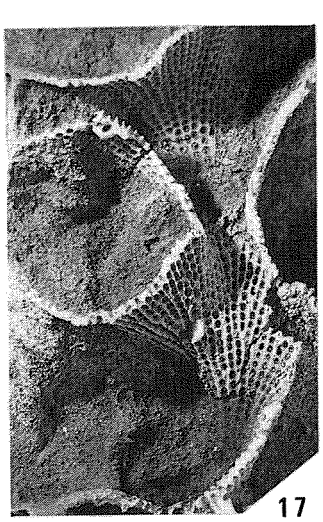
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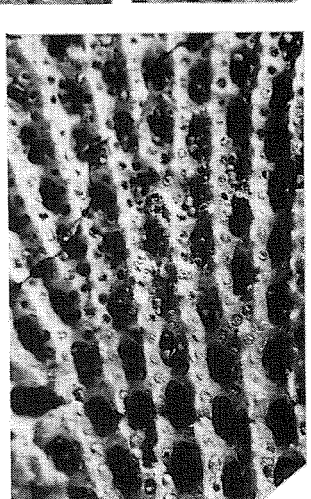
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BRYOZOANS

GSWA 22934

Fig. 12 *Fenestella alia* (Crockford 1944)

Obverse features of **holotype**, CPC 301 (formerly 786); x5.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 13–15 *Fenestella basleoensis* Bassler 1929.

13, 15. Enlarged features of obverse surface of specimen, CPC 1065B; x20.
14. Obverse surface of specimen CPC 1208; x5.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 16–18 *Fenestella columnaris* (Crockford 1944)

16. Obverse surface of **holotype**, UWA 20949; x15.
17. Portion of full colony of **holotype** showing irregular funnel-shaped growth; x2.
18. View of portion of **holotype**; x10.
Minilya River area, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Plate 17

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Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Figs 1, 2 *Fenestella chapmani* (Crockford 1944)

1. Obverse surface of eroded **holotype**, CPC 303 (formerly 788); x5.
2. Surface of **paratype**, CPC 304 (formerly 789?); x5.

West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 3 *Fenestella cacuminatis* (Crockford 1944)

3. Obverse features of **holotype**, UWA 20944A; x10.

Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 4–6 *Fenestella disjecta* (Crockford 1944)

4. Obverse surface of specimen WA 127 on UWA 2793; x10.
5. Obverse surface of **paratype**, WA 130 on UWA 2793; x10.
6. Obverse surface of **holotype**, WA 129 on UWA 2793; x10.

Locality 10.5 km north of Mount Anderson Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 7 *Fenestella hindei* Crockford 1957

Eroded obverse surface of **paratype**, CPC 1078E; x10.

Locality [19], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 8–14 *Fenestella horologia* Bretnall 1926

8. Partial obverse surface of figured specimen, AM F17538; x10.

Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

9. Enlarged obverse fragment illustrating the distinctive stablized arrangement of zooecia in this species, UWA 8499E; x20.

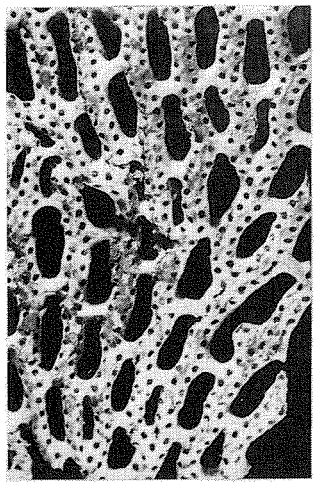
Wooramel River, Carnarvon Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

10. Obverse specimen with a near-linear nodal arrangement, UWA 20942; x10.

Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

11. Near basal thin section illustrating the zooecial chamber arrangement, slide UWA 41214; x15 (after Crockford, 1944a, p.172, text figs 1C, 1D).
13. Obverse surface illustrating the zig-zag nodal arrangement in some specimens, slide UWA 41214; x15.

Locality unspecified, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).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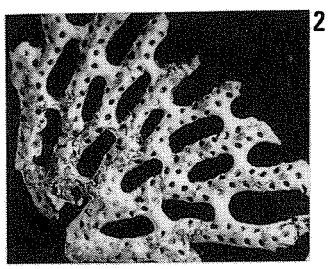
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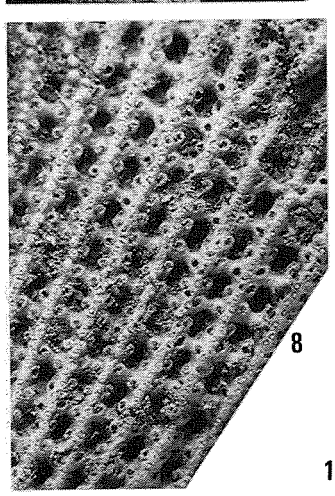
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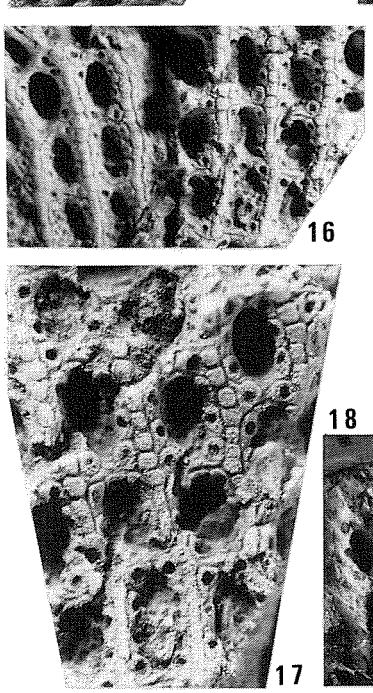
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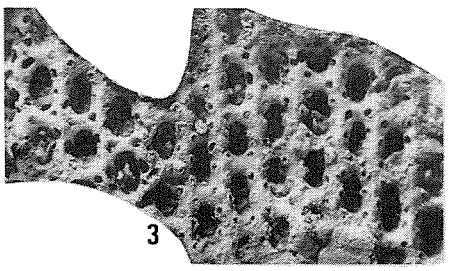
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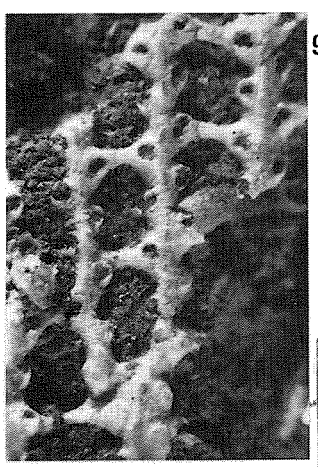
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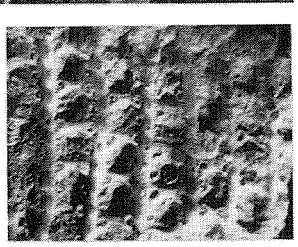
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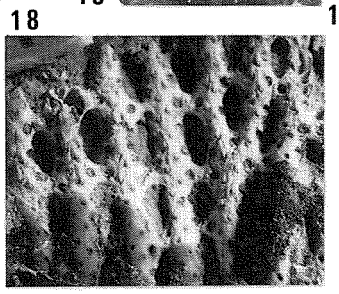
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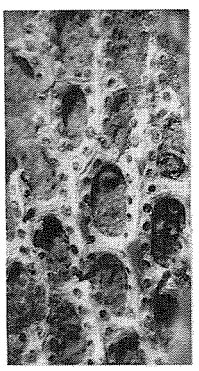
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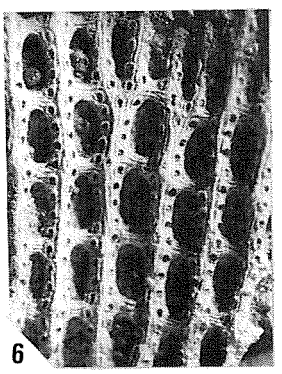
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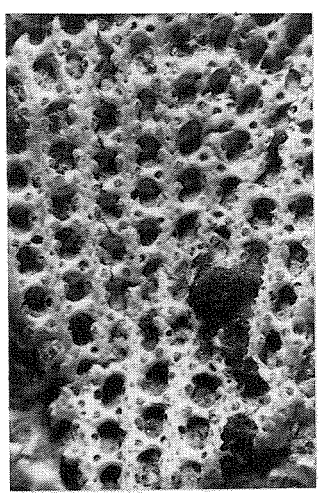
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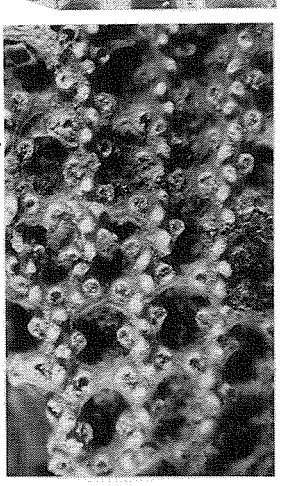
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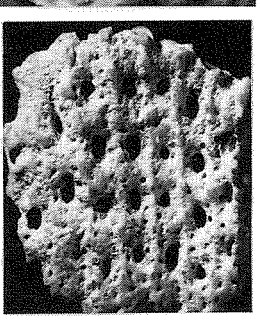
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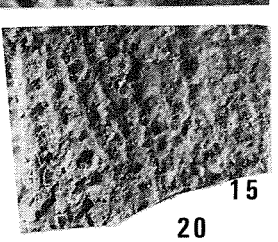
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12. Obverse surface of specimen, CPC 1213C; x10.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

14. Enlarged obverse surface with prominent zig-zag nodes, WA 128 on UWA 2793; x20.
10.5 km north of Mount Anderson Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 15 *Fenestella lennardi* (Crockford 1944)

Remaining fragment of eroded obverse surface of **holotype**, UWA 20948A; x10.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 16, 17 *Fenestella ruidacarinata* (Crockford 1944)

Obverse surface of **holotype** illustrating the distinctive row of low rounded nodes which completely replace the carina, UWA 2757A; x10, x16 respectively.
Locality [31], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 18 *Fenestella princeps* (Crockford 1944)

Obverse surface of **holotype** with zig-zag nodal arrangement, UWA 20945; x10.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 19 *Fenestella sparsigemmata* (Crockford 1944)

Eroded obverse fragment of **holotype** zoarium, CPC 300 (formerly 785); x5.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 20 *Fenestella valentis* (Crockford 1944)

Obverse surface of specimen, CPC 1239, showing the broad flattened branches and dissepiments of this species; x10.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 18

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Figs 1, 2 *Lyropora joselina* Crockford 1957

1. **Paratype**, CPC 1257; upper portion above base of colony showing arrangement of zooecial apertures on the fenestrate mesh; x2.
Locality [1], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

2. **Paratype**, CPC 1256B; x7.
Locality [1A], northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Fig. 3 *Lyroporella erkosoides* (Etheridge Jnr 1926)

Surface of **holotype**, GSWA 513 (formerly 2/2404), showing distinctive form of zoarial mesh and stout lateral supports on its margin; x2.
Daurie Creek, Gascoyne River area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 4 *Polypora bruteni* Wass 1967

Eroded obverse surface of **holotype**, CPC 1250; x5.
Locality [6], northern Canning Basin; Late Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 5, 6 *Australopolypora fovea* (Crockford 1944)

5. Obverse surface of CPC 1211; x5.
6. Enlarged obverse surface of **holotype**, UWA 20947; x10.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 7, 8 *Polypora kimberleyensis* Crockford 1957

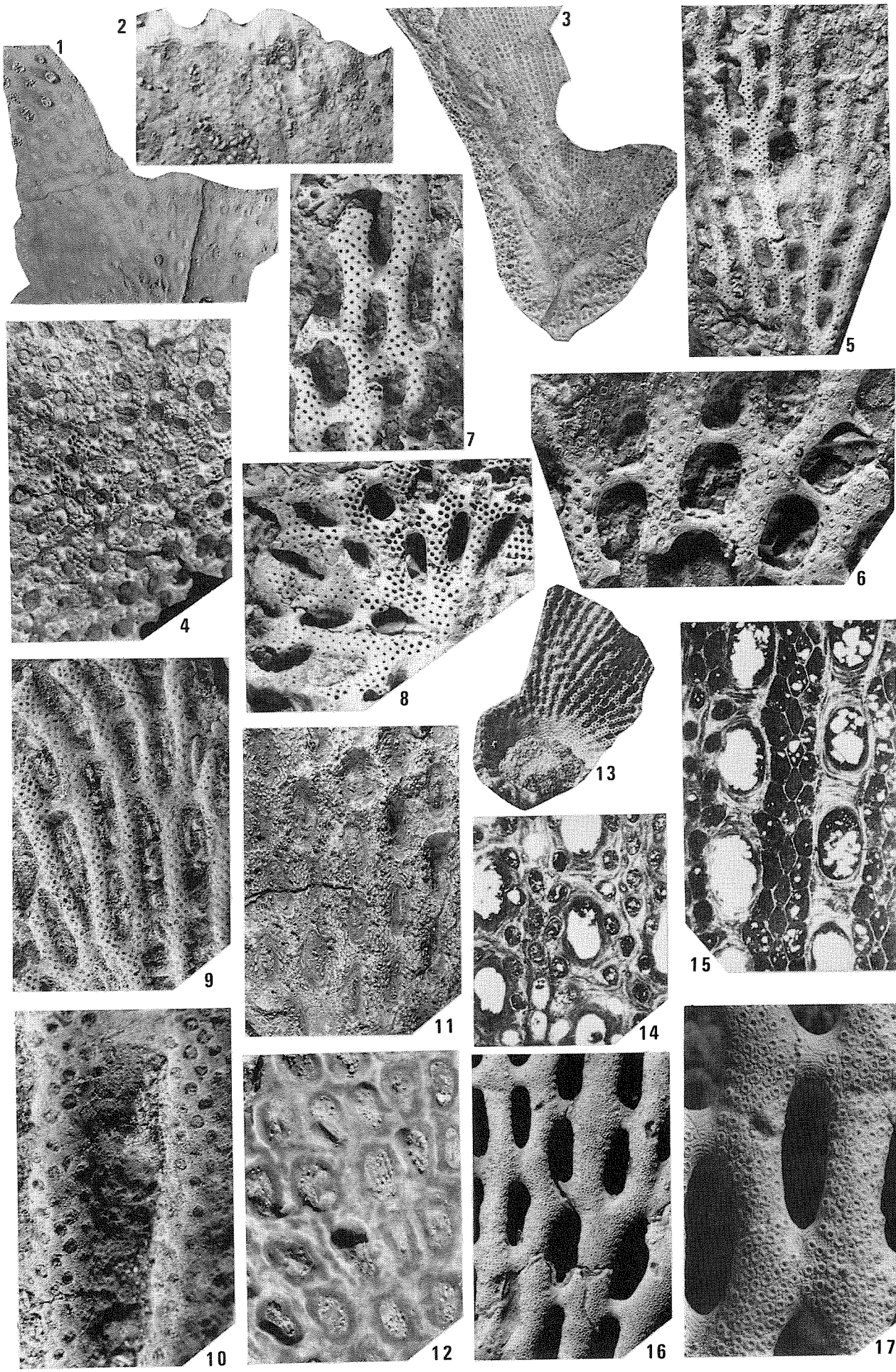
7. Obverse features of zoarium, **paratype**, CPC 1213G; x5.
8. Obverse features of zoarium, **paratype**, CPC 1210B; x5.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 9, 10 *Polypora multiporifera* Crockford 1944

Obverse surface of **holotype**, AM F38441, enlarged to show the extensive zooecial development; x4, x25 respectively.
Locality Minilya River area, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 11, 12 *Polypora megastoma* de Koninck 1863

11. Deeply eroded reverse surface of colony showing partly exposed chambers, CPC 1207; x3.



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Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

12. Distinctive appearance of a reverse surface, CPC 1218; x3.
Locality [7B], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 13–15 *Polypora lyndoni* Ross 1963

13. **Paratype**, CPC ML109-10; view of inner surface of funnel-shaped zoarium near its base showing zooecial apertures; x2 (after Ross, 1963, pl. 9 fig. 11).
14. **Holotype**, CPC ML107-20; tangential section showing round zooecial openings, fine capillaries and an occasional tubule in the zooecial walls, and small fenestrules; x20 (after Ross, 1963, pl. 11 fig. 4).
15. **Paratype**, CPC ML109-11; deep tangential section showing hexagonal form of basal zooecial sections; x20 (after Ross, 1963, pl. 11 fig. 4).
Locality ML109, Lyndon River area, Carnarvon Basin; Lyons Group; ?Asselian–Early Sakmarian (Tastubian).

Figs 16, 17 *Polypora natalis* Crockford 1957

Obverse surface of **holotype**, CPC 1289, showing portion of a large flabellate zoarium; x3, x7 respectively.
Locality [8B], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 19

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Figs 1, 2 *Polypora obesa* Crockford 1957

Enlarged view of obverse surface of **paratype**, CPC 1111D; x5, x10, respectively.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 3, 4 *Polypora woodsi* Etheridge Jnr 1892

3. Obverse surface of portion of zoarium, UWA 20943; x10.
4. Obverse fragment, CPC 1238C; x5.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 5 *Polypora wadei* Crockford 1957

Flattened obverse surface of **holotype**, CPC 1080B; x10.
Locality [12], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 6, 7 *Polypora retificis* Crockford 1944

Two areas of eroded obverse surface of **holotype**, UWA 20951; x10.
Minilya River area, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 8, 9 *Polypora australis* Hinde 1890

Two areas of obverse surface of **holotype**, GSWA F59, showing expansion of zooecial apertures on to the dissepiments; x5.
Gascoyne River area, Carnarvon Basin; ?Callytharra Formation; ?Late Sakmarian (Sterlitamakian).

Figs 10–12 *Protoretepora flexuosa* Crockford 1957

10. Obverse surface of large specimen, **paratype**, CPC 1265; x3.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

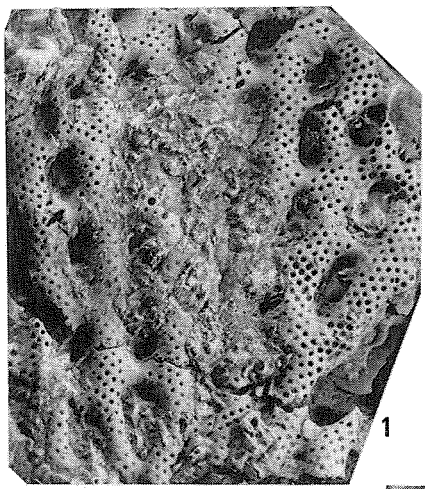
11. Obverse features of **holotype**, CPC 1261; x5.
Locality [5C], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

12. Distinctive reverse surface of **paratype**, CPC 1269; x3.
Locality [7B], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 13–16 *Protoretepora ampla* (Lonsdale 1844)

13, 16. Obverse surface of zoarium, UWA 22320; x5.
Locality [32], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

PLATE 19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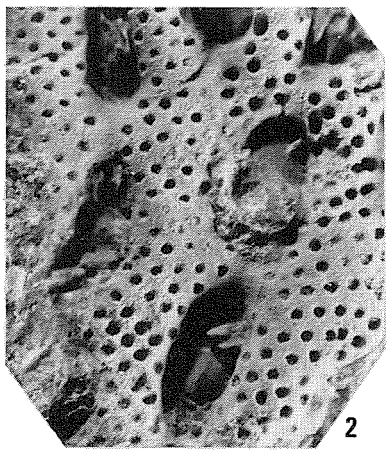
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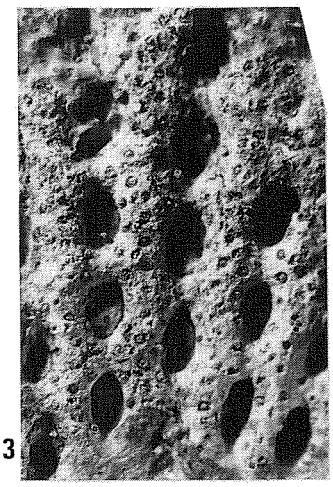
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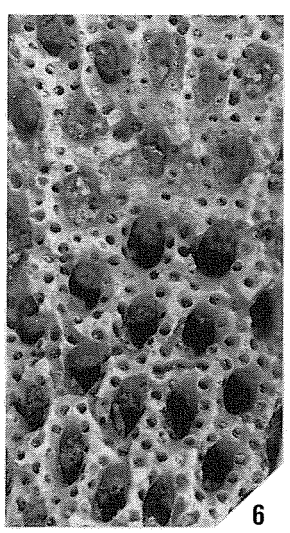
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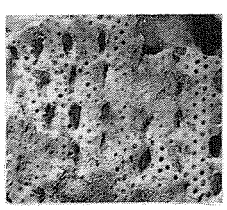
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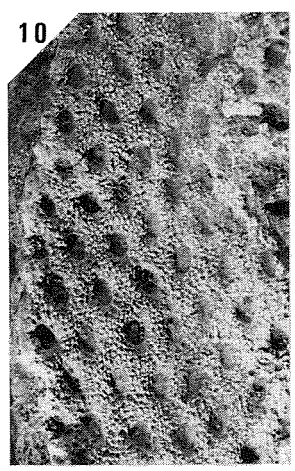
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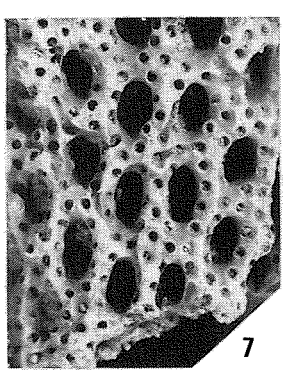
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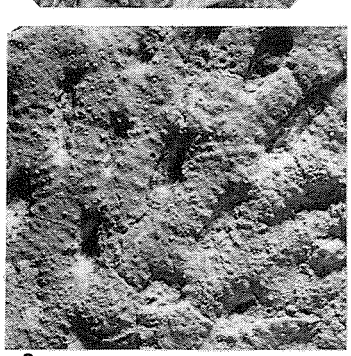
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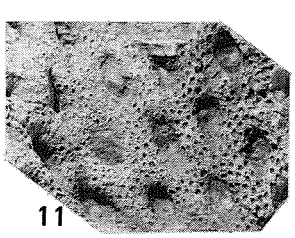
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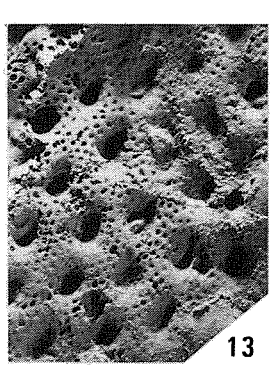
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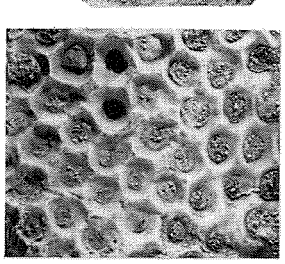
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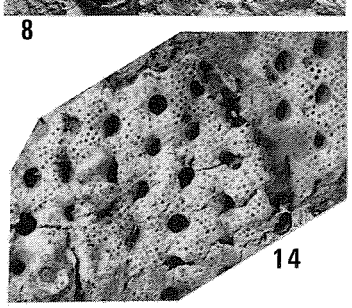
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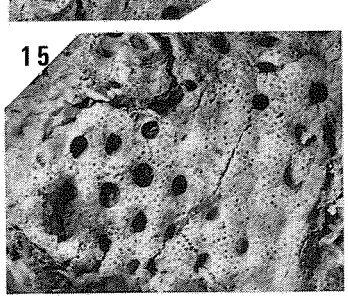
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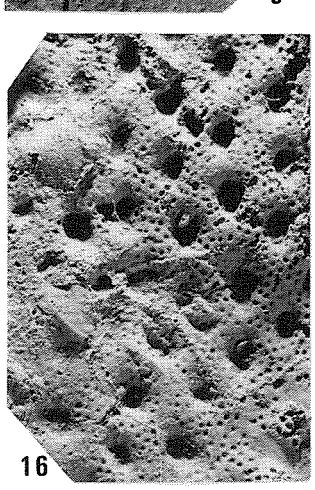
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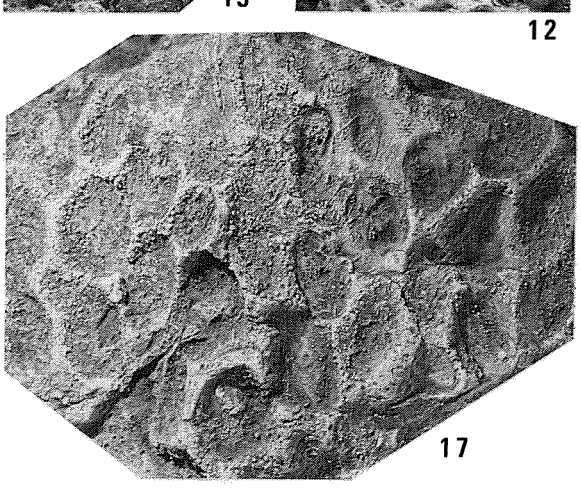
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14, 15. Obverse fragments of specimen, CPC 1259; x3.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 17 *Protoretepora robusta* (Bassler 1929)

Strongly eroded obverse surface of a very large-meshed specimen, CPC 1260; x3.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 20

Figure 2 has been reproduced from Crockford (1944b) with the permission of the Linnean Society of New South Wales. The rest of the figures are either new prints from Crockford's (1957) glass plates or from thin sections originally used to illustrate the BMR Bulletin 34, and have been reproduced with the permission of the Director, Bureau of Mineral Resources.

Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Fig. 1 *Penniretepora fossata* Crockford 1944

Obverse surface of **holotype**, CPC 306 (formerly 803); x15.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 2 *Penniretepora triporosa* Crockford 1944

Obverse surface of **holotype**, CPC 305 (formerly 795); x10 (after Crockford, 1944b, pl. 5 fig. 4).
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 3 *Penniretepora granulata* Crockford 1944

Obverse surface of **holotype**, CPC 325 (formerly 800); x10.
Below and west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4, 5 *Synocladia spinosa* Crockford 1944

4. Latex cast of obverse surface of **paratype**, UWA 22134B; x10.
5. Obverse surface of eroded specimen, UWA 22322; x8.
Wandagee Station, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Figs 6, 7 *Synocladia teicherti* Crockford 1957

6. Obverse surface of **holotype**, CPC 1274; x2.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

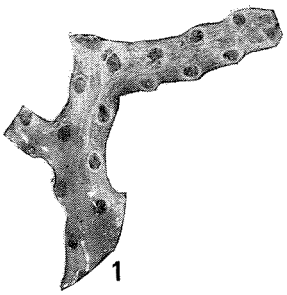
7. **Paratype**, CPC 1205; specimen weathered from the reverse surface showing arrangement of zooecial cells; x5.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 8 *Septopora ornata* Crockford 1944

Obverse surface of **holotype**, CPC 310 (formerly 796); x4.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 9 *Rhabdomeson bispinosum* Crockford 1944

Oblique section of **holotype**, GSWA 2/2405F; x15.
Fossil Hill, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).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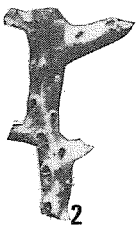
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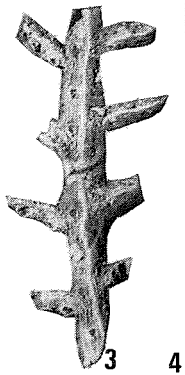
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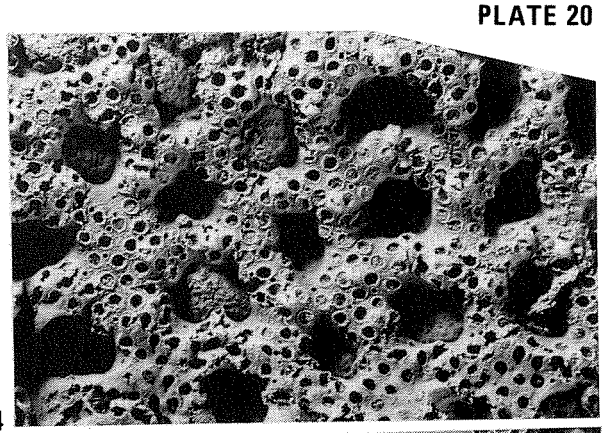
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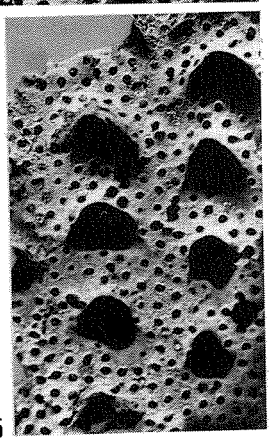
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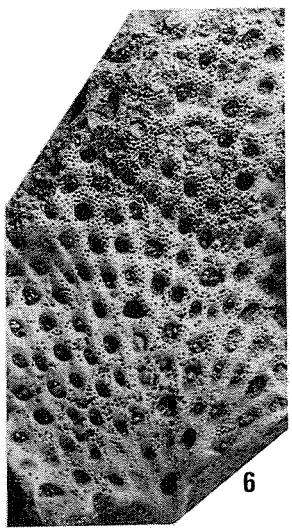
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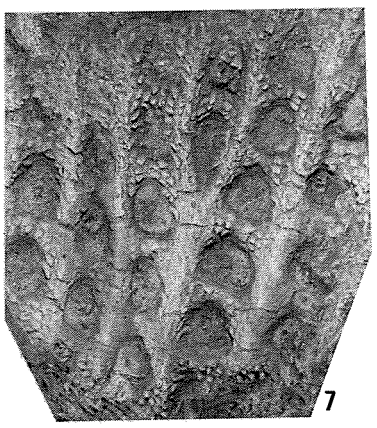
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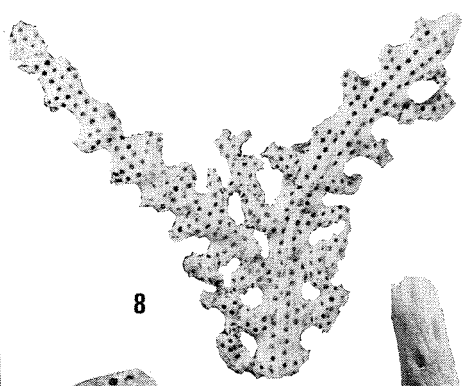
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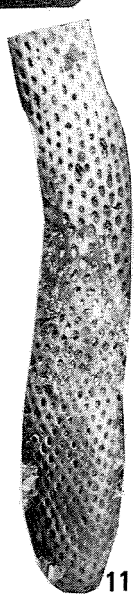
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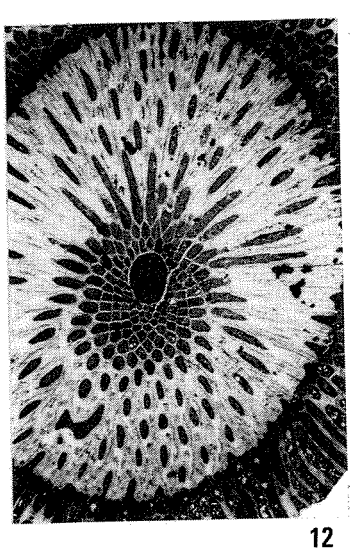
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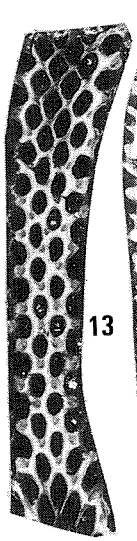
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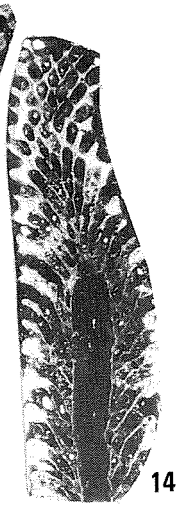
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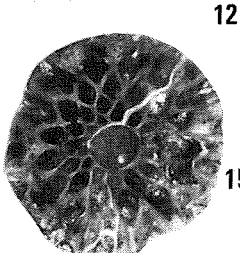
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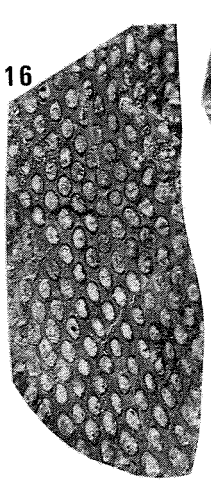
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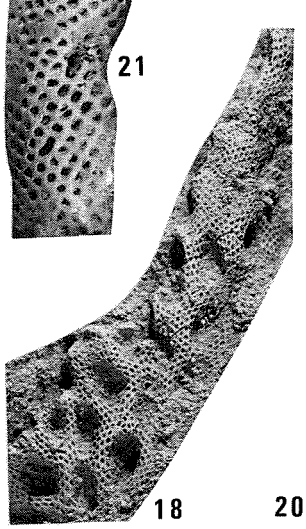
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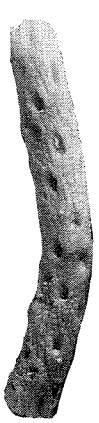
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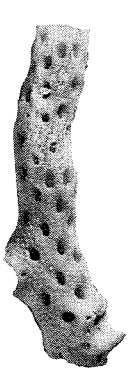
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Figs 10, 11 *Rhabdomeson bretnalli* Crockford 1957

10. Part of thin section of **paratype** showing arrangement of zooecia and numerous megacanthopores, CPC 1187B; x15.
Locality [22], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

11. **Holotype**, CPC 1189A; x5.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 12 *Rhabdomeson grande* Bassler 1929

Thin section of CPC 1144B, with surrounding encrusting stenoporid; x7.5.
Locality [10], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 13–15 *Rhabdomeson mammillatum* (Bretnall 1926)

13. **Holotype**, GSWA 2/10930c (slide UWA 41204); tangential section; x10.
14. **Holotype** (slide UWA 41203); vertical section; x10.
15. **Holotype** (slide UWA 41202); transverse section; x15.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 16 *Rhabdomeson mammillatum* var. nov. Crockford 1957

Eroded external surface of CPC 1185A; x8.
Locality [21], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 17 *Rhombocladia minor* Crockford 1944

Obverse surface of **holotype**, CPC 307 (formerly 805); x25.
Below Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 18 *Rhombocladia spinulifera* Crockford 1944

Growth form of a zoarium, CPC 1275; x2.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 19, 20 *Rhombopora? tenuis* Hinde 1890

Portion of two unnumbered specimens; x6.
Gascoyne River 6.4 km above Winnemia, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 21 *Rhabdomeson? ramosa* Crockford 1957

View of **holotype**, CPC 1180; x6.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Plate 21

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Locality numbers in square brackets correspond to the localities from the Canning Basin listed in Table 9.

Fig. 1 *Saffordotaxis castanea* Crockford 1957

Surface features of the **holotype**, CPC 1073K; x5.
Locality [5J], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 2, 3 *Saffordotaxis elegans* Crockford 1957

2. Parts of a branching colony, **paratype**, CPC 1169; x8.
Locality [19], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

3. **Holotype**, CPC 1185E; x8.
Locality [21], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 4 *Saffordotaxis* sp. cf. *S. wanneri* (Bassler 1929)
Surface features of specimen, CPC 1204; x4.
Locality [5A], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 5–9 *Saffordotaxis multigranulata* (Bretnall 1926)

5. Vertical section of unnumbered specimen; x20.
Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

6. Vertical section of **paratype**, GSWA 3/10930A; x20.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

7. Surface features of CPC 1191A; x8.
Locality [17], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

8, 9. Enlarged views of unnumbered thin sections of marginal portions of a colony showing microstructural details of the laminated tissue and stylets; x200, x80 respectively.
Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

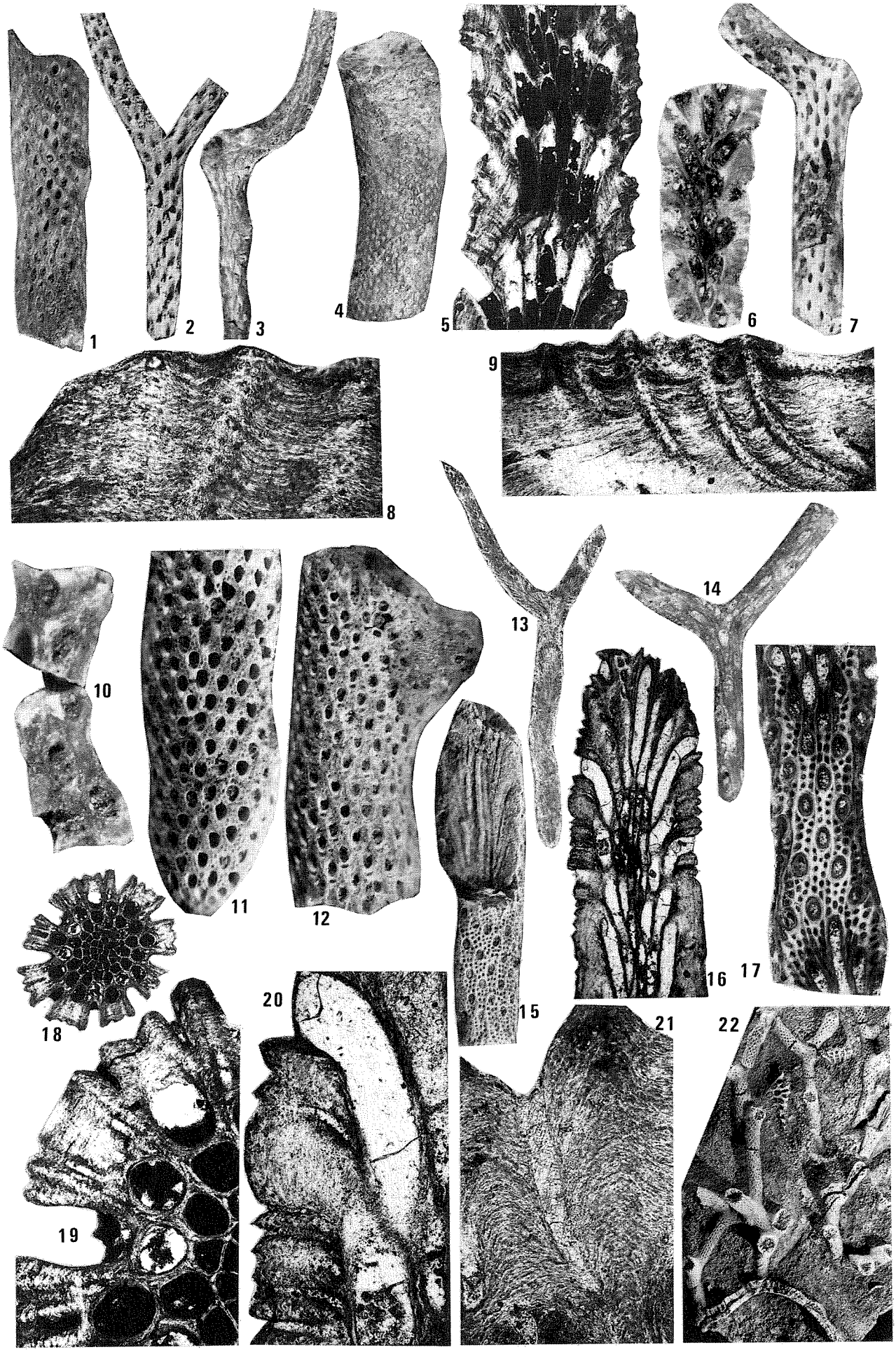
Fig. 10 *Streblocladia excavata* Crockford 1944

Broken, mounted **holotype**, CPC 308 (formerly 806); x25.
West of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 11–13 *Ogbinopora? etheridgei* (Bretnall 1926)

11, 12. Enlarged external details of **holotype**, AM F17550; x15.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

PLATE 21



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GSWA 22939

13. Eroded vertical section showing arrangement of zooecia, UWA 22336A; x2.
Locality [35], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 14 *Streblotrypa* sp. cf. *S. minutula* Bassler 1926

Surface features of specimen, CPC 1185D; x16.
Locality [21], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 15–22 *Streblotrypa (Streblascopora) marmionensis*(Etheridge Jnr 1926)

15. Eroded specimen showing surface details and axial arrangement of zooecia, UWA 98599; x20.
Locality WC8(UWA); Callytharra Spring area, Carnarvon Basin; Late Sakmarian (Sterlitamakian).

16. Vertical thin section of unnumbered specimen; x20.
Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

17. Enlarged detail of surface sculpture, **paratype**, slide UWA 41207; x20.
Locality [29], northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

18, 19. Transverse sections of unnumbered specimens; x20, x80 respectively.
Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

20, 21. Microstructural details of zooecia and peripheral zone structures of unnumbered specimen; x80, x200 respectively.
22. Ramose branching colony with basal attachment, UWA 98599; x2.
Locality WC8 (UWA); Callytharra Spring area, Carnarvon Basin; Late Sakmarian (Sterlitamakian).

Plate 22

All figures are natural size, unless otherwise indicated.

Figures 1–3 from the Proceedings of the Royal Society of Victoria (Archbold, 1981c) and are reproduced with the permission of the Royal Society of Victoria. The rest of the figures are from BMR Bulletin 39 (Thomas, 1958b) and are reproduced with the permission of the Director, Bureau of Mineral Resources.

Figs 1–3 *Semilingula occidentaustralis* (Archbold 1981)

1, 2. **Holotype**, MUGD F5181; x3.5 and x3.2 respectively (after Archbold, 1981c, pl. 14 figs 5a,5c).
3. **Paratype**, MUGD F5189; dorsal valve in dorsal view; x3.5 (after Archbold, 1981c, pl. 14 fig. 15).
Coolkilya Flat, south of Garden Road, Carnarvon Basin; Quinnanie Shale; Late Artinskian (late Baigendzhinian).

Figs 4–10 *Permorthotetes lindneri* Thomas 1958

4–6, 10. **Holotype**, CPC 1494a; internal mould of shell in ventral view; latex cast of dorsal interior, dorsal view and posterior view.
7. **Paratype**, CPC 1502; internal view of part of shell.
8. **Paratype**, CPC 1498; external mould of ventral valve.
9. **Paratype**, CPC 1496; latex cast of shell in dorsal view; x0.8.
25.5 km at 120° from Mount Tuckfield, southern St George Ranges, northern Canning Basin; base of Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 11–13 *Permorthotetes crespinae* Thomas 1958

11. **Paratype**, CPC 1491; external mould of ventral valve.
12. **Holotype**, CPC 1487; internal mould of dorsal valve in dorsal view.
13. **Paratype**, CPC 1489; internal mould of ventral valve in ventral view.
About 0.4 km east of Winderie Station, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

Figs 14–17 *Permorthotetes callytharrensis* Thomas 1958

14, 15, 17. **Holotype**, CPC 1473; internal mould of ventral valve in ventral and posterior views and latex cast of valve interior.
9.4 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

16. Shell in postero-dorsal view; CPC 1532.
Near Trig. Point K52, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).


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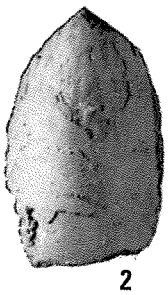
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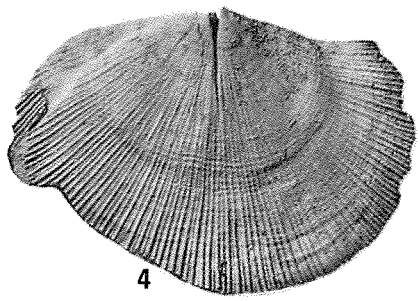
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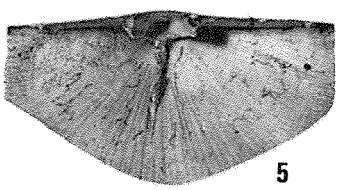
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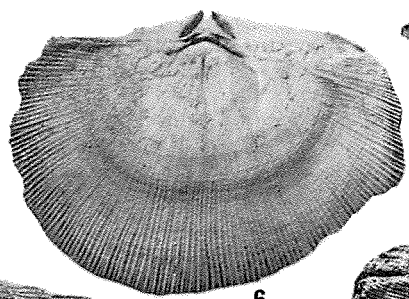
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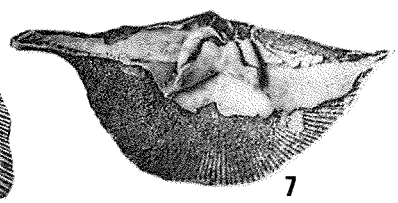
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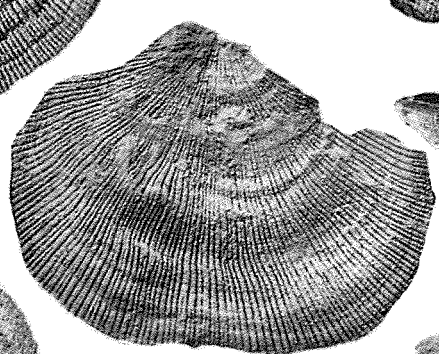
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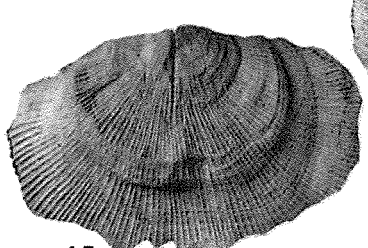
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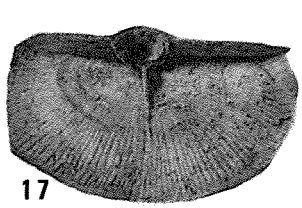
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Plate 23

All figures are natural size, unless otherwise indicated.

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Figs 1, 2 *Permorthotetes callytharrensis* Thomas 1958

1. Shell in dorsal view; CPC 1532.
Near Trig. Point K52, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

2. **Paratype**, CPC 1474; internal mould of dorsal valve.
9.4 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 4 *Permorthotetes camerata* Thomas 1958

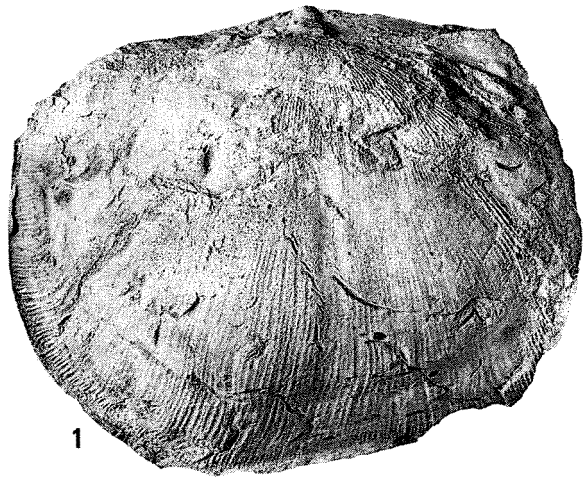
3. **Holotype**, CPC 1514; internal view of ventral valve.
4. Dorsal valve in dorsal view; CPC 1518.
6.4 km at 330° from Mingenew Outcamp, Bidgemia Station, and from about 23.5 km at 59° from Towrana Homestead respectively, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 5–8 *Permorthotetes guppyi* Thomas 1958

5, 6, 8. **Holotype**, CPC 1503; ventral valve in ventral, internal and posterior internal views.
7. Incomplete shell showing dorsal valve interior; CPC 1505.
Type section of Noonkanbah Formation, Brutens Old Yard, Cherrabun Station; and from Mount Marmion respectively, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 9–11 *Permorthotetes teicherti* Thomas 1958

9. **Paratype**, UWA 28045B; ventral valve in ventral view; x0.5.
10. **Holotype**, UWA 28045A; ventral valve in ventral view; x0.5.
11. **Paratype**, UWA 28036; dorsal valve in dorsal view.
Coolkilya Flat, near outcrop of Cretaceous rocks, Carnarvon Basin; Baker Formation; Early and Middle Kungurian.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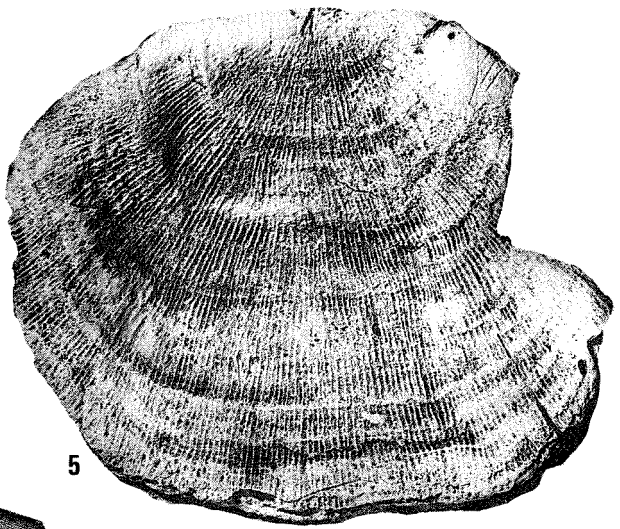
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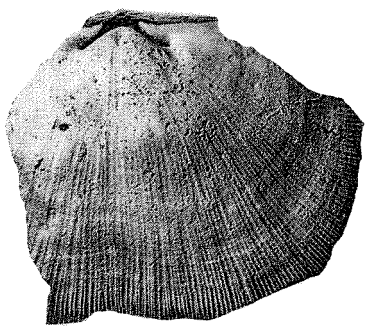
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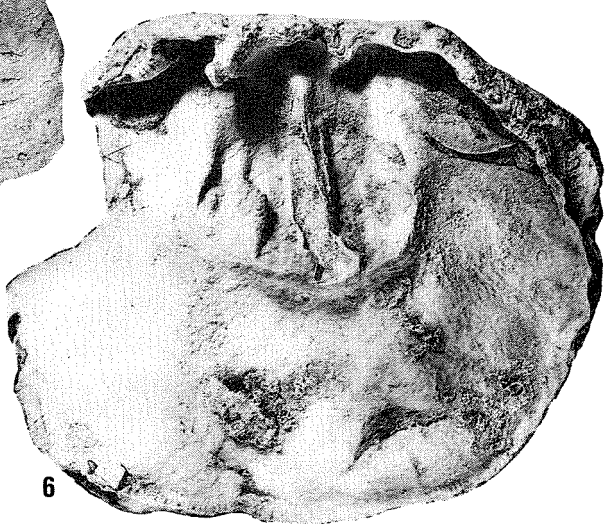
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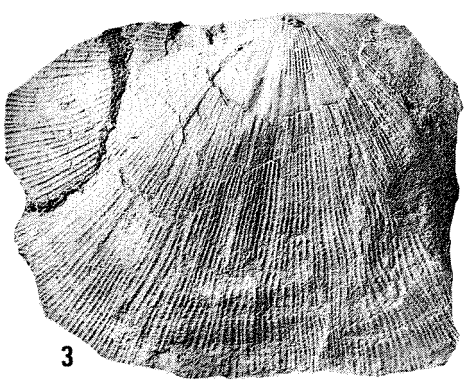
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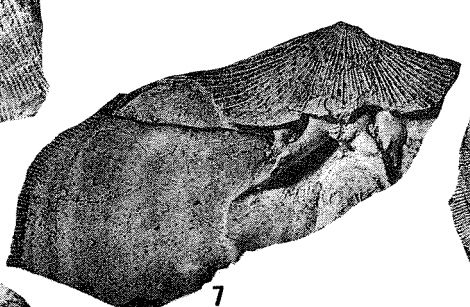
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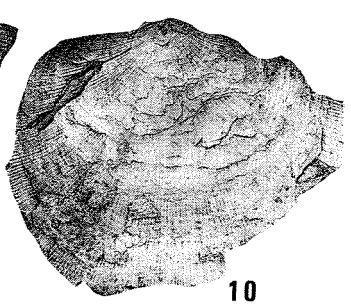
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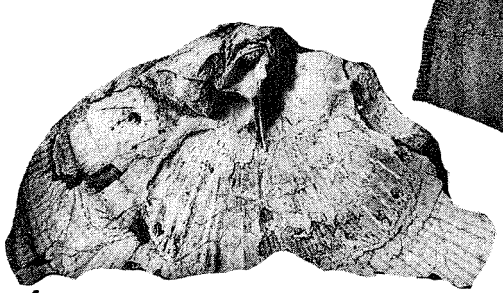
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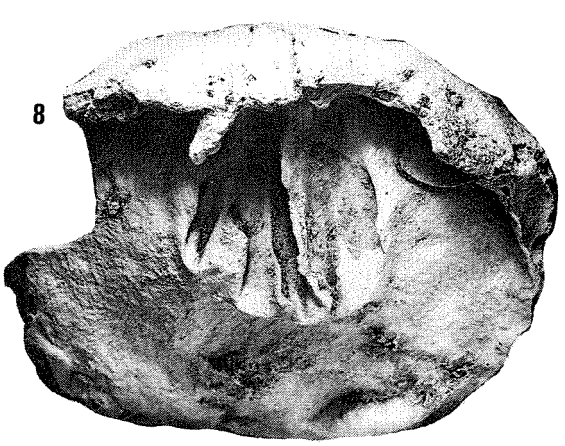
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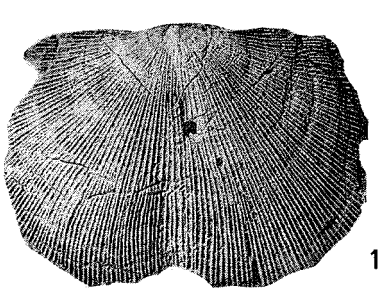
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Plate 24

All figures are natural size, unless otherwise indicated.

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Figs 1–4 *Derbyia hardmani* Thomas 1958

1. Paratype, CPC 1468; ventral valve in ventral view.
2–4. Holotype, CPC 1467; ventral valve in ventral view and showing interarea and septum; x1, x1, and x2 respectively.
Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 5–12 *Kiangsiella condoni* Thomas 1958

5–7, 10. Holotype, CPC 1450; partly exfoliated shell in lateral, dorsal, postero-dorsal, and ventral views.
13.6 km at 82° from Mia Mia Homestead, north bank of Lyndon River, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

8. Paratype, CPC 1456; crushed shell in ventral view.
Locality as above, but 6 m higher in the formation.

9. Paratype, CPC 1458; internal mould of ventral valve in ventral view.
East of Talbots Cairn, Wooramel River, Carnarvon Basin; low in Byro Group; Late Artinskian (early Baigendzhinian).

11, 12. Paratype, CPC 1452; dorsal valve in posterior view (x2) and enlarged (x2.5) ventral surface.
Locality as for CPC 1456, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

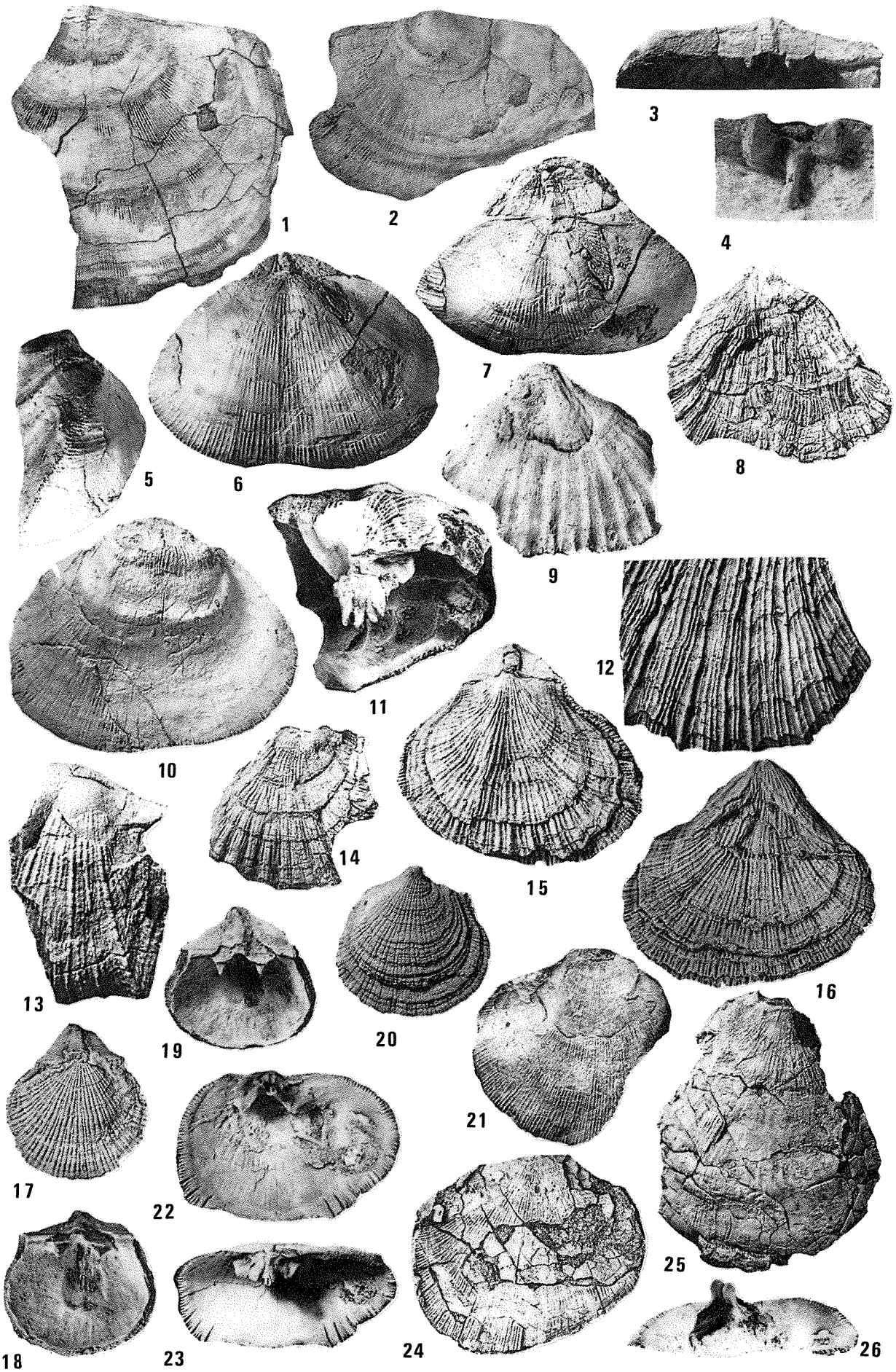
Fig. 13 *Kiangsiella* sp. A

Dorsal valve in external view; CPC 1460; x2.
5.6 km at 65° from Coondoo Well, Arthur River Station, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

Fig. 14 *Kiangsiella* sp. B
Incomplete shell in ventral view; CPC 1465.
Type section of Noonkanbah Formation, Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 15–20 *Arctitreta? plicatilis* (Hosking 1933)

15, 16. Paratype, CPC 1403; shell in dorsal and ventral views; x2.
17. Paratype, CPC 1404; shell in dorsal view; x2.
18–20. Paratype, CPC 1400; ventral valve in anterior, interior, and external views; x2.
About 560 m west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).



BRACHIOPODS

Fig. 21 *Streptorhynchus?* sp. nov.

Ventral valve in ventral view; CPC 1449.
2.6 km west of Cooracootharra Well, Williambury Station, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

Figs 22, 23, 26 *Arctitreta? crassimurus* (Thomas 1958)

22, 23, 26. **Paratype**, CPC 1412; dorsal valve showing interior, posterior, and anterior views of cardinal process.
3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 24, 25 *Streptorhynchus variabilis* Thomas 1958
24. **Paratype**, CPC 1415; dorsal valve in dorsal view.
25. **Holotype**, CPC 1413; ventral valve in ventral view.
3.2 km at 255° from Brutens Old Yard, Cherrabun Station, Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Plate 25

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Figs 1, 2 *Arctitreta? crassimurus* (Thomas 1958)

1. **Holotype**, CPC 1407; ventral valve in ventral view.
2. **Paratype**, CPC, 1411; dorsal valve in dorsal view.
3.2 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Late Baigendzhinian).

Figs 3–7 *Streptorhynchus hoskingae* Thomas 1958

3, 4. Shell in dorsal and profile views; UWA 28185.
UWA (C. Teichert) locality C37.14 on Wandagee Station, Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

5–7. **Holotype**, CPC 1425; ventral valve in dorsal, dorsal posterior and dorsal anterior views; x2.
West limb of Minilya Syncline, about 2.5 km southwest of Coolkilya Pool, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 8–10 *Streptorhynchus costatus* Thomas 1958

8. **Holotype**, CPC 1419; shell in dorsal view.
9. Shell in dorsal view; CPC 1423.
10. Shell in dorsal view; CPC 1523.
South of Grant Range, about 12.5 km southwest of Mount Anderson Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 11, 13 16 *Streptorhynchus* sp. cf. *S. pelargonatus* (Schlotheim 1816)

11. Ventral valve in dorsal view; CPC 1437.
13. Ventral valve in dorsal view; CPC 1436; x2.
16. Dorsal valve in interior view; CPC 1443.
Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

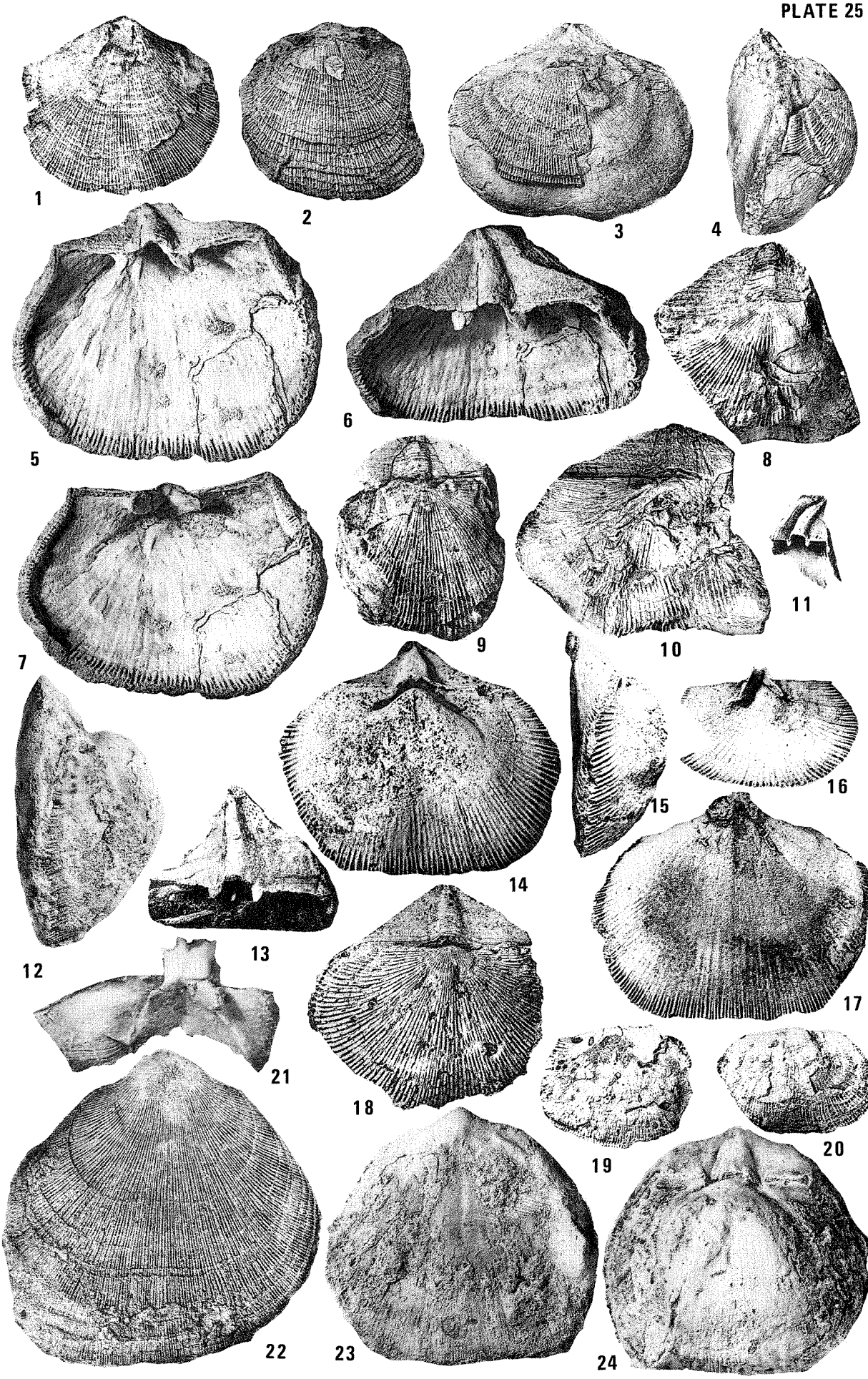
Figs 12, 21–24 *Streptorhynchus luluigui* Hosking 1933

12, 23, 24. Internal mould in profile, ventral, and dorsal views; CPC 1446.
Northern Canning Basin; Hardman Formation; Chhidruan.

21. Cardinal process of UWA 27720.
Near Luluigui Homestead, northern Canning Basin; Hardman Formation; Chhidruan.

22. Ventral valve external mould; CPC 1444.
Near Tutu Bore, Nerrima Station, northern Canning Basin; Hardman Formation; Chhidruan.

PLATE 25



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GSWA 22943

Figs 14, 15, 17, 18 *Streptorhynchus johnstonei* Thomas 1958

14, 15, 17. **Holotype**, CPC 1430a; internal mould in dorsal, profile, and ventral views; x2.

18. **Holotype**, CPC 1430b; latex cast of external mould; x2.
Kennedy Range, 1.1 km south of Southern Cross Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 19, 20 *Streptorhynchus perfidiabadensis* (Etheridge Jnr 1907)

19. Dorsal valve in dorsal view; CPC 1435.
20. Dorsal valve in dorsal view; CPC 1434.
4.2 km at 70° from Shore Range Trig. Point, Shore Range, northern Canning Basin; Lightjack Formation; Middle Kungurian.

Plate 26

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Figs 1–4 *Tornquistia occidentalis* Archbold 1980

Holotype, CPC 19127; in dorsal, ventral, posterior and anterior views; x3.5 (after Archbold, 1980b, pl. 25 figs 1d,a,b,c).
Base of type section of Callytharra Formation, Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 5, 9, 13 *Tornquistia gregoryi* Archbold 1981

5, 9. **Holotype**, NMV P60709; ventral valve in ventral and posterior views; x4.5 (after Archbold, 1981b, pl. 3 figs 20, 18).
13. **Paratype**, NMV P60706; shell in dorsal view; x4.5 (after Archbold, 1981b, pl. 3 fig. 15).
Northeast side of syncline, north of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 6–8 *Tornquistia magna* Archbold 1980

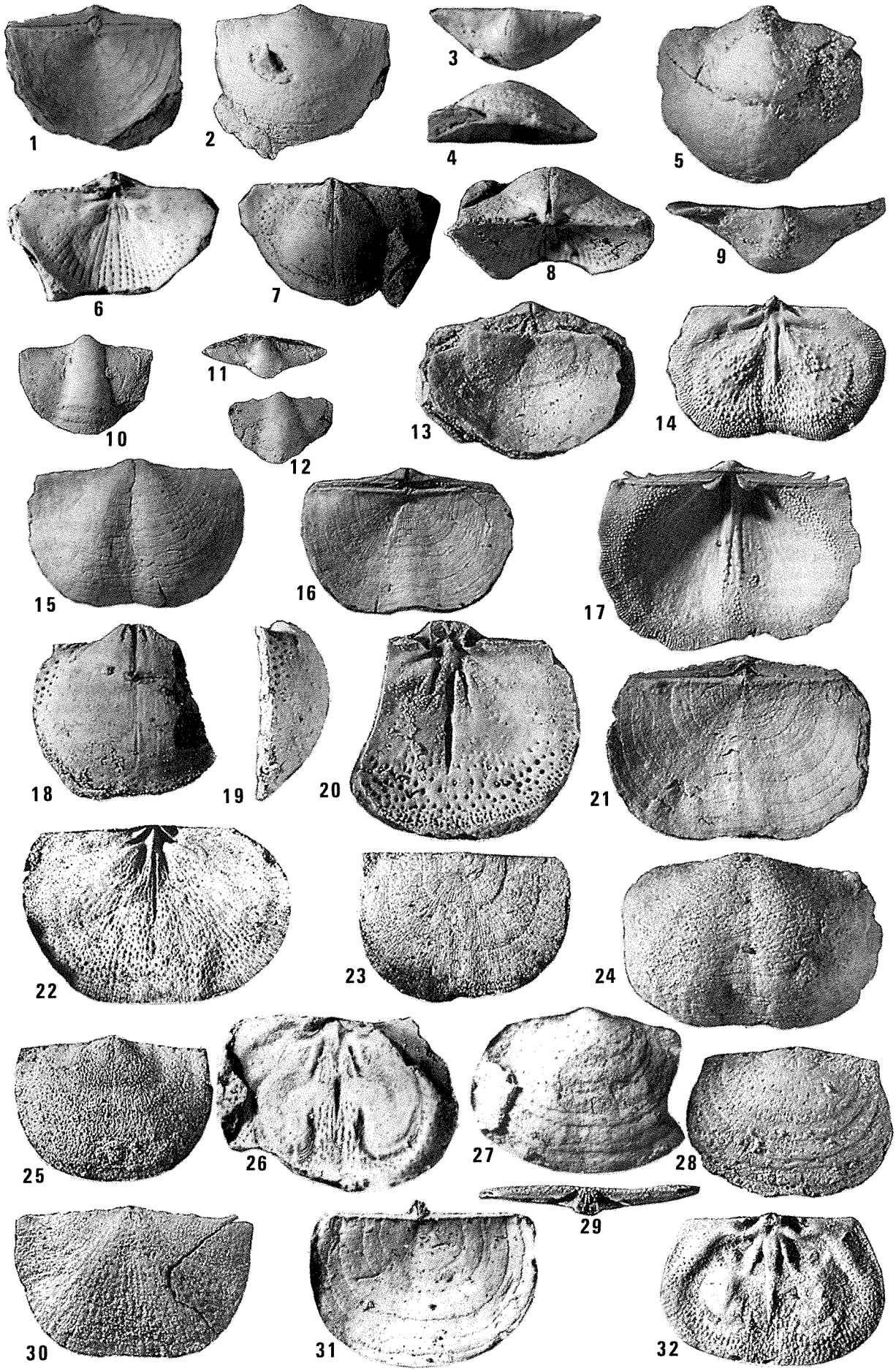
Holotype, CPC 19137; internal mould of shell in dorsal, ventral and posterior views; x3.5 (after Archbold, 1980b, pl. 25 figs 8c,b,a).
12 km south of west of Moogooree Homestead, Lat. 24°05'S, Long. 115°06'E, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (early Baigendzhinian).

Figs 10–12 *Demonedys granti* Archbold 1980

10, 11. **Holotype**, CPC 19131; ventral valve in ventral and posterior views; x3.5 (after Archbold, 1980b, pl. 25 figs 17a,b).
12. **Paratype**, CPC 19132; ventral valve in ventral view; x3.5 (after Archbold, 1980b, pl. 25 fig. 18a).
Minilya River, about 14.6 km southeast of Middalya Homestead, 0.2 km northwest of well, Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

Figs 14–17 *Neochonetes (Sommeriella) pratti* (Davidson 1859)

14. Dorsal valve in ventral view; GSWA F11045; x2 (after Archbold, 1981d, Fig. 4T).
15, 16. Ventral valve in ventral and dorsal views; GSWA F11018; x1.75 (after Archbold, 1981d, Figs 4N,O).
17. Ventral valve in dorsal view; GSWA F11022; x2 (after Archbold, 1981d, Fig. 4C).
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Sakmarian (Sterlitamakian).



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Figs 18–20 *Neochonetes (Sommeriella) robustus* Archbold 1981

Holotype, CPC 19886M; internal mould of shell in ventral, profile, and dorsal views; x2, x2, and x3.5 respectively (after Archbold, 1981d, Figs 7E,C,D).
3.5 km at 358° from Monument Bore, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

Figs 21, 24 *Neochonetes (Sommeriella) tenuicapillatus* Archbold 1981

Holotype, NMV P60731; shell in dorsal and ventral views; x2 (after Archbold, 1981d, Figs 9K,L).
Minilya River district, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 22, 23, 25 *Neochonetes (Sommeriella) afanasyevae* Archbold 1981

22. **Holotype**, CPC 19902A; dorsal valve internal mould; x2.25 (after Archbold, 1981d, Fig. 10A).
Liveringa Ridge, Lat. 18°04'40"S, Long. 124°03'00"E, northern Canning Basin; Lightjack Formation; Middle Kungurian.

23. **Paratype**, CPC 19907D; latex cast of dorsal valve external mould; x2.5 (after Archbold, 1981d, Fig. 10S).
25. **Paratype**, CPC 19905A; latex cast of ventral valve external mould; x2.5 (after Archbold, 1981d, Fig. 10T).
Northwest of Paddys Outcamp, ridge and outliers of Kennedy Range, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 26, 27, 31 *Svalbardia thomasi* Archbold 1981

26. **Holotype**, CPC 19161B; dorsal valve internal mould; x4 (after Archbold, 1981a, Fig. 2A).
27. **Paratype**, CPC 19162A; latex cast of ventral valve external mould; x4 (after Archbold, 1981a, Fig. 2G).
31. **Paratype**, CPC 19161D; latex cast of dorsal valve external mould; x3 (after Archbold, 1981a, Fig. 2N).
Northwest of Paddys Outcamp, ridge and outliers of Kennedy Range, Carnarvon Basin; Baker Formation; Early Kungurian.

Figs 28, 29, 32 *Svalbardia narelliensis* Archbold 1981

28. **Paratype**, CPC 19167F; ventral valve in ventral view; x3 (after Archbold, 1981d, Fig. 2W).
29, 32. **Holotype**, CPC 19167U; dorsal valve in posterior and ventral views; x3 (after Archbold, 1981d, Figs 2C,A).
1.2 km south of Narelli Rockhole, Lat. 20°09'S, Long. 127°56'E, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian) and ?earliest Kungurian.

Fig. 30 *Neochonetes (Sommeriella)* sp. nov. B

Ventral valve in ventral view; CPC 19883; x4 (after Archbold, 1981d, Fig. 12A).
From beds 1.2 m thick about 40 m below the top of Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

Plate 27

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Figs 1–3 *Quinquenella australis* Archbold 1981

1. **Holotype**, UWA 88100; impression of dorsal interior; x 4.5 (after Archbold, 1981e, pl. 1 fig. 1).
2. **Paratype**, UWA 88105; ventral valve exterior; x4 (after Archbold, 1981e, pl. 1 fig. 13).
3. **Paratype**, UWA 88102; dorsal valve exterior; x4 (after Archbold, 1981e, pl. 1 fig. 10).
Wandagee Station area, UWA locality C38.10, Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

Figs 4, 7, 8 *Strophalosia irwinensis* Coleman 1957

4. **Holotype**, MUGD F6577; dorsal valve interior; x1.8.
7, 8. Shell in dorsal and ventral views, MUGD F6578; x1.2.
Measured section at Bilung Creek, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 5, 6 *Strophalosia jimbaensis* Archbold 1986

5, 6. **Holotype**, CPC 24405; shell in dorsal and ventral views; x1.1.
15 km west of Jimba Jimba Homestead, Jimba Jimba Station, Carnarvon Basin; type section of Jimba Jimba Calcarenite Member of the Billidee Formation; Early Artinskian (Aktastinian).

Figs 9, 10 *Heteralosia etheridgei* (Prendergast 1943)

9. Shell in ventral view; CPC 24406; x3.5.
10. Dorsal valve interior; MUGD F6579; x4.5.
Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 11 *Heteralosia complectens* (Etheridge Jnr 1918)

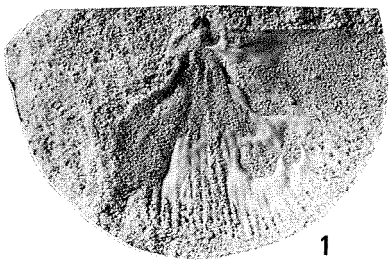
Lectotype, AM F16699a, in top right, dorsal view and ventral valve interior; AM F16699b, bottom of figure; x3.
Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 12, 13 *Heteralosia prendergastae* (Coleman 1957)

Holotype, UWA 28444a; in ventral and dorsal views.
330 m west of fence between Barrabiddy and Weer Paddocks, near Barrabiddy Creek, south of Wandagee Homestead, Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

Figs 14, 17, 18 *Echinalosia (Notolosia) dickinsi* Archbold 1986

14. Dorsal valve in dorsal view; CPC 24407; x3.
17. Dorsal valve in interior view; CPC 24408; x1.8.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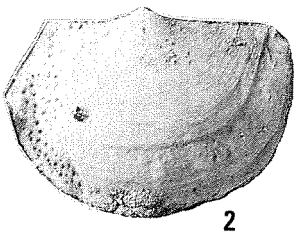
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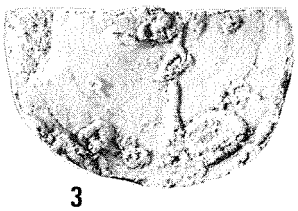
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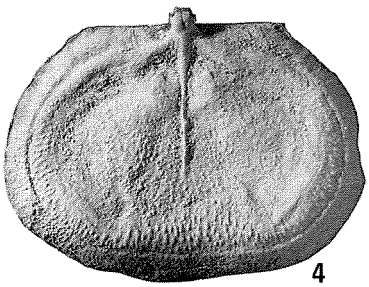
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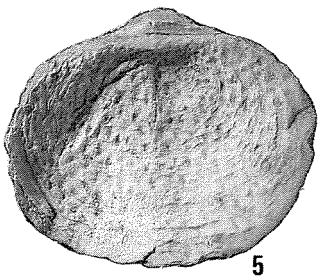
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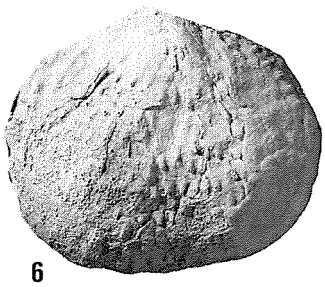
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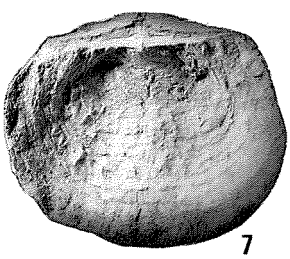
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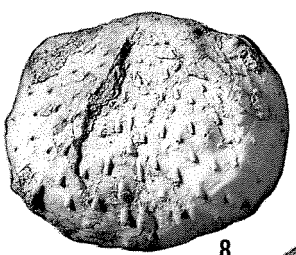
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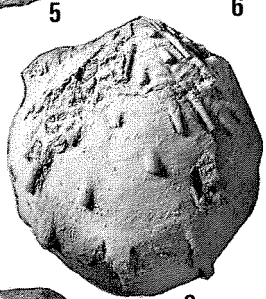
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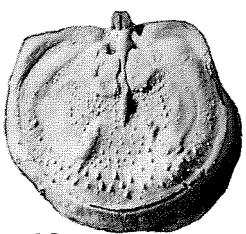
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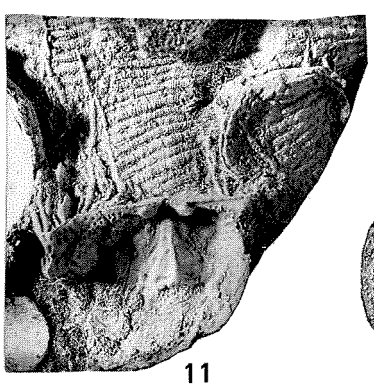
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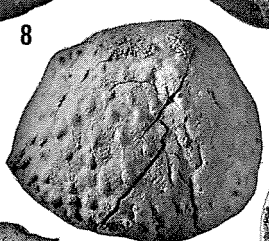
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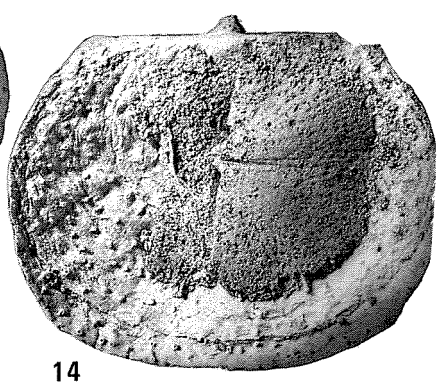
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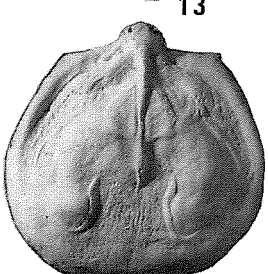
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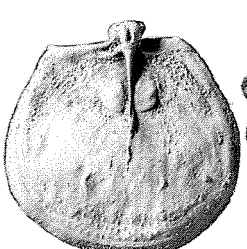
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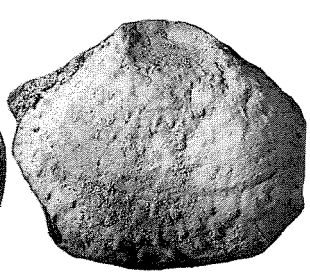
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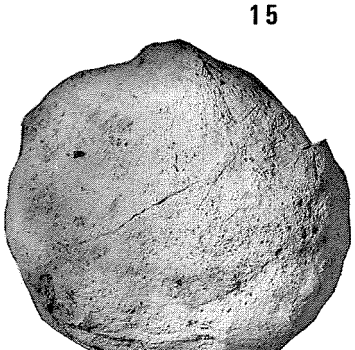
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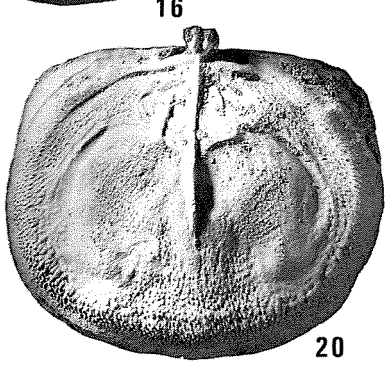
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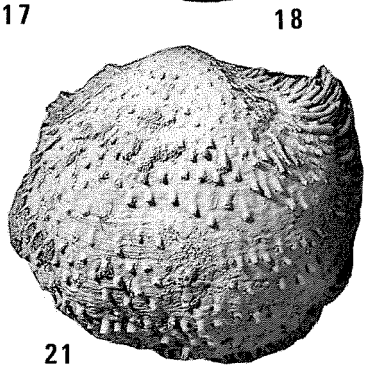
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BRACHIOPODS

Beds about 1.2 m thick at about 40 m below top of Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

18. Natural cast of ventral valve exterior; CPC 24409; x1.6.
Lat. 19°06'39"S, Long. 125°11'27" E, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 15, 16, 19 *Wyndhamia multispinifera* (Prendergast 1943)

15. Ventral valve in posterior view; CPC 24410.
6.9 km at 298° from Brutens Old Yard, at 357 m above formation base, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Late Baigendzhinian).

16. Dorsal valve in interior view; CPC 24412.
19. Ventral valve in ventral view; CPC 24411.
3.5 km at 288° from Brutens Old Yard at 225 m above formation base, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 20, 21 *Wyndhamia colemani* Archbold 1987

20. **Paratype**, CPC 24413; dorsal valve, interior view.
21. **Paratype**, CPC 24414; ventral valve in ventral view.
6.6 km at 205° from Mount Madeline, Carnarvon Basin; upper part of Coyrie Formation; Late Artinskian (early Baigendzhinian).

Plate 28

All figures are natural size, unless otherwise indicated.

Figures 12–15 are reproduced from Journal of Paleontology (Archbold, 1980a) with the permission of the Paleontological Society. The rest of the figures are reproduced from BMR Bulletin 40 (Coleman, 1957), with permission of the Director, Bureau of Mineral Resources.

Figs 1–3, 8 *Echinalosia prideri* (Coleman 1957)

1, 2. Shell in dorsal and ventral views; CPC 24415; x1.3 and x1.2 respectively.
13.6 km at 82° from Mia Mia Homestead, north bank of Lyndon River, Carnarvon Basin; Coyrie Formation; Late Artinskian (Early Baigendzhinian).

3. Shell in ventral view; CPC 24416.
Right bank of Lyndon River, 14.4 km east of Mia Mia Homestead, Carnarvon Basin; Coyrie Formation; Late Artinskian (Early Baigendzhinian).

8. Internal mould of shell in dorsal view; CPC 24417; x1.2.
3.6 km at 225° from Keogh Hill, Carnarvon Basin; lower part of Coyrie Formation; Late Artinskian (late Baigendzhinian).

Figs 4–7 *Lialosia kimberleyensis* (Prendergast 1943)

4. Dorsal valve in dorsal view; CPC 24418; x1.3.
5. Dorsal valve, interior view; CPC 24419; x1.4.
7 km at 298° from Brutens Old Yard, about 357 m above base of formation, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

6. Ventral valve in ventral view; CPC 24420.
5 km west of Cundlego Well, north side of Minilya River, Minilya Syncline, Carnarvon Basin; Nalbia Sandstone; Early Kungurian.

7. External mould of ventral valve; CPC 24421; x1.2.
Locality 48, traverse northwest of Paddys Outcamp, Carnarvon Basin; Baker Formation; Early Kungurian.

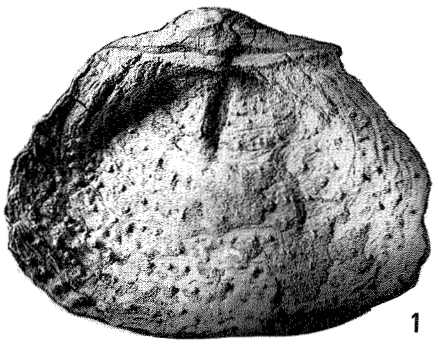
Figs 9–11 *Liveringia magnifica* Archbold 1987

9. **Paratype**, ventral valve in posterior view; CPC 24422; x1.2.
Near Andys Well, Noonkanbah Station, about 13 km at 47° from Mount Fenton, northern Canning Basin; Hardman Formation; Chhidruan.

10. **Paratype**, dorsal valve, interior view; CPC 24423.
11. **Paratype**, CPC 24424; dorsal valve in dorsal view, x2.5.
Near mouth of Nerrima Creek, 4 km at 95° from Luluigui Homestead, high in formation, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 12–15 *Mingenewia anomala* Archbold 1980

12–14. **Holotype**, CPC 19145; latex replica of ventral valve in ventral view and internal mould of shell in dorsal and ventral views; x4 (after Archbold, 1980a, pl. 1 figs 4, 1, 2 respectively).
15. **Paratype**, CPC 19148; latex replica of dorsal valve in dorsal view; x4 (after Archbold, 1980a, pl. 1 fig. 19).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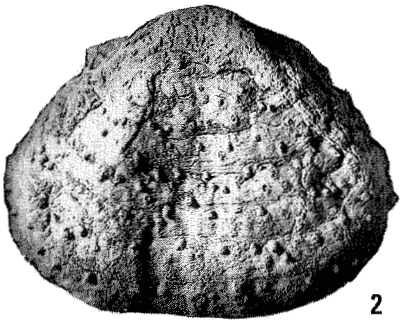
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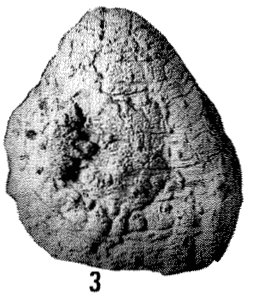
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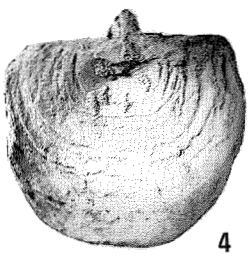
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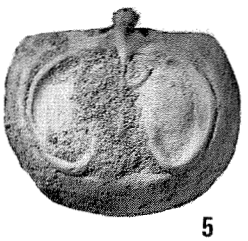
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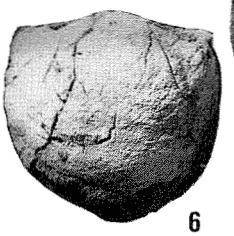
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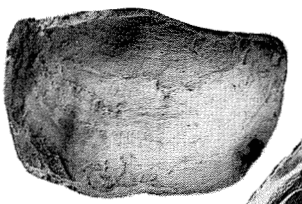
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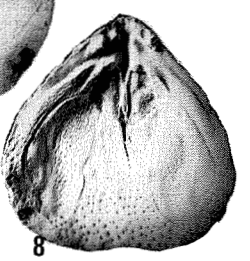
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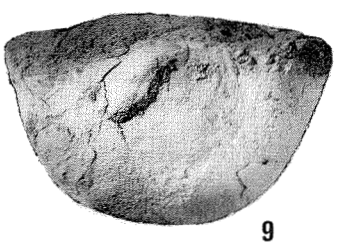
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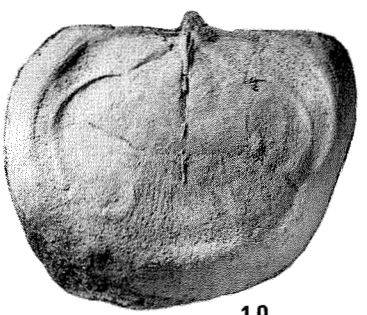
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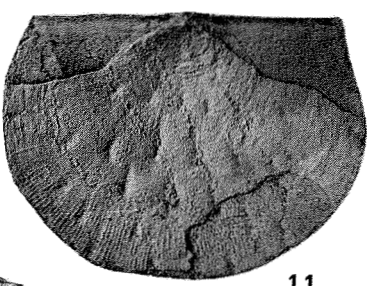
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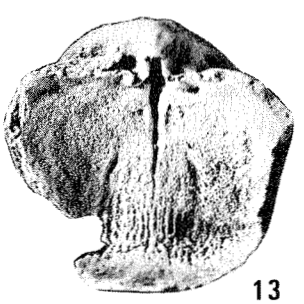
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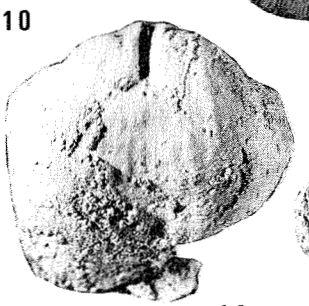
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BRACHIOPODS

Fossil Hill, Mingenew area, Perth Basin; Mingenew Formation; Late Artinskian (early Baigendzhinian).

Figs 16, 17 *Aulosteges baracoodensis* Etheridge Jnr 1903

Lectotype, AM F36218; in dorsal and ventral views.
Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Plate 29

All figures are natural size.

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Figs 1–3 *Aulosteges spinosus* Hosking 1931

Holotype, GSWA 1/4687; ventral valve in dorsal ventral and profile views.
South bank of Wooramel River, below Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4–7 *Aulosteges ingens* Hosking 1931

Lectotype, GSWA 1/5000; decorticated shell in ventral, dorsal, posterior and profile views.
Bed in bank of Wooramel River, 4.8 km above R20, Carnarvon Basin; Coyrie Formation; Late Artinskian (Early Baigendzhinian).

Figs 8, 9 *Aulosteges lyndonensis* Coleman 1957

Holotype, CPC 1001; in ventral and dorsal views.
North bank of Lyndon River, north of Round Hill, 13.5 km east of Mia Mia Homestead, Carnarvon Basin; Coyrie Formation; Late Artinskian (Early Baigendzhinian).

Fig. 10 *Aulosteges reclinis* Coleman 1957

Holotype, UWA 31190; natural cast of shell in posterior view.
6.4 km north of Mount James on boundary fence between Nerrima and Kalyeeda Stations, northern Canning Basin; Hardman Formation; Chhidruan.



BRACHIOPODS

Plate 30

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Figs 1, 2, 4 *Aulosteges reclinis* Coleman 1957

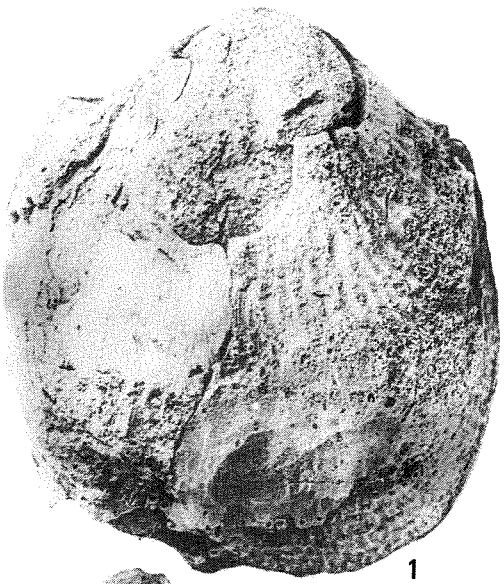
Holotype, UWA 31190; natural cast of shell in ventral, dorsal and profile views.
6.4 km north of Mount James on boundary fence between Nerrima and Kalyeeda Stations, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 3, 5, 6, 9 *Taeniothaerus irwinensis* Coleman 1957

3, 9. **Holotype**, UWA 32044; ventral valve in profile and ventral views.
5, 6. **Paratype**, UWA 10932; dorsal valve in interior and dorsal views.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 7, 8, 10, 11 *Taeniothaerus coolkiliensis* Coleman 1957

Holotype, UWA 27444; shell in dorsal, profile, posterior and ventral views.
Northeast side of syncline north of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).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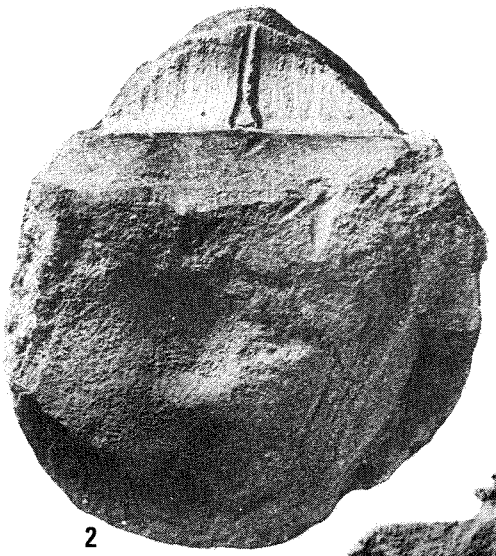
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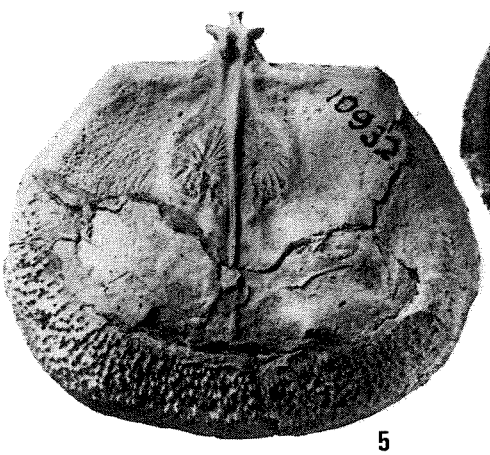

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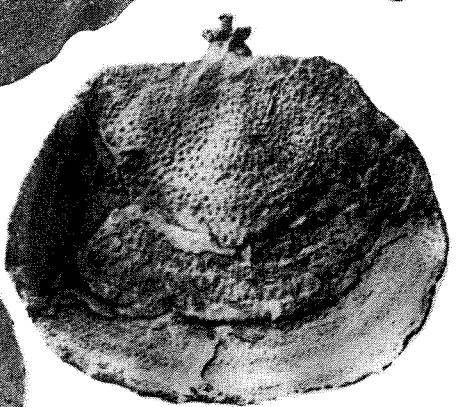
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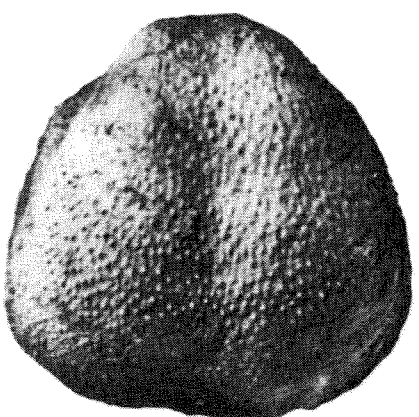
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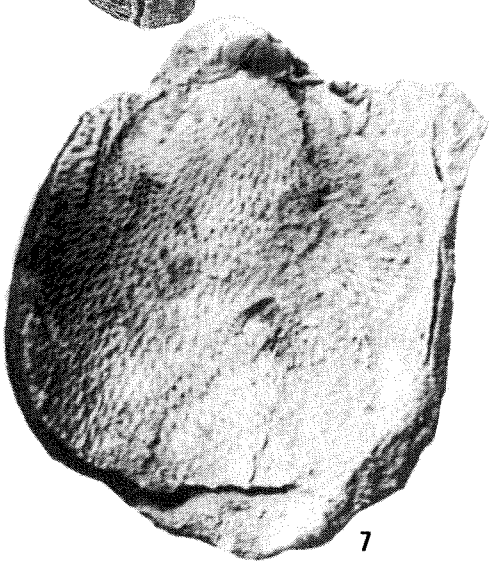
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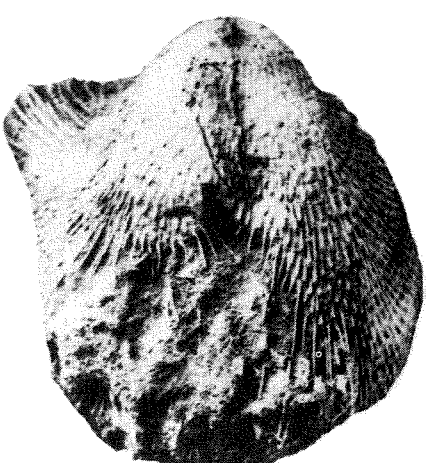
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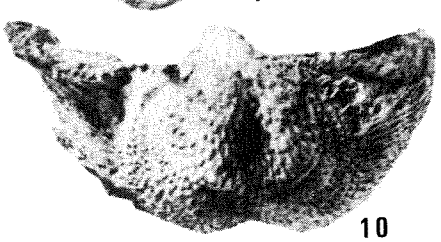
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Plate 31

All figures are natural size.

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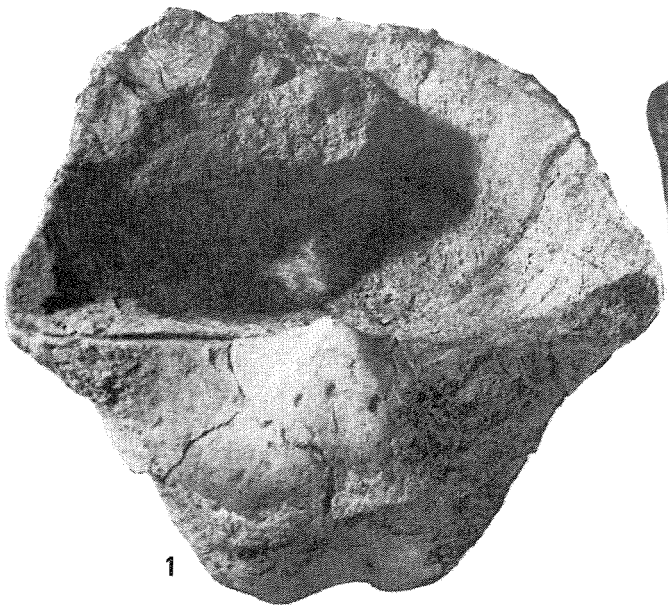
Figs 1–4 *Taeniothaerus teicherti* Coleman 1957

1, 3, 4. **Holotype**, CPC 1008; decorticated shell in posterior, profile and dorsal views.
2. **Paratype**, CPC 1012; dorsal valve interior.
0.8 km east of Calvary Spring, 11.2 km southeast of Mooka Station Homestead, Wandagee area, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 5–7 *Taeniothaerus miniliensis* Coleman 1957

Holotype, UWA 34445; shell in posterior, dorsal and profile views.
West side of syncline, south bank of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).



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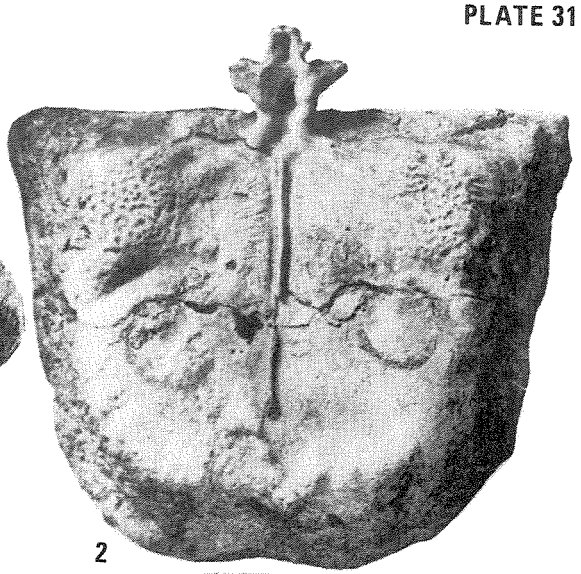

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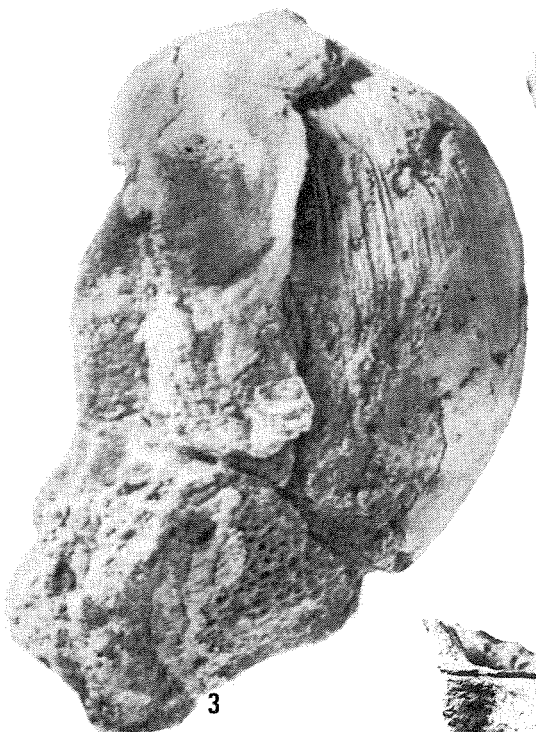

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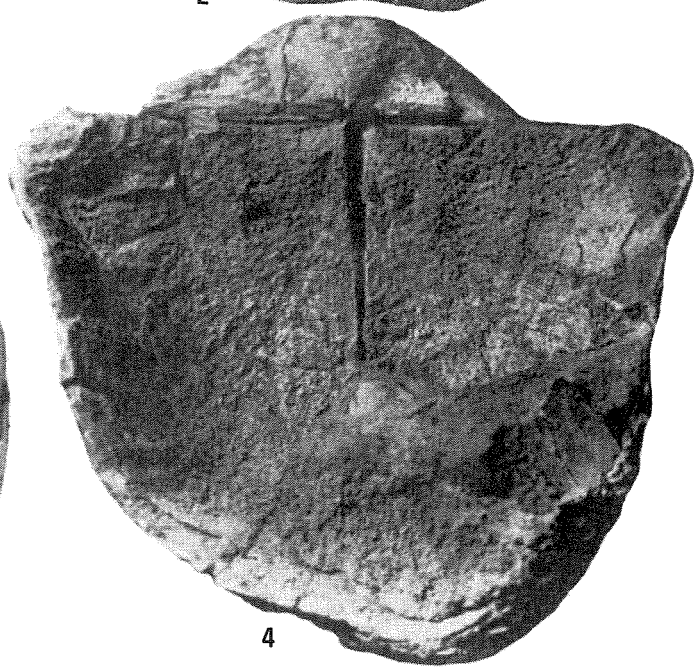

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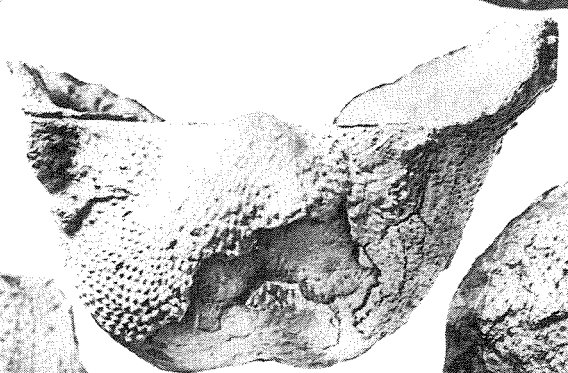

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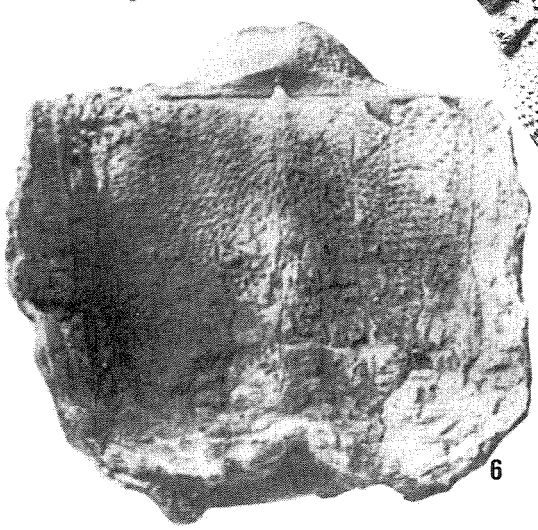

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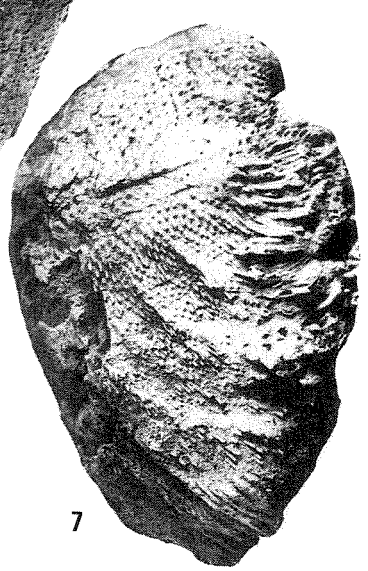

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BRACHIOPODS

Plate 32

All figures are natural size.

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Figs 1, 4 *Taeniothaerus fletcheri* Coleman 1957

Holotype, CPC 1950; ventral valve in ventral and dorsal views.
South side of Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 2, 3, 5, 8 *Megasteges fairbridgei* (Coleman 1957)

Holotype, UWA 29438f; natural cast of ventral valve in ventral, profile, posterior and dorsal views.
Tutu Windmill, Nerrima Creek, Luluigui–Myroodah area, northern Canning Basin; Hardman Formation; Chhidruan.

Fig. 6 *Taeniothaerus* sp. nov.

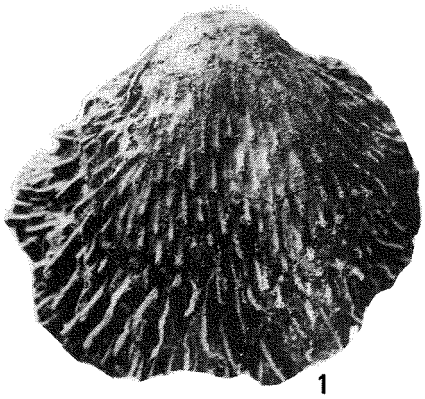
Internal mould of shell in dorsal view; UWA 32043.
Glendevon Homestead area, Woolaga Creek, east of Mingenew, Perth Basin; High Cliff Sandstone; Early Artinskian (Aktastinian).

Figs 7, 10, 11 *Megasteges septentrionalis* (Etheridge Jnr 1907)

7. Natural cast of ventral valve; SAM P2137.
10, 11. **Lectotype**, SAM P2135; internal mould of shell in dorsal and ventral views.
Cape Dombey, Port Keats area, NT, Bonaparte Basin; Upper Marine Beds of the Hyland Bay Formation; Chhidruan.

Figs 9, 12 ***Leptodus*** sp. aff. *L. nobilis* (Waagen 1883)

9. Interior of ventral valve, middle to anterior part; CPC 1529.
12. Interior of ventral valve, posterior part; CPC 1526.
Tchindi Beach about 14.5 km southwest of Ports Keats Mission, Bonaparte Gulf Basin, NT; Upper Marine Beds of the Hyland Bay Formation; Chhidruan.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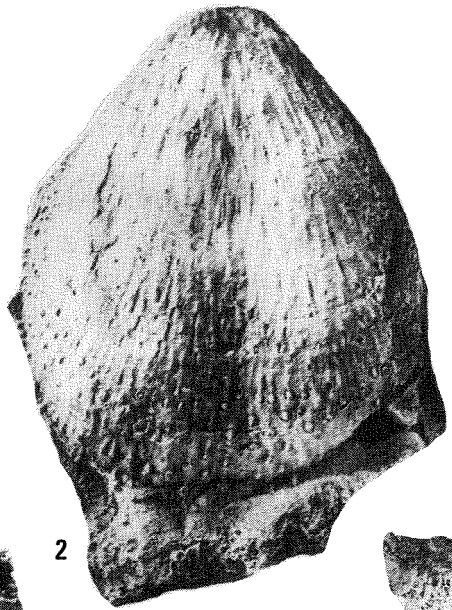
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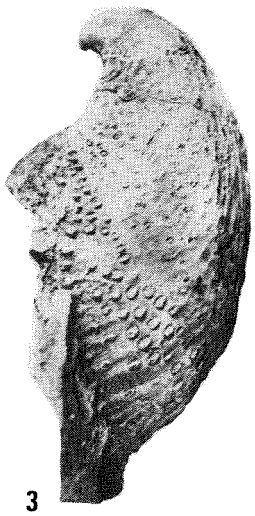
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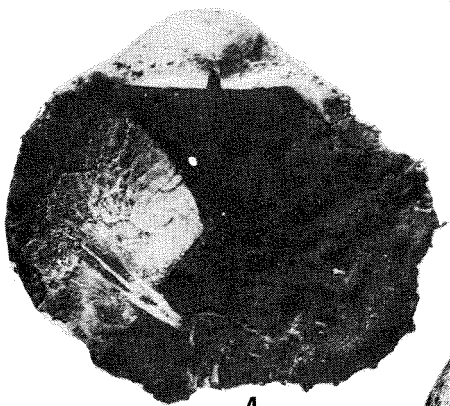
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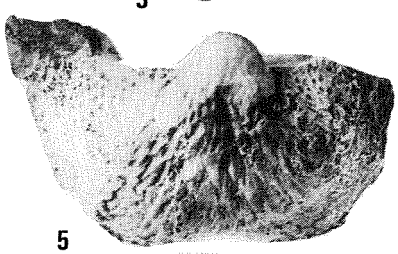
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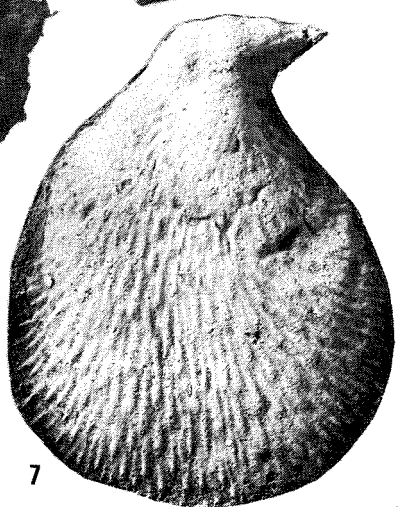
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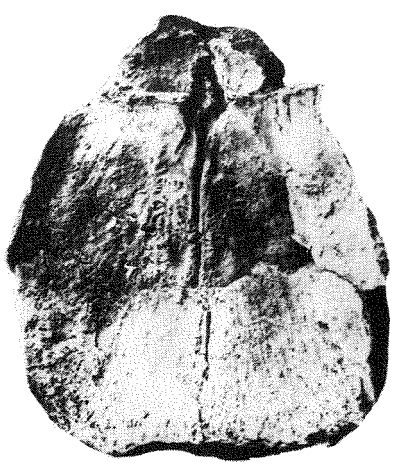
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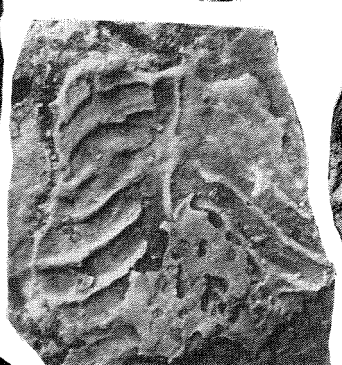
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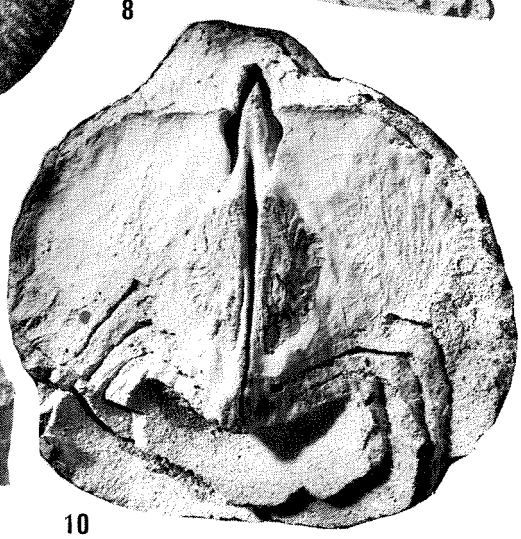
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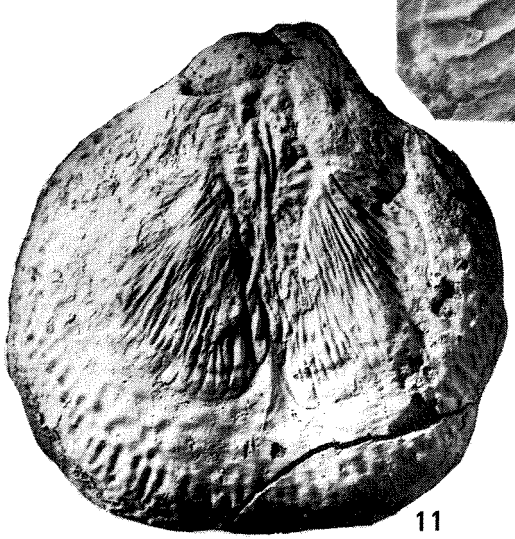
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BRACHIOPODS

Plate 33

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Figs 1–3 *Stictozoster senticosa* (Hosking 1933)

1, 2. **Lectotype**, GSWA 1/4970a1, in ventral and dorsal views; x2 (after Archbold, 1984b, Figs 1A,B).
3. Crushed shell with most of ventral valve removed; GSWA 1/4970a2; x1.5 (after Archbold, 1984b, Fig. 1D).
Creek 0.75 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4–6 *Comuquia australis* Archbold 1984

Holotype, GSWA F11050; in ventral, dorsal and posterior views; x3.5 (after Archbold, 1984b, Figs 1I-K).
Callytharra Spring area, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 7, 8 *?Lethamia obscurus* Archbold 1984

Holotype, CPC 1952; shell in dorsal and ventral views; x2.2 (after Archbold, 1984b, Figs 1L,M).
Pells Range, 24 km northeast of Towrana Homestead, Carnarvon Basin; 36 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 9, 12, 13 *Dyschrestia colemani* Archbold 1984

Holotype, AM F38446; in profile, dorsal and ventral views; x2.2 (after Archbold, 1984b, Figs 3E,A,B).
Minilya River, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

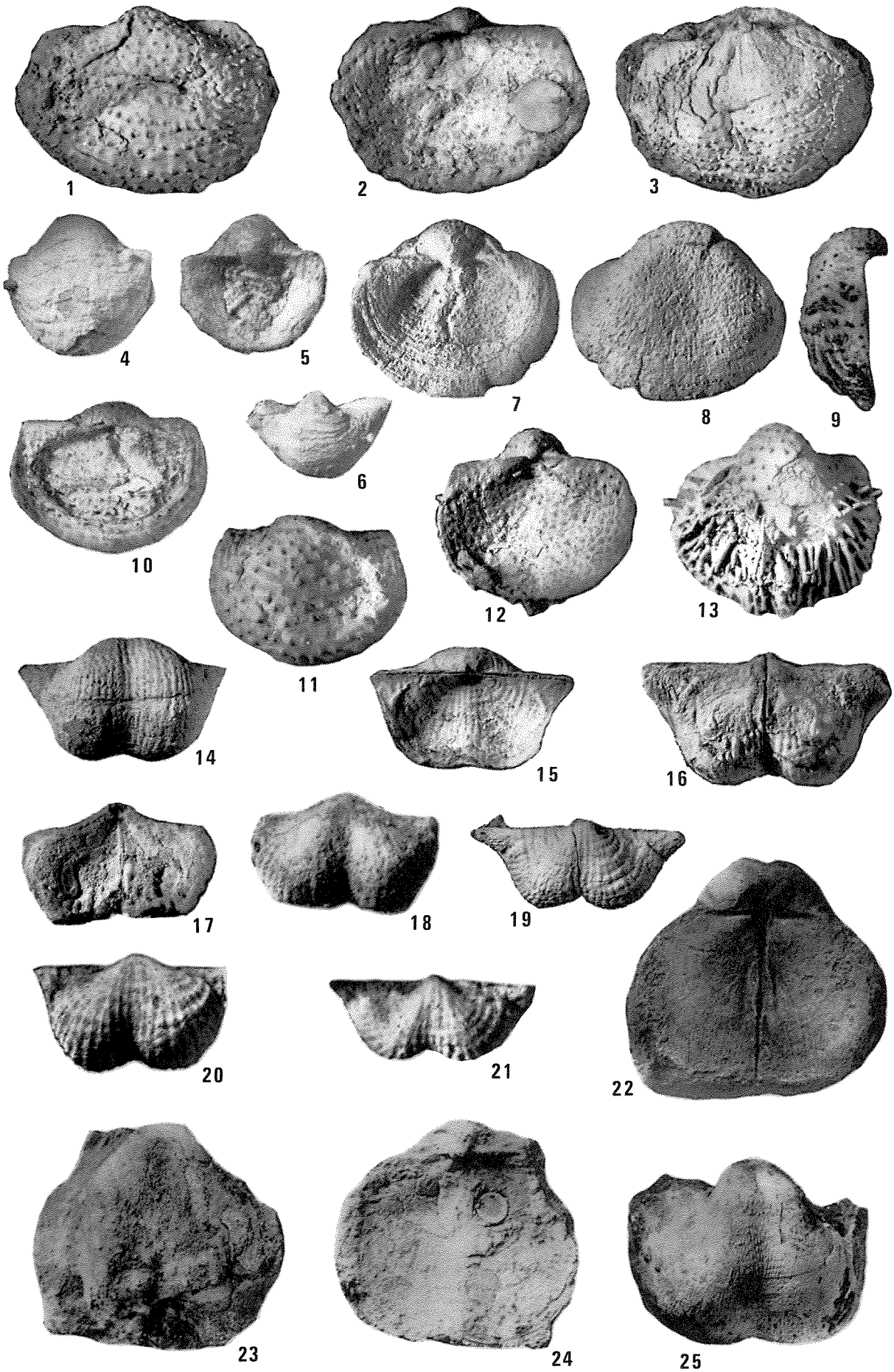
Figs 10, 11 *Dyschrestia micracantha* (Hosking 1933)

Lectotype, GSWA 1/4970b1; in dorsal and ventral views; x2.2 (after Archbold, 1984b, Figs 2C,J).
Creek 1.25 km west of Callytharra Spring, Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 14–16, 19 *Retimarginifera perforata* Waterhouse 1970

14, 15, 19. Shell in ventral, dorsal and posterior views; AM F37569; x1.5 (after Archbold, 1984a, Figs 2T,U,X).
Bank of Minilya River, 0.4 km east of shale outcrop, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

16. Dorsal valve interior view; UWA 28453a; x1.5 (after Archbold, 1984a, Fig. 2Y).



BRACHIOPODS

320 m west of fence between Barrabiddy and Weer Paddocks, 2 km south of gate near Barrabiddy Creek, Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

Figs 17, 18, 20, 21 *Retimarginifera waterhousei* Archbold 1984

17, 18. **Holotype**, UWA 88129; internal mould of shell in dorsal and ventral views; x1.8 (after Archbold, 1984a, Figs 3A,B).
20, 21. Natural cast of ventral valve in ventral and posterior views; UWA 8812; x1.8 (after Archbold, 1984a, Figs 3T,U).
East of Wandagee Hill, Nalbia Paddock, Wandagee Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 22–25 *Waagenoconcha imperfecta* Prendergast 1935

22. Internal mould of shell in dorsal view; UWA 2045a; x1.
North flank of Mount Cedric, northern Canning Basin; Hardman Formation; Chhidruan

23, 24. **Holotype**, UWA 3044; in ventral and dorsal views; x1.
Luluigui Station, northern Canning Basin; Hardman Formation; Chhidruan.

25. Ventral valve in posterior view; UWA 32029; x1.
Base of Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

Plate 34

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Figs 1–5 *Callytharrella callytharrensis* (Prendergast 1943)

1–4. Ventral valve in ventral, profile, antero-ventral and anterior views; AM F36514 (after Archbold, 1985, Figs 2A,D,B,C).
Wyndham Gap, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

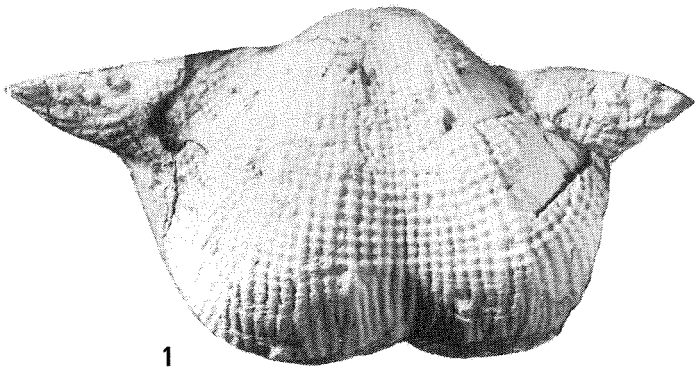
5. Ventral valve in posterior view; GSWA F6380 (after Archbold, 1985, Fig. 1S).
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood shale; Late Sakmarian (Sterlitamakian).

Figs 6–9 *Costiferina wadei* (Prendergast 1943)

Holotype, UWA 20453; ventral valve in ventral, posterior, profile and anterior views (after Archbold, 1985, Figs 4G,I,F,H).
3.2 km east at 10° south of Mount Nicholson, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 10–12 *Costiferina thomasi* Archbold 1985

10. **Holotype**, CPC 24332; external mould of dorsal valve (after Archbold, 1985, Fig. 5B).
11, 12. Incomplete external mould of dorsal valve in lateral and direct views; CPC 24333 (after Archbold, 1985, Figs 5I,J).
On coast, approximately 13.5 km north of Cape Dombey, Port Keats area, NT; Upper Marine Beds of the Hyland Bay Formation; Chhidruan.



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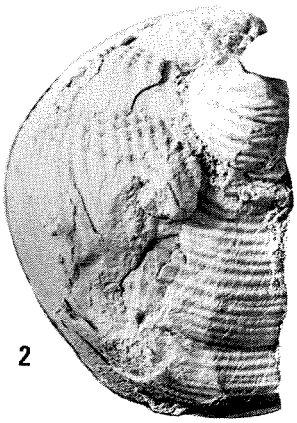

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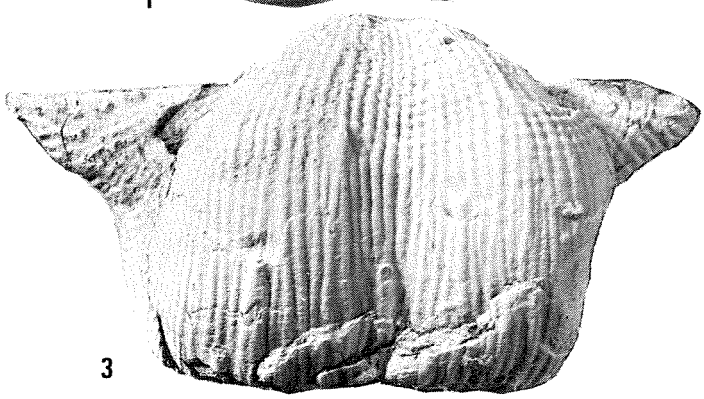

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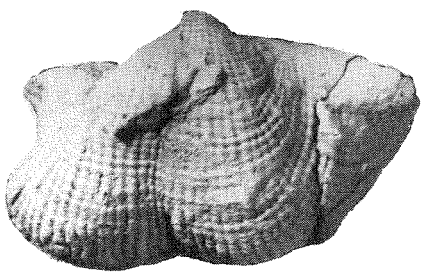

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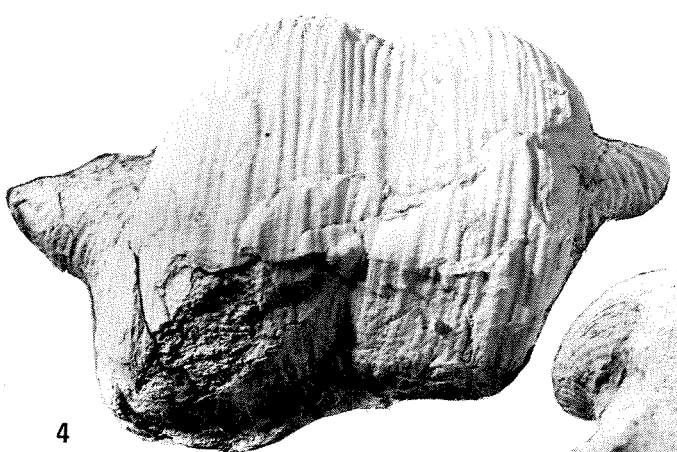

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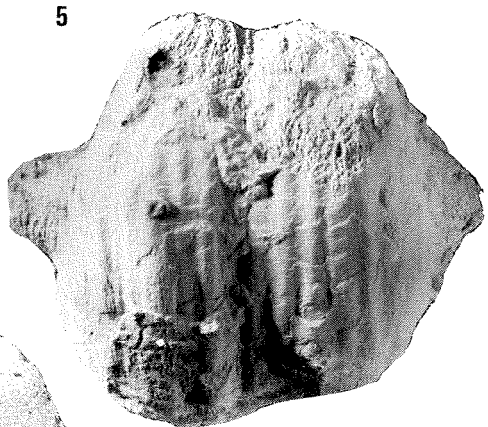

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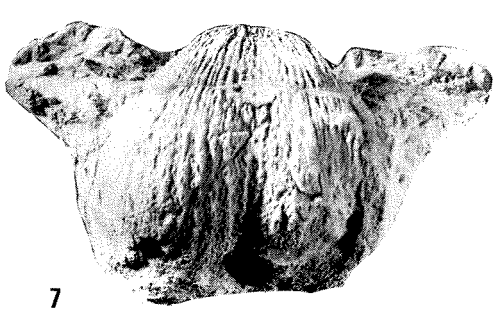

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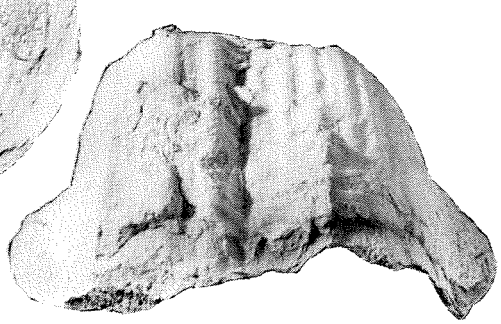

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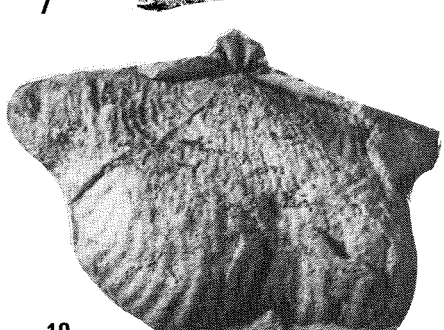

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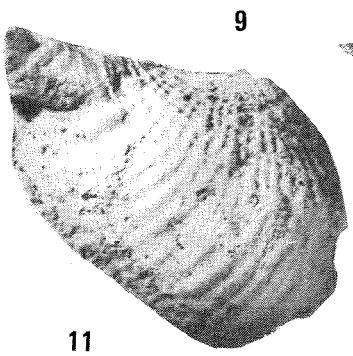

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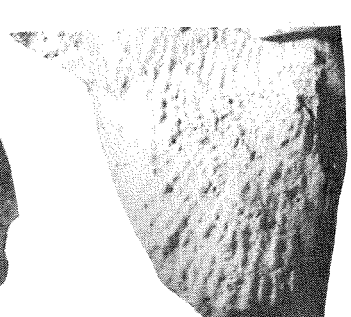

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BRACHIOPODS

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Plate 35

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Fig. 1 *Linoproductus* sp.

Internal mould of ventral valve in ventral view; GSWA F11192 (after Archbold, 1983b, Fig. 1B).
Near Snake Well, Eudamullah Station, Carnarvon Basin; Lyons Group; Asselian, Sakmarian (Tastubian).

Figs 2–4 *Cancrinella irwinensis* Archbold 1983

2, 3. **Holotype**, CPC 19915A; ventral valve internal mould in ventral and profile views; x1.3 (after Archbold, 1983b, Figs 1C,E).
Carynginia Gully, 2.8 km at 297° from Carynginia Well, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

4. Ventral valve in ventral view; MUGD F6027; x1.5 (after Archbold, 1983b, Fig. 1I).
Callytharra Spring area, Carnarvon Basin; 33 m above base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 5–7 *Cancrinella bella* (Etheridge Jnr 1918)

5. **Lectotype**, AM F16742; ventral valve in ventral view; x1.3 (after Archbold, 1983b, Fig. 1W).
6. Ventral valve in ventral view; AM F16731; x1.3 (after Archbold, 1983b, Fig. 1R).
7. Dorsal valve interior; AM F16735; x1.2 (after Archbold, 1983b, Fig. 2A).
Mount Marmion, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

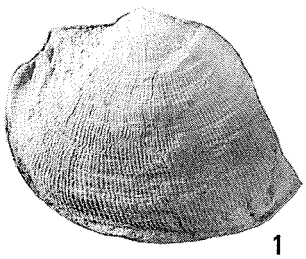
Figs 8–10 *Cancrinella coolkilyaensis* Archbold 1983

Holotype, CPC 19920A; ventral valve internal mould in ventral, posterior and profile views; x1.4 (after Archbold, 1983b, Figs 2C,D,E).
2.4 km southeast of Trig. Point on Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 11–15 *Lyonia lyoni* (Prendergast 1943)

11. **Holotype**, AM F36530; ventral valve in ventral view; x1 (after Archbold, 1983b, Fig. 3N).
201 m northwest of Gnarrea Pool near Winning Station, Carnarvon Basin; Lyons Group; Asselian, Sakmarian (Tastubian).

12, 15. Internal mould of dorsal valve (x1), and enlargement of cardinal area (x6) (after Archbold, 1983b, Figs 3D,G); CPC 19223D.
13, 14. Dorsal valve external mould, enlargement of anterior (x10), and view of mould (x1) (after Archbold, 1983b, Figs 3L,J); CPC 19923E.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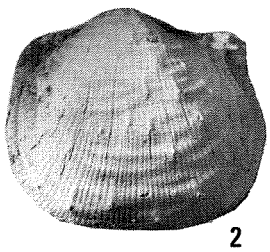
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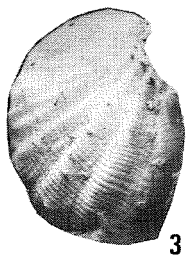
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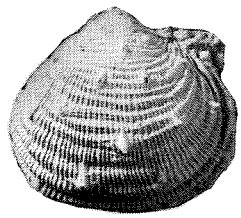
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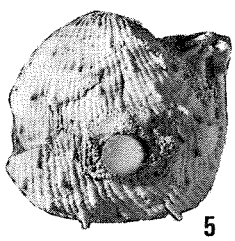
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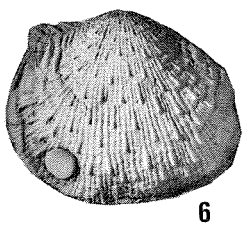
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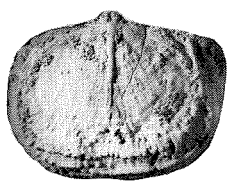
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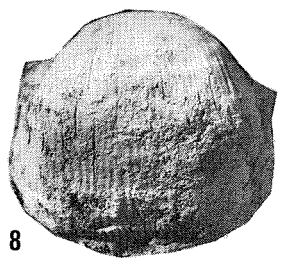
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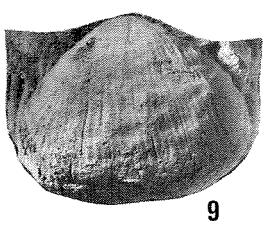
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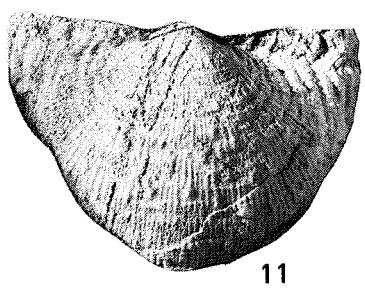
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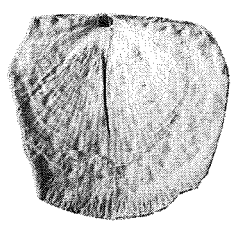
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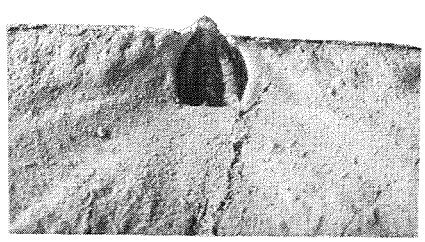
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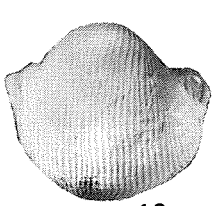
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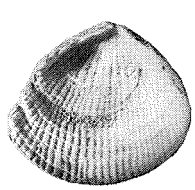
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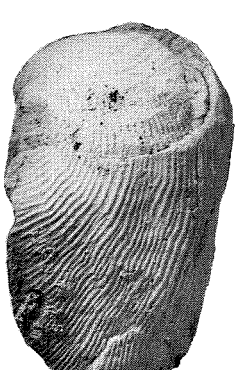
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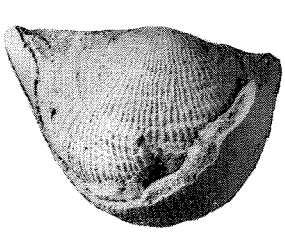
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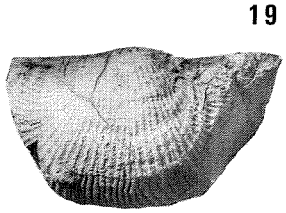
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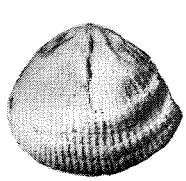
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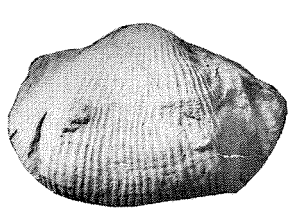
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BRACHIOPODS

4.8 km northeast of Round Hill Well, 210 m west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin; Lyons Group; Sakmarian (Tastubian), possibly ranging down into Asselian.

Figs 16–22, 24 *Globiella foordi* (Etheridge Jnr 1903)

16, 17. Ventral valve in ventral and posterior views; GSWA F11193B (after Archbold, 1983b, Figs 5A,B).
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

18, 19. Ventral valve in ventral and profile views; CPC 19926C (after Archbold, 1983b, Figs 5I,J).
Lat. 25°52'S, Long. 115°30'E, 10 m to 15 m above base of Callytharra Formation, Carnarvon Basin; Late Sakmarian (Sterlitamakian).

20, 24. Dorsal valve in dorsal and interior views; GSWA F11196E; x1.2 (after Archbold, 1983b, Figs 5R,T).
Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

21, 22. Natural cast of gerontic ventral valve in profile and posterior views; CPC 19928A; x1 (after Archbold, 1983b, Figs 5GG,FF).
9.2 km at 335° from Lyons River Homestead, Carnarvon Basin Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 23, 25, 26 *Globiella flexuosa* (Waterhouse 1970)

Ventral valve in postero-ventral, posterior and ventral views; MUGD F6030C (after Archbold, 1983b, Figs 4W,X,V).
15 km west of Jimba Jimba Homestead, Jimba Jimba Station, Carnarvon Basin; Jimba Jimba Calcarenite Member of the Billidee Formation; Early Artinskian (Aktastinian).

Plate 36

All figures are natural size, unless otherwise indicated.

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Figs 1, 2, 4–7 *Camerisma? callytharrensis* (Hosking 1933)

1, 2, 4–6. **Holotype**, GSWA F1/4979a, in ventral, anterior, posterior, dorsal and profile views; x1.8 and rest, x1.5.
7. Ventral valve interior view; GSWA F1/4979b; x1.5.
0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 8–10 *Myodelthyrium dickinsi* (Thomas 1971)

3, 8, 9. **Holotype**, CPC 1636; abraded shell in dorsal, ventral and postero-dorsal views.
Near Round Hill Well at Lat. 23°21'S, Long. 114°40'E, 190 to 193 m above base of Callytharra Formation, Carnarvon Basin; Late Sakmarian (Sterlitamakian).

10. Shell in postero-dorsal view; CPC 1634.
133 m at 270° from Callytharra Spring, 4 m above base of formation, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 11–13 *Punctocyrtella australis* (Thomas 1971)

11. Incomplete dorsal valve in dorsal view; CPC 1650.
108 m west of a point on rabbit proof fence, 5.4 km south of Coyango Well, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

12. Incomplete dorsal valve in dorsal view; CPC 1651.
5.9 km at 137° from Thambrong Pool, Williambury Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

13. Internal mould of dorsal valve; CPC 1648.
2.9 km northwest of Coyango Well, Williambury Station, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

Figs 14–19 *Pseudosyrinx? sinuosa* Thomas 1971

14, 17. **Paratype**, CPC 1656; latex cast of ventral valve in posterior and anterior views.
15, 18, 19. **Holotype**, CPC 1654; internal mould of shell in ventral, posterior and dorsal views.
16. Latex cast of dorsal valve in dorsal view.
5.4 km at 212° from Keogh Hill, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).


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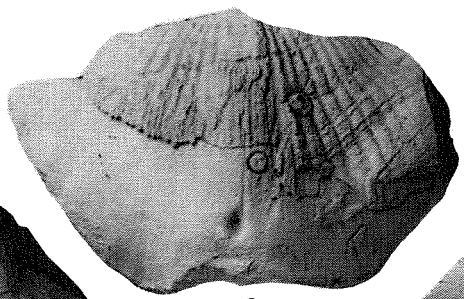
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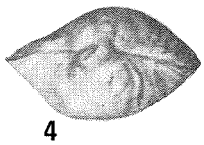
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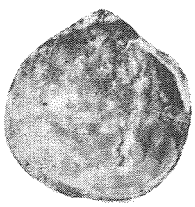
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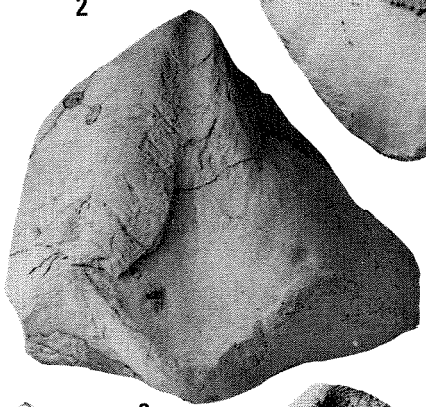
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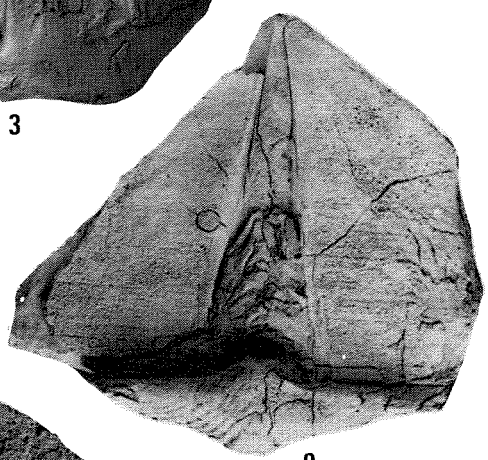
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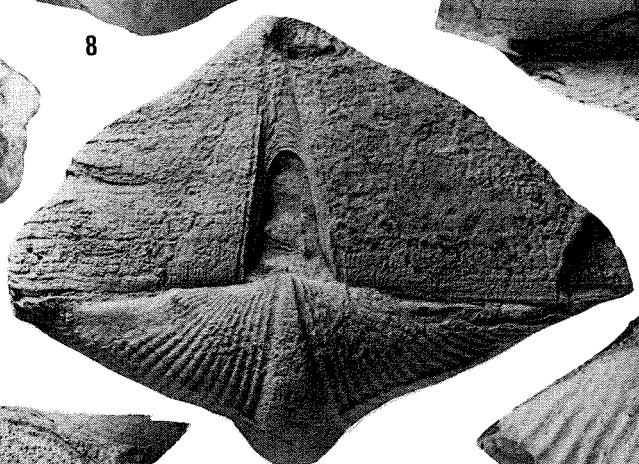
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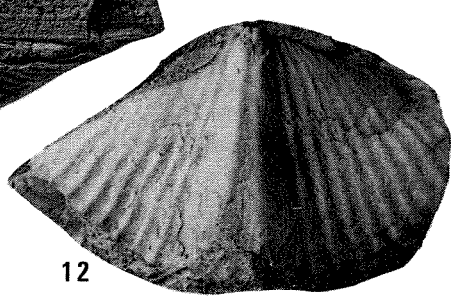
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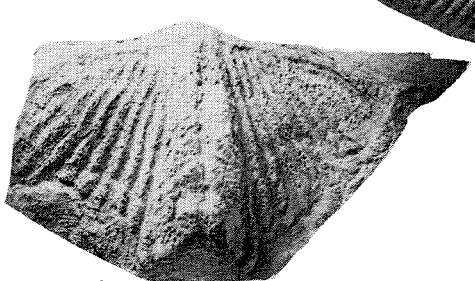
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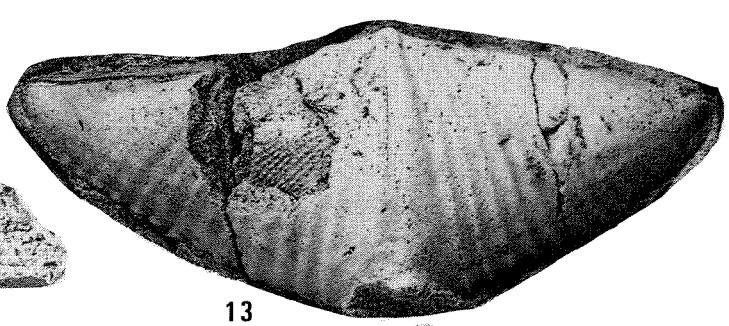
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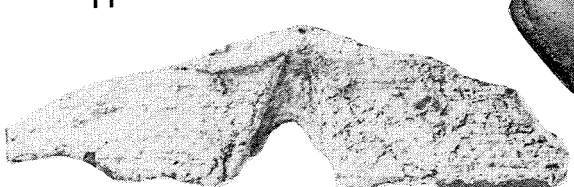
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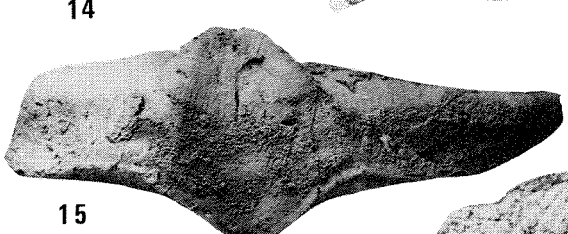
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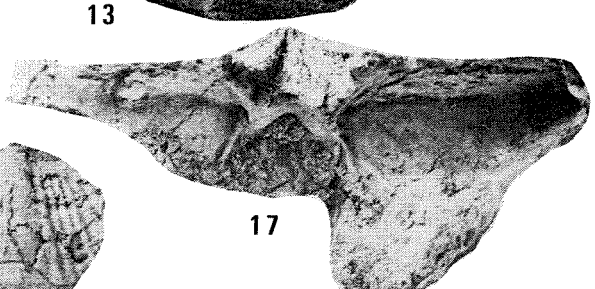
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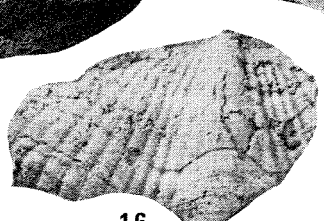
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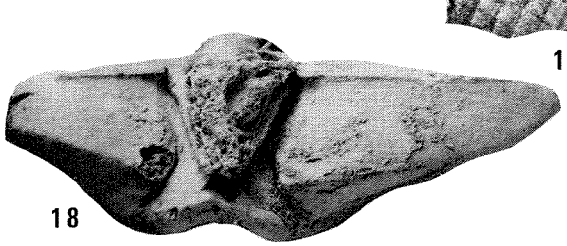
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BRACHIOPODS

Plate 37

All figures are natural size.

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Figs 1, 2, 5 *Latispirifer callytharrensis* Archbold & Thomas 1985

1, 2. **Holotype**, CPC 24292; in dorsal and ventral views (after Archbold & Thomas, 1985b, Figs 1A,C).
South side of Minilya River, near Thambrong Pool on Williambury Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

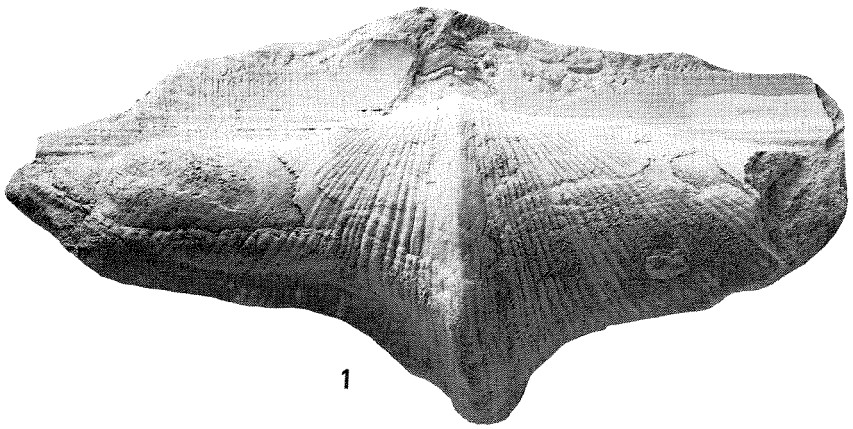
5. **Paratype**, CPC 24294; latex cast of ventral valve (after Archbold & Thomas, 1985b, Fig. 3A).
9.4 km at 335° from Lyons River Homestead, Carnarvon Basin; from Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 4, 6 *Neospirifer hardmani* (Foord 1890)

Shell in profile, ventral and dorsal views; CPC 24338 (after Archbold & Thomas, 1986a, Figs 1A,B,D).
8 km at 116° from Donnellys Well, Williambury Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 7, 8 *Latispirifer amplissimus* Archbold & Thomas 1985

Holotype, CPC 24296; in dorsal and posterior views (after Archbold & Thomas, 1985b, Figs 4A,B).
280 m west of Mount Hardman windmill on south side of hill, northern Canning Basin; Hardman Formation; Chhidruan.



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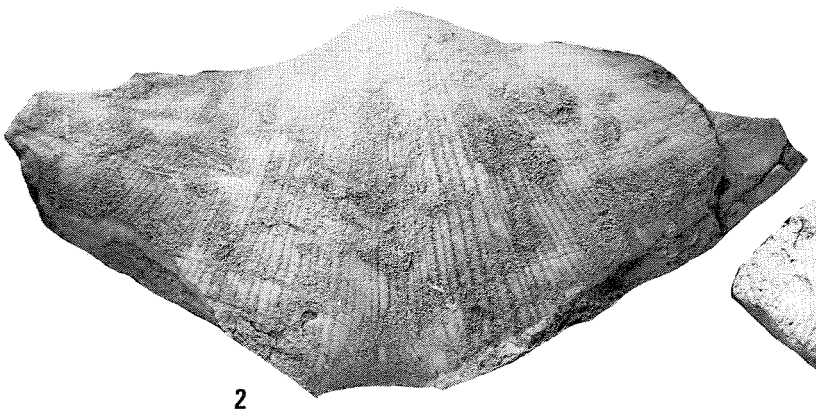

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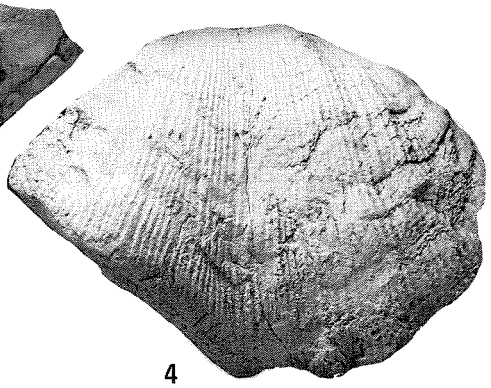

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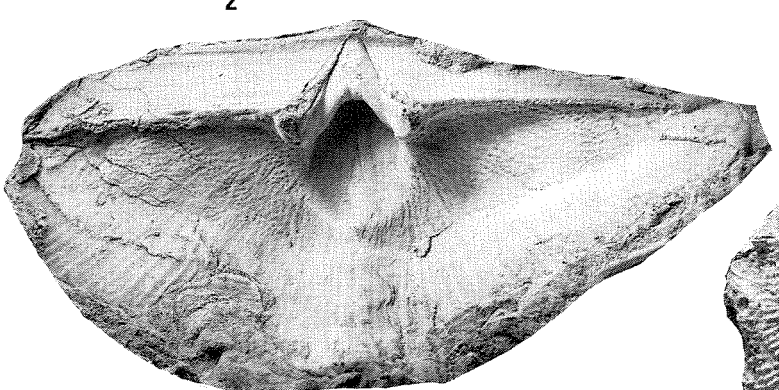

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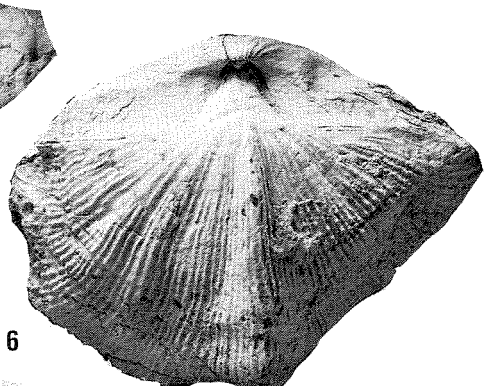

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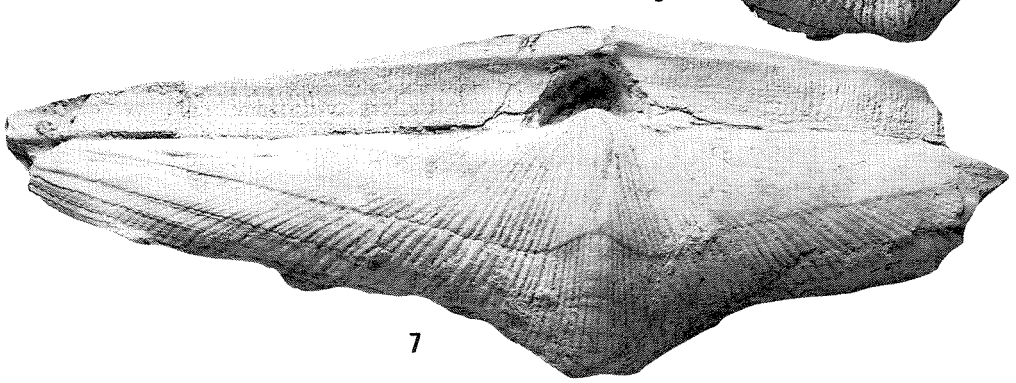

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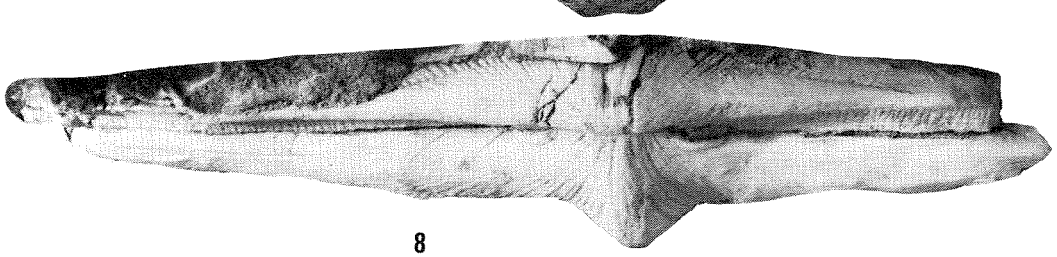

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BRACHIOPODS

Plate 38

All figures are natural size.

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Figs 1–3 *Neospirifer foordi* Archbold & Thomas 1986

Holotype, MUGD F6565; in dorsal, ventral and anterior views.
4.9 km at 198° from South Branch Well, Williambury Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4–7 *Neospirifer plicatus* Archbold & Thomas 1986

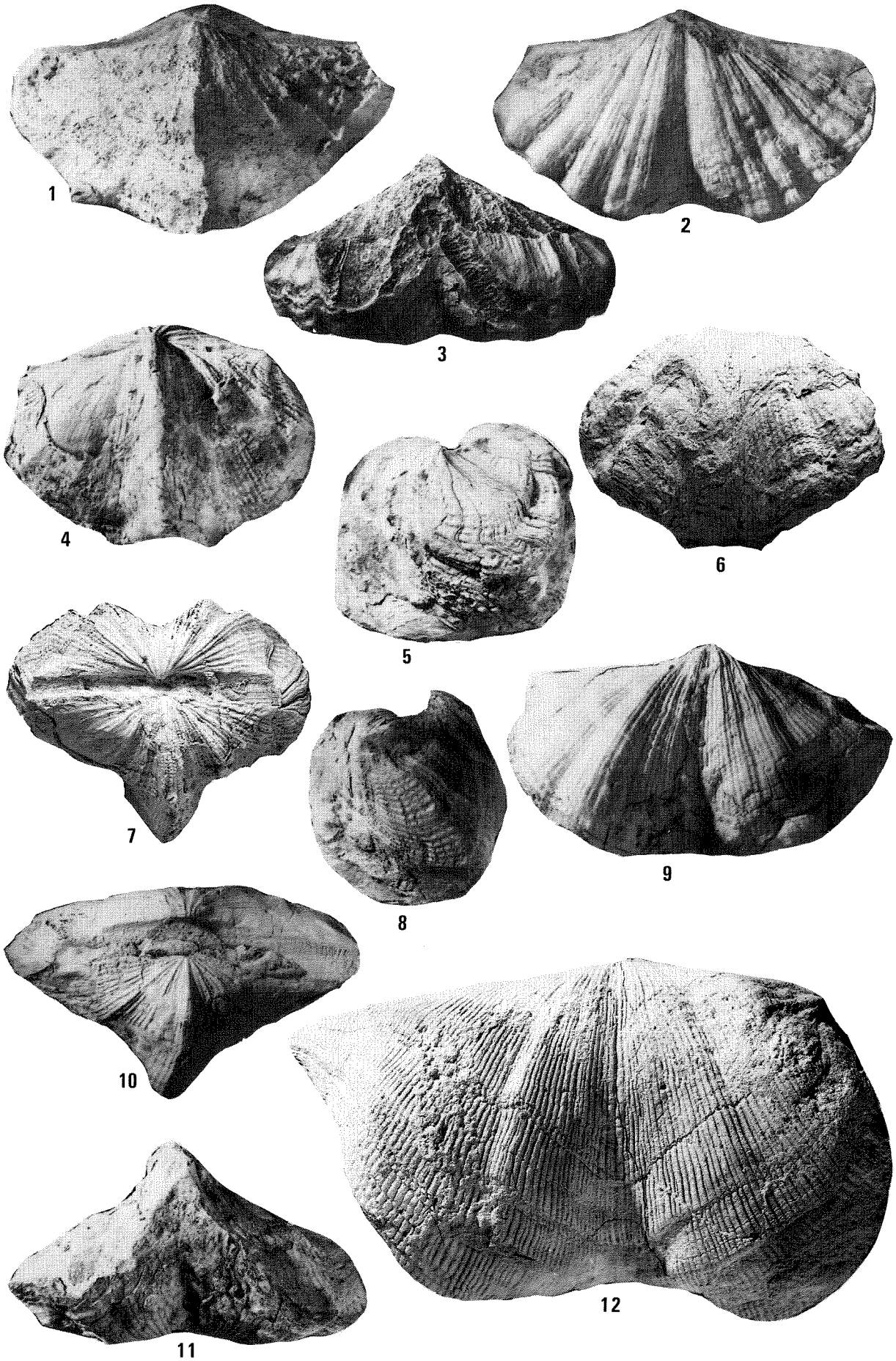
Holotype, CPC 24340; in dorsal, profile, ventral and posterior views.
13.1 km at 82° from Mia Mia Homestead, north bank of Lyndon River, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

Figs 8–11 *Neospirifer postplicatus* Archbold & Thomas 1986

Holotype, CPC 24351; in profile, ventral postero-dorsal and anterior views.
3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Fig. 12 *Neospirifer amplus* Archbold & Thomas 1986

Shell in ventral view; UWA 88145.
400 m northeast of point 800 m north of cattle pit on the Woolshed–Middalya Road on the east fence of Mungadan Paddock, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).



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Figs 1, 2 *Neospirifer amplus* Archbold & Thomas 1986

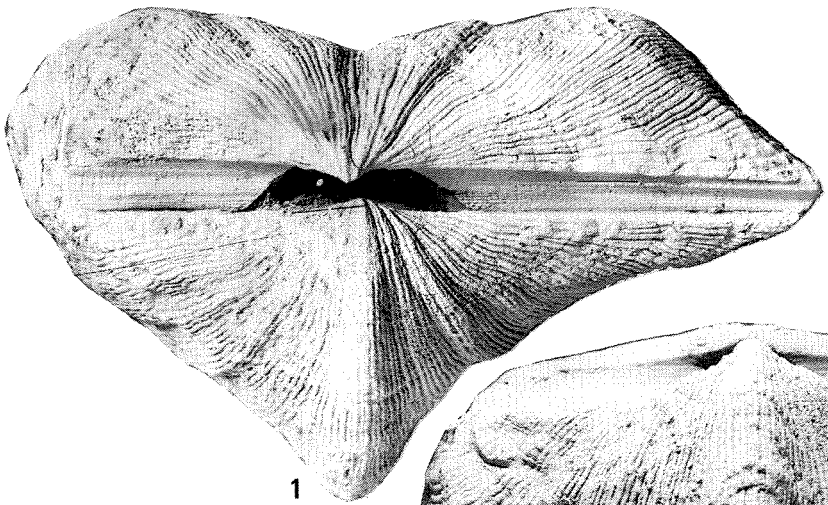
Shell in posterior and dorsal views; UWA 88145.
400 m northeast of point 800 m north of cattle pit on the Woolshed–Middalya Road on the east fence of Mungadan Paddock, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 3–6 *Costatispirifer gracilis* Archbold & Thomas 1985

3. **Paratype**, CPC 24313; dorsal valve in dorsal view (after Archbold & Thomas, 1985b, Fig. 7K).
4. **Holotype**, CPC 24309; dorsal valve in dorsal view (after Archbold & Thomas, 1985b, Fig. 7A).
5. **Paratype**, CPC 24318; ventral valve in ventral view (after Archbold & Thomas, 1985b, Fig. 7N).
6. **Paratype**, CPC 24317; ventral valve internal mould in ventral view (after Archbold & Thomas, 1985b, Fig. 7J).
All specimens from 4.2 km at 70° from the Shore Range Trig. Point, northern Canning Basin; Lightjack Formation; Middle Kungurian.

Figs 7, 8 *Neospirifer grandis* Archbold & Thomas 1986

Holotype, CPC 24354; ventral valve in ventral and dorsal views.
3.3 km at 95° from Luluigui Homestead, northern Canning Basin; Hardman Formation; Chhidruan.



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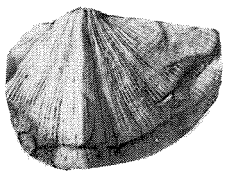

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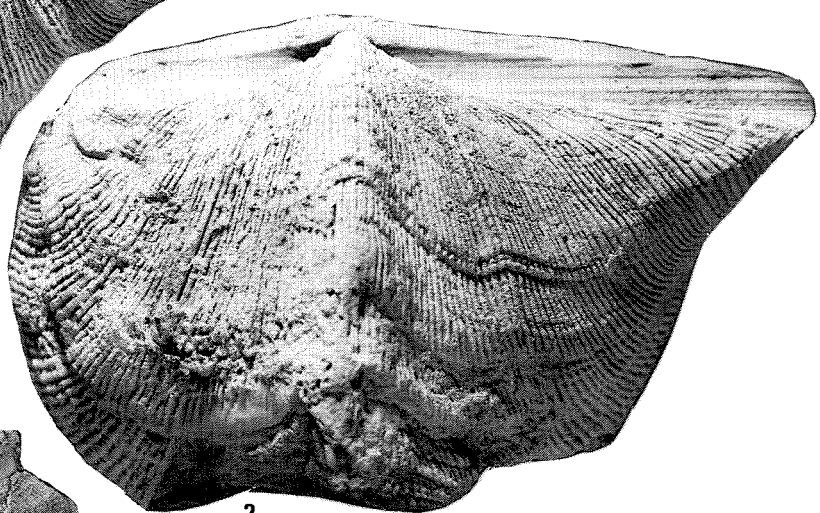

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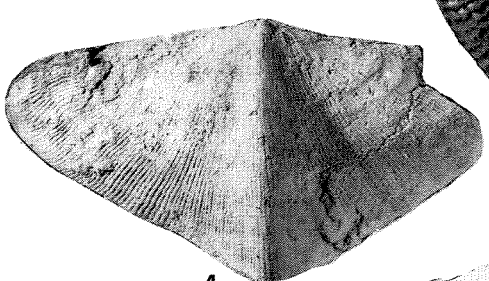

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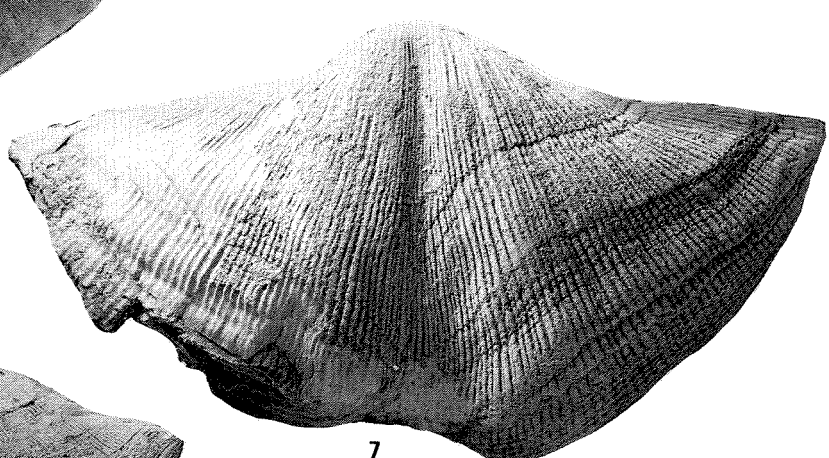

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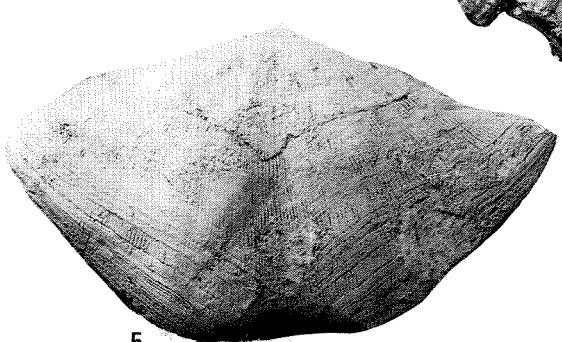

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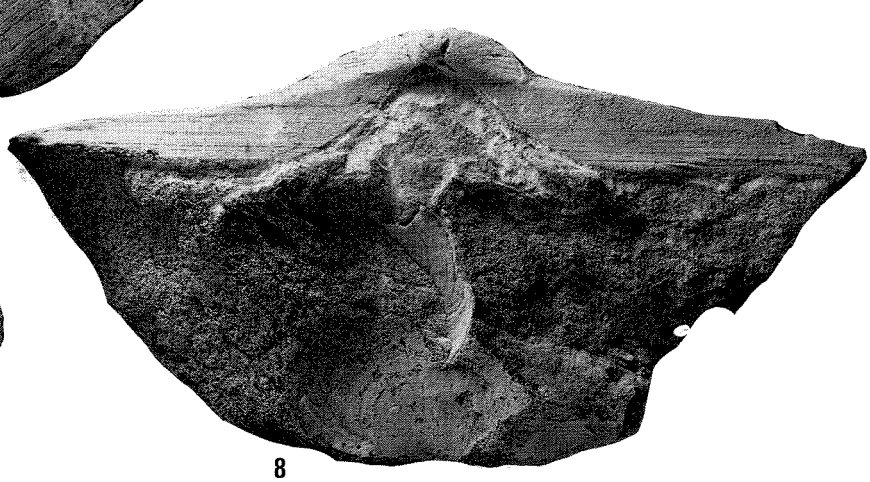

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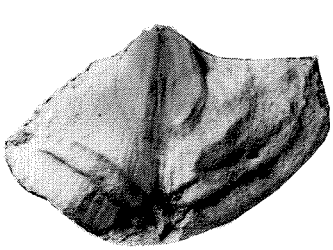

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Plate 40

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Figs 1–3 *Fusispirifer byroensis* (Glauert 1912)

Shell in dorsal, anterior and ventral views; CPC 24425.
6.6 km at 323° from Bogadi Outcamp, Carnarvon Basin; Bogadi Sandstone; Late Artinskian (early Baigendzhinian).

Figs 4, 5 *Cratispirifer nuraensis* Archbold & Thomas 1985

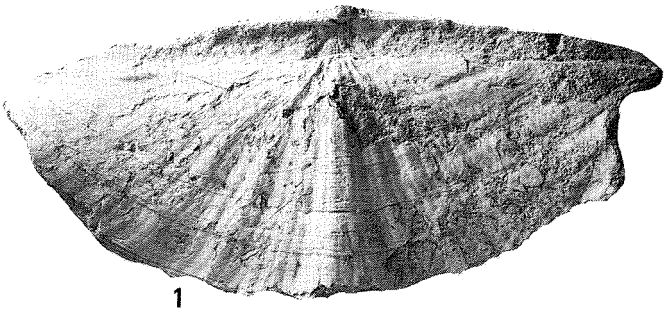
Holotype, CPC 24319; in dorsal and ventral views (after Archbold & Thomas, 1985b, Figs 8A,B).
West of Mount Wynne Trig. Point and southwest of Paradise Homestead at Nura Nura Ridge, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 6–9 *Crassispirifer rostalinus* (Hosking 1931)

6–8. Shell in ventral, dorsal and posterior views; CPC 24426.
9. Shell in dorsal view; CPC 24327.
4.2 km at 46° from Keogh Hill, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

Fig. 10 *Crassispirifer pinguis* Archbold & Thomas 1985

Shell in postero-dorsal view; UWA 88146.
400 m northeast of a point 800 m north of cattle pit on the Woolshed–Middalya road on the east fence of Mungadan Paddock, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).



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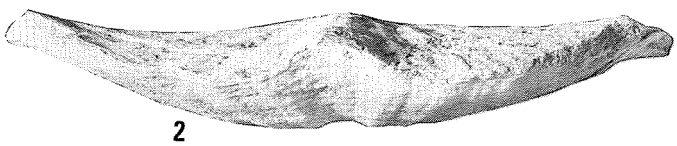

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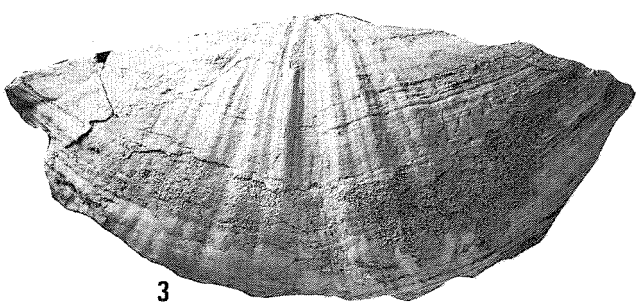

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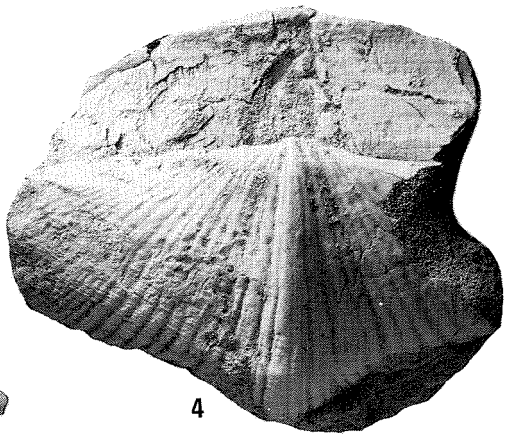

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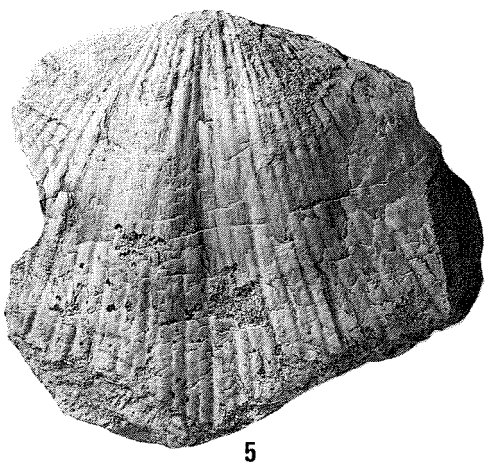

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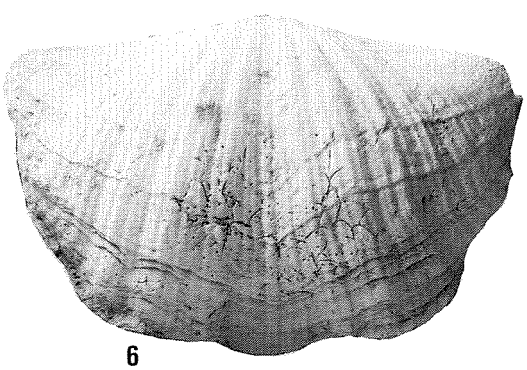

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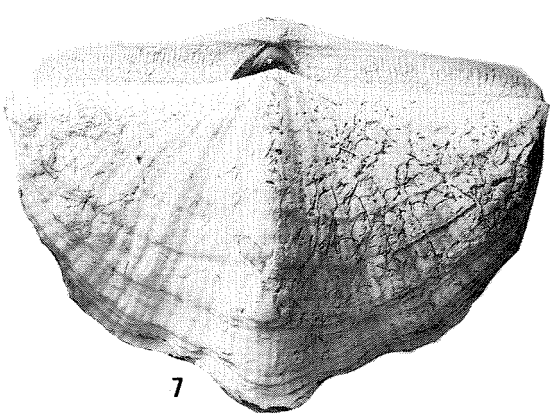

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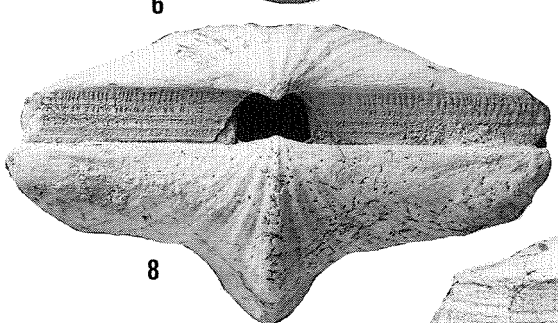

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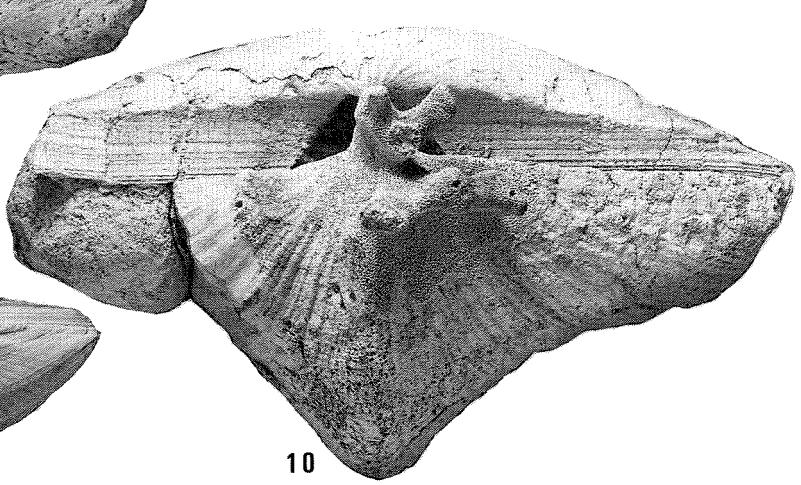

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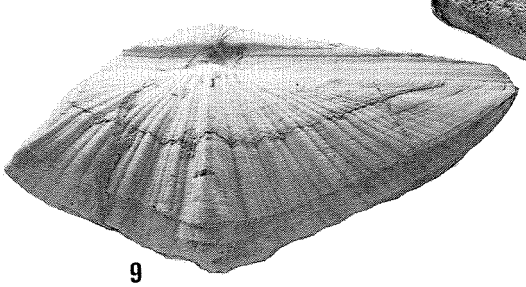

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BRACHIOPODS

Plate 41

All figures are natural size, unless otherwise indicated

Figures 3–5, 7–14 from Alcheringa (Archbold & Thomas, 1985b, 1986a) are reproduced with the permission of the Association of Australasian Palaeontologists.

Figs 1, 2, 6 *Crassispirifer pinguis* Archbold & Thomas 1985

Shell in dorsal, anterior and ventral views; UWA 88146.
400 m northeast of point 800 m north of cattle pit on the Woolshed–Middalya road on the east fence of Mungadan Paddock, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 3–5 *Crassispirifer? kimberleyensis* (Foord 1890)

Holotype, GSWA F10077, in dorsal, posterior and ventral views (after Archbold & Thomas, 1985b, Figs 14G,H,C).
Gascoyne River, Carnarvon Basin; formation not known; Early Permian.

Figs 7, 8 *Trigonotreta dickinsi* Archbold & Thomas 1986

7. **Paratype**, CPC 24371; ventral valve in ventral view; x1.5.
8. **Holotype**, CPC 24370; dorsal valve in dorsal view; x1.5.
3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 9, 10 *Trigonotreta lyonsensis* Archbold & Thomas 1986

9. **Holotype**, CPC 24363; latex cast of dorsal valve in dorsal view.
10. **Paratype**, CPC 24366; internal mould of dorsal valve.
2.8 km northwest of Coyango Well, Williambury Station, Carnarvon Basin; Lyons Group; Sakmarian (Tastubian) ranging down to Asselian.

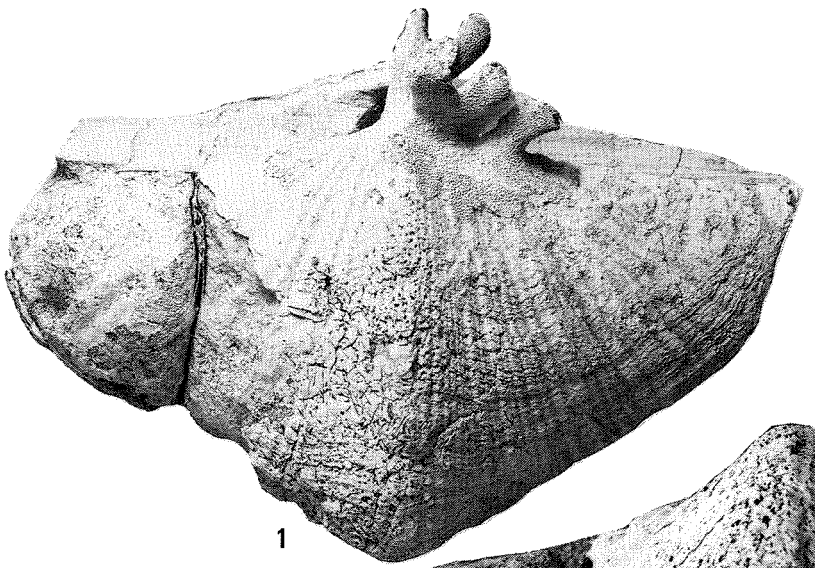
Figs 11, 14 *Trigonotreta lightjacki* Archbold & Thomas 1986

11. **Holotype**, CPC 24388; ventral valve in ventral view; x1.5.
14. **Paratype**, CPC 24398; dorsal valve in dorsal view; x1.5.
4.2 km at a bearing of 70° from the Shore Range Trig. Point, northern Canning Basin; Lightjack Formation; Middle Kungurian.

Figs 12, 13 *Trigonotreta neoaustralis* Archbold & Thomas 1986

12. **Holotype**, GSWA 1/4963A; in ventral view.
Creek, 0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

13. **Paratype**, GSWA F11204; shell in ventral view.
Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Steriitamakian).



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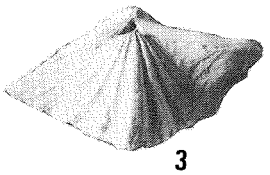

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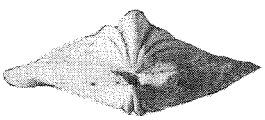

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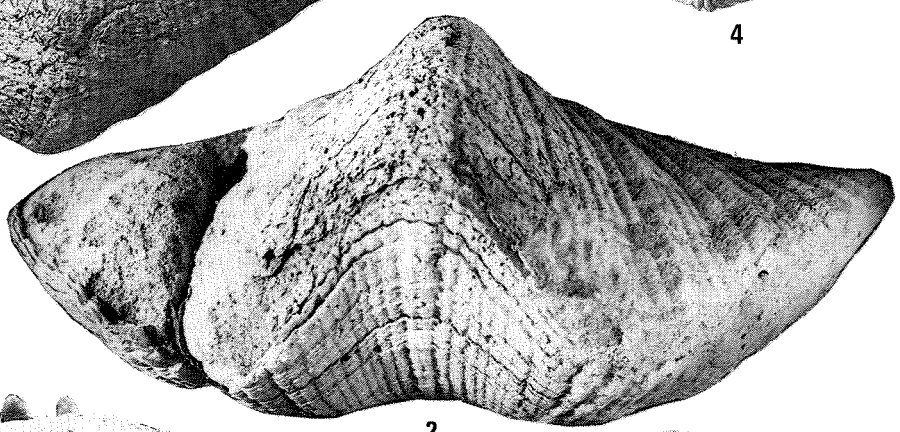

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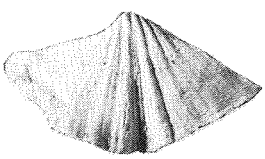

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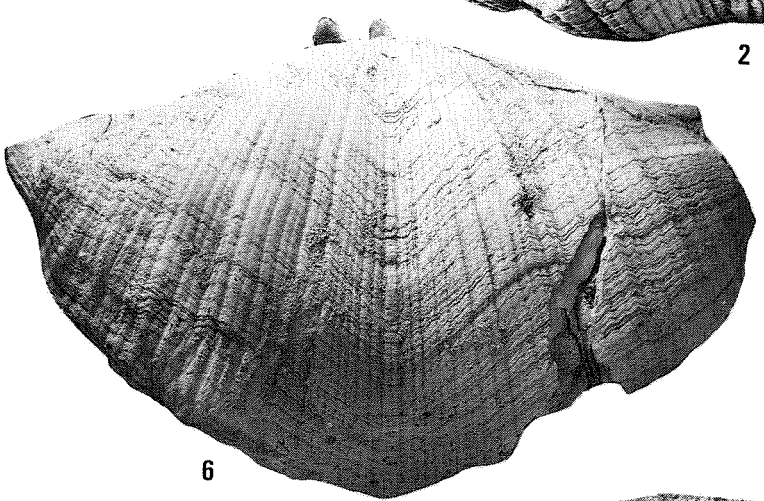

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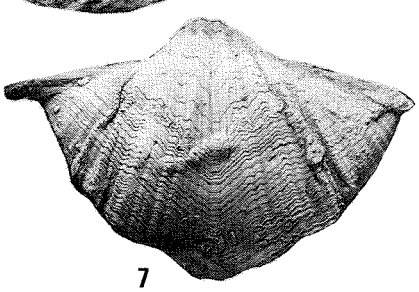

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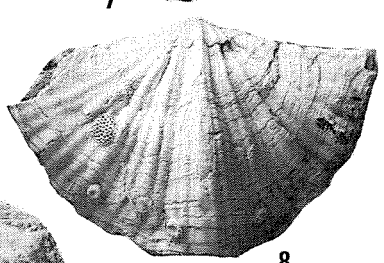

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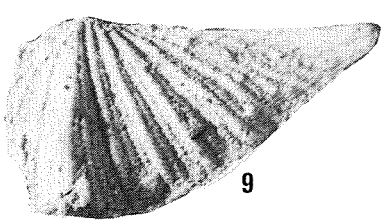

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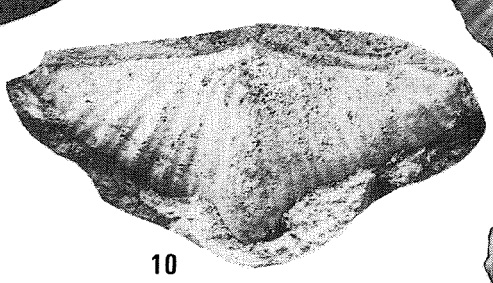

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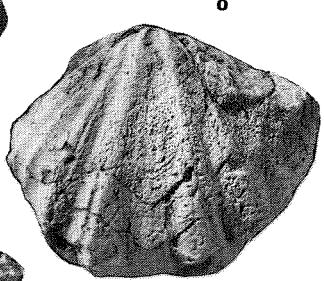

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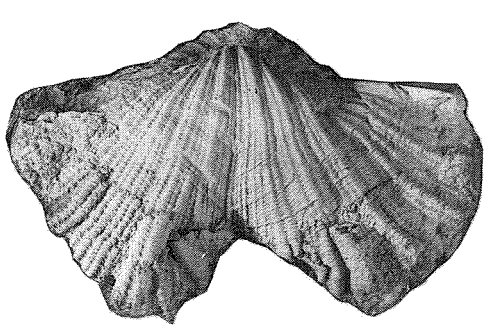

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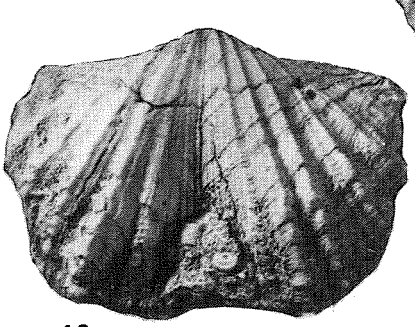

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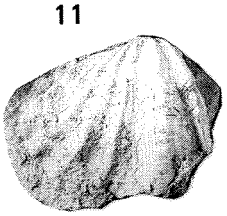

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BRACHIOPODS

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Plate 42

All figures are natural size, unless otherwise indicated.

Figures 1–4 are reproduced from BMR Bulletin 56 (Thomas, 1971) with the permission of the Director of Mineral Resources. Figures 5–30 from Alcheringa (Archbold & Thomas, 1985a) are reproduced with the permission of the Association of Australasian Palaeontologists.

Figs 1–4 *Brachythyrinella occidentalis* (Thomas 1971)

Holotype, CPC 1682; in postero-dorsal, ventral, dorsal, and profile views.
About 4.8 km at 45° from Round Hill Well and 1.6 km west of Kialawibri Creek crossing, Winning Station, Carnarvon Basin; Lyons Group; Asselian, Early Sakmarian (Tastubian).

Figs 5–9 *Spiriferella cundlegoensis* Archbold & Thomas 1985

Holotype, UWA 28180A; in dorsal, ventral, anterior, posterior and profile views; x1.2 (figs 6 & 9 only) (after Archbold & Thomas, 1985a, Figs 1A,B,D,C,E).
Wandagee Station (UWA locality C37.1), Carnarvon Basin; Cundlego Formation; Late Artinskian (late Baigendzhinian).

Figs 10–14 18, 20 *Spiriferella australasica* (Etheridge Jnr 1889)

10. Shell in dorsal view; CPC 24238 (after Archbold & Thomas, 1985a, Fig. 2D).
11, 13. Ventral valve in posterior and ventral views; CPC 24236 (after Archbold & Thomas, 1985a, Figs 2B,A).
12, 14. Shell in dorsal and ventral views; CPC 24235 (after Archbold & Thomas, 1985a, Figs 1CC,BB).
18, 20. Ventral valve in ventral and interior views; CPC 24240 (after Archbold & Thomas, 1985a, Figs 2L,M).
Mount Marmion, about 1.6 km at 22° from Kimberley Downs Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Late Baigendzhinian).

Figs 15, 16, 21, 22 *Elivina hoskingae* Archbold & Thomas 1985

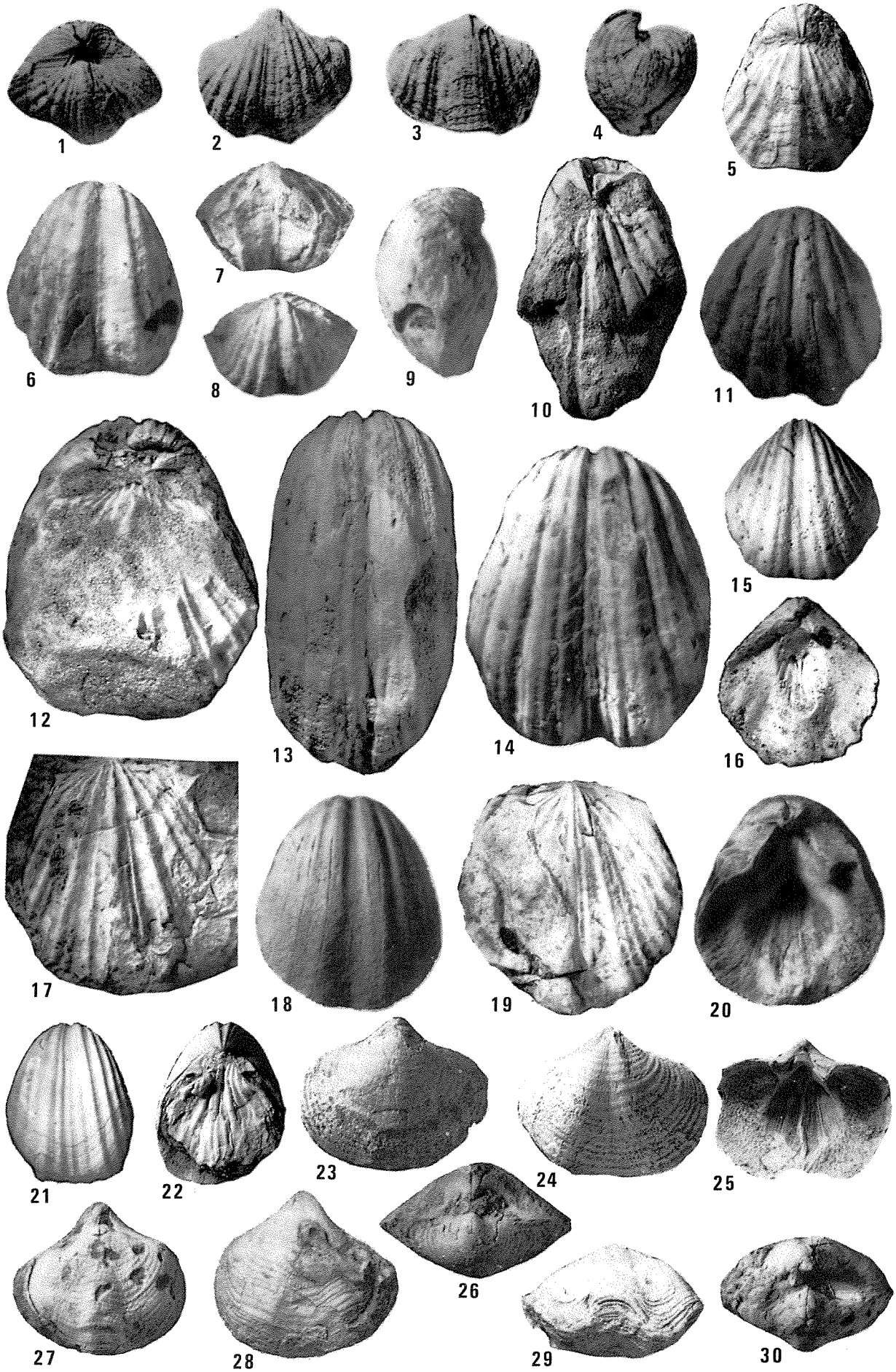
15, 16. **Paratype**, GSWA F18; ventral valve in ventral and dorsal views (after Archbold & Thomas, 1985a, Figs 3A,B).
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

21, 22. **Holotype**, GSWA F9187; in ventral and dorsal views (after Archbold & Thomas, 1985a, Figs 3F,G).
Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 23–26 *Spirelytha fredericksi* Archbold & Thomas 1984

23, 24, 26. **Holotype**, CPC 19931; in dorsal, ventral, and posterior views (after Archbold & Thomas, 1984, Figs 1A,B,C).
1.6 km slightly south of west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

25. **Paratype**, UWA 10927; ventral valve in interior view; (after Archbold & Thomas, 1984, Fig. 1E).



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Waltharrie Pools, Wooramel River District, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 27–30 *Spirelytha miloradovichi* Archbold & Thomas 1984

Holotype, CPC 19938; in dorsal, ventral, anterior and posterior views (after Archbold & Thomas, 1984, Figs 2T,U,Y,S).
Right bank of Minilya River, 13.6 km west of Wandagee Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Plate 43

All figures are natural size, unless otherwise indicated.

Figures 9–30 from the Journal of Paleontology (Archbold & Thomas, 1986b) are reproduced with the permission of the Paleontological Society. The remaining figures (1–8) are from Alcheringa (Archbold & Thomas, 1984), and are reproduced with the permission of the Association of Australasian Palaeontologists.

Figs 1–4 *Spirelytha stepanoviana* Archbold & Thomas 1984

Holotype, UWA 88134; internal mould of shell in dorsal, ventral, posterior and anterior views; x1.4 and x1 respectively (after Archbold & Thomas, 1984, Figs 4F,G,I,H).
Nalbia Paddock, east of Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 5–8 *Phricodothyris occidentalis* Archbold & Thomas 1984

Holotype, CPC 24232; in dorsal, ventral, anterior and posterior views; x1.5 (after Archbold & Thomas, 1984, Figs 4GG,HH,FF,EE).
Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 9–11 *Tomiopsis notoplicatus* Archbold & Thomas 1986

Holotype, CPC, 24245; in dorsal, ventral, and posterior views (after Archbold & Thomas, 1986b, pl. 3 figs 8-10).
1.4 km west of Callytharra Spring, Byro Station, Carnarvon Basin; Carrandibby Formation; Early Sakmarian (Tastubian).

Figs 12–15 *Tomiopsis woodwardi* Archbold & Thomas 1986

12, 13. **Holotype**, CPC 24246; shell in ventral and dorsal views (after Archbold & Thomas, 1986b, pl. 3 Figs 12, 13).
Callytharra Spring area, Byro Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

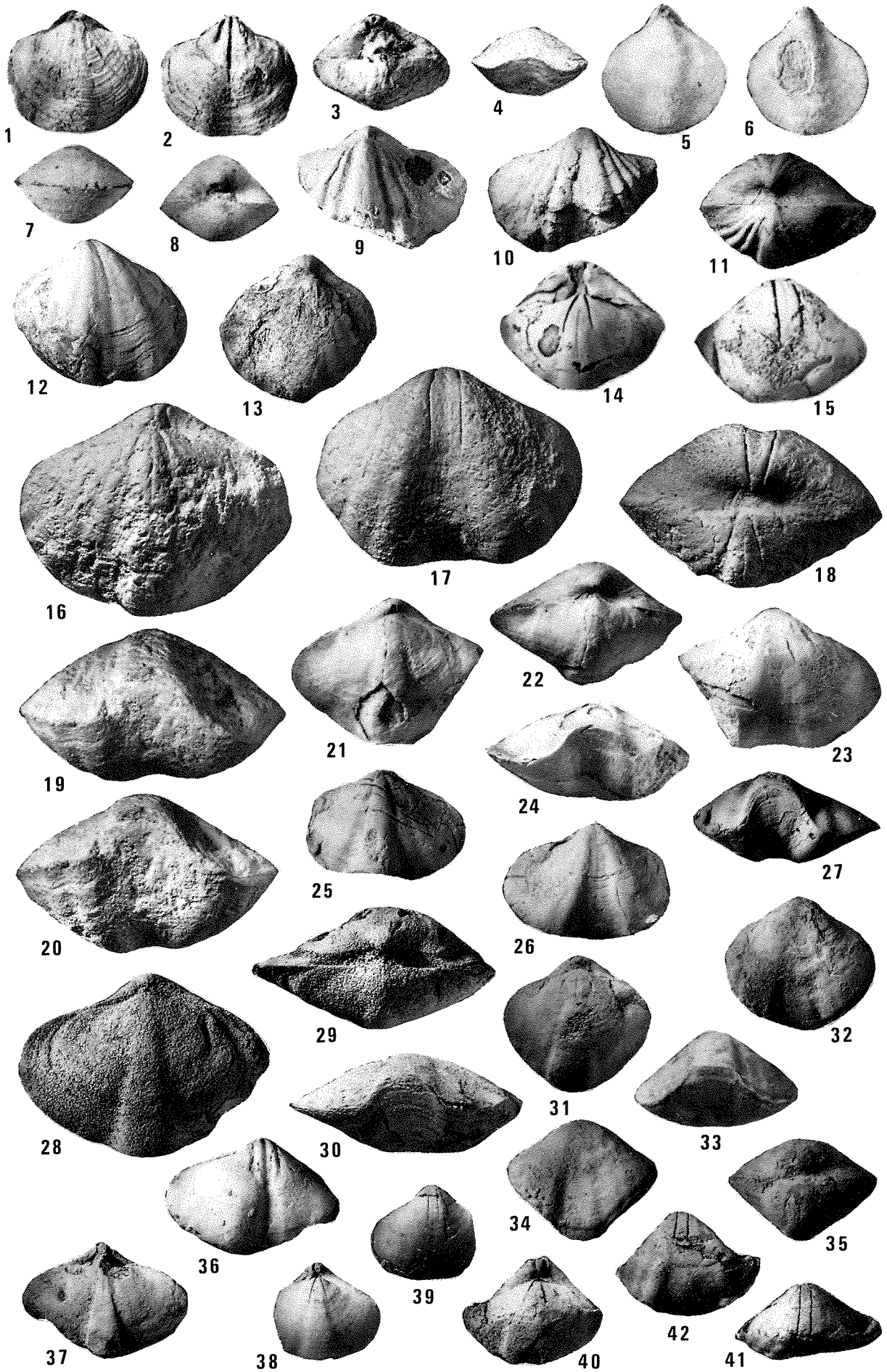
14, 15. Internal mould of shell in dorsal and ventral views; MUGD F6048 (after Archbold & Thomas, 1986b, pl. 3 figs 14, 15).
8.4 km at 226° from Coondoo Outcamp, Bidgemia Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 16–20 *Tomiopsis rarus* Archbold & Thomas 1986

Holotype, UWA 34319; internal mould in dorsal, ventral, posterior and two anterior views (after Archbold & Thomas, 1986b, pl. 4 figs 1-5).
Woolaga Creek, Irwin River District, Perth Basin; High Cliff Sandstone; Early Artinskian (Aktastinian).

Figs 21–24 *Tomiopsis pauciplicatus* Archbold & Thomas 1986

Holotype, CPC 24253; in dorsal, postero-dorsal, ventral and anterior views (after Archbold & Thomas, 1986b, pl. 4 figs 6-9).
8.8 km at 150° from Mount Madeline, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).



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Figs 25–27 *Tomiopsis teicherti* Archbold & Thomas 1986

Holotype, CPC 24261; in dorsal, ventral and anterior views (after Archbold & Thomas, 1986b, pl. 6 figs 1-3).
Right bank of Minilya river, 13.6 km west of Wandagee Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 28–30 *Tomiopsis balgoensis* Archbold & Thomas 1986

Holotype, CPC 24270; natural cast of shell in dorsal, posterior and anterior views (after Archbold & Thomas, 1986b, pl. 7 figs 5, 6, 8).
Long. 128°06'E, Lat. 21°28'S, northern Canning Basin; Lightjack Formation; Middle Kungurian.

Figs 31–35 *Tomiopsis globosus* Archbold & Thomas 1986

Holotype, CPC 24286; in dorsal, ventral, anterior, antero-ventral and posterior views (after Archbold & Thomas, 1986b, pl. 6 figs 14-18).
3.7 km at 70° from Shore Range Trig. Point, northern Canning Basin; Lightjack Formation; Middle Kungurian.

Figs 36, 37 *Tomiopsis hardmani* Archbold & Thomas 1986

Holotype, CPC 24273; internal mould of shell in ventral and dorsal views (after Archbold & Thomas, 1986b, pl. 7 figs 15, 16).
3 km west of Mount Goodwin, Port Keats area, NT, Bonaparte Basin; Upper Marine Beds of the Hyland Bay Formation; Chhidruan.

Figs 38, 39 *Fredericksia?* sp. nov. A

Internal mould of shell in dorsal and ventral views; MUGD F6556 (after Archbold & Thomas, 1986b, pl. 8 figs 20, 21).
6.5 km at 39° from Tallangatta Well, Bidgemia Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 40–42 *Fredericksia?* sp. nov. B

Internal mould of shell in dorsal, ventral and postero-ventral views; CPC 24285 (after Archbold & Thomas, 1986b, pl. 8 figs 22-24).
1.2 km southeast of BMR locality CP 144, 2 km east of Middle Well, Middalya Station, small sandy wash about 200 m north of low hill, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (late Baigendzhinian).

Plate 44

All figures are natural size, unless otherwise indicated.

Figures 1, 3–8 are from the Royal Society of Western Australia Journal (Hosking, 1933c) and reproduced with the permission of the Royal Society of Western Australia. Figures 14–30 are reproduced from BMR Bulletin 68 (Campbell, 1965), with permission of the Director, Bureau of Mineral Resources.

Figs 1–3 *Gjelispinifera decipiens* (Hosking 1933)

1. **Lectotype**, GSWA 1/4971cl; ventral valve in ventral view; x1.5. 0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

2. Portion of ventral valve enlarged; GSWA F11207; x3. Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

3. Crushed shell in dorsal view; GSWA 1/4971c2; x1.5. 0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4–8 *Lamnaespina papilionata* (Hosking 1933)

4–6, 8. **Lectotype**, GSWA F1/4971b1; ventral valve in ventral, profile, posterior and dorsal views; x1.5. 0.8 km west of Callytharra Spring, Carnarvon Basin: Callytharra Formation; Late Sakmarian (Sterlitamakian).

7. Portion of ventral valve surface enlarged; MUGD F6580; x20. Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 9–13 *Hustedia? basedowi* (Etheridge Jnr 1918)

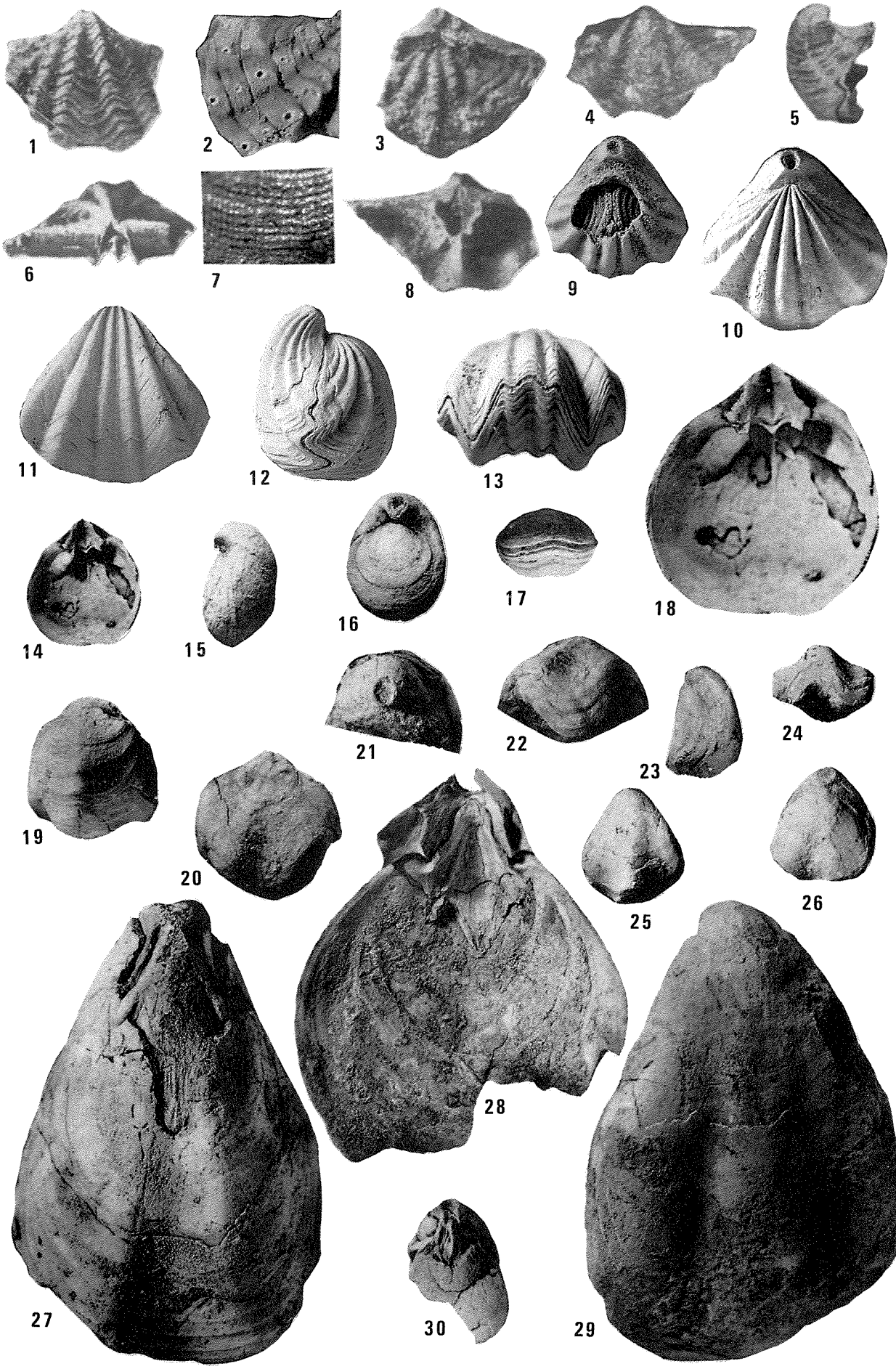
9. Shell in dorsal view; CPC 24427; x2.
10–13. Shell in dorsal, ventral, profile and anterior views; CPC 24428; x2.
Right bank of Minilya River, 13.6 km west of Wandagee Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 14–18 *Fletcherithyris hardmani* Campbell 1965

14, 18. **Holotype**, CPC 5329; dorsal valve interior; x2 and x4.
15–17. Shell in profile, dorsal and anterior views; CPC 5330; x2.
South slope of Mount Hardman, northern Canning Basin; Hardman Formation; Chhidruan.

Figs 19–22 *Yochelsonia stehlii* Campbell 1965

19, 21. **Paratype**, CPC 5229; ventral valve in ventral and posterior views.
20, 22. **Holotype**, CPC 5228; dorsal and anterior views of dorsal valve.
4 km at 70° from the Shore Range Trig. Point, northern Canning Basin; Lightjack Formation; Middle Kungurian.



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Figs 23–26 *Yochelsonia thomasi* Stehli 1961

Shell in profile, anterior, ventral and dorsal views; CPC 5223; x1.5.
Minilya River, south bank, 14.5 km west of Wandagee Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 27–29 *Hoskingia grandis* Campbell 1965

27, 29. **Holotype**, CPC 5265; internal mould in dorsal and ventral views.
7.8 km at 339° from Moffatts Bore, Nerrima Station, northern Canning Basin; Hardman Formation; Chhidruan.

28. Internal view of dorsal valve with portion of ventral valve attached; CPC 5294.
Near Mount Hardman Windmill, northern Canning Basin; Hardman Formation; Chhidruan.

Fig. 30 *Fletcherithyris?* sp.

Dorsal view of crushed specimen; CPC 5305.
2.7 km at 240° from northern tank, 12.8 km southwest from Jimba Jimba Homestead, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

Plate 45

All figures are of natural size, unless otherwise indicated.

All figures are reproduced from BMR Bulletin 68 (Campbell, 1965), with permission of the Director, Bureau of Mineral Resources, Canberra.

Figs 1–3 *Hoskingia kennediensis* Campbell 1965

1, 2. **Holotype**, UWA 17612a; dorsal views of latex cast and internal mould.
3. Internal mould in dorsal view; UWA 17612b.
1.2 km southeast of BMR locality CP144, 2 km east of Middle Well, Middalya Station, Carnarvon Basin; Bulgadoo shale; Late Artinskian (late Baigendzhinian).

Figs 4, 5, 9–11 *Hoskingia nobilis* (Etheridge Jnr 1907)

4, 5, 10, 11. Internal mould in profile, dorsal, anterior and ventral views; UWA 29908a.
9. Internal mould in dorsal view; UWA 29908b.
450 m northeast of entrance to Eregulla Springs Station, 3 km from Mingenew, Perth Basin; Mingenew Formation; Late Artinskian (early Baigendzhinian).

Figs 6–8 *Fletcherithyris* sp. cf. *F. hardmani* Campbell 1965

Internal mould in dorsal, profile and anterior views; CPC 5355; x1.5.
3.1 km at 255° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Figs 12–16 *Hoskingia trigonopsis* (Hosking 1933)

12. Shell in dorsal view; CPC 5260.
Wooramel River District, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

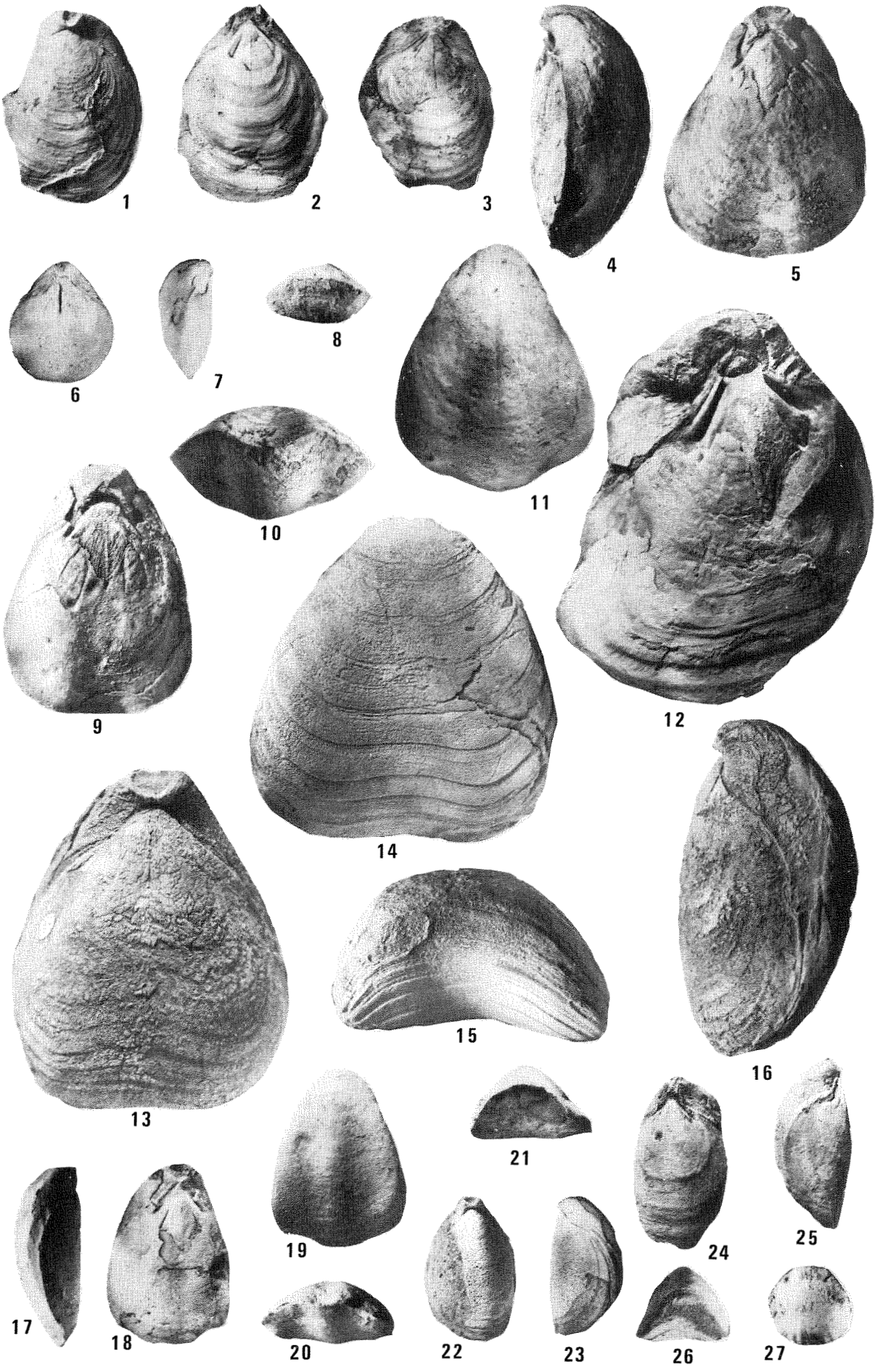
3–16. **Lectotype**, GSWA 1/4950; in dorsal, ventral, anterior and profile views.
3.1 km almost due east of Survey Station R20, Wooramel River, Carnarvon Basin; Coyrie Formation; Late Artinskian (early Baigendzhinian).

Figs 17–20 *Hoskingia wandageensis* Campbell 1965

Holotype, UWA 27301a; in profile, dorsal, ventral and anterior views.
West side of syncline, south of Minilya River, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Figs 21, 24, 25 *Gilledia woolagensis* Campbell 1965

Holotype, UWA 31563a; internal mould in anterior, dorsal and profile views.
Woolaga Creek, Perth Basin; High Cliff Sandstone; Early Artinskian (Aktastinian).



BRACHIOPODS

Figs 22, 23, 26 *Gilledia* sp. cf. *G. homevalensis* Campbell 1965

Shell in dorsal, profile and anterior views; UWA 33359/4.
5.6 km west of Binthabooka Creek and 8.8 km west of Lyons River Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (late Baigendzhinian).

Fig. 27 *Hemiptychina?* sp.

Dorsal valve in dorsal view; CPC 5969.
3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin; Noonkanbah Formation; Late Artinskian (late Baigendzhinian).

Plate 46

Figures 1–4, 8–15, 17, 21, 23, 28 and 29 are from BMR Bulletin 63 (Dickins, 1963). Figures 7, 18, 25, 26, 30 and 34 are from BMR Bulletin 29 (Dickins, 1956). Figures 22, and 31–33 are from BMR Bulletin 41 (Dickins, 1957). All are reproduced with the permission of The Director, Bureau of Mineral Resources. Figures 5, 16, 19, 20 and 24 are reproduced from Australian Museum Record (Fletcher, 1945). Figure 22 is reproduced from Geological Survey of W.A. Bulletin 27 (Etheridge Jnr, 1907b).

Figs 1, 2 *Nuculopsis bangarraensis* Dickins 1963

1. **Holotype**, UWA 45348; partly exfoliated left valve; x4.
2. **Paratype**, UWA 45380; front view; x4.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 3, 4 *Nuculopsis darlingensis* Dickins 1963

3. **Paratype**, CPC 3861; left valve; x4.
2.6 km southwest of Paradise Homestead,northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

4. **Holotype**, CPC 3859; internal cast of right valve; x4.
0.75 km at 334° from Carynginia Well, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 5 *Nucundata undulostriata* (Fletcher 1945)

Left valve; L36(3); x1 (after Etheridge Jnr., 1907c, pl. 5 fig. 10)
Fossil Head, Treachery Bay, NT; Permian.

Fig. 6 *Phestia thomasi* (Dickins 1956)

Holotype, CPC 737; left valve; x2.
2.8 km southeast of Muderong Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Fig. 7 *Glyptoleda* sp.

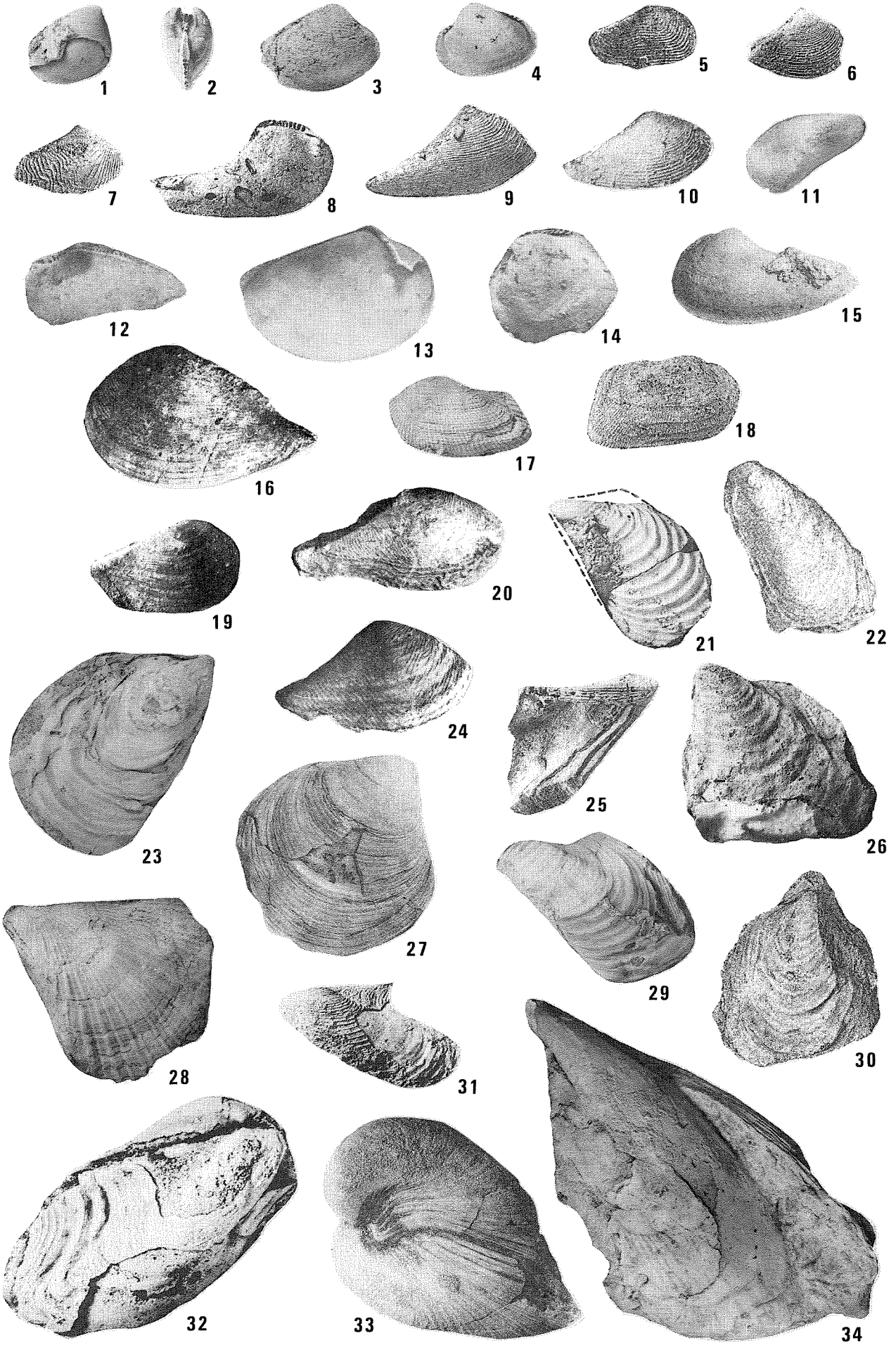
External impression of left valve, CPC 740; x2.
South of Merlinleigh Homestead, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 8, 9 *Phestia lyonsensis* (Dickins 1956)

8. **Holotype,** CPC 734; internal impression of left valve; x1.
9. **Paratype**, CPC 736; latex copy of anteriorly incomplete external impression of left valve; x1.
4.8 km west of Moogooree Homestead, Carnarvon Basin; Lyons Formation; Asselian–Late Sakmarian (Sterlitamakian).

Figs 10, 15 *Phestia darwini* (de Koninck 1877)

10. **Hypotype**, CPC 2203; external impression of left valve; x4.
15. **Hypotype**, CPC 2204; internal cast of right valve; x4.
1.6 km west of Callytharra Spring, Carnarvon Basin; top of Lyons Formation; Late Sakmarian (Sterlitamakian).



BIVALVES

GSWA 22964

Fig. 11 *Modiolus koneckii* Dickins 1963

Holotype, UWA 45388; internal cast of right valve; x1.
Becketts Gully, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 12, 13 *Palaeoneilo* sp. nov.

12. Latex cast showing dentition; UWA 45349; x2.
Fossil Ridge, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

13. Internal cast; UWA 45350; x2.
Becketts Gully, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 14 *Quadratonucula australiensis* Dickins 1963

Holotype, CPC 3863; internal cast of left valve; x4.
0.75 km at 334° from Carynginia Well, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 16, 19 *Phestia basedowi* (Etheridge Jnr 1907)

16. Right valve; UWA 42065; x1/3 (after Fletcher, 1945, pl. 22 fig. 6; x0.5).
19. Right valve; UWA 42064; x1 (after Fletcher, 1945, pl. 22 fig. 7; x0.5).
South bank of Minilya River near Bulgadoo Pool, 3042 m, N 110° W from Bulbawardoo Windmill, Carnarvon Basin; ?Upper Bulgadoo Shale; Artinskian.

Fig. 17 *Parallelodon bimodoliratus* Dickins 1963

Paratype, CPC 3878; latex cast of external impression of left valve; x2.
48 km west-northwest of Curbur Homestead, Carnarvon Basin; Callytharra Formation; Sakmarian.

Fig. 18 *Parallelodon subtilistriatus* Wanner 1922

Hypotype, CPC 742; latex cast of external impression of right valve; x2.
0.75 km northwest of Muderong Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Artinskian.

Figs 20, 24 *Glyptoleda coleyi* Fletcher 1945

20. **Holotype,** UWA 42060; right valve; about x1 (after, Fletcher, 1945, pl. 19 fig. 7).
Barrabiddy Creek, 382 m upstream from fence between Weir and Barradibby Paddock, Carnarvon Basin; Cundlego Formation; Artinskian.

24. **Paratype,** UWA 42061; in dorsal view; about x1 (after Fletcher, 1945, pl. 19 fig. 8).
About 201 m from south bank of Whitfields Creek, 2215 m from its junction with the Minilya River, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Figs 21, 23 *Atomodesma (Atomodesma) mytiloides* Beyrich 1864

21. Specimen CPC 3905; right valve; x1.
12 km at 335° from Lyons River Homestead, Carnarvon Basin; top of Callytharra Formation; Late Sakmarian (Sterlitamakian).

23. Specimen CPC 3906; left valve; x1.
48 km west-northwest of Curbur Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 22 *Modiolus?* sp. indet.

Cast of a nearly complete left value; x1 (after Etheridge Jnr, 1907b, pl. 5 fig. 4).
Mingenew, Irwin River area, Perth Basin; Mingenew Formation; Late Artinskian (Baigendzhinian).

Figs 25, 34 *Pseudomyalina obliqua* Dickins 1956

25. **Holotype**, CPC 756; internal impression of right valve (specimen positioned on its side); x0.5.
34. **Paratype**, CPC 757; specimen showing structure of anterior part of hinge on left valve; x0.5.
1.4 km east of south of Muderong Bore, Middalya Station; Coolkilya Sandstone; Middle Kungurian.

Figs 26, 30 *Atomodesma exarata* Beyrich 1864

26, 30. **Hypotype**, BMR F17.078; left and right valves; x1.
1.4 km northwest of Muderong Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 27, 33 *Eurydesma playfordi* Dickins 1957

27. **Paratype**, CPC 2231; right valve; x0.5.
33. **Paratype**, CPC 2229; oblique dorsal view; x1.
1.6 km west of Callytharra Spring, Carnarvon Basin; Lyons Group; Asselian–Early Sakmarian (Tastubian).

Fig. 28 *Pseudomyalina* sp. A

Latex cast of external impression of left valve; CPC 3915; x0.5.
4.6 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 29 *Atomodesma (Atomodesma)* sp. cf. *A. (A.) timorense*(Wanner 1922)

Left valve; CPC 3909; x1.
12 km east of Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 31, 32 *Leiopteria? carrandibbiensis* Dickins 1957

31. **Holotype**, CPC 2224; partly exfoliated left valve; x1.
32. **Paratype**, CPC 2225; dorso-lateral view of valve; x4.
1.6 km west of Callytharra Spring, Carnarvon Basin; Lyons Group; Asselian–Early Sakmarian (Tastubian).

Plate 47

Figures 18 and 20 are from Royal Society of Western Australia Journal (Hosking, 1931) and reproduced with permission from the Royal Society of Western Australia. Figure 14 is from BMR Bulletin 41 (Dickins, 1937), and the rest of the figures are from BMR Bulletin 63 (Dickins, 1963); all are reproduced with permission from the Director, Bureau of Mineral Resources.

Fig. 1 *Etheripecten?* sp.

Left valve, CPC 3924; x1.
25.5 km at 120° from Mount Tuckfield, southern Saint George Ranges, northern Canning Basin; near base of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 2, 4, 8, 9 *Etheripecten tenuicollis* (Dana 1847)

2. Incomplete valve with primary and secondary costae (after Etheridge Jnr, 1907b, pl. 6 fig. 7).
8. Specimen with auricles preserved and fewer secondary costae; x1 (after Etheridge Jnr, 1907b, pl. 7 fig. 5).
Shale below coal seam, Irwin River area, Perth Basin; stratigraphic unit not known; Permian.

4. Type specimen figured by Dana (1849, pl. 9 figs 7, 7a); x1.
Harpers Hill, NSW.

9. **Hypotype**, CPC 2253; latex cast of left valve; x2.
4.8 km west of Moogooree Homestead, Carnarvon Basin; Lyons Formation, about 415 m below top; Asselian–Early Sakmarian (Tastubian).

Fig. 3 *Streblopteria* sp.

Left valve, CPC 3932; x2.
25.5 km at 120° from Mount Tuckfield, south part of Saint George Ranges, northern Canning Basin; near base of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

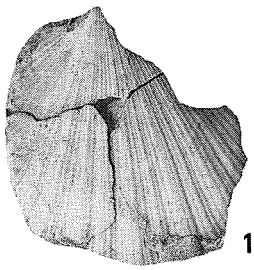
Figs 5, 16 *Euchondria callytharraensis* Dickins 1963

5. **Holotype**, CPC 3928; latex cast of left valve; x1.
16. **Paratype**, CPC 3929; detail of hinge of right valve; x4.
About 10 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 6, 7 *Girtypecten ovalis* Dickins 1963

6. **Holotype**, UWA 45397; internal cast of left valve; x2.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

7. **Paratype**, CPC 3925; latex cast of incomplete external impression of left valve; x2.
48 km west-northwest of Curbur Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).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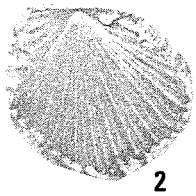
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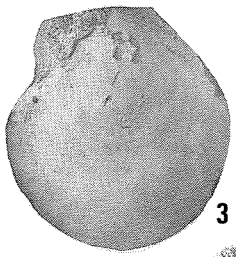
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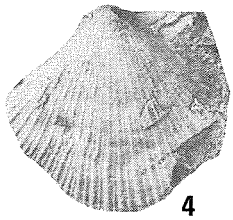
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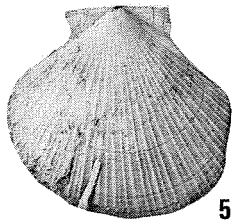
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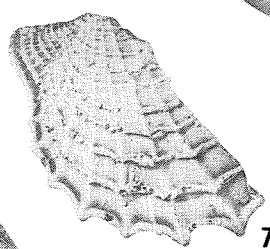
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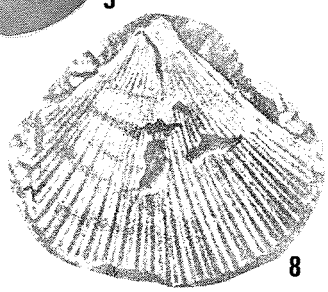
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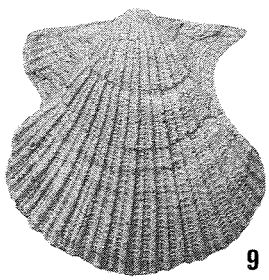
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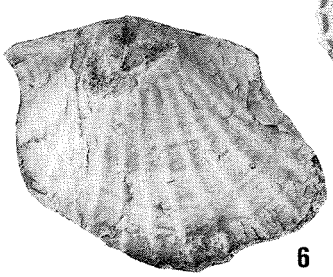
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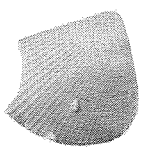
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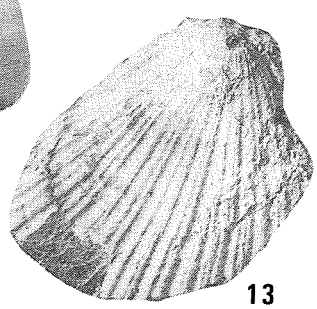
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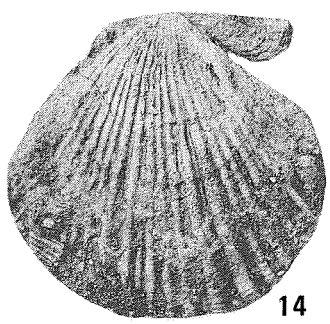
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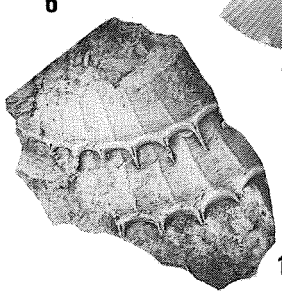
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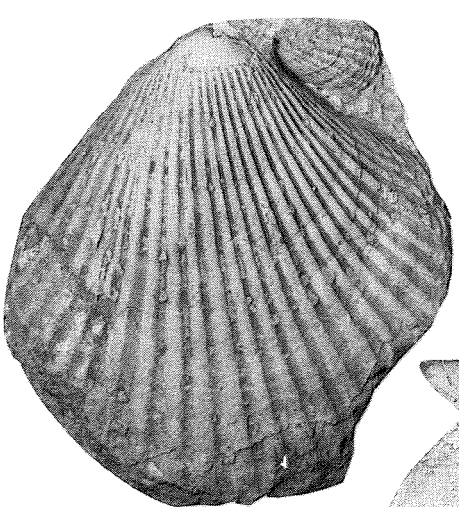
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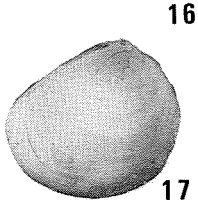
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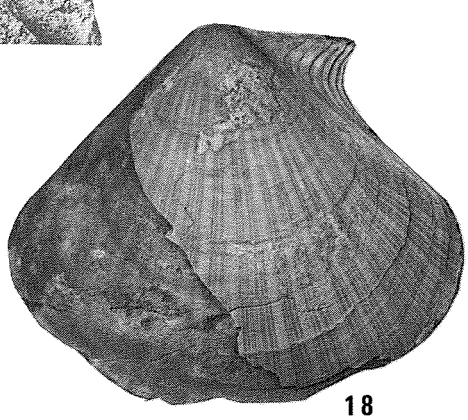
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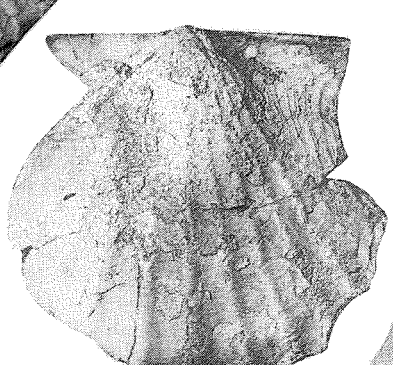
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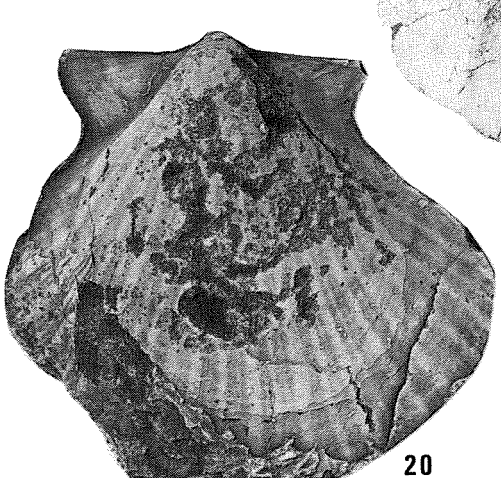
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21

BIVALVES

Figs 10, 11, 19 *Acanthopecten?* sp.

10. Exfoliated left valve, CPC 3927; x0.5.
Callytharra (Oil Search Loc. 8), Wooramel River, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

11. Latex cast of incomplete external impression, CPC 3926; x2.
48 km west-northwest of Curbur Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

19. Left valve, UWA 45399; x0.5.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 12 *Plagiostoma?* sp. nov.

Left valve; CPC 3938; x4.
0.75 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 13 *Palaeolima* sp. nov.

Left valve; UWA 45404; x1.
Fossil Ridge on Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 14 *Deltopecten lyonsensis* Dickins 1957

Holotype, CPC 2244; right valve; x0.5.
1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin; Upper Lyons Formation; Early Sakmarian (Tastubian).

Fig. 15, 21 *Deltopecten waterfordi* Dickins 1963

15. Left valve, GSWA 1/5085; x0.4.
Byro Plains, Wooramel River district, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

21. **Holotype**, CPC 3918; left valve; x0.5.
19 km south of Lyons River Homestead, Gascoyne River area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 17 *Elimata guppyi* Dickins 1963

Holotype, CPC 3939; left valve; x2.
25.5 km at 120° from Mount Tuckfield, south part of Saint George Ranges, northern Canning Basin; near base of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 18, 20 *Heteropecten comptus* (Dana 1847)

18. **Hypotype**, GSWA 1/4643; left valve; x0.7.
2 km east-southeast of Survey Station R20, Wooramel River District, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

20. **Hypotype**, GSWA F47C; exfoliated proximal part of left valve; x1.
Byro Plains south of Carrandibby Range, Byro Station, Carnarvon Basin; Coyrie or Mallens Formation; Late Artinskian (Baigendzhinian).

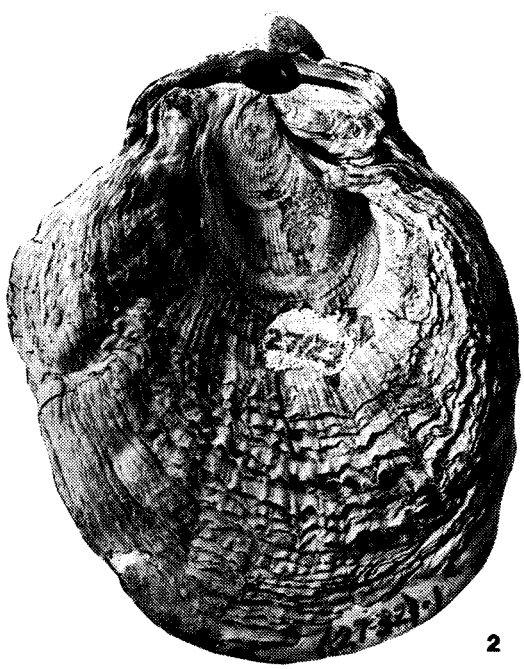
Plate 47A

Figs 1, 2 *Pseudomonotis (Treumaticonda) wandageensis* Newell & Boyd 1970

1, 2. **Holotype,** UWA 27123; left and right valves; x1.
North bank of Minilya River west of Coolkilya Pool, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).



1



2

BIVALVES

Plate 48

Figures 1, 2, 12, 25, 27 and 32 are from BMR Bulletin 41 (Dickens, 1957). Figures 3, 5, 9, 15–17, 23, 24, and 26 are from BMR Bulletin 29 (Dickins, 1957). Figures 4, 6–8, 10, 11, 13, 14, 18–22, and 28–31 are from BMR Bulletin 63 (Dickins, 1963). All figures are reproduced with permission of the Director, Bureau of Mineral Resources.

Figs 1, 2 *Schizodus crespinae* Dickins 1957

1. **Holotype**, CPC 2241; right valve; x4.
2. **Paratype**, CPC 2242; dentition on left valve; x4.

1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin; upper Lyons Formation; Early Sakmarian (Tastubian).

Fig. 3 *Neoschizodus johnstonei* (Dickins 1956)

Paratype, CPC 1304; left valve; x1.
6 km slightly north of east of Southern Cross Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Fig. 4 *Schizodus sandimanensis* Dickins 1963

Paratype, UWA 45418; left valve; x2.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 5 *Schizodus kennedyensis* Dickins 1956

Holotype, CPC 764; x1.
1.2 km south of Southern Cross Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Fig. 6 *Schizodus fitzroyensis* Dickins 1963

Holotype, CPC 3945; internal impression of right valve; x1.
24 km at 120° from Mount Tuckfield, Saint George Ranges, northern Canning Basin; near base of the Poole Sandstone; Artinskian.

Fig. 7 *Stutchburia hoskingae* Dickins 1963

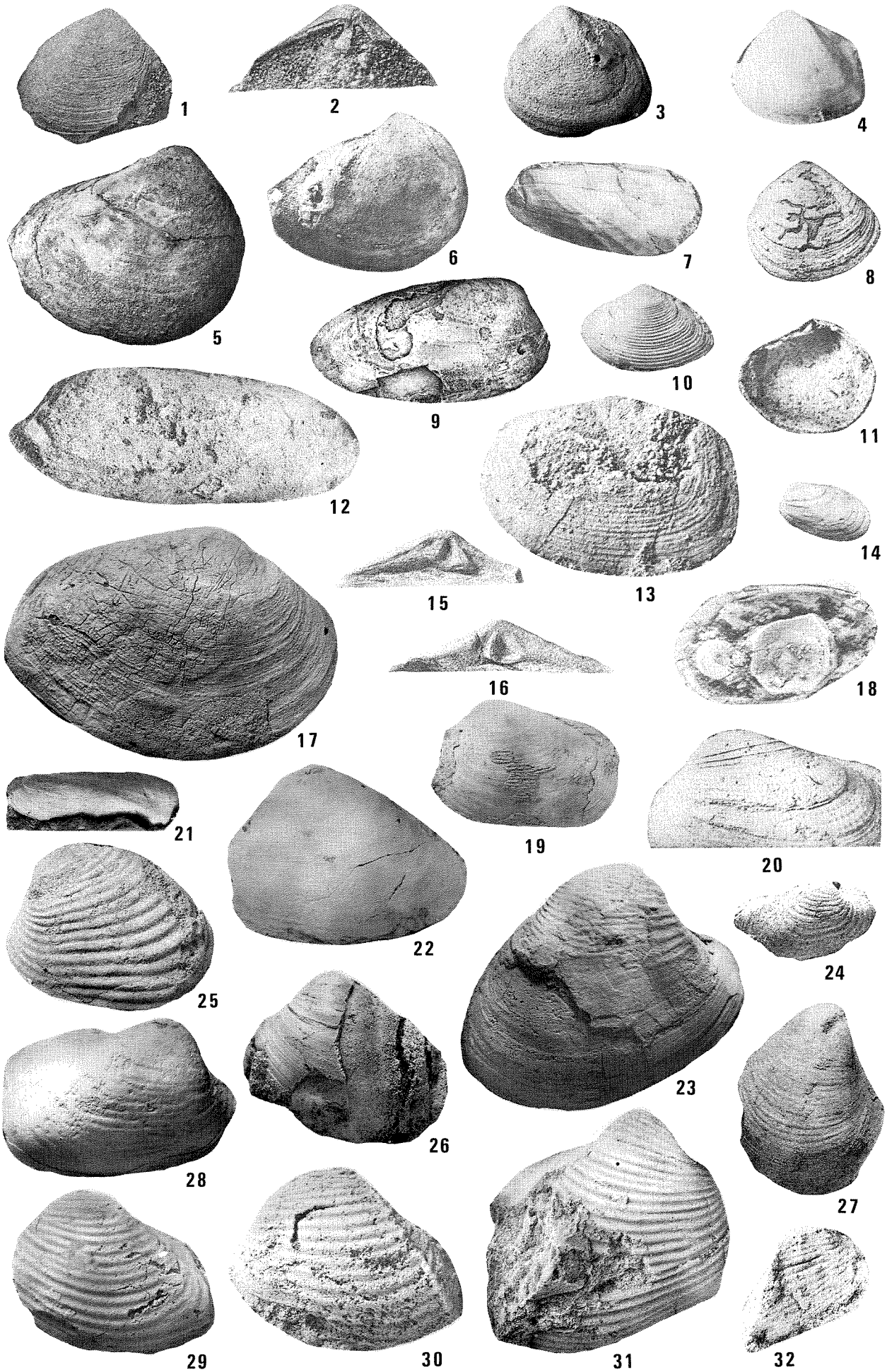
Paratype, UWA 45406; left valve; x1.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 8, 11 *Astartella obliqua* Dickins 1963

Holotype, UWA 45419; exterior and interior views of right valve; x2.
3.5 km south of Mount Sandiman Woolshed, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 9 *Stutchburia muderongensis* Dickins 1956

Paratype, CPC 749; right valve; x1.
2.8 km southeast of Muderong Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Artinskian.



BIVALVES

GSWA 22966

Figs 10, 13 *Oriocrassatella* sp.

10. Latex cast of external impression of left valve; CPC 3956; x1.
25.6 km at 120° from Mount Tuckfield, Saint George Ranges, north Canning Basin; near base of the Poole Sandstone; Artinskian.

13. Left valve, CPC 3958; x1.
Daurie Creek, 1.6 km southeast of Monument Bore, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 12 *Stutchburia variabilis* Dickins 1957

Holotype, CPC 2205; internal cast of left valve; x1.
2 km west of Callytharra Spring, Carnarvon Basin; top bed of Lyons Formation; Late Sakmarian (Sterlitamakian).

Figs 14, 18, 20 *Cypricardinia? elegantula* Dickins 1963

14, 20. **Holotype**, UWA 45411; left valve; x1, x4.
18. **Paratype**, UWA 45415; showing dentition of right valve; x2.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 15–17 *Oriocrassatella stokesi* Etheridge Jnr 1907

15. **Hypotype**, UWA 33925; hinge of left valve; x1.
16. **Hypotype**, UWA 33924; hinge of right valve; x1.
17. **Hypotype**, UWA 33922; right valve; x1.
3.2 km north of Wandagee Hill, Wandagee Station, Carnarvon Basin; Nalbia Sandstone; Early Kungurian.

Fig. 19 *Edmondia prichardi* Dickins 1963

Holotype, UWA 45361; mostly exfoliated left valve; x0.5.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 21 *Palaeosolen? badgeraensis* Dickins 1963

Holotype, CPC 3894; latex cast of external impression; x1.
0.75 km at 334° from Carynginia Well, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 22 *Megadesmus* sp.

Left valve, CPC 3880; x0.5.
9.6 km south-southeast from Plant Well, Coordewandy Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 23 *Astartila blatchfordi* (Hosking 1931)

Hypotype, UWA 29345; right valve; x1.
1.6 km downstream from Coolkilya Pool, Minilya River, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 24, 26 *Astartila fletcheri* Dickins 1956

24. **Paratype**, CPC 753; latex cast showing interpolation of ribs on right valve; x1.
26. **Holotype**, CPC 750; partly exfoliated left valve; x1.
1 km southeast of Southern Cross Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Fig. 25 *Astartila condoni* Dickins 1957

Holotype, CPC 2212; left valve; x1.
1 km west from Callytharra Spring, Carnarvon Basin; top of Lyons Formation; Early Sakmarian (Tastubian).

Fig. 27 *Astartila? obscura* Dickins 1957

Holotype, CPC 2215; right valve; x1.
1.6 km west from Callytharra Spring, Carnarvon Basin; top of Lyons Group; Early Sakmarian (Tastubian).

Fig. 28 *Astartila? tumida* Dickins 1963

Holotype, UWA 45367; right valve; x1.
Near Holmwood, Irwin River area, Perth Basin; ?Fossil Cliff Member of the Holmwood Shale; Late ?Sakmarian (Sterlitamakian).

Fig. 29 *Myofossa subarbitrata* (Dickins 1963)

Holotype, CPC 3385; left valve; x2.
4.8 km southwest from Paradise Homestead, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Fig. 30 *Myonia* sp. nov.

Left valve; CPC 3891; x2.
About 9 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Fig. 31 *Astartila?* sp. A

Right valve; UWA 45372; x1.
Woolaga Creek, Irwin River area, Perth Basin; High Cliff Sandstone; Early Artinskian (Aktastinian).

Fig. 32 *Pachymyonia occidentalis* Dickins 1957

Holotype, CPC 2221; right valve; x1.
1.6 km west of Callytharra Spring, Carnarvon Basin; top of Lyons Group; Early Sakmarian (Tastubian).

Plate 49

Figures 5, and 9–12 are from Geological Society of Australia Journal (Dickins and Shah, 1965), and reproduced with permission of the Geological Society of Australia. Figures 3 and 7 are from BMR Bulletin 41 (Dickins, 1957), and figures 1, 2, 4, 6, 13 and 14 are from BMR Bulletin 63 (Dickins, 1963); all are reproduced with permission of the Director Bureau of Mineral Resources.

Fig. 1 *Chaenomya? nuraensis* Dickins 1963

Right valve, CPC 2223; x1.
1.6 km west of Callytharra Spring, Carnarvon Basin; top part of Lyons Group; Early Sakmarian (Tastubian).

Fig. 2 *Chaenomya* sp. B

Left valve, CPC 3881; x0.5.
About 10 km at 335° from Lyons River Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 8 *Praeundulomya concentrica* Dickins 1957

3. **Paratype**, CPC 2196; immature left valve; x2.
8. **Holotype**, CPC 2193; left valve; x1.
8 km southwest of Moogooree Homestead, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Fig. 4 *Cosmomya (Palaeocosmomya)* sp. nov.

Posteriorly incomplete right valve; UWA 45383; x1.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 5 *Cosmomya (Palaeocosmomya) teicherti* Fletcher 1946

Paratype, UWA 42057; left valve; x2.
Near mouth of northwest gully of Wandagee Hill, Wandagee Station; Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Fig. 6 *Praeundulomya subelongata* Dickins 1963

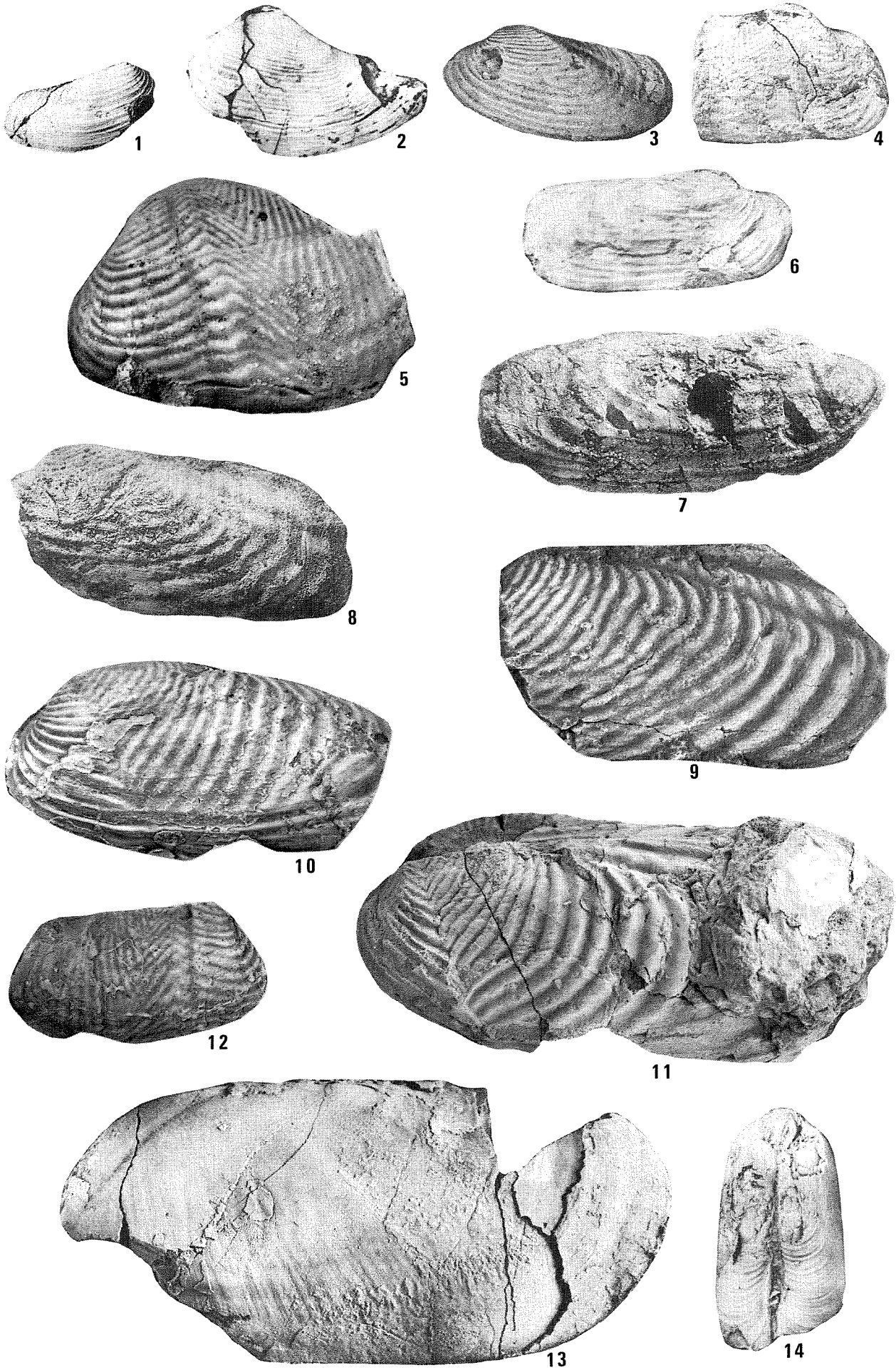
Holotype, UWA 45381; right valve; x0.5.
Fossil Ridge on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Fig. 7 *Praeundulomya elongata* Dickins 1957

Holotype, CPC 2238; right valve; x1.
1.6 km west of Callytharra Spring; top part of Lyons Formation; Early Sakmarian (Tastubian).

Figs 9, 11 *Undulomya pleiopleura* Fletcher 1946

9. **Holotype**, UWA 42050; incomplete left valve; x1.
Uppermost bed in centre of syncline, 1.6 km west of Coolkilya Pool, north bank of Minilya River, Wandagee Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.



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11. **Hypotype,** CPC 763; x1.
3.2 km north of Muderong Bore, Middalya Station, Carnarvon Basin; top of Nalbia Sandstone or Baker Formation; Early Kungurian.

Fig. 10 *Undulomya rugulata* Fletcher 1946

Holotype, UWA 42055; left valve distally incomplete; x1.
East limb of syncline, north bank of Minilya River, Wandagee Station, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Fig. 12 *Cosmomya (Palaeocosmomya) aplatum* Fletcher 1946

Holotype, UWA 42059; right valve with obscured rear margin; x1.
East limb of syncline west of Coolkilya Pool, north bank of Minilya River, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 13, 14 *'Solemya' holmwoodensis* Dickins 1963

13. **Holotype**, UWA 45384; incomplete internal cast of left valve; x2.
14. **Paratype**, UWA 45387; dorsal view of young bivalve; x1.
Woolaga Creek, Irwin River area, Perth Basin; Holmwood Shale; Late Sakmarian (Sterlitamakian).

Plate 50

Figs 1, 2 *Agathiceras applanatum* Teichert 1944

Holotype, UWA 21451; x2.5.
Type locality; Coolkilya Sandstone; Roadian.

Figs 3–6 *Thalassoceras wadei* Miller 1936

3, 4. **Paralectotype**, UWA 19987; x2.
5. **Lectotype**, UWA 19988; x4.
Paradise Homestead area, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

6. **Hypotype**, CPC 1766; x3.
Nura Nura Ridge, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Fig. 7 *Propopanoceras ruzhencevi* Glenister & Furnish 1961

Holotype, CPC 1773; x4.
Paradise Homestead area, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 8, 9 *Neocrimites* sp.

Modelling clay cast of specimen CPC 1777; x3.
Moogooree Station, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 10–17 *Bamyaniceras australe* (Teichert 1942)

10, 11. **Holotype**, UWA 20145; x1.
Wandagee Hill area, Wandagee Station, Carnarvon Basin; Nalbia Sandstone; Roadian.

12, 13. **Hypotype**, UWA 20510; x2.
Coolkilya Pool area, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

14. **Hypotype**, UWA 20509; x4.
Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

15–17. **Hypotype**, CPC 1764; x1.5.
Donellys Well, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 18, 19 *Bamyaniceras* sp. nov. Glenister & Furnish 1961

Specimen CPC 1765; x2.
Moogooree Station, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).


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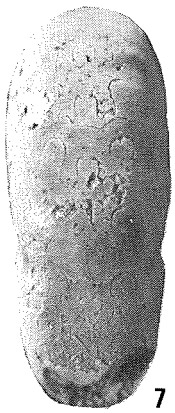
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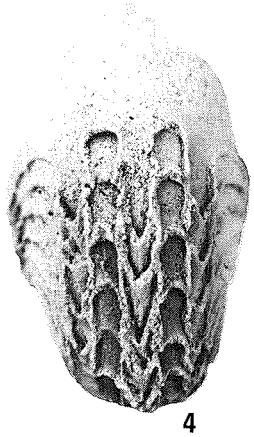
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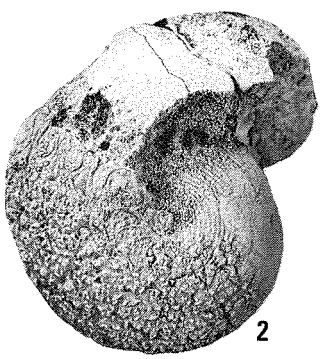
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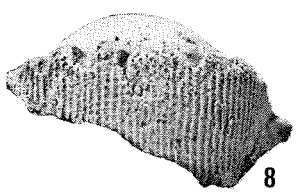
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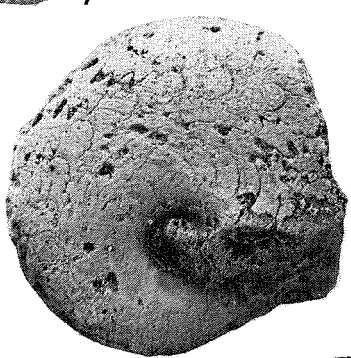
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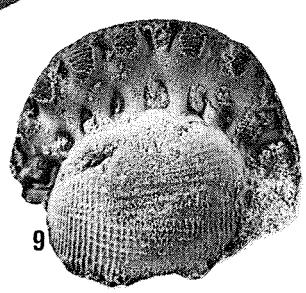
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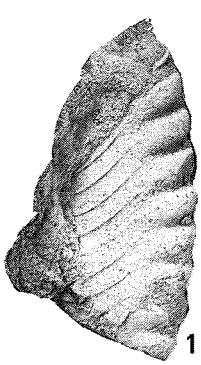
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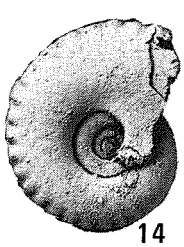
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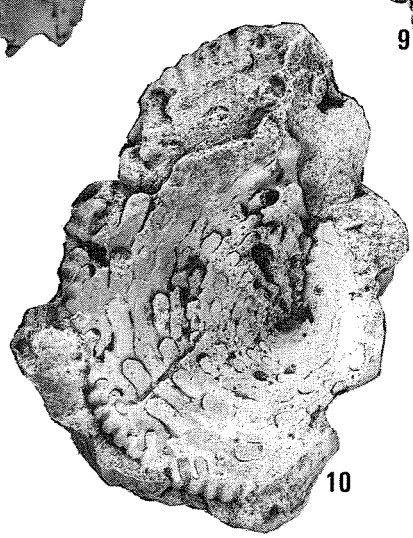
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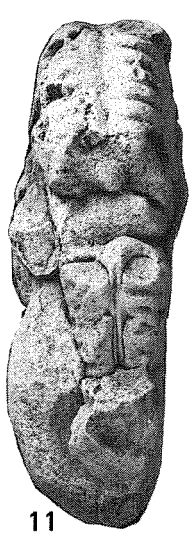
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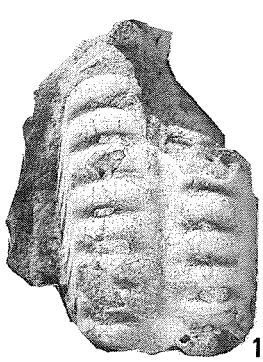
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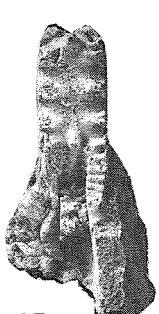
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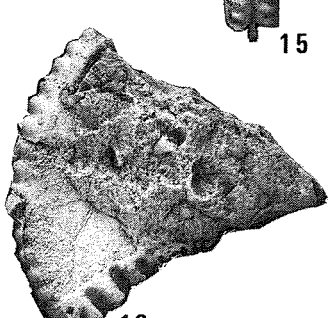
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AMMONOIDS

Plate 51

Figs 1–4 cf. *Mescalites* sp.

1, 2. Specimen MUGD F6667; x3.
3, 4. Specimen MUGD F6668; x3.
Bidgemia Station, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 5–6 *Svetlanoceras irwinense* (Teichert & Glenister 1952)

5. **Hypotype,** SUI 51333; x3.
6. **Holotype,** UWA 32036; x2.
Priders Lookout area, Irwin River area, Perth Basin; Woolaga Member of the Holmwood Shale; Early Sakmarian (Tastubian).

Figs 7–9 *Paragastrioceras wandageense* Teichert 1942

Holotype, UWA 20142; x1.5.
North of road north of Wandagee Hill, Carnarvon Basin; Nalbia Sandstone; Roadian.

Fig. 10 *Popanoceras* sp. indet.

Specimen CPC 1775; x1.5
Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Roadian.

Figs 11–13 *Propopanoceras ruzhencevi* Glenister & Furnish 1961

11. **Paratype**, CPC 1774; x4.
12, 13. **Holotype**, CPC 1773; x4.
Paradise Homestead area, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 14, 15 *Cyclolobus persulcatus* Rothpletz 1892

Hypotype, CPC 25340; x2.
Kirkby Range, Crossland sheet, northern Canning Basin; Cherrabun Member of the Hardman Formation; Amarassian.



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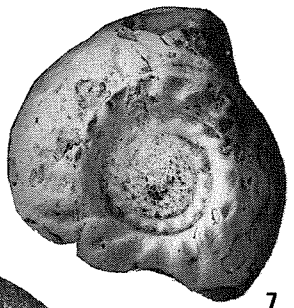

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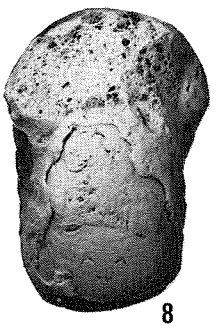

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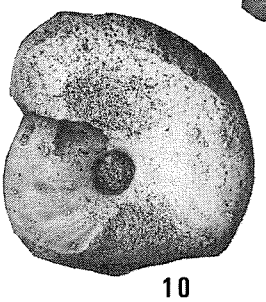

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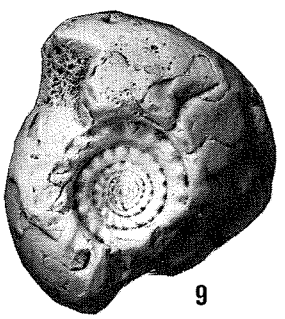

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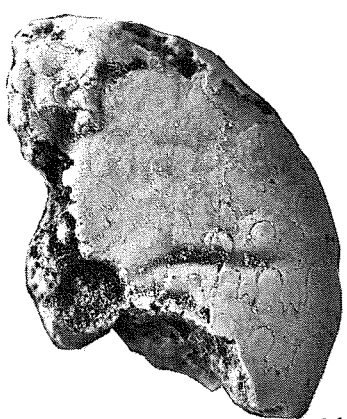

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AMMONOIDS

Plate 52

Figs 1–5 *Juresanites jacksoni* (Etheridge Jnr 1907)

1, 2. **Hypotype**, UWA 35779; x1.
Irwin River area, Perth Basin; Beckett Member of the Holmwood Shale; Early Sakmarian (Tastubian).

3–5. MUGD F1981 (**Holotype** of *J. campbelli*); x4.
Irwin River area, Perth Basin; Woolaga Member of the Holmwood Shale; Early Sakmarian (Tastubian).

Fig. 6 *Pseudoschistoceras simile* Teichert 1944

Hypotype, GSWA F10163; x1.
Barrabiddy Well area, Wandagee Station, Carnarvon Basin; Cordalia Sandstone; Early Artinskian (Aktastinian).

Fig. 7 *Thalassoceras wadei* Miller 1936

Hypotype, UWA 20143; x2.
Nura Nura Outcamp area, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).



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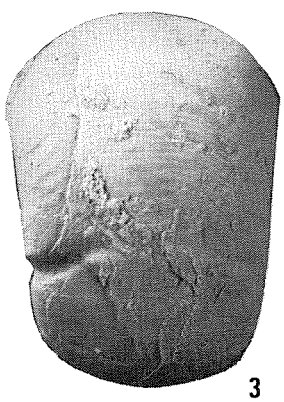

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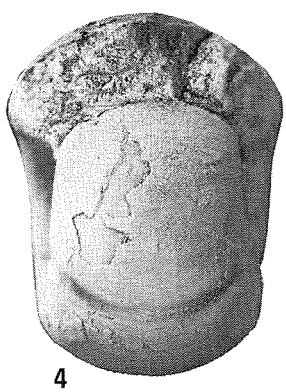

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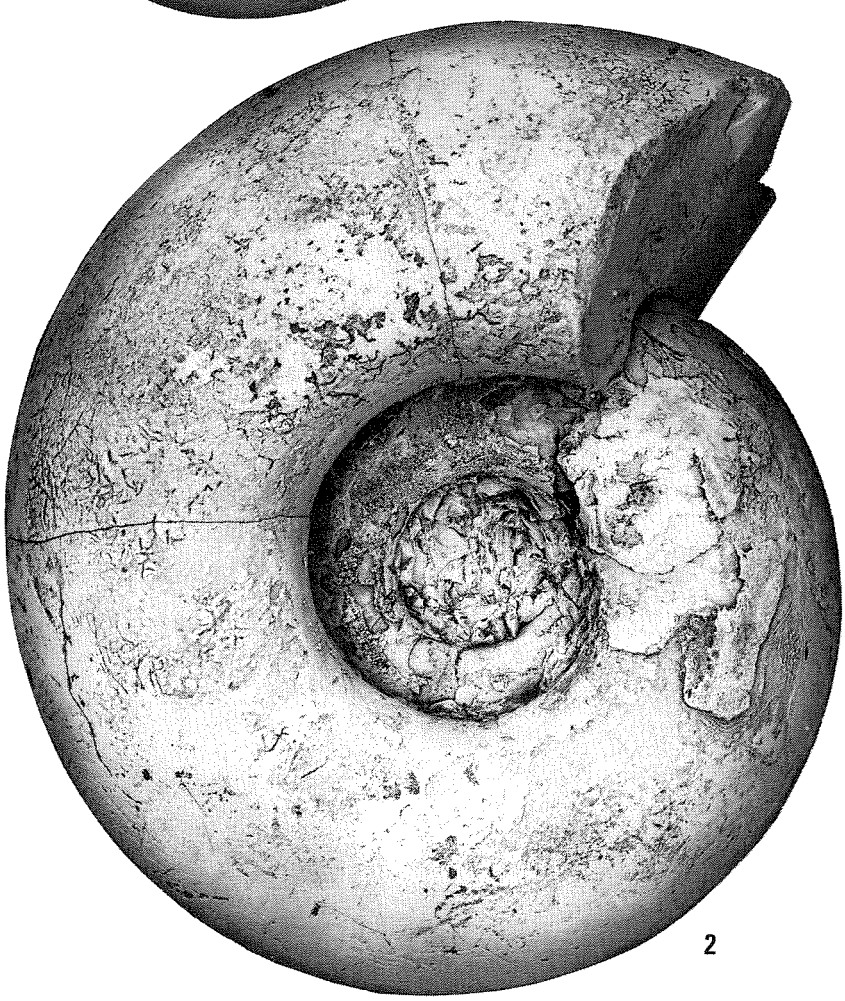

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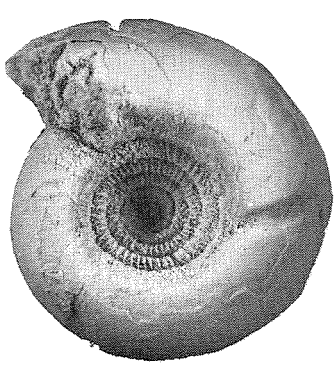

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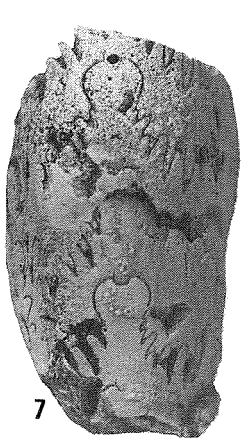

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AMMONOIDS

Plate 53

Figs 1–4 *Metalegoceras striatum* Teichert 1942

1, 2. **Holotype,** UWA 20508; x3.
3, 4. **Hypotype,** CPC 1769; x2.5.
Nura Nura Ridge, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 5, 6 *Metalegoceras kayi* Glenister, Windle & Furnish 1973

Holotype, UWA 45246; x2.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 7–14 *Metalegoceras australe* (Smith 1927)

7–9. **Hypotype,** UWA 35776; x2.5.
10. **Hypotype,** CPC 1768; x2.5.
11. **Hypotype,** CPC 1767; x2.
12–14. UWA 19985 (**Cotype** of *M. clarkei*); x2.5.
Mount Wynne area, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

PLATE 53


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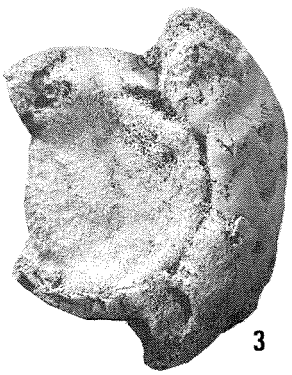
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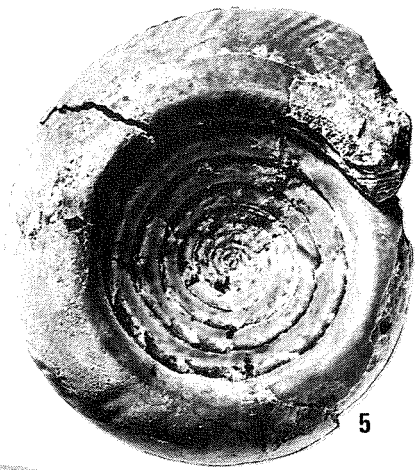
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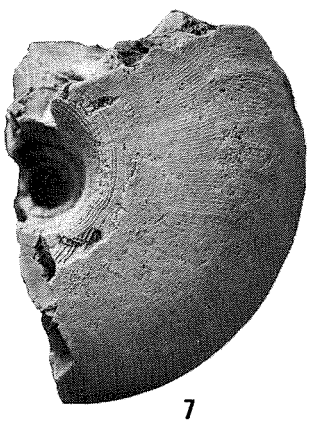
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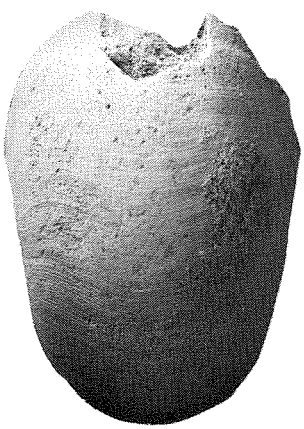
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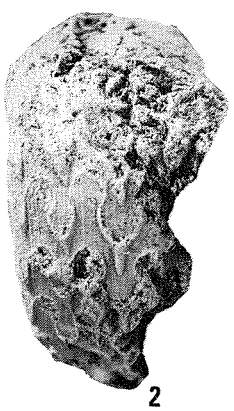
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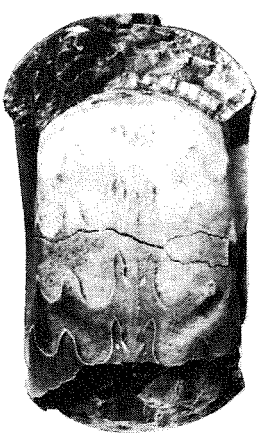
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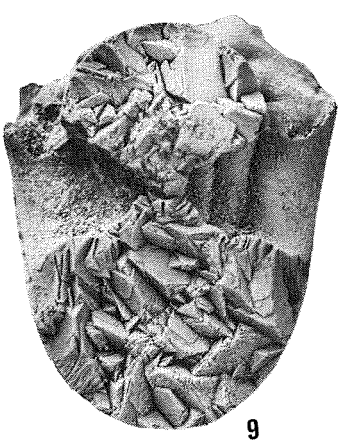
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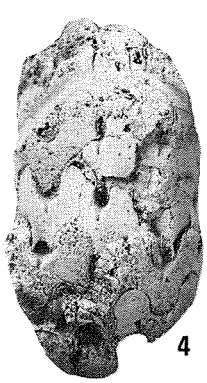
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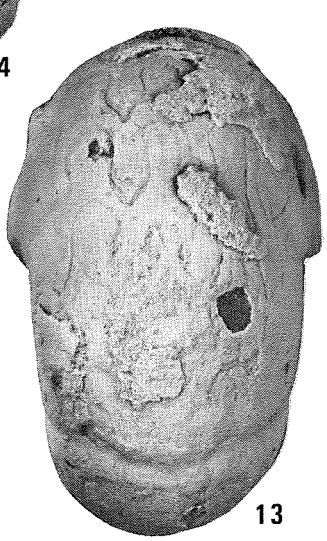
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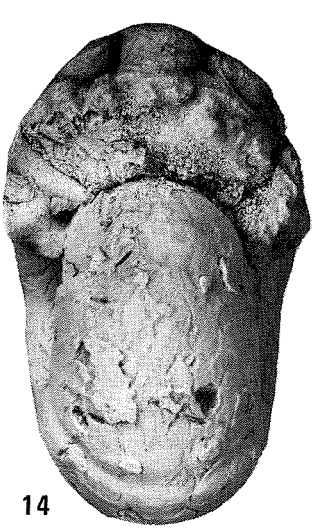
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AMMONOIDS

GSWA 22971

Plate 54

Figs 1, 2 *Neocrimites* sp.

Specimen CPC 1776; x3.
Mount Sandiman Woolshed area, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

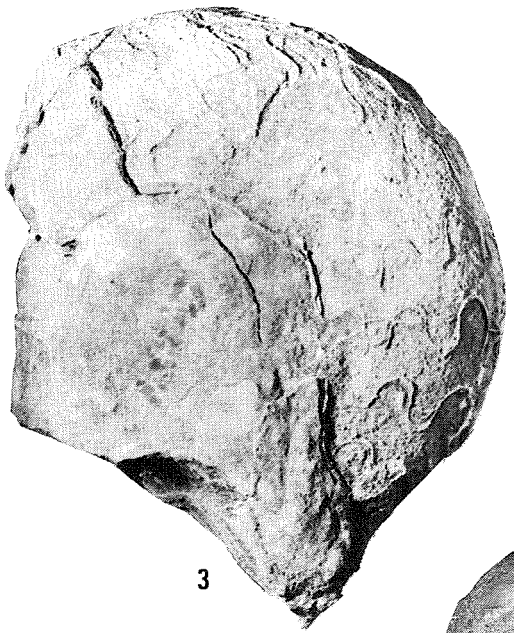
Figs 3–10 *Pseudoschistoceras simile* Teichert 1944

3, 4. **Hypotype**, GSWA F10163; x1.
Round Hill Well area, Carnarvon Basin; Cordalia Sandstone; Early Artinskian (Aktastinian).

5–7. **Paratype,** UWA 21440; x1.
8. **Holotype,** UWA 21326; x1.
9, 10. **Paratype**, UWA 21328; x1.
Barrabiddy Dam area on Wandagee Station, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Fig. 11 *Metalegoceras* sp. nov. Glenister & Furnish 1961

Specimen CPC 1770; x0.75
Lyons River Station, Carnarvon Basin; base of the Callytharra Formation; Late Sakmarian (Sterlitamakian).



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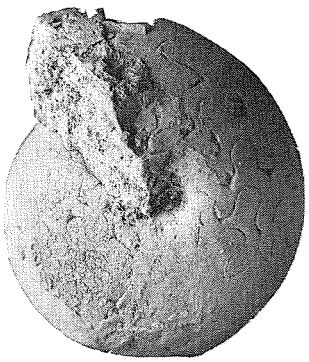

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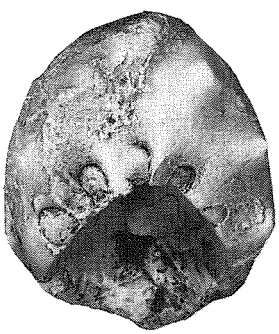

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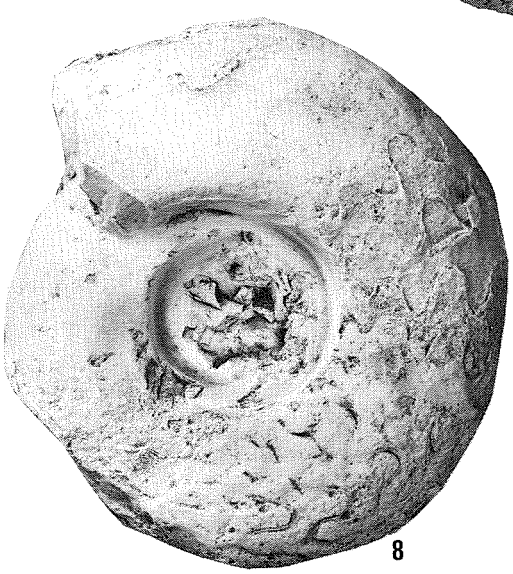

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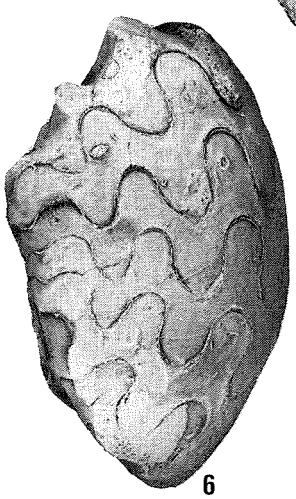

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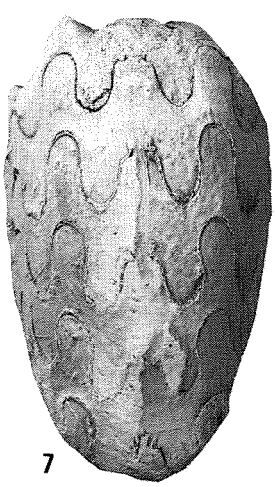

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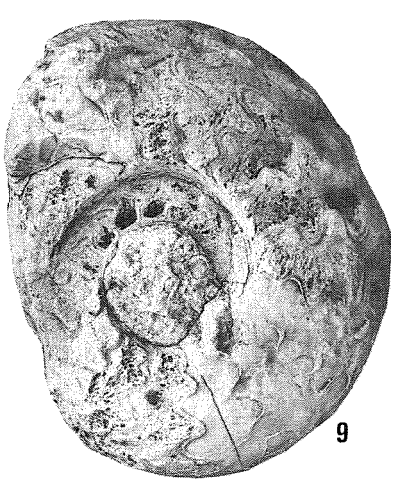

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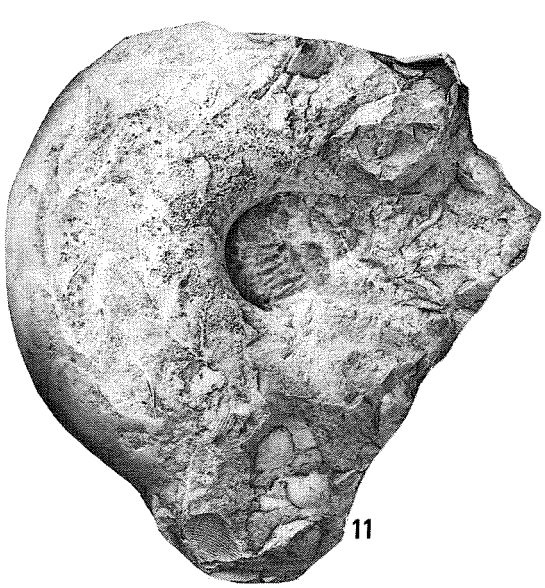

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AMMONOIDS

Plate 55

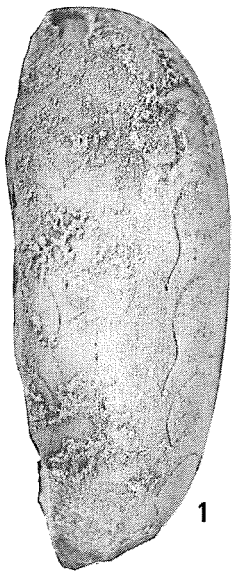
Figs 1–9 *Daubichites goochi* (Teichert 1942)

1, 2. **Hypotype**, CPC 1771; x1.5.
Duchess Ridge, northern Canning Basin; Lightjack Formation; Roadian.

3, 4. **Paratype**, UWA 20505; x1.5.
5. **Hypotype,** UWA 35777; x1.3.
Wandagee Station, Carnarvon Basin; Coolkilya Sandstone; Roadian.

6, 7. **Holotype,** UWA 20504; x1.
Near Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Roadian.

8, 9. **Hypotype,** CPC 1772; x3.
Duchess Ridge, northern Canning Basin; Lightjack Formation; Roadian.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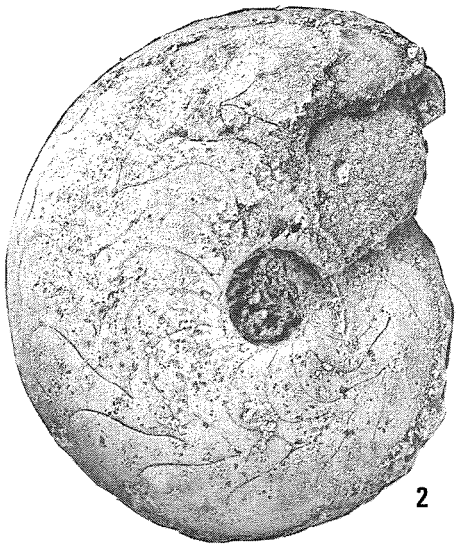
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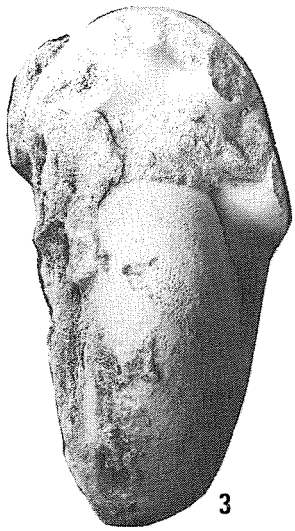
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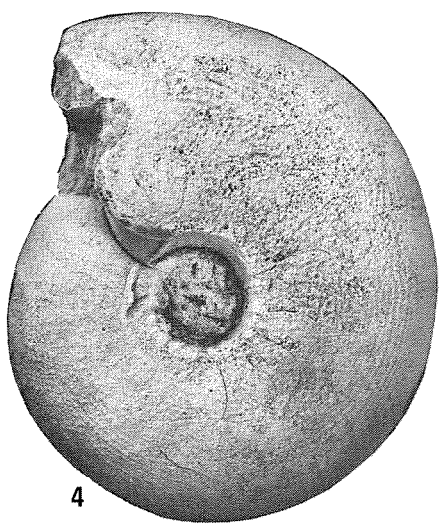
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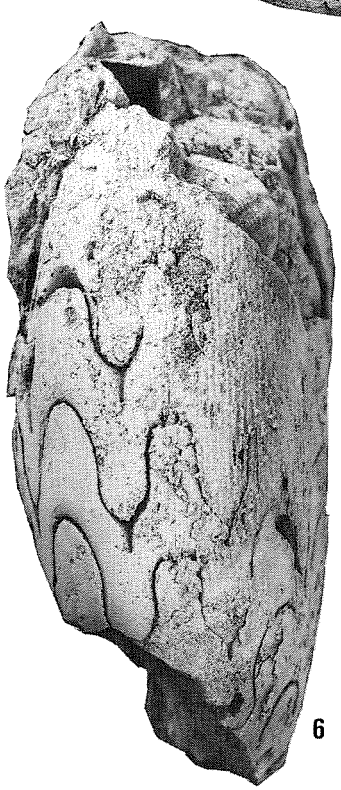
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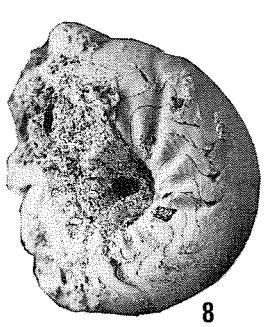
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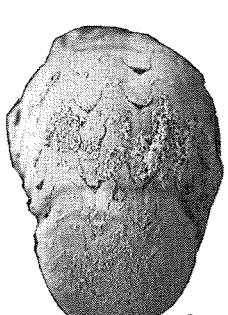
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AMMONOIDS

Plate 56

Specimens were coated with ammonium chloride, unless otherwise stated.

Figures 16, 17 and 20 are reproduced from Geological Survey of W.A. Bulletin 27 (Etheridge Jnr, 1907). Figures 36, 39 and 40 are from BMR Bulletin 41 (Dickens, 1957) and figures 1–15, 18–21, 23–35, 37 and 38 are from BMR Bulletin 63 (Dickins, 1963); all figures are reproduced with permission of the Director, Bureau of Mineral Resources.

Figs 1–3 *Warthia intermedia* Dickins 1963

Holotype, CPC 3979; in adapertural, side, and apertural views; x2. About 2.5 km southwest of Paradise Homestead, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 4, 5 *Warthia* sp. A cf. *W. micromphala* (Morris 1845)

Specimen CPC 3984; in side and tilted apertural views; x1. From Dry Corner Syncline, Canning Basin; upper Liveringa Group; Chhidruan.

Figs 6, 10, 11 *Warthia? carinata* Dickins 1963

Holotype, UWA 45432; in adapertural, side, and apertural views; x4. Mount Wynne, about 2 km east of Nura Nura Ridge, northern Canning Basin; Nura Nura Member of the Poole Formation; Late Sakmarian (Sterlitamakian).

Figs 7, 8, 12 *Euphemites wynnensis* Dickins 1963

7, 8. **Holotype**, CPC 3986; specimen in side and apertural views; x2.
12. **Paratype**, CPC 3990; plasticene squeeze; x2.
About 2 km southwest of Paradise Homestead, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 9, 13–15 *Stachella crucilirata* Dickins 1963

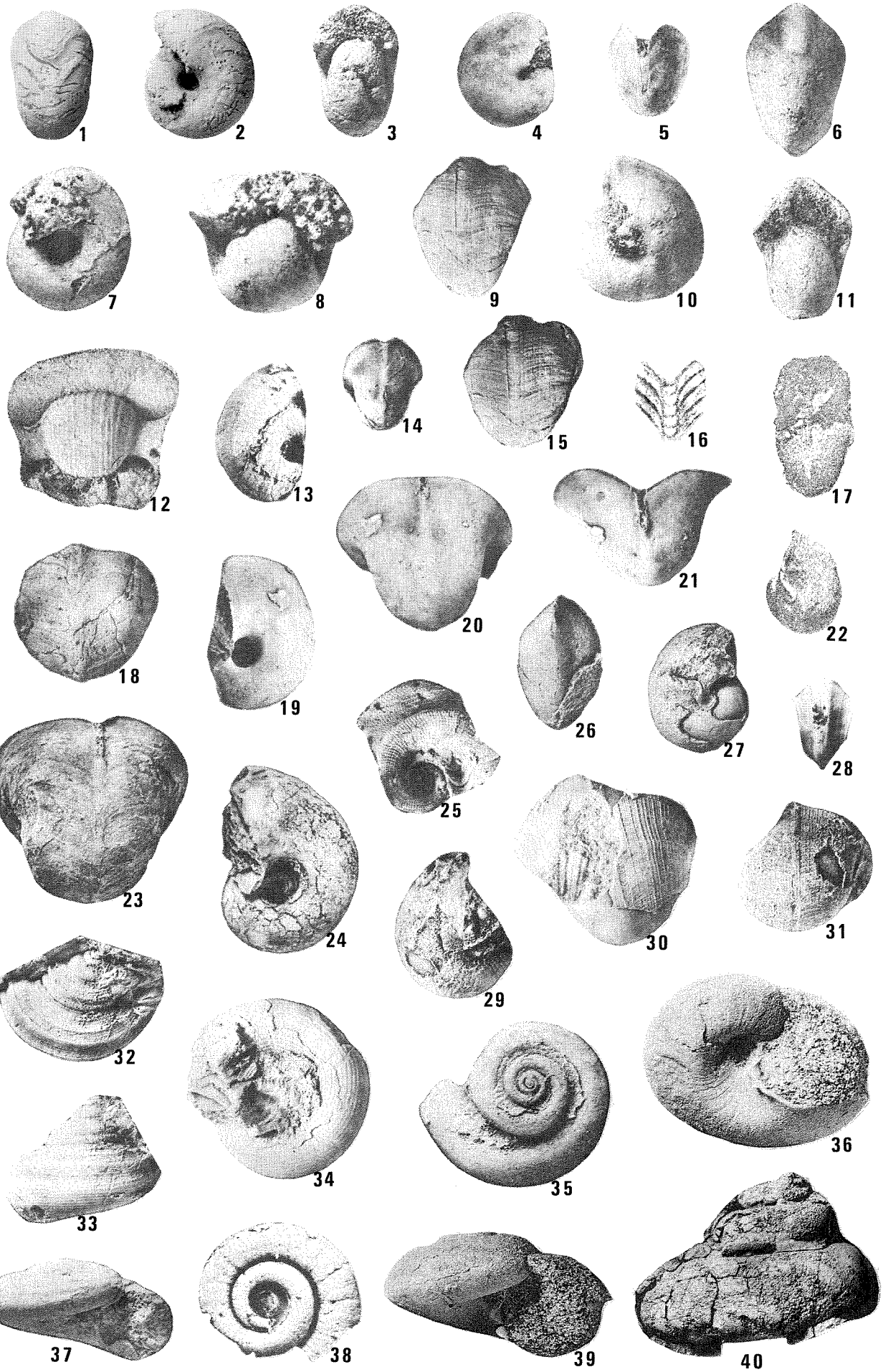
9, 13, 15. **Paratype**, CPC 3973; in adapertural, side and tilted adapertural views; x2.
14. **Holotype**, CPC 3972; internal impression in adapertural view; x1.
Becketts Gully, 0.7 km above road crossing, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 16, 17, 22 *Bellerophon costatus* Sowerby 1834

One specimen showing detail of sculpture, one in adapertural, and another in side views (after Etheridge Jnr, 1907, pl. 7 figs 11, 14, 15). Irwin River area, Perth Basin; probably Fossil Cliff Member; Late Sakmarian (Sterlitamakian).

Figs 18–21 *Bellerophon formani* Dickins 1963

18. **Paratype**, CPC 3967; latex cast of internal impression in adapertural view; x1.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19–21. **Holotype**, CPC 3966; in side and adapertural views showing apertural slit; x1.
25 km at 120° from Mount Tuckfield, southern part of Saint George Ranges; near base of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 23, 24 *Bellerophon* sp. cf. *B. formani* Dickins 1963

23. Specimen UWA 45422; in adapertural view; x1.
24. Specimen UWA 45423; in side view; x1.
Old Glendevon Homestead area on Woolaga Creek, Irwin River area, Perth Basin; High Cliff Sandstone; Early Artinskian (Aktastinian).

Figs 25, 28 *'Retispira' clarkei* Dickins 1963

25. **Paratype**, CPC 3978; side view of latex cast; x2.
28. **Holotype**, CPC 3977; adapertural view of internal impression; x2.
Carynginia Gully, about 0.8 km at 334° from Carynginia (No. 1) Well, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 26, 27 *Bellerophon* sp. nov. A

Specimen UWA 45427; in adapertural and side views; x1.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 29–31 *Retispira irwinensis* Dickins 1963

29, 31. **Holotype**, UWA 45429; in side and adapertural views; x2.
30. **Paratype**, UWA 45430; in adapertural view; x2.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 32–34 *Baylea perthensis* Dickins 1963

32, 33. **Holotype**, UWA 45446; in tilted apical and side views; x4.
34. **Paratype**, UWA 45447; in basal view; x4.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 35, 37 *Keeneia?* sp. nov.

Holotype, UWA 45449; in apical and apertural views; x4.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 36, 39 *Keeneia carnarvonensis* Dickins 1957

Holotype, CPC 2264; in oblique-ventral and apertural views; x4.
1.6 km west of Kialawibri Creek road crossing, Carnarvon Basin; upper part of Lyons Group; Early Sakmarian (Tastubian).

Fig. 38 *Straparolus (Leptomphalus) besselensis* Dickins 1963

Holotype, CPC 4010; in apical view; x4.
2.5 km southwest of Paradise Homestead, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).

Fig. 40 *Platyschisma?* sp. nov.

Specimen CPC 2266; in lateral view; x1.
5.4 km south of Coyango Well on Williambury Station; Lyons Group; Asselian–early Sakmarian.

Plate 57

Specimens were coated with ammonium chloride, unless otherwise stated.

Figures 15, 16, 22, 23, 24, 27 and 28 are reproduced from Paleontology (Dickins, 1961) with the permission of the Palaeontological Association. Figures 3, 6, 17 and 18 are from BMR Bulletin 41 (Dickins, 1957), and the rest of the figures are from BMR Bulletin 63 (Dickins, 1963); all figures are reproduced with permission of the Director, Bureau of Mineral Resources.

Fig. 1 *Mourlonia (Pseudobaylea) freneyensis* Dickins 1963

Holotype, CPC 3999; in side view; x2.
2.3 km southwest of Paradise Homestead, northern Canning Basin; Nura Nura Member of Poole Sandstone; Late Sakmarian (Sterlitamakian).

Figs 2, 9 *Mourlonia (Mourlonia)* sp. nov. A

Specimen CPC 3997; in side and apical views; x4.
48 km west-northwest of Curbur Homestead, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 6 *Mourlonia (Mourlonia) lyndonensis* Dickins 1957

3. **Holotype**, CPC 2255; side view; x2.
6. **Paratype**, CPC 2257; tilted apical view; x2.
4.8 km northwest of Round Hill Well, 1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin; upper Lyons Group; Early Sakmarian (Tastubian).

Fig. 4 *Ptychomphalina maitlandi* Etheridge Jnr 1903

Lectotype, GSWA F169A; in side view; x1 (after Etheridge Jnr, 1903, pl. 1 fig. 13).
Wandagee Station, Carnarvon Basin; ?Wandagee Formation; Late Artinskian (Baigendzhinian).

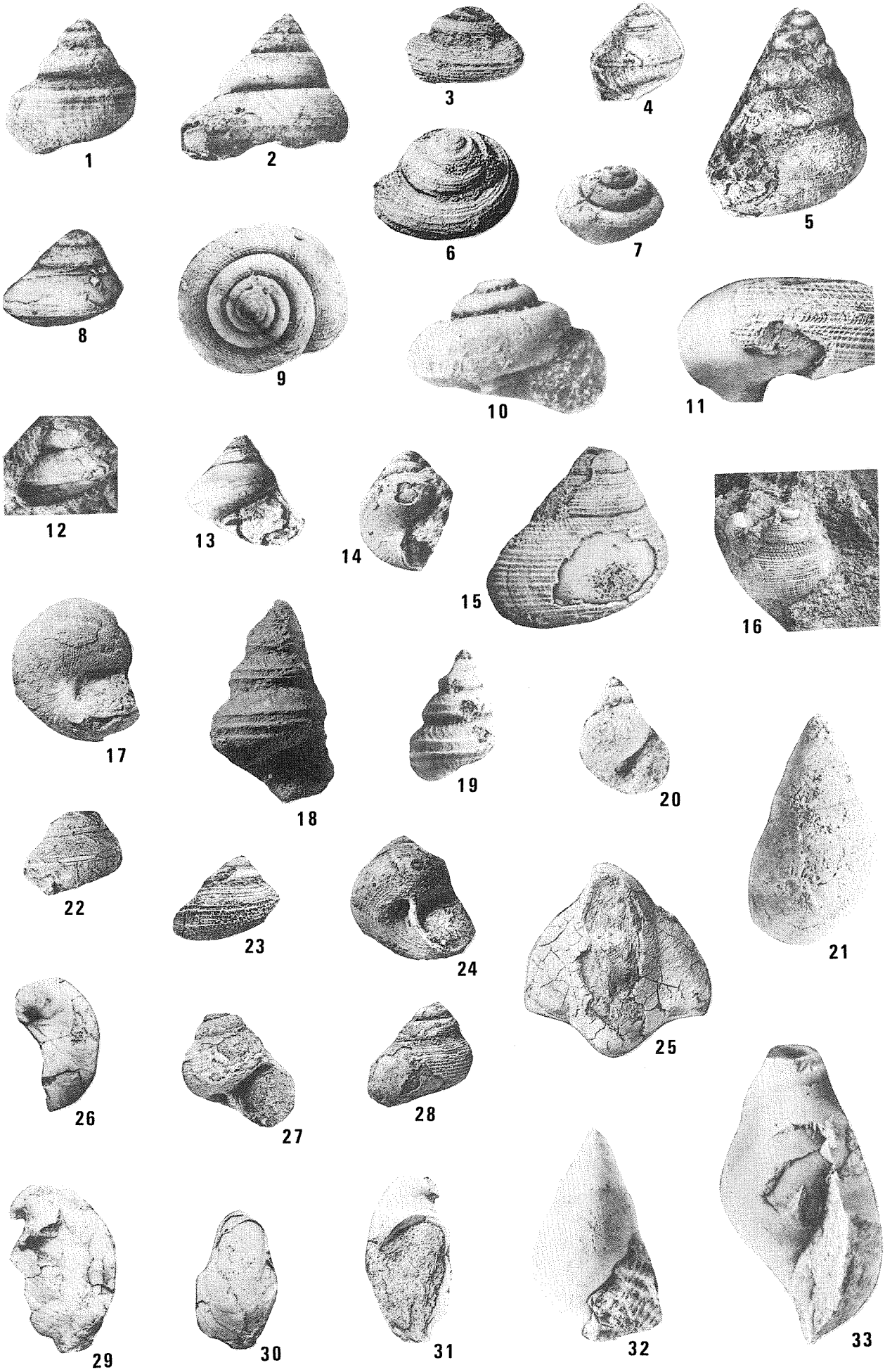
Figs 5, 11 *Mourlonia (Woolnoughia) angulata* Dickins 1963

5. **Holotype**, UWA 45436; side view; x1.
11. **Paratype**, UWA 45439; detail of ornament; x4.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 7, 10 *Mourlonia? obscura* Dickins 1963

7. **Holotype**, CPC 3993; tilted apical view of latex cast; x4.
Carynginia Gully about 0.75 km at 334° from Carynginia Well, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

10. **Paratype**, CPC 3995; apertural view; x4.
2.5 km southwest of Paradise Homestead, northern Canning Basin; Nura Nura Member of the Poole Sandstone; Late Sakmarian (Sterlitamakian).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Figs 8, 12, 13 *Ptychomphalina talboti* Dickins 1963

8, 13. **Paratype**, UQGD F27126; specimen in side and apertural views; x1.
Fossil Cliff or Fossil Ridge, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

12. **Holotype**, CPC 4007; in side view; x1.
Fossil Ridge, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 14, 19 *Peruvispira* sp. cf. *P. umariensis* (Reed 1928)

Latex cast of CPC 4009; in tilted basal and lateral views; x4.
Carynginia Gully, about 0.75 km at 334° from Carynginia Well, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Figs 15, 16, *Platyteichum johnstonei* Dickins 1961

15. **Holotype**, CPC 108; in side view; x2 (after Dickins, 1961, pl. 17 fig. 9).
7.2 km west of south of Merlinleigh Homestead, Carnarvon Basin; Nalbia Sandstone; Late Artinskian (Baigendzhinian)–early Kungurian.

16. **Paratype**, UWA 42115; x1 (after Dickins, 1961, pl. 17 fig. 12).
3.2 km north-northeast of Trig. Station 56, Carnarvon Basin; top of Bulgadoo Shale or bottom of Cundlego Formation; Late Artinskian (Baigendzhinian).

Figs 24, 27, 28 ?*Platyteichum johnstonei* Dickins 1961

24, 27, 28. Specimen CPC 109; in three views; x1 (after Dickins, 1961, pl. 17 figs. 3, 2, 1).
2.6 km southeast of Muderong Bore, Middalya Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Figs 17, 18 *Peruvispira umariensis* (Reed 1928)

Hypotype, CPC 2259; in tilted ventral and apertural views; x4.
4.8 km northeast of Round Hill Well, 1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin; upper Lyons Group; Early Sakmarian (Tastubian).

Fig. 20 *Naticopsis?* sp. nov.

Specimen UWA 45460; in apertural view; x1.
Old Glendevon Homestead area, Woolaga Creek, Irwin River area, Perth Basin; basal High Cliff Sandstone; Early Artinskian (Aktastinian).

Figs 21, 32, 33 *Macrochilina winensis* Dickins 1963

21, 32. **Holotype**, UWA 45455; in side and apertural views; x4.
Fossil Ridge, Irwin River area, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

33. **Paratype**, UWA 45458 in oblique apertural view; x8.
Becketts Gully, Perth Basin; labelled 'Upper Holmwood Shale', but probably Fossil Cliff Member of the Holmwood Shale (Dickins, 1963, p.134).

Figs 22, 23 *Platyteichum?* sp. nov.

22. Specimen CPC 111; in side view; x1 (after Dickins, 1961, pl. 17 fig. 8).
About 5 km from Trig. Station K38 on a bearing of 197°, and 9 km from Walbarune Peak (K40) on a bearing of 340°, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

23. Specimen CPC 110; in side view; x1 (after Dickins, 1961, pl. 17 fig. 7).
7.2 km west of south of Merlinleigh Homestead, Carnarvon Basin; Nalbia Sandstone; Late Artinskian, Early Kungurian.

Fig. 25 *Platyceras* sp. nov.

Specimen CPC 4014; in apertural view; x1.
About 3.2 km north-northeast of Round Hill Well, Winning Station, Carnarvon Basin; near base of Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 26, 29–31 *Platyceras* sp. cf. *P. abundans* (Wanner 1922)

26, 30. Specimen UWA 45450; in side and adapertural views; x1.
29, 31. Specimen UWA 45454; in side and apertural views; x1.
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).

Plate 58

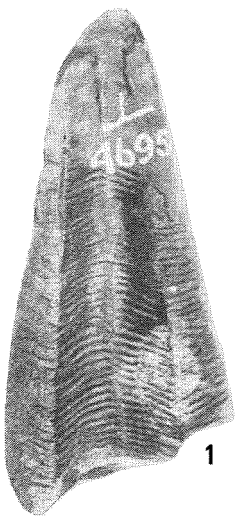
Figures are natural size, unless otherwise indicated.

Figs 1–5 *Paraconularia* sp. cf. *P. warthi* (Waagen)

1. Slightly crushed shell; GSWA 1/4695; x0.9 (after Hosking, 1931, pl. 11 fig. 6).
2. Impression showing ornamentation; UWA 8478 (after Hosking, 1931, pl. 11 fig. 3).
3, 4. Two views of shell; GSWA 1/4695 (after Hosking, 1931, pl. 11 figs 4, 5).
5. Worn shell showing corner groove and two sides; GSWA 1/4695.
Byro Group, Carnarvon Basin; Late Artinskian (Baigendzhinian).

Figs 6–9 *Paraconularia* sp. nov.

6. **Holotype**, AM F45107; internal mould in oblique view showing corner groove and two sides with deep longitudinal septa.
7. **Paratype**, AM F45102; latex cast of external impression showing costal and corner groove; x3.
8, 9. **Paratype**, CPC 24401; worn mould showing two sides.
Port Keats area, NT; 'Upper Marine Beds', Hyland Bay Formation; Chhidruan.



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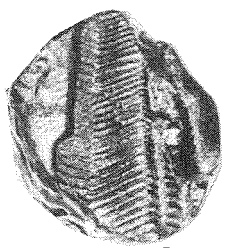

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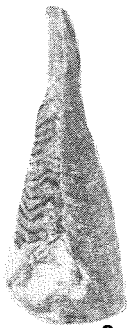

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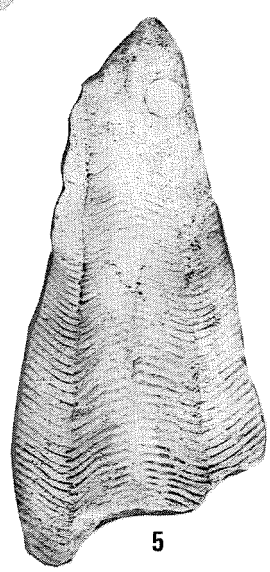

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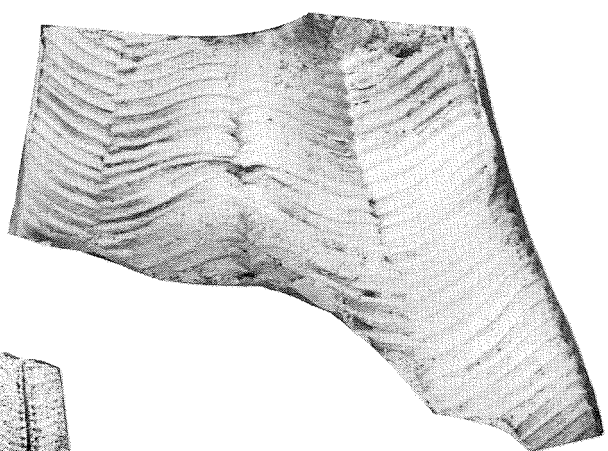

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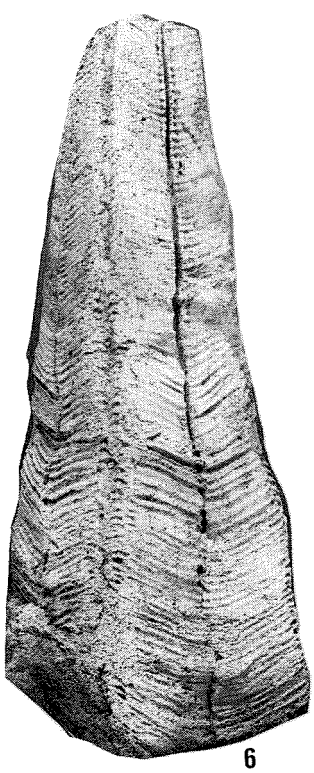

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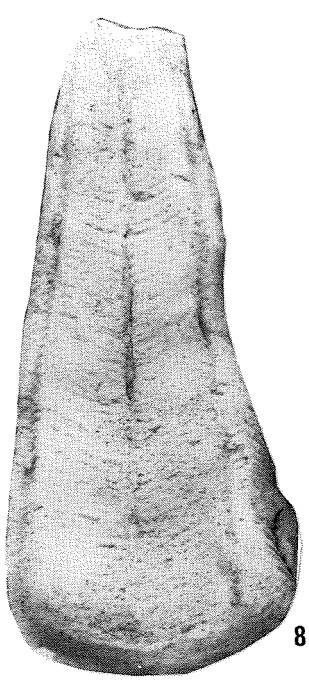

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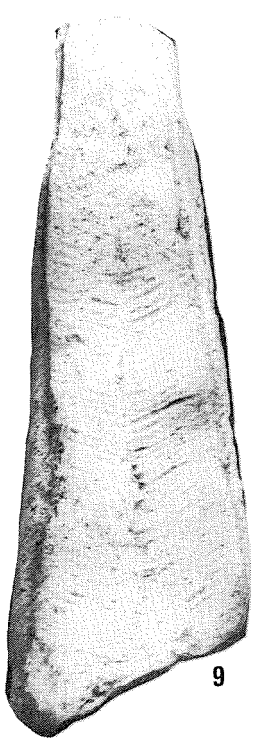

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CONULARIIDS

Plate 59

All specimens are from the Late Sakmarian (Sterlitamakian) Fossil Cliff Member of the Holmwood Shale at the Fossil Cliff, Perth Basin.

All figures are from South Australian Department of Mines and Energy, Special Paper no. 5 (Fleming *in* Foster et al., 1959), and reproduced with permission of the Director General, South Australian Department of Mines and Energy.

Fig. 1 *Hollinella?* sp.

Rear part of strongly reticulate but non-tuberculate right valve; WAM 83.2753, WA17; SEM, x120.

Fig. 2 Kirkbyacean? indet. sp. A

Fragment of valve with strong ridge and reticulation, and tubercles in marginal region; WAM 83.2754, WA16; SEM, x80.

Fig. 3 Kirkbyacean? indet. sp. B

Right valve of complete carapace; strongly inflated, sinuous ventral profile, smooth carapace, slight kirkbyan pit above mid-height; WAM 83.2755, WA17; SEM, x150.

Figs 4–6 *Roundyella ludbrookae* Fleming 1985

4. Interior of left valve; WAM 83.2723, WA16; SEM, x110.
5. Exterior of right valve; WAM 83.2724, WA16; SEM, x120.
6. **Holotype**, exterior of exquisitely preserved left valve; WAM 83.2722, WA16; SEM, x80.

Figs 7–10 *Bairdia* sp. A

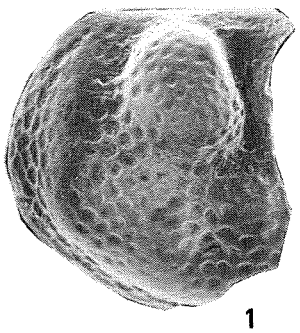
7. Right-hand view of small carapace, probably instar; WAM 83.2725, WA16; SEM, x60.
8. Right-hand view of complete carapace; WAM 83.2726, WA16; SEM, x60.
9. Interior of left valve; WAM 83.2729, WA17; SEM, x60.
10. Interior of thick right valve; WAM 83.2730, WA17; SEM, x80.

Fig. 11 *Bairdia* sp. B

Right-hand view of complete carapace, showing, in comparison with *Bairdia* sp. A (Pl. 59 figs 7 - 10), lower profile, less acuminate rostrum, and finer pustules; WAM 83.2732, WA17; SEM, x60.

Figs 12–15 *Healdia irwinensis* Fleming 1985

12. Probable adult right valve, with tips of stout spines broken away; WAM 83.2735, WA17; SEM, x70.
13. Interior of probable adult left valve, with upper spine broken; WAM 83.2736, WA17; SEM, x70.
14. Interior of probable adult right valve with stout spines and small muscle field slightly behind centre; WAM 83.2737, WA17; SEM, x120.
15. **Holotype**, Right-hand view of complete carapace; WAM 83.2733, WA16; SEM, x100.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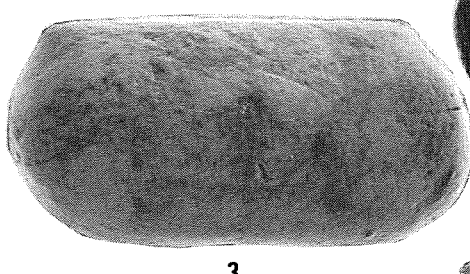
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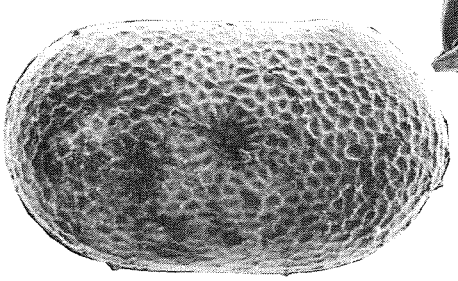
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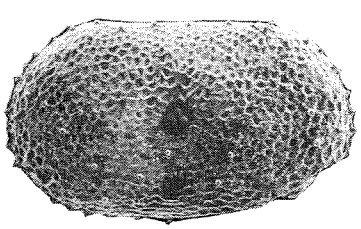
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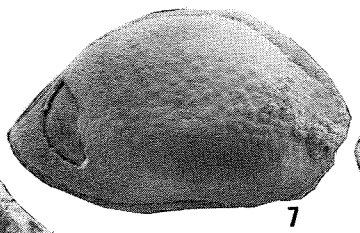
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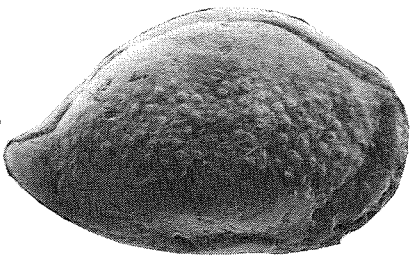
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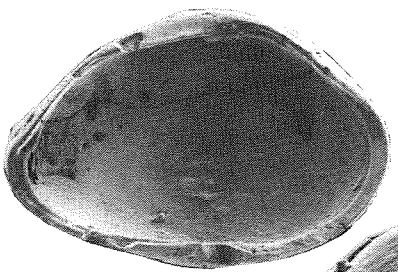
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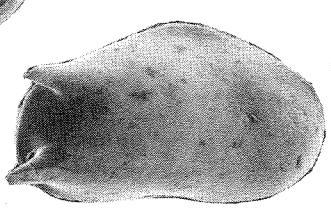
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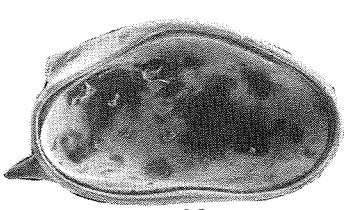
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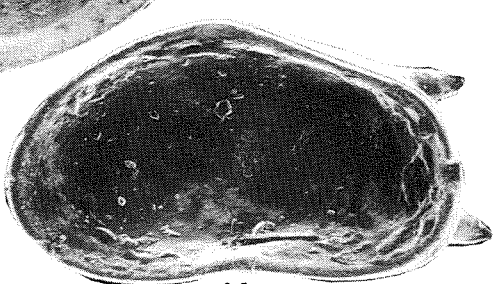
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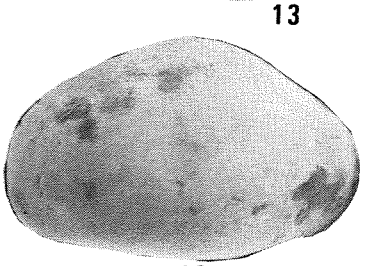
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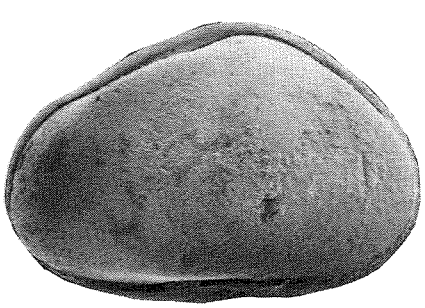
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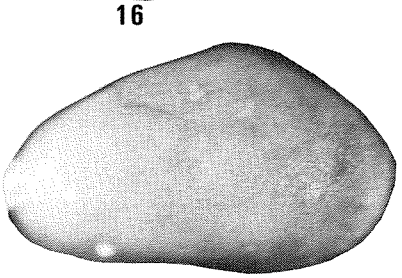
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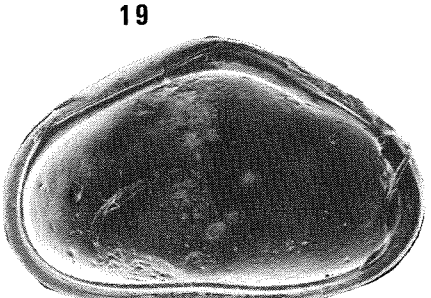
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OSTRACODS

GSWA 22977

Figs 16–18 *Healdia* spp. B

16. Exterior of left valve; WAM 83.2742, WA17; SEM, x100.
17. Right-hand view of complete carapace; WAM 83.2743, WA16; SEM, x70.
18. Interior of left valve; WAM 83.2744, WA17; SEM, x110.

Figs 19–20 *Healdia* spp. A

Respectively SEM, x80, and optical micrograph, x100, slightly different orientations; fine pores? shown in fig. 20 apparently covered by coating in SEM photo of fig. 19; WAM 83.2741, WA17.

Plate 60

All specimens are from the Late Sakmarian (Sterlitamakian) Fossil Cliff Member of the Holmwood Shale at Fossil Cliff, Perth Basin.

All figures are from South Australian Department of Mines and Energy, Special Paper no. 5 (Fleming *in* Foster et al., 1959), and reproduced with permission of the Director General, South Australian Department of Mines and Energy.

Figs 1, 2 *Healdia chapmani* Crespin 1945

1. Interior of left valve showing, compared with *Healdia irwinensis* sp. nov. (Plate 59 figs 12–15), higher profile, convex venter, coarser marginal structure, and larger and lower muscle field; WAM 83.2739, WA17; SEM, x120.
2. Left-rear view of complete carapace with tips of spines and antero-dorsal part broken; WAM 83.2738, WA16; SEM, x100.

Fig. 3 *Healdia grayi* (Crespin 1945)

Interior of left valve; WAM 83.2740, WA17; SEM, x70.

Fig. 4 *Healdioides* sp.

Exterior of left valve with very strong posterior arcuate ridge; WAM 83.2745, WA17; SEM, x150.

Figs 5, 9 Healdiacean indet.

5. Interior of left valve showing large circular muscle field and weak marginal structures; WAM 83.2757, WA17; SEM, x100.
9. Exterior of right valve; WAM 83.2756, WA17; SEM, x70.

Fig. 6 Cavellinidae indet.

Right-hand view of strongly inequivalve complete carapace; WAM 83.2759, WA16; SEM, x120.

Fig. 7 *Healdianella?* sp.

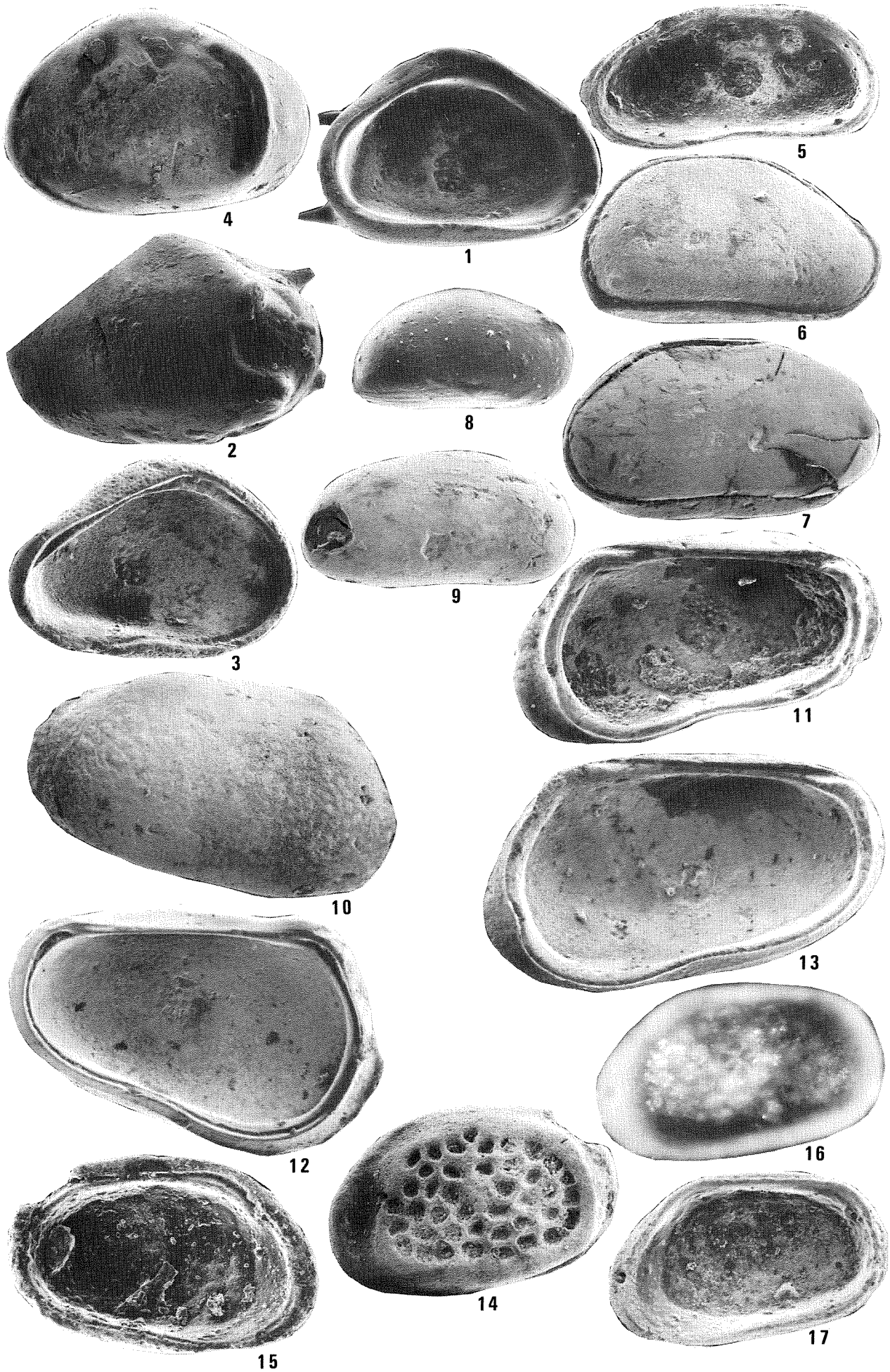
Right-hand view of crushed, strongly inequivalve carapace; WAM 83.2760, WA17; SEM, x80.

Fig. 8 Bairdiocyprinidae indet.

Exterior of left valve of probable instar; WAM 83.2758, WA17; SEM, x150.

Figs 10–13 *Graphiadactyllis alveiformis* Fleming 1985

10. Exterior of right valve with rough surface; WAM 83.2747, WA16; SEM, x60.
11. Interior of thickened (old?) right valve with large, high muscle field; WAM 83.2749, WA16; SEM, x50.
12. **Holotype**, interior of left valve with small, high muscle field; WAM 83.2746, WA17; SEM, x70.
13. Interior of right valve with small muscle field; WAM 83.2748, WA17; SEM, x60.



OSTRACODS

Figs 14–17 *Zarinia ludbrookae* Fleming 1985

14. **Holotype,** exterior of left valve; sediment in some surface pits, postero-dorsal corner broken; WAM 83.2750, WA17; SEM, x150.
15. **Holotype,** interior of left valve of fig. 14; SEM, x150.
16. Interior of left valve, showing roseate muscle field; WAM 83.2751, WA17; optical micrograph, x150.
17. Interior of right valve; WAM 83.2752, WA17; SEM, x150.

Plate 61

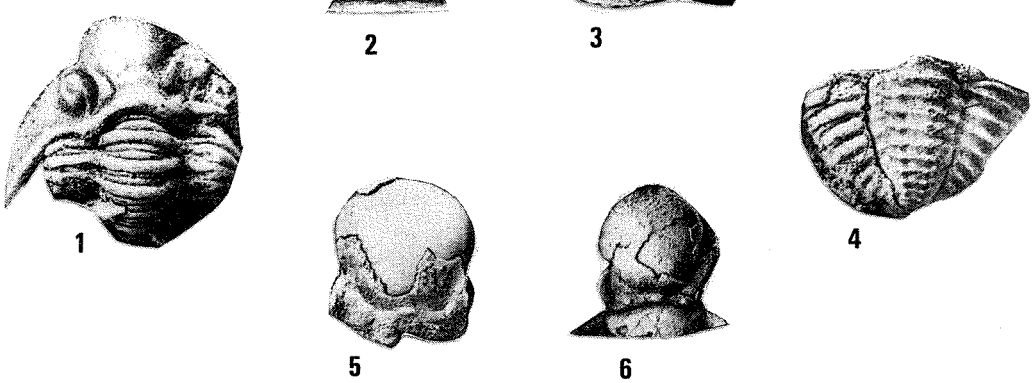
All figures are reproduced from the Journal of Paleontology with the permission of the Paleontological Society.

Figs 1–5 *Ditomopyge meridionalis* Teichert 1944

1. Cast of external mould of **holotype**, UWA 21331; x2 (after Teichert, 1944, pl. 77 fig. 5).
2. Posterior view of pygidium of **paratype**, UWA 21333; x2 (after Teichert, 1944, pl. 77 fig. 11).
3, 5. Lateral and dorsal views of **paratype**, UWA 21334; both x2 (after Teichert, 1944, pl. 77 figs 4 and 2).
4. Dorsal view of pygidium of **paratype**, UWA 21332; x2 (after Teichert, 1944, pl. 77 fig. 8).
Near Minilya River, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 6 *Ditomopyge?* sp. Teichert 1944

Dorsal view of cranidium, WAM F4860; x1 (after Teichert, 1944, pl. 77 fig. 6).
Fossil Cliff on Irwin River, Perth Basin; Fossil Cliff Member of the Holmwood Shale; Late Sakmarian (Sterlitamakian).



TRILOBITES

Plate 62

All figured specimens are from about 50 m above the base of the Wandagee Formation on the southeast limb of syncline north of Minilya River, about 1 km southwest of Coolkilya Pool, Carnarvon Basin, and are Late Artinskian (Baigendzhinian) in age.

Prior to photography the specimens were coated with ammonium chloride. All figures are magnified x2.

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Figs 1, 2, 8 *Monaster wandageensis* Kesling 1969

1. Aboral view of disc and arm bases with ornamentation incompletely indicated.
2. Oral view.
8. **Holotype**, UWA 26992a; oral view (after Kesling, 1969, text figs 1, 2; pl. 1 fig. 2).

Figs 3, 6, 7, 11 *Monaster carnarvonensis* Kesling 1969

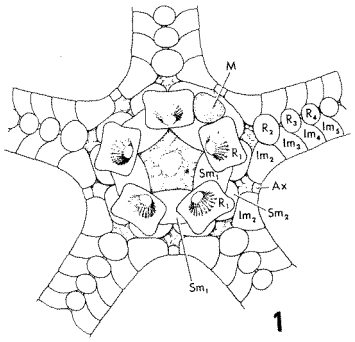
3. Aboral view with ornamentation incompletely indicated.
6. Oral view with ornamentation incompletely indicated.
7, 11. **Holotype**, UWA 26992d; in oral and aboral views (after Kesling, 1969, text figs 3, 4; pl. 1 figs 7, 8).

Figs 4, 5, 10, 12 *Permaster grandis* Kesling 1969

4. Aboral view of disc and arm bases; one Sm1 removed (at left) to show extent of underlying Sm2 plates.
5. Oral view, short Admm spines shown on base of upper arm.
10 - 12. **Holotype**, UWA 26992e; in oral, ?aboral and side views (after Kesling, 1969, text figs 5, 6; pl. 1 fig. 9; pl. 2 fig. 2).

Fig. 9 *?Monaster wandageensis* Kesling 1969

Aboral view of badly weathered disc; UWA 26992b (after Kesling, 1969, pl. 1 fig. 3).



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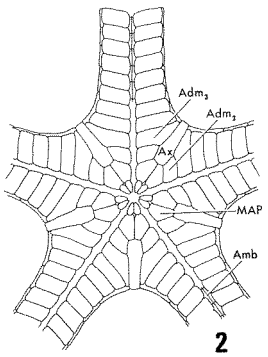

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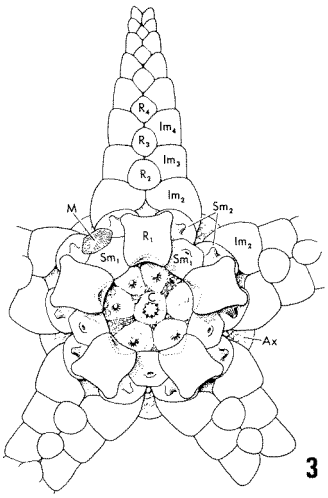

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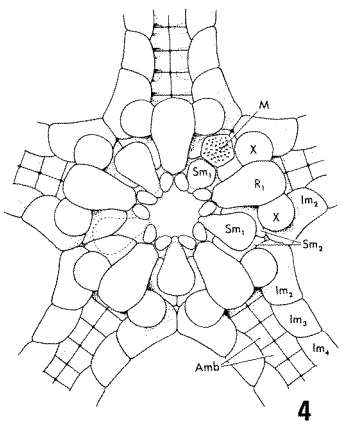

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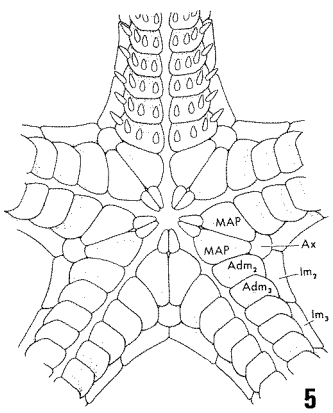

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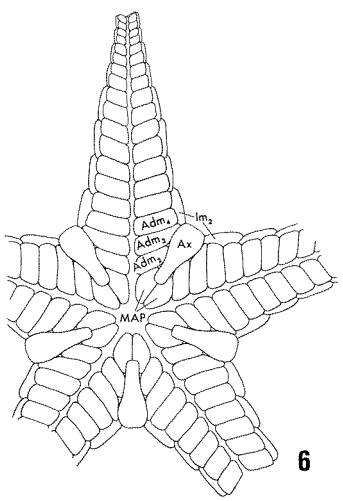

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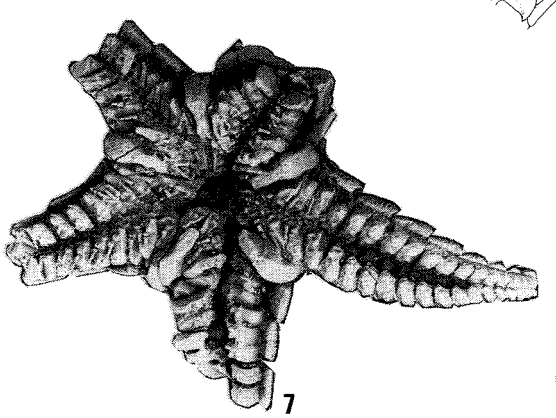
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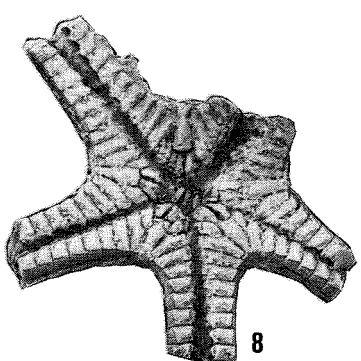
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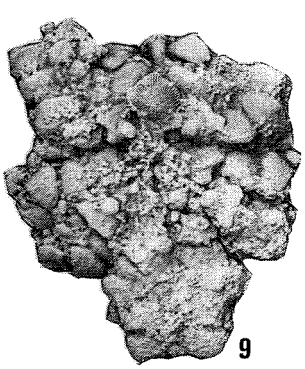
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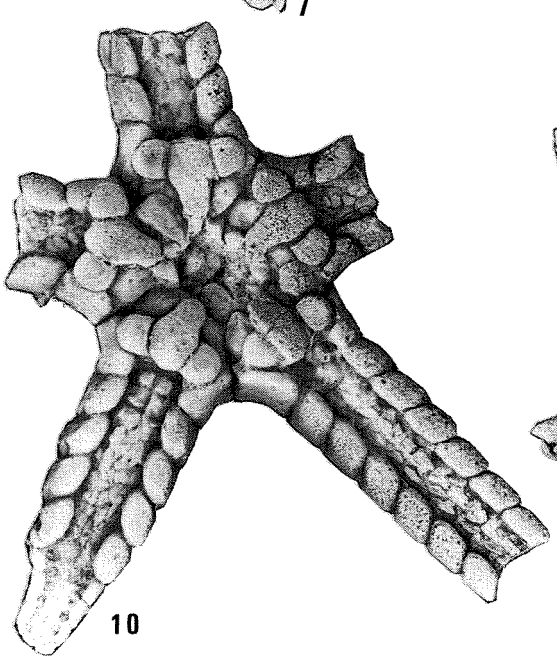
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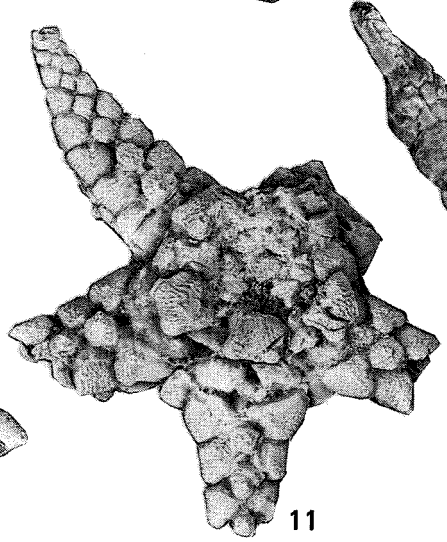
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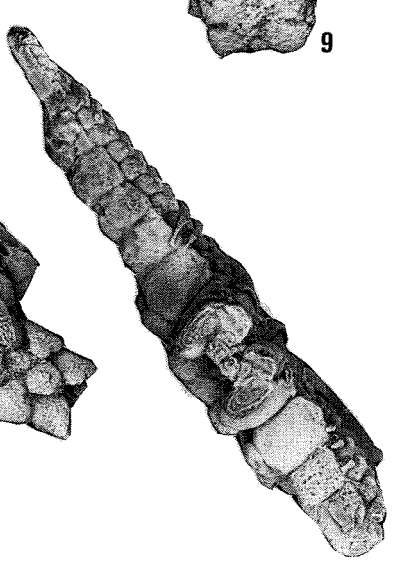
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ASTEROIDS

Plate 63

All figures are magnified x3.

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Figs 1, 2, 7, 10, 11, 16 *Neoschisma australe* Breimer & Macurda 1972

1. Internal view of isolated deltoid, UWA 5714A.
2, 7. **Holotype**, UMMP 58682; in oral and lateral (CD) views.
10. Inclined oral view of C radial; BMR GW137.
11. Lateral view of D radial; BMR GW137.
16. Oral view of reassembled isolated plates.

Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 9, 12 *Notoblastus stellaris* Breimer & Macurda 1972

3. Oral view of isolated deltoid; UWA 5714E.
9. **Holotype**, UMMP 58683; in inclined oral view (centred on B).
12. **Holotype**, in lateral (B) view.

Callytharra Spring area, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 4, 5, 14, 15 *Notoblastus* sp.

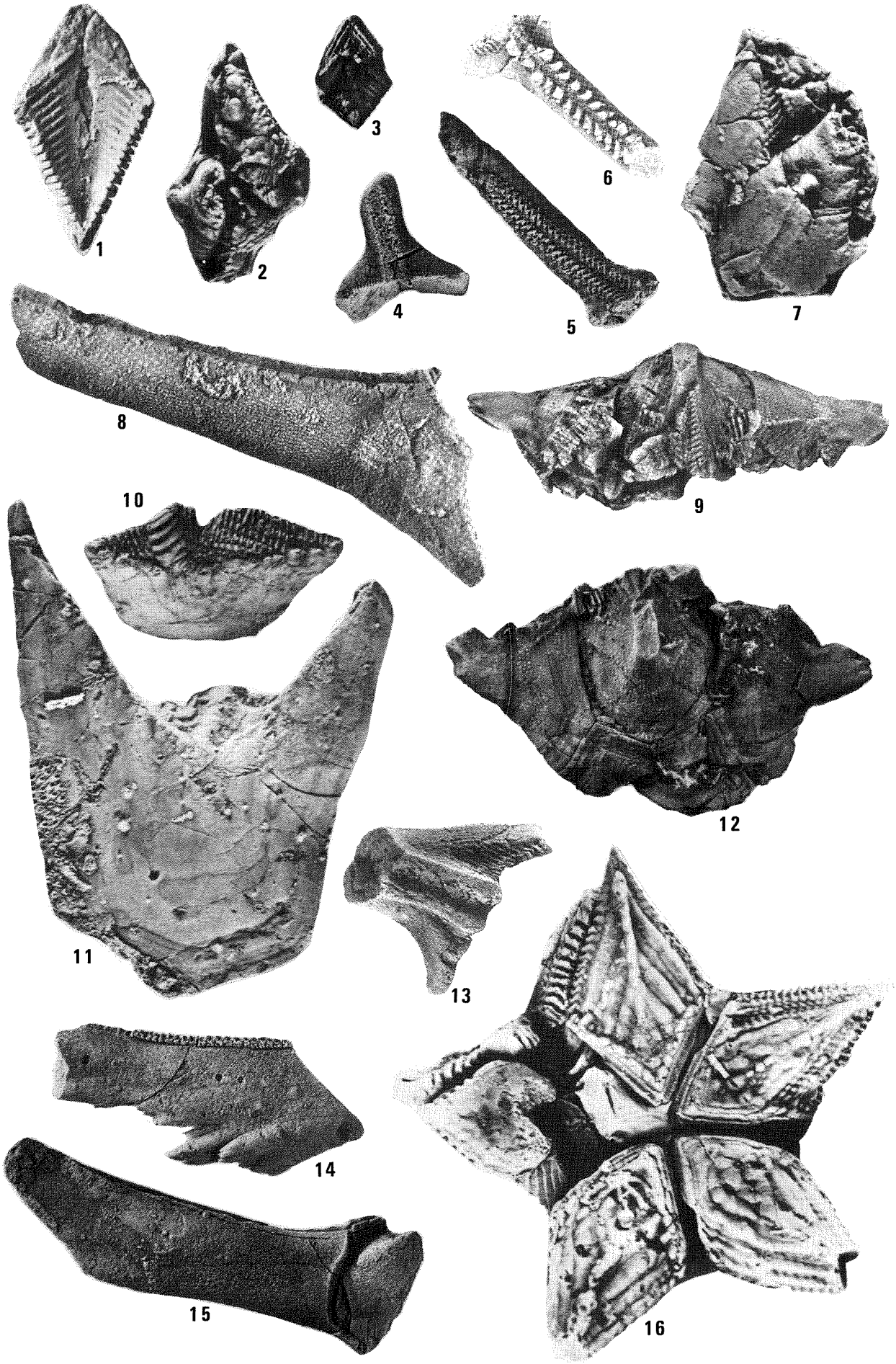
4. Oral view of radial with broken prong; UMMP 59727.
5. Oral view of median part of radial prong; UMMP 59726.
14. Lateral view of median part of radial prong; UMMP 59729.
15. Lateral view of radial prong; UMMP 59728.

West side of north - south wash, 0.2 km south of Wooramel River, 0.4 km south-southeast of junction of Wooramel River and Bilung Creek, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 6, 8, 13 *Thaumatoblastus longiramus* Wanner 1924

6. Oral view of radial part of prong.
8. Lateral view of radial and part of prong.
13. Oral view of part of radial.

North bank of Lyndon River east of Mia Mia Homestead, Carnarvon Basin (BMR locality ML87); Coyrie Formation; Late Artinskian (Baigendzhinian).



BLASTOIDS

Plate 64

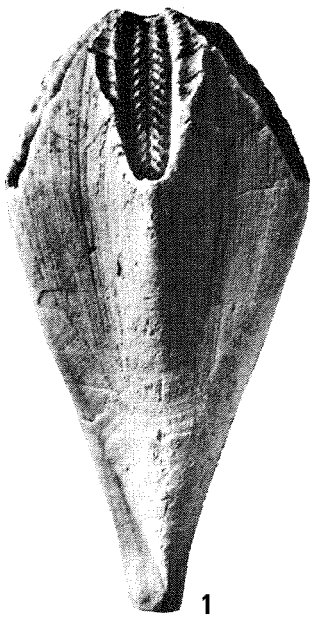
All figures are reproduced from Contributions from the Museum of Paleontology, the University of Michigan (Macurda, 1973), with the permission of The University of Michigan, USA.

Figs 1, 2, 4, 6, 7 *Rhopaloblastus* sp.

1, 2. Lateral view, centred on E ambulacrum, and oral view, anus at 6 o'clock, of complete theca; GSWA F5712; x3.5.
4, 6. View of stereom in interior of radial in weathered right RB sector; UMMP 60499; x100 and x1000 respectively.
7. View of an ambulacrum from an aboral direction; UMMP 60497; x100.
Creek 0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 3, 5 *Neoschisma australe* Breimer & Macurda 1972

View of a posterior left lateral edge of a deltoid from a somewhat forward internal vantage point; UMMP 60501; x100 and x1000.
Creek, 0.8 km west of Callytharra Spring, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).



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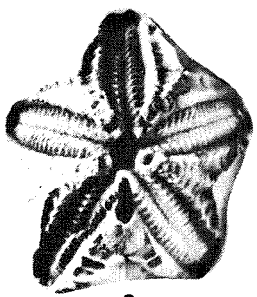

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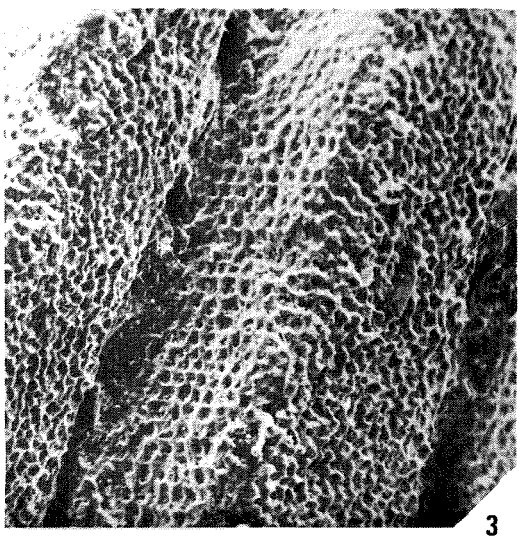

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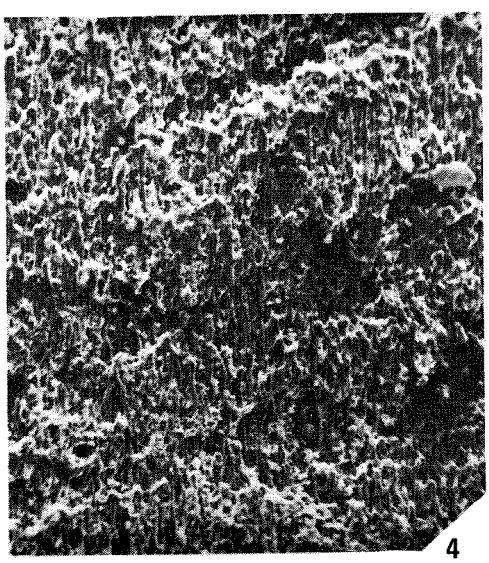

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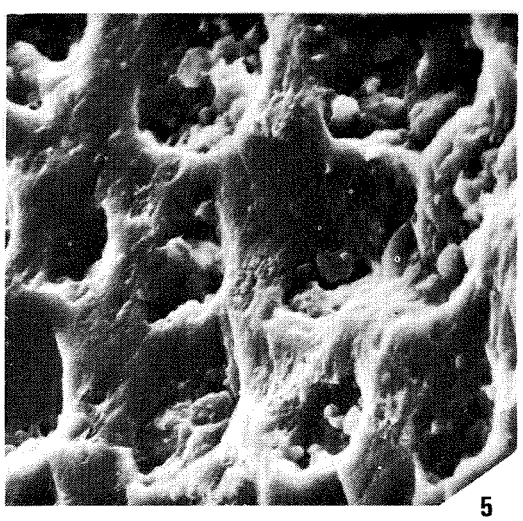

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BLASTOIDS

Plate 65

The specimens figured on this plate are from the type section of the Callytharra Formation, Callytharra Spring area, Carnarvon Basin. Their age is Late Sakmarian (Sterlitamakian).

All figures are from Alcheringa (Webster, 1987) and reproduced with the permission of the Association of Australasian Palaeontologists.

Figs 1–3 *Actinocrinites* sp. cf. *A. brouweri* (Wanner 1924)

1. Outer view of interradial plate; UMMP 61855; x2.
2. Outer view of radial plate; UMMP 61853; x1.6.
3. Outer view of basal circlet; UMMP 61852; x2.

Figs 4–6 *Platycrinites wrighti* (Marez-Oyens 1940)

4. Outer view of tegmen plate; UMMP 61860; x1.4.
5. Outer view of radial plate; UMMP 61859; x1.4.
6. Outer view of basal circlet; UMMP 61858; x1.4.

Figs 7–10 *Synbathocrinus campanulatus* (Wanner 1916)

7. Lateral view of flattened partial crown; UMMP 61898; x2.
8–10. A ray, basal and posterior views, respectively; UMMP 61895; x2.

Figs 11–13 *Synbathocrinus constrictus* (Wanner 1916)

Oral, A ray, and basal views, respectively; UMMP 61901; x2.

Figs 14–16 *Camptocrinus* sp. cf. *C. indoaustralicus* (Wanner 1924)

Views of articular facet, outer side, and lateral side, respectively; UMMP 61974; x1.

Fig. 17 *Calceolispongia digitata* Teichert 1949

Lateral view of basal; UMMP 61941; x1.

Figs 18, 19 *Calceolispongia spinosa* Teichert 1949

Basal and oral views of second primibrachial; UMMP 61940; x2.

Figs 20–23 *Cydonocrinus* sp. cf. *C. turbinatus* (Wanner 1916)

Oral, A ray, posterior, and basal views, respectively; UWA 27026; x2.

Figs 24–27 *Notiocatillocrinus callytharraensis* Webster 1987

24, 25. **Holotype**, GSWA 7861; posterior and E-A rays views, respectively; x2.
26, 27. **Paratype**, UMMP 61887; oral and basal views, respectively; x2.


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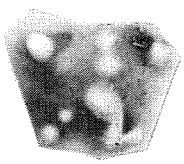
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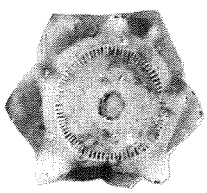
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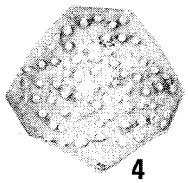
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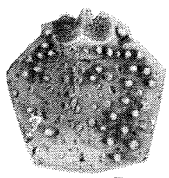
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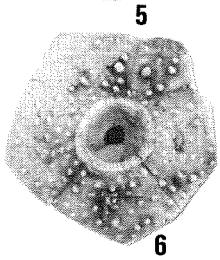
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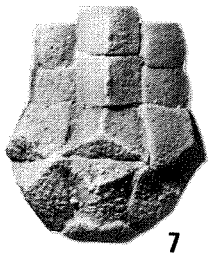
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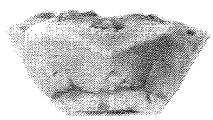
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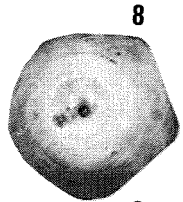
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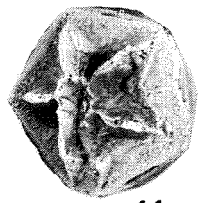
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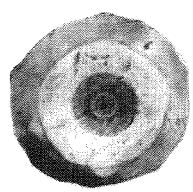
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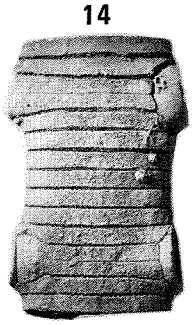
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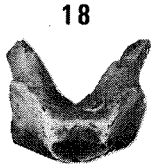
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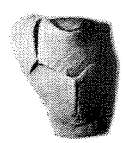
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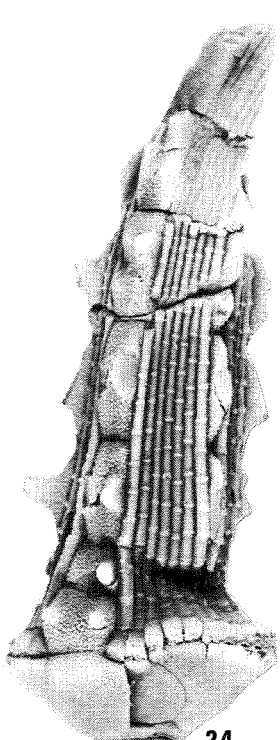
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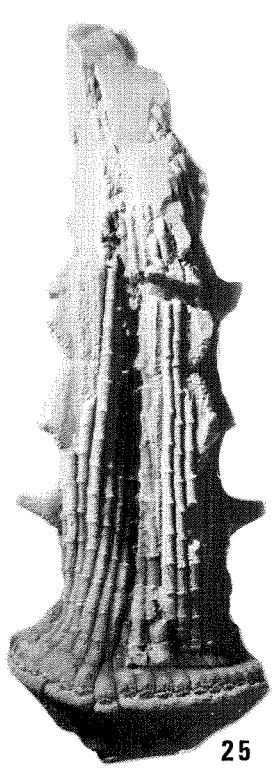
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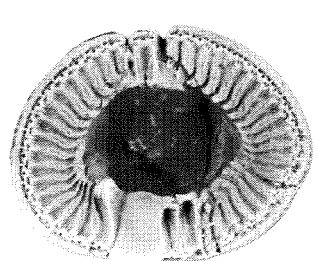
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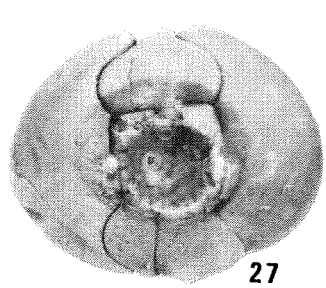
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CRINOIDS

Plate 66

The specimens figured on this plate are from the type section of the Callytharra Formation, Callytharra Spring area, Carnarvon Basin. Their age is Late Sakmarian (Sterlitamakian).

All figures are from Alcheringa (Webster, 1987) and reproduced with the permission of the Association of Australasian Palaeontologists.

Figs 1–4 *Tapinocrinus macurdai* Webster 1987

Holotype, WAM 84.656; A ray, oral, posterior, and basal views, respectively; x2.

Figs 5–8 *Tapinocrinus ingrami* Webster 1987

Holotype, WAM 84.658; A ray, oral, posterior, and basal views, respectively; x2.

Figs 9–12 *Parabursacrinus granulatus* (Wanner 1949)

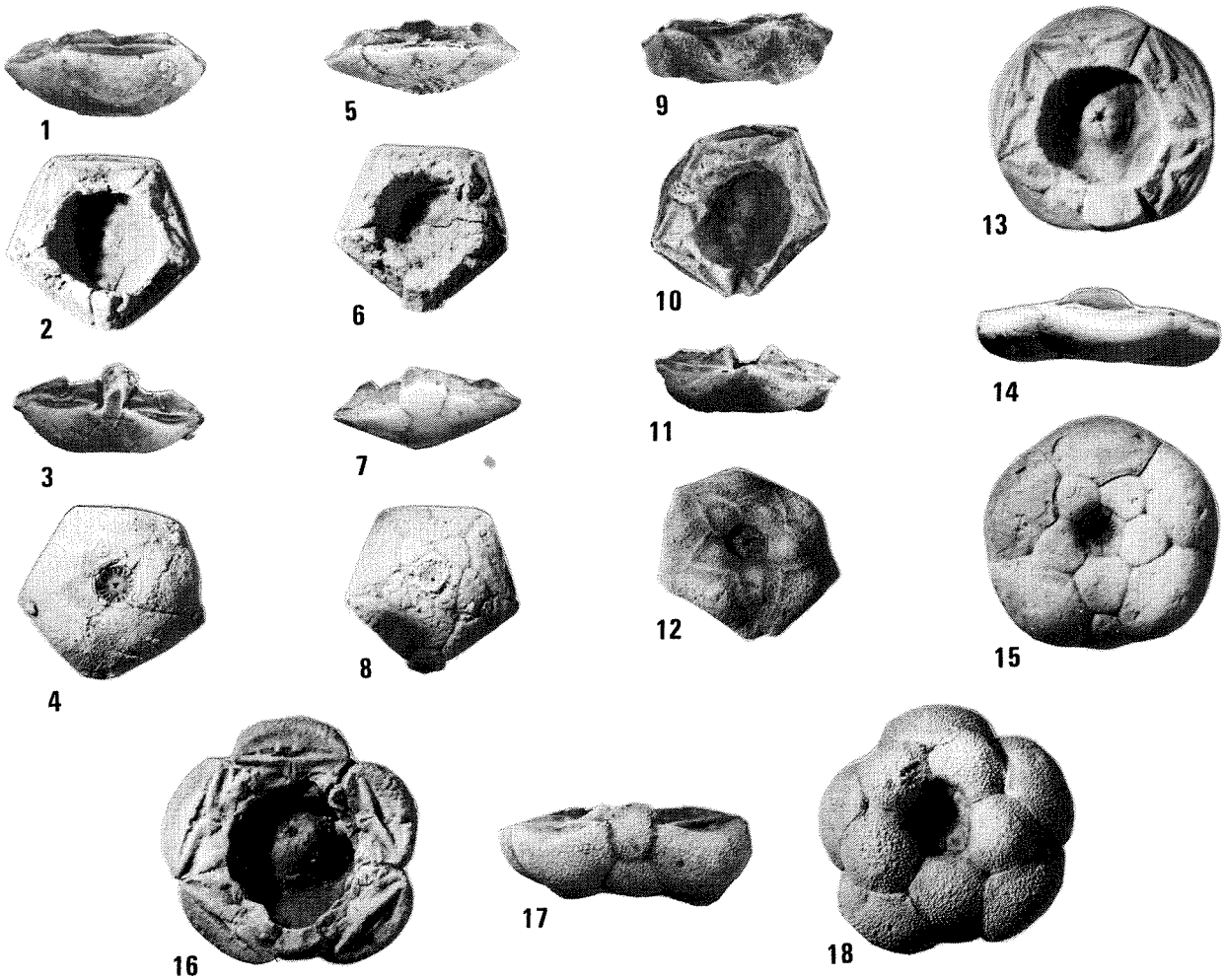
A ray, oral, posterior, and basal views, respectively; UMMP 61934; x2.

Figs 13–15 *Parabursacrinus magnificus* (Wanner 1916)

Oral, A ray, and basal views, respectively; WAM 84.663; x2.

Figs 16–18 *Apographiocrinus pumilus* (Wanner 1916)

Oral, posterior, and basal views, respectively; UMMP 61917; x2.



CRINOIDS

Plate 67

All figures are from the Geological Society of America Memoir (Teichert, 1949) and reproduced with the permission of the Geological Society of America.

Figs 1–15 *Calceolispongia abundans* Teichert 1949

1–3. Basal plate in inner, upper, and lateral views; UWA 22235; x0.9.
4, 7, 10. Basal plate in upper, lateral and inner views; UWA 22235; x0.9.
5, 6, 9. Basal plate in inner, upper, and lateral views; UWA 22235; x0.9.
8, 13, 14. **Holotype**, WAM G8501; in ventral, dorsal, and lateral views; x1.
11. Radial plate in ventral view; UWA 22239; x2.
12. Cup in side view, with stem and portions of arms in natural position; UWA 22225; x1.
15. Unsorted natural assemblage of cup plates; UWA 21186; x1.
East limb of syncline west of Coolkilya Pool, Minilya River, north bank, Carnarvon Basin, 25–35 m above the base of the '*Calceolispongia* Stage'; Wandagee Formation; Late Artinskian (Baigendzhinian).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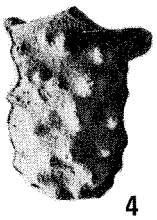
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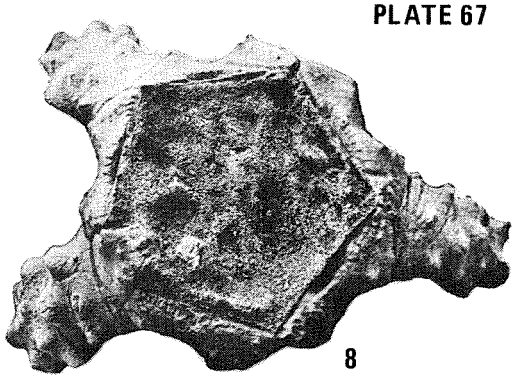
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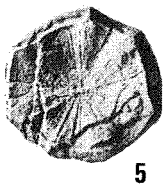
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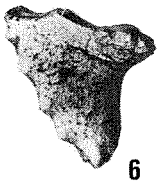
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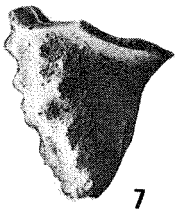
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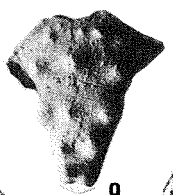
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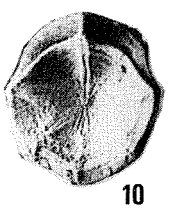
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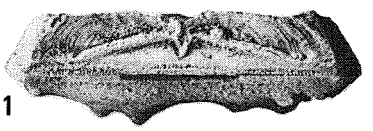
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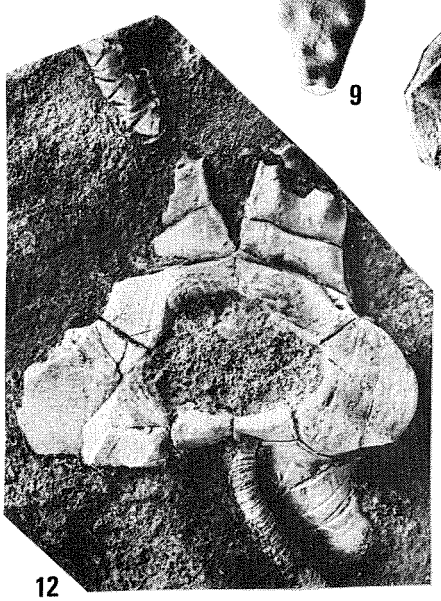
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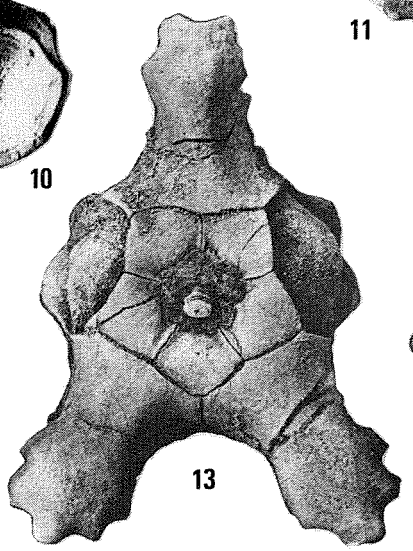
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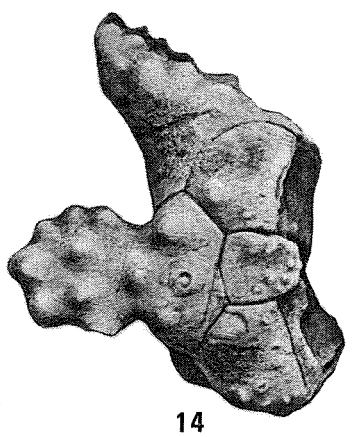
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CRINOIDS

Plate 68

Figures are natural size, unless indicated otherwise.

All figures are from the Geological Society of America Memoir (Teichert, 1949) and reproduced with the permission of the Geological Society of America.

Figs 1, 2, 9, 10, 22 *Calceolispongia acuminata* Teichert 1949

1, 9, 22. **Holotype** (basal plate), UWA 21538; in inner, upper, and lateral views.
2. Radial plate in outer view; UWA 21540.
10. Second brachial plate in outer view; UWA 21541.
Type locality, Carnarvon Basin; Bulgadoo Shale; Late Artinskian (Baigendzhinian).

Figs 3–8 *Calceolispongia barrabiddiensis* Teichert 1949

3–5. **Holotype** (basal plate), UWA 21523; in inner, upper, and lateral views.
6–8. **Topotype**, UWA 21524; as for the holotype.
Type locality, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 11–21, 27–29 *Calceolispongia digitata* Teichert 1949

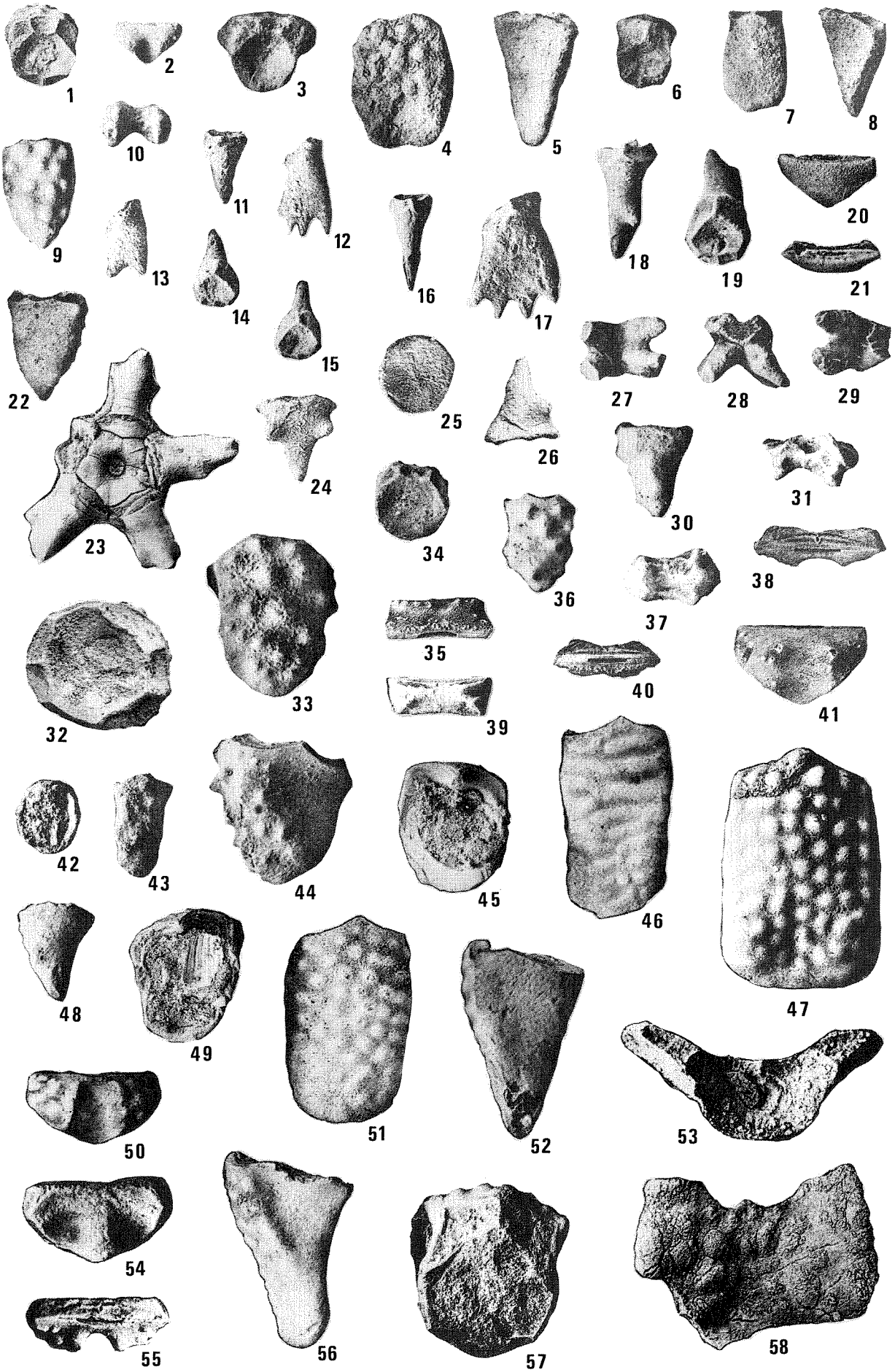
11, 13, 14. Basal plate in upper, lateral, and inner views; UWA 21527; x2.
12, 15, 16. Basal plate in lateral, inner, and upper views; UWA 21527; x2.
17–19. **Holotype** (basal plate), UWA 21526; in lateral, upper, and inner views; x2.
20, 21. Radial plate in outer and ventral views; UWA 21529; x2.
27–29. Second brachial in outer, ventral, and lateral views; UWA 21531; x2.
Type locality, Carnarvon Basin; Callytharra Formation; Late Sakmarian (Sterlitamakian).

Figs 23–26, 30–41, 44 *Calceolispongia elegantula* Teichert 1949

23. Cup in dorsal view, WAM 8430.
24–26. Basal plate in upper, inner, and lateral views; UWA 22082; x2.
30, 34, 36. Basal plate in upper, inner, and lateral views; UWA 22063; x2.
31, 37. Second brachial plate in ventral and outer views; UWA 22069.
32, 33, 44. Basal plate in basal, outer, and lateral views; UWA 22063.
35, 39, 40. First brachial plate in outer, inner, and lateral views; UWA 22068.
38, 41. Radial plate in outer and ventral views; UWA 22067.
Syncline west of Coolkilya Pool, Minilya River, east limb, north bank; from lowermost 25 m of Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 42, 43, 45–52, 54–57 *Calceolispongia hindei* Etheridge Jnr 1915

42, 43, 48. Basal plate in inner, upper and lateral views; UWA 20773.
45, 46, 52. Basal plate in inner, upper, and lateral views; UWA 20773.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CRINOIDS

47, 57. Basal plate in upper and inner views; UWA 20773.
49, 51, 56. Basal plate in inner, upper, and lateral views; UWA 20773.
50, 54, 55. Radial plate in outer, inner and ventral views; UWA 20774.
Type locality; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Figs 53, 58 *Calceolispongia* sp. indet. C

Basal plate in inner and upper views; UWA 21499.
East of mouth of southeast gully of Wandagee Hill, Mungadan Paddock, Wandagee Station, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Plate 69

Figures are natural size, unless indicated otherwise.

All figures are from the Geological Society of America Memoir (Teichert, 1949) and reproduced with the permission of the Geological Society of America.

Figs 1–9, 11–16, 19, 20 *Calceolispongia multiformis* Teichert 1949

1. Pinnulate portion of arms; UWA 22203; x2.
2. Dorsal facets of first brachial plate; UWA 22198; x1.9.
3–5. Basal plate in inner, upper, and lateral views; UWA 22149; x2.
6, 11, 12. Basal plate in inner, upper, and lateral views; UWA 22147.
7, 8. Radial plate in outer and ventral views; UWA 22166.
9, 13. First brachial in outer and ventral views; UWA 22197.
14, 15. Second brachial in outer and ventral views; UWA 22199.
16, 19, 20. Basal plate in inner, lateral, and upper views; UWA 22147.
Syncline west of Coolkilya Pool, Minilya River, east limb, north bank; 50 m above base of the Wandagee Formation; Late Artinskian (Baigendzhinian).

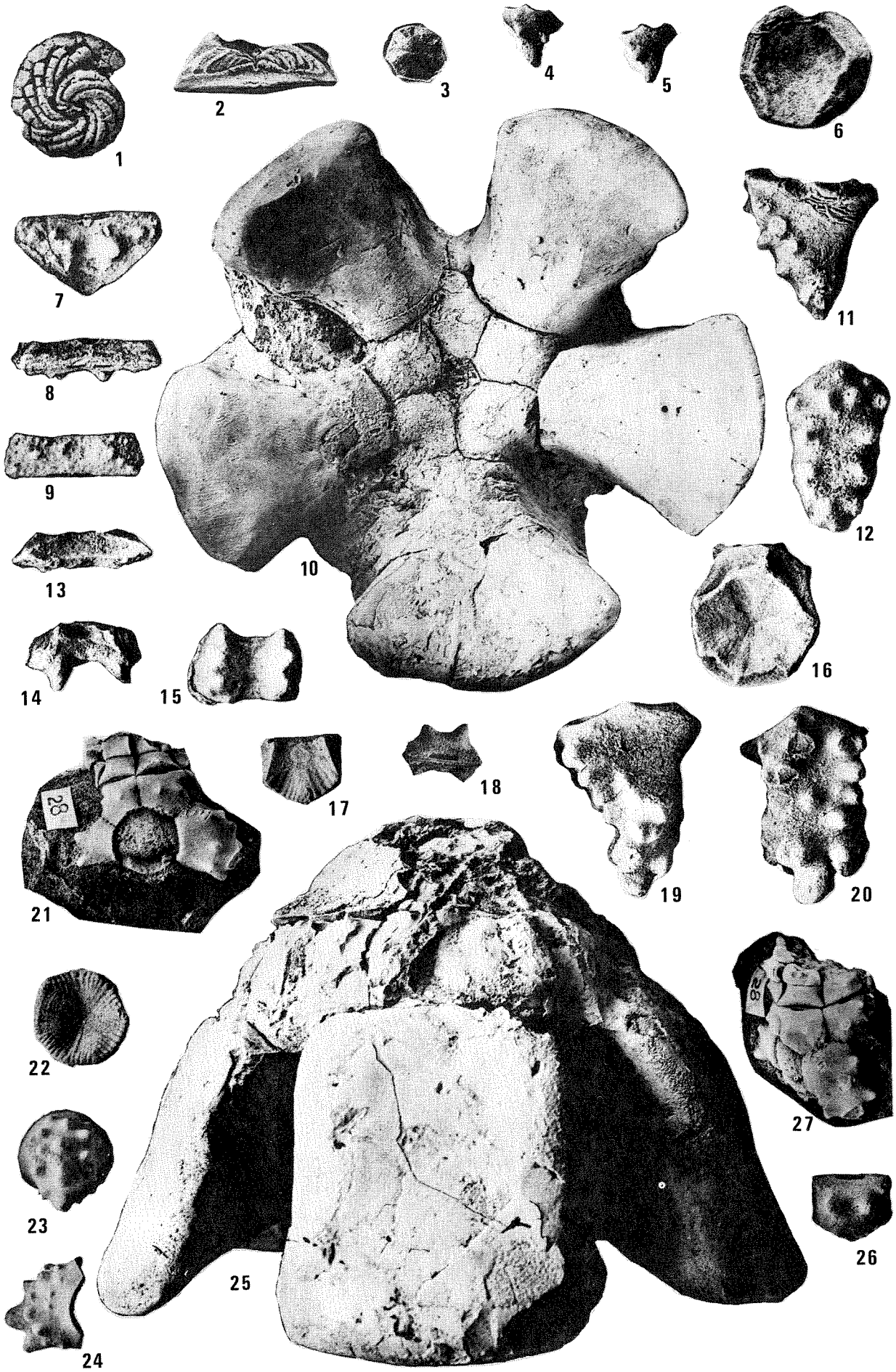
Figs 10, 25 *Calceolispongia robusta* Teichert 1949

Holotype, UWA 21476; in posterior and dorsal views; x0.9.
Type locality, Coolkilya Sandstone; Late Kungurian.

Figs 17, 18, 21–24, 26, 27 *Calceolispongia rotundata* Teichert 1949

17, 18, 26. Radial plate in inner ventral and outer views; UWA 21510b,c.
21, 27. **Holotype**, UWA 21504; in two views.
22–24. Large basal in inner, outer and lateral views; UWA 21510a.
Syncline west of Coolkilya Pool, Minilya River; main horizon with *C. abundans*; 30.5 m above base of Wandagee Formation; Late Artinskian (Baigendzhinian).

PLATE 69



CRINOIDS

GSWA 22987

Plate 70

Figures are natural size, unless indicated otherwise.

All figures are from the Geological Society of America Memoir (Teichert, 1949) and reproduced with the permission of the Geological Society of America.

Figs 1–4, 10–12, 28, 29, 36–38, 40 *Calceolispongia rubra* Teichert 1949

1–3. Basal plate in inner, upper, and lateral views; UWA 22207.
4, 12. Second brachial in ventral and outer views; UWA 22211.
10, 11. First brachial plate in outer and ventral views; UWA 22210.
28, 29, 36. Basal plate in lateral, inner, and upper views; UWA 22207.
37, 38, 40. **Holotype** (basal plate), UWA 22206; in lateral, inner and upper views.
Type locality, Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 5–9, 13–16, 23–25 *Calceolispongia spinosa* Teichert 1949

5–7. Basal plate in outer, lateral, and inner views; UWA 21536; x2.
8, 9, 16. Basal plate in outer, lateral, and inner views; UWA 21534; x2.
13–15. Second brachial plate in ventral, outer, and lateral views; UWA 22287.
23–25. Radial plate in outer, ventral, and lateral views; UWA 21534; x2.
Type locality, Callytharra Formation; Late Sakmarian.

Figs 17–22, 27, 30, 31, 41–44, 48, 49 *Calceolispongia spectabilis* Teichert 1949

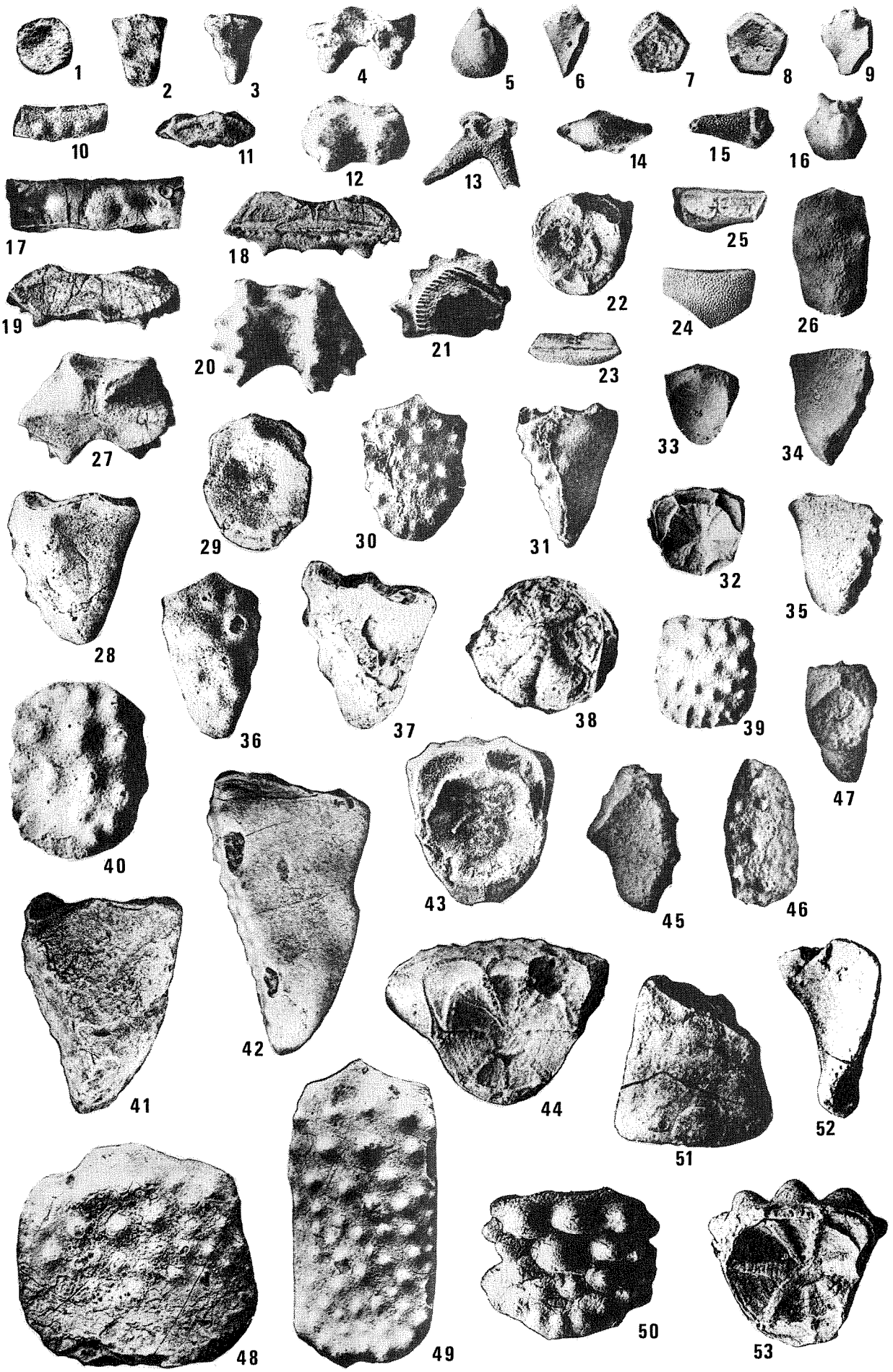
17–19. First brachial in outer, dorsal, and ventral views; UWA 22139.
20, 21, 27. Second brachial plate in outer, inner, and lateral views; UWA 22140.
22, 30, 31. Basal plate in inner, upper, and lateral views; UWA 22135.
41, 44, 48. Basal plate in lateral, inner, and upper views; UWA 21135.
42, 43, 49. Basal plate in lateral, inner, and upper views; UWA 22135.
Type locality, Wandagee Formation, Carnarvon Basin; Late Artinskian (Baigendzhinian).

Figs 26, 33, 34 *Calceolispongia* sp. indet. E

Basal plate in upper, inner and lateral views; UWA 21520.
Mungadan Paddock, Carnarvon Basin; Quinnanie Shale; Late Artinskian (Baigendzhinian).

Figs 32, 35, 39 *Calceolispongia truncata* Teichert 1949

Basal plate in inner, lateral and upper views; UWA 21544.
South bank of Whitfields Creek, Wandagee Station, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).



CRINOIDS

GSWA 22988

Figs 45–47 *Calceolispongia* sp. indet. F

Basal plate in lateral, upper and inner views; UWA 21522a. 0.75 km south of Barrabiddy Dam, Wandagee Station, Carnarvon Basin; Coyrie Formation; Late Artinskian (Baigendzhinian).

Figs 50, 53 *Calceolispongia* sp. indet. A

Basal plate in upper and inner views; UWA 21501. Wandagee Station, Carnarvon Basin; ?Nalbia Sandstone; Late Artinskian (Baigendzhinian)–Early Kungurian.

Figs 51, 52 *Calceolispongia* sp. indet. B

Basal plate in upper and lateral views; UWA 21498. Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Middle Kungurian.

Plate 71

All figures are natural size.

All figures from the Journal of Palaeontology (Teichert, 1954) and reproduced with the permission of the Paleontological Society.

Figs 1–14 *Jimbacrinus bostocki* Teichert 1954

1–3. Outer, ventral, and dorsal views of excessively spinose radial plate; CPC 332.
4, 8. Lateral and outer views of irregularly tuberculate basal plate; CPC 334.
5–7. Outer, dorsal, and ventral views of the first brachial plate; CPC 333.
9, 11, 14. **Holotype**, CPC 326; in anal, postero-lateral, and dorsal views.
10. Large cup with some brachials; CPC 330.
12. **Paratype**, CPC 329; showing well-preserved anal sac.
13. **Paratype**, CPC 327; a complete crown with stem.
South side of Gascoyne River, 3.2 km east of Jimba Jimba Homestead, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).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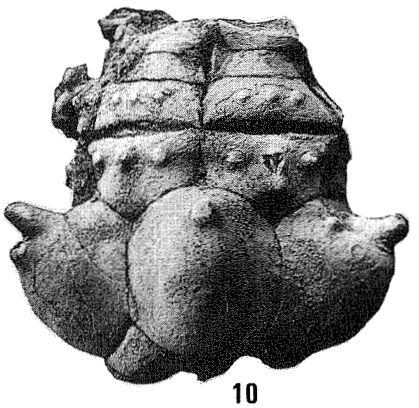
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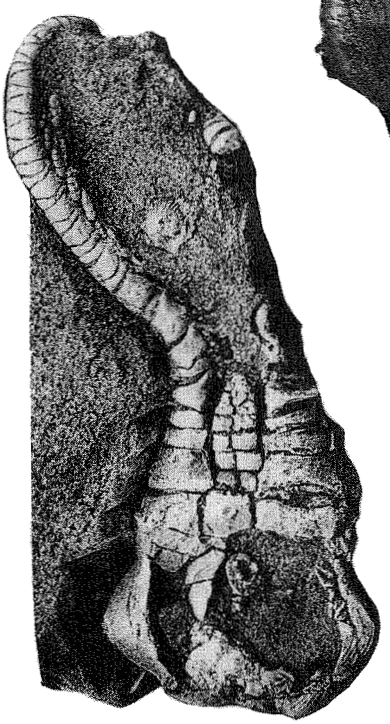
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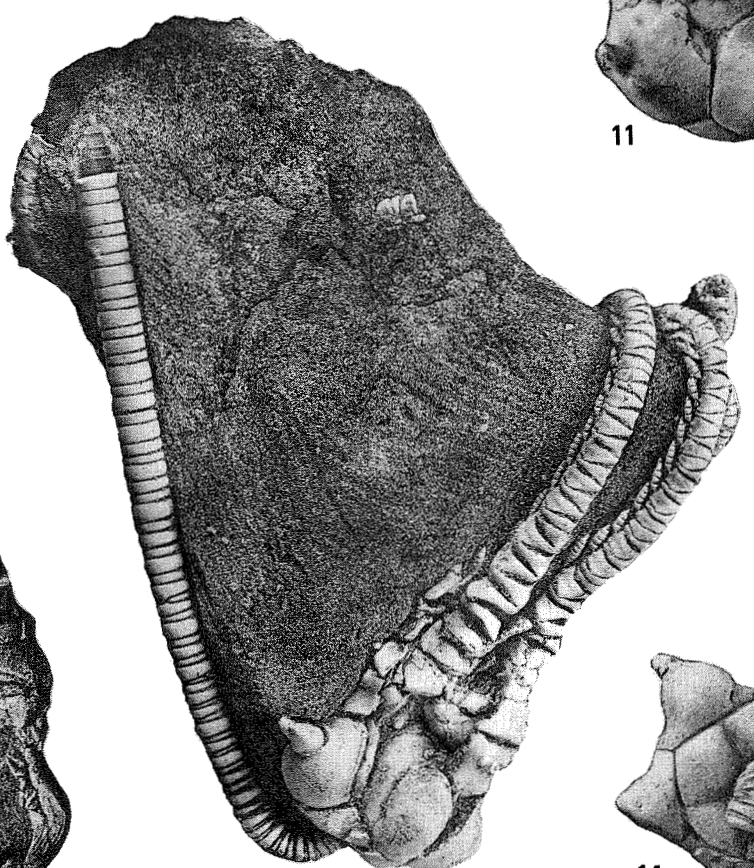
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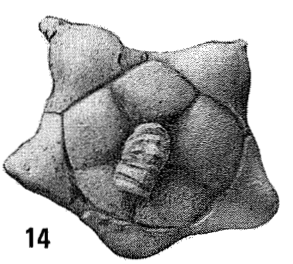
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CRINOIDS

Plate 72

All figures are magnified x600.

Fig. 1 *Circulisporites parvus* de Jersey 1962

Specimen UWA 55626.

Fig. 2 *Brazilea plurigenus* (Balme & Hennelly) Foster 1979

Topotype, B.E. Balme collection.

Fig. 3 *Brazilea scissa* (Balme & Hennelly) Foster 1975

Specimen UWA 55612.

Figs 4, 5 *Spongocystia eraduica* Segroves 1967

Holotype, UWA 55616; optical section and surface focus.

Fig. 6 *Tetraporina horologia* (Staplin) Playford 1963

Specimen UWA 55630.

Fig. 7 *Peltacystia monile* Balme & Segroves 1966

Paratype, UWA 53998.

Fig. 8 *Peltacystia galeoides* Segroves 1967

Paratype, UWA 55608.

Figs 9–11 *Peltacystia venosa* Balme & Segroves 1966

9. B.E. Balme collection.
10. **Holotype**, UWA 53992.
11. B.E. Balme collection.

Fig. 12 *Peltacystia calvitium* Balme & Segroves 1966

Paratype, UWA 54002.

Fig. 13 *Haplocystia pellucida* Segroves 1967

Paratype, UWA 55629; in optical section.

Fig. 14 *Spheripollenites* sp. cf. *S. psilatus* Couper 1958

Specimen UWA 55610.

Figs 15, 19 *Quadrisporites horridus* Hennelly ex Potonié & Lele 1961

15. Specimen UWA 55597.
19. B.E. Balme collection.


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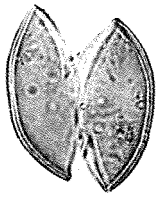
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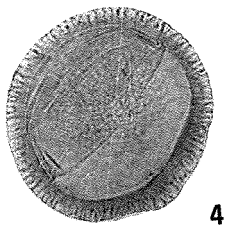
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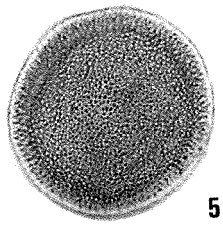
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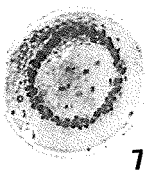
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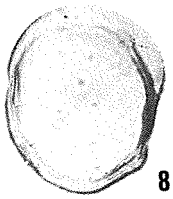
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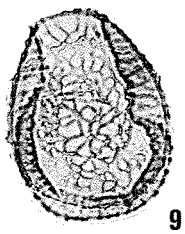
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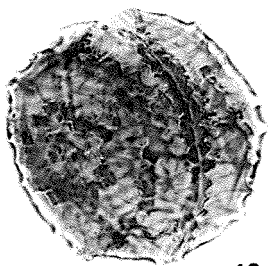
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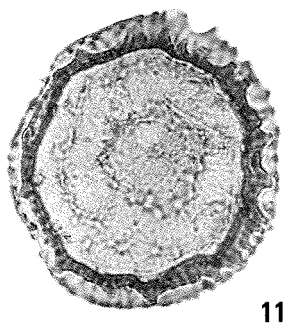
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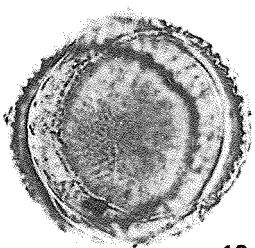
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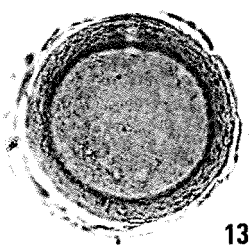
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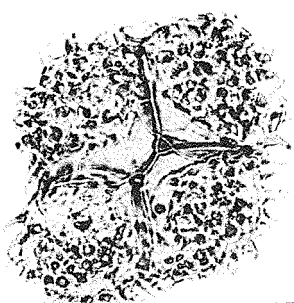
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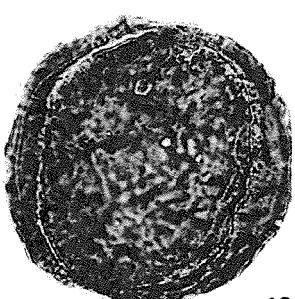
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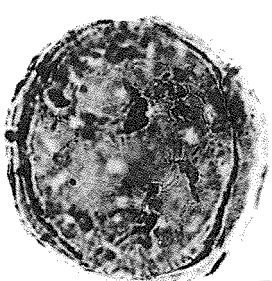
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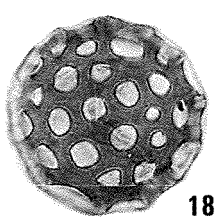
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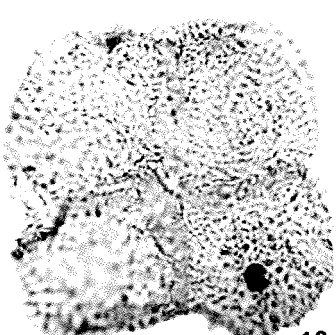
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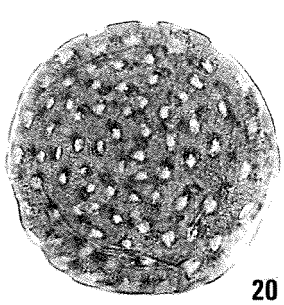
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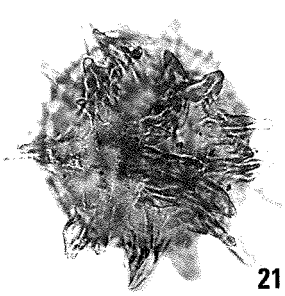
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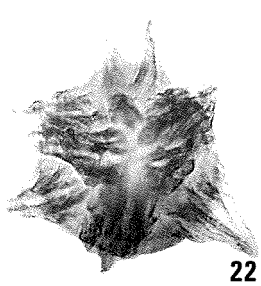
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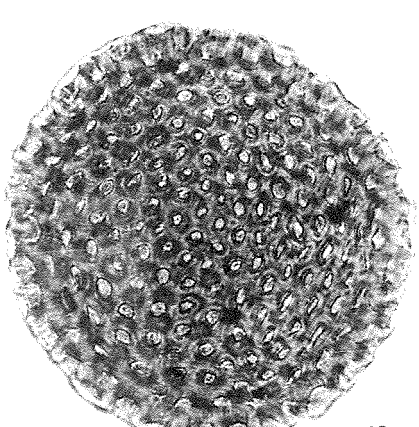
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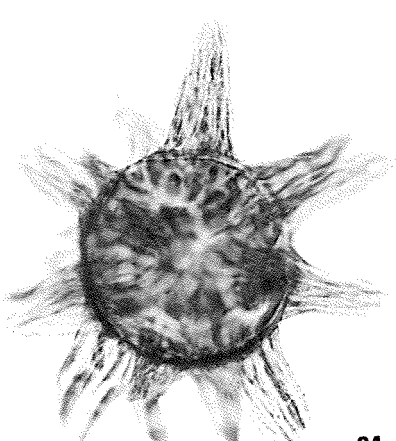
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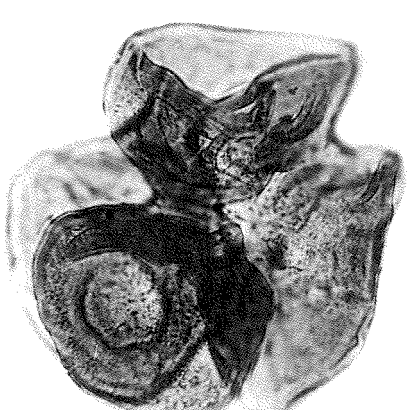
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ACRITARCHS

Fig. 16, 17 *Schizosporis dejerseyi* Segroves 1967

16. **Paratype**, UWA 55614.
17. **Holotype**, UWA 55613.

Fig. 18 *Maculatasporites minimus* Segroves 1967

Holotype, UWA 55619.

Figs 20, 23 *Maculatasporites amplus* Segroves 1967

20. Specimen UWA 55625.
21. **Holotype**, UWA 55622.

Figs 21, 22 24 *Mehlisphaeridium fibratum* Segroves 1967

21. **Paratype**, UWA 55604.
22. Specimen UWA 55605.
23. **Holotype**, UWA 55601.

Fig. 25 *Pyramidosporites cyathodes* Segroves 1967

Paratype, UWA 55600.

Plate 73

All figures are magnified x600.

Fig. 1 *Indospora laevigata* Bharadwaj & Salujha 1964

Specimen UWA 58628.

Fig. 2 *Indospora clara* Bharadwaj 1962

Specimen UWA 58627.

Figs 3, 4 *Horriditriletes ramosus* (Balme & Hennelly) Bharadwaj & Salujha 1964

3, 4. B.E. Balme collection.

Fig. 5 *Granulatisporites quadruplex* Segroves 1970

Paratype, UWA 58597.

Figs 6, 7 *Gondisporites imbricatus* Segroves 1970

6. B.E. Balme collection.
7. **Holotype**, UWA 58639.

Fig. 8 *Dulhuntyispora dulhuntyi* Potonié 1956

B.E. Balme collection.

Fig. 9 *Dulhuntyispora parvithola* (Balme & Hennelly) Potonié 1960

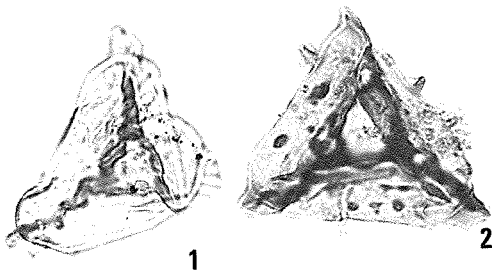
Specimen UWA 58630.

Fig. 10 *Dulhuntyispora stellata* Price 1983

B.E. Balme collection.

Fig. 11 *Dulhuntyispora inornata* Segroves 1970

Paratype, UWA 58633.



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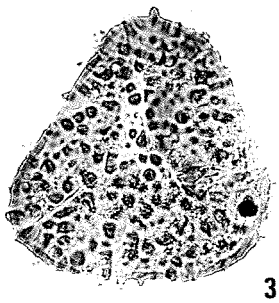

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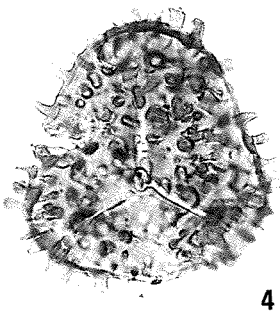

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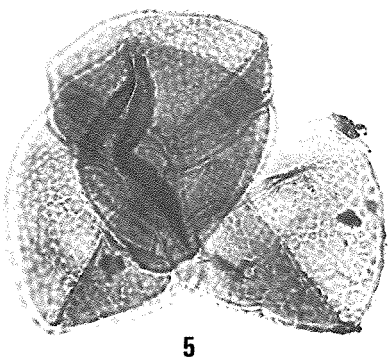

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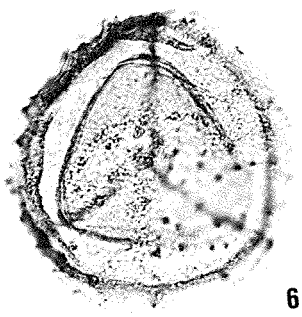

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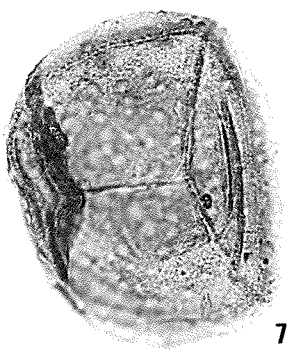

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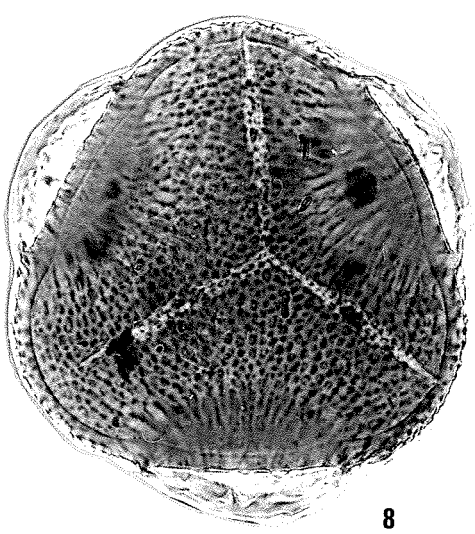

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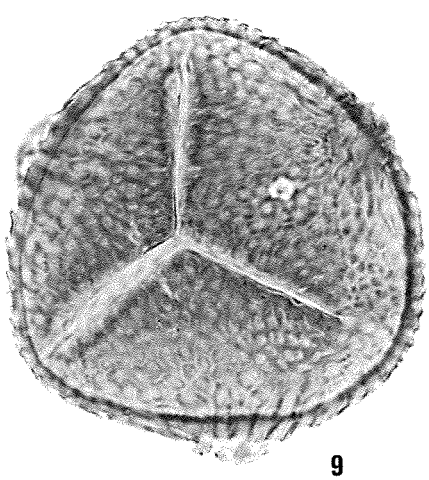

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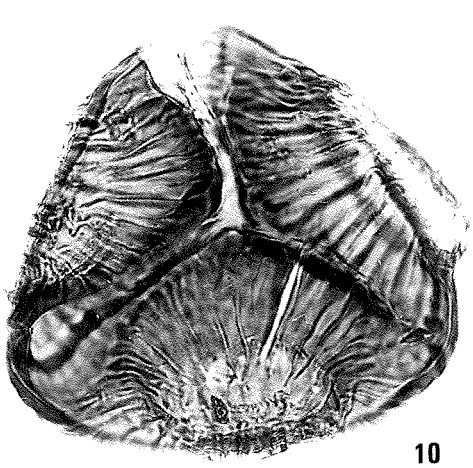

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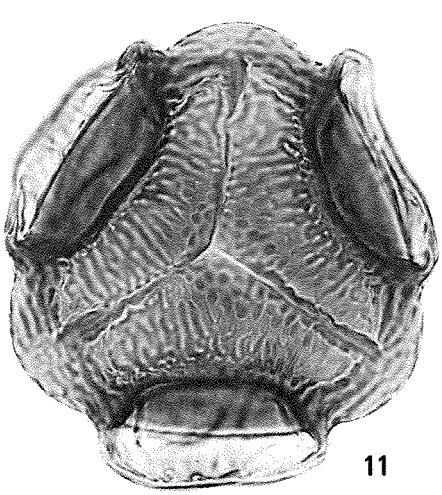

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Plate 74

Figures are magnified x600, unless otherwise indicated.

Fig. 1 *Acanthotriletes tereteangulatus* Balme & Hennelly 1956

B.E. Balme collection.

Figs 2, 3 *Apiculatisporis cornutus* (Balme & Hennelly) Høeg & Bose 1960

2. B.E. Balme collection.
3. Specimen UWA 55641.

Fig. 4 *Bipartitisporis tumulosus* Segroves 1970

B.E. Balme collection.

Figs 5–7 *Brevitriletes levis* (Balme & Hennelly) Bharadwaj & Srivastava 1969

5-7. B.E. Balme collection.

Figs 8, 9 *Densoisporites solidus* Segroves 1970

8. **Holotype**, UWA 58635.
9. Specimen UWA 53096.

Fig. 10 *Calamospora* sp. cf. *C. microrugosa* (Ibrahim) Schopf, Wilson & Bentall 1944

Specimen UWA 58583.

Figs 11, 12 *Densosporites rotundidentatus* Segroves 1970

11. **Paratype**, UWA 58638.
12. **Holotype**, UWA 58637.

Figs 13, 14 *Diatomozonotriletes townrowii* Segroves 1970

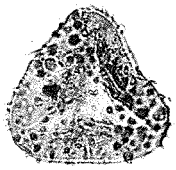
13, 14. B.E. Balme collection; x1000

Figs 15, 16 *Dictyotriletes aules* Rigby 1977

15. B.E. Balme collection.
16. Specimen UWA 58877; x750.

Figs 17–19 *Didecitriletes ericianus* (Balme & Hennelly) Venkatachala & Kar 1965

17. Lateral view; B.E. Balme collection.
18, 19. B.E. Balme collection.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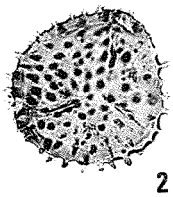
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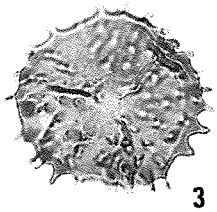
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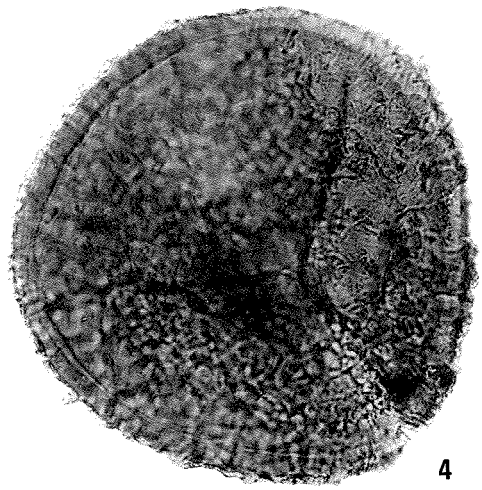
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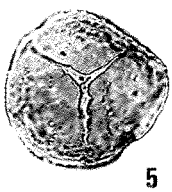
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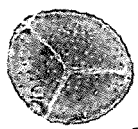
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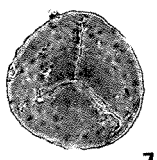
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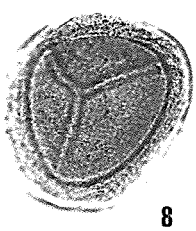
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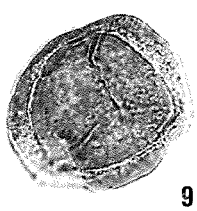
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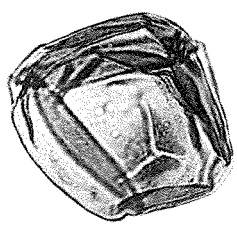
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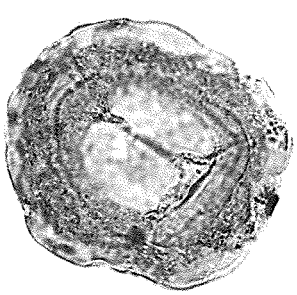
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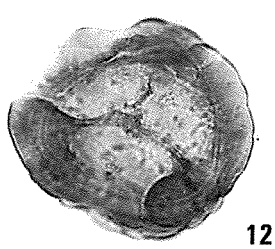
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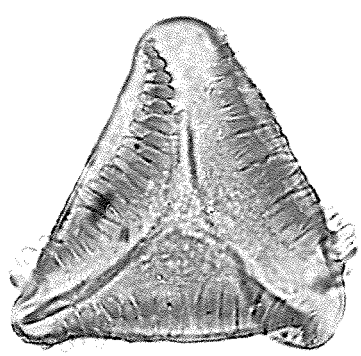
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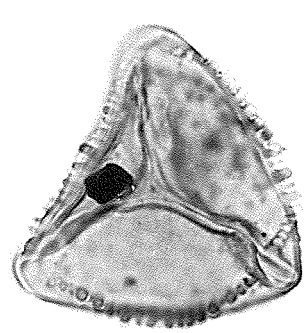
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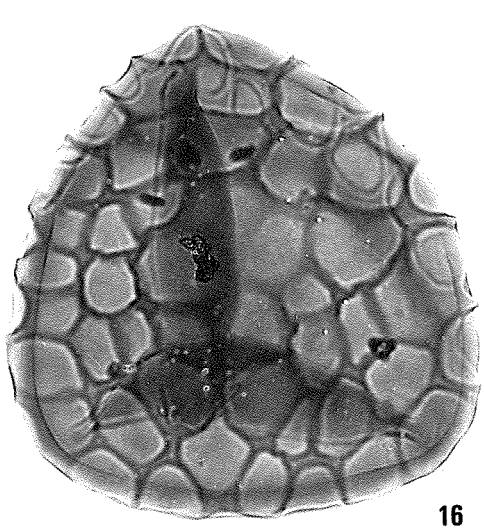
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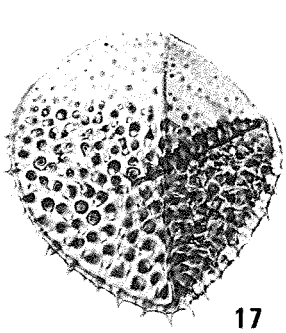
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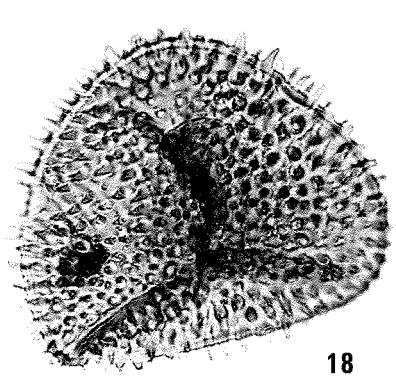
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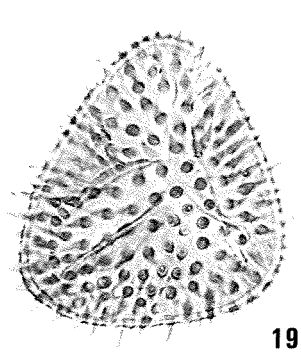
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SPORES

Plate 75

Figures are magnified x600, unless otherwise indicated.

All figures are from negatives prepared by P.E. Price.

Figs 1, 2 *Lopadiospora vermitholus* Price 1983

Specimen APG S2816/1.

Figs 3, 5 *Dulhuntyispora granulata* Price 1983

3, 4. **Holotype**, APG S1220/1.
5. Specimen APG AJ216-2816/1/5; SEM, proximal face; x650.

Figs 6, 7 *Dulhuntyispora spongia* Price 1983

Holotype, APG S3459/2.

Figs 8, 9 *Dulhuntyispora maewestae* Price 1983

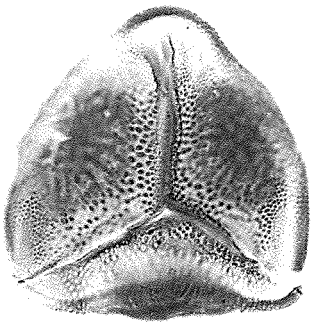
Holotype, APG S3457/1; x450.

Figs 10–12 *Dulhuntyispora omasi* Price 1983

10, 11. **Holotype**, APG S3496/7; x450.
12. Specimen APG ANP21-3459/9/3; SEM, proximal face; x650.

Figs 13, 14 *Phaselisporites cicatricosus* (Balme & Hennelly) Price 1983

Specimen APG S1811/2; x800.



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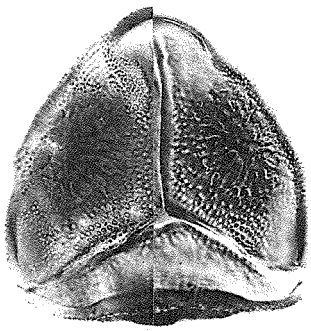

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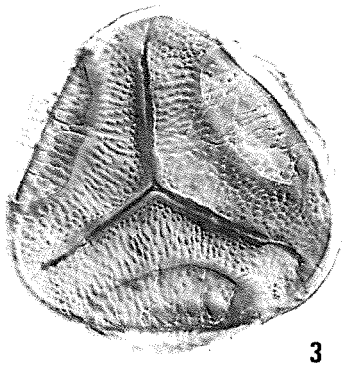

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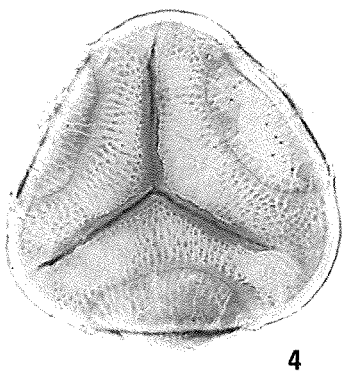

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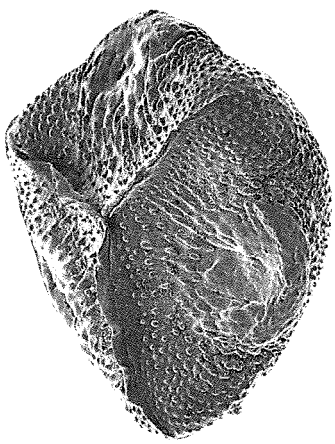

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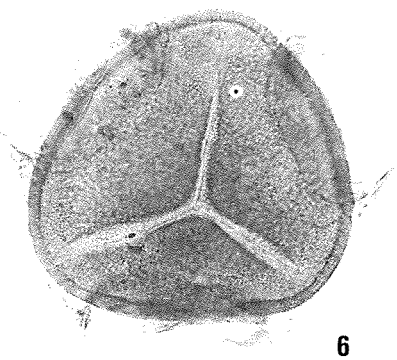

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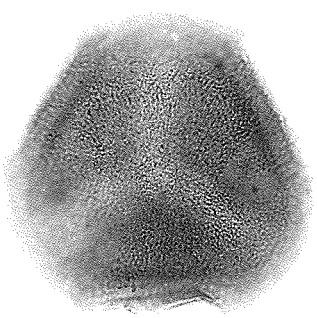

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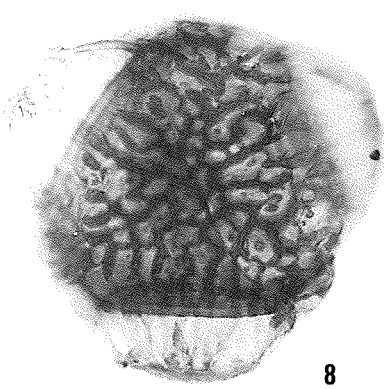

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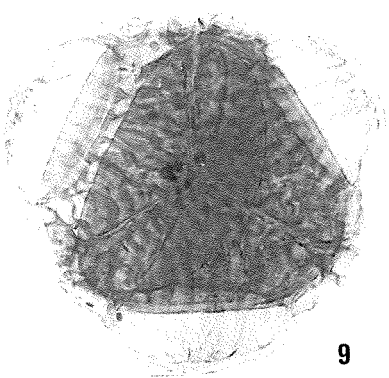

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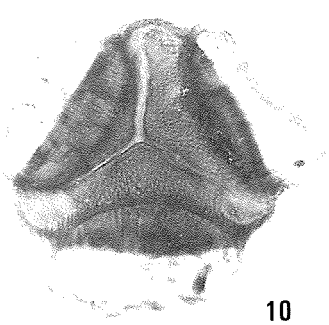

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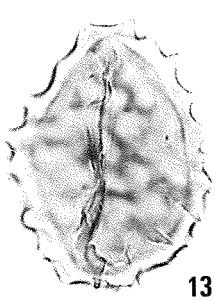

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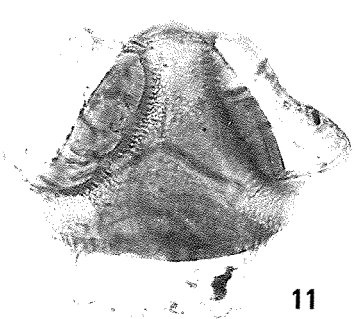

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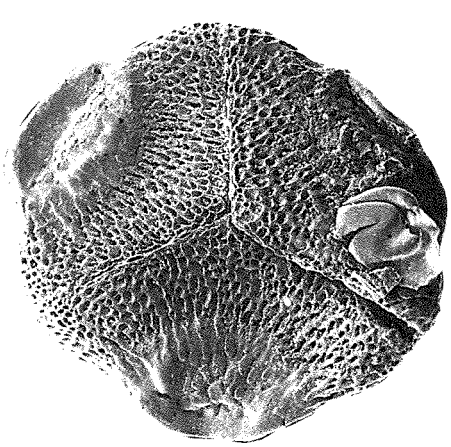

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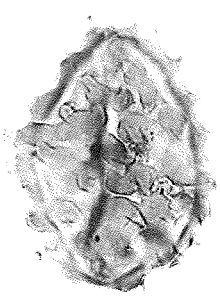

14

SPORES

Plate 76

All figures are magnified x600.

Fig. 1 *Retusotriletes diversiformis* (Balme & Hennelly) Balme & Playford 1967

B.E. Balme collection.

Fig. 2 *Lophotriletes* sp. cf. *L. rarus* Bharadwaj & Salujha 1964

Specimen UWA 58611.

Figs 3, 4 *Lophotriletes scotinus* Segroves 1970

3. **Paratype**, UWA 58613.
4. **Holotype**, UWA 58612.

Fig. 5 *Tuberculatosporites modicus* Balme & Hennelly 1956

B.E. Balme collection

Fig. 6 *Leschikisporis cestus* Segroves 1970

Holotype, UWA 58599.

Fig. 7 *Laevigatosporites flexus* Segroves 1970

Holotype, UWA 58663.

Figs 8, 9 *Laevigatosporites colliensis* (Balme & Hennelly) Venkatachala & Karl 1968

8. Specimen UWA 58666.
9. B.E. Balme collection.

Figs 10, 11 *Indotriradites enormis* (Segroves) Foster 1979

10. B.E. Balme collection
11. **Holotype**, UWA 58653.

Figs 12, 14, 15 *Kraeuselisporites niger* Segroves 1970

12. **Holotype**, UWA 58651.
14. **Paratype**, UWA 58652.
15. B.E. Balme collection.

Figs 13, 16, 19 *Indotriradites splendens* (Balme & Hennelly) Foster 1979

13. Specimen UWA 58649.
16, 19. B.E. Balme collection.

Figs 17, 18 *Punctatisporites gretensis* Balme & Hennelly 1956

17, 18. B.E. Balme collection.


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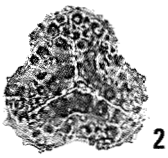
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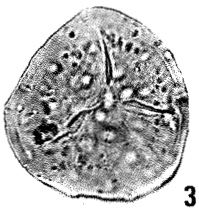
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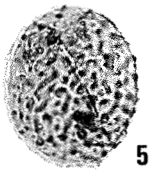
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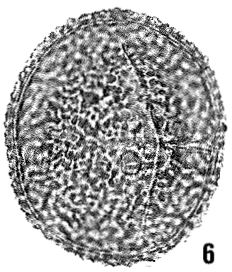
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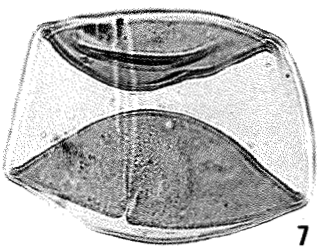
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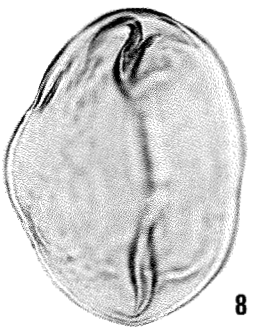
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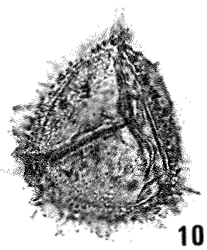
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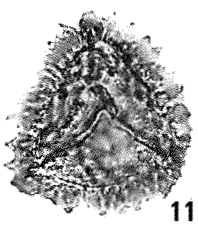
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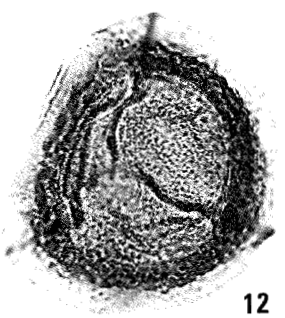
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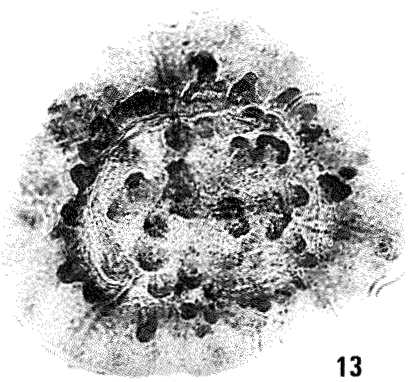
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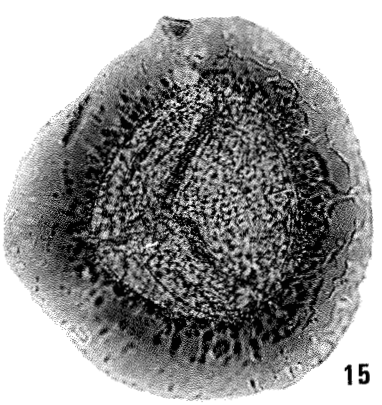
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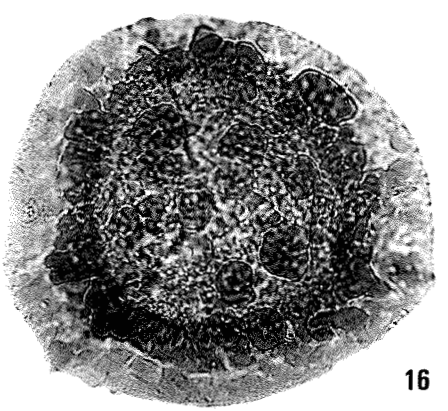
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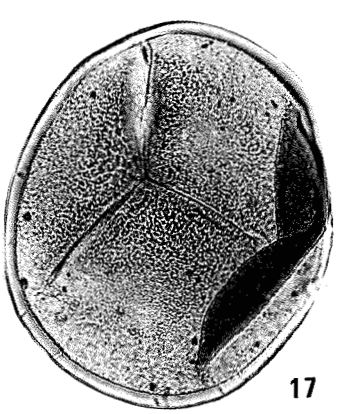
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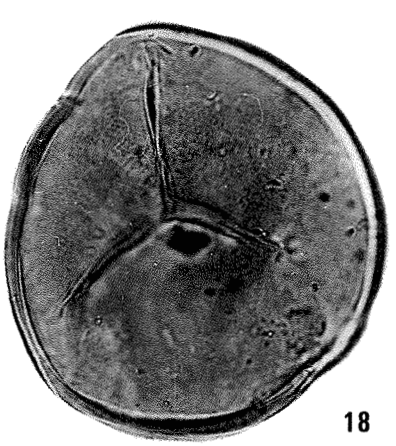
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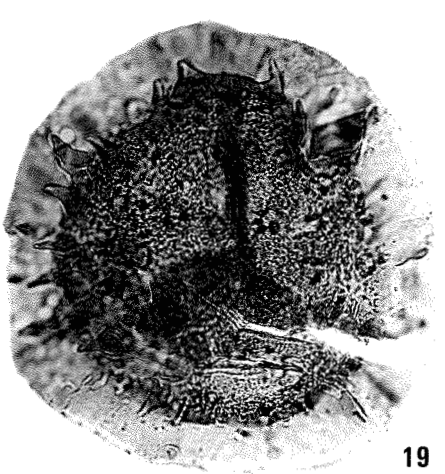
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SPORES

Plate 77

All figures are magnified x600.

Fig. 1 *Microbaculispora tentula* Tiwari 1965

B.E. Balme collection.

Fig. 2 *Microreticulatisporites bitriangularis* Balme & Hennelly 1956

B.E. Balme collection.

Fig. 3 *Microbaculispora micronodosa* (Balme & Hennelly) Anderson 1977

B.E. Balme collection.

Figs 4, 5 *Leiotriletes directus* Balme & Hennelly 1956

4, 5. B.E. Balme collection.

Figs 6, 7 *Interradispora versus* Price 1979

6. Specimen APG S1807/10.
7. B.E. Balme collection.

Figs 8, 9 *Verrucosisporites naumovae* Hart 1963

8, 9. B.E. Balme collection.

Figs 10–12 *Pseudoreticulatispora pseudoreticulata* (Balme & Hennelly) Bharadwaj & Srivastava 1969

10. B.E. Balme collection.
11. Specimen UWA 58602.
12. B.E. Balme collection.

Figs 13, 14 *Microbaculispora trisinus* (Balme & Hennelly) Anderson 1977

13. B.E. Balme collection.
14. Specimen UWA 58589.

Figs 15, 16 *Microbaculispora villosa* (Balme & Hennelly) Bharadwaj 1962

15, 16. B.E. Balme collection.


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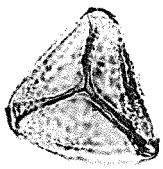
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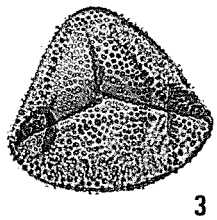
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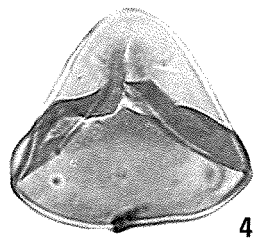
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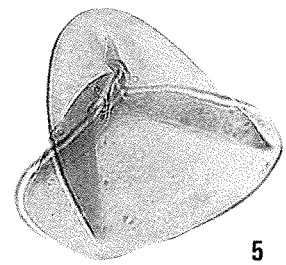
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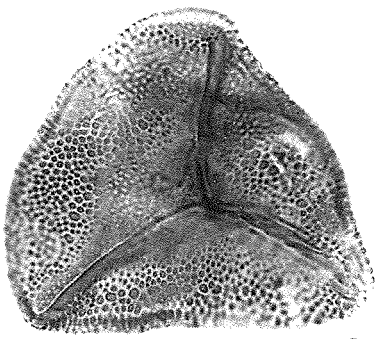
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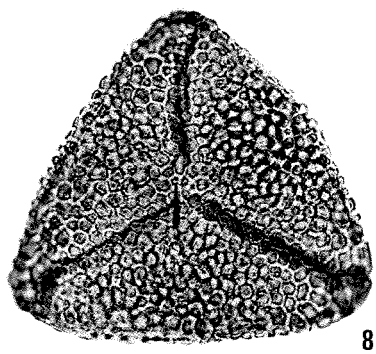
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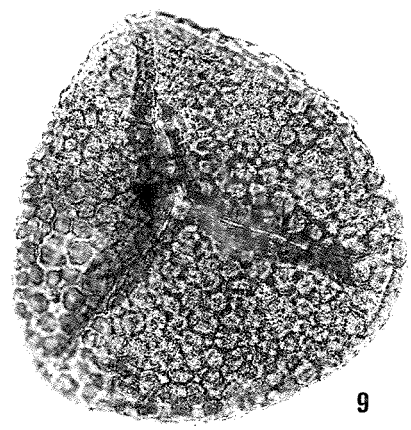
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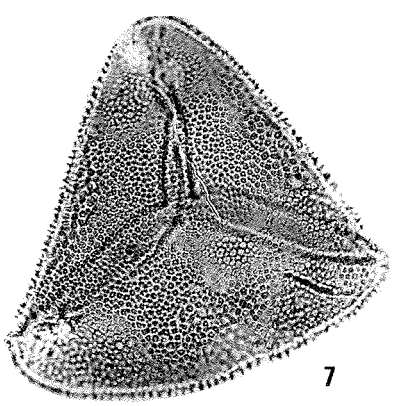
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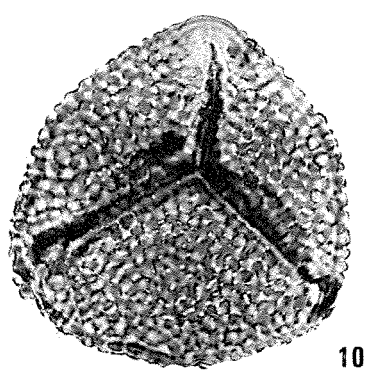
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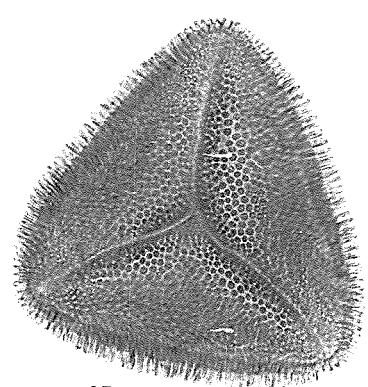
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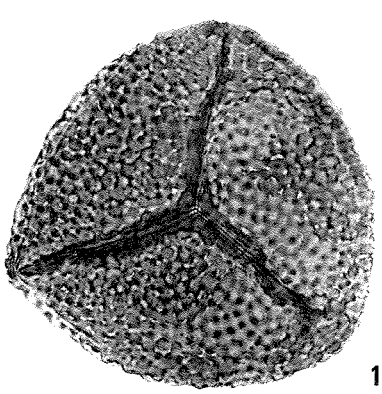
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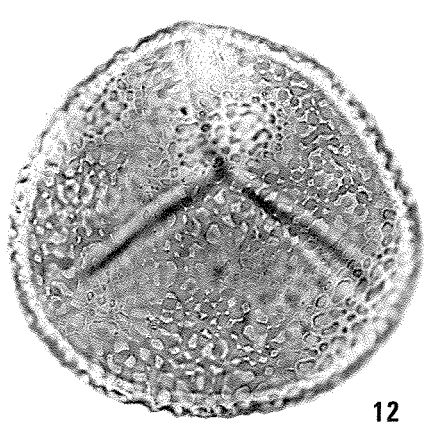
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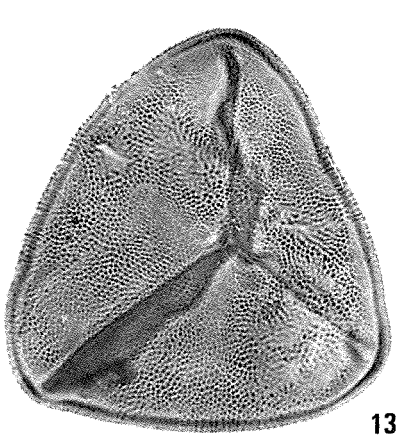
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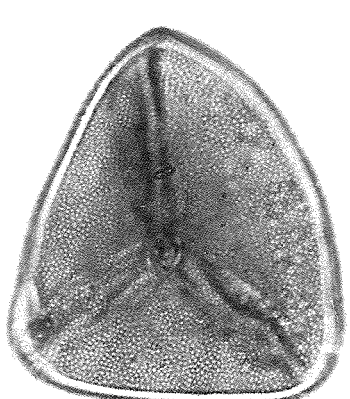
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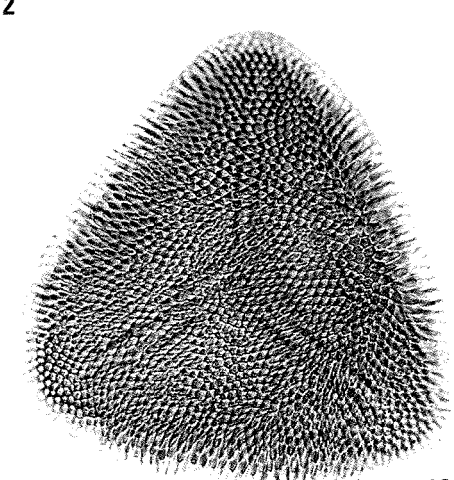

16

SPORES

Plate 78

All figures are magnified x600.

Fig. 1 *Alisporites indarraensis* Segroves 1969

Holotype, UWA 58696.

Figs 2–4 *Alisporites splendens* (Leschik) Foster 1979

2. Specimen UWA 58705.
3. B.E. Balme collection.
4. Specimen UWA 58690.

Figs 5, 6 *Bascanisporites undosus* Balme & Hennelly 1956

5, 6. B.E. Balme collection.

Fig. 7 *Alisporites gracilis* Segroves 1969

Paratype, UWA 58694.

Figs 8, 9 *Corisaccites alutas* Venkatachala & Kar 1966

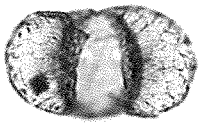
8, 9. B.E. Balme collection.

Figs 10, 11 *Cycadopites cymbatus* (Balme & Hennelly) Hart 1965

10, 11. B.E. Balme collection.

Figs 12, 13 *Barakarites rotatus* (Balme & Hennelly) Bharadwaj & Tiwari 1964

12, 13. B.E. Balme collection.



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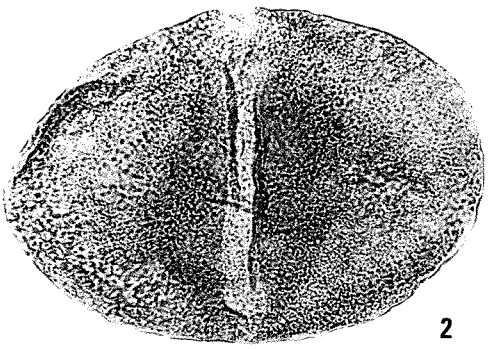

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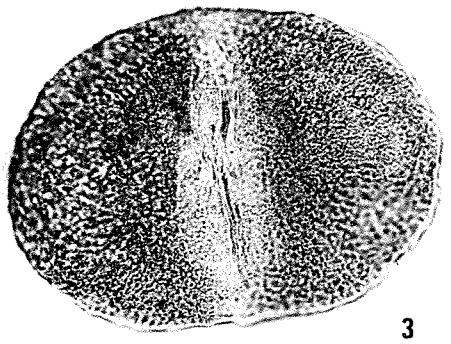

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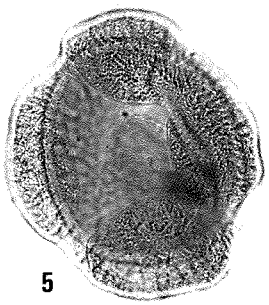

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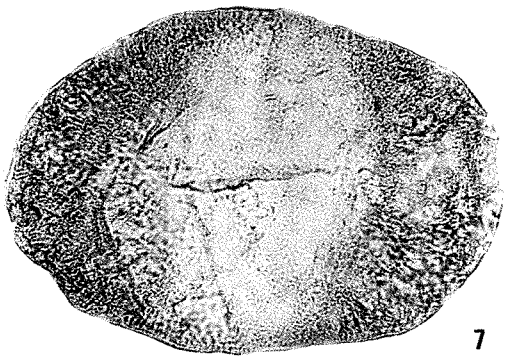

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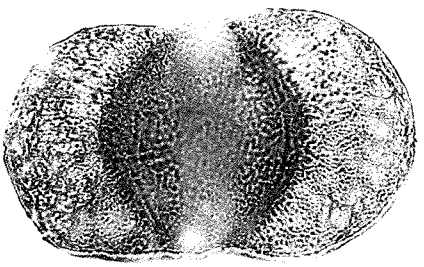

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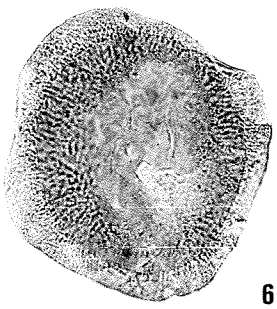

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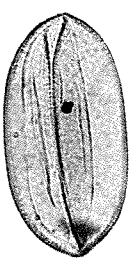

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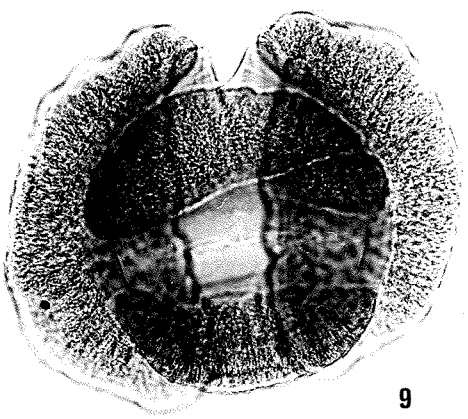

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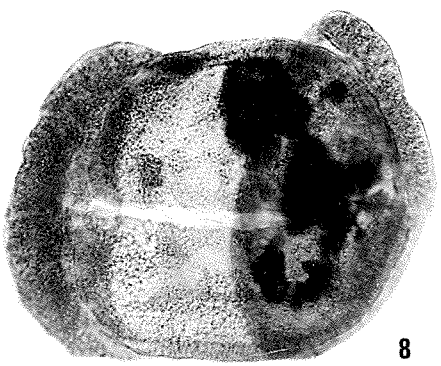

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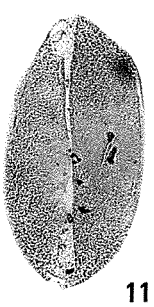

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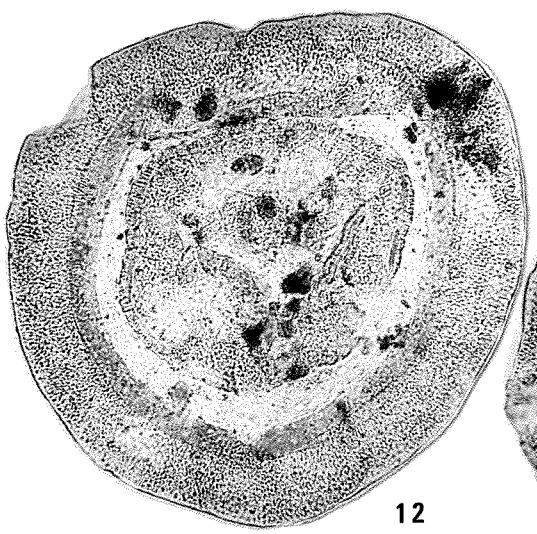

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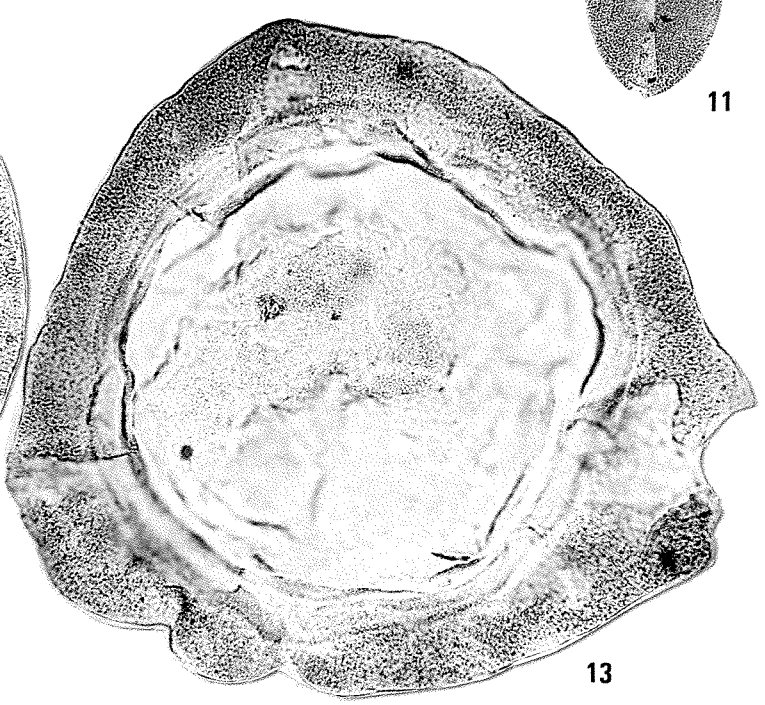


13

POLLEN GRAINS

Plate 79

All figures are magnified x600.

Figs 1–3 *Marsupipollenites triradiatus* Balme & Hennelly 1956

1–3. B.E. Balme collection.

Fig. 4 *Marsupipollenites striatus* (Balme & Hennelly) Hart 1965

B.E. Balme collection.

Figs 5–7 *Limitisporites rectus* Leschik 1956

5. Specimen UWA 58711.
6, 7. B.E. Balme collection.

Figs 8, 9 *Distriatites dettmannae* Segroves 1969

8. **Holotype**, UWA 588731.
9. **Paratypes**, UWA 58733.

Figs 10, 11 *Florinites eremus* Balme & Hennelly 1955

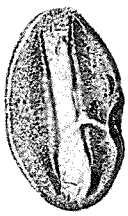
10, 11. B.E. Balme collection.

Fig. 12 *Parasaccites bilateralis* Tiwari 1965

Specimen UWA 58680.

Figs 13, 14 *Parasaccites diffusus* Tiwari 1965

13. B.E. Balme collection.
14. Specimen UWA 58679.



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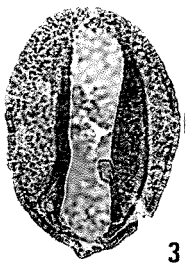

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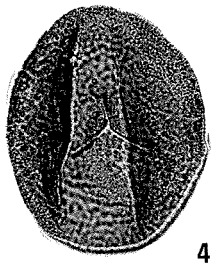

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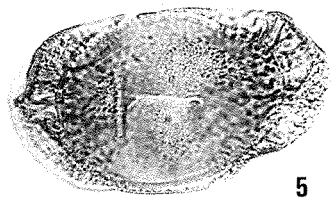

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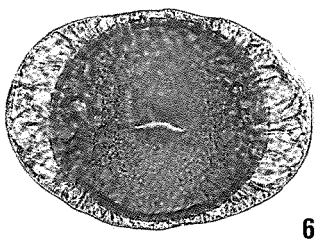

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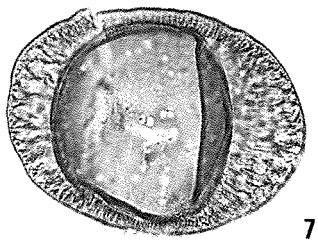

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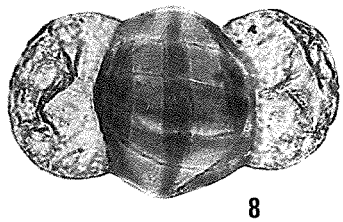

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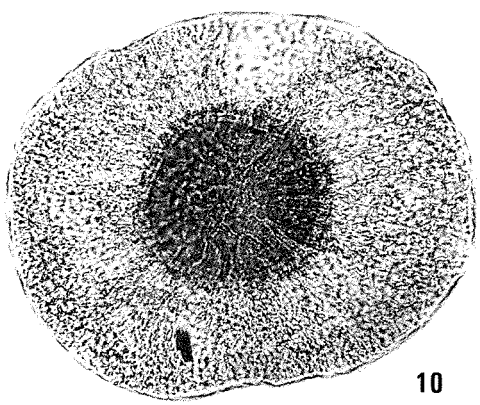

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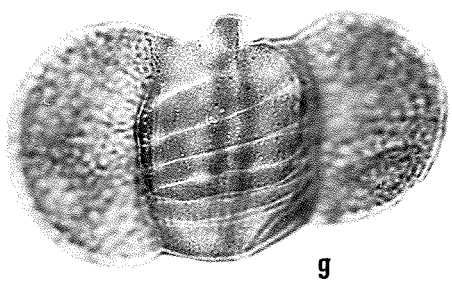

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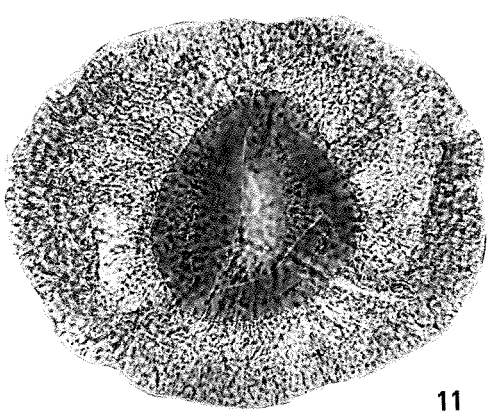

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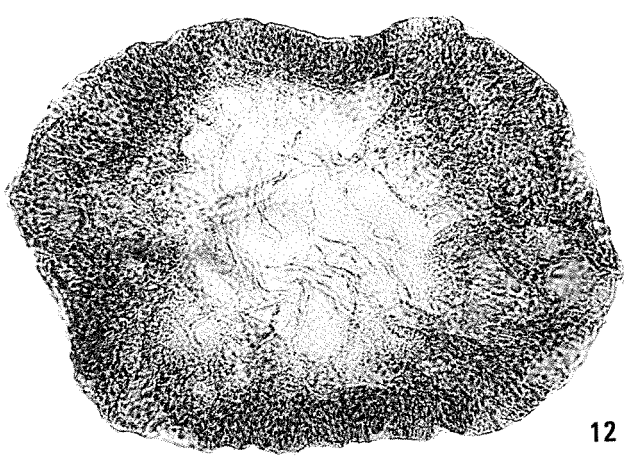

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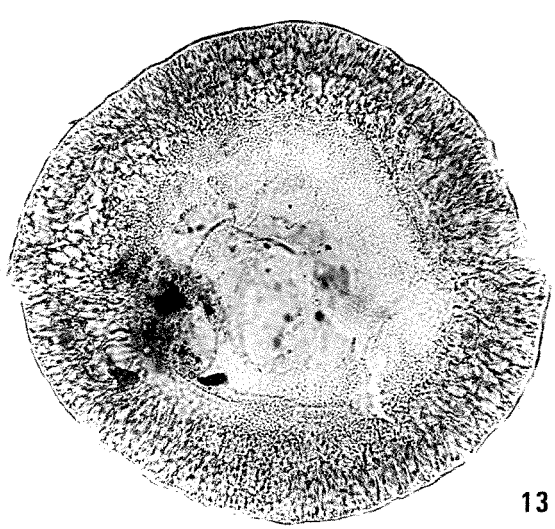

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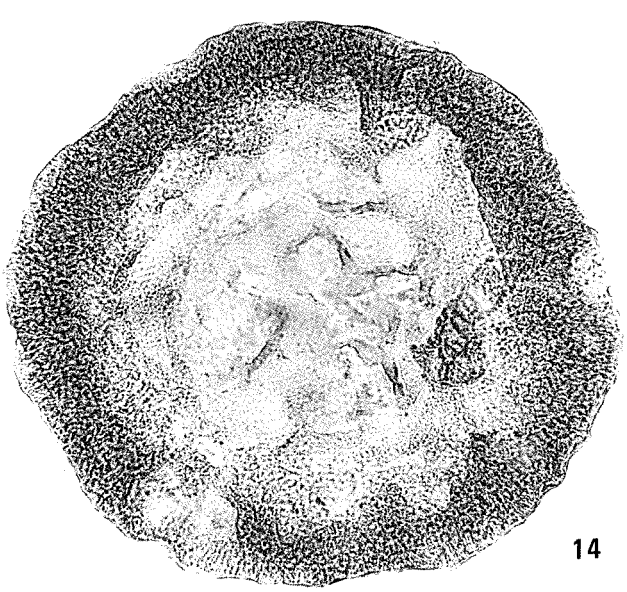


14

POLLEN GRAINS

Plate 80

All figures are magnified x600.

Figs 1, 2 *Praecolpatites sinuosus* (Balme & Hennelly) Bharadwaj & Srivasta 1969

1, 2. B.E. Balme collection.

Figs 3, 4 *Scheuringipollenites ovatus* (Balme & Hennelly) Foster 1975

3. B.E. Balme collection.
4. Specimen UWA 58701.

Fig. 5 *Potonieisporites balmei* (Hart) Segroves 1969

B.E. Balme collection.

Fig. 6 *Densipollenites indicus* Bharadwaj 1962

B.E. Balme collection.

Fig. 7 *Scheuringipollenites maximus* (Hart) Tiwari 1973

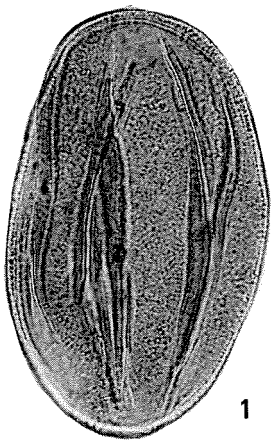
Specimen UWA 58707.

Fig. 8 *Densipollenites pullus* Segroves 1969

Holotype, UWA 58686.

Figs 9, 10 *Plicatipollenites gondwanensis* (Balme & Hennelly) Lele 1964

9. B.E. Balme collection.
10. Specimen UWA 58682.



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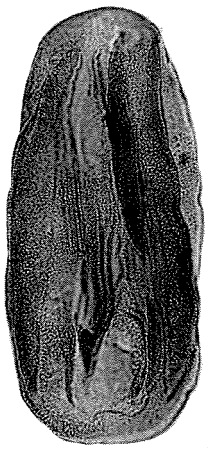

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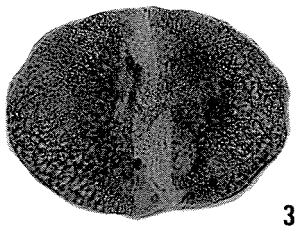

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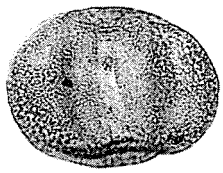

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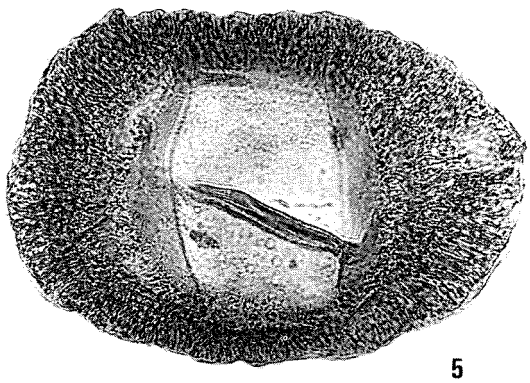

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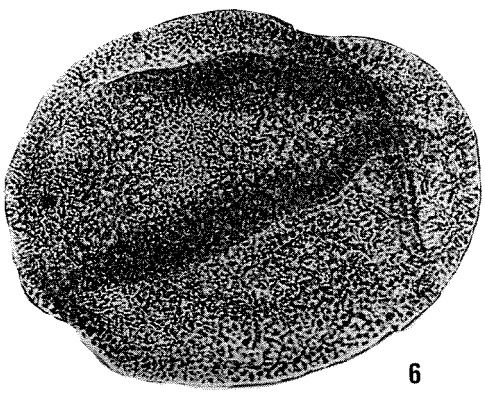

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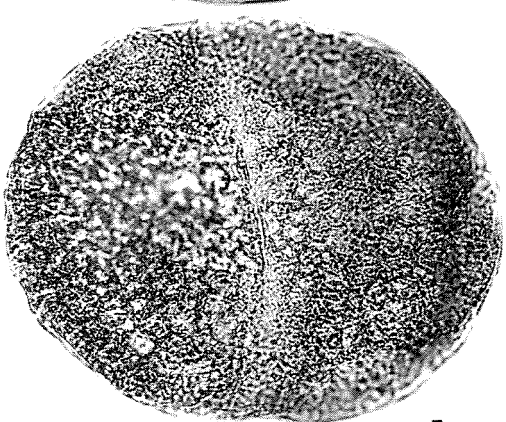

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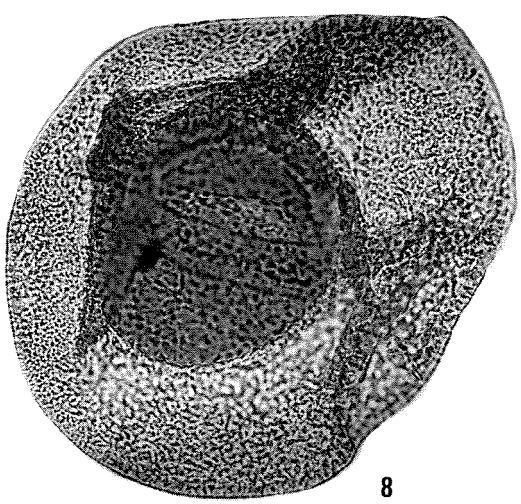

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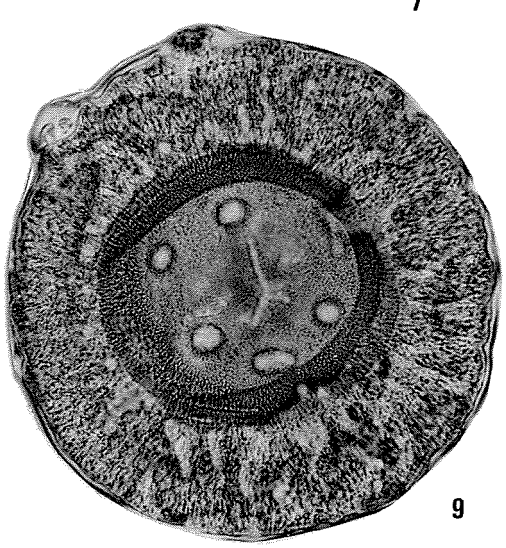

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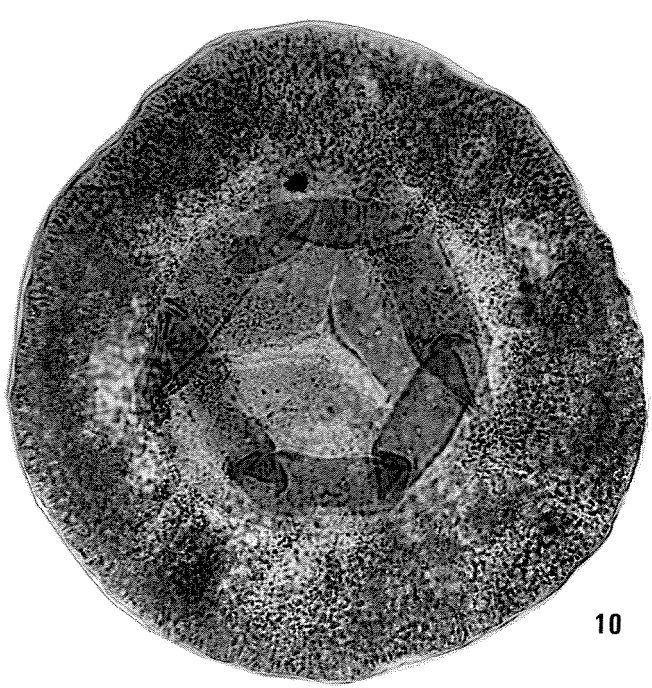


10

POLLEN GRAINS

Plate 81

All figures are magnified x600.

Figs 1–3 *Weylandites lucifer* (Bharadwaj & Salujha) Foster 1975

1–3. B.E. Balme collection.

Fig. 4 *Vittatina fasciolata* (Balme & Hennelly) Bharadwaj 1962

B.E. Balme collection.

Fig. 5 *Striatoabieites multistriatus* (Balme & Hennelly) Hart 1964

B.E. Balme collection.

Fig. 6 *Protohaploxypinus rugatus* Segroves 1969

Paratype, UWA 58723.

Figs 7, 8 *Protohaploxypinus limpidus* (Balme & Hennelly) Balme & Playford 1967

7, 8. B.E. Balme collection.

Figs 9, 10 *Striatopodocarpites cancellatus* (Balme & Hennelly) Hart 1964

9. B.E. Balme collection.
10. Specimen UWA 58734.

Figs 11, 12 *Vittatina scutata* (Balme & Hennelly) Bharadwaj 1962

11, 12. B.E. Balme collection.

Fig. 13 *Striatopodocarpites gondwanensis* Lakhanpal, Sah & Dube 1960

Specimen UWA 58738.

Figs 14, 15 *Platysaccus leschiki* Hart 1960

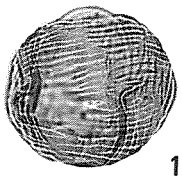
14. B.E. Balme collection.
15. Specimen UWA 58708.

Fig. 16 *Striatopodocarpites fusus* (Balme & Hennelly) Potonié 1958

B.E. Balme collection.

Figs 17, 18 *Protohaploxypinus amplus* (Balme & Hennelly) Hart 1964

17, 18. B.E. Balme collection.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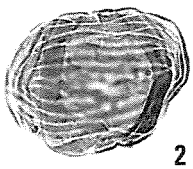
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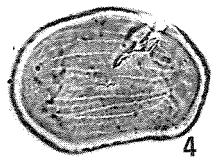
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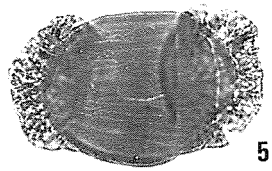
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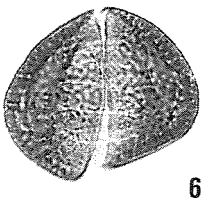
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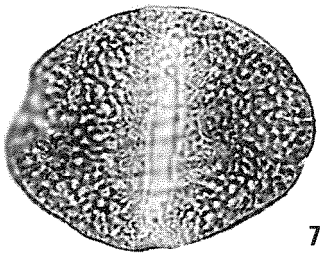
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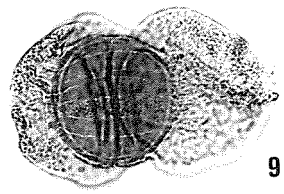
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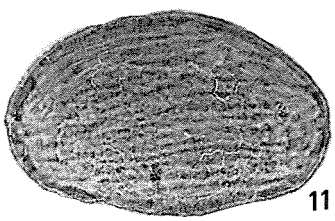
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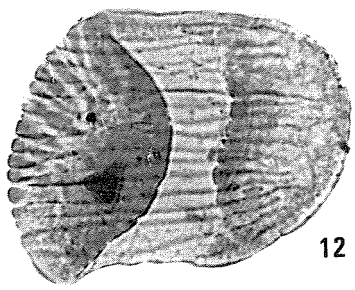
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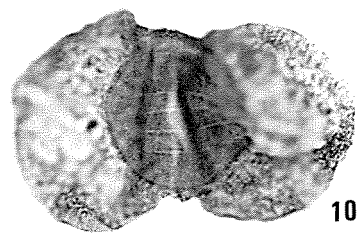
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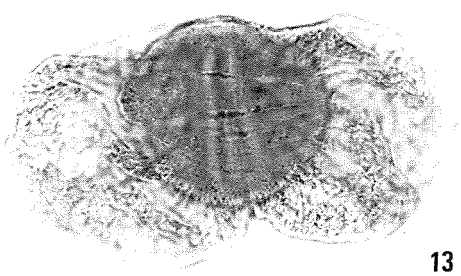
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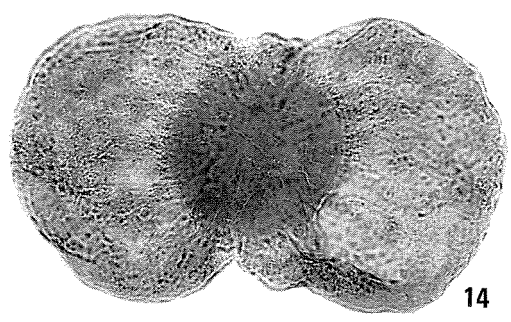
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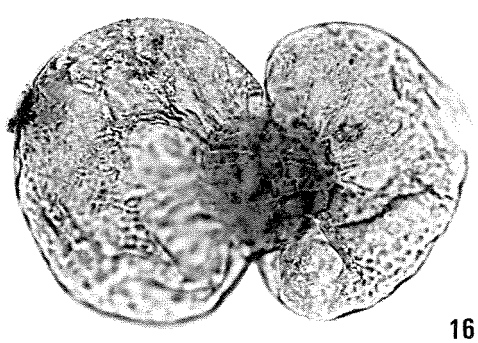
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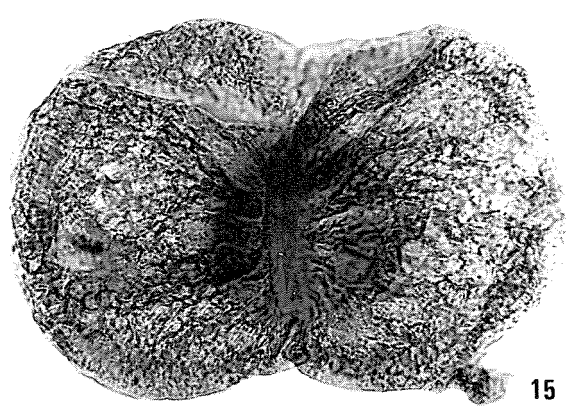
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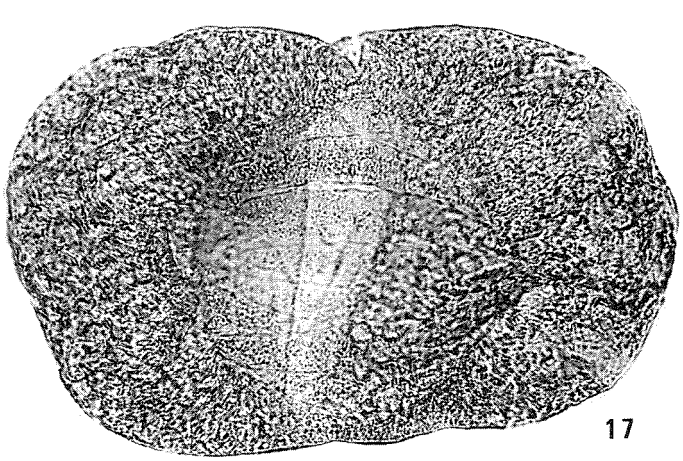
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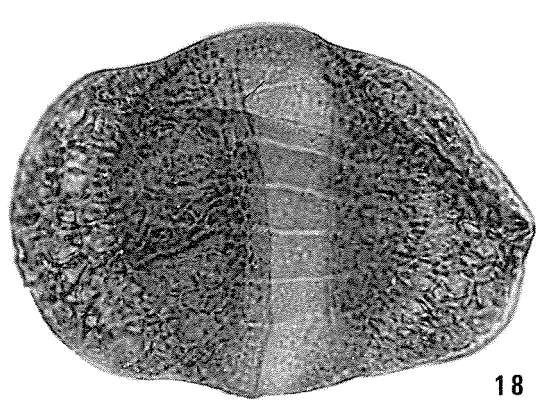

18

POLLEN GRAINS

10436—24

Plate 82

Paracalamites australis Rigby 1966

Holotype, UWA 22972, x1.
Ewington Member of the Collie Coal Measures; Collie Basin.



PLANTS

Plate 83

All figures are natural size.

Figs 1, 2, 4–6 *Cyclodendron leslii* (Seward 1903) Kraüsel 1928

1. Specimen UN 745.
Irwin River Coal Measures; Perth Basin.

2. Specimen BM(NH) V.25713.
No location data.

4. Specimen BM(NH) V.25716.
5. Back of counterpart of BM(NH) V.25712.
6. Specimen BM(NH) V.25713.
Nura Nura Member of the Poole Sandstone, Grant Group; Canning Basin.

Fig. 3a *Raniganjia minima* (Rigby 1966) Rigby comb. nov.

3a. **Holotype**, UWA 52986.
Wagina Sandstone; Perth Basin.

Fig. 3b *Cordaites spatulata* (Dana 1849) Rigby, Maheshwari & Schopf 1980

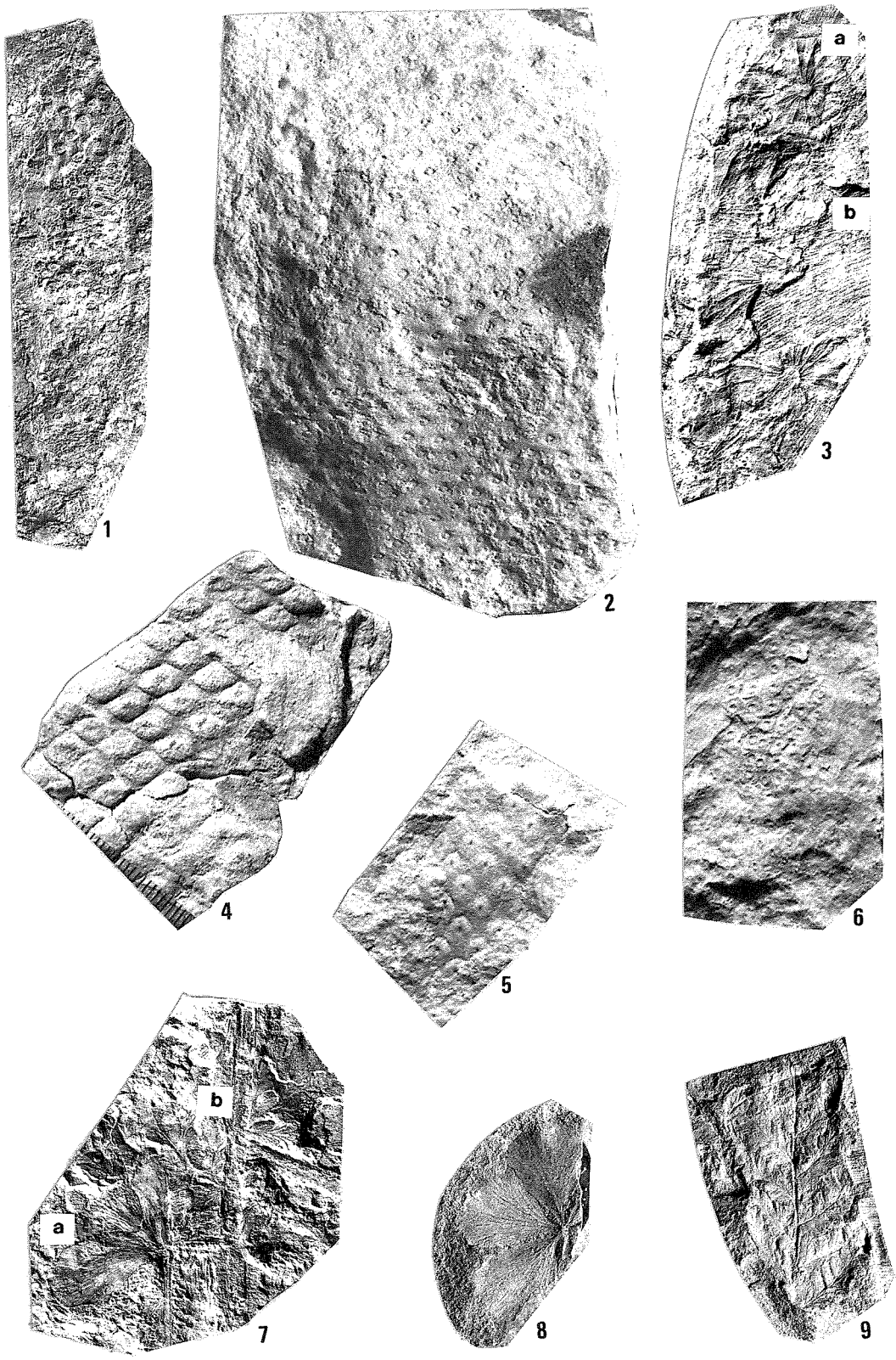
3b. Parallel-veined leaf fragment, UWA 52986.
Wagina Sandstone; Perth Basin.

Figs 7a, 8 *Sphenophyllum rhodesii* Rigby 1966

7a. Specimen UWA 53779.
8. **Paratype**, UWA 32684.
Irwin River Coal Measures; Perth Basin.

Figs 7b, 9 *Neomariopteris lobifolia* (Morris 1845) Maithy 1974

7b. Specimen UWA 53779.
9. Specimen UWA 23680.
Irwin Coal Measures; Perth Basin.



PLANTS

Plate 84

All figures are natural size.

Figs 1, 2, 5 *Glossopteris condrenensis* Rigby, Chandra & Surange 1988

1. Specimen BMR F23666.
'Blina Shale'; Canning Basin.

2. **Holotype**, CPC 26551.
Condren Sandstone, Liveringa Group; Canning Basin.

5. Specimen UWA 21562.
Ewington Member of the Collie Coal Measures; Collie Basin.

Fig. 3 *Glossopteris irwinensis* Rigby, Chandra & Surange 1988

Holotype, UWA 52982.
Wagina Sandstone; Perth Basin.

Fig. 4 *Glossopteris linearis* M'Coy 1847

Specimen NMV P10311.
Collie Coal Measures; Collie Basin.



PLANTS

Plate 85

Both figures are natural size.

Figs 1, 2 *Glossopteris condrenensis* Rigby, Chandra & Surange 1988

1. Specimen UWA 21562.
Ewington Member of the Collie Coal Measures; Collie Basin.

2. Specimen CPC 30659.
Grant Group or Poole Sandstone; Canning Basin.



PLANTS

Plate 86

All figures are natural size.

Fig. 1 *Glossopteris waginanus* (Rigby 1966) Rigby, Chandra & Surange 1988

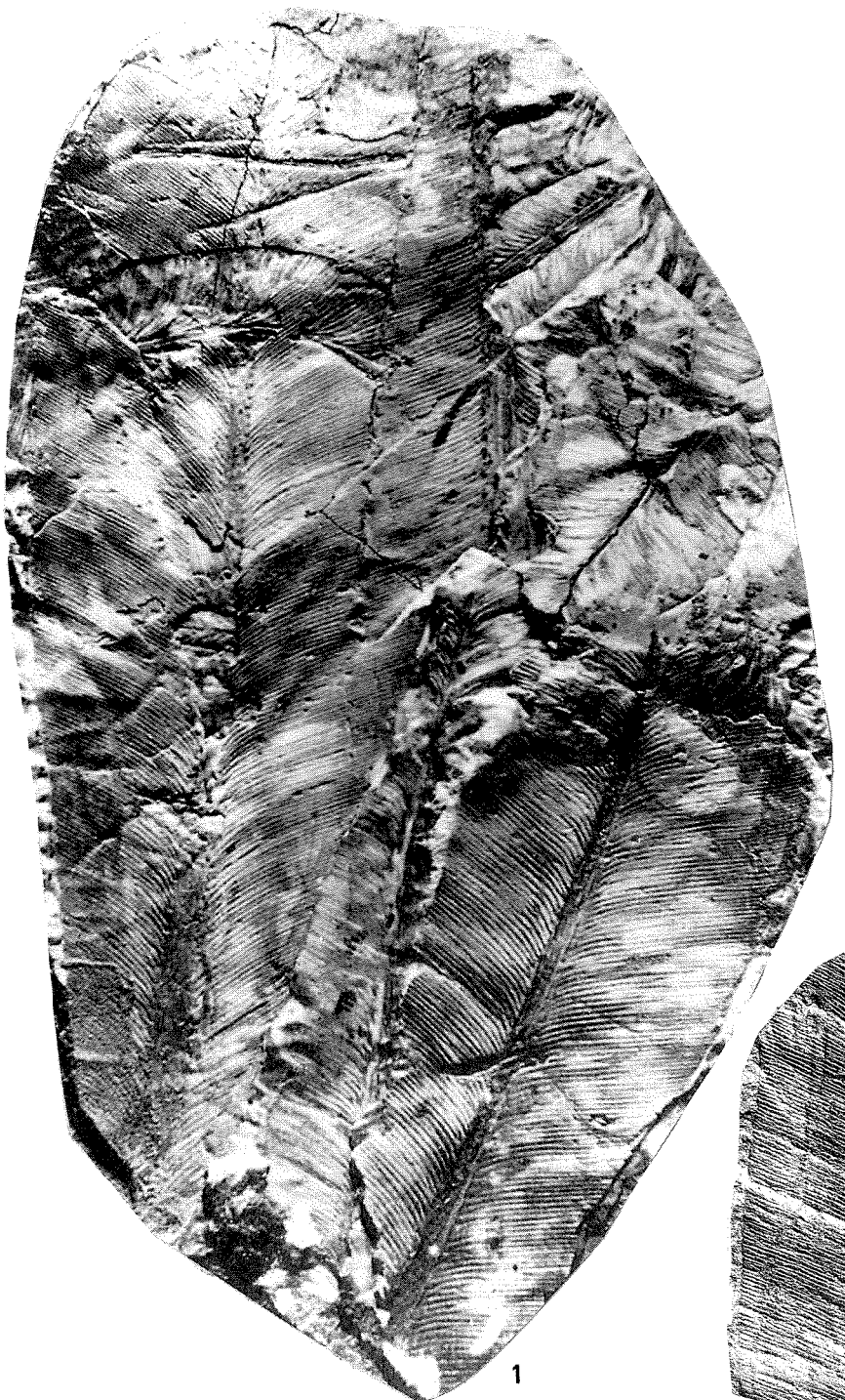
Holotype, UWA 37594.
Wagina Sandstone; Perth Basin.

Fig. 2 *Glossopteris* sp. cf. *G. decipiens* Feistmantel 1879

Specimen UN 731.
Ewington Member of the Collie Coal Measures; Collie Basin.

Fig. 3 *Glossopteris* sp. cf. *G. hispida* Pant 1966

Specimen UN 740.
Ewington Member of the Collie Coal Measures; Collie Basin.



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PLANTS

Plate 87

All figures are natural size.

Fig. 1a *Gangamopteris spatulata* M'Coy 1875

1a. Small, asymmetrical leaf (half-way across width of the slab and quarter-way from the top of the slab); UWA 52987.
Wagina Sandstone; Perth Basin.

Fig. 1b *Glossopteris waginanus* (Rigby 1966) Rigby, Chandra & Surange 1988

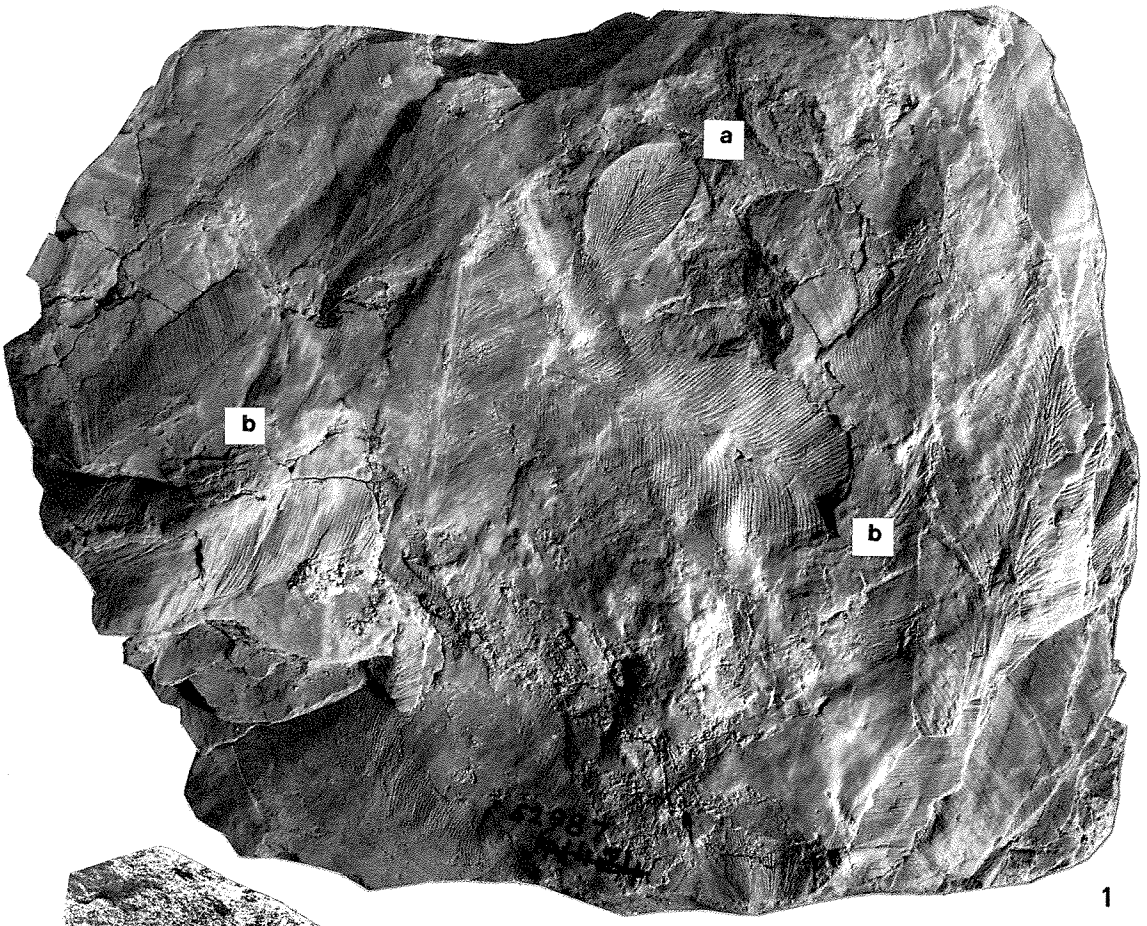
1b. Remaining leaf fragments; UWA 52987.
Wagina Sandstone; Perth Basin.

Fig. 2 *Glossopteris erregullanus* Rigby, Chandra & Surange 1988

Holotype, UWA 41425.
Mingenew Formation; Perth Basin.

Fig. 3 *Gangamopteris cyclopteroides* Feistmantel 1876

Small leaf; UN 719.
Ewington Member of the Collie Coal Measures; Collie Basin.



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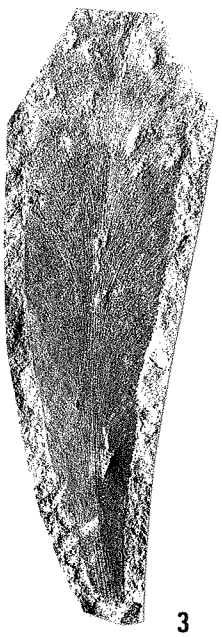

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PLANTS

Plate 88

All figures are natural size.

Fig. 1 *Glossopteris* sp. B

Specimen BMR F23679.
Condren Sandstone, Liveringa Group; Canning Basin.

Figs 2, 3 *Glossopteris gregoryi* Rigby, Chandra & Surange 1988

2. **Holotype**, UWA 45318.
Irwin River Coal Measures; Perth Basin.

3. Specimen UWA 23315.
Ewington Member of the Collie Coal Measures; Collie Basin.

Fig. 4 *Glossopteris waginanus* (Rigby 1966) Rigby, Chandra & Surange 1988

Specimen UWA 52980.
Wagina Sandstone; Perth Basin.



PLANTS

Plate 89

All figures are natural size.

Figs 1a, 2a *Glossopteris waginanus* (Rigby 1966) Rigby, Chandra & Surange 1988

1a. Specimen UWA 52987.
2a. Specimen UWA 52979.
Wagina Sandstone; Perth Basin.

Figs 1b, 2b *Cordaites spatulata* (Dana 1849) Rigby, Maheshwari & Schopf 1980

1b. Specimen UWA 52987.
2b. Specimen UWA 52979.
Wagina Sandstone; Perth Basin.

Fig. 1c *Glossopteris gregoryi* Rigby, Chandra & Surange 1988

1c. Leaves with closely spaced, arched venation; UWA 52987.
Wagina Sandstone; Perth Basin.

Fig. 2c *Raniganjia minima* (Rigby 1966) Rigby comb. nov.

2c. Specimen UWA 52979.
Wagina Sandstone; Perth Basin.

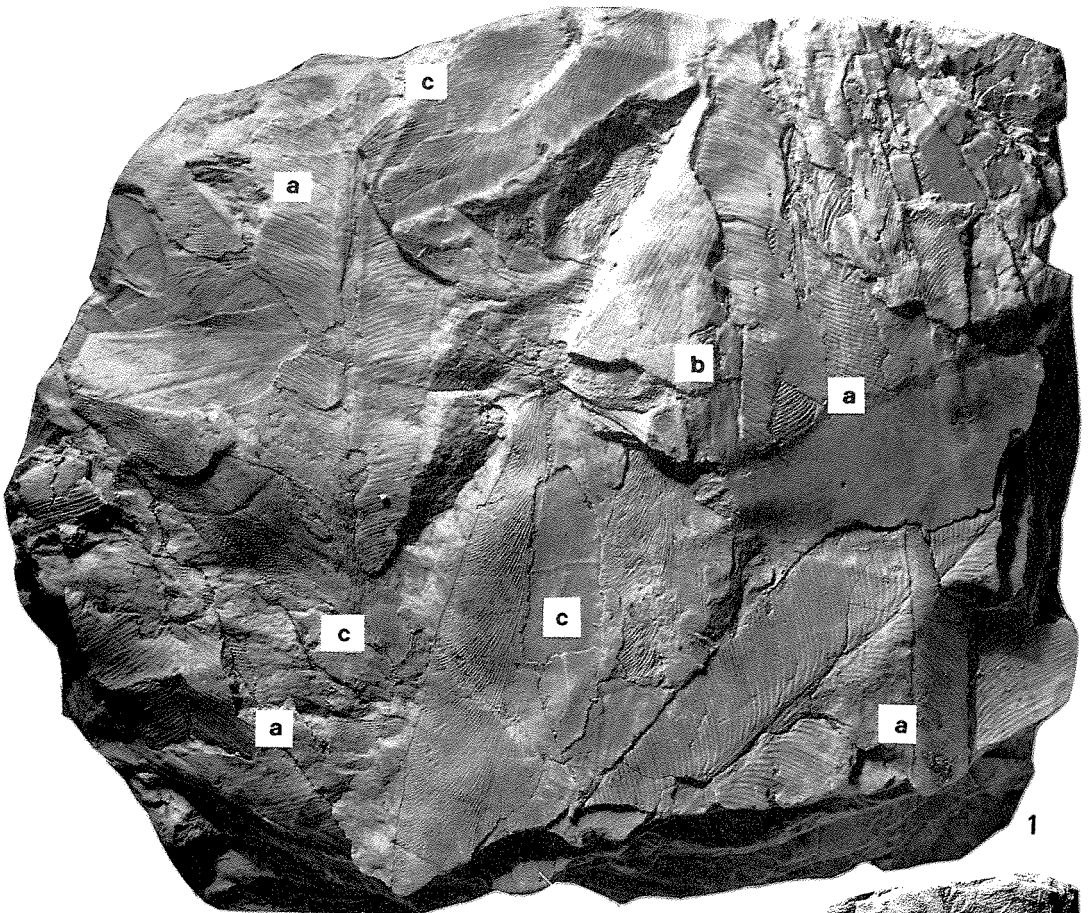
Fig. 3 *Glossopteris woolaganus* Rigby, Chandra & Surange 1988

Specimen UN 743.
Irwin River Coal Measures; Perth Basin.

Figs 4, 5 *Glossopteris* sp. A

4. Specimen UWA 53784.
Irwin River Coal Measures; Perth Basin.

5. Specimen UWA 52988.
Mingenew Formation; Perth Basin.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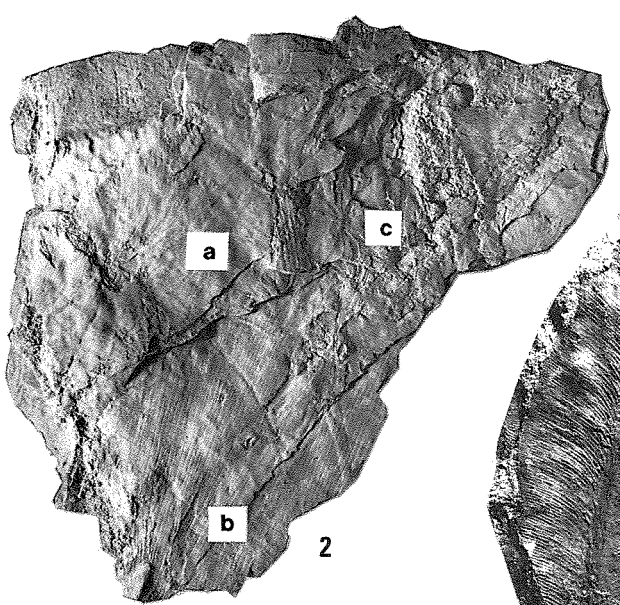
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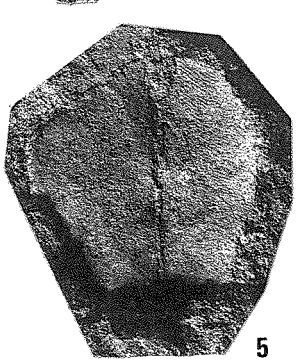
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Plate 90

All figures are natural size.

Fig. 1 *Samaropsis* sp. cf. *S. milleri* (Feistmantel 1879) Seward 1917

Specimen BM(NH) V.25721.
Nura Nura Member of the Poole Sandstone, Grant Group; Canning Basin.

Fig. 2 *Glossopteris* sp. D

Specimen NMV P10308.
Collie Coal Measures; Collie Basin.

Figs 3, 5a *Cordaites spatulata* (Dana 1849) Rigby, Maheshwari & Schopf 1980

3. Specimen BM(NH) V.25722.
Nura Nura Member of the Poole Sandstone; Grant Group; Canning Basin.

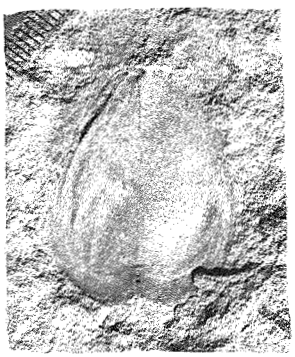
5a. Specimen UWA 52983.
Wagina Sandstone; Perth Basin.

Fig. 4 *Gangamopteris cyclopteroides* Feistmantel 1878

Specimen UN 730.
Cardiff Member of the Collie Coal Measures; Collie Basin.

Fig. 5b *Glossopteris waginanus* (Rigby 1966) Rigby, Chandra & Surange 1988

Specimen UWA 52983.
Wagina Sandstone; Perth Basin.



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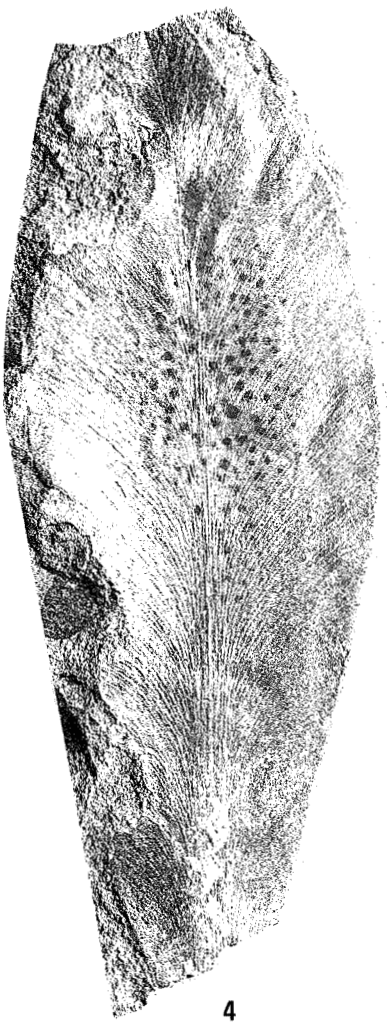

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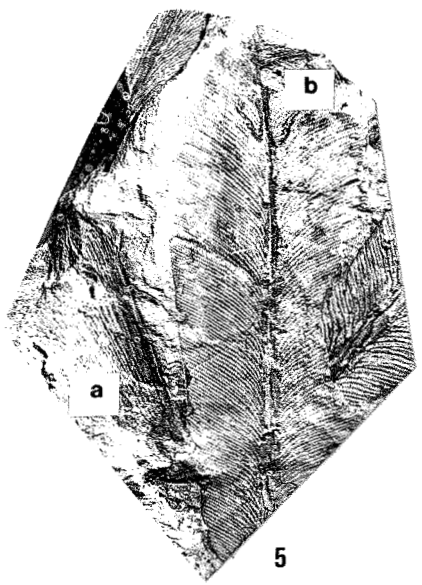

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PLANTS

Plate 91

Figures are natural size, unless otherwise indicated.

Fig. 1 *Liknopetalon enigmata* Smithies *ex* Anderson & Anderson 1985

Daymond, personal collection, x4.7.
Irwin River Coal Measures; Perth Basin.

Fig. 2 *Cyclodendron leslii* (Seward 1903) Kräusel 1928

Specimen UWA 10250.
Irwin River Coal Measures; Perth Basin.

Fig. 3 Scale leaf

Specimen UWA 37570.
Irwin River Coal Measures; Perth Basin.

Fig. 4 *Senia?* sp.

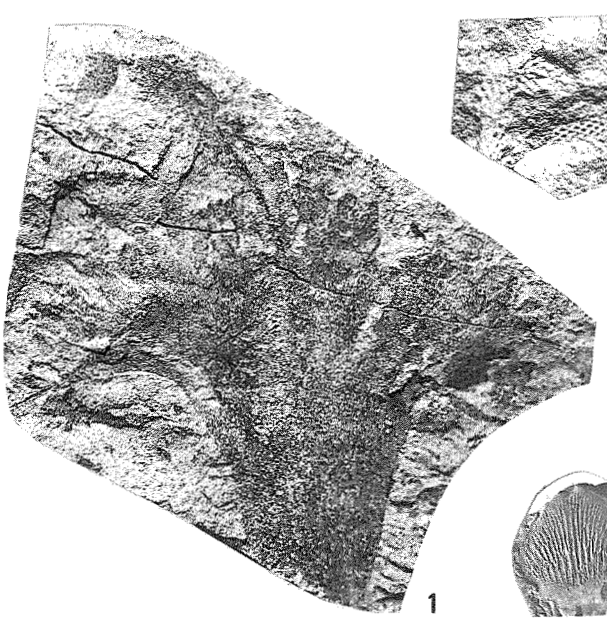
Specimen UWA 23679.
Irwin River Coal Measures; Perth Basin.

Fig. 5 *Gondwanophyton daymondii* Rigby sp. nov.

Specimen WAM P86.58.
Irwin River Coal Measures; Perth Basin.

Fig. 6 *Ginkgophyllum diazii* Archangelsky & Arrondo 1975

Specimen UN 754.
Ewington Member of the Collie Coal Measures; Collie Basin.



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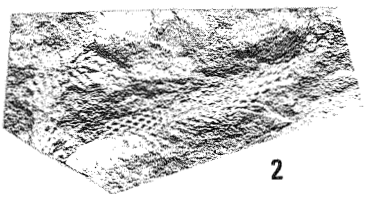

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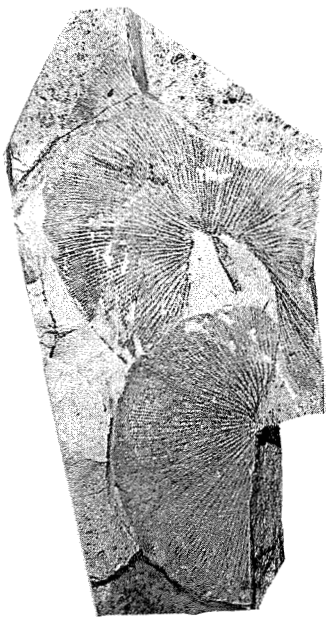

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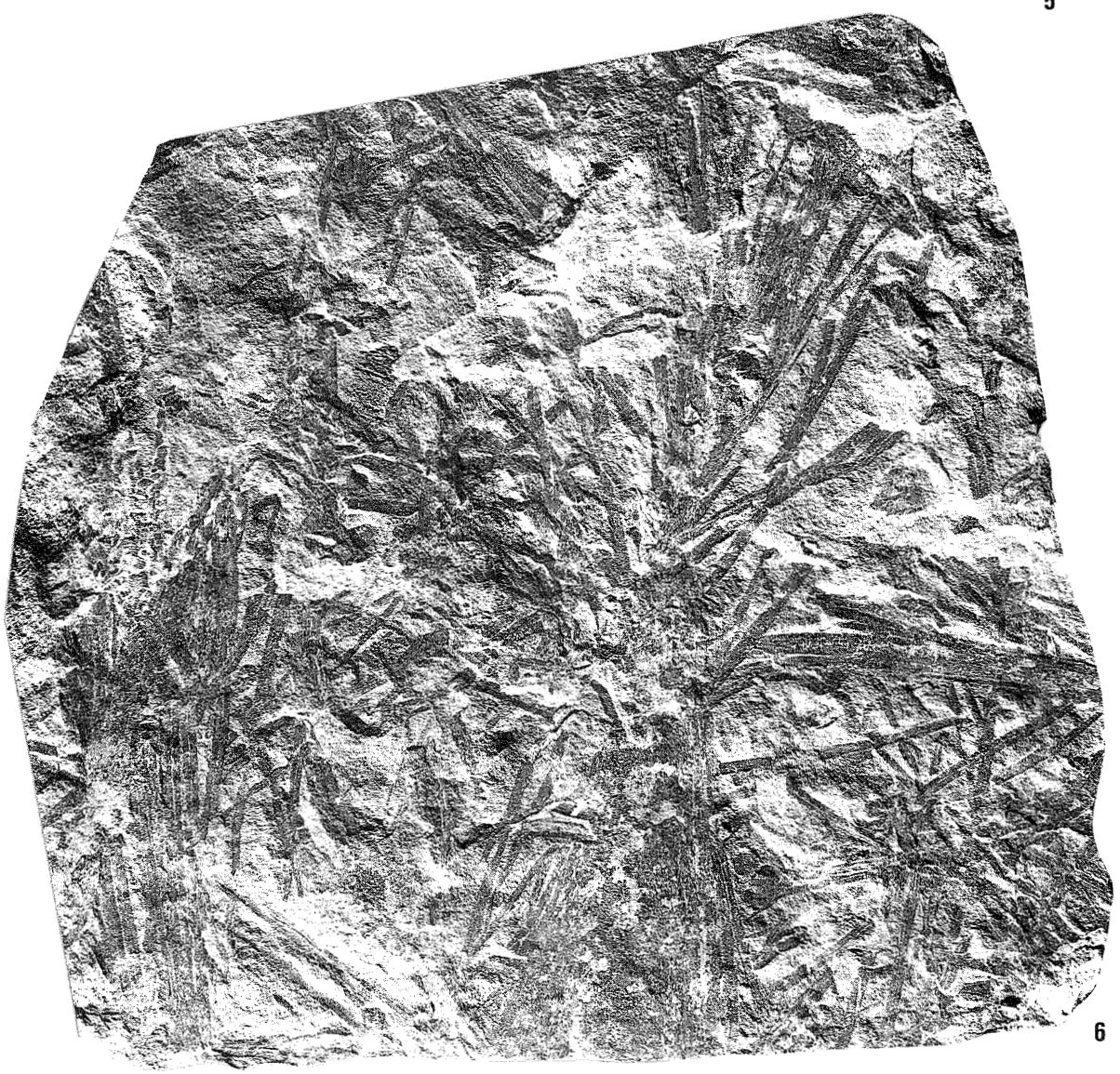

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PLANTS

Plate 92

Specimens are natural size, unless otherwise indicated.

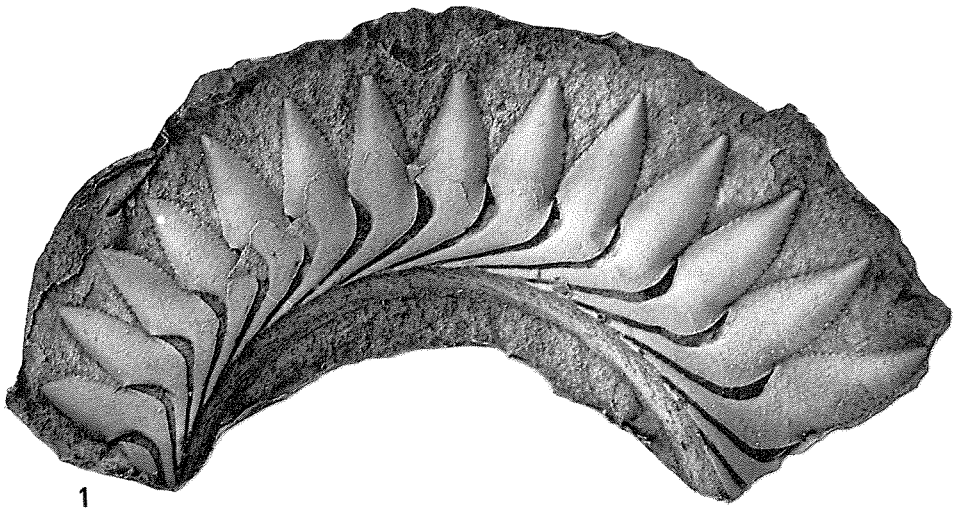
Figs 1–5 *Helicoprion davisi* (H. Woodward 1886)

1. Plaster cast of **Holotype**, WAM 9080 (Teichert, 1940, pl. 22 fig. 1).
Arthur River valley, Gascoyne River District, Carnarvon Basin; not *in situ*; Late Artinskian (Baigendzhinian).

2. External mould of specimen, UWA 19221a (Teichert, 1940, pl. 23 fig. 3).
3. External mould of UWA 19221b (Teichert, 1940, pl. 23 fig. 1).
183 m north of Wandagee - Minilya road, west side of syncline, north of Wandagee Hill, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

4. Specimen WAM G8523 (Teichert, 1940, pl. 22 fig. 2).
Minilya River near Wandagee Homestead, Carnarvon Basin; not *in situ*; Late Artinskian (Baigendzhinian).

5. T.s. denticle showing typical high triangular shape, central osteodentine surrounded by thick layer of orthodentine; x4.
Locality not known.



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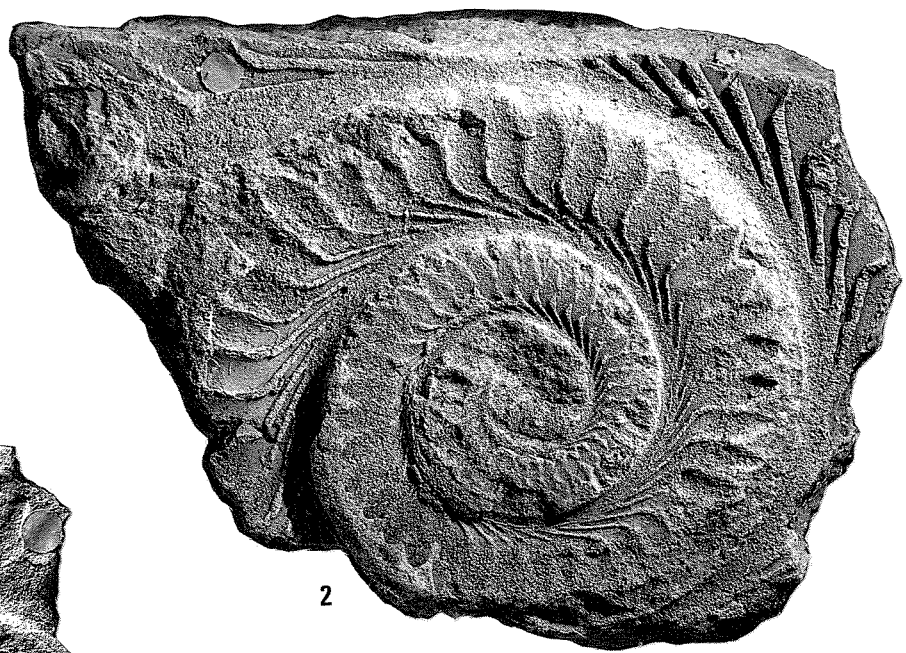

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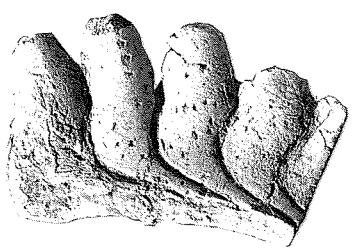

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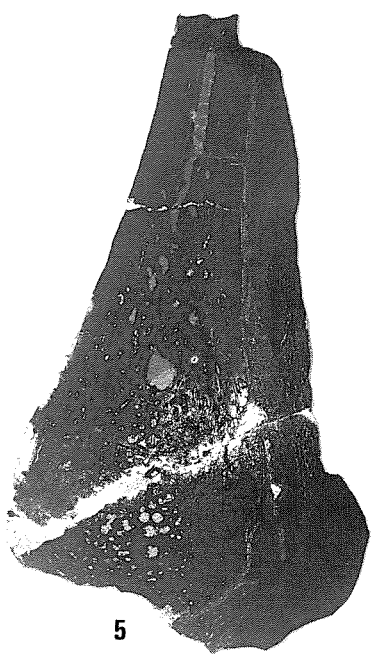

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FISH

Plate 93

Specimens are natural size, unless otherwise indicated.

Figs 1–7, 9–10 *Crassidonta? subcrenulata* Teichert 1943

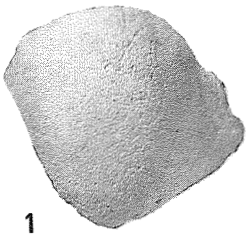
1. **Lectotype**, UWA 21401f; in coronal view (Teichert, 1943, pl. 1 fig. 3).
2. **Lectotype**, UWA 21401e; in coronal view (Teichert, 1943, pl. 1 fig. 7).
3. **Holotype,** UWA 21401a; in basal view.
4. **Holotype,** UWA 21401a; in coronal view (Teichert, 1943, pl. 1 fig. 5).
5. **Lectotype,** UWA 21401e; in ventral view.
6. **Lectotype,** UWA 21401f; in ventral view (Teichert, 1943, pl. 1 fig 13).
7. **Holotype,** UWA 21401a; in lateral view (Teichert, 1943, pl. 1 fig. 14).
9. **Tectotype,** slide UWA 41176; portion of longitudinal section through dentine of tooth; x35 (Teichert, 1943, pl. 2 fig. 18).
10. **Tectotype,** slide UWA 41175; portion of transverse section through denteons of tooth; x35 (Teichert, 1943, pl. 2 fig. 17).

Nalbia Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 8 *Helodus?* sp. Teichert 1943

8. **Holotype,** UWA 21400; in coronal view (Teichert, 1943, pl. 1 fig. 15).

274 m east of southeastern gully of Wandagee Hill, Mungadan Paddock, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).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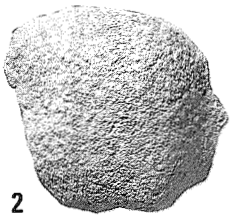
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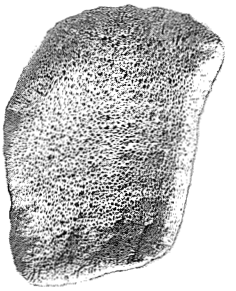
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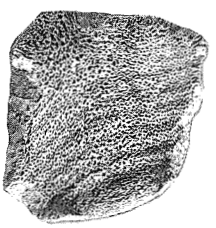
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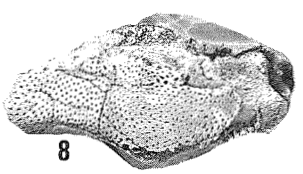
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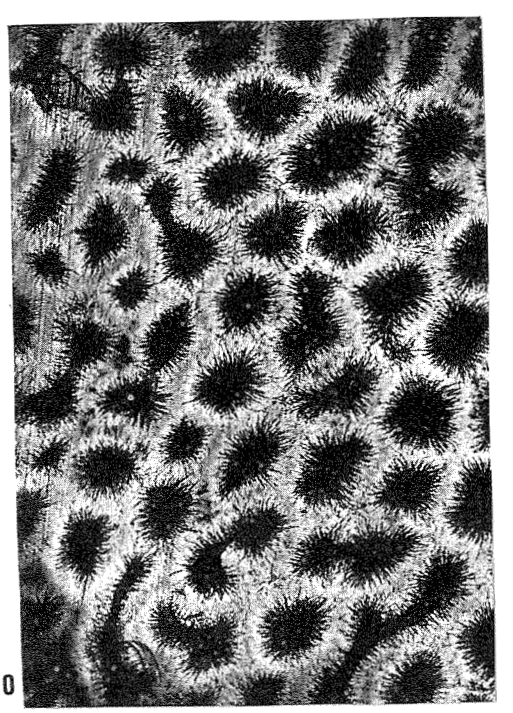
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FISH

Plate 94

Figs 1–9 Cryphiolepidid? gen. et. sp. indet. (Archbold 1981)

1. Dorsal view of scale (posterior to top), GSWA F11006; x5.
2. Dorsal view of scale; GSWA F11010; x5.
3. Close up of portion of dorsal scale ornament, GSWA F11012; x12.
4. Dorsal view of scale; GSWA F11009; x5.
5. Possible coprolitic block full of scales, GSWA F11016; x1.
6. Dorsal view of scale; GSWA F11008; x4.5.
7. Dorsal view of scale; GSWA F11012; x5.
8. Dorsal view of scale, GSWA F11007; x5.
9. Dorsal view of scale, GSWA F11006; x5.

All specimens from GSWA sample 44553, about 300 m south of Wooramel River, northeast of Darcy Hill, Carnarvon Basin; near top of Coyrie Formation; Late Artinskian (Baigendzhinian).


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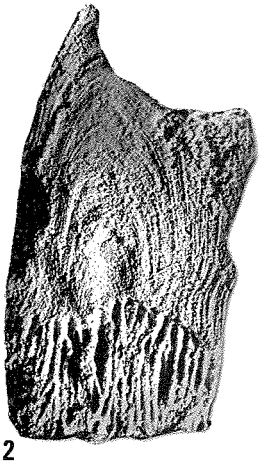
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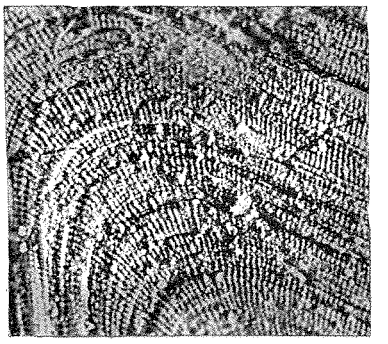
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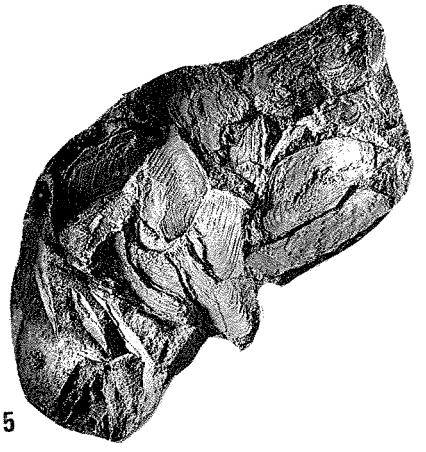
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FISH

Plate 95

Figures are natural size, unless otherwise indicated.

Figs 1–6 *Paramelonella etheridgei* Howell 1956

1, 4–6. '*Stylopegma incerta* Howell 1956': **holotype**, UWA 36400.
2. '*P. lata* Howell 1956': **holotype**, UWA 36395.
3. '*S. singularis* Howell 1956': **holotype**, UWA 36399.
Minilya River, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Fig. 7 *Amphictene permiana* Parr 1942

Holotype, UWA 20672; x20.
South side of Minilya River, near Coolkilya Pool, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

Figs 8–10, 12 *Conchotrema tubulosa* Teichert 1945

8. Specimen infecting dorsal valve of *Spirifer*; UWA 8483.
3.2 km east-southeast of Survey Station R.20 on Wooramel River, Carnarvon Basin; Late Artinskian (Baigendzhinian).

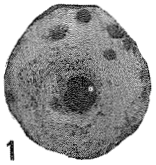
9. Specimen infecting ventral valve of a *?Taeniothaerus*; UWA 21441.
West of Coolkilya Pool, Minilya River, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).

10. Specimen infecting dorsal value of *Crassispirifer rostalinus* (Hosking); UWA 21270; x2.
Wooramel River area, Carnarvon Basin; Byro Group; Late Artinskian (Baigendzhinian).

12. **Holotype**; infecting dorsal value of a productid; UWA 21319; x3.
3.2 km east of Christmas Creek Homestead, northern Canning Basin; Noonkanbah Formation; Late Artinskian (Baigendzhinian).

Fig. 11 *Conchotrema tenuis* Teichert 1945

Specimen infecting dorsal valve of a *Spirifer*; UWA 21321; x3.
West of Coolkilya Pool, Wandagee Station, Carnarvon Basin; Wandagee Formation; Late Artinskian (Baigendzhinian).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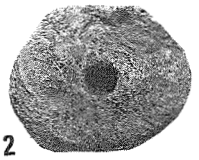
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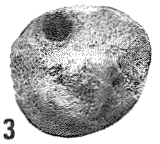
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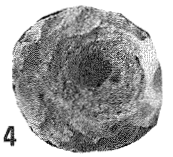
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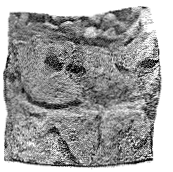
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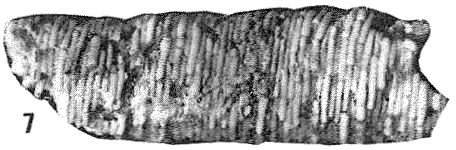
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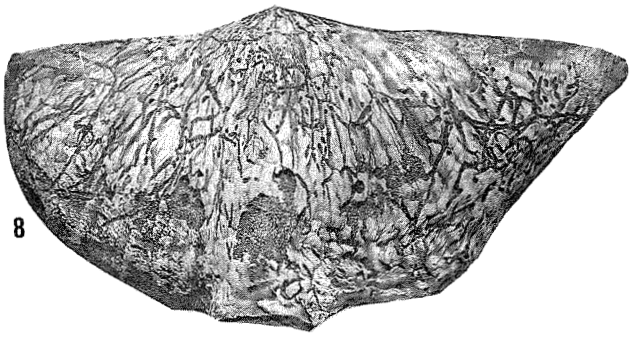
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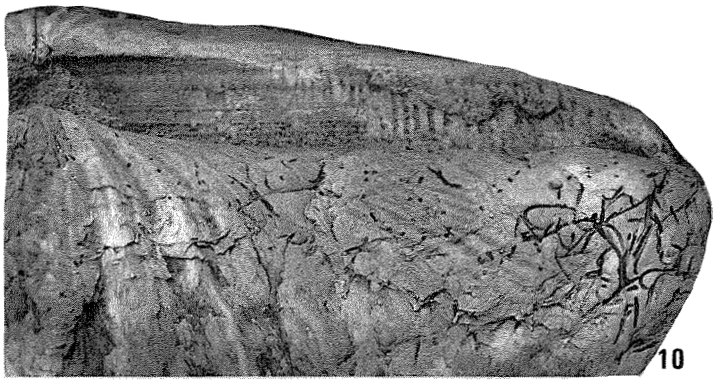
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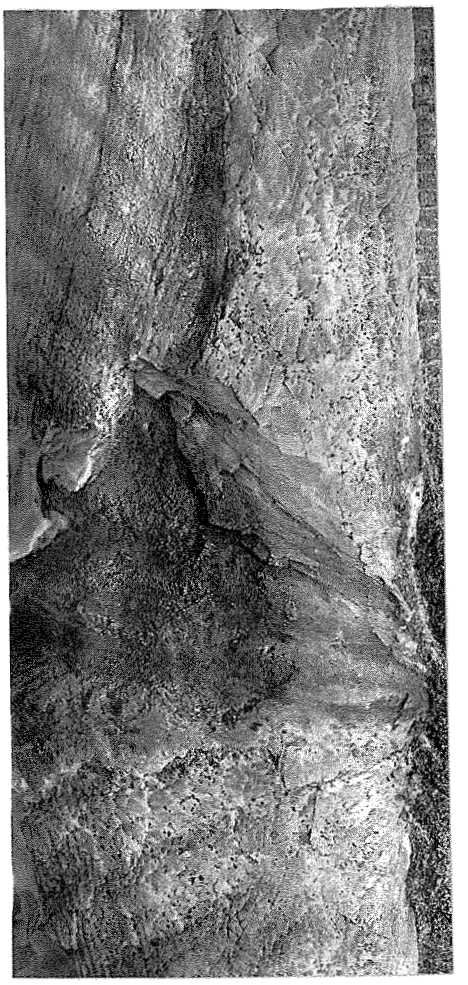
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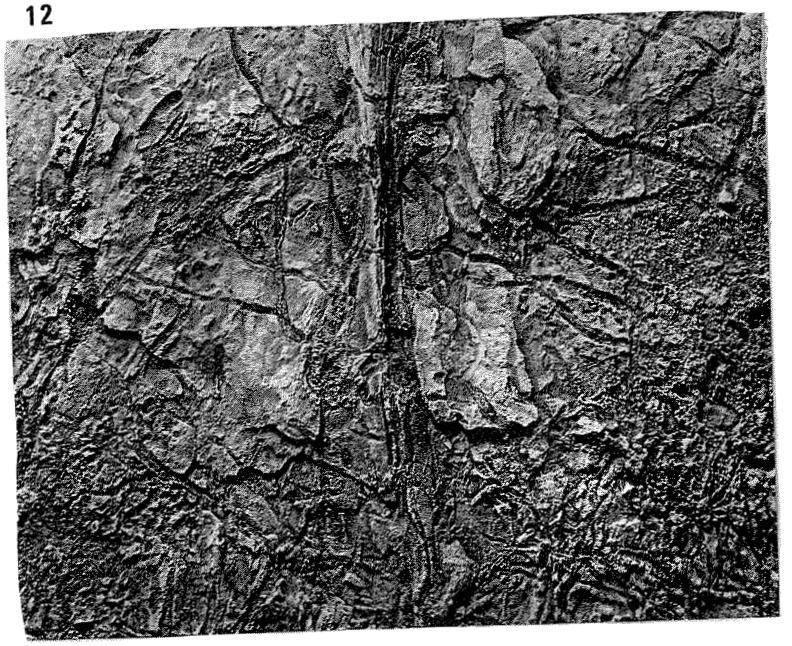
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ANNELIDS

Plate 96

All specimens coated with ammonium chloride.

Figs 1a, 3, 5a *Paleodictyon?* sp.

1a. Specimen GSWA F46903a; x0.5.
3. Specimen GSWA F46902; x1.
Locality 69552; nearest hill due west from Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

5a. Specimen GSWA F46904a; x1.
Locality 69565; north-facing scarp south of track and west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Coolkilya and Mungadan Sandstones; Kungurian.

Figs 1b, 2, 5b *Paleodictyon? (Squamodictyon?)* sp.

1b. Specimen GSWA F46903b; x0.5.
Locality 69552; see fig. 1a above.

2. Specimen GSWA F46905; x0.5.
5b. Specimen GSWA F46904b; x1.
Locality 69565; see fig. 5a above.

Figs 4, 10 *Margaritichnus* sp. 1

4. Specimen GSWA F46911; x0.6.
10. Specimen GSWA F46910; x0.5.
Locality 69545; low hill south of road 1.5 km south of Bucknall Pinnacle, west of Cherrabun Homestead, Canning Basin; Lightjack Formation; Kungurian.

Fig. 6 *Margaritichnus* sp. 1?

Specimen GSWA F46909; x0.5.
Locality 69569; Gascoyne River, 1 km downstream from Gascoyne Junction crossing, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Fig. 7 *Margaritichnus* sp.

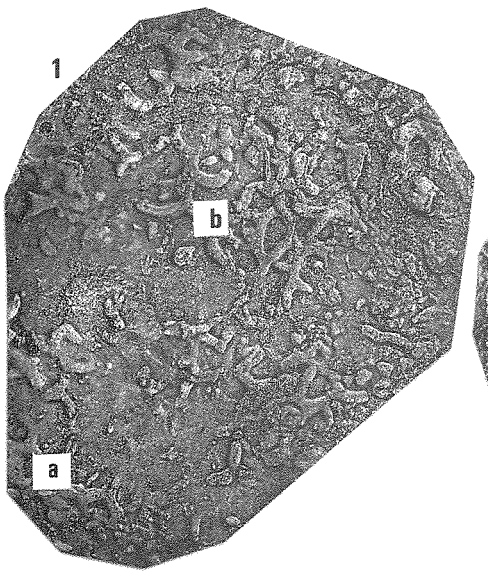
Specimen GSWA F46908; x0.5.
Locality 69536; small hill north of track between Donnellys Bore and Moogooree Homestead, Carnarvon Basin; Billidee Formation; Artinskian.

Fig. 8 *Scolicia* sp. 1

Specimen GSWA F46919; x0.5.
Locality 69569; see fig. 6 above.

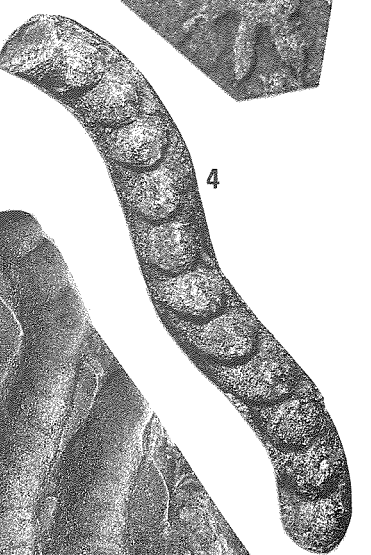
Fig. 9 *Scolicia* sp. 2

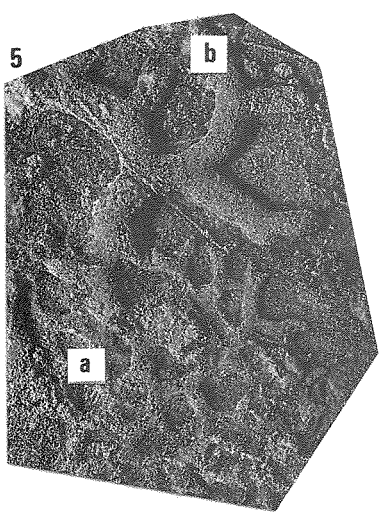
Specimen GSWA F46931a; x0.5.
Locality 69560; flat-topped hill east of road and about 4 km north of Swordfish Bore, Canning Basin; Hardman Formation; Chhidruan.

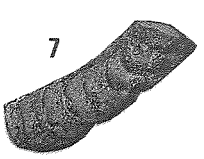


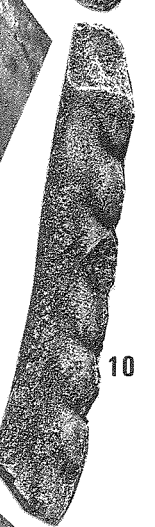


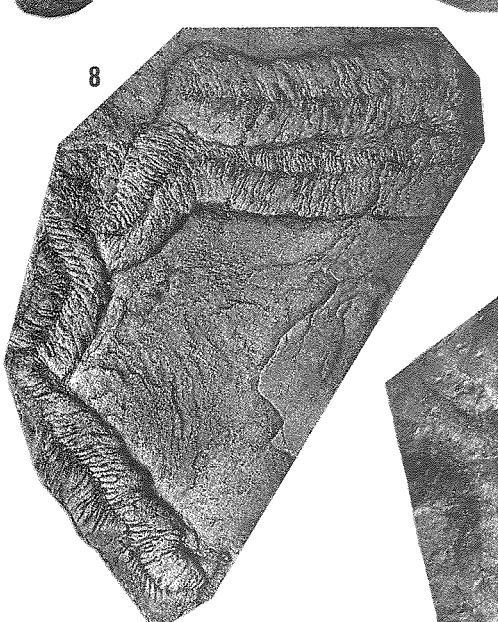


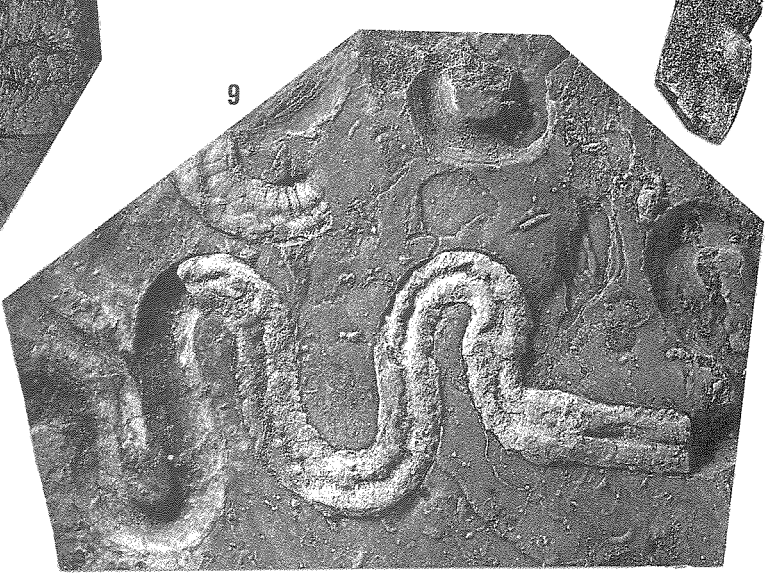












TRACE FOSSILS AND PROBLEMATICA

Plate 97

All specimens coated with ammonium chloride.

Fig. 1 *Scolicia* sp. 3

Specimen GSWA F46924; x1.
Locality 69543; Shore Range, nearest hill west of road south of Cherrabun Homestead, Canning Basin; Lightjack Formation; Kungurian.

Fig. 2 *Scolicia* sp. 1?

Specimen GSWA F45918; x0.5.
Locality 69543; see fig. 1 above.

Fig. 3 *Scolicia* sp. 3?

Specimen GSWA F46922; x0.5.
Locality 69569; Gascoyne River, 1 km downstream from main crossing at Gascoyne Junction, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).

Figs 4, 5 *Curvolithus* sp.

4. Specimen GSWA F46940; x0.5.
Locality 69552; nearest hill due west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

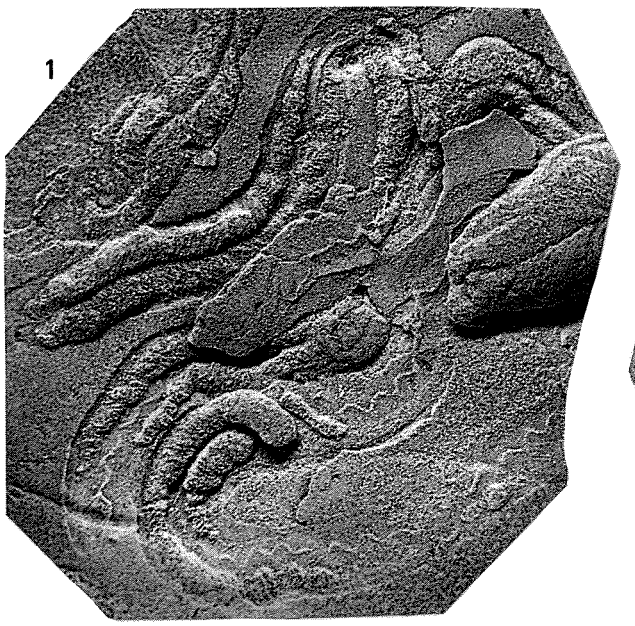
5. Specimen GSWA F46921; x1.
Locality 69518A; east side of Wandagee Hill, Wandagee Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

Fig. 6 *Didymaulichnus?* sp. 1

Specimen GSWA F46932; x0.5.
Locality 69530; Cundlego Crossing on Minilya River, Wandagee Station, Carnarvon Basin; Cundlego Formation; Artinskian (Baigendzhinian).

Fig. 7 *Scolicia* sp. 4

Specimen F46929; x0.5.
Locality 69552; nearest hill due west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.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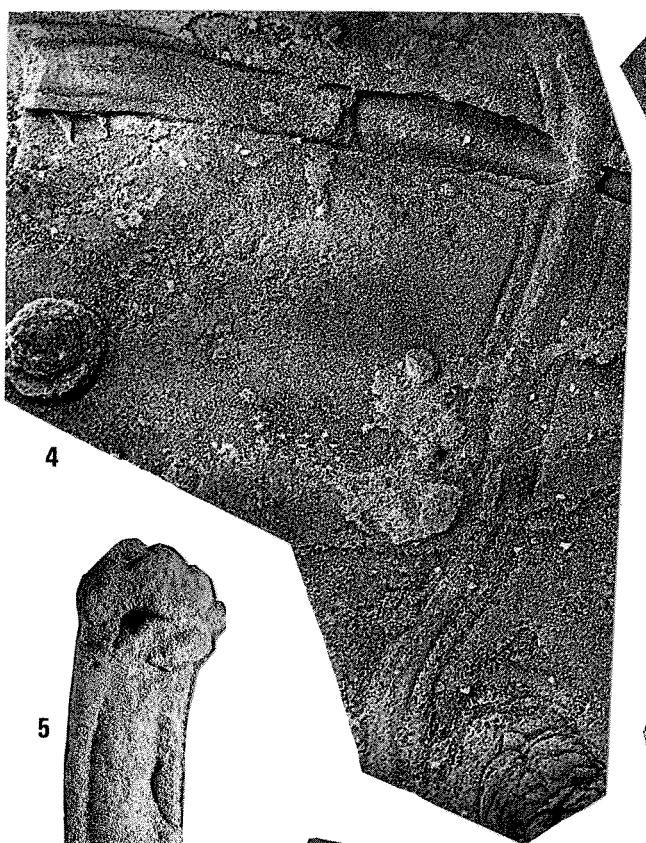
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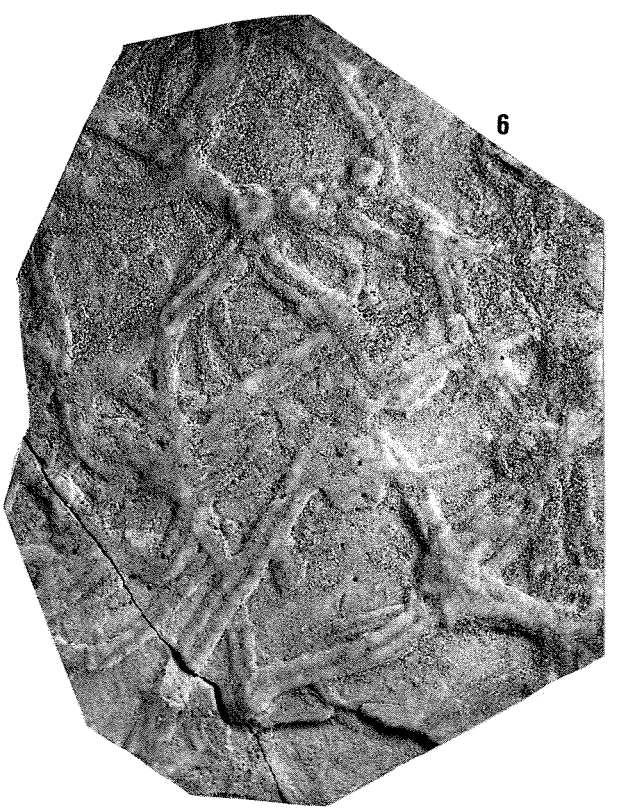
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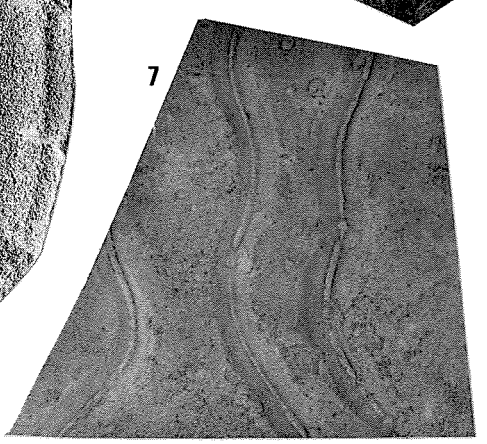
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TRACE FOSSILS AND PROBLEMATICA

10436—26

Plate 98

All specimens coated with ammonium chloride.

Fig. 1 *Didymaulichnus?* sp. 2

Specimen GSWA F46937c; x0.67.
Locality 69561; rim of plateau, east side of road about 4 km north of Swordfish Bore, Canning Basin; Hardman Formation; Chhidruan.

Fig. 2 Problematicum 1

Specimen GSWA F46945b; x0.5.
Locality 69552; nearest hill due west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

Fig. 3 *Gyrochorte?* sp.

Specimen GSWA F46944c; x2.
Locality 69543; Shore Range, nearest hill west of road south of Cherrabun Homestead, Canning Basin; Lightjack Formation; Kungurian.

Fig. 4a *Cruziana?* sp. 1

Specimen GSWA F46935a; x1.
Locality 69561; see fig. 1 above.

Fig. 4b *Cylindricum?* sp.

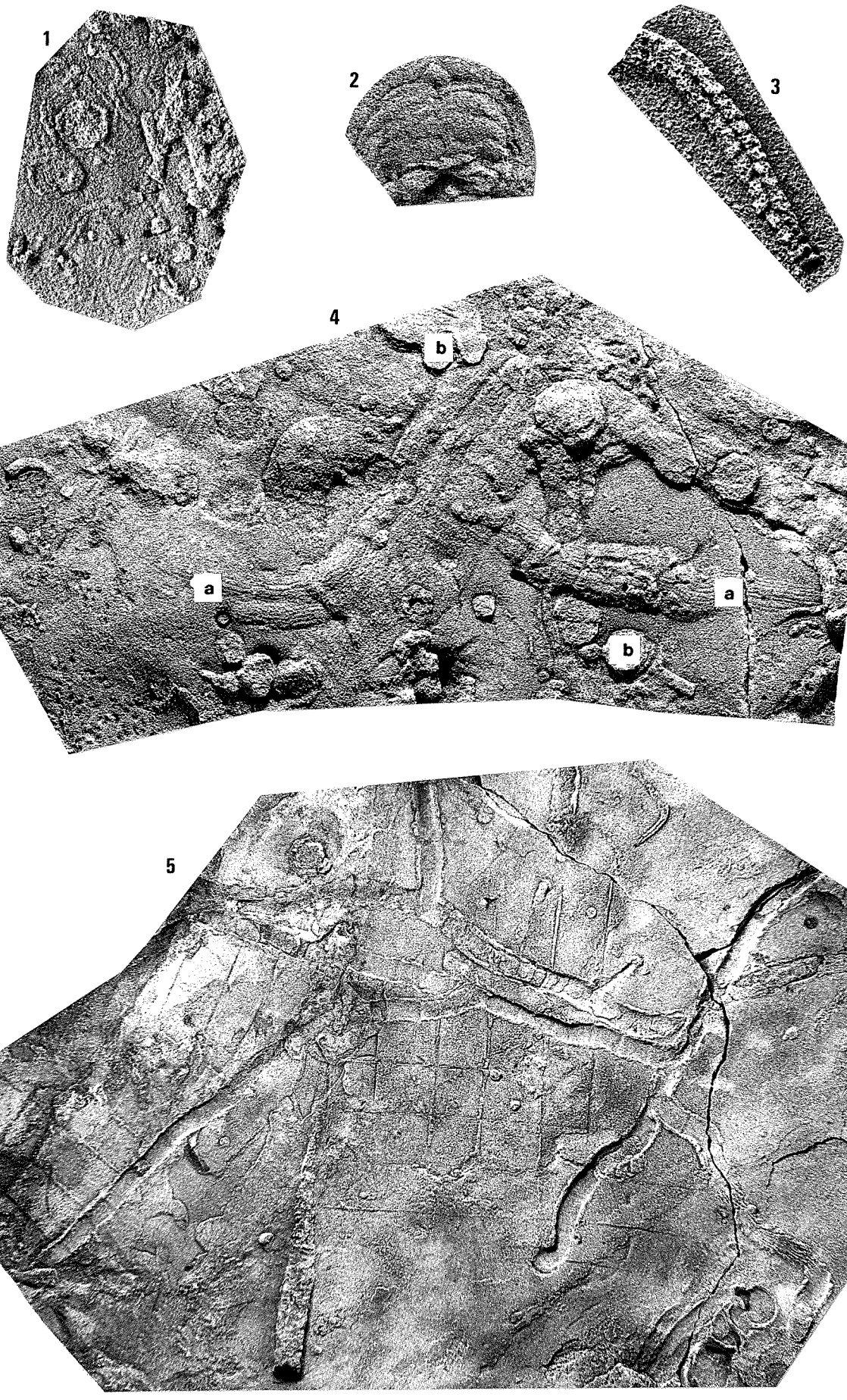
Specimen GSWA F46935b; x1.
Locality 69561; see fig. 1 above.

Fig. 5a *Macaronichnus* sp. 1

Specimen, GSWA F46944a; x0.5.
Locality 69543; see fig. 3 above.

Fig. 5b Problematicum 2

Specimen GSWA F46939; x0.5.
Locality 69543; see fig. 3 above.



TRACE FOSSILS AND PROBLEMATICA

Plate 99

All specimens coated with ammonium chloride.

Fig. 1 *Lophoctenium* sp. 1

UWA 113240; x1.
Wandagee Station, Carnarvon Basin; ?Wandagee Formation; ?Artinskian (Baigendzhinian).

Fig. 2 *Cylindricum?* sp.

Specimen GSWA F46970; x1.
Locality 69534; about 3 km east of Kennedy Bore, northern Kennedy Range, Carnarvon Basin; Nalbia Sandstone; Late Artinskian (Baigendzhinian).

Fig. 3 *Cruziana?* sp. 2

Specimen GSWA F46936; x1.
Locality 69569; float in Gascoyne River downstream from Gascoyne Junction crossing, Carnarvon Basin; unit and age not known.

Fig. 4 '*Lophoctenium*' sp. 2

Specimen GSWA F46971; x0.5.
Locality 69518A; east side of Wandagee Hill, Wandagee Station, Carnarvon Basin; Coolkilya and Mungadan Sandstones; Kungurian.

Fig. 5a,b 5a. '*Lophoctenium*' sp. 3

5b. *Phycosiphon incertum* von Fischer-Ooster 1858

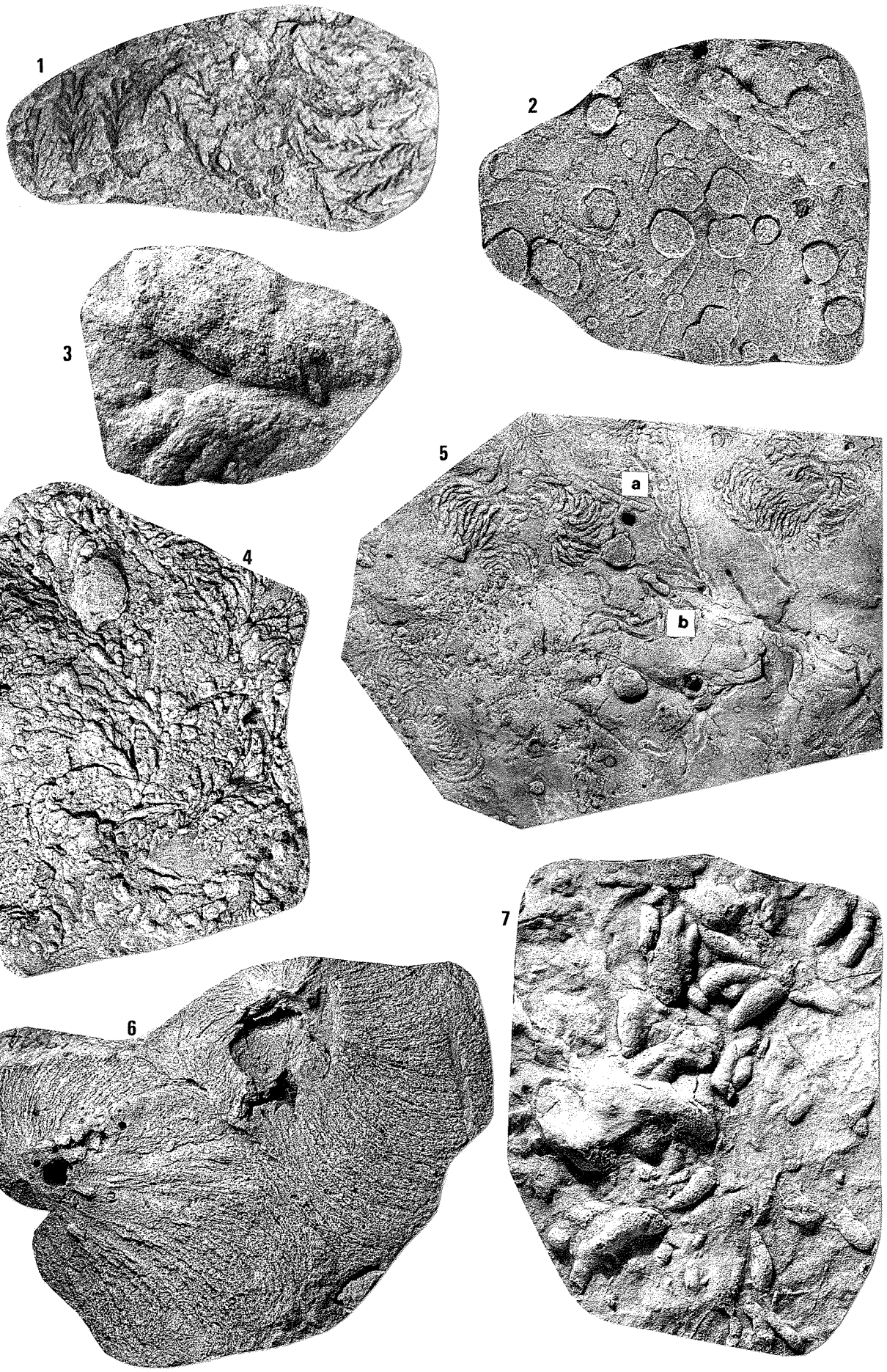
Specimen GSWA F46950a-c; x0.5.
Locality 69552; nearest hill due west from Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

Fig. 6 *Zoophycos* sp.

Specimen GSWA F46946; x0.5.
Locality 69534; Kennedy Bore, northern Kennedy Range, Carnarvon Basin; Nalbia Sandstone; Kungurian.

Fig. 7 Gen. and sp. 1

Specimen GSWA F46964; x1.
Locality 69561; rim of plateau, east of road, about 4 km north of Swordfish Bore, Canning Basin; Hardman Formation; Chhidruan.



TRACE FOSSILS AND PROBLEMATICA

Plate 100

All specimens coated with ammonium chloride.

Fig. 1 *Pelecypodichnus* sp.

Specimen GSWA F46959; x0.5.
Locality 69534; about 3 km east of Kennedy Bore, northern Kennedy Range, Carnarvon Basin; Nalbia Sandstone; Late Artinskian–Early Kungurian.

Fig. 2 Gen. and sp. 2

Specimen GSWA F46960; x0.5.
Locality 69565; north-facing scarp south of track west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mungadan Sandstone; Kungurian.

Fig. 3 *Scolicia* sp. 2

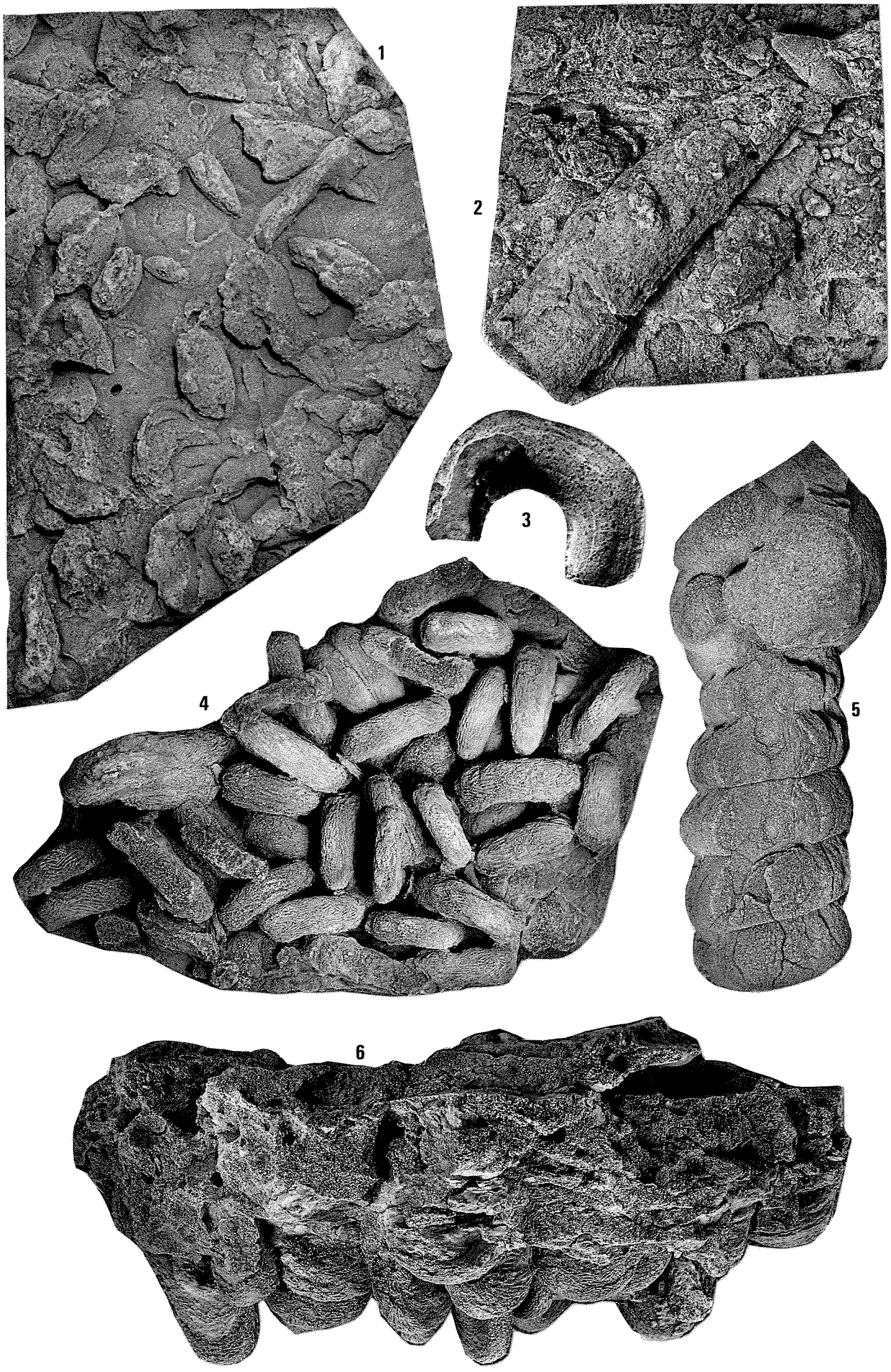
Specimen GSWA F46931b; x1.
Locality 69560; flat-topped hill east of road about 4 km north of Swordfish Bore, Canning Basin; Hardman Formation; Chhidruan.

Figs 4, 6 *Diplocraterion* sp.

Specimen UWA 21307; in ventral and lateral views; x0.5.
Locality UWA WH3; northern slope of Madbie Hills, Wandagee Station, Carnarvon Basin; stratigraphic unit and age not known.

Fig. 5 Helicoidal backfill burrow

Specimen GSWA F46961; x0.5.
Locality 69530; Minilya River crossing at Cundlego Well, Wandagee Station, Carnarvon Basin; Cundlego Formation; Late Artinskian (Baigendzhinian).



TRACE FOSSILS AND PROBLEMATICA

Plate 101

All specimens coated with ammonium chloride.

Fig. 1 *Scolicia* sp. 5

Specimen GSWA F48500; x1.
Locality 69558; Scrivener Hills, Crossland 1:250 000 sheet area, Canning Basin; Kirkby Range Member; Chhidruan.

Fig. 2 Gen. and sp. 5

Specimen GSWA F46978; x1.
Locality 69552; nearest hill west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Mundagan Sandstone; Kungurian.

Fig. 3 Problematicum 3

Specimen GSWA F46965; x1.
Locality 69561; rim of plateau east side of road about 4 km north of Swordfish Bore, Canning Basin; Hardman Formation; Chhidruan.

Fig. 4 Gen. and sp. 6

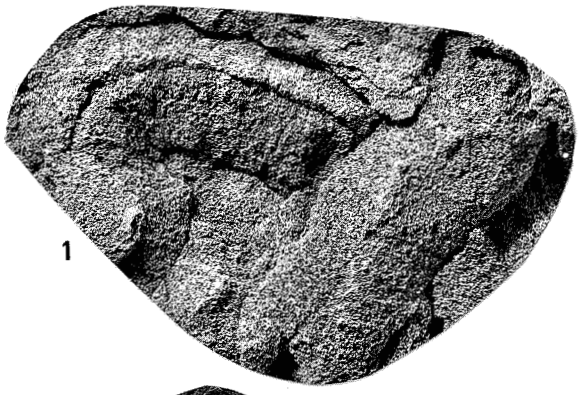
Specimen GSWA F46967; x0.5.
Locality 69565; north-facing scarp south of track west of Twin (triple) Bore, Middalya Station, Carnarvon Basin; Coolkilya and Mundagan Sandstones; Kungurian.

Fig. 5 *Imbrichnus* sp.

Specimen GSWA F46958; x0.5.
Locality 69518A; east side of Wandagee Hill, Wandagee Station, Carnarvon Basin; Coolkilya and Mungadan Sandstones; Kungurian.

Fig. 6 Gen. and sp. 7

Specimen GSWA F46972; x0.33.
Wandagee Hill, Carnarvon Basin; Coolkilya Sandstone; Kungurian.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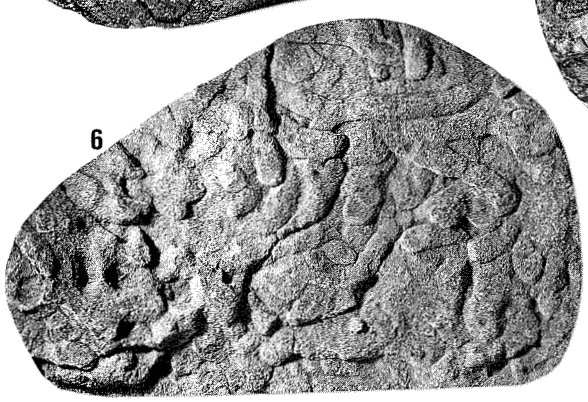

6

TRACE FOSSILS AND PROBLEMATICA

Plate 102

Fig. 1 Various aspects of *Scolicia* depending on the level at which the animal bulldozed relative to the sand–mud interface.

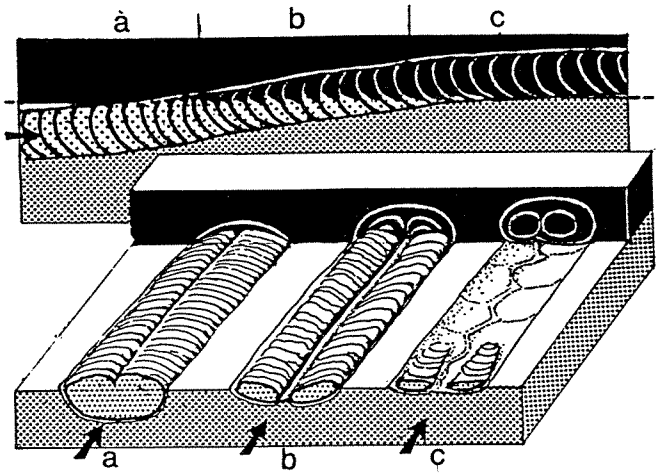
Fig. 2 The sandy 'tongues' of *Curvolithus* provide a phantom of the unknown burrower (as does the muddy tongue in sand), due to the change in backfill the moment the animal's head end touched the interface. This suggests a flatworm. The two lateral lobes should be subtracted, because they are probably the product of an undulating margin (Seilacher, 1990).

Fig. 3 The almond-shaped trace fossil *Pelecypodichnus* (= *Lockeia*) is the undertrace of a burrowing bivalve. Since the impression was made by the soft foot, its shape may vary, but multiple occurrences (as in Plate 100 figure 1) corroborates the identification.

Fig. 4 The Permian fossil in Plate 100 figure 5 may be compared to this trace fossil (Princeton Collection). It stems from the White River Formation (late Oligocene) of Wyoming and was associated with terrestrial *Titanothere* remains. A possible explanation is that a large insect larva ate its way through the sediment in a spiral fashion and then retired for the pupa stage inside this protective structure. Scale 1 cm.

Fig. 5 In *Margaritichnus*, backstuffing of sediment appears to have occurred in steps by a stamp-like rear end in a postero-dorsal direction (Seilacher, 1990).

Fig. 6 Trilobite burrows have so far not been found in rocks from later than Early Carboniferous. Plate 99 figure 3 may, therefore, extend the range of *Cruziana* into the Permian. Plate 98 figure 4, if it is also a sole face, may be a furrowed cruzianae form version with parallel longitudinal scratches on the two lobes.



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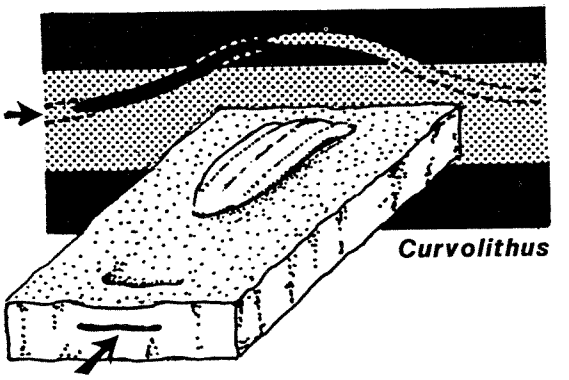

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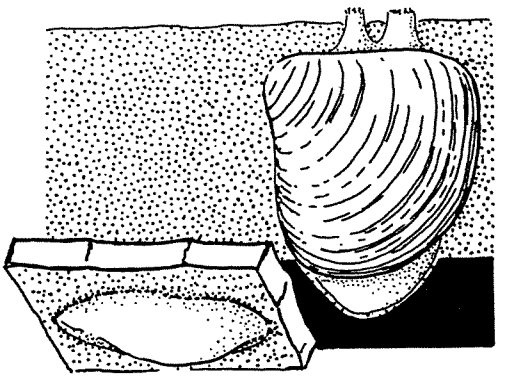

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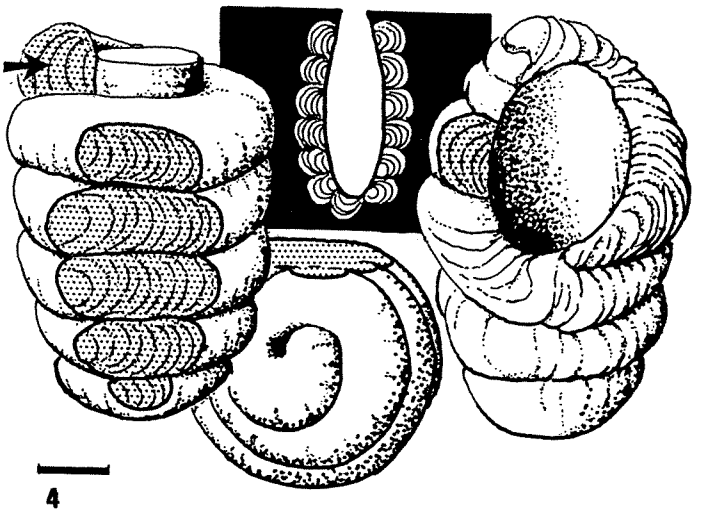

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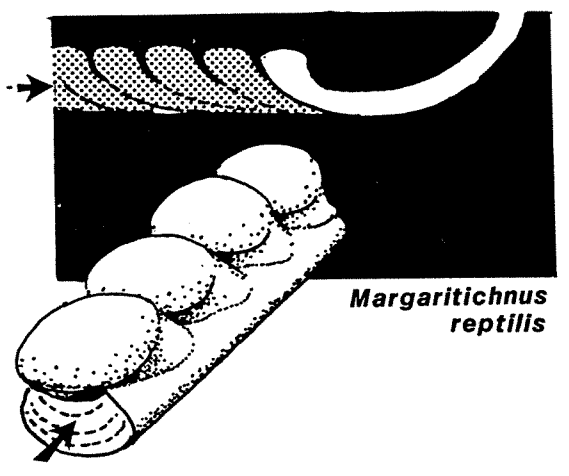

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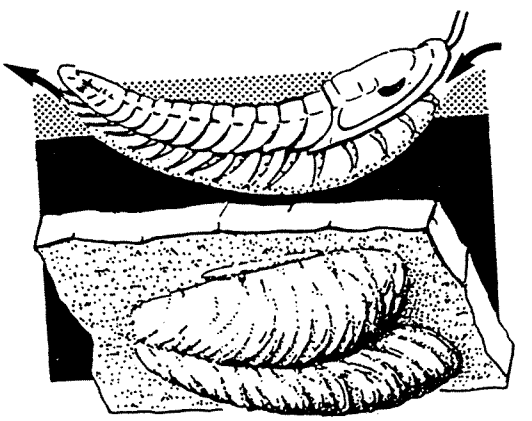

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  Cordalia Sandstone 8, 10, 15, 35, 56, 69T, 96–97; T2, T5, T7
  Keogh Formation 15, 97; T2, T5
  Moogooloo Sandstone 8, 10, 15, 35, 63, 69T, 97; T2, T5, T7
  'One Gum Formation' 8, 10, 15; T2, T5
Wye Worry Member 7, 10, 13, 14, 104; T3, T5

Z

Zechstein (Germany) 1, 18

10436/3/93—400—L/6018 GARRY L. DUFFIELD, Government Printer, Western Australia

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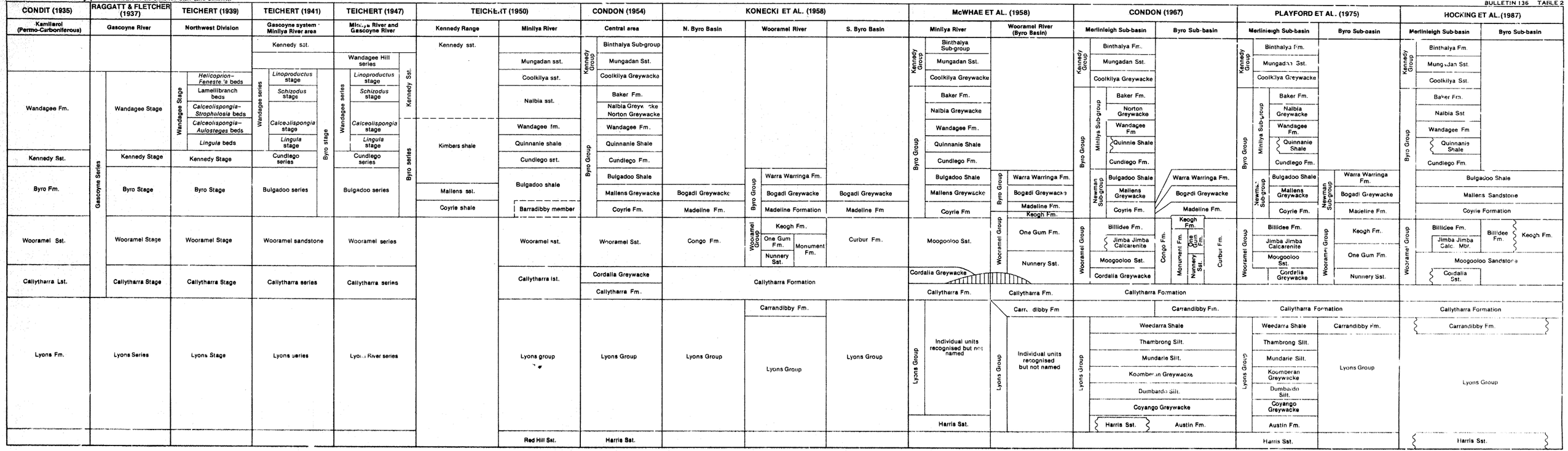
Evolution in the Permian stratigraphic nomenclature in the Perth Basin (S.K. Skwarko).

CAMPBELL (1910)	WOOLNOUGH & SOMMERVILLE (1924)	RAGGATT (1937)	TEICHERT (1941)	CLARKE ET AL. (1951)	JOHNSON ET AL. (1954)	McWHAE ET AL. (1956)	PLAYFORD ET AL. (1976)
	? Mingenew Beds ?				? Mingenew Beds / Enanty Hill Beds ?	? Indarra Beds ? / ? Mingenew Fm ?	? Mingenew Fm. ?
				Wagina Sandstone	Wagina Sst. Fm.	Wagina Fm.	"Yardarino Sst. Member" Wagina Sst.
Argillaceous sst.	Upper Marine Beds	Upper marine bed	Upper Marine series	Carynginia Shale	Irwin River Coal Measures Fm.	Carynginia Fm.	Carynginia Fm
Shale and coal	Freshwater series with coal seams	Coal Measures	Five named fossilliferous beds	Irwin River Coal Measures		Irwin River Coal Measures	Irwin River Coal Measures
				High Cliff Sst.	High Cliff Sst. Fm.	High Cliff Sst.	High Cliff Sandstone
Thin limestones	Fossil Cliff Beds	Fossil Cliff Beds	Fossil Cliff lst.	Fossil Cliff Fm.	Holmwood Shale Fm.	Fossil Cliff Fm.	Holmwood Shale: Fossil Cliff Member
Argillaceous sandstone, clay and thin argillaceous limestone	Olive Shales *Gastrioceras* Bed Buff Beds Bull Paddock Lst. Grey lst. Spheroidal marls	Shale and mudstone with cephalopod horizons	*Metalegoceras* series	Upper Holmwood Shale Lower		Holmwood Shale Beckett Member	Holmwood Shale: Woolaga Lst. Member Holmwood Shale: Beckett Member
Glacial erratics Argillaceous limestone and brown clays	Main Glacial Horizon Sub-glacial beds Basal grits and boulder clays	Glacial beds and shales	Tillites Calcareous grits Fountainebleau sst.	Nangetty Glacial Fm.	Nangetty Glacial Fm.	Nangetty Fm	Nangetty Fm.

Evolution of the Permian stratigraphic nomenclature in the Cooranbong Basin (S.K. Skwarko).



Evolution of the Permian stratigraphic nomenclature in the Canning Basin (S.K. Skwarko).

WADE (1937)	REEVES (1949)		GUPPY ET AL. (1952)	McWHAE ET AL. (1956)		GUPPY ET AL. (1958)		PLAYFORD ET AL. (1975)		CROWE & TOWNER (1981)			TOWNER & GIBSON (1983)		
Northern Canning Basin	Northern Canning Basin		"Northern part"	Southern	Northern	Northeast		Southwest	Northeast	Noonkanbah 1:250 000 Sheet			Northern Canning Basin		Southern and Eastern Canning Basin
															? ? ? ?
Erskine Series															
	Liveringa beds	Blina Shale													
Upper Ferruginous or Liveringa Series		Liveringa Sandstone	Liveringa Group		Liveringa Formation: Hardman Member	Liveringa Formation	Hardman Member		Liveringa Formation: Hardman Member	Liveringa Group	Hardman Formation	Undivided	Liveringa Group	Hardman Formation	Cherrabun Member	Chirup Fm.
												Cherrabun Member			Hicks Range Sandstone Member	? ? ? ?
												Hicks Range Sst. Mbr.			Kirkby Range Member	Godfrey beds
												Kirkby Range Member				
				Triwhite Sandstone			Plant-bearing rocks		Condren Sandstone Member		Condren Sandstone			Condren Sandstone		
					Lightjack Mbr.		Lightjack Member	Triwhite Sandstone	Lightjack Member		Lightjack Formation			Lightjack Formation		Triwhite Sandstone
Noonkanbah Series	Noonkanbah Shale		Noonkanbah Formation	Dora Shale	Noonkanbah Formation	Noonkanbah Formation		? Lucas Beds	Noonkanbah Formation	Noonkanbah Formation			Noonkanbah Formation		
								? Dora Shale							
Lower Ferruginous Series (= Nura Nura Group; Poole Range Group)	Hawkstone Sandstone	Poole Range sandstone	Poole Sandstone	Cuncudgerie Sandstone	Poole Sandstone	Poole Sandstone			Poole Sandstone	Poole Sandstone	Undivided		Poole Sandstone	Unnamed	
											Christmas Creek Member			Christmas Creek Member	
											Tuckfield Member			Tuckfield Member	
Glacial Series: Nura Nura Limestone			Nura Nura Member		Nura Nura Member	Nura Nura Member		Cuncudgerie Sandstone	Nura Nura Member		Nura Nura Member			Nura Nura Member	
Glacial Series: Grant Range Group (= Willangie Beds)			Grant Formation	Paterson Formation	Grant Formation	Grant Formation		Grant Formation: Paterson Formation and Braeside Tillite	Grant Formation	Grant Group	Carolyn Formation	Millajidee Member	Grant Group	Carolyn Formation / Lilly-booroora Cgl.	Buck Fm.
												Wye Worry Member			
												Undivided			Paterson Formation
Glacial Series: Kungangie Beds				Braeside Tillite							Winifred Formation			Winifred Formation	
Glacial Series: J.8 Beds											Betty Formation			Betty Formation	

Evolution of the Permian stratigraphic nomenclature in the Bonaparte Basin (A. Mory)

ETHERIDGE (1907)	NOAKES ET AL. (1952)	THOMAS (1957)	DUCHEMIN & CREEVEY (1966)	GUILLAUME (1966)	CAYE (1966)	DICKINS ET AL. (1972)	DICKINS (1976)	LAWS & BROWN (1976)	KEMP ET AL. (1977)	HUGHES (1978)	BROWN (1980)	BHATIA ET AL. (1984)	MORY (1988)
"Cape Ford (Anson Bay) and Cape Dombey (Hyland Bay) beds"	Port Keats Group: "upper horizon with a marine fauna"	Port Keats Group: marine beds	Port Keats Group: Sugarloaf Formation	Port Keats Group: Sugarloaf Formation	Port Keats Group: Upper Permian marine beds	"Upper Permian marine beds"	"Upper Marine Beds"	Hyland Bay Formation	Hyland Bay Formation	Hyland Bay Formation	Hyland Bay Formation	Hyland Bay Formation: Tern Member	Kinmore Group: Hyland Bay Formation: Tern Member
	"lower stage with plants"	plant bearing sandstone				"plant-bearing beds"	Middle part with plants					H4 Member	Dombey Member
"Fossil Head (Treachery Bay, Victoria River Estuary) sandstone"		marine beds			? ?	"marine horizon of Fossil Head"	"Lower Marine Part" (incl. beds at Fossil Head)					Hay Member	Cape Hay Member
						? ?						H5 Member	Pearce Member
												Basal Member	
					Fossil Head beds	"siltstone"		Fossil Head Formation	Sugarloaf Formation: "Marine A"	Kulshill Formation	Fossil Head Formation	Fossil Head Formation	Fossil Head Formation
						"basal limestone" (loc. 627)	? ?		"Marine B"		Sugarloaf Formation		
				not present in outcrop			Sandstone & siltstone (some coal)						
			Kulshill Formation		Kulshill formation			Kulshill Formation	Kulshill Formation: "Non-Marine A"		Kulshill Formation	Kulshill Formation	Kulshill Group: Keyling Formation
				Keep Inlet Formation			Possible glacigene beds near base		"Non-Marine B"				Treachery Shale

GSWA 22907

Correlation chart for the Permian of Western Australia, based on all available data (S.K. Skwarko, N.W. [illegible], J. Backhouse, J.M. Dickins & G.A. Thomas).

	INTERNATIONAL STAGES/SUB-STAGES		STAGES (Dickins, 1963)
LATE PERMIAN	TATARIAN	DORASHAMIAN	
		DZHULFIAN	
		CHHIDRUAN	F
	KAZANIAN	Late	E
		Early	
	UFIMIAN		
EARLY PERMIAN	KUNGURIAN	IRENIAN	D_2
		FILIPPOVIAN	
	ARTINSKIAN	BAIGENDZHINIAN	D_1
		AKTASTINIAN	C
	SAKMARIAN	STERLITAMAKIAN	B
		TASTUBIAN	
	ASSELIAN		A
CARBONIFEROUS			?

COLLIE BASIN

Lithostratigraphy

- Collie Coal Measures
- Cardiff Member ≡ upper part of Muja Member
- Collieburn Member ≡ Premier and Chicken Creek Members
- Ewington Member
- Stockton Formation

PERTH BASIN

Palynostratigraphy

- *Protohaploxypinus microcorpus* Zone ?
- *Dulhuntyispora* Assemblage
- *Haplocystia* Assemblage
- *Acanthotriletes* Assemblage
- *Quadrisporites* Assemblage
- *Microbaculispora* Assemblage

Lithostratigraphy

- Sabina Sst.
- Sue Coal Measures
- Unnamed glacigene unit
- Wagina Sandstone
- Caryngina Formation
- Mingenew Formation
- Irwin River Coal Measures
- High Cliff Sandstone
- Holmwood Shale
- Fossil Cliff Member
- Woolaga Lst. Mbr.
- Beckett Mbr.
- Nangetty Formation

CARNARVON BASIN

Lithostratigraphy

- KENNEDY GROUP
  - Binthalya Formation
  - Mungadan Sandstone
  - Coolkilya Sandstone
- BYRO GROUP
  - Baker Formation
  - Nalbia Sandstone
  - Wandagee Formation
  - Cundlego Formation / Quinnanie Shale
  - Bulgadoo Shale
  - Mallens Sandstone
  - Coyrie Formation
- WOORAMEL GROUP
  - Billidee Fm. / Keogh Fm.
  - Jimba Jimba Calcarenite Mbr.
  - Cordalia Sst. / Moogooloo Sst.
- Callytharra Formation
- Carrandibby Formation
- LYONS GROUP
  - Harris Sst.

CANNING BASIN

Palynostratigraphy

- *P. microcorpus* Zone ?
- Unit VIII
- Unit VII
- Unit VI
- Unit V
- Unit IV
- *D. townrowii* Zone
- Unit III
- *M. tentula* Zone
- Unit II
- *P. novicus* Zone
- Unit I

Lithostratigraphy

- LIVERINGA GROUP
  - Herdman Fm.
  - Cherrabun Mbr.
  - Hicks Range Sst. Mbr.
  - Kirkby Range Mbr.
  - Chirup Fm.
  - Godfrey beds
  - Condren Sandstone
  - Lightjack Formation
  - Triwhite Sst.
- Noonkanbah Formation
- Poole Sandstone
  - Undivided
  - Christmas Creek Mbr.
  - Tuckfield Mbr.
  - Nura Nura Mbr.
- GRANT GROUP
  - Carolyn Fm.
  - Millajidee Mbr.
  - Wye Worry Mbr.
  - Undivided
  - Winifred Formation
  - Betty Formation
- Paterson Formation

BONAPARTE BASIN

Lithostratigraphy

- KINMORE GROUP
  - "Upper Marine Beds" (onshore)
  - "Middle Non-marine Beds" (onshore)
  - "Lower Marine Beds" (onshore)
  - Hyland Bay Formation (offshore)
  - Tern Member
  - Dombey Member
  - Cape Hay Member
  - Pearce Member
  - Fossil Head Fm. (sub surface)
  - Unnamed limestone (onshore)
- KULSHILL GROUP
  - Keyling Formation
  - Treachery Shale
  - Keep Inlet Formation (onshore)
  - Kuriyippi Fm.

QUEENSLAND

Palynostratigraphy

Tr 1a	PP 6
Upper Stage 5	PP 5
Lower Stage 5	PP 4
Upper Stage 4	PP 3
Lower Stage 4	
Stage 3b	PP 2
Stage 3a	
Stage 2	PP 1
Stage 1	PC 4

EASTERN AUSTRALIA

Equivalent Units

- Fauna IV (Dickins, 1969) Faunizone 10 (Tasmania)
- Catherine Sst. (Bowen Basin) Faunizones 8-79 (Tasmania)
- Gebbie Sub-group (Bowen Basin) Fauna IIIa , IIIb (Dickins, 1970)
- Lower Branxton Fm. (Sydney Basin)
- Faunizones 6-7 (Tasmania) (Clarke & Banks, 1975)
- Farley Fm. (Sydney Basin) Fauna II (Bowen Basin) Faunizone 5 (Tasmania)
- ?Rutherford Formation / Faunizone 4 (Tasmania)
- Faunizone 3
- Faunizone 2
- Faunizone 1 (Tasmania)
- Allandale Fm. (Sydney Basin) Lochinvar Fm.

WORLD-WIDE CORRELATIONS

- Basleo and Amarassi Beds of Timor
- Chiddru Fm. of Salt Range, Pakistan
- Captanian of U.S.A.
- Magnesian Limestone of U.K.
- Nargal Fm. of Salt Range, Pakistan
- Wordian of U.S.A.
- Roadian of U.S.A., Assistance Formation of Arctic Canada
- Leonardian of U.S.A.
- Amb Formation of Himalayas
- Chihsia Fm of China
- Bitauni Beds of Timor
- Wolfcampian of U.S.A.
- Hausni Fm. of Oman
- Badhaura Beds of Peninsular India
- Agglomeratic Slate (upper beds), Talchir and Umaria Beds of Peninsular India
- Somohole Beds of Timor
- Lower part of Agglomeratic Slate of Kashmir
- Upper part of Maping Limestone of China

GSWA 22903

Correlation of the Western Australian Permian sequences based on marine invertebrates (M.W. Archbold, J.M. Dickins, G.A. Thomas).

	INTERNATIONAL STAGES/SUB-STAGES		PERTH BASIN	CARNARVON BASIN		CANNING BASIN		BONAPARTE BASIN			MACROFAUNAL STAGES
PERMIAN	TATARIAN	DORASHAMIAN									
		DZHULFIAN									
		CHHIDRUAN									
	KAZANIAN	Late	Wagina Sandstone	KENNEDY GROUP	Binthalya Formation	LIVERINGA GROUP	Hardman Fm. Cherrabun Mbr. Hicks Range Sst.Mbr. Kirkby Range Mbr.	KINMORE GROUP	Hyland Bay Fm. (offshore)	"Upper Marine Beds"(onshore)	F
		Early			Mungadan Sandstone		Condren Sandstone			"Middle Non-marine Beds" (onshore)	E
	UFIMIAN				Coolkilya Sandstone		Lightjack Formation			"Lower Marine Beds" (onshore) "beds at Fossil Head" (onshore)	D_2
	KUNGURIAN	IRENIAN		BYRO GROUP	Baker Formation					Fossil Head Formation (offshore)	
		FILIPPOVIAN			Nalbia Sandstone						
	ARTINSKIAN	BAIGENDZHINIAN			Wandagee Formation		Noonkanbah Formation				D_1
					Cundlego Formation / Quinnanie Shale						
					Bulgadoo Shale						
					Mallens Sandstone					Unnamed limestone (onshore)	
			Carynginia Formation / Mingenew Formation		Coyrie Formation		? ?				
			Irwin River Coal Measures	WOORAMEL GROUP			Poole Sandstone				C
	AKTASTINIAN		High Cliff Sandstone								
	SAKMARIAN	STERLITAMAKIAN	Fossil Cliff Member	Callytharra Formation			Nura Nura Member	KULSHILL GROUP	Keyling Formation		B
		TASTUBIAN	Holmwood Shale	Carrandibby Formation			GRANT GROUP				A
		ASSELIAN	Nangetty Formation	LYONS GROUP					Treachery Shale	Keep Inlet Fm. (onshore)	?

GSWA 22908

Correlation of Permian stratigraphic units in Western Australia based solely on ammonoid evidence. (B.F. Glenister, F.S. Rogers & S.K. Skwarko).

SERIES / STAGE / Substage	PERTH BASIN	CARNARVON BASIN	CANNING BASIN
LOWER TRIASSIC	Kockatea Sh.	Locker Sh.	Blina Sh.
U. PERMIAN — GUADALUPIAN — CHANGHSINGIAN			Hardman Fm. — Cherrabun Mbr.*
U. PERMIAN — GUADALUPIAN — DZHULFIAN			Hardman Fm. — Hicks Range Sst. Mbr.
U. PERMIAN — GUADALUPIAN — AMARASSIAN			Hardman Fm. — Kirkby Range Mbr.
U. PERMIAN — GUADALUPIAN — CAPITANIAN	Wagina Sst.	Kennedy — Binthalya Fm. / Mungadan Sst. / Coolkilya Sst.*	Liveringa Group — Condren Sst.
U. PERMIAN — GUADALUPIAN — WORDIAN			Liveringa Group — Lightjack Fm.*
U. PERMIAN — LEONARDIAN — ROADIAN		Baker Fm. / Nalbia Sst.*	
LOWER PERMIAN — ARTINSKIAN — Baigendzhinian	Carynginia Fm.	Byro Group — Wandagee Fm.* / Quinnanie Sh.* / Cundlego Fm. / Bulgadoo Sh.* / Mallens Sst.* / Coyrie Fm.*	Noonkanbah Formation
LOWER PERMIAN — ARTINSKIAN — Aktastinian	Irwin River Coal Measures / High Cliff Sst.	Wooramel — Billidee Fm.* / Moogooloo Sst. / Cordalia*	Poole Sandstone
LOWER PERMIAN — SAKMARIAN — Sterlitamakian	Fossil Cliff Mbr.*	Callytharra Fm.*	Nura Nura Mbr.*
LOWER PERMIAN — SAKMARIAN — Tastubian	Holmwood Sh.*	Lyons Group	Grant Group
LOWER PERMIAN — ASSELIAN	Nangetty Fm.		

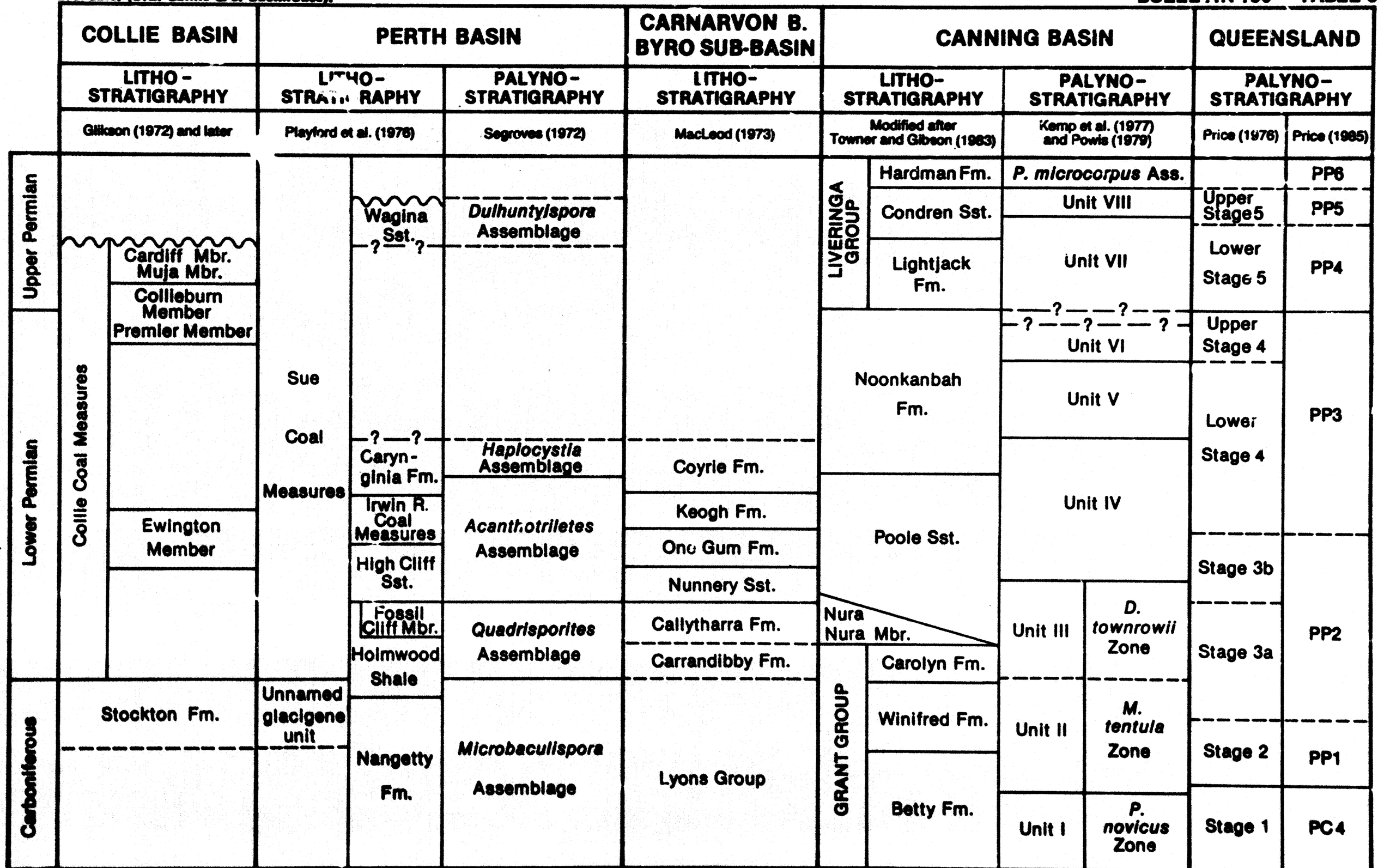
Lines are omitted between formations in cases where their presence may suggest greater precision in correlation then has been achieved.

* ammonoid bearing units

GSWA 22908

Correlation of Western Australian Late Palaeozoic units from which palynological data are available. (B.E. Balme & J. Backhouse).

BULLETIN 136 TABLE 8



GSWA 22910

REFERENCE

Major road

Formed road

Watercourse

Homestead

5 km

LOCALITIES IN THE NORTHERN PART OF THE PERTH BASIN

115° 30'

115° 40'

29° 00'

29° 10'

Mullewa 48 km

NORTH BRANCH

Carynginia Ck

Carynginia Well

Fossil Cliff

High Cliff

Nangetty

IRWIN RIVER

Prider Lookout

SOUTH BRANCH

Gully

Beckett

Holmwood

LOCKIER RIVER

Green Brook

Woolaga Creek

Glendevon (ruins)

Mingenew

Eyregulla Spring

Arrino 29 km

GSWA 22900

MAJOR LOCALITIES IN THE CARNARVON BASIN

REFERENCE
- Highway
- Formed road
- Track
- Watercourse
- Salt Lake
- Homestead/Outcamp
- Town

50 km

114° 115° 116°

24° 25°

Winning
Gnarrea Pool
Windalia Bore
Mia Mia
Round Hill Well
Round Hill
Kiolowibri Creek
LYNDON RIVER
Maroonah
Lyndon
Coolkilya Pool
Cundlego Well
Curdamunda Well
Wandagee
MINILYA RIVER
Minilya
Wandagee Hill
Nalbia Dam
Williambury
Barrabiddy Creek
Corrakootharra Pool
Middalya
K52
Thambrong Bore
Barrabiddy Dam
Middle Well
Donnelly Well
Moogooree
Lake MacLeod
Muderong Bore BMR 6 & 7
Paddy Outcamp
Southern Cross Bore
Birdrong Tank
Kennedy Bore
Hill Springs
Merlinleigh (ruins)
Mt. Sandiman
Mt. Sandiman
Binthabooka Ck
Lyons River
Arthur River Outcamp
Arthur River
Cream Creek ("Arthur River")
K34
Coondoo Outcamp
Fossil Hill
Carnarvon
Winnemia Bore
Mooka
Walbarune Peak
Black Hill Well
Baragooda Pool
Jimba Jimba
Bidgemia
Gascoyne Junction
Winderie
Dairy Creek
Towrana
Deurie Creek
Glenburgh
Helen Hill
Coordewandy (ruins)
Monument Bore
Bilung Pool
Coor De Wandy Hill
Meedo
Wooramel
Callytharra Springs
Callytharra Spring
Mt. Madeline
Darcy Hill
Bogadi Outcamp
Keogh Hill
Byro Plains
Byro Homestead 12 km

HIGHWAY
NORTH WEST COASTAL
GASCOYNE RIVER
KENNEDY RANGE
LYONS RIVER
PELLS RANGE
WOORAMEL RIVER
CARRANDIBBY RANGE
SHARK BAY

INDIAN OCEAN

Cape Leveque
Lombadina Mission
Broome
WAPET Roebuck Bay No. 1 Bore
Derby
Meda No. 1 Bore
Meda
Mt. Marmion
Kimberley Downs
Gibb River
GIBB RIVER ROAD
GREAT NORTHERN HIGHWAY
Barnetts Tank
Mt. Percy
Pilot Camp
Ellendale
Bells Ck
Udialla
Keevies Bore
FITZROY RIVER
GRANT RANGE
Mt. Anderson
Mt Anderson
Liveringa
Lake
Paradise Outcamp
Nura Nura Ridge
Mofletts Bore (Sholls Bore)
Calwynyardah
Joscelines
Mt. Wynne
Duchess Ridge
Luluigui
Myroodah
Myroodah 1
Mt. Wynne Ck
Mt. Hardman
Mt. Cedric
Gogo
Fitzroy Crossing
Halls Creek
Nerrima Creek
Gasgully Creek
Moulamen Hill
Little Flow Bore
Asso. Freney Nerrima 1
Tutu Bore
Freney Kimberley
Nerrima 1
Nerrima
Noonkanbah
Kalyeeda
Christmas Ck
Mt. James
ST. GEORGE RANGES
Mt. Tuckfield
Chestnut Bore
Bruten Hill
Mt. Fenton
Millajiddee Outcamp
Bucknall Pinnacle
Cherrabun
Blue Bush Bore
Christmas Creek
Donkey Gorge Bore
Woods Bore
Bohemia Downs
SHORE RANGE
KIRKBY RANGE
Scrivener Hills
MILLYIT RANGE
Swordfish Bore
Balgo Hill
Balgo Mission
Nemalook Rockhole
STOCK ROUTE
CANNING
STANSMORE RANGE
Great Sandy Desert
Cunnudgerra Hill
Percival Lakes
Tobin Lake
Lake Auld
Wanda Well
Emudata Hills
Scott Bluff
Lake Gladstone
Mirtan Hill
Well 27

REFERENCE
Highway
Formed Road
Track
Watercourse
Salt Lake
Bore/Well/Tank
Mt./Hill
Homestead/Outcamp
Town

LOCALITIES IN THE CANNING BASIN



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

edited by
S.K. Skwarko

Perth 1992

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Foraminifers

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FORAMINIFER GENERA AND SPECIES

Order FORAMINIFERIDA Eichwald 1830
Suborder TEXTULARIINA Delage & Herouard 1896

Superfamily ASTRORHIZACEA Brady 1881
Family HIPPOCREPINELLIDAE Loeblich & Tappan 1984

Genus **HIPPOCREPINELLA** Heron-Allen & Earland 1932

Type species: *Hippocrepinella hirudinea* Heron-Allen & Earland 1932; OD.

Hippocrepinella biaperta Crespin 1958
(Plate 1 figs 1-4)

1958b *Hippocrepinella biaperta* Crespin: p.37-38, pl. 1 figs 1-8
1961 *Hippocrepinella biaperta* Crespin; Crespin: p.19, 20
1967 *Hippocrepinella biaperta* Crespin; Ludbrook: p.73, pl. 3 fig. 1
1973 *Hippocrepinella biaperta* Crespin; Harris & McGowran: p.62, pl. 1 figs 3, 4
1982 *Hippocrepinella biaperta* Crespin; Scheibnerova: p.53
1983 *Bathysiphon biapertus* (Crespin); Palmieri: p.146

Diagnosis: "Free, elongate, finely siliceous, tubular form with apertural openings at both ends of the test" (modified after Crespin, 1958b, p.37).

Closest species: *H. hirudinea* Heron-Allen & Earland, from which it differs in the thickened lip around the broader, circular apertural openings.

Types: Holotype - CPC 2351; paratypes - CPC 2352-2355.

Type locality: Oonah, Tasmania - Quamby Mudstone.

Distribution and range: Jurgurra Creek BMR bores, northern **Canning Basin** - Noonkanbah Formation, Grant Group. Tasmania - Quamby Mudstone, Golden Valley Group; Sydney Basin (NSW) - Branxton Formation, Wandrawandian Siltstone; Bowen Basin (Qld) - Cattle Creek Formation; Arckaringa and Trowbridge Basins, Renmark Trough (SA) - Stuart Range Formation, Cape Jervis Beds.

Age: Asselian, Sakmarian, Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian - Artinskian elsewhere in Australia.

Abundance: A common species at the type locality, Grant Group and Cattle Creek Formation; rare elsewhere.

Value in correlation and dating: Good in Australia-wide correlation.

Climate: Species occurs in sedimentary rocks that were deposited in both glacial and warmer water environments.

Family PSAMMOSPHAERIDAE Haeckel 1894
Subfamily PSAMMOSPHAERINAE Haeckel 1894

Genus **PSAMMOSPHAERA** Schultze 1875

Type species: *Psammosphaera fusca* Schultze 1875; OD.

Psammosphaera pusilla Parr 1942
(Plate 1 figs 5-8)

1942 *Psammosphaera pusilla* Parr: p.106, pl. 1 figs 6, 7
1947 *Psammosphaera pusilla* Parr; Crespin: table (p.17, 18)
1958b *Psammosphaera pusilla* Parr; Crespin: p.38, 207, pl. 2 figs 4, 5
1965 *Psammosphaera pusilla* Parr; Crespin: p.17
1968 *Psammosphaera pusilla* Parr; Belford: p.17, pl. 1 figs 2, 3
1976 *Psammosphaera pusilla* Parr; Playford et al.: p.93
1982 *Psammosphaera pusilla* Parr; Scheibnerova: p.56, pl. 5 figs 1-3; pl. 6 figs 1, 2, 4, 5; pl. 7 fig. 1

Diagnosis: "Test very small, spherical, consisting of a single chamber; wall comparatively thick, formed of fine quartz grains, very firmly cemented, the cement apparently siliceous; surface smoothly finished" (Parr, 1942, p.106).

Closest species: *P. cava* Moreman 1930 from the Early Palaeozoic of the USA, from which it differs by its thicker wall.

Types: Holotype - UWA 20680; hypotype - CPC 2358; topotype - CPC 2357.

Type locality: Minilya River near Coolkilya Pool, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale; Wandagee Station, **Carnarvon Basin** - basal Byro Group, Bulgadoo Shale, Quinnanie Shale; AFO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Branxton Formation, Singleton Supergroup.

Age: Early Sakmarian (Tastubian) - Late Artinskian (Tigendzhinian) in Western Australia. Artinskian - ?Tatarian in New South Wales.

Abundance: Not common.

Value in correlation and dating: Fair in regional correlation.

Family SACCAMMINIDAE Brady 1884
Subfamily SACCAMMININAE Brady 1884

Genus **HYPERAMMINITA** Crespin 1958

Type species: *Hyperammina(?) rudis* Parr 1942; OD.

Hyperamminita rudis (Parr 1942)
(Plate 1 figs 12-15)

1942 *Hyperammina(?) rudis* Parr: p.105, pl. 1 fig. 3
1947 *Hyperammina? rudis* Parr; Crespin: table (p.17-18)
1952 *Hyperammina rudis* Parr; Teichert: p.122
1958a *Hyperamminita rudis* (Parr); Crespin: p.114
1958b *Hyperamminita rudis* (Parr); Crespin: p.54-55 pl. 6, fig. 13; pl. 7 figs 1, 2
1982 *Brachysiphon rudis* (Parr); Scheibnerova: p.56

Diagnosis: "Test elongate cylindrical, consisting of a tubular chamber closed at one end and of almost one diameter throughout; wall thick, composed of large angular to subangular sand grains firmly cemented; surface very rough; aperture formed by the open end of the tube" (Parr, 1942, p.105).

Closest species: *Brachysiphon corbuliformis* Chapman, from which it differs in the size, shape, and structure of the apertural end.

Types: Holotype - UWA 20677; hypotypes - CPC 2419, 2420, 2534.

Type locality: East of Coolkilya Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Near Nalbia Dam on Wandagee Station, Callytharra Springs, Bidgemia Homestead area, and on Wooramel River west of junction with Madeline Creek, **Carnarvon Basin** - Callytharra Formation, Coyrie Formation, Bulgadoo Shale, Wandagee Formation; Jurgurra Creek, BMR Water Bore, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Mulbring Siltstone.

Age: Late Sakmarian (Sterlitamakian), and Late Artinskian (Baigendzhinian) in Western Australia. Kazanian in New South Wales.

Abundance: Rare in Wandagee Formation; common in Callytharra Formation.

Value in correlation and dating: Good on a regional basis.

Climate: Species associated with sedimentary rocks that were laid down in cold-temperate environment.

Genus **SACCULINELLA** Crespin 1958

Type species: *Sacculinella australis* Crespin 1958; OD.

Sacculinella australis (Crespin 1958)
(Plate 1 figs 9-11)

1958b *Sacculinella australae* Crespin: p.43-44, pl. 3 figs 4, 5
1983 *Sacculinella australae* Crespin; Palmieri: p.141, 146

Diagnosis: "Sack-like, with a thickened lip surrounding the apertural opening. Test finely siliceous" (modified after Crespin, 1958b, p.43)

Closest species: *Hyperamminita rudis* (Parr) from which it differs in the sack-like test, broadened aperture and finely arenaceous test wall.

Types: Holotype - CPC 2375; paratypes - CPC 2376-2379.

Type locality: 0.4 km upstream from Wandagee Homestead on Minilya River, Carnarvon Basin - Bulgadoo Shale.

Distribution and range: WAPET Giralia 1, Moogooree Homestead area, Ninigo Dam on Middalya Station, **Carnarvon Basin** - Byro Group, Coyrie Formation, Bulgadoo Shale; Jurgurra Creek BMR 1, northern **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Queensland.

Abundance: Not a common species.

Value in correlation and dating: Good on a regional basis.

Climate: Species associated with sedimentary rocks that were laid down under cold-temperate conditions.

Genus **SACCAMMINA** M. Sars in Carpenter 1869

Type species: *Saccammina sphaerica* Brady 1871; SD Cushman 1928.

Saccammina ampulla (Crespin 1958)
(Plate 1 figs 16, 17)

1958a *Pelosina ampulla* Crespin; Crespin: p.114
1958b *Pelosina ampulla* Crespin: p.42-43, 207, pl. 2 figs 1-3
1965 *Pelosina ampulla* Crespin; Crespin: p.17
1965 *Pelosina ampulla* Crespin; Belford: p.17, pl. 1 fig. 3
1967 *Lagenammina ampulla* (Crespin); Ludbrook: p.75, pl. 3 fig. 14
1968 *Pelosina ampulla* Crespin; Belford: p.4-5, pl. 1 fig. 1
1973 *Pelosina ampulla* Crespin; Harris & McGowran: pl. 1 fig. 22
1976 *Pelosina ampulla* Crespin; Playford et al.: p.93
1982 *Pelosina ampulla* Crespin; Scheibnerova: p.56-57, pl. 6 fig. 3

Diagnosis: "A flask-shaped, single chambered form with smooth, finely siliceous test and a short apertural neck" (Crespin, 1958b, p.42).

Closest species: *S. hemisphaerica* (Chapman & Howchin 1905), from which it differs in the smooth siliceous test.

Types: Holotype - CPC 2372; paratypes - CPC 2373, 2374.

Type locality: Oonah, Tasmania.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale; Moogooree Homestead area, Williambury Homestead area, Ninigo Dam on Middalya Station, Minilya River near Wandagee Homestead, **Carnarvon Basin** - basal Byro Group, Coyrie Formation, Bulgadoo Shale;

near Jurgurra Creek BMR 1, northern **Canning Basin** - upper part of Noonkanbah Formation. Tasmania - Quamby Mudstone; Arckaringa Basin (SA) - Stuart Range Formation; Sydney Basin (NSW) - Allandale Formation, Rutherford Formation, Farley Formation, Branxton Formation, Mulbring Siltstone, Snapper Point Formation, Berry Formation, and Erinsvale Formation. Bowen Basin (Qld) - Cattle Creek Formation, Pedwaddy Formation.

Age: Early Sakmarian (Tastubian), and Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in South Australia. Sakmarian - Kazanian in New South Wales and Queensland.

Abundance: A common species.

Value in correlation and dating: An ubiquitous species.

Saccammina arenosa (Crespin 1958)
(Plate 1 figs 21, 22)

1958b *Proteonina arenosa* Crespin: p.38-39, 206, 207, pl. 2 figs 6, 7
1961 *Proteonina arenosa* Crespin; Crespin: p.19, 20
1976 *Proteonina arenosa* Crespin; Playford et al.: p.95

Diagnosis: "Globular test composed of large and small angular quartz grains, and a short apertural neck" (Crespin, 1958b, p.38).

Closest species: *S. cervicifera* (Cushman & Waters), from which it differs in the shorter apertural neck and the unevenly sized quartz grains of the test.

Types: Holotype - CPC 2359; paratype - CPC 2360.

Type locality: Wooramel River, 3.6 km west of junction with Madeline Creek, Carnarvon Basin - Coyrie Formation.

Distribution and range: Woolaga Creek, High Cliff, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, High Cliff Sandstone, Carynginia Formation; Callytharra Springs area, **Carnarvon Basin** - Coyrie Formation, Wandagee Formation; **Canning Basin** - Samphire Marsh 1.

Age: ?Asselian, Late Sakmarian (Sterlitamiakian) - Late Artinskian (Baigendzhinian).

Value in correlation and dating: Fair in regional correlation.

Climate: Species associated with sedimentary rocks that were laid down under both glacial and cold temperate conditions

Saccammina hemisphaerica (Chapman & Howchin 1905)
(Plate 1 figs 18-20)

1905 *Pelosina hemisphaerica* Chapman & Howchin: p.6, pl. 12 figs 2a, b
193- *Pelosina hemisphaerica* Chapman & Howchin; Chapman et al.: p.183

1947 *Pelosina hemisphaerica* Chapman & Howchin; Crespin: table (p.17-18)
1958b *Pelosina hemisphaerica* Chapman & Howchin; Crespin: p.42, pl. 2 figs 8-10
1982 *Pelosina hemisphaerica* Chapman & Howchin; Scheibnerova: p.57, pl. 5 fig. 4

Diagnosis: "Test somewhat irregularly flask-shaped, flattened on one side, convex on the other. Aperture a short, but probably originally prolonged, tubular neck. Structure of test apparently composed of fine sandy mud, in which are embedded various coarser bodies, such as fragments of shells, sand-grains, and other foraminiferal tests" (Chapman & Howchin, 1905, p.6).

Closest species: *S. sphaerica* Brady 1871 from which it differs in having a distinctly flattened and convex side.

Hypotypes: CPC 2369-2371.

Type locality: Wollong Horizon, Branxton Formation, Sydney Basin (NSW).

Distribution and range: Ninigo Dam on Middalya Station, Bidgemia Station area, **Carnarvon Basin** - Bulgadoo Shale, Baker Formation; FKO Nerrima 1, near Liveringa Homestead, Jurgurra Creek BMR 1, northern **Canning Basin** - Nura Nur[illegible] Member of the Poole Sandstone, Noonkanbah Formation; [illegible]sin (NSW) - Farley Formation, Branxton Formation, Mulbring Siltstone, Tomago Coal Measures.

Age: Late Sakmarian (Sterlitamakian) - Early Kungurian in Western Australia. Artinskian - Tatarian in New South Wales.

Abundance: A common species.

Value in correlation and dating: An ubiquitous species.

Subfamily THURAMMININAE A.D. Mikluklo-Maklay 1963

Genus **THURAMMINA** Brady 1879

Type species: *Thurammina papillata* Brady 1879; SD Cushman 1910.

Thurammina phialaeformis Crespin 1958
(Plate 1 figs 23-25)

1905 *Thurammina papillata* Chapman & Howchin (*non* Brady): p.9, pl. 11 fig. 13
1942 *Thurammina papillata* Parr (*non* Brady): p.107, pl. 1 fig. 8
1947 *Thurammina papillata* Chapman & Howchin; Crespin: table (p.17-18)
?1952 *Thuramina papillata* Brady; Teichert: p.122
1958a *Thurammina phialaeformis* Crespin; Crespin: p.109, 113, 114
1958b *Thurammina phialaeformis* Crespin: p.39-40, 207, pl. 3 figs 6-8

Diagnosis: "Single-chambered globular test composed of moderately coarse quartz grains with numerous and irregularly scattered apertures with nipple-like projections" (Crespin, 1958b, p.39).

Closest species: *T. texana* Cushman & Waters, from which it differs in the slightly rougher test.

Types: Holotype - CPC 2361; paratypes - CPC 2362-2363.

Type locality: Upstream 0.4 km from Wandagee Homestead on Minilya river, Carnarvon Basin - Bulgadoo Shale.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale and Fossil Cliff Member; near Cundlego Crossing on Minilya River, Coordewandy Homestead area, Moogooree Homestead area, etc., **Carnarvon Basin** - Callytharra Formation, Coyrie Formation, Bulgadoo Shale, Quinnanie Shale, Wandagee Formation, Baker Formation; Brutens Yard, FKO Nerrima 1, Myrooda 1, Jurgurra Creek BMR bores, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Dalwood Group, Maitland Group; Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Sakmarian, Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Queensland and New South Wales.

Abundance: Common in Western Australia, less common elsewhere.

Value in correlation and dating: An ubiquitous species.

Genus **THURAMMINOIDES** Plummer 1945

Type species: *Thuramminoides sphaeroidalis* Plummer 1945; OD.

Thuramminoides sphaeroidalis Plummer 1945
(Plate 1 figs 26,27,30,31)

1945 *Thuramminoides sphaeroidalis* Plummer: p.218, pl. 15 figs 4-10
1958a *Thuramminoides sphaeroidalis* Plummer; Crespin: p.114
1958b *Thuramminoides sphaeroidalis* Plummer; Crespin: p.40-41, 206, 207, pl. 3 figs 9-11; pl. 31 figs 1, 2
1961 *Thuramminoides sphaeroidalis* Plummer; Crespin: p.20
1962 *Thuramminoides sphaeroidalis* Plummer; Crespin: p.25
1965 *Thuramminoides sphaeroidalis* Plummer; Crespin: p.17
1965 *Thuramminoides sphaeroidalis* Plummer; Belford: p.17, pl. 1 fig. 2
1967 *Thuramminoides sphaeroidalis* Plummer; Ludbrook: p.76-77, pl. 3 figs 15, 16
1976 *Thuramminoides sphaeroidalis* Plummer; Playford et al.: p.110
1982 *Thuramminoides sphaeroidalis* Plummer; Scheibnerova: p.57, pl. 7 figs 2a-2c
1983 *Thuramminoides sphaeroidalis* Plummer; Palmieri: p.141

Diagnosis: "Finely arenaceous, white to pale-grey sphaeroidal tests. Shell wall composed of uniformly very fine quartz grains, bound by insoluble cement. Inside wall displays reticulate pattern. Presence of apertural protuberances exceedingly variable; many tests are devoid of them, others have one to many" (Plummer, 1945, p. 218; abridged in Crespin, 1958b, p.40).

Closest species: *Oryctoderma teicherti* (Parr), which, however, is quite circular.

Hypotypes: CPC 2364, 2365, 2366, 2886.

Type locality: San Saba, Texas - lower Strawn Shale.

Distribution and range: Woolaga Creek and High Cliff, Irwin River area, **Perth Basin** - Holmwood Shale, High Cliff Sandstone, Carynginia Formation; Donnellys Well on Williambury Station, Wandagee Homestead area, Mount Sandiman Station, etc., **Carnarvon Basin** - Callytharra Formation, basal Byro Group, Coyrie Formation, Mallens Sandstone, Bulgadoo Shale, Wandagee Formation, Baker Formation; Brutens Yard, South of Grant Range, Jurgurra Creek BMR 1, Myroodah 1, northern **Canning Basin** - Grant Group, Noonkanbah Formation. Tasmania - Quamby Mudstone; Sydney Basin (NSW) - Maitland Group; Bowen Basin (Qld) - Cattle Creek, Ingelara, and Peawaddy Formations; Arckaringa Basin (SA) - Stuart Range Formation; USA.

Age: Sakmarian (Tastubian), Early Kungurian in Western Australia. Artinskian - Kazanian in Queensland and New South Wales; Sakmarian in Tasmania; Sakmarian - Artinskian in South Australia.

Abundance: Common, particularly in Western Australia.

Value in correlation and dating: Good in regional correlation.

Climate: Species present in sedimentary rocks that were laid down under both glacial and warmer environments.

Family HEMISPHAERAMMINIDAE Loeblich & Tappan 1961
Subfamily ORYCTODERMINAE Saidova 1981

Genus **ORYCTODERMA** Loeblich & Tappan 1961

Type species: *Oryctoderma rotundata* (Cushman 1910); SD Loeblich & Tappan 1961.

Oryctoderma teicherti (Parr 1942)
(Plate 1 figs 28,29,32,33)

1942 *Crithionina teicherti* Parr: p.107, pl. 1 figs 9, 10
1947 *Crithionina teicherti* Parr; Crespin: table (p.17-18), p.19
1952 *Crithionina teicherti* Parr; Teichert: p.122, 125
1958a *Thuramminoides teicherti* (Parr); Crespin: p.114
1958b *Thuramminoides teicherti* (Parr); Crespin: p.41-42, pl. 3 figs 12, 13
1961 *Thuramminoides teicherti* Parr; Crespin: p.20
1967 *Oryctoderma teicherti* (Parr); Ludbrook: p.77
1982 *Thuramminoides teicherti* (Parr); Scheibnerova: p.57-58, pl. 8 figs 1-2a,c

Diagnosis: "Test free, comparatively large, spherical, thick-walled but variable in this respect, central cavity large, connected with the outside surface by numerous moderately-sized pits which extend irregularly through the thickness of the shell wall and reach the

exterior surface through minute openings; wall composed of fine sandy material fairly well cemented, with a thin compact surface layer" (Parr, 1942, p.107).

Closest species: *O. palaeozoica* (Conkin) from which it differs by its thinner test wall.

Types: Holotype - UWA 20674; hypotypes - CPC 2367, 2368.

Type locality: Coolkilya Paddock, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Near Coolkilya Pool on Wandagee Station, and Gascoyne River near the hotel, **Carnarvon Basin** - Callytharra Formation, Cundlego Formation, Quinnanie Shale, Wandagee Formation; Brutens Yard and Grant Range, northern **Canning Basin** - Grant Group, Noonkanbah Formation. Sydney Basin (NSW) - Branxton Formation, Mulbring Siltstone, Erinsvale Formation.

Age: ?Asselian, Early and Late Sakmarian, Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - Kazanian in New South Wales.

Abundance: Not common to rare.

Value in correlation and dating: Fair in regional correlation.

Climate: Species found in sedimentary rocks that were laid down in glacial and cold-temperate environments.

Superfamily HYPERAMMINACEA Eimer & Fickert 1899

Family HYPERAMMINIDAE Eimer & Fickert 1899
Subfamily HYPERAMMININAE Eimer & Fickert 1899

Genus **HYPERAMMINA** Brady 1878

Type species: *Hyperammina elongata* Brady 1878; OD.

Hyperammina callytharraensis Crespin 1958
(Plate 2 figs 1, 2)

1958b *Hyperammina callytharraensis* Crespin: p.45-56, 207, pl. 4 figs 1-5
1961 *Hyperammina callytharraensis* Crespin; Crespin: p.19, 20
1965 *Hyperammina callytharraensis* Crespin; Crespin: p.17
1982 *?Hyperammina callytharraensis* Crespin; Scheibnerova: p.53, pl. 1 fig. 4

Diagnosis: "Short, slightly sinuous test of almost uniform width; aperture at the end of a smooth constricted neck" (Crespin, 1958b, p.45).

Closest species: Not given.

Types: Holotype - CPC 2382; paratypes - CPC 2383-2386.

Type locality: Callytharra Springs area, Carnarvon Basin - Callytharra Formation.

Distribution and range: ?Woolaga Creek and High Cliff, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, High Cliff Sandstone, ?Carynginia Formation; Pells Range, Callytharra Springs area, Bidgemia Station, **Carnarvon Basin** - Callytharra Formation, basal Byro Group. Sydney Basin (NSW) - ?Branxton Formation, Mulbring Siltstone, Wandrawandian Siltstone, Berry Formation.

Age: Late Sakmarian (Sterlitamakian), Early and Late Artinskian in Western Australia. ?Artinskian - Kazanian in New South Wales.

Abundance: A common species.

Value in correlation and dating: Good in regional correlation.

Climate: Species associated with sedimentary rocks deposited under cold- to warm-temperate conditions.

Hyperammina coleyi Parr 1942
(Plate 2 figs 9-13)

1942 *Hyperammina coleyi* Parr: p.104-105, pl. 2 fig. 3
1947 *Hyperammina coleyi* Parr; Crespin: table (p.17-18), p.19
1952 *Hyperammina coleyi* Parr; Teichert: p.125
1958b *Hyperammina coleyi* Parr; Crespin: p.46-47, pl. 6 figs 5, 6; pl 7 figs 3-5; pl. 33 figs 1, 2
1965 *Hyperammina coleyi* Parr; Belford: p.17, pl. 1 figs 4, 5
1982 *Hyperammina coleyi* Parr; Scheibnerova: p.54, pl. 4 fig. 1

Diagnosis: "Test elongate, cylindrical, consisting of sub-globular proloculus and long slender tubular chamber of less diameter than proloculus, widest in middle portion, occasionally slightly constricted at irregular intervals; wall thick, composed of medium-sized grains firmly cemented, surface rough, interior not smoothly finished; aperture circular, formed by open end of tube" (Parr, 1942, p.104).

Closest species: *H. elongata* Brady from which it differs in its tapering apertural end, thicker wall, and bigger size.

Types: Holotype - UWA 20676; hypotypes - CPC 2388, 2389-2392, 2887, 2888.

Type locality: Minilya River, near Coolkilya Pool, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Williambury Station, Callytharra Springs area, Cundlego Crossing, Wandagee Station, Coordewandy Homestead area, Ninigo Dam on Middalya Station, **Carnarvon Basin** - Callytharra Formation, Coyrie Formation, Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, Wandagee Formation, ?Baker Formation; Lake Dora area, southern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Branxton Formation, Mulbring Siltstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian, and ?Early Kungurian in Western Australia. Artinskian - Kazanian in New South Wales.

Abundance: Common in Wandagee Formation, rare elsewhere.

Value in correlation and dating: Good in regional correlation.

Hyperammina elegantissima Plummer 1945
(Plate 2 figs 6-8)

1945 *Hyperammina elegantissima* Plummer: p.222, pl. 15 figs 17-25
1958b *Hyperammina elegantissima* Plummer; Crespin: p.48-49, pl. 7 figs 8-10
1968 *Hyperammina elegantissima* Plummer; Belford: p.5, pl. 1 fig. 23
1982 *Hyperammina elegantissima* Plummer; Scheibnerova: p.54

Abridged description of holotype: "Slender, usually rather glossy, smooth test with a very narrow rounded initial extremity, and straight to arcuate, gradually expanding tubular chamber, which is only rarely separated from megalosphere by faint constricting. Microspheric form finely tapering. Shell wall composed of minute siliceous granules, is thin, so that most tests are strongly compressed or otherwise deformed, but considerable proportion of siliceous cement makes them unusually rigid for size. Oral extremity somewhat constricted around circular terminal aperture" (Plummer 1945, p.222; abridged in Crespin, 1958b).

Hypotypes: CPC 2397, 2398, 2399.

Type locality: The Strawn, Palopinto County, Texas - Middle Pennsylvanian.

Distribution and range: Nangetty Station, **Perth Basin** - Nangetty Formation; Callytharra Springs, Giralia 1, northern **Carnarvon Basin** - Callytharra Formation. Sydney Basin (NSW) - Wandrawandian Siltstone, Mulbring Siltstone.

Age: Asselian - Late Sakmarian in Western Australia. Artinskian - ?Kazanian in New South Wales.

Abundance: Rare to frequent.

Value in correlation and dating: An ubiquitous species.

Climate: Species occurs in sedimentary rocks laid down under glacial and temperate conditions.

Hyperammina fusta Crespin 1958
(Plate 2 figs 3-5)

1958a *Hyperammina fusta* Crespin; Crespin: pl. 3
1958b *Hyperammina fusta* Crespin: p.18, 25, 51, 206, pl. 4 figs 6-8
1965 *Hyperammina fusta* Crespin; Crespin: p.17
1965 *Hyperammina fusta* Crespin; Belford: p.17, pl. 2 figs 8, 9
1982 *Hyperammina fusta* Crespin; Scheibnerova: p.55, pl. 2 fig. 5; pl. 3 fig. 5; pl. 4 fig. 3

Diagnosis: "Test short, with proloculus gradually merging into the very slightly narrower tubular second chamber. Wall finely arenaceous" (Crespin, 1958b, p. 51).

Types: Holotype - CPC 2407; paratypes - CPC 2408, 2409.

Type locality: 7.4 km southwest of Moogooree Homestead, Carnarvon Basin - Coyrie Formation.

Distribution and range: Irwin River area, **Perth Basin** - Carynginia Formation; Wyndham Gap area, Bidgemia Station, Moogooree Homestead area, **Carnarvon Basin** - ?Callytharra Formation, basal Byro Group, Coyrie Formation; Lake Dora area and Mount Hardman, Jurgurra Creek BMR water bore, northern **Canning Basin** - Noonkanbah Formation, Hardman Formation. Bonaparte Basin (NT); Sydney Basin (NSW) - Branxton Formation, Singleton Supergroup, Shoalhaven Group, Illawarra Coal Measures.

Age: ?Late Sakmarian, Late Artinskian (Baigendzhinian), Chhidruan in Western Australia. Artinskian, ?Tatarian in New South Wales.

Abundance: A rare to frequent species.

Value in correlation and dating: An ubiquitous species.

Subfamily HIPPOCREPININAE Rhumbler 1895

Genus **GIRALIARELLA** Crespin 1958

Type species: *Giraliarella angulata* Crespin 1958; OD.

Giraliarella angulata Crespin 1958
(Plate 1 figs 34, 36, 37)

1958b *Giraliarella angulata* Crespin: p.56-57, pl. 9 figs 1-5
1965 *Giraliarella angulata* Crespin; Crespin p.17

Diagnosis: "Test elongate, tapering, sharply angulate, may be triangular to quadrate" (Crespin, 1958b, p.56).

Closest species: See under *G. rhomboidalis*, *G. travesi*, and *G. triloba*.

Types: Holotype - CPC 2428; paratype - CPC 2429.

Type locality: Giralia 1, Core 66, northern Carnarvon Basin - Callytharra Formation.

Distribution and range: Giralia 1, **Carnarvon Basin** - Callytharra Formation, basal Byro Group.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: A common species.

Value in correlation and dating: Good in regional correlation.

Giraliarella rhomboidalis Crespin 1958
(Plate 1 figs 35, 44)

1958b *Giraliarella rhomboidalis* Crespin: p.58, pl. 9 figs 9, 10

Diagnosis: "Rhomboid in cross-section, with acute ridges in longer axis and rounded ones on shorter axis. Test deeply sulcate between ridges" (Crespin, 1958b, p.58).

Closest species: *G. angulata* Crespin 1958 from which it differs in the broader and more compressed test and in the smooth surface.

Holotype: CPC 2432.

Type locality: 3.1 km west of south of Merlinleigh Homestead, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Wandagee Formation; Jurgurra Creek BMR water bore, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Good in regional correlation.

Giraliarella travesi Crespin 1958
(Plate 1 figs 41-43)

1958b *Giraliarella travesi* Crespin: p.57-58, pl. 9 figs 6-8
1965 *Giraliarella travesi* Crespin; Belford: p.17, pl. 1 figs 11-14
1968 *Giraliarella travesi* Crespin; Belford: p.4, pl. 2 figs 3-6

Diagnosis: "Small, test elongate, straight, sharply angulate, quadrate: smooth thick lip surrounding aperture" (Crespin, 1958b, p.57).

Closest species: *G. angulata* Crespin 1958, from which it differs in its smaller and more uniform size, and its thick smooth lip.

Holotype: CPC 2431.

Type locality: Myroodah 1, 652.3 - 653.8 m, northern Canning Basin.

Distribution and range: Dairy Creek Station, BMR Muderong Bores, **Carnarvon Basin** - Byro Group; type locality, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: A rare species.

Value in correlation and dating: Good in regional correlation.

Giraliarella triloba Belford 1961
(Plate 1 figs 45-47)

1961 *Giraliarella triloba* Belford: p.81-82, pl. 3 figs 9-13
1968 *Giraliarella triloba* Belford; Belford: p.5, pl. 2 figs 7-11

Diagnosis: "Test elongate, trilobate, smooth, edges at first angulate, then rounded; non-septate; aperture terminal" (Belford, 1961, p.81).

Closest species: *G. angulata* Crespin, *G. rhomboidalis* Crespin, and *G. travesi* Crespin, from which it differs in its trilobate outline in end view.

Types: Holotype - CPC 3856; paratypes - CPC 3857, 3858.

Type locality: BMR 9 bore, Core 11, Daurie Creek, Carnarvon Basin.

Distribution and range: Type locality, and BMR Muderong Bores, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 18 incomplete specimens.

Genus **PSEUDOHYPERAMMINA** Crespin 1958

Type species: *Pseudohyperammina radiostoma* Crespin 1958; OD.

Pseudohyperammina radiostoma Crespin 1958
(Plate 1 figs 38-40)

1958a *Pseudohyperammina radiostoma* Crespin; Crespin: p.109, 110
1958b *Pseudohyperammina radiostoma* Crespin: p.55-56, pl. 8 figs 1-7
1962 *Pseudohyperammina radiostoma* Crespin; Crespin: p.25
1965 *Pseudohyperammina radiostoma* Crespin; Belford: p.17, pl. 1 fig. 10
1968 *Pseudohyperammina radiostoma* Crespin; Belford: p.4, pl. 1 fig. 25
1983 *Pseudohyperammina radiostoma* Crespin; Palmieri: p.141, 146

Diagnosis: "Test smooth, tapering, arenaceous; apertural opening surrounded by radially arranged elongate grooves" (Crespin, 1958b, p.55).

Closest species: None.

Types: Holotype - CPC 2421; paratypes - CPC 2422-2427.

Type locality: AFO Nerrima 1, 143.3 m, northern Canning Basin.

Distribution and range: Nalbia Dam, Wandagee Station, **Carnarvon Basin** - Bulgadoo Shale, Wandagee Formation; AFO and FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Queensland.

Abundance: A common to rare species.

Value in correlation and dating: Good in regional correlation.

Family HYPERAMMINOIDIDAE Loeblich & Tappan 1984

Genus **HYPERAMMINOIDES** Cushman & Waters 1928

Type species: *Hyperamminoides elegans* (Cushman & Waters 1928); OD.

Hyperamminoides acicula Parr 1942
(Plate 2 figs 14, 15)

1942 *Hyperamminoides acicula* Parr: p.105-106, pl. 1 figs 4, 5; pl. 2 fig. 4
1944 *Hyperamminoides acicula* Parr; Crespin: p.59
1945 *Hyperamminoides acicula* Parr; Crespin: p.24, pl. 3 fig. 1
1947 *Hyperamminoides acicula* Parr; Crespin: table (p.17-18), p.19, 21, pl. 1 fig. 1; (*non* pl. 2 figs 19, 20)
1950 *Hyperamminoides acicula* Parr; Crespin: p.68
1952 *Hyperamminoides acicula* Parr; Teichert: p.122
1956 *Hyperamminoides acicula* Parr; Crespin: p.54
1958a *Hyperammina acicula* (Parr); Crespin: p.109, 114
1958b *Hyperammina acicula* (Parr); Crespin: p.44-45, pl. 5 fig. 11; pl. 6 fig. 7
1962 *Hyperammina acicula* (Parr); Condon: p.16

Diagnosis: "Test elongate, tapering, sometimes at first slightly curved, very narrow at initial end and from there gradually widening; tube constricted at irregular intervals but not separate, constrictions strongest in early part of the shell; wall thick, composed of comparatively small quartz grains set in abundant siliceous cement; exterior smooth; apertural end not constricted; aperture circular, formed by open end of tube" (Parr, 1942, p.105).

Closest species: *H. proteus* (Cushman & Waters 1928), from which it differs by its longer length and different outline.

Types: Holotype - UWA 20679; hypotypes - CPC 2380, 2381.

Type locality: South side of Minilya River, near Coolkilya Pool, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Williambury Station, Gascoyne River below Bidgemia Homestead, and many others, **Carnarvon Basin** - Coyrie Formation, Mallens Sandstone, Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, Wandagee Formation, Baker Formation, Coolkilya Sandstone; Brutens Yard and Jurgurra Creek BMR 1, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhian), middle Kungurian.

Abundance: Common at the type locality.

Value in correlation and dating: Important for regional correlation.

Hyperamminoides elegans (Cushman & Waters 1928)
(Plate 2 figs 19, 20)

1928a *Hyperamminella elegans* Cushman & Waters: p.36, pl. 4 figs 3, 4
1928c *Hyperamminoides elegans* (Cushman & Waters); Cushman & Waters: p.112
1930 *Hyperamminoides elegans* (Cushman & Waters); Cushman & Waters: p.175, pl. 10 figs 8, 9
1952 *Hyperamminoides acicula* Parr; Teichert: p.125
1958b *Hyperammina elegans* (Cushman & Waters); Crespin: p.47-48, 206, pl. 5 figs 1-5
1961 *Hyperammina elegans* (Cushman & Waters); Crespin: p.19
1965 *Hyperammina elegans* (Cushman & Waters); Belford: p.17, pl. 1 fig. 6

Diagnosis: "Test elongate, tapering, microspheric form very pointed at initial end and rapidly enlarging, megalospheric form with large bulbous proloculum and breadth of chamber not greatly increasing towards aperture; interior of tubular chamber slightly constricted but not divided; wall siliceous, very slightly grained, exterior smooth and polished; aperture at constricted end of tubular chamber rounded or elliptical" (Cushman & Waters, 1928a, p.36).

Hypotypes: CPC 2393-2386, 2611.

Type locality: North of Ranger, Caddo Road, Stephens County, Texas.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, Carynginia Formation; Moogooree Homestead area, Williambury Station and many others, **Carnarvon Basin** - Callytharra Formation, Coyrie Formation, Bulgadoo Shale, Quinnanie Shale, Wandagee Formation; Grant Range, Myroodah 1, Jurgurra Creek BMR 1, northern **Canning Basin** - Grant Group, Noonkanbah Formation. Tasmania - Golden Valley Group; USA.

Age: Asselian, Early Sakmarian (Tastubian) - Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania.

Abundance: Common.

Value in correlation and dating: Good in regional correlation.

Climate: Species occurs in sedimentary rocks which were laid down under glacial and warmer conditions.

Hyperamminoides expansus Plummer 1945
(Plate 2 figs 16-18)

1945 *Hyperamminoides expansus* Plummer: p.223, pl. 16 figs 1-6
1958a *Hyperammina expansa* (Plummer); Crespin: p.114
1958b *Hyperammina expansa* (Plummer); Crespin: p.25, 49-50, 206, pl. 4 figs 9-11
1961 *Hyperammina expansa* (Plummer); Crespin: p.19, 20
1965 *Hyperammina expansa* (Plummer); Belford: p.17, pl. 1 fig. 7
1967 ?*Hyperammina expansa* (Plummer); Ludbrook: p.74, pl. 3 fig. 10

1968 *Hyperammina expansa* (Plummer); Belford: p.3, 5, pl. 1 figs 13-15
1973 *Hyperammina expansa* (Plummer); Harris & McGowran: p.62, pl. 3 figs 9-10

Diagnosis: Test short with very widely expanding second chamber, marked by sharp growth constrictions. Proloculum broadly round in megalospheric form, sharply pointed in microspheric. Wall finely arenaceous with siliceous cement, externally smooth, internally rough and pustulate. Characters of oral extremity and aperture questionable (abridged after Plummer, 1945, p.223).

Hypotypes: CPC 2400-2402.

Type locality: Algerita, Texas - Strawn Group, (Middle Pennsylvanian).

Distribution and range: Irwin River area, **Perth Basin** - Carynginia Formation; near Cundlego Crossing on Mir lya River, Wandagee Station, Middalya Station, **Carnarvon Basin** - Callytharra Formation, Byro Group, Bulgadoo Shale, Baker Formation; Brutens Yard, Roebuck Bay 1, AFO Nerrima 1, northern **Canning Basin** - Grant Group, Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Arckaringa and Trowbridge Basins, Renmark Trough (SA) - Stuart Range Formation, Cape Jervis Beds; Sydney Basin (NSW) - Maitland Group.

Age: Asselian, Early Sakmarian (Tastubian), Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia. Sakmarian - Artinskian in South Australia; ?Kazanian in New South Wales.

Abundance: Not common.

Value in correlation and dating: Good in regional correlation.

Climate: Species occurs in sedimentary rocks which were laid down under glacial and warmer conditions.

Hyperamminoides hadzeli (Crespin 1958)
(Plate 2 figs 21-23)

1958b *Hyperammina hadzeli* Crespin: p.51-52, 207 pl. 5 figs 6-10
1961 *Hyperammina hadzeli* Crespin; Crespin: p.19
1968 *Hyperammina hadzeli* Crespin; Belford: p.5, pl. 1 fig. 24

Diagnosis: "Proloculus small, followed by a long tubular second chamber, which expands rapidly towards the apertural opening. Test finely arenaceous" (Crespin, 1958b p.51).

Closest species: *H. expansus* (Plummer) from which it differs in its bigger size.

Types: Holotype - CPC 2410; paratypes - CPC 2411-2414.

Type locality: Callytharra Springs area, Carnarvon Basin - Callytharra Formation.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale and Fossil Cliff Member; type locality, **Carnarvon Basin** - ?Byro Group, Callytharra Formation; **Canning Basin** - Grant Group.

Age: Asselian - Late Artinskian (Baigendzhinian).

Abundance: Abundant in the Callytharra Formation, not common in the Grant Group.

Value in correlation and dating: Important in regional correlation.

Climate: Species occurs in sedimentary rocks which were laid down under glacial and temperate conditions.

Superfamily AMMODISCACEA Reuss 1862

Family AMMODISCIDAE Reuss 1862
Subfamily AMMODISCINAE Reuss 1862

Genus **AMMODISCUS** Reuss 1862

Type species: *Ammodiscus infimus* Bornemann 1874; SD Loeblich & Tappan, 1952.

Ammodiscus erugatus Crespin 1958
(Plate 2 fig. 24)

1958b *Ammodiscus erugatus* Crespin: p.66-67, pl. 12 figs 1-3

Diagnosis: "Test smooth, arenaceous, consisting of about four to six whorls. Rounded periphery and distinct spiral sutures" (Crespin, 1958b, p.66).

Closest species: *A. multicinctus* Crespin & Parr from which it differs by the rounded tube of the last-formed chamber and its few whorls.

Types: Holotype - CPC 2462; paratypes - CPC 2463, 2464.

Type locality: Myroodah 1, 265.2 - 266.7m, northern Canning Basin - Liveringa Formation.

Distribution and range: Type locality, Jurgurra Creek BMR 1 area, Brutens Yard, northern **Canning Basin** - Noonkanbah Formation, Liveringa Group.

Age: Late Artinskian (Baigendzhinian), Kungurian, and Chhidruan .

Abundance: Not given, probably not common.

Value in correlation and dating: Fair in local correlation.

Ammodiscus multicinctus Crespin & Parr 1941
(Plate 2 figs 25, 28)

1941 *Ammodiscus multicinctus* Crespin & Parr: p.303-304, pl. 12 figs 1a,b
1947 *Ammodiscus multicinctus* Crespin & Parr; Crespin: table (p.17-18), p.19, 22, pl.1 fig. 2; pl. 2 fig. 18
1952 *Ammodiscus multicinctus* Crespin & Parr; Teichert: p.122
1958b *Ammodiscus multicinctus* Crespin & Parr; Crespin: p.67-68, pl. 12 figs 4-6
1982 *Ammodiscus multicinctus* Crespin & Parr; Scheibnerova: p.58, pl. 14 fig. 4; pl. 15 figs 1-3
1985 *Ammodiscus multicinctus* Crespin & Parr; Palmieri *in* Foster et al.: p.79, pl. 4 figs 2,3

Diagnosis: Test coarsely arenaceous, consisting of about six whorls, last chamber constricted at fairly regular intervals; lobulate periphery, roughened surface, generally circular aperture (abridged from Crespin & Parr 1941, p.303).

Closest species: *A. semiconstrictus* Waters from which it differs in the close constriction of the spiral tube.

Types: Holotype - CPC 149; hypotypes - CPC 2465, 2466; other figured specimens - WAM 83.2763, 83.2764.

Type locality: West of Farley Station, Hunter River area, Sydney Basin, NSW - Farley Formation.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Gascoyne River area, **Carnarvon Basin** - Callytharra Formation, Byro Group, Wandagee Formation. Tasmania - Quamby Mudstone; Sydney Basin (NSW) - Dalwood Group, Maitland Group, Singleton Supergroup, Conjola Subgroup, Berry Formation, Illawarra Coal Measures; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania; Artinskian - Kungurian in Queensland; Artinskian - ?Tatarian in New South Wales.

Abundance: Very common to fairly rare.

Value in correlation and dating: An ubiquitous species in the Permian of Australia.

Ammodiscus nitidus Parr 1942
(Plate 2 figs 26, 29, 32)

1907 *Cornuspira involvens* Etheridge Jnr. (*non* Reuss): pl. 12 fig. 12
1942 *Ammodiscus nitidus* Parr: p. 103, pl. 1 figs 1a, b
1947 *Ammodiscus nitidus* Parr; Crespin: table (p.17-18), p.19, 20, 22
1950 *Ammodiscus nitidus* Parr; Crespin: p.68
1952 *Ammodiscus nitidus* Parr; Teichert: p.122
1956 *Ammodiscus nitidus* Parr; Crespin: p.54

1958a *Ammodiscus nitidus* Parr; Crespin: p.109, 110, 113
1958b *Ammodiscus nitidus* Parr; Crespin: p.68-69, 206, 207, pl. 12 figs 7-9
1962 *Ammodiscus nitidus* Parr; Crespin: p.25
1965 *Ammodiscus nitidus* Parr; Crespin: p.16
1968 *Ammodiscus nitidus* Parr; Belford: pl. 1 figs 5-7
1982 *Ammodiscus nitidus* Parr; Scheibnerova: p.58, pl. 11 fig. 2; pl. 13 figs 2, 4; pl. 14 figs 1, 3a,b, 5
1983 *Ammodiscus nitidus* Parr; Palmieri: p.141, 146
1985 *Ammodiscus nitidus* Parr; Palmieri *in* Foster et al.: p.79, pl. 4 figs 4, 5

Diagnosis: "Test small, free, composed of minute proloculus and an elongate, tubular chamber, almost semicircular in section and slowly increasing in diameter, often transversely ridged, number of whorls usually seven or eight, each whorl overlapping to a considerable extent its predecessor; spiral suture only slightly depressed; wall thin for its genus, composed of very small quartz grains with little visible cement; shell surface comparatively smooth; aperture semicircular, formed by open end of tube" (Parr, 1942, p.103).

Closest species: *A. multicinctus* Crespin & Parr from which it differ, in the smoother surface of the test and absence of fine constrictions.

Types: Holotype - UWA 20670; hypotypes - CPC 2467-2469; other figured specimens - WAM 83.2765, 83.2766.

Type locality: Burna Burna Paddock, Wandagee Station, Carnarvon Basin - Wandagee Formation.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Holmwood Shale and Fossil Cliff Member, High Cliff Sandstone, Carynginia Formation; Minilya River, Coolkilya Paddock, Wandagee Station, Merlinleigh Homestead area, and many others, **Carnarvon Basin** - Callytharra Formation, basal Byro Group, Coyrie Formation, Warra Warringa Formation, Mallens Sandstone, Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, Wandagee Formation, Baker Formation; Grant Range, Liveringa Homestead area, Dampier Downs 1, Brutens Yard, FKO Nerrima 1, Jurgurra Creek BMR 1, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation; Lake Dora and Lake Blanche area, southern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Allandale Formation, Maitland Group, Singleton Supergroup, Berry Formation, Illawarra Coal Measures; Bowen Basin (Qld) - Cattle Creek Formation; Port Keats (NT).

Age: Early Sakmarian (Tastubian) - Early Kungurian in Western Australia. Artinskian in Queensland; Sakmarian - ?Tatarian in New South Wales.

Abundance: Common to rare.

Value in correlation and dating: Ubiquitous in the Permian of Australia.

Ammodiscus wandageeensis Parr 1942
(Plate 2 fig. 27)

1942 *Ammodiscus wandageeensis* Parr: p.102, pl. 11 fig. 1
1947 *Ammodiscus wandageeensis* Parr; Crespin: table (p.17-18)
1952 *Ammodiscus wandageeensis* Parr; Teichert: p.125
1958b *Ammodiscus wandageeensis* Parr; Crespin: p.69-70, pl. 12 fig. 12
1968 *Ammodiscus wandageeensis* Parr; Belford: p.5, pl. 1 fig. 8

Diagnosis: "Test large, free, planispiral, composed of a small globular proloculus, followed by a long undivided tubular chamber, closely coiled in single plane, the tube fairly thick-walled, almost circular in section and slowly increasing in diameter as it lengthens; number of whorls usually six or seven; spiral suture strongly depressed; wall coarsely arenaceous with a rough surface and little visible cement; aperture formed by the rounded open end of the chamber" (Parr, 1942, p.102).

Closest species: *A. semiconstrictus* var. *regularis* Waters from which it differs in its larger size and the use of sponge spicules in the test structure.

Types: Holotype - UWA 20671; hypotype - CPC 2472.

Type locality: Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Wandagee Station near Wandagee Hill, **Carnarvon Basin** - Coyrie Formation, Quinnanie Shale, Wandagee Formation, ?Baker Formation.

Age: Late Artinskian (Baigendzhinian) - ?Early Kungurian.

Abundance: Common in the Wandagee Formation and Quinnanie Shale.

Value in correlation and dating: Restricted to local correlation.

Genus **GLOMOSPIRELLA** Plummer 1945

Type species: *Glomospira umbilicata* Cushman & Waters 1927; OD (Monotypy).

Glomospirella nyei Crespin 1958
(Plate 2 figs 30, 34)

1958b *Glomospirella nyei* Crespin: p.70-71, 207, pl. 13 figs 1-5
1965 *Glomospirella nyei* Crespin; Belford: p.17, pl. 1 fig. 17
1965 *Glomospirella nyei* Crespin; Crespin: p.17
1968 *Glomospirella nyei* Crespin; Belford: pl. 2 figs 1, 2
1982 *Glomospirella nyei* Crespin; Scheibnerova: p.59
1983 *Glomospirella nyei* Crespin; Palmieri: p.141, 146
1985 *Glomospirella nyei* Crespin; Palmieri *in* Foster et al.: p.79, pl. 4 figs 6, 7

Diagnosis: "A finely arenaceous tubular chamber, which, after coiling itself in different directions in the initial portion, becomes planispiral for two or three whorls. Spiral suture distinct and periphery rounded" (Crespin, 1958b, p.70).

Closest species: *G. umbilicata* (Cushman & Waters), from which it differs in its smaller size.

Types: Holotype - CPC 2475; paratypes - UQGD F23211, CPC 2476-2478; other figured specimens - WAM 83.2767, 83.2768.

Type locality: Cundlego Crossing, Minilya River, Carnarvon Basin - Cundlego Formation.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Holmwood Shale; Callytharra Springs, Giralia 1, Minilya River area, **Carnarvon Basin** - Callytharra Formation, basal Byro Group, Cundlego Formation; Dampier Downs 1, FKO and AFO Nerrima 1, Roebuck Bay 1, northern **Canning Basin** - ?Grant Group, Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Bowen Basin (Qld) - Blenheim Subgroup; Sydney Basin (NSW) - Branxton Formation.

Age: Early Sakmarian (Tastubian) - Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in New South Wales; ?Kazanian in Queensland.

Abundance: Common in Callytharra Formation and Blenheim Subgroup.

Value in correlation and dating: Fair in local correlation.

Subfamily TOLYPAMMINAE Cushman 1928

Genus **TOLYPAMMINA** Rhumbler 1895

Type species: *Hyperammina vagans* Brady 1879; OD (Monotypy).

Tolypammina adhaerens (Parr 1942)
(Plate 2 figs 31, 35)

1942 *Glomospira adhaerens* Parr: p.103, pl. 1 fig. 2
1947 *Glomospira adhaerens* Parr; Crespin: table (p.17-18), p. 19
1958b *Glomospira adhaerens* Parr; Crespin: p.70, pl. 13 figs 6, 7
1968 *Lituotuba adhaerens* (Parr); Belford: p.6, pl. 2 fig. 13

Diagnosis: "Test usually attached, early portion coiled planispirally after which tubular second chamber increases in diameter and winds rather irregularly over the early portion to form a subglobular heap, finally in some specimens extending as a straight or curved tube adherent to the object of attachment; wall composed of fine quartz grains firmly cemented to form a comparatively smooth surface; aperture formed by open end of tube" (Parr, 1942, p.70).

Types: Holotype - UWA 20675; hypotypes - CPC 2473, 2474.

Type locality: Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Arthur River near Bidgemia Homestead, Giralia 1, northern **Carnarvon Basin** - Callytharra Formation, Quinnanie Shale, Wandagee Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Fair in local correlation.

Tolypammina undulata Parr 1942
(Plate 2 figs 33, 36)

1942 *Tolypammina undulata* Parr: p.104, pl. 2 fig. 2
1947 *Tolypammina undulata* Parr; Crespin: table (p.17-18), p.19
1952 *Tolypammina undulata* Parr; Teichert: p.122, 125
1958b *Tolypammina undulata* Parr; Crespin: p.72, pl. 19 figs 7, 8
1967 *Tolypammina undulata* Parr; Ludbrook: p.79-80, pl. 4 figs 5, 9
1968 *Ammovertella undulata* (Parr); Belford: p.6, pl. 2 fig. 12
1973 *Tolypammina undulata* Parr; Harris & McGowran: p.62, pl. 1 figs 5, 6
1982 *Hyperammina vagans* Scheibnerova (*non* Brady): p.55-56, pl. 4 fig. 4

Diagnosis: "Test adherent, tubular, earliest portion apparently a small planispiral coil of about one whorl after which tube winds from one side to the other or irregularly meanders over the object of attachment, the tube and undulations meanwhile gradually increasing in size; wall formed of sand grains set in abundant cement; surface comparatively smooth; aperture formed by open end of tube" (Parr, 1942, p.104).

Closest species: *Tolypammina adhaerens*, from which it differs in the regular increase in the diameter of the tube with growth and thicker tube wall.

Types: Holotype - UWA 20682; hypotypes - CPC 2479, 2481.

Type locality: Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Near Merlinleigh Homestead, Coolkilya Paddock and elsewhere on Wandagee Station, **Carnarvon Basin** - Bulgadoo Shale, Quinnanie Shale, Wandagee Formation; ?Baker Formation, Wandagee Formation; **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Mantuan Productus Bed; Sydney Basin (NSW) - Mulbring Subgroup, Maitland Group, Wandrawandian Siltstone; Arckaringa Basin (SA) - Stuart Range Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian, ?Early Kungurian in Western Australia. Sakmarian - Artinskian in New South Wales; Kazanian in Queensland.

Abundance: Common in Wandagee Formation, and in the Hunter River area.

Value in correlation and dating: An ubiquitous species in the Australian Permian.

Subfamily AMMOVERTELLININAE Saidova 1981

Genus **AMMOVERTELLA** Cushman 1928

Type species: *Ammodiscus (Psammophis) inversus* Schellwein 1898; OD.

Ammovertella inclusa (Cushman & Waters 1927)
(Plate 3 fig. 1)

1927a *Psammophis inclusus* Cushman & Waters: pl. 26, fig. 12
1930 *Tolypammina inclusa* (Cushman & Waters); Galloway & Ryniker: p.11, pl. 1 figs 12, 13
1930 *Ammovertella inclusa* (Cushman & Waters); Cushman & Waters: p.44, pl. 7 fig. 13
1958b *Ammovertella inclusa* (Cushman & Waters); Crespin: p.72-73, pl. 18 fig. 5

Figured specimen: CPC 2480.

Type locality: Graham, Young County, Texas - Gunsight Limestone (Pennsylvanian).

Distribution and range: Callytharra Springs, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Good in local correlation.

Superfamily HORMOSINACEA Haeckel 1894

Family HORMOSINIDAE Haeckel 1894
Subfamily REOPHACINAE Cushman 1910

Genus **REOPHAX** Montfort 1808

Type species: *Reophax scorpiurus* Montfort 1808; OD.

Reophax asper Cushman & Waters 1928

1928a *Reophax asperus* Cushman & Waters: p.37, pl. 4 fig. 7
1930 *Reophax asper* Cushman & Waters: p.37, pl. 2 fig. 10
1958b *Reophax asper* Cushman & Waters; Crespin: p.59-60, pl. 10 figs 1-4
1961 *Reophax asperus* Cushman & Waters; Crespin: p.19, 20
1982 *Reophax asper* Cushman & Waters; Scheibnerova: p.59, 60

Diagnosis: "Test elongate, somewhat tapering, generally rounded in section, chamber several, somewhat obscure; sutures not deeply depressed; wall arenaceous composed of siliceous grains of angular shape, firmly cemented; aperture small, rounded" (Cushman & Waters, 1928a, p.37).

Closest species: *Reophax subasper* Parr, from which it differs in its straight test and almost uniform size of the chambers.

Hypotypes: CPC 2436-2439.

Type locality: Young County, Texas - Graham Formation, Cisco Group, (Pennsylvanian).

Distribution and range: Southern **Canning Basin** - Grant Group. Sydney Basin (NSW) - Dalwood Group, Maitland Group, Capertee Group, Shoalhaven Group; Bowen Basin (Qld) - Ingelara Formation. Texas (USA).

Age: Asselian, Early Sakmarian (Tastubian) in Western Australia. ?Tatarian in New South Wales; Kungurian in Queensland.

Abundance: A common species.

Value in correlation and dating: An ubiquitous species.

Climate: Associated with sedimentary rocks laid down under glacial and warmer water conditions.

Reophax belfordi Crespin 1958
(Plate 3 figs 4, 5)

1958b *Reophax belfordi* Crespin: p.60-61, pl. 10 figs 8-11
1982 *Reophax belfordi* Crespin; Scheibnerova: p.60, pl. 9 figs 1, 4; pl. 10 fig. 2

Diagnosis: "Test small, slender, tapering, irregularly elongated and composed of small angular quartz grains" (Crespin, 1958b, p.60).

Closest species: *R. expatiatus* Plummer from which it differs in the slower increase in width and greater number of chambers.

Types: Holotype - CPC 2440; paratypes - CPC 2441-2443.

Type locality: Giralia 1, 167.6 - 170.7 m, northern Carnarvon Basin - Byro Group.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - Byro Group. Sydney Basin (NSW) - Singleton Supergroup.

Age: Late Artinskian (Baigendzhinian) in Western Australia. ?Tatarian in New South Wales.

Abundance: A rare species.

Value in correlation and dating: Good in local correlation.

Reophax ellipsiformis Crespin 1958
(Plate 3 fig. 6)

1958a *Reophax ellipsiformis* Crespin; Crespin: p.114
1958b *Reophax ellipsiformis* Crespin: p.61-62, pl. 11 figs 1-4
1962 *Reophax ellipsiformis* Crespin; Crespin: p.25
1982 *Reophax ellipsiformis* Crespin; Scheibnerova: p.60, pl. 9 figs 3a,b

Diagnosis: "Test coarsely arenaceous, ellipsoidal, almost bilaterally symmetrical along direction of longitudinal axis, tapering regularly to initial and to apertural end from broad central portion of test, and with a well-defined apertural tube" (Crespin, 1958b, p.61).

Closest species: *R. fittsi* (Warthin) from which it differs in its bilaterally symmetrical and compressed test and in the absence of distinct chambers.

Types: Holotype - CPC 2444; paratypes - CPC 2445-2447.

Type locality: 7.4 km southwest of Moogooree Homestead, Carnarvon Basin - Coyrie Formation.

Distribution and range: Giralia 1, near Wandagee Homestead, and Williambury Station, near Merlinleigh Homestead, **Carnarvon Basin** - Byro Group, Coyrie Formation, Bulgadoo Shale, Cundlego Formation; south of Grant Range, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Singleton Supergroup.

Age: Late Artinskian (Baigendzhinian) in Western Australia. ?Tatarian in New South Wales.

Value in correlation and dating: Fair in local correlation.

Reophax emaciatus Plummer 1945
(Plate 3 figs 2, 3)

1945 *Reophax emaciatus* Plummer: p.227, pl. 17 figs 18-22
1958b *Reophax emaciatus* Plummer; Crespin: p.62-63, pl. 11 figs 5, 6
1965 *Reophax emaciatus* Plummer; Crespin: p.17
1982 *Reophax emaciatus* Plummer; Scheibnerova: p.60, pl. 9 fig. 5; pl. 10 figs 1a,b, 4

Diagnosis: "Test flattened, spatulate, straight, bluntly pointed at initial end, and constricted at apertural end. Separate elongate chambers that overlap by about one-half, obscure with sutures faintly constricted. First two or three chambers broaden rapidly. Shell wall thin and usually flattend by sedimentary compaction so that combination of clear quartz grains in clear siliceous cement makes some tests translucent. Aperture a large opening at end of short neck" (Plummer, 1945, p.227).

Closest species: *R. fittsi* (Warthin) from which it differs by the more elongate and less tapering shape, straight axis of growth, and broad apertural extremity.

Hypotypes: CPC 2448, 2449.

Type locality: South Saba County, Texas - Strawn Shale, (Pennsylvanian).

Distribution and range: Giralia 1, Williambury Homestead area, Middalya Station, Merlinleigh Homestead area, **Carnarvon Basin** - basal Byro Group, Coyrie Formation Bulgadoo Shale, Wandagee Formation; Grant Range, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Singleton Supergroup.

Age: Late Artinskian (Baigendzhinian) in Western Australia. ?Tatarian in New South Wales.

Value in correlation and dating: Fair in local correlation.

Reophax fittsi (Warthin 1930)
(Plate 3 fig. 7)

1930 *Nodosinella? fittsi* Warthin: p.27, pl. 2 fig. 7
1945 *Reophax fittsi* (Warthin); Plummer: p.228, pl. 17 figs 10-17
1958b *Reophax fittsi* (Warthin); Crespin: p.63, pl. 11 figs 7-9

Diagnosis: "Test carrot-shaped, consisting of from four to six chambers, circular in cross-section, uniserially arranged, regularly increasing; sutures slightly depressed, somewhat obscure; wall coarsely arenaceous except near aperture where the secreted cement predominates; surface rough; aperture terminal, rounded, with a faintly produced neck" (Warthin, 1930, p.27).

Closest species: *R. tricameratus* Pair, from which it differs in having more chambers and a slightly produced apertural neck.

Hypotypes: CPC 2450-2452.

Type locality: West of Allen, Oklahoma - Wewoka Formation (Pennsylvanian).

Distribution and range: Near Moogooree Homestead, **Carnarvon Basin** - Coyrie Formation; Roebuck Bay 1, southern **Canning Basin** - ?Grant Group.

Age: ?Asselian - Late Artinskian (Baigendzhinian).

Abundance: A rare species.

Value in correlation and dating: Fair in local correlation.

Reophax minutissimus Plummer 1945
(Plate 3 fig. 13)

1945 *Reophax minutissimus* Plummer: p.230, pl. 17 figs 25-30
1958b *Reophax minutissimus* Plummer; Crespin: p.63-64, pl. 10 figs 5-7
1982 *Reophax minutissimus* Plummer; Scheibnerova: p.60-61, pl. 10 figs 2, 3

Diagnosis: Small, moderately rough and slender test composed of six to eight chambers of almost the same size, (condensed from Plummer, 1945, p.230).

Closest species: *R. belfordi* Crespin from which it differs in the greater number of chambers.

Hypotypes: CPC 2453-2455.

Type locality: South Saba County, Texas - Strawn Shale (Pennsylvanian).

Distribution and range: Moogooree Homestead area, Giralia 1, **Carnarvon Basin** - Coyrie Formation, Byro Group. Sydney Basin (NSW) - Mulbring Siltstone, Singleton Supergroup, Berry Formation; Bowen Basin (Qld) - Ingelara Formation.

Age: Late Artinskian, (Baigendzhinian), Early Kungurian in Western Australia. Kungurian in Queensland; Kazanian in New South Wales.

Abundance: A common species.

Value in correlation and dating: Ubiquitous in the Permian of Australia.

Reophax subasper Parr 1942
(Plate 3 figs 11, 12)

1942 *Roephax subasper* Parr: p.108-109, pl. 1 fig. 12
1947 *Reophax subasper* Parr; Crespin: table (p.17-18)
1958a *Reophax subasper* Parr; Crespin: p.114
1958b *Reophax subasper* Parr; Crespin: p.64, pl. 11 figs 10-11
1982 *Reophax subasper* Parr; Scheibnerova: p.61, pl. 9 figs 2a,b

Diagnosis: "Test consisting of up to seven chambers rapidly increasing in size as added, early chambers indistinct, usually arranged in a curved series, later chambers larger and more distinct, in nearly a straight line; wall built of coarse quartz grains, firmly cemented, surface rough, aperture a small opening between three or more sand grains at end of the final chamber" (Parr, 1942, p.108).

Closest species: *R. asper* Cushman & Waters from which it differs in the more acutely tapering test and in the greater width of the final chamber.

Types: Holotype - UWA 20685; hypotypes - CPC 2456-2457.

Type locality: "*Lingula* beds", east of Coolkilya Paddock, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Near Paddys Outcamp on Middalya Station, near Madeline Creek on Wooramel River, Gascoyne River, Minilya River, **Carnarvon Basin** - Coyrie Formation Cundlego Formation, Quinnanie Shale, Wandagee Formation, Baker Formation; south of Grant Range, northern **Canning Basin** - Noonkanbah Formation, Lightjack Formation, Liveringa Group. Sydney Basin (NSW) - Maitland Group, Conjola Subgroup.

Age: Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia. Sakmarian - Kungurian in New South Wales.

Abundance: Common to rare.

Value in correlation and dating: Fair in local correlation.

Reophax? thomasi (Crespin 1958)
(Plate 3 figs 14, 15)

1958b *Lugtonia thomasi* Crespin: p.65-66, pl. 7 figs 6, 7
1967 *Reophax(?) thomasi* (Crespin); Ludbrook: p.80-81, pl. 4 figs 16, 19, 20

Diagnosis: "Six inflated chambers, which gradually increase in size. Test arenaceous, polished, with large rounded aperture" (Crespin, 1958b, p.65).

Closest species: *Lugtonia elongata* Cummings 1955 from the Carboniferous of Scotland from which it differs in having an arenaceous wall and in the lesser inflation of the earlier chambers.

Types: Holotype - CPC 2460; paratype - CPC 2461.

Type locality: 2 km southwest of Nalbia Dam, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Bulgadoo Shale. Arckaringa and Trowbridge Basins, Renmark Trough (SA) - Stuart Range Formation, Cape Jervis Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian - Artinskian in South Australia.

Value in correlation and dating: Fair in interregional correlation.

Reophax tricameratus Parr 1942
(Plate 3 figs 8-10)

1942 *Reophax tricameratus* Parr: p.109, pl. 1 fig. 13
1947 *Reophax tricameratus* Parr; Crespin: table (p.17-18)
1952 *Reophax tricameratus* Parr; Teichert: p.125
1956 *Reophax tricameratus* Parr; Crespin *in* Reynolds: p.65
1958b *Reophax tricameratus* Parr; Crespin: p.65, pl. 11 figs 12, 13

Diagnosis: "Test composed of a few (typically three) chambers, increasing rapidly in size as added, the last-formed chamber making up about half the length of the test; axis of test straight or slightly curved; wall composed of medium-sized sand grains, firmly cemented; surface rough; apertural end slightly produced; aperture terminal" (Parr, 1942, p.109).

Closest species: *R. fittsi* (Warthin), from which it differs in its very inflated apertural chamber and very coarse arenaceous test.

Types: Holotype - UWA 20684; hypotypes - CPC 2458, 2459.

Type locality: Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Near Moogooree Homestead, near Gascoyne River, Dairy Creek Station, near Coordewandy Homestead, Minilya River, **Carnarvon Basin** - Lyons Group, Callytharra Formation, Coyrie Formation, Quinnanie Shale, Wandagee Formation; Brutens Yard, south of Grant Range, northern **Canning Basin** - Noonkanbah Formation, Liveringa Group. BMR 14(T) Ponds Creek, Sydney Basin (NSW) - Maitland Group, Singleton Supergroup, Wandrawandian Siltstone, Perry Formation.

Age: Asselian, Early Sakmarian (Tastubian), ?Chhidruan in Western Australia. Artinskian, ?Tatarian in New South Wales.

Abundance: Not common in the Carnarvon Basin.

Value in correlation and dating: An ubiquitous species.

Superfamily LITUOLACEA de Blainville 1827

Family LITUOLIDAE de Blainville 1827
Subfamily AMMOMARGINULINAE Podobina 1978

Genus **AMMOBACULITES** Cushman 1910

Type species: *Spirolina agglutinans* d'Orbigny 1846; OD.

Ammobaculites eccentrica Crespin 1958
(Plate 3 figs 16, 17, 20)

1958b *Ammobaculites eccentrica* Crespin: p.73-74, pl. 14 figs 4-9
1982 *Ammobaculites eccentrica* Crespin; Scheibnerova: p.62, 63, pl. 21 fig. 3

Diagnosis: "Test minute, arenaceous, consisting of numerous small chambers in planispiral portion, the uniserial chambers being eccentric in growth" (Crespin, 1958b, p.73).

Closest species: *A. minuta* Waters, from which it differs in the eccentrical growth of the uncoiled portion.

Types: Holotype - CPC 2482; paratypes - CPC 2483, 2484.

Type locality: Callytharra Springs area, Carnarvon Basin - Callytharra Formation.

Distribution and range: Type locality, near Merlinleigh Homestead, Giralia 1, **Carnarvon Basin** - Callytharra Formation, Bulgadoo Shale. Sydney Basin (NSW) - Allandale Formation, Branxton Formation.

Age: Late Sakmarian (Sterlitamakian) - Artinskian (Baigendzhinian) in Western Australia. Sakmarian - Artinskian in New South Wales.

Abundance: Common in the Callytharra Formation.

Value in correlation and dating: Good in regional correlation.

Ammobaculites sp. cf. **A. eccentrica** Crespin 1958

1968 *Ammobaculites* sp. cf. *A. eccentrica* Crespin; Belford: p.5, pl. 1 fig. 9

Figured specimen: CPC 6830.

Type locality: BMR 8, Core 13, 365.5 - 367.9 m, Byro Station, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Single occurrence.

Ammobaculites wandageeensis Crespin 1958
(Plate 3 fig. 18)

1958b *Ammobaculites wandageeensis* Crespin: p.74-75, pl. 14 figs 1-3
1982 *Ammobaculites wandageeensis* Crespin; Scheibnerova: p.63, pl. 18 figs 1, 3, 4; pl. 19 fig. 1; pl. 20 figs 1, 2; pl. 21 fig. 4; pl. 22 figs 1, 3, 4

Diagnosis: "Test arenaceous, consisting of four chambers in planispiral portion and three or four in uniserial portion" (Crespin, 1958b, p.74).

Closest species: *A. inconspicua* Cushman & Waters, from which it differs in the smaller number of chambers.

Types: Holotype - CPC 2485; paratypes - CPC 2486, 2487.

Type locality: Cundlego Crossing on Minilya River, Wandagee Station, Carnarvon Basin - Cundlego Formation.

Distribution and range: Near Moogooree Homestead, and Williambury Station, **Carnarvon Basin** - Callytharra Formation, Coyrie Formation, Bulgadoo Shale, Cundlego Formation; Jurgurra Creek BMR water bore, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Allandale Formation, Branxton Formation, Singleton Supergroup.

Age: Late Sakmarian (Sterlitamakian) - Artinskian (Baigendzhinian) in Western Australia. Sakmarian - ?Tatarian in New South Wales.

Abundance: Common in the type locality.

Value in correlation and dating: Good in local correlation.

Ammobaculites woolnoughi Crespin & Parr 1941
(Plate 3 fig. 19)

1941 *Ammobaculites woolnoughi* Crespin & Parr: p.304-305, pl. 12 figs 2a,b, 3a,b
1942 *Ammobaculites woolnoughi* Crespin & Parr; Parr: p.108, pl. 1 fig. 11

1945 *Ammobaculites woolnoughi* Crespin & Parr; Crespin: p.25, pl. 3 fig. 4

1947 *Ammobaculites woolnoughi* Crespin & Parr; Crespin: table (p.17-18), p.19, 22, pl. 1 fig. 4; pl. 2 figs 16, 17

1948 *Endothyranella woolnoughi* (Crespin & Parr); Branson: p.14

1950 *Ammobaculites woolnoughi* Crespin & Parr; Crespin: p.68

cf. 1956 *Ammobaculites woolnoughi* Crespin & Parr; Crespin: p.54

1958b *Ammobaculites woolnoughi* Crespin & Parr; Crespin: p.75-76, 206, pl. 14 figs 10, 11

1965 *Ammobaculites woolnoughi* Crespin & Parr; Belford: p.17, pl. 1 fig. 19

1968 *Ammobaculites woolnoughi* Crespin & Parr; Belford: p.4, pl. 1 fig. 10

1982 *Ammobaculites woolnoughi* Crespin & Parr; Scheibnerova: p.63, pl. 18 figs 2, 5; pl. 21 figs 1, 6; pl. 22 fig. 2

1985 *Ammobaculites woolnoughi* Crespin & Parr; Palmieri *in* Foster et al.: p.79-80, pl. 4 fig. 1.

Diagnosis: "Test crozier-shaped, with the early portion closely coiled and consisting of a single whorl of five or six inflated chambers, in rectilinear series, frequently gradually increasing in size as added; slightly compressed; sutures depressed; wall coarsely arenaceous with a rough surface; aperture terminal and nearly circular" (Crespin & Parr, 1941, p.304).

Closest species: *A. eiseli* (Spandel) from the Zechstein (Permian) of Germany which is small smooth-walled with a rectilinear series of chambers of uniform width.

Types: Holotype - CPC 151; paratype - CPC 150; hypotypes - CPC 2488, 2489; another figured specimen - WAM 83.2782.

Type locality: Farley Road, Farley Station, northern Sydney Basin - Farley Formation.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Muderong Bore, Cundlego Crossing on Minilya River, Gascoyne River near hotel, Minilya River near Coolkilya Pool, and Giralia 1, **Carnarvon Basin** - Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, **Canning Basin** - Noonkanbah Formation. Tasmania - Quamby Mudstone; Sydney Basin (NSW) - Dalwood Group, Maitland Group, Capertee Group, Wandrawandian Siltstone; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania; Sakmarian - ?Tatarian in New South Wales; Artinskian - Kungurian in Queensland.

Abundance: Common at the type locality.

Value in correlation and dating: Important in Australia-wide correlation.

Family PLACOPSILINIDAE Rhumbler 1913

Genus **PLACOPSILINA** d'Orbigny 1850

Type species: *Placopsilina cenomana* d'Orbigny 1850; SD Cushman, 1920.

Placopsilina wooramelensis Crespin 1958
(Plate 3 fig. 21)

1958b *Placopsilina wooramelensis* Crespin: p.94-95, pl. 19 figs 4-6

Diagnosis: "Finely arenaceous encrusting form consisting of approximately five visible chambers of varying shapes and arranged in a linear series" (Crespin, 1958b, p.94).

Closest species: *P. ciscoensis* Cushman & Waters 1930, from which it differs in the more flattened and tightly arranged chambers.

Types: Holotype - CPC 2530; paratype - CPC 2616.

Type locality: Callytharra Springs, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamalian).

Abundance: Common.

Value in correlation and dating: Single occurrence.

Superfamily SPIROPLECTAMMINACEA Cushman 1927

Family SPIROPLECTAMMINIDAE Cushman 1927
Subfamily SPIROPLECTAMMININAE Cushman 1927

Genus **SPIROPLECTAMMINA** Cushman 1927

Type species: *Textularia agglutinans* d'Orbingy var. *biformis* Parker & Jones 1865; OD.

Spiroplectammina carnarvonensis Crespin 1958
(Plate 4 figs 4, 8)

1958b *Spiroplectammina carnarvonensis* Crespin: p.76-77, 206, pl. 22 figs 7-9
1965 *Spiroplectammina carnarvonensis* Crespin; Crespin: p.17
1982 *Spiroplectammina carnarvonensis* Crespin; Scheibnerova: p.64, pl. 22 fig. 7; pl. 25 fig. 5

Diagnosis: "Test small, short, arenaceous, consisting of four planispiral chambers then becoming biserial with three or four chambers on either side of median sutural line" (Crespin, 1958b, p.76).

Closest species: *S. clavata* Cushman & Waters 1930, from which it differs in its coarser and slightly wider test.

Types: Holotype - CPC 2490; paratypes - CPC 2491, 2492.

Type locality: Minilya River 0.5 km upstream from Garden Outcamp, Wandagee Station, Carnarvon Basin - Bulgadoo Shale.

Distribution and range: Irwin River area, **Perth Basin** - Carynginia Formation; Giralia 1, near Moogooree Homestead, Wandagee Station, and near Bidgemia Homestead, **Carnarvon Basin** - basal Byro Group, Coyrie Formation, Bulgadoo Shale, Cundlego Formation. Tasmania - Quamby Mudstone; Sydney Basin (NSW) - Singleton Supergroup.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania; ?Tatarian in New South Wales.

Abundance: Rare.

Value in correlation and dating: Fair in local correlation.

Superfamily TROCHAMMINACEA Schwager 1877

Family TROCHAMMINIDAE Schwager 1877
Subfamily TROCHAMMININAE Schwager 1877

Genus **TROCHAMMINA** Parker & Jones 1859

Type species: *Nautilus inflatus* Montagu 1808; OD (Monotypy).

Trochammina pulvilla Crespin & Parr 1941
(Plate 4 figs 5, 6)

1941 *Trochammina pulvillus* Crespin & Parr: p.308-309, pl. 12 figs 6 a-c
1947 *Trochammina pulvillus* Crespin & Parr; Crespin: pl. 2 figs 21, 22
1950 *Trochammina pulvillus* Crespin & Parr; Crespin: p.68
1956 *Trochammina pulvillus* Crespin & Parr; Crespin *in* Reynolds: lists
1958b *Trochammina pulvilla* Crespin & Parr; Crespin: p.91-92, pl. 22 figs 1-4
1982 *Trochammina pulvilla* Crespin & Parr; Scheibnerova: p.65, pl. 29 fig. 1

Diagnosis: "Test small, trochospirally arranged; with six chambers in the last whorl; sutures nearly straight, depressed, aperture umbilical, wall arenaceous" (condensed from Crespin & Parr, 1941, p.308).

Closest species: None closely related; *T. nitida* Brady has a much flatter test and about nine chambers in the last-formed whorl.

Types: Holotype - CPC 156; hypotypes - CPC 2525, 2526.

Type locality: Victoria Pass, Mitchell Highway, Sydney Basin, NSW - Capetree Group.

Distribution and range: **Carnarvon Basin** - Wandagee Formation. Sydney Basin (NSW) - Maitland Group, Singleton Supergroup, Berry Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - ?Tatarian in New South Wales.

Abundance: Common in the Sydney Basin.

Value in correlation and dating: Important in Australia-wide correlation.

Trochammina subobtusa Parr 1942
(Plate 4 figs 9-11)

1942 *Trochammina subobtusa* Parr: p.109, pl. 1 figs 14a-c
1947 *Trochammina subobtusa* Parr; Crespin: table (p.17-18)
1952 *Trochammina subobtusum* Parr; Teichert: p.122
1958a *Trochammina subobtusa* Parr; Crespin: p.114
1958b *Trochammina subobtusa* Parr; Crespin: p.92, 207, pl. 21 figs 5-6
1965 *Trochammina subobtusa* Parr; Belford: p.17, pl. 2 figs 1, 2
1965 *Trochammina subobtusa* Parr; Crespin: p.17
1982 *Trochammina subobtusa* Parr; Scheibnerova: p.65-66, pl. 25 figs 7; pl. 29 figs 2-4

Diagnosis: "Test globose, trochoid, spire low, under side umbilicate, composed of three whorls; chambers strongly inflated, with four in the last-formed whorl, the chambers of which are so much larger than those in the preceding whorl that they form the greater part of the test; sutures distinct and depressed; wall finely arenaceous, with the surface smoothly finished but not polished; aperture an arched slit at the base of the last-formed chamber, opening into the umbilical depression" (Parr, 1942, p.109).

Closest species: *T. arenosa* Cushman & Waters 1927 from the Pennsylvanian of Texas is flatter and spreading out, its wall is rather coarsely arenaceous.

Types: Holotype - UWA 20683; hypotype - CPC 2527.

Type locality: Minilya River at Coolkilya Pool, Wandagee Station, Carnarvon Basin - Quinnanie Shale.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale and Fossil Cliff Member; Wooramel River near Madeline Creek, Minilya River near Garden Outcamp, Merlinleigh Homestead area, **Carnarvon Basin** - Callytharra Formation, basal Byro Group, Coyrie Formation, Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, Wandagee Formation; south of Grant Range, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Dalwood Group, Singleton Supergroup, Wandrawandian Siltstone.

Age: Early and Late Sakmarian, Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian - ?Tatarian in New South Wales.

Abundance: Not common.

Value in correlation and dating: Fair in regional correlation.

Superfamily ATAXOPHRAGMIACEA Schwager 1877

Family DOROTHIIDAE Balakhmatova 1972
Subfamily DOROTHIINAE Balakhmatova 1972

Genus **DIGITINA** Crespin & Parr 1941

Type species: *Digitina recurvata* Crespin & Parr 1941; OD.

Digitina recurvata Crespin & Parr 1941
(Plate 4 fig. 7)

1941 *Digitina recurvata* Crespin & Parr: p.307-308, pl. 13 figs 9a,b, 10a,b
1947 *Digitina recurvata* Crespin & Parr; Crespin: table (p.17-18), p. 19, pl. 2 fig. 23
1950 *Digitina recurvata* Crespin & Parr; Crespin: p.68
1958b *Digitina recurvata* Crespin & Parr; Crespin: p.79, pl. 15 figs 10, 11
1967 *Digitina recurvata* Crespin & Parr; Ludbrook: p.83, pl. 4 figs 10-12
1973 *Digitina recurvata* Crespin & Parr; Harris & McGowran: p.62, 63, pl. 1 figs 15-20
1982 *Digitina recurvata* Crespin & Parr; Scheibnerova: p.66, pl. 22 figs 8a,b; pl. 24 fig. 1
1983 *Digitina* sp. Palmieri: p.142

Diagnosis: "Test free, elongate, curved, generally almost circular in cross section, early chambers arranged irregularly in the form of a cone, later chambers biserial; wall coarsely arenaceous, consisting of a single layer; interior of chamber undivided; aperture an arched slit set in a re-entrant angle at base of last-formed chamber" (Crespin & Parr, 1941, p. 306-307).

Closest species: *Mooreinella biserialis* Cushman & Waters 1928 from the Pennsylvanian of Texas, from which it differs in possessing an early trochospiral portion and a slit-like aperture.

Types: Holotype - CPC 154; paratype - CPC 155; hypotypes - CPC 2499, 2500.

Type locality: Victoria Pass, Mitchell Highway, Sydney Basin, NSW - Capetree Group.

Distribution and range: Near K34 Trig, **Carnarvon Basin** - Byro Group, Wandagee Formation; Brutens Yard, northern **Canning Basin** - Noonkanbah Formation. Tasmania - Quamby Mudstone; Sydney Basin (NSW) - Dalwood Group, Erinsvale Formation, Singleton Supergroup; Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania and South Australia. Sakmarian - ?Tatarian in New South Wales; Sakmarian - Artinskian in Queensland.

Value in correlation and dating: Important in Australia-wide correlation.

Superfamily TEXTULARIACEA Ehrenberg 1838

Family TEXTULARIIDAE Ehrenberg 1838
Subfamily TEXTULARIINAE Ehrenberg 1838

Genus ***TEXTULARIA*** Defrance *in* de Blainville 1824

Type species: *Textularia sagittula* Defrance 1824; OD.

Textularia bookeri Crespin 1958
(Plate 4 fig. 1)

1941 *Textularia eximia* Crespin & Parr (*non* Eichwald 1860) p.305-306, pl. 13 figs 7a-c, 8a-c
1947 *Textularia eximia* Crespin (*non* Eichwald 1860): table (p.17-18), pl. 2 figs 23-24
1958b *Textularia bookeri* Crespin: p.77-78, pl. 15 figs 1-7
1967 *Textularia bookeri* Crespin; Ludbrook: p.82, pl. 4 figs 18
1982 *Textularia bookeri* Crespin; Scheibnerova: p.64, pl. 22 figs 5, 6; pl. 23 figs 1-4, 6; pl. 24 figs 2-6; pl. 25 figs 4, 6
1983 *Textularia bookeri* Crespin; Palmieri: p.141, 146

Diagnosis: "Test very gently curved, coarsely arenaceous, consisting of five to six biserial chambers in the megalospheric form and eight to nine in the microspheric form. Aperture a semicircular opening at base of last-formed chamber" (Crespin, 1958b, p.77).

Closest species: *T. eximia* (Eichwald) from the Carboniferous of the USSR, from which it differs in its coarse wall structure and semicircular aperture.

Types: Holotype - CPC 153; paratypes - CPC 152, 2493-2496.

Type locality: Farley Station, Hunter River Valley, Sydney Basin, NSW - Farley Formation.

Distribution and range: Gascoyne River near Bidgemia Homestead, **Carnarvon Basin** - Byro Group. Sydney Basin (NSW) - Dalwood, Maitland, and Capertee Subgroups; Bowen Basin (Qld) - Cattle Creek Formation; Arckaringa and Trowbridge Basins (SA) - Stuart Range Formation, Cape Jervis Beds.

Age: Late Artinskian, (Baigendzhinian) in Western Australia. Sakmarian in South Australia; Artinskian in Queensland; Artinskian - Tatarian in New South Wales.

Abundance: A common species.

Value in correlation and dating: Important in Australia-wide correlation.

Textularia improcera Crespin 1958
(Plate 4 figs 2, 3)

1958b *Textularia improcera* Crespin: p.78-79, pl. 15 figs 8, 9
1982 *Textularia improcera* Crespin; Scheibnerova: p.64; pl. 23 fig. 5

Diagnosis: "Test small, stout, arenaceous, consisting of a small proloculus, followed by four biserial chambers" (Crespin, 1958b, p.78).

Types: Holotype - CPC 2497; paratype - CPC 2498.

Type locality: Williambury Station, Carnarvon Basin - Coyrie Formation.

Distribution and range: Near Moogooree Homestead, Southern Cross Bore on Middalya Station, **Carnarvon Basin** - Coyrie Formation, Baker Formation. Sydney Basins (NSW) - Mulbring Siltstone, Singleton Supergroup.

Age: Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia. Kazanian - ?Tatarian in New South Wales.

Abundance: Very common at the type locality.

Value in correlation and dating: Fair in local correlation.

Suborder FUSULININA Wedekind 1937
Superfamily EARLANDIACEA Cummings 1955

Family EARLANDIIDAE Cummings 1955

Genus **EARLANDIA** Plummer 1930

Type species: *Earlandia perparva* Plummer 1930; OD.

Earlandia condoni Crespin 1958
(Plate 4 figs 15, 20)

1958b *Earlandia condoni* Crespin: p.58-59, pl. 23 figs 6-8

Diagnosis: "Test elongate, slender, straight or gently curved, calcareous, imperforate, consisting of a large globular proloculus, followed by a long tubular chamber and with a rounded aperture at end of tube" (Crespin, 1958b, p.58).

Types: Holotype - CPC 2433; paratypes - CPC 2434, 2435.

Type locality: Giralia 1, Core 66, 949.5 - 950.9 m, northern Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Callytharra Formation. Bowen Basin (Qld) - Cattle Creek Formation; Sydney Basin (NSW) - Dalwood Group; Tasmania - Gray Limestone.

Age: Late Sakmarian (Baigendzhinian) in Western Australia. Artinskian in Queensland; Artinskian in Tasmania.

Abundance: Common in the type locality.

Value in correlation and dating: Important in Australia-wide correlation.

Superfamily TETRATAXACEA Galloway 1933

Family TETRATAXIDAE Galloway 1933

Genus **TETRATAXIS** Ehrenberg 1854

Type species: *Tetrataxis conica* Ehrenberg 1854; OD (Monotypy).

Tetrataxis conica Ehrenberg 1854
(Plate 4 figs 14, 18, 19)

1843 *Tetrataxis conica* Ehrenberg: p.106 (*nom. nud.*)
1854 *Tetrataxis conica* Ehrenberg; Ehrenberg: p.24, pl. 37 fig. 12
1936 *Tetrataxis conica* Ehrenberg; Chapman (*in* Raggatt): p.126
1936 *Tetrataxis conica* Ehrenberg; Condit et al.: p.1041
1952 *Tetrataxis conica* Ehrenberg; Teichert: p.122
1947 *Tetrataxis conica* Ehrenberg; Crespin: table (p.17-18), p.19
1958b *Tetrataxis conica* Ehrenberg; Crespin: p.93, pl. 23 figs 1-5; pl. 31 fig. 3
1968 *Tetrataxis conica* Ehrenberg; Belford: p.4,5, pl. 3 fig. 4
1985 *Tetrataxis conica* Ehrenberg; Palmieri *in* Foster et al.: p.80, pl. 4 figs 8-10

Diagnosis: Shell more or less conical on the spiral side, flat or little concave on the bottom side. Chambers flat more or less distinctly arranged, trapezoidal, with septal openings toward central cavity (condensed from Moller, 1879, p.71).

Hypotypes: CPC 2528, 2529, 2895; another figured specimen - WAM 83.2769.

Type locality: Tula, USSR - Carboniferous.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Bidgemia Station, Pells Range, Callytharra Springs, **Carnarvon Basin** - Callytharra Formation. Europe, Asia, Africa, and America.

Age: Late Sakmarian (Sterlitamakian) in Western Australia; Carboniferous and Permian of Europe, Asia, Africa and America.

Abundance: Rare in Callytharra Formation.

Value in correlation and dating: Important in regional correlation.

Tetrataxis sp.

1958 *Tetrataxis* sp. Crespin: p.94
1962 *Tetrataxis* sp. Crespin: p.26
1985 *Tetrataxis* sp. Palmieri: p.80

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Dampier Downs 1, northern **Canning Basin** - Grant Group, Nura Nura Member of the Poole Sandstone.

Figured specimen: WAM 83.2770.

Age: Asselian, Early and Late Sakmarian.

Value in correlation and dating: Important in regional correlation.

Suborder MILIOLINA Delage & Herouard 1896
Superfamily CORNUSPIRACEA Schultze 1854

Family CORNUSPIRIDAE Schultze 1854
Subfamily CORNUSPIRINAE Schultze 1854

Genus **FLECTOSPIRA** Crespin & Belford 1957

Type species: *Flectospira prima* Crespin & Belford 1957; OD.

Flectospira prima Crespin & Belford 1957
(Plate 5 figs 4, 5)

1957 *Flectospira prima* Crespin & Belford: p.76, pl. 16 figs 11-19
1958b *Flectospira prima* Crespin & Belford; Crespin: p.88, pl. 20 figs 14-17
1965 *Flectospira prima* Crespin & Belford; Belford: p.17, pl. 2 figs 9-11
1965 *Flectospira prima* Crespin & Belford; Crespin: p.17
1968 *Flectospira prima* Crespin & Belford; Belford: p.3, pl. 3 figs 22-24

Diagnosis: "A planispiral, evolute, compressed species" (Crespin & Belford, 1957, p.76).

Closest species: *Meandrospira meandrina* Crespin & Belford 1957 from which it differs in the planispiral and evolute form of the test.

Types: Holotype - CPC 2275; paratypes - CPC 2276, 2277.

Type locality: Giralia 1, Core 14, 170.7 - 173.7 m, northern Carnarvon Basin - Byro Group.

Distribution and range: Type locality, **Carnarvon Basin** - basal Byro Group, Wandagee Formation; Mount Marmion, AFO Nerrima 1, and Myroodah 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not common.

Value in correlation and dating: Important in regional correlation.

Genus **ORTHOVERTELLA** Cushman & Waters 1928

Type species: *Orthovertella protea* Cushman & Waters 1928; OD.

Orthovertella protea Cushman & Waters 1928
(Plate 5 fig. 22)

1928 *Orthovertella protea* Cushman & Waters: p.45, pl. 6 figs 3, 4
1958b *Orthovertella protea* Cushman & Waters; Crespin: p.82, pl. 18 figs 7-9
1983 *Orthovertella protea* Cushman & Waters; Palmieri: p.141, 146
1985 *Orthovertella protea* Cushman & Waters; Palmieri *in* Foster et al.: p.81 pl. 5 figs 5-7

Diagnosis: "Test small, consisting of a close coiled young, the coils in constantly changing planes and later portion becoming uncoiled and nearly straight, consisting of a proloculum and tubular undivided second chamber of nearly even diameter; wall smooth, calcareous, imperforate; sutures well marked; aperture formed by open end of tubular chamber, not constricted, without tooth" (Cushman & Waters, 1928a, p.45).

Hypotypes: CPC 2509, 2510; another figured specimen - WAM 83.2774.

Type locality: Texas - Moran Formation, Cisco Group (Pennsylvanian).

Distribution and range: Becketts Gully, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation; FKO Nerrima 1 Bore, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Dalwood Group; Bowen Basin (Qld) - Peawaddy Formation; Tasmania - Gray Limestone; Texas (USA).

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Tasmania; Kazanian in Queensland.

Abundance: Not uncommon.

Value in correlation and dating: Good in regional correlation.

Subfamily HEMIGORDIOPSINAE A. Nikitina 1969

Genus **HEMIGORDIUS** Schubert 1908

Type species: *Cornuspira schlumbergeri* Howchin 1895; SD Schubert, 1908.

Hemigordius harltoni Cushman & Waters 1928
(Plate 4 figs 12, 13)

1928a *Hemigordius harltoni* Cushman & Waters: p.43, pl. 5 figs 8, 9
1958a *Hemigordius harltoni* Cushman & Waters; Crespin: p.109

1958b *Hemigordius harltoni* Cushman & Waters; Crespin: p.79-81, pl. 16 figs 1-6; pl. 31 figs 6
1965 *Hemigordius harltoni* Cushman & Waters; Belford: p.17, pl. 2 fig. 3
1965 *Hemigordius harltoni* Cushman & Waters; Crespin: p.17
1968 *Hemigordius harltoni* Cushman & Waters; Belford: p.3, 5, pl. 2 figs 14-16
1982 *Hemigordius harltoni* Cushman & Waters; Scheibnerova: p.67, pl. 12 fig. 3
1983 *Hemigordius harltoni* Cushman & Waters; Palmieri: p.141, p.141, 146

Diagnosis: "Test compressed, circular in outline in side view, with the early stages coiled in varying planes, the later ones becoming planispiral, a proloculum and second chamber consisting of an elongate undivided tube, the middle portion of test on either side with a secondary growth of material largely concealing the structure; wall calcareous, imperforate, smooth; aperture rounded opening formed by the open end of tubular chamber" (Cushman & Waters, 1928a, p.43).

Closest species: *H. schlumbergeri* (Howchin 1895) from which it differs in its deeply incised spiral sutures and in the thinness of the wall.

Hypotypes: CPC 2501-2504, 2613-2615.

Type locality: Texas - Graham Formation, Cisco Group (Pennsylvanian).

Distribution and range: Giralia 1, Minilya River near Wandagee Homestead, **Carnarvon Basin** - Callytharra Formation, basal Byro Group, Bulgadoo Shale, Wandagee Formation; Jurgurra Creek BMR 1 and water bore, FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Maitland Group, Singleton Supergroup; Bowen Basin (Qld) - Peawaddy Formation; Texas (USA); Europe.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - Kazanian in New South Wales; Kazanian in Queensland.

Abundance: Not uncommon.

Value in correlation and dating: Good in regional correlation.

Hemigordius schlumbergeri (Howchin 1895)
(Plate 4 figs 16, 17)

1894a *Cornuspira schlumbergi* Howchin: p.366 (*err. cit.*)
1895 *Cornuspira schlumbergi* Howchin: p.195-196, p.10 figs 1-3 (*err. cit.*)
1933 *Hemigordius schlumbergi* (Howchin); Chapman: p.454
1947 *Hemigordius schlumbergi* (Howchin); Crespin: table (p.17-18), p.19
1951 *Hemigordius schlumbergi* (Howchin); Clarke et al.: p.55
1952 *Hemigordius schlumbergeri* (Howchin); Teichert: p.122
1958a *Hemigordius schlumbergi* (Howchin); Crespin: p.109
1958b *Hemigordius schlumbergi* (Howchin); Crespin: p.81, pl. 16 figs 7-9; pl. 31 figs 4, 5

1962 *Hemigordius schlumbergi* (Howchin); Crespin: p.26
?1982 *Hemigordius schlumbergi* (Howchin); Scheibnerova: p.67, pl. 11 fig. 3; pl. 13 fig. 5
1983 *Hemigordius schlumbergi* (Howchin); Palmieri: p.141, 142
1985 *Hemigordius schlumbergeri* (Howchin); Palmieri *in* Foster et al.: p.81-82, pl. 6 figs 1-9

Diagnosis: Test discoidal, flat or biconvex, convoluted; consisting of a non-septate tube following an initial spherical chamber (abridged from Howchin, 1895, p.195).

Hypotypes: CPC 2505-2509; some other figured specimens - WAM 83.2780-83.2783.

Type locality: Becketts Gully and Fossil Cliff on Irwin River, Perth Basin - Fossil Cliff Member of the Holmwood Shale.

Distribution and range: Type locality, and Nangetty Station, **Perth Basin** - Nangetty Formation, Fossil Cliff Member of the Holmwood Shale; Callytharra Springs area, Bidgemia Station, Pells Range, Byro - Glenburgh Road, **Carnarvon Basin** - Callytharra Formation; Mount Wynne, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone. Bowen Basin (Qld) - Cattle Creek Formation; Sydney Basin (NSW) - Dalwood Group, Mulbring Siltstone, Erinsvale Formation; Tasmania - Golden Valley Group.

Age: Asselian, Early Sakmarian (Sterlitamakian) in Western Australia. Sakmarian in Tasmania; Sakmarian - Artinskian in Queensland. Sakmarian - ?Tatarian in New South Wales.

Abundance: Common in Perth Basin, rare in Carnarvon Basin; locally abundant in the Sydney Basin.

Value in correlation and dating: Very important.

Hemigordius volutus Palmieri 1985

1985 *Hemigordius volutus* Palmieri *in* Foster et al.: p.82, pl. 6 figs 10-14

Diagnosis: Test oblong, convolute; consisting of proloculus followed by undivided chamber coiled in miliolline (quinqueloculine) manner in the first five whorls, then planispirally; tubular chamber subdivided into rudimentary septa in last whorl; alar extension of tube calcitic wall covering preceding whorls; aperture at open end of tube. The test wall consists of a calcareous, imperforate, porcellaneous layer on a thin, dark pseudochitinous lining (Palmieri *in* Foster et al. 1985, p.82).

Closest species: *H. schlumbergeri* from which it differs by its oblong rather than compressed shape, by distinct milioline coiling in the early stage of development, and by showing rudimentary septa in the planispiral arrangement of the tubular chamber.

Types: Holotype - WAM 83.2785; paratype - WAM 83.2784.

Type locality: Becketts Gully, Irwin River area, Perth Basin.

Distribution and range: Also at Fossil Cliff on Irwin River - Fossil Cliff Member of the Holmwood Shale.

Age: Early Sakmarian (Sterlitamakian).

Subfamily MEANDROSPIRINAE Saidova 1981

Genus **MEANDROSPIRA** Loeblich & Tappan 1946

Type species: *Meandrospira washitensis* Loeblich & Tappan 1946; OD.

Meandrospira australis (Crespin & Belford 1957)
(Plate 5 figs 8-11)

1957 *Streblospira australae* Crespin & Belford: p.75, pl. 12 figs 1-10
1958b *Streblospira australae* Crespin & Belford; Crespin: p.88-89, pl. 20 figs 10-13; pl. 22 fig. 1
1968 *Meandrospira australae* (Crespin & Belford); Belford: p.5, 6, pl. 3 figs 19-20

Diagnosis: "A minute, involute, globular, very asymmetrical species with very slight axial depression" (Crespin & Belford, 1957, p.75).

Closest species: *M. meandrina* and *M. kimberleyensis* are larger and lack the fast changes in the plane of coiling.

Types: Holotype - CPC 2268; paratype - CPC 2269.

Type locality: Giralia 1, Core 66, 949.5 - 950.9 m, northern Carnarvon Basin.

Distribution and range: Type locality, and Middalya Station, **Carnarvon Basin** - Callytharra Formation. Sydney Basin (NSW) - Dalwood Group.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian in New South Wales.

Abundance: Abundant at the type locality and elsewhere in the Callytharra Formation.

Value in correlation and dating: Good in regional correlation.

Meandrospira kimberleyensis (Crespin & Belford 1957)
(Plate 5 figs 1-3)

1957 *Streblospira kimberleyensis* Crespin & Belford: p.75, pl. 11 figs 13-21
1958a *Streblospira kimberleyensis* Crespin & Belford; Crespin: p.109
1958b *Streblospira kimberleyensis* Crespin & Belford: Crespin: p.89, pl. 20 figs 6-9

Diagnosis: "A minute asymmetrical not completely involute species, with a slight axial depression" (Crespin & Belford, 1957, p.75).

Closest species: *M. meandrina* which lacks the elongate, compressed, not completely involute test.

Types: Holotype - CPC 2296; paratypes - CPC 2293, 2297; other figured specimens - CPC 2299, 2300, 2301.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basi .

Distribution and range: FKO Nerrima 1, Myroodah 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not uncommon.

Value in correlation and dating: Good in regional correlation.

Meandrospira meandrina (Crespin & Belford 1957)
(Plate 5 figs 6, 7, 12, 13)

1957 *Streblospira meandrina* Crespin & Belford: p.74, pl. 11 figs 1-12
1958a *Streblospira meandrina* Crespin & Belford; Crespin: p.109
1958b *Streblospira meandrina* Crespin & Belford; Crespin: p.89-90, pl. 20 figs 1-5
1968 *Meandrospira meandrina* (Crespin & Belford); Belford: p.5, 6; pl. 3 fig. 21

Diagnosis: "A minute asymmetrical involute species with a distinct axial depression" (Crespin & Belford 1957, p.74).

Closest species: *M. washitensis* Loeblich & Tappan from which it differs in the asymmetrical test and continuing changing axis of coiling in adult form.

Types: Holotype - CPC 2289; paratype - CPC 2290; figured sections - CPC 2291-2295, 2302, 2303.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basin.

Distribution and range: Near Cundlego Crossing on Minilya River, **Carnarvon Basin** - Callytharra Formation, Cundlego Formation; AFO Nerrima 1, Myroodah 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: Abundant at the type locality.

Value in correlation and dating: Good in regional correlation.

Subfamily CALCIVERTELLINAE Loeblich & Tappan 1964

Genus **CALCITORNELLA** Cushman & Waters 1928

Type species: *Calcitornella elongata* Cushman & Waters 1928; OD.

Calcitornella dickinsi (Crespin 1958)
(Plate 5 figs 16, 17)

1958b *Stacheia dickinsi* Crespin: p.95, pl. 19 figs 1-3
1985 *Calcitornella dickinsi* (Crespin); Palmieri *in* Foster et al.: p.80, pl. 5 fig. 15

Diagnosis: "Adherent, coiling, attached to productid spines; wall generally covered with outer calcareous, imperforate layer, white" (Crespin, 1958b, p.95).

Types: Holotype - CPC 2531; paratypes - CPC 2532, 2533; another figured specimen - WAM 83.2779.

Type Locality: Giralia 1, Core 66, 949.5 - 951.0 m, northern Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Not common.

Value in correlation and dating: Good in local correlation.

Calcitornella elongata Cushman & Waters 1928
(Plate 6 figs 1, 2)

1928a *Calcitornella elongata* Cushman & Waters: p.47, pl. 6 fig. 5
1958b *Calcitornella elongata* Cushman & Waters; Crespin: p.82-83, pl. 17 figs 1-3
1982 *Calcitornella elongata* Cushman & Waters; Scheibnerova: p.68, pl. 34 figs 2a-b
1985 *Calcitornella elongata* Cushman & Waters; Palmieri *in* Foster et al.: p.80 pl. 5 figs 11-13

Diagnosis: "Test elongate, attached, consisting of a close coiled early portion and an elongate later growth, tubular chamber bending back and forth on itself along a nearly straight axis, attached side conforming to the surface to which it is attached, outer surface convex and the structure obscured; sutures very distinct on attached side; wall calcareous, imperforate, more or less roughened and irregular on the outer surface; aperture formed by open end of tubular chamber" (Cushman & Waters, 1928a, p.47).

Closest species: *Calcitornella heathi* Cushman & Waters from which it differs in its somewhat zig-zag form along the axis and its elongate test.

Hypotypes: CPC 2511, 2512; another figured specimen - WAM 83.2777.

Type locality: Texas - Graham Formation, Cisco Group (Pennsylvanian).

Distribution and range: Becketts Gully, and Fossil Cliff on Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale;

Giralia 1, northern **Carnarvon Basin** - Callytharra Formation. Sydney Basin (NSW) - Pokolbin Limestone (Rutherford or Farley Formation), Singleton Supergroup.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian, ?Tatarian in New South Wales.

Abundance: Not uncommon.

Value in correlation and dating: Good in regional correlation.

Calcitornella heathi Cushman & Waters 1928
(Plate 5 figs 19, 23)

1928a *Calcitornella heathi* Cushman & Waters: p.48, pl. 6 figs 8a,b
1958a *Calcitornella heathi* Cushman & Waters; Crespin: p.109
1958b *Calcitornella heathi* Cushman & Waters; Crespin: p.83, pl. 13 figs 8-11; pl. 19 fig. 11
1965 *Calcitornella heathi* Cushman & Waters; Belford: p.17, pl. 2 figs 4, 5
1968 *Calcitornella heathi* Cushman & Waters; Belford: p.4, pl. 2 figs 17-18
1982 *Calcitornella heathi* Cushman & Waters; Scheibnerova: p.68, pl. 34 figs 3, 4
1985 *Calcitornella heathi* Cushman & Waters; Palmieri *in* Foster et al.: p.80-81, pl. 5 fig. 14; pl. 6 figs 15, 16

Diagnosis: "Test attached, compressed and scalelike, ventral side conforming to surface to which attached, dorsal side irregular and earlier coils obscured; consisting of a proloculum and elongate tubular second chamber, early portion definitely spiral, later ones bending back and forth about the periphery of the earlier ones, often partially involute; sutures distinct on ventral side; wall calcareous, imperforate, exterior roughened; aperture formed by open end of tubular chamber" (Cushman & Waters, 1928a, p.48).

Hypotypes: CPC 2513-2516; other figured specimens - WAM 83.2778, 83.2786.

Type locality: Texas - Graham Formation, Cisco Group, (Pennsylvanian).

Distribution and range: Becketts Gully, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Giralia 1, **Carnarvon Basin** - Callytharra Formation; Jurgurra Creek BMR 1, northern **Canning Basin** - Noonkanbah Formation; Sydney Basin (NSW) - Rutherford Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Sakmarian in New South Wales.

Abundance: Common in the Noonkanbah Formation.

Value in correlation and dating: Good in regional correlation.

Calcitornella sp.

1947 *Apterinella* cf. *grahamensis* (Harlton); Crespin: p.17-18 (*err. cit.*)
1952 *Apterinella* cf. *grahamensis* (Harlton); Teichert: p.12
1958a *Apterinella* sp. Crespin: p.109
1958b *Apterinella* sp. Crespin: p.86

Distribution and range: Carnarvon Basin - Callytharra Formation; **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: Several tests, unsuitable for illustration.

Calcitornella stephensi (Howchin 1894)
(Plate 5 figs 14, 18)

1882 *Cornuspira* sp. Jones: p.6
1894b *Nubecularia lucifuga* Defrance var. *stephensi* Howchin: p.345, pls 10a, 11a
1905 *Nubecularia stephensi* Howchin; Chapman & Howchin: p.5, pl. 1 figs 1, 2; pl. 3 figs 3, 4; pl. 5 figs 1, 4
1905 *Placopsilina tenuitesta* Howchin; Chapman & Howchin: p.8, pl. 3 fig. 9
1907 *Nubecularia stephensi* Howchin; Etheridge Jnr et al.: p.13, pl. 12 fig. 11
1907 *Nubecularia stephensi* Howchin; Etheridge Jnr: p.26-27, pl. 10 figs 4-9
1910 *Nubecularia lucifuga* var. *stephensi* Howchin; Campbell: p.51
1910 *Nubecularia stephensi* Howchin; Glauert *in* Campbell: table on p.52
1912 *Nubecularia lucifuga* var. *stephensi* Howchin; Maitland: p.15
1919 *Nubecularia lucifuga* var. *stephensi* Howchin; Maitland: p.37
1931 *Nubecularia lucifuga* var. *stephensi* Howchin; David & Süssmilch: p.509
1934 *Calcitornella stephensi* Howchin; Chapman et al.: p.187
1936 *Calcitornella stephensi* Howchin; Condit et al.: p.509
1936 *Calcitornella stephensi* Howchin; Raggatt: p.126
1945 *Calcitornella stephensi* Howchin; Crespin: p.25, pl. 3 fig. 3
1947 *Calcitornella stephensi* Howchin; Crespin: pl. 1 fig. 3, lists;
1948 *Ammovertella stephensi* Howchin; Branson: p.6
1950 *Calcitornella stephensi* (Howchin); Crespin: p.68
1951 *Calcitornella stephensi* Howchin; Clarke et al.: p.55
1952 *Calcitornella stephensi* Howchin; Teichert: p.122
1958a *Calcitornella stephensi* (Howchin); Crespin: p.109, 110, 113
1958b *Calcitornella stephensi* (Howchin); Crespin: p.84-85, pl. 17 figs 4-8; pl. 32 figs 1, 2, 4, 9
1968 *Calcitornella stephensi* (Howchin); Belford: p.4, 5, pl. 2 figs 19-20
1982 *Nubecularia stephensi* Howchin; Scheibnerova: p.68-69, pl.32 figs 1-4; pl. 33 figs 1-3; pl. 3 fig. 1
1985 *Calcitornella stephensi* Howchin; Palmieri *in* Foster et al.: p.81, pl. 5 figs 1-4

Diagnosis: "Initial chamber, globular. Subsequent chambers, elongated and slightly inflated. Chambers arranged, either on a spiralline plan, in rectilinear order, or in irregular acervuline masses. Walls of the test, thin, uniform in thickness, and sharply defined in outline. Septal divisions marked on exterior surface by sunken lines" (Howchin, 1894b, p.343).

Closest species: *C. heathi* (Cushman & Waters), from which it differs in its broader and more rounded tubular second chamber and more meandering habits.

Types: Hypotypes - CPC 2517-2519, 2890, 2891, UWA 27687, UT 50203; another figured specimen - WAM 83.2773.

Type locality: Limestone near Lilydale, Piper River area, Tasmania.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Middalya Station, Dairy Creek Station, Winning Homestead area, Bidgemia Station, Pells Range and many others, **Carnarvon Basin** - Callytharra Formation, Byro Group; Grant Range, FKO Nerrima 1, Derby town bore, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Sydney Basin (NSW) - Wandrawandian Siltstone, Dalwood Group; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation; Tasmania - Darlington Limestone, Golden Valley Group; Port Keats 3 (NT) - Port Keats Group.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania and Northern Territory; Sakmarian - Artinskian in New South Wales; Artinskian - Kungurian in Queensland.

Abundance: Characteristic of Callytharra Formation and Fossil Cliff Member of the Holmwood Shale and also abundant in New South Wales and Tasmania.

Value in correlation and dating: Very important.

Genus **CALCIVERTELLA** Cushman & Waters 1828

Type species: *Calcivertella adherens* Cushman & Waters 1828; OD.

Calcivertella palata Crespin 1958
(Plate 5 fig. 15)

1958b *Calcivertella palata* Crespin: p.85, pl. 18 fig. 6
1968 *Calcivertella palata* Crespin; Belford: p.4, pl. 2 fig. 23

Diagnosis: "Test attached, calcareous, imperforate, with tubular second chamber winding back and forth in a zigzag manner, later becoming straight" (Crespin, 1958b, p.85).

Closest species: *C. adherens* Cushman & Waters from which it differs in more closely coiled early portion of the tubular chamber, the greater length between bends, and the more gradual increase in width of the chamber.

Holotype: CPC 2520.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basin.

Distribution and range: ?Muderong Bore, **Carnarvon Basin** - Callytharra Formation; type locality, **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Value in correlation and dating: Good in regional correlation.

Calcivertella sp. cf. **C. palata** Crespin 1958

1965 *Calcivertella* cf. *palata* Crespin; Belford: p.17, pl. 2 fig. 6
1968 *Calcivertella* sp. cf. *C. palata* Crespin; Belford: p.3, pl. 2 fig. 24

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Genus **PLUMMERINELLA** Cushman & Waters 1928

Type species: *Plummerinella complexa* Cushman & Waters 1928; OD.

Plummerinella kimberleyensis Crespin 1958
(Plate 6 figs 3, 7)

1958b *Plummerinella kimberleyensis* Crespin: p.85-86, pl. 19 figs 9, 10
1958a *Plummerinella kimberleyensis* Crespin; Crespin: p.109

Diagnosis: "Test attached, the attached surface showing a complex structure in which tubular second chamber is incompletely divided by small projections from outer portion of previous whorl" (Crespin, 1958b, p.85).

Closest species: *P. complexa* Cushman & Waters from which it differs in the more regular arrangement of the convolutions.

Types: Holotype - CPC 2521; paratype - CPC 2604.

Type locality: Jurgurra Creek BMR 1, northern Canning Basin.

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Value in correlation and dating: Good in regional correlation.

Genus **?TREPEILOPSIS** Cushman & Waters 1928

Type species: *Turritellella grandis* Cushman & Waters 1927; OD.

Trepeilopsis australiensis Crespin 1958
(Plate 5 figs 20, 21)

1936 *Trepeilopsis grandis* Chapman (*non* Cushman & Waters) *in* Raggatt: p.126
1947 *Trepeilopsis grandis* Chapman; Crespin: table (p.17-18)
1958b *Trepeilopsis australiensis* Crespin: p.86-88, pl. 18 figs 1-4; pl. 22 figs 3, 5-8
1962 *Trepeilopsis australiensis* Crespin; Crespin: p.26
1968 *Trepeilopsis australiensis* Crespin; Belford: p.4, 5, pl. 3, figs 1-3
1982 *Trepeilopsis australiensis* Crespin; Scheibnerova: p.59, pl. 34, fig. 5
1985 *Trepeilopsis australiensis* Crespin; Palmieri *in* Foster et al.: p.81, pl. 5 figs 8-10

Diagnosis: "Undivided tubular chamber which coils itself in a close helical spiral around a productid spine" (Crespin, 1958b, p.86).

Closest species: *T. grandis* Cushman & Waters from which it differs in the coiling at right angle to the spine and in the calcareous imperforate test.

Types: Holotype - CPC 2606; paratypes - CPC 2607-2609, 2892-2894, UWA 38423; other figured specimens - WAM 83.2775, 83.2776.

Type locality: Callytharra Springs area, Callytharra Formation, Carnarvon Basin.

Distribution and range: Becketts Gully, and Fossil Cliff in Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Middalya Station, Bidgemia Station, Byro - Glenburgh Rd, and near Lyons River Homestead, **Carnarvon Basin** - Callytharra Formation; **Canning Basin** - Nura Nura Member of the Poole Sandstone. Sydney Basin (NSW) - Dalwood Group, Mulbring Siltstone; Tasmania - Gray Limestone.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian in Tasmania; Artinskian - Kazanian in New South Wales; Kazanian in Queensland.

Abundance: A common species.

Value in correlation and dating: Good on regional correlation.

Suborder SPIRILLININA Hohenegger & Piller 1975

Family SPIRILLINIDAE Reuss & Fritsch 1861

Genus **SPIRILLINA** Ehrenberg 1843

Type species: *Spirillina vivipara* Ehrenberg 1943; OD (Monotypy).

Spirillina papillodentata Crespin 1958
(Plate 5 figs 24, 25)

1958b *Spirillina papillo-dentata* Crespin: p.119, pl. 16 figs 10, 11 (*err. cit.*)

Diagnosis: "Closely coiled on dorsal surface with grooves radiating and extending from wall of preceding whorl. Ventral surface flat and covered with papillae" (Crespin, 1958b, p.119).

Closest species: *S. concavo-convexa* Galloway & Rynikev 1930 lacks the flat papillate ventral surface and the slightly concave dorsal surface.

Holotype: CPC 2605.

Type locality: Giralia 1, Core 66, 949.5 - 951.0 m northern Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common at the type locality.

Value in correlation and dating: Single occurrence.

Suborder LAGENINA Delage & Herouard 1896
Superfamily GEINITZINACEA Bozorgnia 1973

Family GEINITZINIDAE Bozorgnia 1973

Genus **LUNUCAMMINA** Spandel 1898

Type species: *Geinitzella (Lunucammina) permiana* Spandel 1898; OD.

Lunucammina triangularis (Chapman & Howchin 1905)
(Plate 6 figs 4, 5)

1905 *Geinitzina triangularis* Chapman & Howchin: p.16, pl. 2 figs 9a, b, 10
1905 *Geinitzina postcarbonica* Chapman & Howchin (*non* Spandel): p.17, pl. 4 fig. 5
1915 *Geinitzina chapmani* Schubert: p.58, pl. 39 (1) fig. 4; text figs 1-5
1934 *Geinitzina triangularis* Chapman & Howchin; Chapman et al.: p.180, text figs 1-5
1945 *Geinitzina triangularis* Chapman & Howchin; Crespin: p.29, pl. 3 figs 14, 15
1947 *Geinitzina triangularis* Chapman & Howchin; Crespin: p.19, 21, pl. 1 figs 14, 15
1952 *Geinitzina triangularis* Chapman & Howchin; Teichert: p.122
1958a *Geinitzina triangularis* Chapman & Howchin; Crespin: p.109, 113
1958b *Geinitzina triangularis* Chapman & Howchin; Crespin: p.118-119, pl. 30 figs 8-11; pl. 31 fig. 8

1962 *Geinitzina triangularis* Chapman & Howchin; Crespin: p.25
1965 *Geinitzina triangularis* Chapman & Howchin; Belford: p.17, pl. 2 fig. 19
1968 *Geinitzina triangularis* Chapman & Howchin; Belford: p.3, 5, pl. 3 figs 17-18
1983 *Lunucammina triangularis* (Chapman & Howchin); Palmieri: p.141, 142
1985 *Lunucammina triangularis* (Chapman & Howchin); Palmieri *in* Foster et al.: p.83, pl. 8 figs 1-17

Diagnosis: "Test sub-triangular or triangular, compressed, decidedly hollowed along the median longitudinal axis. Primordial chamber globular, the remainder crescentic or feebly chevroned one within the other. More rarely the shells exhibit a flabelline commencement" (Chapman & Howchin, 1905, p.16).

Closest species: *Geinitzina postcarbonica* Spandel from the Zechstein of Germany, from which it differs in its broadly triangular shape and greater compression of the lateral faces of the test.

Hypotypes: CPC 285, 2600-2602, 2901; other figured specimens - WAM 83.2800-83.2808.

Type locality: Wollong Horizon, Branxton Formation, Sydney Basin, NSW.

Distribution and range: Fossil Cliff on Irwin River **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Coordewandy Homestead area, Bidgemia Station, Pells Range, Callytharra Springs, Lyndon River, **Carnarvon Basin** - Callytharra Formation; FKO Nerrima 1, Jurgurra Creek BMR water bore, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Dalwood Group, Branxton Formation; Bowen Basin (Qld) Cattle Creek Formation, Ingelara Formation, Peawaddy Formation; Tasmania - Darlington Limestone.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Sakmarian in Tasmania; Sakmarian - Artinskian in New South Wales; Sakmarian - ?Kazanian in Queensland.

Abundance: Common in Perth, Carnarvon, and Canning Basins.

Value in correlation and dating: Important in regional correlation.

Genus **HOWCHINELLA** Palmieri 1985

Type species: *Frondicularia woodwardi* Howchin 1895; SD Palmieri 1985.

Howchinella aulax (Crespin 1945)
(Plate 6 figs 10, 11)

1945 *Frondicularia woodwardi* Crespin (*non* Howchin): pl. 3 fig. 13
1947 *Frondicularia woodwardi* Crespin (*non* Howchin): pl. 1 fig. 13
1958b *Frondicularia aulax* Crespin: p.109-110, p. 28 figs 1-4
1965 *Frondicularia aulax* Crespin; Belford: p.17, pl. 2 fig. 16
1968 *Frondicularia aulax* Crespin; Belford: p.5, pl. 3 figs 12-13

1982 *Frondicularia aulax* Crespin; Scheibnerova: p.9-70, pl. 36 figs 3, 4; pl. 37 figs 6-7; pl. 39 fig. 4
1983 *Howchinella aulax* (Crespin); Palmieri: p.141, 142

Diagnosis: "Test straight, tapering, consisting of proloculus followed by six or seven chambers in megalospheric form and by sixteen in microspheric form; pronounced furrow along median line" (Crespin, 1958b, p.109).

Closest species: *F. woodwardi* from which it differs in having a deep median furrow, the neck-like shape of the arched portion of the sutures along the median line, and a very rounded periphery.

Types: Holotype - CPC 2571; paratypes - CPC 2572-2574.

Type locality: Watershed between Little Gorge and Cabbage Tree Creeks, Springsure area, Bowen Basin, Qld - Cattle Creek Formation.

Distribution and range: Muderong Bore, Middalya Station, **Carnarvon Basin** - Callytharra Formation; **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation; Bowen Basin (Qld) - Cattle Creek Formation, Peawaddy Formation (Mantuan *Productus* Bed); Sydney Basin (NSW) - Maitland Group, Singleton Supergroup; Tasmania - Golden Valley Group.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian in Tasmania; Artinskian - Kazanian in Queensland; Artinskian - ?Tatarian in New South Wales.

Abundance: Common to rare in Canning Basin.

Value in correlation and dating: Good in regional correlation.

Howchinella hillae (Crespin 1958)
(Plate 6 figs 13, 14)

1958b *Frondicularia hillae* Crespin: p.110-111, pl. 28 figs 5-8
1982 *Frondicularia hillae* Crespin; Scheibnerova: p.70

Diagnosis: "Much compressed, strongly tapered test covered with irregular strong striae" (Crespin, 1958b, p.110).

Closest species: None in the Permian.

Types: Holotype - CPC 2575; paratypes - CPC 2576, 2577, UT 28000.

Type locality: Cattle Creek, below waterfall, Springsure area, Bowen Basin, Qld - Cattle Creek Formation.

Distribution and range: Near Coordewandy Homestead, **Carnarvon Basin** - Callytharra Formation. Bowen Basin (Qld) - Cattle Creek Formation, Peawaddy Formation (Mantuan *Productus* Bed); Tasmania - Golden Valley Group; Sydney Basin (NSW) - Maitland Group.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Sakmarian in Tasmania; Artinskian - Kazanian in Queensland.

Abundance: Not common.

Value in correlation and dating: Good in regional correlation.

Howchinella parri (Crespin 1945)
(Plate 6 figs 15, 16)

1945 *Frondicularia parri* Crespin: p.27, pl. 3 figs 9-11
1947 *Frondicularia parri* Crespin; Crespin: table (p.17-18), p.19, 21, pl. 1 figs 9-11
1958a *Frondicularia parri* Crespin; Crespin: p.109, 113
1958b *Frondicularia parri* Crespin; Crespin: p.113, pl. 29 figs 3-7
1962 *Frondicularia parri* Crespin; Crespin: p.25
1965 *Frondicularia parri* Crespin; Belford: p.17, pl. 2 fig. 17
1968 *Frondicularia parri* Crespin; Belford: p.3, pl. 3 fig. 15

Diagnosis: "Test elongate, compressed, with greatest width near apertural end; earlier portion tapering sharply, sides of later portion almost parallel. Aboral end subacute. Peripheral margin rounded. Chambers ten. Sutures distinct, marked by clear shell matter, already arched along median line. Wall ornamented with distinct irregular longitudinal costae, extending over whole of test. Aperture small, terminal" (Crespin, 1945, p.27).

Closest species: *Howchinella semicostula* (Crespin) from which it differs in the greater number of ribs extending over the whole test and bifurcating along the median line.

Types: Holotype - CPC 279; hypotypes - CPC 2583-2586.

Type locality: Kulnura Bore, south of Koree Trig Station, County Northumberland, Sydney Basin (NSW).

Distribution and range: Giralia 1, **Carnarvon Basin** - Byro Group, Wandagee Formation; FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Maitland Group, Branxton Formation; Tasmania - Gray Limestone.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian elsewhere in Australia.

Abundance: Common in the Canning Basin.

Value in correlation and dating: Good in regional correlation.

Howchinella semicostula (Crespin 1958)
(Plate 6 fig. 17)

1958b *Frondicularia semicostula* Crespin: p.113-114, pl. 29 figs 8, 9

Diagnosis: "Test short, moderately stout, compressed, covered with strong rounded ribs which do no extend over last-formed chamber" (Crespin, 1958b, p.113).

Closest species: *Howchinella parri* (Crespin) from which it differs in being shorter and having fewer ribs which do not extend over the last formed chamber.

Types: Holotype - CPC 2587; paratype - CPC 2588.

Type locality: Myroodah 1, 483.1 - 484.6 m, northern Canning Basin.

Distribution and range: Type locality only, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not common.

Value in correlation and dating: Good in local correlation.

Howchinella striatosulcata (Crespin 1958)
(Plate 6 figs 6, 12)

1958a *Geinitzina striatosulcata* Crespin; Crespin: p.109, 113
1958b *Geinitzina striatosulcata* Crespin: p.116-18, pl. 30 figs 4-7
1962 *Geinitzina striatosulcata* Crespin; Crespin: p.25
1983 *Howchinella striatosulcata* (Crespin); Palmieri: p.141, 146

Diagnosis: "Test cuneiform, with large last-formed chamber; margin of apertural portion almost at right angle to longitudinal median axis. Test covered with very fine striae which diverge from a deep sulcus which extends along the median line" (Crespin, 1958b, p.116).

Closest species: *Howchinella fissicostata* (Cushman & Waters) from the Early Permian of Texas, from which it differs in the more numerous and finer striations.

Types: Holotype - CPC 2596; paratypes - CPC 2597-2599.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basin.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - Callytharra Formation; Jurgurra Creek BMR 1, northern **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Cattle Creek Formation, Barfield Formation, Peawaddy Formation (Mantuan *Productus* Bed).

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - Kazanian in Queensland.

Abundance: Common.

Value in correlation and dating: Important in regional correlation.

Howchinella woodwardi (Howchin 1895)
(Plate 6 figs 8, 9)

1894b *Frondicularia* sp. Howchin: p.336
1895 *Frondicularia woodwardi* Howchin: p.197-198, pl. 10 figs 4-6
1933 *Spandelina woodwardi* (Howchin); Chapman: p.454
1936 *Frondicularia woodwardi* (Howchin); Condit et al.: p.1041
1936 *Frondicularia woodwardi* Howchin; Raggatt: p.126



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Foraminifers
(continued)

1945 *Frondicularia woodwardi* (Howchin); Crespin: p.28, pl. 3 fig. 12
1947 *Frondicularia woodwardi* Howchin; Crespin: p.19, 21, pl. 1 figs 12, 13
1950 *Frondicularia woodwardi* Howchin; Crespin: p.68
1951 *Frondicularia woodwardi* Howchin; Clarke et al.: p.55
1952 *Frondicularia woodwardi* Howchin; Teichert: p.122
1953a *Frondicularia woodwardi* Howchin; Crespin: p.109, 110, 113
1958b *Frondicularia woodwardi* Howchin; Crespin: p.115-116, pl. 29 figs 10-12
1962 *Frondicularia woodwardi* Howchin; Crespin: p.25
1965 *Frondicularia woodwardi* Howchin; Belford: p.17, pl. 2 fig. 18
1965 *Frondicularia woodwardi* Howchin; Crespin: p.16
1968 *Frondicularia woodwardi* Howchin; Belford: p.3, pl. 3 fig. 16
1982 *Frondicularia woodwardi* Howchin; Scheibnerova: p.71, pl. 35 figs 1-2, pl. 37 figs 1-5; pl. 38 figs 5, 6; pl. 39 figs 2, 3
1983 *Howchinella woodwardi* (Howchin); Palmieri: p.141, 142
1985 *Howchinella woodwardi* (Howchin); Palmieri *in* Foster et al.: p.84, pl. 9 figs 5-20

Diagnosis: "Test elongate, tapering, compressed and subject to considerable variation in external form. Oral end broad, rounded and regularly curved. Aboral extremity obtusely pointed. Peripheral margins rounded. Segments from seven to ten in number, gradually increasing in size, acutely arched. Final chamber relatively large, inflated and lobulated. Sutures flush, marked by clear shell substance. Length of shell twice or three times breadth" (Howchin, 1895, p.197).

Closest species: *Howchinella excavata* (Cushman & Waters, 1928) from the Permian of Texas, from which it differs in having flush sutures, radiate aperture, and weak median depression.

Hypotypes: CPC 2589-2591; other figured specimens - WAM 83.2810-83.2816.

Type locality: Fossil Cliff in Irwin River area, Perth Basin.

Distribution and range: Becketts Gully, and Fossil Cliff on Irwin River **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Coordewandy Homestead area, Bidgemia Station, Pells Range, **Carnarvon Basin** - Callytharra Formation, Byro Group; FKO Nerrima 1, Jurgurra Creek BMR 1, northern **Canning Basin** - Noonkanbah Formation, Liveringa Group. Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation, Peawaddy Formation (Mantuan *Productus* Bed); Sydney Basin (NSW) - Dalwood Group, Branxton Formation, Maitland Group; Tasmania - Golden Valley Group, Gray Limestone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian - Artinskian in Tasmania; Sakmarian - Kazanian in Queensland and New South Wales.

Abundance: Common in Canning Basin.

Value in correlation and dating: Important in Australia-wide correlation despite its considerable stratigraphic range.

Genus **ICHTHYOLARIA** Wedekind 1937

Type species: *Frondicularia bicostata* d'Orbigny 1850; SD Wedekind, 1937.

Ichthyolaria impolita (Crespin 1958)
(Plate 7 figs 2, 3)

1958b *Frondicularia impolita* Crespin: p.111, pl. 28 figs 9-12
1968 *Frondicularia impolita* Crespin; **Belford:** p.5, pl. 3 fig. 14
1982 *Frondicularia impolita* Crespin; Scheibnerova: p.70, pl. 37 fig. 8; pl. 38 figs 4, 6; pl. 39 fig. 5

Diagnosis: "Test small, flattened, consisting of seven or eight chambers. Surface rough and almost hispid" (Crespin, 1958b, p.111).

Closest species: *Frondicularia minutissima* Paalzow, Permian of Germany, from which it differs in having depressed and strongly arched sutures.

Types: Holotype - CPC 2578; paratypes - CPC 2579, 2580, 2592.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basin.

Distribution and range: Type locality only, **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Rutherford Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Sakmarian - Artinskian in New South Wales.

Abundance: Not common.

Value in correlation and dating: Good in regional correlation.

Ichthyolaria limpida (Crespin 1958)
(Plate 7 figs 4, 5)

1958b *Frondicularia limpida* Crespin: p.112-113, pl. 29 figs 1-2
1982 *Frondicularia limpida* Crespin; Scheibnerova: p.70, 71
1983 *Frondicularia limpida* (Crespin); Palmieri: p.141, 146

Diagnosis: "Test smooth, transparent, gradually increasing in width until last-formed chamber, when it slopes sharply to the apertural opening" (Crespin, 1958b, p.112).

Closest species: None close.

Types: Holotype - CPC 2581; paratype - CPC 2582.

Type locality: Cattle Creek below waterfall, Springsure area, Bowen Basin Qld - Cattle Creek Formation.

Distribution and range: Giralia 1, **Carnarvon Basin** - Callytharra Formation. Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation, Peawaddy Formation; Sydney Basin (NSW) - Erinsvale Formation, Singleton Supergroup.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian - Kazanian in Queensland; Kazanian - Tatarian in New South Wales.

Abundance: Not uncommon.

Value in correlation and dating: Good in regional correlation.

Family PACHYPHLOIIDAE Loeblich & Tappan 1984

Genus **PACHYPHLOIA** Lange 1925

Type species: *Pachyphloia ovata* Lange 1925; SD Galloway, 1933.

Pachyphloia caseyi (Crespin 1958)
(Plate 7 fig. 1)

1958a *Geinitzina caseyi* Crespin; Crespin: p.10
1958b *Geinitzina caseyi* Crespin: p.116, pl. 30 figs 1-3
1962 *Geinitzina caseyi* Crespin; Crespin: p.25
1982 *Geinitzina caseyi* Crespin; Scheibnerova: p.71-72, pl. 36 figs 1-2
1983 *Pachyphloia caseyi* (Crespin); Palmieri: p.141, 146

Diagnosis: "Test compressed, shield-shaped, slightly biconvex, consisting of seven to eight uniserial chambers; surface smooth, polished" (Crespin, 1958b, p.116).

Types: Holotype - CPC 2593; paratypes - CPC 2494, 2595.

Type locality: Jurgurra Creek BMR 1, 150.6 m, northern Canning Basin.

Distribution and range: Type locality only, **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Mulbring Siltstone; Bowen Basin (Qld) - Peawaddy Formation (Mantuan *Productus* Bed).

Age: Late Artinskian (Baigendzhinian) in Western Australia. Kazanian in New South Wales and Queensland.

Abundance: Common at the type locality and in the Mantuan *Productus* Bed.

Value in correlation and dating: Important in regional correlation.

Superfamily NODOSARIACEA Ehrenberg 1838

Family NODOSARIIDAE Ehrenberg 1838
Subfamily NODOSARIINAE Ehrenberg 1838

Genus **PROTONODOSARIA** Gerke 1959

Type species: *Protonodosaria proceraformis* Gerke 1959.

Protonodosaria irwinensis (Howchin 1895)
(Plate 7 figs 8, 9)

1894b *Nodosaria* sp. Howchin: p.366
1895 *Nodosaria irwinensis* Howchin: p.196-197, pl. 10 figs 7-8
1905 *Nodosaria (Dentalina) labiata* Chapman & Howchin (*non D. labiata* Spandel 1898): p.16, pl. 3 fig. 4
1933 *Spandelina (Spandelinoides) irwinensis* (Howchin); Chapman: p.454
1934 *Nodosaria irwinensis* Howchin; Chapman et al.: p.184
1947 *Nodosaria irwinensis* Howchin; Crespin: table (p.17-18) p.19, 20
1951 *Nodosaria irwinensis* Howchin; Clarke et al.: p.55
1952 *Nodosaria irwinensis* Howchin; Teichert: p.122
1958b *Nodosaria irwinensis* Howchin; Crespin: p.103, pl. 25 figs 4-8; pl. 31 figs 8, 11
1962 *Nodosaria irwinensis* Howchin; Crespin: p.26
1968 *Nodosaria irwinensis* Howchin; Belford: p.5, pl. 3 fig. 10
1983 *Protonodosaria irwinensis* (Howchin); Palmieri: p.141
1985 *Protonodosaria irwinensis* (Howchin); Palmieri *in* Foster et al.: p.82, pl. 7 figs 11-20

Diagnosis: "Test elongate, straight, or very slightly arcuate, tapering. Segments about eight in number. The shell either slightly inflated near centre or gradually increasing in size. Chambers of greater width than length. Sutural lines straight, thick and slightly depressed. Surface of test ornamented with numerous, closely set, longitudinal and continuous costae. Length 1/33 in". (Howchin, 1895, p.196).

Closest species: *Protonodosaria tereta* (Crespin) from which it differs in possessing external costae and in being of short length.

Hypotypes: CPC 2555-2559, 2896, 2897; other figured specimens - WAM 83.2794-83.2799.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Becketts Gully, and Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Pells Range, Salt Gully on Callytharra Springs, near Dairy Creek Homestead, near Bidgemia Homestead, **Carnarvon Basin** - Callytharra Formation; **Canning Basin** - Nura Nura Member of the Poole Sandstone. Sydney Basin (NSW) - Dalwood Group; Bowen Basin (Qld) - Cattle Creek Formation; Tasmania - Gray Limestone.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Sakmarian - Artinskian elsewhere in Australia.

Abundance: Rare in Canning Basin; common in Perth and Carnarvon Basins.

Value in correlation and dating: Important in Australia-wide correlation.

Protonodosaria tereta (Crespin 1958)
(Plate 7 figs 6, 7)

1958b *Nodosaria tereta* Crespin: p.99-100, pl. 26 figs 1-4; pl. 31 figs 9, 10, 12
1982 *Nodosaria tereta* Crespin; Scheibnerova: p.69, pl. 33 fig. 4
1983 *Protonodosaria tereta* (Crespin); Palmieri: p.141, 142
1985 *Protonodosaria tereta* (Crespin); Palmieri *in* Foster et al.: p.82-83, pl. 7 figs 1-10

Diagnosis: "Seven to twelve chambers, which gradually increase in size; straight sides; aperture non-radiate" (Crespin, 1958b, p.99).

Closest species: *Nodosaria cushmani* Paalzow 1935 lacks the straight sides of the test and the gradual increase in the size of the chambers.

Types: Holotype - CPC 2542; paratypes - CPC 2543, 2574, 2898-2900; other figured specimens - WAM 83.2787-83.2793.

Type locality: Callytharra Springs, Carnarvon Basin - Callytharra Formation.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs area, near Coordawandy Homestead, Pells Range, Bidgemia Homestead area, **Carnarvon Basin** - Callytharra Formation; FKO Nerrima 1, Roebuck Bay 1, Dampier Downs 1, Jurgurra Creek BMR 1, northern **Canning Basin** - ?Grant Group, Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Sydney Basin (NSW) - Dalwood Group, Maitland Group, Singleton Supergroup; Bowen Basin (Qld) - Cattle Creek Formation; Tasmania - Gray Limestone.

Age: ?Asselian, Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Sakmarian, Artinskian, ?Kazanian, Tatarian in New South Wales; Sakmarian - Artinskian in Tasmania and Queensland.

Abundance: A common species.

Value in correlation and dating: Important in regional correlation.

Genus **NODOSARIA** Lamarck 1812

Type species: *Nautilus radicula* Linne 1758; SD Lamarck 1816.

Nodosaria conicodensestriata Paalzow 1935
(Plate 7 fig. 12)

1935 *Nodosaria conico-densestriata* Paalzow: p.38, pl. 4 figs 21-23 (*err. cit.*)
1958b *Nodosaria conico-densestriata* Paalzow; Crespin: p.100-101, pl. 26 figs 5, 6
1965 *Nodosaria conico-densestriata* Paalzow; Crespin: p.17

1965 *Nodosaria conico-densestriata* Paalzow; Belford: p.17, pl. 2 fig. 2
1968 *Nodosaria conico-densestriata* Paalzow; Belford: p.4, pl. 3 fig. 9

Diagnosis: "Test pointed towards beginning but increases evenly. Surface from the beginning to aperture covered with fine compact ribs. Shell begins with small initial chamber, the successive chambers increasing moderately in width as in height. Last chamber comes to slight point bearing apertural opening. Sutures indistinct at beginning, stronger and more distinct in younger chambers. Length of shell varies from 0.6 mm to 1.0 mm" (Paalzow, 1935, p.38).

Closest species: *Nodosaria striatella* (Paalzow), from which it differs in the stronger and less numerous striae which do not extend to the aperture.

Hypotypes: CPC 2546, 2547.

Type locality: Permian of Öst-Thuringen, Austria.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - basal Byro Group, Cundlego Formation, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Good in local correlation.

Nodosaria crassula Crespin 1958
(Plate 7 fig. 13)

1958b *Nodosaria crassula* Crespin: p.101, pl. 26 figs 7-8

Diagnosis: "Test short, stout, consisting of four chambers and covered with 16 coarse ribs which do not extend over the last-formed chamber" (Crespin, 1958b, p.101).

Closest species: *N. striatoclavata* Spandel 1898 lacks the smooth upper portion of the apertural chamber and the apparently much stronger ribs.

Types: Holotype - CPC 2548; paratype - CPC 2549.

Type locality: Giralia 1, 201.2 - 204.2 m, northern Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Good in local correlation.

Nodosaria decoris Crespin 1958
(Plate 7 fig. 15)

1958b *Nodosaria decoris* Crespin: p.101-102, pl. 26 figs 9, 10
1962 *Nodosaria decoris* Crespin; Crespin: p.25

Diagnosis: Elongate, slender; test covered with sharp striae. Aperture protruding, rounded, non-radiate (Crespin, 1958b, p.101).

Types: Holotype - CPC 2550; paratype - CPC 2551.

Type locality: Giralia 1, 170.7 - 173.7 m, northern Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Byro Group; **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: A rare species.

Value in correlation and dating: Good in local correlation.

Nodosaria fisheri Crespin 1958
(Plate 7 figs 10, 11)

1958b *Nodosaria fisheri* Crespin: p.102, pl. 25 figs 1-3

Diagnosis: "Small, straight, seven to twelve chambers. Surface of test hispid; delicate striae cover sutural area, extending very slightly over chambers immediately above and below sutural line. Aperture thick, rounded, non-radiate" (Crespin, 1958b, p.102).

Closest species: None close.

Types: Holotype - CPC 2552; paratypes - CPC 2553, 2554.

Type locality: FKO Nerrima 1, 39.3 m, northern Canning Basin.

Distribution and range: Type locality only, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Good in local correlation.

Nodosaria raggatti Crespin 1958
(Plate 7 fig. 21)

1958a *Nodosaria raggatti* Crespin; Crespin: p.109, 110, 113, 114
1958b *Nodosaria raggatti* Crespin: p.104, pl. 27 figs 1-5
1962 *Nodosaria raggatti* Crespin; Crespin: p.25
1965 *Nodosaria raggatti* Crespin; Belford: p.17, pl. 2 fig. 13
1965 *Nodosaria raggatti* Crespin; Crespin: p.17
1968 *Nodosaria raggatti* Crespin; Belford: p.4, 5, pl. 3 figs 5-6
1982 *Nodosaria raggatti* Crespin; Scheibnerova: p.69, pl. 38 figs 1-3
1983 *Nodosaria raggatti* Crespin; Palmieri: p.141, 146

Diagnosis: "Test short, smooth, aperture radiate" (Crespin, 1958b, p.104).

Closest species: *N. cushmani* Paalzow from which it differs in its radiate aperture and less inflated chambers.

Types: Holotype - CPC 2560; paratypes - CPC 2561-2564.

Type locality: Minilya River, 0.5 km upstream from Wandagee Homestead, Carnarvon Basin - Bulgadoo Shale.

Distribution and range: Giralia 1, Wandagee Station, Cundlego Crossing on Minilya River, **Carnarvon Basin** - basal Byro Group, Bulgadoo Shale, Cundlego Formation, Wandagee Formation; FKO Nerrima 1, Jurgurra Creek BMR 1, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Branxton Formation, Maitland Group; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation, Peawaddy Formation.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - Kazanian in Queensland and New South Wales.

Abundance: Very common at the type locality.

Value in correlation and dating: Good in regional correlation.

Nodosaria spiculata Crespin 1958
(Plate 7 fig. 17)

1958b *Nodosaria spiculata* Crespin: p.105, pl. 25 figs 10-12

Diagnosis: Minute; two to four slightly inflated chambers with initial chamber sharply pointed and with the apertural chamber attenuated (Crespin, 1958b, p.105).

Closest species: *Dentalina bradyi* Spandel which has its aperture in asymmetrical position and a globular initial chamber.

Types: Holotype - CPC 2534; paratypes - CPC 2535, 2536.

Type locality: Jurgurra Creek BMR 1, Core 5, 146.3 - 152.4 m, northern Canning Basin.

Distribution and range: Giralia 1, **Carnarvon Basin** - Byro Group; type locality, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Moderately numerous at the type locality.

Value in correlation and dating: Good in local correlation.

Nodosaria springsurensis Crespin 1945
(Plate 7 fig. 16)

1945 *Nodosaria springsurensis* Crespin: p.26, pl. 2 fig. 5
1947 *Nodosaria springsurensis* Crespin; Crespin: pl. 1 fig. 5
1958b *Nodosaria springsurensis* Crespin; Crespin: p.106, pl. 26 figs 11, 12
1983 *Nodosaria springsurensis* Crespin; Palmieri: p.141, 146

Diagnosis: "Test elongate, gently tapering, greatest width near apertural end, circular in transverse section. Chambers six; sutures distinct, depressed. Test covered with about 16 raised longitudinal

costae, which extend over the length of the shell. Aperture central, terminal, radiate" (Crespin, 1945, p.106).

Closest species: *Nodosaria striatoclavata* Spandel from which it differs in its longer ornamentation and less numerous costae.

Types: Holotype - CPC 295; hypotype - CPC 2567.

Type locality: Cattle Creek below waterfall, Springsure area, Bowen Basin, Qld - Cattle Creek Formation.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - Byro Group; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation, Peawaddy Formation.

Age: Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia. Artinskian - Kazanian in Queensland.

Abundance: A rare species.

Value in correlation and dating: Good in local correlation.

Nodosaria striatella (Paalzow 1935)
(Plate 7 fig. 14)

1935 *Dentalina striatella* Paalzow: p.38, pl. 4 fig. 24
1958b *Nodosaria striatella* (Paalzow); Crespin: p.106-107, pl. 25 fig. 9

Diagnosis: "Test only very slightly curved, beginning with a large spherical initial chamber, followed by a number of slightly broader chambers. Sutures are usually not depressed and distinctly seen through shell wall. They are more depressed on the younger chambers. Aperture sharp, slightly to one side. The whole test is strongly ornamented with very close and very fine striae. Length 1.4 mm" (Paalzow, 1935, p.38).

Closest species: *Nodosaria conicodensestriata* Paalzow from which it differs in possessing very fine and more numerous striae which cover the whole test.

Hypotype: CPC 2568.

Type locality: Permian of Öst-Thuringen, Austria.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Value in correlation and dating: Single occurrence.

Nodosaria sp. cf. **N. striatella** (Paalzow 1935)

1968 *Nodosaria* sp. cf. *N. striatella* (Paalzow); Belford: p.4, pl. 3 fig. 8

Figured specimen: CPC 6867.

Distribution and range: **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Value in correlation and dating: Single occurrence.

Genus **DENTALINA** Risso 1826

Type species: *Nodosaria (Dentalina) cuvieri* d'Orbigny 1926; OD.

Dentalina grayi Crespin 1945
(Plate 7 fig 20)

1945 *Dentalina grayi* Crespin: p.27, pl. 3 fig. 8
1947 *Dentalina grayi* Crespin; Crespin: table (p.17-18), pl. 1 fig. 8
1958a *Dentalina grayi* Crespin; Crespin: p.109
1958b *Dentalina grayi* Crespin; Crespin: p.97, pl. 24 figs 4, 5

Diagnosis: "Test small, elongate, slender, gently curved and tapering, with greatest width in apertural chamber. Chambers seven, slightly inflated and gradually increasing in size towards apertural end. Sutures distinct, straight, depressed. Aperture terminal, radiate" (Crespin, 1945, p.97).

Closest species: *Dentalina bradyi* Spandel from which it differs in its more slender appearance.

Types: Holotype - CPC 278; hypotype - CPC 2537.

Type locality: Argus Selection, Springsure area, Bowen Basin. Queensland - Ingelara Formation.

Distribution and range: **Carnarvon Basin** - Byro Group; FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Maitland Group; Bowen Basin (Qld) - Ingelara Formation, Peawaddy Formation.

Age: Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia. Artinskian - Kazanian in Queensland and New South Wales.

Abundance: Rare in the Noonkanbah Formation.

Value in correlation and dating: Good in regional correlation.

Dentalina habra Crespin 1958
(Plate 7 fig. 18)

1958b *Dentalina habra* Crespin: p.98, pl. 24 figs 6,7

Diagnosis: "Test gently curved, each of the five chambers becoming more attenuated than preceding one" (Crespin, 1958b, p.98).

Closest species: *D. grayi* Crespin has less attenuated chambers.

Types: Holotype - CPC 2538; paratype - CPC 2539.

Type locality: FKO Nerrima 1, 21.0 m, northern Canning Basin.

Distribution and range: Giralia 1, northern **Carnarvon Basin** - Byro Group; type locality, northern **Canning Basin** - Noonkanbah Formation.

Age: Latee Artinksian (Baigendzhinian), Early Kungurian.

Abundance: Not common.

Value in correlation and dating: Fair in local correlation.

Dentalina nerrimaensis Crespin 1958
(Plate 7 fig. 19)

1958b *Dentalina nerrimaensis* Crespin: p.98, pl. 24 figs 10, 11

Diagnosis: "Slender, tapering; chambers become attenuated with growth; whole test covered with fine delicate striae" (Crespin, 1958b, p.98).

Types: Holotype - CPC 2540; paratype - CPC 2541.

Type locality: FKO Nerrima 1, 21.0 m, northern Canning Basin.

Distribution and range: Type locality, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: A rare species.

Value in correlation and dating: Single occurrence.

Genus **PSEUDONODOSARIA** Boomgaart 1949

Type species: *Glandulina discreta* Reuss 1859; OD.

Pseudonodosaria serocoldensis (Crespin 1945)
(Plate 7 figs 22, 23)

1945 *Nodosaria serocoldensis* Crespin: p.26, pl. 3 figs 6, 7
1947 *Nodosaria serocoldensis* Crespin; Crespin: table (p.17-18), p.19, pl. 1 figs 6, 7
1952 *Nodosaria serocoldensis* Chapman; Teichert: p.122
1958a *Rectoglandulina serocoldensis* (Crespin); Crespin: p.114
1958b *Rectoglandulina serocoldensis* (Crespin); Crespin: p.107, pl. 27 figs 6-10
1962 *Rectoglandulina serocoldensis* (Crespin); Crespin: p.25
1965 *Rectoglandulina serocoldensis* (Crespin); Belford: p.17, pl. 2 fig. 15
1965 *Rectoglandulina serocoldensis* (Crespin); Crespin: p.16
1968 *Rectoglandulina serocoldensis* (Crespin); Belford: p.3, pl. 3 fig. 11
1983 *Pseudonodosaria serocoldensis* (Crespin); Palmieri: p.141, 146

Diagnosis: "Test elongate, smooth, tapering, greatest width in apertural chamber, circular in transverse section. Chambers six, apertural chamber large, others gradually decreasing in size. Suture indistinct, straight. Aperture small, central, radiate, terminal" (Crespin, 1945, p.26).

Closest species: *Nodosaria radicula* Linnaeus from which it differs in the more acute tapering towards aboral end and the less impressed sutures.

Types: Holotype - CPC 276; paratype - CPC 277; hypotypes - CPC 2565, 2566, 2610.

Type locality: Cattle Creek, below waterfall, Springsure area, Bowen Basin, Qld - Cattle Creek Formation.

Distribution and range: Minilya River near Wandagee Homestead, **Carnarvon Basin** - basal Byro Group; Bulgadoo Shale, Wandagee Formation, Myroodah 1, Mount Marmion, northern **Canning Basin** - Noonkanbah Formation. Sydney Basin (NSW) - Mulbring Siltstone, Maitland Group; Bowen Basin (Qld) - Cattle Creek Formation, Ingelara Formation, Peawaddy Formation.

Age: Late Artinskian, (Baigendzhinian) in Western Australia. Artinskian - Kazanian in Queensland; Kazanian in New South Wales.

Abundance: Rare in Carnarvon Basin; common in Canning Basin.

Value in correlation and dating: Good in regional correlation.

GENERA AND SPECIES OF UNCERTAIN AFFINITIES AND VALIDITY

The identifications listed below are insufficiently documented and in many cases are probably erroneous; they are included here merely to complete the record.

"**Ammobaculites** sp."

1947 *Ammobaculites* sp. Crespin: table (p. 17-18)

Distribution and range: **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: Rare.

"**Ammobaculites** sp. c . **A. woolnoughi** Crespin & Parr"

1956 *Ammobaculites* cf. *woolnoughi* Crespin & Parr; Crespin: p.54

Distribution and range: Southwest **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Single occurrence.

"Ammodiscus incertus d'Orbigny"

1933 *Ammodiscus incertus* Chapman: p.454
1936 *Ammodiscus incertus* Chapman; Condit et al.: p.1041
1936 *Ammodiscus incertus* Raggatt: p.126

"Ammodiscus milletianus Chapman"

1947 *Ammodiscus milletianus*; Crespin: table
1951 *Ammodiscus milletianus*; Chapman; Clarke et al.: p.55
1952 *Ammodiscus milletianus*; Chapman; Teichert: p.122

Distribution and range: Perth Basin - Fossil Cliff Member of the Holmwood Shale; **Carnarvon Basin** - Callytharra Formation, Byro Group, Wandagee Formation.

Age: Late Sakmarian, (Sterlitamakian), Late Artinskian (Baigendzhinian).

Remarks: This is an Early Cretaceous species from the Gault of England; Crespin thought it to be a *Thuramminoides sphaeroidalis*.

"Ammodiscus sp. cf. **A. nitidus** Parr"

1961 *Involutina* cf. *nitida* Parr; Crespin: p.19, 20

Distribution and range: Canning Basin - Grant Group.

Age: ?Asselian - Early Sakmarian (Tastubian).

"Ammodiscus sp."

1936 *Ammodiscus* sp. Chapman in Condit et al.: p.1041
1936 *Ammodiscus* sp. Raggatt: p.126

Distribution and range: Callytharra Springs, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Bigenerina sp."

1947 *Bigenerina* sp. Crespin: table (p.17-18)
1952 *Bigenerina* sp. Teichert: p.122

Distribution and range: Carnarvon Basin - Callytharra Formation; **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

"Bulimina? sp."

1907 *Bulimina?* sp. Chapman: p.16-17, pl. 2 figs 9a,b

Distribution and range: Collie Basin.

Remarks: The reputed presence of this species in the Collie Basin is questionable. Chapman's material cannot now be located. Parr and Crespin did not consider it authentic.

"Cibicides haidingeri (d'Orbigny)"

1846 *Rotalina haidingeri* d'Orbigny: p.154, pl. 7 figs 7-9
1907 *Truncatulina haidingeri* d'Orbigny; Chapman: p.17, pl. 2 figs 7a,b
1919 *Truncatulina haidingeri* d'Orbigny; Maitland, p.38

Distribution and range: Collie Basin

Remarks: The reputed presence of this species in the Collie Basin is questionable; as Chapman's material cannot now be located

"Dentalina labiata"

1936 *Dentalina labiata* Chapman *in* Condit et al.: p.1041
1936 *Dentalina labiata* Raggatt: p.126

Distribution and range: Callytharra Springs, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Dentalina sp."

1936 *Dentalina* sp. Chapman *in* Condit et al.: p.1041
1936 *Dentalina* sp. Raggatt: p.126

Distribution and range: Callytharra Springs, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Digitina sp. cf. **D. recurvata** Crespin & Parr"

1958a *Digitina* cf. *recurvata* Crespin & Parr; Crespin: p.114

Distribution and range: Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

"Endothyra sp. cf. **E. media** Waters"

1947 *Endothyra* cf. *media* Waters; Crespin: table (p.17-18)
1951 *Endothyra* cf. *media* waters; Clarke et al.: p.55

Distribution and range: Perth Basin - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

"?Endothyra sp."

1907 *?Endothyra* sp. Chapman: p.16, pl. 2 figs 8a,b
1919 *Endothyra* sp. Maitland: p.38

Distribution and range: **Collie Basin.**

Remarks: The reputed presence of this species in the Collie Basin is questionable. Chapman's material cannot now be located.

"Eponides sp. E. exigua Brady"

1907 *Pulvinulina* cf. *exigua* Brady; Chapman: p.17, pl. 2 figs 6a,b
1919 *Pulvinulina* cf. *exigua* Brady; Maitland: p.38

Distribution and range: **Collie Basin.**

Age: Permian.

Remarks: Identification doubtful; it could be a *Globivalvulina* sp. Chapman's material cannot be located. Parr and Crespin did not consider this identification as authentic.

"Frondicularia sp."

1958a *Frondicularia* sp. Crespin: p.109
1965 *Frondicularia* sp. Crespin: p.16

Distribution and range: **Carnarvon Basin** - basal Byro Group; **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available.

"Frondicularia sp. nov."

1962 *Frondicularia* sp. nov. Crespin: p.25

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available.

"Globivalvulina? plicata (Brady 1876)"

1876 *Valvulina plicata* Brady: p.88, pl. 4 figs 10, 11
1907 *Valvulina plicata* Brady; Chapman: p.16, pl. 2 figs 10a-c
1919 *Valvulina plicata* Brady; Maitland: p.38
1936 *Globivalvulina plicata* Brady; Condit et al.: p.1041
1936 *Globivalvulina plicata* Brady; Raggatt: p.126

Closest species: *Discorbina globularis* d'Orbigny from which it differs in the finely arenaceous shell structure (Chapman, 1907, p.16, abridged).

Distribution: **Collie Basin.**

Remarks: This form has been described as having a finely arenaceous (?microgranular) test and for this reason it is questionably placed in *Globivalvulina?* (Chapman, 1907, p.16). Chapman's material cannot now be located.

"Glomospira sp."

1947 *Glomospira* sp. Crespin: table (p.17-18)
1952 *Glomospira* sp. Teichert: p.122

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Remarks: Insufficient data available.

"Haplophragmoides sp. 1"

1947 *Haplophragmoides* sp. 1 Crespin: table (p.17-18)

Distribution and range: **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: Rare.

"Haplophragmoides sp. 2"

1947 *Haplophragmoides* sp. 2 Crespin: table (p.17-18)
1952 *Haplophragmoides* sp. Teichert: p.182

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Remarks: Insufficient data available on this record.

"Hippocrepinella sp."

1958b *Hippocrepinella* sp. nov. Crespin: p.206

Closest species: *H. biperta* Crespin.

Distribution and range: **Perth Basin** - Carynginia Formation.

Age: Late Artinskian (Baigendzhinian).

"Hyperammina sp. cf. H. elegantissima Plummer"

1965 *Hyperammina* cf. *elegantissima* Plummer; Crespin: p.17

Distribution and range: **Carnarvon Basin** - basal Byro Group.

Age: Late Artinskian (Baigendzhinian).

Remarks: The identity of this form cannot now be verified.

"Hyperamminoides sp."

1947 *Hyperamminoides* sp. Crespin: table (p.17-18)
1958a *Hyperammina* sp. Crespin: p.109
1962 *Hyperammina* sp. Crespin; Crespin: p.25
1965 *Hyperammina* sp. Crespin: p.16
1965 *Hyperammina* sp. Belford: p.17

Distribution and range: **Carnarvon Basin** - Byro Group; **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: Rare in the Byro Group.

Remarks: The above references may not be to the same species and are of little value.

"Hyperamminoides sp. cf. H. expansus (Plummer)"

1956 *Hyperammincides* cf. *expansus* Plummer; Crespin *in* Traves et al.: p.54

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: It is no longer possible to verify the identity of this form.

"Neoschwagerina sp."

1937 *Neoschwagerina* sp. Chapman & Parr; p.176
1947 *Neoschwagerina* sp. Crespin: table (p.17-18), p.19

Distribution and range: **Canning Basin** - "Upper Ferruginous Series".

Remarks: The reputed presence of this form in the Canning Basin cannot now be confirmed.

"Nodosaria sp."

1947 *Nodosaria* sp. Crespin: p.15, table (p.17-18)
1949 *Nodosaria* sp. Clarke et al.: p.55
1958a *Nodosaria* sp. Crespin: pl. 3
1965 *Nodosaria* sp. Belford: p.17

Distribution and range: **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; **Carnarvon Basin** - Callytharra Formation, Wandagee Formation; **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Lake Sakmarian (Sterlitamakian) Late Artinskian (Baigendzhinian).

Remarks: The above references are not necessarily to the same form.

"Nodosaria sp. nov"

1962 *Nodosaria* sp. nov. Crespin: p.25

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available on this record.

"Nodosinella sp."

1947 *Nodosinella* sp. Crespin: table (p.17-18)

Distribution and range: **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: Rare.

Remarks: Insufficient data available on this record.

"Orthovertella sp."

1958a *Orthovertella* sp. Crespin: p.109

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available on this record.

"Palaeobigenerina sp."

1936 *Palaeobigenerina* sp. Chapman *in* Condit et al.: p.104
1936 *Palaeobigenerina* sp. Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Reophax sp."

1961 *Reophax* sp. Crespin: p.19

Distribution and range: **Canning Basin** - Grant Group.

Age: ?Asselian - Early Sakmarian (Tastubian).

Abundance: Rare.

Remarks: Insufficient data available on this record.

"Reophax sp. nov. aff. R. expatiatus Plummer"

1961 *Reophax* sp. nov. aff. *R. expatiatus* Plummer; Crespin: p.19

Distribution and range: **Canning Basin** - Grant Group.

Age: ?Asselian - Early Sakmarian (Tastubian).

Abundance: Common.

Remarks: Insufficient data available on this record.

"Ruditaxis rudis Brady"

1936 *Ruditaxis rudis* Chapman *in* Condit et al.: p.104
1936 *Ruditaxis rudis* Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"cf. **Septammina** sp."

1947 cf. *Septammina* sp. Crespin: table (p.17-18)

Distribution and range: Carnarvon Basin - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Remarks: Insufficient data available on this record.

"Spandelinoides striatoclavata (Spandel)"

1936 *Spandelinoides striatoclavata* Chapman *in* Condit et al.: p.1041
1937 *Ruditaxis rudis* Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"**Spiroplectammina** sp."

1947 *Spiroplectammina* sp. Crespin: table (p.17-18)
1952 *Spiroplectammina* sp. Teichert: p.122

Distribution and range: **Carnarvon Basin** - Byro Group, Wandagee Formation, Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: Rare.

Remarks: Insufficient data available on this record.

"Stacheia marginulinoides"

1936 *Stacheia marginulinoides* Chapman *in* Condit et al.: p.1041
1936 *Stacheia marginulinoides* Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Stacheia pupoides"

1936 *Stacheia pupoides* Chapman *in* Condit et al.: p.1041
1936 *Stacheia pupoides* Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Stacheia sp."

1936 *Stacheia* sp. Chapman *in* Condit et al.: p.1041
1936 *Stacheia* sp. Raggatt: p.126

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Textularia sp."

1947 *Textularia* sp. Crespin: table (p 17-18)

Distribution and range: **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: Rare.

Remarks: Insufficient data available on this record.

"Thuramminoides sp. cf. T. teicherti (Parr)"

1958a *Thuramminoides* cf. teicherti (Parr); Crespin: p.114

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: The identity of this form cannot now be verified.

"Tolypammina sp."

1958a *Tolypammina* sp. Crespin: p.109

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available on this record.

"Trepeilopsis grandis (Cushman & Waters)"

1936 *Trepeilopsis grandis* Chapman *in* Condit et al.: p.1041
1936 *Trepeilopsis grandis* Raggatt: p.126

Distribution and range: Callytharra Spring on Wooramel River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

"Trepeilopsis sp. cf. **T. grandis** (Cushman & Waters)"

1947 *Trepeilopsis* cf. *grandis* Cushman & Waters; Crespin: table (p.17-18)
1951 *Trepeilopsis* cf. *grandis* Cushman & Waters; Clarke et al.: p.55
1952 *Trepeilopsis* cf *grandis* Cushman & Waters; Teichert: p.122

Distribution and range: Perth Basin - Fossil Cliff Member of the Holmwood Shale; Carnarvon Basin - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common to rare in the Carnarvon Basin; rare in the Perth Basin.

Remarks: It could be *T. australiensis* - insufficient data available on this record.

"Trochammina sp. cf. **T. subobtusa** (Parr)"

1958a *Trochammina* cf. *subobtusa* Parr; Crespin: p.114

Distribution and range: Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: Insufficient data available on this record.

"Verbeekina sp."

1937 *Verbeekina* sp. Chapman & Parr: p.177, pl. 16 figs 3, 4, 5
1947 *Verbeekina* sp. Crespin: table (p.17-18), p.19

Distribution and range: Canning Basin - "Upper Ferruginous Series" (below non-marine Erskine Series).

Remarks: The reputed presence of this species in the Canning Basin is questionable. Chapman's material cannot now be located.

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Corals

CORAL GENERA AND SPECIES

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Subclass RUGOSA Milne-Edwards & Haime 1850
Order STAURIIDA Verrill 1865
Suborder STAURIINA Verrill 1865

Family AMPLEXIDAE Chapman 1893

Genus **AMPLEXUS** Sowerby 1814

Type species: *Amplexus coralloides* Sowerby 1814.

Diagnosis: "Solitary, cylindrical and scolecoid; wall very thin, interseptal ridges indistinguishable; tabulae flat, with downturned edges and with cardinal fossular depression; major septa thin, subequal, continuous vertically only at peripheral edges, but may extend about halfway toward axis as low, short ridges developed only on upper surfaces on tabulae; minor septa commonly not distinguishable; dissepiments absent" (Hill, 1981, p.F144).

Range: *Amplexus* s.s. is recorded from Early Carboniferous of Europe (Eire, United Kingdom, Belgium) and Asia (Kazakhstan, Japan), and Missisippian of North America.

Remarks: Although the genus is strictly confined to the Early Carboniferous, there are quite a number of solitary cylindrical rugosans with short septa and complete horizontal tabulae from other parts of the stratigraphic column that are referred to this genus. Until many of these other forms are better known, the genus is best interpreted broadly: the Western Australian Permian forms have been retained in *Amplexus* s.l.

"Amplexus" sp. cf. **"A." nodulosus** Phillips 1841

1883 *Amplexus* cf. *nodulosus* Phillips; Hudleston: p.591
1910 *Amplexus* cf. *nodulosus* Phillips; Glauert: p.82
1937a *Amplexus* cf. *nodulosus* Phillips; Hill: p.46

This species, reputedly from the Gascoyne River area, Carnarvon Basin, was never illustrated, and according to Hill (1937a, p.46) has been lost.

"Amplexus" pustulosus Hudleston 1883
(Plate 8 figs 1, 2)

1883 *Amplexus pustulosus* Hudleston: p.591, pl. 23 figs 1a-c
1890 *Amplexus pustulosus* Hudleston; Hinde: p.194 (*pars*)
?1903 *Amplexus pustulosus* Hudleston; Etheridge Jnr: p.8
1910 *Amplexus pustulosus* Hudleston; Glauert: p.82
1921 *Amplexus coralloides* Sowerby var. *pustulosus* Hudleston; Gerth: p.96
1926 *Amplexus pustulosus* Hudleston; Glauert: p.45
1937a *Amplexus? pustulosus* Hudleston; Hill: p.45-46, pl. 1 fig. 1; text fig. 1
1942 *"Amplexus" pustulosus* Hudleston; Hill: p.59, pl. 1 fig. 1

Diagnosis: Erect, turbinate rugose coral with relatively deep calyx; septa dilated and laterally contiguous, leaving a wide area free of septa; tabulae complete, flat or shallow domed.

Closest species: *A. selwyni* de Koninck resembles the Western Australian form but has shorter septa and a fossular depression can be recognized within the tabulae.

Types: Lectotype (chosen by Hill, 1937a) - BM(NH) R2275; paratypes - BM(NH) R13972, R13973, R13977, R13978; hypotype - UWA 41071.

Type locality: Fossil Range, near junction of Gascoyne and Lyons Rivers, Carnarvon Basin.

Distribution and range: Gascoyne River, Minilya River and Kennedy Range areas, **Carnarvon Basin** - ?Callytharra Formation.

Age: ?Late Sakmarian (Sterlitamakian).

Abundance: Only six specimens have been recorded and four of these have been lost; all were described as distorted.

Value in correlation and dating: Insignificant as material is poor and rare, and generic designation doubtful.

"Amplexus" sp.
(Plate 8 fig. 27)

1942 *"Amplexus"* sp. Hill: p.59-60, pl. 2 fig. 1

Closest species: *A. coralloides* of Gerth 1921 (*non* Sowerby) from the Late Artinskian of Bitauni, Timor, from which it differs in thinner septa and usually thinner tabulae. Thin sections of both forms are needed.

Figured specimen: UWA 20212.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen only.

Value in correlation and dating: Minimal, being so rare.

Suborder STEREOLASMATINA Hill 1981

Family HAPSIPHYLLIDAE Grabau 1928
Subfamily HAPSIPHYLLINAE Grabau 1928

Genus **ALLOTROPIOPHYLLUM** Grabau 1928

Type species: *Amplexus spinosus* de Koninck var. *sinensis Grabau* 1922; OD.

Diagnosis: "Small, ceratoid and typically with scattered hollow spines; fossula on concave side, narrowing inward and then expanding into axial space, bounded on narrow counter side by conjoined axial ends of septa of counter quadrants, in which septal insertion is greatly accelerated; axial ends of long, thin metasepta of cardinal quadrants may reach across axial space to partial inner wall or may themselves join and extend wall around fossula; cardinal septum short; tabulae rising to wall of fossula; minor septa short; no dissepiments" (Hill, 1981, p.F314).

Range: Early Carboniferous of Europe (Belgium, United Kingdom); Mississippian of Canada; Early Permian of China and Australia.

Allotropiophyllum sp.
(Plate 8 fig. 20)

1942 *Allotropiophyllum* sp. Hill: p.60, pl. 1 fig. 2

Figured specimen: UWA 20207 (slide 41072).

Distribution and range: Coolkilya Pool area, Minilya River, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Limited because rare.

Genus **EURYPHYLLUM** Hill 1938

Type species: *Euryphyllum reidi* Hill 1938; OD.

Diagnosis: "Solitary, commonly small, typically with oblique calical floor; major septa extending to axis and pinnately grouped about long, closed fossula bisected by long cardinal septum on concave side of corallum; alar fossulae present; septa dilated, in early stages laterally contiguous throughout, but with growth dilation decreases in a widening zone midway between periphery and axis, leaving wide peripheral stereozone, and an axial structure formed by the conjoined axial edges of septa; minor septa very short; tabulae widely separated, complete or incomplete; no dissepiments" (Hill, 1981, p.F315).

Range: Permian of Australia, New Zealand, and Asia (Timor, western Urals).

Euryphyllum minutum Hill 1937
(Plate 8 figs 13-16)

1937a *Eurphyllum minutum* Hill: p.52, pl. 1 figs 8-11; text fig. 5

Diagnosis : Minute ceratoid *Euryphyllum* with septa dilated peripherally and grouped axially in each quadrant and joining the protosepta at the axis; fossula closed and expanded axially.

Closest species: *E. trizonatum* Hill from which it is distinguished by its smaller size and its less radial arrangement of septa.

Types: Holotype - UWA 19983; hypotypes - 4 sections from 2 specimens on slide UWA 40967.

Type locality: The creek 0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Wooramel River area, **Carnarvon Basin** - stratigraphic range not known; type material from ?Callytharra Formation.

Age: Permian; Late Sakmarian (Sterlitamokian).

Abundance: One specimen and five fragments.

Value in correlation and dating: Insignificant.

Euryphyllum reidi Hill 1938
(Plate 8 figs 28, 29)

1937b *Euryphyllum reidi* Hill: p.150, *nom. nud.*
1937a *Euryphyllum reidi* Hill; Hill: p.50, *nom. nud.*
1938 *Euryphyllum reidi* Hill; Hill: p.25, pl. 1
1942 *Euryphyllum reidi* Hill; Hill: p.61-62, pl. 1 fig. 3; pl. 2 fig. 2
1964 *Euryphyllum reidi* Hill; Hill & Woods: p.P4, pl. P2 fig. 2
1972 *Euryphyllum reidi* Hill; Hill et al.: p.P4, pl. P2 fig. 2

Diagnosis: Turbinate to ceratoid *Euryphyllum* with oblique calical floor; major septa extend to axis, cardinal quadrants being wider than the counter; closed narrow fossula bisected by long cardinal septum; the peripheral stereozone irregular and very wide with septal dilation not decreasing until very late; minor septa short and embedded in peripheral stereozone; tabulae complete or incomplete.

Closest species: *E. reidi* most closely resembles *E. trizonatum* but can be distinguished by its greater and less regular dilation of septa.

Types: Holotype - UQGD F3243; hypotypes from Western Australia - UWA 20205 (slide 41073), 20213.

Type locality: Cabbage Tree Creek, Springsure District, Bowen Basin, Qld.

Distribution and range: Coolkilya Pool area on Minilya River, **Carnarvon Basin** - Wandagee Formation. Bowen Basin (Qld); Sydney Basin (NSW); Tasmanian Basin (Tasmania).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: About 20 specimens from Western Australia.

Value in correlation and dating: Limited as this species is known to be wide ranging in eastern Australia.

Euryphyllum? sp.
(Plate 8 fig. 31)

1942 *?Euryphyllum* sp. Hill: p.62, pl. 1 fig. 4

Figured specimen: UWA 20206 (slide 41074).

Distribution and range: Coolkilya Pool area on Minilya River, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Limited.

Euryphyllum trizonatum Hill 1937
(Plate 8 figs 11, 12)

1937a *Euryphyllum trizonatum* Hill: p.51-52, pl. 1 fig. 7; text fig. 4

Diagnosis: Turbinate, erect *Euryphyllum* with major septa peripherally dilated throughout to give a regular narrow peripheral stereozone, along their mid section septa are thin leaving interseptal loculi, the axial ends are thickened and confluent; fossula closed, narrow, parallel-sided, bisected by cardinal septum.

Closest species: This species is distinguished from *E. minutum* and *E. reidi* by its regular septal dilation.

Types: Holotype - UWA 19976 (slide 40962); paratypes - UWA 19973 (slide 40958); Sedgwick Museum A8643.

Type locality: Fossil Cliff, on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; ?Nerrima Homestead, northern **Canning Basin** - stratigraphic range not known.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common.

Value in correlation and dating: Limited.

Suborder PLEROPHYLLINA Sokolov 1960

Family POLYCOELIIDAE de Fromentel 1861
Subfamily POLYCOELIINAE de Fromentel 1861

Genus **GERTHIA** Grabau 1928

Type species: *Polycoelia angusta* Rothpletz 1892; OD.

Diagnosis: Small, solitary, slightly curved; cardinal, counter, and two alar septa longer and rhopaloid, strongly thickened toward their rounded axial edges; other major septa unequal, longest commonly occupying median position in each quadrant; septal insertion accelerated in counter quadrants; minor septa moderately long, no dissepiments, marginarium a narrow peripheral stereozone; tabulae thin (Hill, 1981, p.F324).

Range: Early Permian of Western Australia; Late Permian of Timor.

Gerthia sulcata (Hinde 1890)
(Plate 8 fig. ?)

1890 *Plerophyllum sulcatum* Hinde: p.197, pl. 8A figs 2,2a
1910 *Pleurophyllum* (*sic*) *sulcatum* Hinde; Glauert: p.83
1928 *Gerthia*(?) *sulcata* Hinde; Grabau: p.34, pl. 1 fig. 4
1937a *Gerthia sulcata* (Hinde); Hill: p.46-47, pl. 1 fig. 2

Diagnosis: Large sub-cyclindrical *Gerthia* with the septa so dilated as to be laterally contiguous and fill the lumen; cardinal, counter and alar septa prominent and dilated axially.

Closest species: *G. sulcata* is much larger than most other species of the genus.

Holotype: BM(NH) R2274.

Type locality: Irwin River area, Perth Basin.

Distribution and range: Type locality, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale.

Age: ?Late Sakmarian (Sterlitamakian).

Abundance: Several specimens.

Value in correlation and dating: Minimal.

Family PLEROPHYLLIDAE Koker 1924
Subfamily PLEROPHYLLINAE Koker 1924

Genus **PLEROPHYLLUM** Hinde 1890

Type species: *Plerophyllum australe* Hinde 1890; SD Grabau, 1928.

Diagnosis: "Solitary, ceratoid, cardinal side commonly concave; five septa (cardinal, counter-lateral, and alar) larger and more dilated and rhopaloid than other major septa; in early stages septal plan zaphrentoid, and septa may be thickened so that lumen is filled; in later stages axial edges of septa free; distal edges of septa smooth; trabeculae where noted monacanthine; minor septa rudimentary to short; tabulae gently declined from axis; no dissepiments" (Hill, 1981, p.F326).

Range: Early Permian of Australia (Western Australia, Queensland); Late Permian of Asia (Timor, northwest Iran, Nakhichev); Europe (northern Urals).

Plerophyllum australe Hinde 1890
(Plate 8 figs 4-8)

1890 *Plerophyllum australe* Hinde: p.196, pl. 8A figs 1a-1
1903 *Pleurophyllum (sic) australe* Hinde; Etheridge Jnr: p.8
1907 *Pleurophyllum australe* Hinde; Etheridge Jnr: p.27, pl. 7 fig. 1; pl. 8 fig. 10
1910 *Pleurophyllum australe* Hinde; Glauert: p.83
1914 *Pleurophyllum australe* Hinde; Etheridge Jnr: p.13
1926 *Pleurophyllum australe* Hinde; Glauert: p.45
1928 *Plerophyllum australe* Hinde; Grabau: p.46, pl. 1 figs 5, 6
1931 *Plerophyllum australe* Hinde; Hosking: p.11, pl. 3 figs 4-6
1937a *Plerophyllum australe* Hinde; Hill: p.49-50, pl. 1 figs 3-6; text fig. 3

Diagnosis: Small ceratoid *Plerophyllum* with the septa so dilated in proximal parts to be laterally contiguous throughout, in later stages dilation not as extensive with interseptal loculi developed midway between the axis and periphery; cardinal, counter lateral and alar septa prominent and club-shaped; tabulae rarely developed.

Closest species: *Plerophyllum radiciforme* Gerth from the middle Permian of Basleo, Timor, but *P. australe* can be distinguished by the greater dilation of the septa so that the lumen is nearly filled.

Types: Lectotype BM(NH) R13984 (chosen by Hill, 1937a, p.49); syntypes - BM(NH) R2273, R13983, R12985; topotypes - GSWA F520, UWA 8491, 8501; hypotypes - UWA 19979 (slide 40965).

Type locality: Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale; Gascoyne River, Minilya River, Wyndham River and Wooramel River areas, **Carnarvon Basin** - Callytharra Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Fairly common at some localities.

Value in correlation and dating: May be valuable when its stratigraphic range in the various basins is confirmed.

Plerophyllum sp.
(Plate 8 figs 9, 10)

1942 *Plerophyllum* sp. Hill: p.62, pl. 2 fig. 3

Closest species: This form may be a young *Plerophyllum australe* and more material is needed before it can be definitely diagnosed.

Hypotype: UWA 20214 (slide 41080).

Distribution and range: Coolkilya Pool on Minilya River, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Nil.

Family PENTAPHYLLIDAE Schindewolf 1942
Subfamily PENTAPHYLLINAE Schindewolf 1942

Genus **TACHYLASMA** Grabau 1922

Type species: *Tachylasma cha* Grabau 1922; OD.

Diagnosis: "Solitary, small, four protosepta (alar and counter-lateral) longest, tallest, and most rhopaloid; counter septum thin but moderately long and rhopaloid, cardinal septum greatly shortened; metasepta unequal, somewhat rhopaloid, those in midquadrant stronger than others; minor septa very short; tabulae sparse; early stages in type species unknown" (Hill, 1981, p.F332).

Range: Permian of Asia (China, Timor); Early Permian of Western Australia.

Tachylasma densum Hill 1937
(Plate 8 fig. 21)

1937a *Tachylasma densum* Hill: p.53, text fig. 12

Diagnosis: Trochoid *Tachylasma* with septa short and dilated so as to be in contact except for a narrow zone just inside the periphery until just below the calice.

Closest species: *T. densum* differs from the type species in that its septa are more dilated and almost completely fill the lumen.

Holotype: UWA 19975 (slide 40961).

Type locality: North of Hill C, Freney Oil area, Kimberley, northern Canning Basin.

Distribution and range: Type locality - Liveringa Group.

Age: Kungurian - Chhidruan.

Abundance: 3 specimens.

Value in correlation and dating: Very limited

Tachylasma sp.
(Plate 8 fig. 30)

1937a *Tachylasma sp.* Hill: p.53-54, pl. 1 fig. 12

Closest species: *T. densum* from which it is distinguished by its dilation of the septa being restricted to a narrow peripher zone.

Hypotype: GSWA F517.

Distribution and range: West of Callytharra Springs, Wooramel River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen.

Value in correlation and dating: Insignificant.

Family VERBEEKIELLIDAE Schouppé & Stacul 1955

Genus **VERBEEKIELLA** Penecke 1908

Type species: *Verbeekia permica* Penecke 1908.

Diagnosis: "Solitary, with large axial column of few to numerous septal lamellae (in some with long or short medial plate) and axial tabellae; major septa in late stages discontinuous with column, their distal edges may be convex; cardinal septum shortens; septa may be thickened, especially in cardinal quadrants, and moderately wide peripheral stereozone may form; minor septa may be rudimentary to projecting from stereozone; axial tabellae domes or cones, numerous; pericolumnar tabellae less numerous, abaxially declined and weakly to moderately globose; no dissepiments" (Hill, 1981, p.F338).

Range: Permian of Asia (Timor, Japan, Nepal, Iran), Europe (Urals), Western Australia, and ?North America (Texas).

Verbeekiella mersa Hill 1942
(Plate 8 figs 17-19)

1942 *Verbeekiella mersa* Hill: p.63-64, pl. 1 figs 5, 6; pl. 2 fig. 4

Diagnosis: Trochoid *Verbeekiella* with septa greatly dilated at first but lessens with growth; without minor septa; axial structure quite dense, of dilated lamellae attached to the counter septum.

Closest species: *V. talboti* (Hosking), from which it can be distinguished by the general absence of spaces in its axial structure and in the absence of irregularity in dilation.

Types: Holotype - UWA 20208 (slide 41075); paratypes - UWA 20209 (slide 41076), 20215.

Type locality: East limb of syncline west of Coolkilya Pool, Minilya River, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Wandagee and Cundlego Formations.

Age: Late Artinskian (Baigendzhinian).

Abundance: Only six specimens recorded.

Verbeekiella talboti (Hosking 1931)
(Plate 8 figs 22-26)

1931 *Clisiophyllum talboti* Hosking: p.10-11, pl. 3 figs 1-3
1937a *Verbeekia talboti* (Hosking); Hill: p.55-56, pl. 1 figs 13-17; text figs 6, 7
1942 *Verbeekiella talboti* (Hosking); Hill: p.64, pl. 1 fig. 7

Diagnosis: "*Verbeekiella* with dibunophylloid axial structure containing few septal lamellae" (Hill, 1942, p.64).

Closest species: *Verbeekia rothpletzi* (Gerth) from the Early and mid-Permian of Timor and the Artinskian of the Urals differs from *V. talboti* in that the axial structure of the latter is relatively smaller.

Types: Lectotype - GSWA F521 (chosen by Hill, 1978, p.32); syntypes - GSWA F515, F516; hypotype - UWA 20210 (slide 41077), UWA 9670b (slides 40959, 40960).

Type locality: The creek 0.8 km west of Callytharra Springs, Wooramel River, Carnarvon Basin.

Distribution and range: Callytharra Springs area, Wooramel River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Several specimens.

Value in correlation and dating: Might be useful if more material available.

Subclass TABULATA Milne-Edwards & Haime 1850
Order FAVOSITIDA Wedekind 1937
Suborder FAVOSITINA Wedekind 1937
Superfamily PACHYPORICAE Gerth 1921

Family PACHYPORIDAE Gerth 1921

Genus **GERTHOLITES** Sokolov 1955

Type species: *Pachypora curvata* Waagen & Wentzel 1886 of Gerth 1921, p.107; OD.

Diagnosis: "Corallum branching; branches of radially diverging corallites increasing notably in diameter during growth and opening normal to surface of branch; edges of tabularium raised in calice, variable in size and distant; septal spines visible in calices; skeletal thickening great; mural tunnels vermiform, anastomosing; tabulae rare to absent" (Hill, 1981, p.F577).

Range: Permian of Asia (Salt Range in Pakistan, Timor, ?Yakutia) and Australia (Western Australia, Queensland, New South Wales, Tasmania).

Remarks: The branching tabulate corals common in the Australian Permian have previously been referred to *Thamnopora*, the ubiquitous Devonian genus. Herein, they are referred to the Permian pachyporid *Gertholites* even though many of the Australian forms have well-developed tabulae whereas the tabulae of *G. curvatus* are described as rare or absent. The whole group is in need of revision based on large collections which are obtainable. This may show the necessity for new generic taxa for the Australian forms.

Gertholites immensa (Hill 1937)
(Plate 9 figs 14-18)

1937a *Thamnopora immensa* Hill: p.58, pl. 1 figs 21, 22; text fig. 9
1942 *Thamnopora immensa* Hill: p.65-66, pl. 1 fig. 8; pl. 2 fig. 6

Diagnosis: Thickly branched *Gertholites* with corallite calices of two sizes opening at right angles to the surface of a branch, excessively dilated walls, thin tabulae, and numerous large, regular mural tunnels, frequently further excavated by boring organisms.

Closest species: *Gertholites immensa* resembles *Pachypora lobata* Gerth and *P. curvata* Gerth from the mid-Permian of Timor, but differs by forming very large coralla of large coalescent branches.

Types: Holotype - GSWA F518; hypotype - UWA 20204 (slides 41069, 41070).

Type locality: 3.2 km east of Christmas Creek Homestead, south of "Rough Range" (Emanuel Range), northern Canning Basin.

Distribution and range: Minilya River area, and north of Wandagee Woolshed, **Carnarvon Basin** - Bulgadoo Shale, Wandagee Formation; Rough Range area, northern **Canning Basin** - stratigraphic horizon unknown.

Age: Late Artinskian (Baigendzhinian).

Abundance: Fairly common.

Value in correlation and dating: May be useful when stratigraphic distribution known.

Gertholites insculpta (Hill 1942)
(Plate 9 figs 5-11)

1942 *Thamnopora insculpta* Hill: p.67-68, pl. 1 figs 9a-d; pl. 2 figs 8, 9

Diagnosis: Slender branching *Gertholites* with the coralites opening a little obliquely to the surface, dilation of the walls increasing greatly towards the surface, so that the openings are distant, and sunken into the unridged, faintly tuberculated wall tissue (after Hill, 1942, p.67).

Closest species: *Gertholites wilkinsoni* Etheridge Jnr from eastern Australia is very similar but has better developed septal lamellae than *G. insculpta*.

Types: Lectotype - UWA 20218 (chosen by Hill, 1978, p.24) one of 11 fragments that were possibly from the one specimen (thin sections on one slide 41078 are from some of these fragments); syntype - UWA 20219.

Type locality: Near Callytharra Springs on Wooramel River, Carnarvon Basin.

Distribution and range: Callytharra Springs area on Wooramel River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Eleven fragments, possibly from one specimen, and several others.

Value in correlation and dating: Might be useful when this group is revised.

Gertholites marmionensis (Etheridge Jnr 1914)
(Plate 9 figs 1-4)

1914 *Favosites marmionensis* Etheridge Jnr: p.13, pl. 1 fig. 1; pl. 2 figs 2-4; pl. 8 fig. 2
1926 *Thamnopora marmionensis* Etheridge Jnr; Glauert: p.45
1937a *Thamnopora marmionensis* (Etheridge Jnr); Hill: p.57, pl. 1 figs 18-20; text fig. 8
1942 *Thamnopora marmionensis* (Etheridge Jnr); Hill: p.66

Diagnosis: *Gertholites* forming large lobate masses, with corallites of two sizes opening obliquely to the surface, calices frequently with lower lip semi-circular, and with corallite walls becoming very thick distally; with large irregular mural pores, frequent tabulae, and without septal spines (after Hill, 1942, p.66).

Closest species: *Gertholites curvatus* (Waagen & Wentzel) from mid-Permian of Timor, from which it can be separated in having a ramose and flattened corallum.

Types: Lectotype - GSWA F492 (chosen by Hill, 1978, p.26); syntypes - GSWA F522, 523.

Type locality: Mount Marmion, northern Canning Basin.

Distribution and range: Station 4A north of Minilya River, **Carnarvon Basin** - Wandagee Formation; type locality, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Three or four fragments.

Value in correlation and dating: Very limited.

Gertholites sp. aff. **G. marmionensis** (Etheridge Jnr 1914)
(Plate 9 fig. 19)

1942 *Thamnopora* aff. *marmionensis* (Etheridge Jnr); Hill: p.66, pl. 2 fig. 7

Figured specimen: UWA 20217.

Distribution and range: Minilya River area, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Three fragments.

Value in correlation and dating: Nil.

Gertholites? sp.
(Plate 9 figs 23, 24)

1942 *?Thamnopora* sp. Hill: p.68, pl. 1 fig. 10; pl. 2 fig. 10

Figured specimen: UWA 20211 (with slide 41079).

Distribution and range: Callytharra Springs, Wooramel River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen.

Value in correlation and dating: Unknown.

FAMILY UNCERTAIN

Favositoid fragments
(Plate 9 figs 25, 26)

1942 *Favosites* sp. Hill: p.65, pl. 2 fig. 5

Figured specimen: UWA 20216.

Distribution and range: Coolkilya Pool area on Minilya River, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Two specimens.

Value in correlation and dating: Unknown.

Order AULOPORIDA Sokolov 1947
Superfamily AULOPORICAE Milne-Edwards & Haime 1851

Family PYRGIIDAE de Fromental 1861

Genus **CLADOCHONUS** M'Coy 1847

Type species: *Cladochonus tenuicollis* M'Coy 1847; SD Milne-Edwards & Haime, 1850.

Diagnosis: "Proximal parts of corallum prostrate, annular when attached to crinoid stem; distal parts of corallum erect branches that may fork; corallites commonly opening through wall near base of calice of parent; wall moderately thick, in some states of preservation including holacanthine spinules; in other states ?growth lamellae of sclerenchyme of wall may be slightly separate and connected by granules; tabulae absent or sparse" (Hill, 1981, p.F635).

Range: Middle Upper Devonian of Europe and North America; Carboniferous - Permian, cosmopolitan.

Cladochonus nicholsoni (Etheridge Jnr 1914)
(Plate 9 figs 20-22)

1914 *Monilopora nicholsoni* Etheridge Jnr: p.14-16, pl. 1 figs 2-4; pl. 7 fig. 4
1918 *Monilipora nicholsoni* Etheridge Jnr; Etheridge Jnr: pl. 39 figs 2, 3
1924 *?Monilipora nicholsoni* Etheridge Jnr; Richards & Bryan: p.102, pl. 18 figs 5, 6
1930 *Monilipora nicholsoni* Etheridge Jnr; Reid: fig. on p.99
not 1937a *Monilipora? nicholsoni* Etheridge Jnr; Hill: p.59, pl. 1 figs 23, 24; text-figs 10, 11
1942 *Cladochonus nicholsoni* (Etheridge Jnr); Hill: p.69
1964 *Cladochonus nicholsoni* (Etheridge Jnr); Hill & Woods: p.4, pl. P2 figs 6, 7
1972 *Cladochonus nicholsoni* (Etheridge Jnr); Hill et al.: p.4, pl. P2 figs 6, 7

Diagnosis: "Bifurcating, free branches, 4.5 to 7 mm thick, with successive corallites on opposite sides of a branch, the diameter at the edge of the calice being constantly 4.5 mm" (Hill, 1942, p.69).

Closest species: Similar to *C. beecheri* and *C. magnus* from the mid-Permian of Basleo, Timor, but these species are larger.

Types: Lectotype - GSWA F506 (chosen by Hill, 1978, p.27); syntypes - AM F16418, UWA 19980 (with slides 40966, 40968).

Type locality: Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Distribution and range: Common throughout the Permian of Australia.

Age: Early Permian.

Abundance: Very common in a number of horizons.

Value in correlation and dating: Limited.

Cladochonus striatus Hill 1942
(Plate 9 figs 12, 13)

1937a *Monilipora ?nicholsoni* Etheridge Jnr; Hill: p.59, pl. 1 figs 23, 24; text figs 10, 11
1942 *Cladochonus striatus* Hill: p.70, pl. 2 fig. 11

Diagnosis: "Slender *Cladochonus*, with corallites widest at the calical rim, which is 3 or 4 mm in diameter, and with 18-20 faint longitudinal striations on the epitheca" (Hill, 1942, p.70).

Closest species: Differs from *C. nicholsoni* in being more slender and showing longitudinal striations on its epitheca.

Types: Holotype - UWA 20220; paratype - UWA 19980a.

Type locality: 0.8 km west of Callytharra Springs, Wooramel River, Carnarvon Basin - Callytharra Formation.

Distribution and range: Only recorded from the type locality.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A number of fragments.

Value in correlation and dating: Not known.

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Bryozoans

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NOTES ON LOCALITY DESIGNATION CONVENTION USED

Table 9 is a list of Canning Basin localities as published by Crockford (1957, p.88). These numbers are quoted (in square brackets) in the following text for all species from that basin.

Class STENOLAEMATA Borg 1926
Order CYSTOPORATA Astrova 1964
Suborder FISTULIPORINA Astrova 1964

Family FISTULIPORIDAE Ulrich 1882

Genus **FISTULIPORA** M'Coy 1850

Type species: *Fistulipora minor* M'Coy 1850; SD Milne-Edwards & Heime, 1850.

Generic range: Silurian - Permian; worldwide.

Fistulipora compacta Crockford 1944
(Plate 10 figs 1, 2)

1944b *Fistulipora compacta* Crockford: p.145-147, text figs 3, 4

Diagnosis: Massive *Fistulipora* with large zooecia; slightly thickened lunaria with little indentation of zooecial apertures; thin-walled, coarse vesicles generally isolate zooecia; abundant diaphragms in zooecial tubes.

Holotype: UWA 22129 (Slides UWA 41190, 41191).

Type locality: Syncline west of Coolkilya Pool, Minilya River, Carnarvon Basin.

Distribution and range: Type locality - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals*.

Fistulipora conica Crockford 1944
(Plate 10 figs 3, 4)

1944b *Fistulipora conica* Crockford: p.147, text figs 9, 10

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* Terminology used is that of Wilson (1975).

Diagnosis: Massive *Fistulipora* with large zooecia; strongly thickened lunaria with little indentation of zooecial apertures; diaphragms numerous; coarse vesicles separate zooecial tubes.

Types: Holotype - UWA 22130 (Slides UWA 41192, 41193); paratype - AM F37592 (Slides AM 3587, 3588).

Type locality: Syncline west of Coolkilya Pool, Minilya River, Carnarvon Basin.

Distribution and range: Type locality - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora gigantea Crockford 1944
(Plate 10 figs 5, 6)

1944b *Fistulipora gigantea* Crockford: p.147-149, text figs 11, 12

Diagnosis: Large massive *Fistulipora* with small zooecia; inconspicuous scattered lunaria with no thickening; diaphragms numerous; coarse vesicles.

Types: Holotype - UWA 22127A (Slides UWA 41186, 41187); paratype - UWA 22127B.

Type locality: Wandagee Hill area, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality - Baker Formation.

Age: Kungurian.

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora liveringa Crockford 1957
(Plate 10 figs 7, 8)

1957 *Fistulipora liveringa* Crockford: p.14-15, pl. 2 figs 5, 6

Diagnosis: Small, massive *Fistulipora* with zooecia that are variable in size in transverse section; coarse vesicles indent zooecial tubes with numerous diaphragms; inconspicuous, unthickened lunaria.

Closest species: Unique; shares similar incomplete calcification of the zooecial walls with the older *F. stereos* (Crockford, 1957, p.15).

Holotype: CPC 1057.

Type locality: Christmas Creek Station [37], northern Canning Basin.

Distribution and range: Type locality - Lightjack Formation.

Age: Kungurian.

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora nura Crockford 1957
(Plate 10 figs 9, 10)

1957 *Fistulipora nura* Crockford: p.12-13, pl. 1 figs 1-3; text fig. 1

Diagnosis: Massive multilaminate *Fistulipora* with large zooecia; inconspicuous, unthickened lunaria; fine vesicles separate zooecia; diaphragms infrequent.

Closest species: *F. basleoensis* Bassler from the Permian of Timor is similar internally but has much thinner lamellae and larger and more widely spaced zooecia (Crockford, 1957, p.13).

Holotype: CPC 1054.

Type locality: Mount Wynne area [1], northern Canning Basin.

Distribution and range: Type locality - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora stereos Crockford 1957
(Plate 10 figs 11, 12)

1957 *Fistulipora stereos* Crockford: p.13-14, pl. 1 figs 4, 5

Diagnosis: Lobate or ramose *Fistulipora* with large zooecial apertures separated by stereom with occasional vesicles; strongly thickened lunaria; numerous diaphragms.

Closest species: Unique internal structures. Structure of lunaria is found in several Western Australian and Timor species (Crockford, 1957).

Types: Holotype - CPC 1058; paratypes - CPC 1059, UWA 22343.

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Near Barnes Flow [18], Nerrima Homestead area [34], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora vacuolata Crockford 1944
(Plate 10 figs 13, 14)

1944b *Fistulipora vacuolata* Crockford: p.143, text figs 1, 2
1957 *Fistulipora vacuolata* Crockford: p.12

Diagnosis: Massive *Fistulipora* with large zooecia with numerous diaphragms; thick lunaria with little indentation of zooecial apertures; coarse vesicles.

Closest species: Crockford (1957) made some comparisons with *Dybowskiella arborescens* Crockford.

Types: Holotype - UWA 22126 (Slides UWA 41184, 41185); other figured specimens - CPC 1053, 1292.

Type locality: Limestone horizon southeast side of Mount Marmion [29], northern Canning Basin.

Distribution and range: Christmas Creek Station [5B], Cherrabun Station [13], northern **Canning Basin** - Noonkanbah Formation (lower middle, and top of the formation).

Age: Late Artinskian (Baigendzhinian).

Abundance: Common(?).

Value in correlation and dating: Very long stratigraphic range through the formation; useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Fistulipora wadei Crockford 1944
(Plate 10 figs 15, 16)

1944b *Fistulipora wadei* Crockford: p.145, text figs 5,6

Diagnosis: Massive *Fistulipora* with large zooecia generally separated by coarse, angular and thin-walled vesicles; lunaria usually do not indent zooecial apertures; numerous diaphragms in zooecial tubes.

Holotype: UWA 22124 (Slides UWA 41179, 41180).

Type locality: Southeast side of Mount Marmion [29], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation (top fossil horizon).

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Genus **DYBOWSKIELLA** Waagen & Wentzel 1886

Type species: *Dybowskiella grandis* Waagen & Wentzel 1886; OD.

Generic range: Permian; Asia, North America, Australia.

Dybowskiella arborescens Crockford 1957
(Plate 12 figs 3 - 5)

1957 *Dybowskiella arborescens* Crockford: p.15-17, pl. 2 figs 1-4

Diagnosis: Coarse ramose *Dybowskiella*; thick lunaria indent the zooecial tubes in the outer region; thin-walled, coarse vesicles in the axial region and these flatten and thicken slightly in the outer region.

Closest species: *Fistulipora vacuolata* Crockford which shows differences in growth form, regular pattern of monticules and lunarial development (Crockford, 1957, p.16).

Types: Holotype - CPC 1056; paratypes - CPC 1055, UWA 22332, 22333 (both missing).

Type locality: Christmas Creek Station [21], northern Canning Basin.

Distribution: Wandagee Hill (west side), Carnarvon Basin - Baker Formation; Cherrabun Station [12], Mount Marmion [29A], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Common(?).

Value in correlation and dating: Useful guide to the age of the Lower Permian strata. Present in both Canning and Carnarvon Basins.

Sedimentary environment: Upper foreslope and shoals.

Dybowskiella crescens (Crockford 1944)
(Plate 12 figs 1, 2)

1944b *Fistulipora crescens* Crockford: p.143-145, pl. 4 fig. 1; text figs 7, 8
1957 *Dybowskiella crescens* (Crockford); Crockford: p.15-17, pl. 2 figs 1-4

Diagnosis: Massive *Dybowskiella* with small zooecia with thick, irregularly spaced diaphragms; thick lunaria strongly indent zooecia; flattened vesicles separate zooecia.

Types: Holotype - UWA 22123A (Slides UWA 41177, 41178, 41211, 41212); paratypes - UWA 22123B, 22336B; other figured specimens - CPC 1282A, CPC 1060 (topotype).

Type locality: Southeast side of Mount Marmion [29, 29A], northern Canning Basin.

Distribution and range: Barnetts Tank [26], Duchess Ridge [35], northern **Canning Basin** - Noonkanbah Formation (top fossil horizon).

Age: Late Artinskian (Baigendzhinian).

Abundance: Common(?).

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Genus **ERIDOPORA** Ulrich 1882

Type species: *Eridopora macrostoma* Ulrich 1882; OD.

Generic Range: Late Mississippian - ?Permian; North America, USSR, Australia.

Eridopora permiana Crockford 1957
(Plate 12 figs 6, 7)

1957 *Eridopora permiana* Crockford: p.17-18, pl. 3 figs 1-4; text fig. 2

Diagnosis: Thin encrusting colonies of *Eridopora* with sub-triangular zooecial apertures; two rows of vesicles between zooecia that are not enlarged around maculae.

Closest species: *E. major* and *E. oculata* Bassler from Timor and *Fistulipora parasitica* Waagen & Wentzel from the Middle *Productus* Limestone of India (Crockford, 1957, p.18).

Types: Holotype - CPC 1065A; paratypes -- CPC 1061A, 1062, 1063A, 1064A.

Type locality: Christmas Creek Station [5A], northern Canning Basin.

Distribution and range: Christmas Creek Station [19, 21], Liveringa Station [15], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Apparently common.

Value in correlation and dating: Not determined at present.

Sedimentary environment: Upper foreslope and shoals.

Family HEXAGONELLIDAE Crockford 1947

Genus **HEXAGONELLA** Waagen & Wentzel 1886

Type species: *Hexagonella ramosa* Waagen & Wentzel 1886; SD Nickless & Bassler, 1900, p.291.

Generic range: Permian; Asia, Australia.

Hexagonella australis (Bretnall 1926)
(Plate 11 figs 1, 2)

1926 *Coscinum? australe* Bretnall: p.25, pl. 1 fig. 5; pl. 2 fig. 2
1944b *Hexagonella australe* (Bretnall); Crockford: p.149-151, pl. 4 fig. 3; text figs 13-16
1957 *Hexagonella australis* (Bretnall); Crockford: p.19
1967 *Hexagonella australis* (Bretnall); Condon: p.7

Diagnosis: Flat ribbon branches of *Hexagonella* with lobate margins; small zooecia with faint lunaria and without diaphragms; thin vesicles are replaced by thick vesicles about half-way to the colony surface.

Closest species: *H. dendroidea* (Hudleston) from the Gascoyne River district is much coarser (Crockford, 1944b, p.151).

Types: Holotype - GSWA 6 (also recorded as 2/2405G); paratypes - AM F36572 (part of holotype); other figured specimens - CPC 1066, 1067A, 1068A, 1071B, 1290G.

Type locality: Fossil Hill near Wyndham River, Carnarvon Basin.

Distribution and range: Jacobs Gully, **Carnarvon Basin** - Callytharra Formation; Mount Wynne area [2], Mount Anderson Homestead area [17], Christmas Creek Station [22], Little Flow [27], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella bifida Crockford 1944
(Plate 11 figs 6, 7)

1944b *Hexagonella bifida* Crockford: p.154, text figs 19-20a
1957 *Hexagonella bifida* Crockford; Crockford: p.19

Diagnosis: Flat, ribbon branches of *Hexagonella* with small maculae; small zooecia without lunaria and with rare diaphragms; coarse vesicles near mesotheca flatten and thicken into stereom near the surface; vesicles separate zooecia.

Closest species: Compare with *Hexagonella australis* (Bretnall).

Types: Holotype - UWA 22132 (Slides UWA 41194-41196); other figured specimens - CPC 1069, 1070.

Type locality: North of Hill C, Grant Range [33], northern Canning Basin.

Distribution and range: Christmas Creek Station [10, 19], and type locality, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common(?).

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella densa Crockford 1944
(Plate 11 figs 3-5)

1944b *Hexagonella densa* Crockford: p.151-153, pl. 4 fig. 2; text figs 21-22a
1967a *Hexagonella densa* Crockford; Wass: p.164

Diagnosis: Broad flattened fronds of *Hexagonella* with large maculae of vesicles and stereom; small zooecia with occasional faint lunaria and diaphragms; vesicles separate zooecia and thicken towards surface; no hexagonellid ridges apparent on colony surface; thin mesotheca with coarse median tubuli.

Types: Holotype - UWA 22131 (Slides UWA 41199 - 41201, 22131); other figured specimens - CPC 7707.

Type locality: Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality - Bulgadoo Shale ("Barrabiddy Shale series"). Port Keats area (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: Unknown.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella hudlestoni Crockford 1957
(Plate 11 figs 11, 12)

1957 *Hexagonella hudlestoni* Crockford: p.20-21, pl. 4 figs 1-5

Diagnosis: Narrow, flattened fronds of *Hexagonella* with faint hexagonellid ridges; prominent maculae of stereom; zooecia with two to three diaphragms in the recumbent inner region.

Closest species: *Meekopora parilis* and *M. opima* (Moore & Dudley) from the Permian of Kansas have a strong general resemblance to this species (Crockford, 1957, p.21).

Types: Holotype - CPC 1074; paratypes - AM F6539A/B, F6546, F6552; other figured specimens - CPC 1071A, 1072A, 1073A, 1075, 1076.

Type locality: Christmas Creek Station [5C], northern Canning Basin.

Distribution and range: Bilung Pool, Wooramel River area, **Carnarvon Basin** - Callytharra Formation; Christmas Creek Station [5A, 5J, 10], Mount Wynne area [2], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: A common form in both basins.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella lineata Crockford 1944
(Plate 11 figs 13-15)

1944b *Hexagonella lineata* Crockford: p.154-155, pl. 4 fig. 4; text figs 23, 24
1957 *Hexagonella? lineata* Crockford: p.21

Diagnosis: Broad fronds of *Hexagonella* with distinct hexagonellid ridges and small, regularly spaced maculae; small zooecia with distinct lunaria and rare diaphragms; coarse, thin-walled vesicles near mesotheca become replaced first with flatter and thicker vesicles and then subsequently with stereom near the surface.

Closest species: The broad frond form of the colonies separates this species from all other species.

Types: Holotype - AM F17567 (slides AM 3583, 3584, UWA 17567); paratype - AM F17569 (slides AM 3585, 3586, 3589); other figured specimens - CPC 1284-1286 (topotypes).

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation (top fossil horizon).

Age: Late Artinskian (Baigendzhinian).

Abundance: Common at type locality.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella nalbia Crockford 1944
(Plate 11 figs 16-18)

1944b *Hexagonella nalbia* Crockford: p.153-154, text figs 27,28

Diagnosis: Broad fronds of *Hexagonella* with large, irregularly and closely spaced maculae and distinct hexagonellid ridges; small zooecia with faint lunaria and rare diaphragms; bands of flattened vesicles of irregular outline alternate with bands of dense stereom.

Holotype: UWA 22133 (Slides UWA 22133, 41197, 41198).

Type locality: Between Wandagee and Middalya Stations, Carnarvon Basin.

Distribution and range: Type locality - Baker Formation.

Age: Kungurian.

Abundance: Unknown.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella plana Crockford 1944
(Plate 11 figs 8-10)

1944b *Hexagonella plana* Crockford: p.155, text figs 17-18a
1957 *Hexagonella? plana* (Crockford); Crockford: table, p.135-136

Diagnosis: Broad fronds of *Hexagonella* with small, regularly spaced maculae and no hexagonellid ridges; small zooecia with faint lunaria and numerous diaphragms; thick-walled, flattened vesicles separate zooecia in medial region and then alternate with bands of stereom in other parts of the colony.

Types: Holotype - UWA 22125 (Slides UWA 22125, 41181-41183).

Type locality: Southeast side of Mount Marmion [29, 2SA], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation (top fossil horizon).

Age: Late Artinskian (Baigendzhinian).

Abundance: Unknown.

Value in correlation and dating: Very useful guide to the Lower Permian.

Sedimentary environment: Upper foreslope and shoals.

Hexagonella undulata Crockford 1944
(Plate 11 figs 19, 20)

1944b *Hexagonella undulata* Crockford: p.154, text figs 25, 26

Diagnosis: Broad fronds of *Hexagonella* with large maculae and distinct hexagonellid ridges; small zooecia with thick lunaria and no diaphragms; bands of vesicles alternate with bands of stereom.

Closest species: This species resembles *Hexagonella nalbia* Crockford in its surface features, except in the thickness of the colony. It is distinct in the spacing of the zooecial tubes, more strongly formed lunaria internally and the character of the vesicles and stereom (after Crockford, 1944b).

Holotype: UWA 22128 (Slides UWA 22128, 41188, 41189).

Type locality: Coolkilya Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality - Baker Formation.

Age: Kungurian.

Abundance: Unknown.

Value in correlation and dating: Very useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Genus **FISTULAMINA** Crockford 1947

Type species: *Fistulamina inornata* Crockford 1947; OD.

Generic range: Viséan - ?Early Permian; Australia, USSR.

Fistulamina lata Crockford 1957
(Plate 12 figs 8-10)

1957 *Fistulamina lata* Crockford: p.21-22, pl. 4 figs 6,7; text fig.3

Diagnosis: Broad, flat branches of *Fistulamina* with slightly lobed margins; 8-11 rows of small and widely spaced zooecial apertures; lunaria usually indistinct and not indenting zooecial apertures.

Closest species: Separated by larger size and internal structure from associated species of *Etherella*. *F. lata* has a finer zoarium than any described species of *Hexagonella* from which it differs by the lack of maculae and surface ridges (Crockford, 1957, p.22).

Types: Holotype - CPC 1077C; paratypes - CPC 1077A,B (topotypes), CPC 116, 1063C, 1078A, 1079A, 1230B, UWA 22337.

Type locality: Cherrabun Station [12], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 19], Liveringa Station [15], Meeda Station [30], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Genus **PRISMOPORA** Hall 1883

Type species: *Prismopora triquetra* Hall 1883; SD Hall & Simpson, 1887, p.xxi.

Generic range: Devonian - Permian; North America, Australia.

Prismopora? attenuata Crockford 1957
(Plate 12 figs 18, 19)

1957 *Prismopora? attenuata* Crockford: p.26-27, pl.5 figs 6, 7

Diagnosis: Erect, triradiate colonies like *Prismopora* with extremely thin rays; zooecial apertures clustered in bands between prominent, solid maculae; no distinguishable lunaria.

Closest species: *P.? attenuata* Crockford is much thinner, has more extended rays and differs in other measurements from the similar species *P. digitata* (Crockford, 1957).

Holotype: CPC 1087.

Type locality: Christmas Creek Station [5C], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Too rare to be useful but a distinctive Early Permian species.

Sedimentary environment: Shoals on or near upper foreslope.

Prismopora digitata Crockford 1957
(Plate 12 figs 15-17)

1957 *Prismopora digitata* Crockford: p.23-24, pl. 5 figs 1-4

Diagnosis: Triradiate colonies of *Prismopora* with one division into three, blunt thinner triradiate branches; zooecial apertures crowded between prominent, solid maculae; lunaria faintly indent zooecial apertures.

Closest species: *P. triangulata* (White) from the Pennsylvanian of Texas and Missouri is smaller; *P. lobata* Warthin from the Late Pennsylvanian of Oklahoma is much finer (Crockford, 1957).

Types: Holotype - CPC 1073B; paratypes - CPC 1073C, 1081A, 1082, 1083A-C, 1084A, 1085A, 1086, 1150A.

Type locality: Christmas Creek Station [5J], northern **Canning Basin**.

Distribution and range: Christmas Creek Station [5N], near Barnes Flow [18A], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Shoals on or near upper foreslope.

Prismopora? triradiata Crockford 1957
(Plate 12 figs 11-14)

1957 *Prismopora? triradiata* Crockford: p.24-26, pl. 6 figs 1-4

Diagnosis: Large colonies with three bifoliate rays but without apparent further division to form triradiate branches as in *Prismopora*; rays extend from slightly spreading base; elongate solid maculae have a radial pattern; lunaria indent zooecial apertures.

Closest species: Zoaria of this species are larger than those of any other described *Prismopora* species.

Types: Holotype - CPC 1088; paratypes - CPC 1089A, 1090-1092, 1093A/B, 1094A, 1095.

Type locality: Brutens Yard [8], northern Canning Basin.

Distribution and range: Brutens Yard [7A, 10], Cherrabun Station [9, 13], Christmas Creek Station [19], Bohemia Downs Station [16], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common in the middle but absent from the top of the formation.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Shoals on or near upper foreslope.

Genus **EVACTINOSTELLA** Crockford 1957

Type species: *Evactinopora crucialis* Hudleston 1883; OD.

Generic range: Early Permian (Artinskian); Australia.

Evactinostella crucialis (Hudleston 1883)
(Plate 12 figs 20-23)

1883 *Evactinopora crucialis* Hudleston: p.593, pl.23 figs 2a-c
1888 *Evactinopora crucialis* Hudleston; Etheridge Jnr: p.207-208
1903 *Hexagonella? crucialis* (Hudleston); Etheridge Jnr: p.9-10, pl. 3 fig. 1
1914 *Evactinopora crucialis* Hudleston; Etheridge Jnr: p.18, pl. 2 fig. 7; pl. 5 figs 1-2
1944 *Meekoporella crucialis* (Hudleston); Moore & Dudley: p.305
1957 *Evactinostella crucialis* (Hudleston); Crockford: p.28-30, pl. 7 figs 1-5
1967a *Evactinostella crucialis* (Hudleston); Wass: p.162-163

Diagnosis: Free colonies of *Evactinostella* with usually four, rarely five, broad and curved rays; small round maculae; faint lunaria do not indent zooecial apertures.

Closest species: *E. crucialis* by its quadrate form is allied to *Evactinopora grandis* Meek & Worthen (Burlington Limestone, Iowa), but is a more robust form and apparently less symmetrical species (Etheridge Jnr, 1914, p.18).

Types: Holotype - presumed lost (Crockford, 1957, p.28); hypotypes - GSWA F464, 465; other figured specimens - UWA 22335, 22338, 22339A-B, 22340, 22341, AM F6817, F6919, F1647, F9036, CPC 1063B, 1096A-D, 1097A-C, 1098A/B, 1099A/B, 1100A/B, 1101A, 1230A, 1295, 7703-7705.

Type locality: Fossil Range north of the Lyons River, Carnarvon Basin.

Distribution and range: North of Gascoyne Junction, west of Mount Sandiman Station and Baragooda Pool, Arthur River, Gascoyne River area, Wandagee Hill, Mungadan Paddock, Wandagee Woolshed area, **Carnarvon Basin** - Callytharra Formation, Nalbia Sandstone, Baker Formation; Mount Wynne area [1], Gogo Station [11], Liveringa Station [15], Mount Marmion [29, 29A], north of Hill C, Grant Range [33], near Barnes Flow [18A], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Port Keats area (NT).

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian), Early Kungurian in Western Australia.

Abundance: Common.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Family ETHERELLIDAE Crockford 1957

Genus **ETHERELLA** Crockford 1957

Type species: *Etherella porosa* Crockford 1957; OD.

Generic range: Early Permian; Australia.

Etherella irregularis Crockford 1957
(Plate 13 figs 7-9)

1957 *Etherella irregularis* Crockford: p.34-35, pl. 9 figs 1-3

Diagnosis: Irregular cribrose colonies of *Etherella* with rounded, bifoliate branches usually dividing in the plane of the mesotheca; hook-shaped zooecia in the recumbent part near the mesotheca; no diaphragms, hemisepta, or lunaria; a few angular vesicles near the mesotheca.

Closest species: Closely similar to *E. porosa* Crockford, the type species, except for irregular cribrose form of colony and rounded branches.

Types: Holotype - CPC 1073H; paratype - CPC 1073G.

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Etherella porosa Crockford 1957
(Plate 13 figs 11, 12)

1957 *Etherella porosa* Crockford: p.32-33, pl. 8 figs 1-3

Diagnosis: Regular cribrose colonies of *Etherella* with flat, bifoliate branches, hook-shaped zooecia in the recumbent part near the mesotheca; no diaphragms, hemisepta, or lunaria; a few vesicles near the mesotheca.

Closest species: *E. porosa*, is closely similar to *E. irregularis* except that *E. porosa* is regularly cribrose and has flat branches.

Types: Holotype - CPC 1102A; paratypes - CPC 1068B, 1103A, 1104, 1105A; other figured specimens - GSWA F5815, F5816.

Type locality: Christmas Creek Station [5B], northern Canning Basin.

Distribution and range: Christmas Creek Station area [5A, 5C, 22, 37], northern **Canning Basin** - Noonkanbah Formation, basal Liveringa Group.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Common.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Etherella porosa var. **minor** Crockford 1957
(Plate 13 fig. 10)

1957 *Etherella porosa* var. *minor* Crockford: p.33-34, figs 4-6

Diagnosis: Regularly cribrose colonies of *Etherella* with narrow, flat, bifoliate branches; irregular diagonal rows of crowded zooecial apertures; only a few, tiny, vertically elongate vesicles between zooecial tubes near the mesotheca.

Closest species: Like *E. porosa* Crockford except that *E. porosa* var. *minor* has narrow branches, crowded zooecial apertures, and very few vesicles.

Types: Holotype - CPC 1073D; paratypes - CPC 1073E, 1073F, 1085B.

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Type locality, and near Barnes Flow [18], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Genus **LIGULOCLEMA** Crockford 1957

Type species: *Liguloclema typicalis* Crockford 1957; OD.

Generic range: Early Permian; Australia.



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PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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Bryozoans
(continued)

Liguloclema meridianus (Etheridge Jnr 1926)
(Plate 13 figs 1-3)

1926 *Sulcoretepora(?) meridianus* Etheridge Jnr MS, *in* Bretnall: p.19-20, pl. 1 fig. 9
1931 *Sulcoretepora meridianus* Etheridge Jnr; Hosking: p.15
1944b *"Sulcoretepora" meridianus* (Etheridge Jnr); Crockford: p.156, pl. 4 fig. 6; text figs 29, 30
1957 *Liguloclema meridianus* (Etheridge Jnr); Crockford: p.37

Diagnosis: Narrow, bifoliate branches of *Liguloclema*; regular, diagonal rows of oval zooecial apertures; zooecial apertures not indented by lunaria.

Closest species: *L. meridianus* is similar to *L. typicalis*, the type species, but it has narrower branches.

Types: Holotype - 15 on GSWA 10930A; paratypes - GSWA 10930B (2 slides UWA 15/10930B); other figured specimens - CPC 1085C, 1108A-B, 1109B, 1179A [not 1179B].

Type locality: Mount Marmion [29A], northern Canning Basin.

Distribution and range: Gascoyne River district, **Carnarvon Basin** - ?Callytharra Formation; Christmas Creek Station [6,19], Gogo Station [11], near Barnes Flow [18], northern **Canning Basin** - Noonkanbah Formation.

Age: ?Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: A few specimens.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope and shoals.

Liguloclema typicalis Crockford 1957
(Plate 13 fig. 4)

1957 *Liguloclema typicalis* Crockford: p.36-37, pl. 9 fig. 4; text fig. 5

Diagnosis: Wide, bifoliate branches of *Liguloclema*; faint lunaria do not indent zooecial apertures.

Closest species: *Fistulamina lata* Crockford has different dimensions; *Liguloclema meridianus* (Etheridge Jnr) has thicker zoarial form.

Types: Holotype - CPC 1106A; paratypes - CPC 1094C, 1107A, 1279, 1287A.

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: Bohemia Downs Station [16], Ellendale Station [23], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Unknown.

Value in correlation and dating: Useful guide to the age of the Lower Permian strata.

Sedimentary environment: Upper foreslope and shoals.

Family GONIOCLADIIDAE Waagen & Pichl 1885

Genus **GONIOCLADIA** Etheridge Jnr 1876

Type species: *Carinella cellulifera* Etheridge Jnr 1873; OD.

Generic range: Mississippian - Permian; Europe, Asia, Australia.

Goniocladia indica Waagen & Pichl 1885
(Plate 13 fig. 5)

1885 *Goniocladia indica* Waagen & Pichl: p.805-806, pl.93 fig.3
1929 *Goniocladia indica* Waagen & Pichl; Bassler: p.88
1957 *Goniocladia indica* Waagen & Pichl; Crockford: p.38

Diagnosis: Fan- or leaf-shaped expansions of *Goniocladia* with irregular branching; branches have a high carina on both the obverse and reverse surfaces; carina on obverse surface is more rounded and less prominent that the one on the reverse surface; large fenestrules of irregular outline; three alternating rows of zooecial apertures on each side of the carina (after Waagen & Pichl, 1885).

Closest species: *G. timorensis* Bassler from Basleo Beds of Timor is a finer-meshed species.

Types: Holotype - (Not known); other figured specimens - CPC 1077E, 1078B, UWA 22336C.

Distribution and range: Cherrabun Station [12], Christmas Creek Station [19], Duchess Ridge [35], northern **Canning Basin** - Noonkanbah Formation. India - Middle *Productus* Limestone; Timor - Basleo Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Chhidruan in Timor.

Abundance: Common(?).

Value in correlation and dating: Useful indicator to the age of the Lower Permian strata.

Sedimentary environment: Foreslope or open shelf.

Goniocladia timorensis Bassler 1929
(Plate 13 fig. 6)

1929 *Goniocladia timorensis* Bassler: p.89, pl. 247(23), figs 8-15
1944b *Goniocladia timorensis* Bassler; Crockford: p.157-158, pl. 5 fig. 8
1957 *Goniocladia timorensis* Bassler; Crockford: p.38

Diagnosis: Colonies of *Goniocladia* with widely spaced zooecia in three parallel rows on each side of the outer carina; 4.5 fenestrules per 20 mm.

Closest species: This species has shorter and distinctly smaller fenestrules than *G. indica* Waagen & Pichl.

Figured specimens: UWA 2757E,F; CPC 1101B, 1109A, 1111A, 1212, 1280.

Distribution and range: St George Ranges [31], Christmas Creek Station [5A, 6], ?near Barnes Flow [18A], Barnetts Tank area [28], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation, ?basal Liveringa Group. Timor - Basleo Beds.

Age: Late Artinskian (Baigendzhinian) - Kungurian in Western Australia. Chhidruan in Timor.

Abundance: Rare to common.

Value in correlation and dating: Not determinable at present. Useful guide to the Lower Permian strata.

Sedimentary environment: Foreslope or open shelf.

Genus **AETOMACLADIA** Bretnall 1926

Type species: *Aetomacladia ambrosioides* Bretnall 1926; Monotypy.

Generic range: Carboniferous - Permian; Australia.

Aetomacladia ambrosioides Bretnall 1926
(Plate 13 figs 13-20)

1926 *Aetomacladia ambrosioides* Bretnall: p.21
1926 *Aetomacladia ambrosiodes (sic)* Bretnall: pl. 1, fig. 4
1929 *Acanthocladia acuticosta* Bassler: p.85, pl. 244(20) fig. 13
1931 *Aetomacladia ambrosoides (sic)* Bretnall; Hosking: p.12, pl. 4 fig.4
1936 *Aetomacladia ambrosoides (sic)* Bretnall; Chapman *in* Raggatt: p.106
1936 *Aetomacladia ambrosioides* Bretnall; Chapman *in* Raggatt: p.128
1936 *Aetomacladia ambronis (sic)* Bretnall; Chapman *in* Raggatt: p.148
1937 *Aetomacladia ambrosioides* Bretnall; Raggatt & Fletcher: p.169, 173
1944c *Ramipora ambrosoides (sic)* (Bretnall); Crockford: p.193, pl. 1 figs 3-5; pl. 2 figs C-F
1957 *Ramipora ambrosoides (sic)* (Bretnall); Crockford: p.38
1964 *Aetomacladia ambrosoides (sic)* (Bretnall); Crespin: p.50

1964 *Ramipora ambrosoides (sic)* (Bretnall); Crespin: p.56
1968a *Ramipora ambrosioides* (Bretnall); Wass: p.22-23, pl. 1 figs 4-5; pl. 2 figs 1-2
1983 *Aetomacladia ambrosioides* Bretnall; Utgaard *in* Boardman et al.: p.434, pl. 214 figs 2a-e

Diagnosis: Fine colonies of *Aetomacladia* with three to five rows of zooecial apertures on each side of the mesotheca and six to eight zooecial apertures between the lateral branches (after Wass, 1968a, p.22).

Closest species: *Ramipora hochstetteri* Toula and *R.* cf. *hochstetteri* (Reed, 1925, p.107, pl. 10 figs 9-9a) differ with their slightly broader branches and larger measurements (Crockford, 1944c). *Ramipora ambigua* Sakagami is possibly identical (Wass, 1968a). *A. ambrosioides* is the only species assigned to this genus.

Types: Syntypic series - GSWA 12 (7 specimens including 3 taxa not labelled); lectotype - (Crockford, 1944c) GSWA 2/2405B; other figured specimens - CPC 1064C, 1068C, 1077G, 1078C, 1084B, 1112A, 1113B, 1114, 1115A/B, 1158, 1278, 1283A/B, 1290A, 7017-7024, UWA 2793E, 8499D, 20948B, 41208 - 41210, AM F36574.

Type locality: Fossil Hill near Wyndham River, Carnarvon Basin.

Distribution and range: Gascoyne River area, **Carnarvon Basin** - Callytharra Formation, Byro Group; Cherrabun Station [12], Gogo Station [11], Christmas Creek Station [5C, 5N, 19, 21, 22], Little Flow [27], Mount Marmion [29A], Mount Anderson Homestead area [17], Brutens Yard [8], Ellendale Station [23, 25], northern **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: A widespread, common species.

Value in correlation and dating: A long-ranging species. A useful guide to the age of the Lower Permian strata.

Sedimentary environment: Shoals on or near the upper foreslope.

Order TREPOSTOMATA Ulrich 1882
Family ULRICHOTRYPELLIDAE Romanchuk 1967

Genus **HINGANELLA** Romanchuk 1967

Type species: *Stenopora laeviuscula* Bassler 1929; OD.

Generic range: Early Permian; USSR, Mongolia, Timor, Australia.

Hinganella? bella (Crockford 1957)
(Plate 15 figs 10-12)

1957 *Stenopora bella* Crockford: p.42-43, pl. 11 figs 1-5

Diagnosis: Small, ramose colonies with round zooecial apertures separated by numerous exilazooecia; abundant, tiny acanthopores that are inconspicuous at the surface; arcuate rows of monilae in the inner region; monticules of thick-walled zooecia surrounded by abundant exilazooecia; diaphragms generally absent except for the very rare one.

Closest species: Resembles *Stenopora ramulosa* (Bassler) which has a finer form with larger zooecial apertures.

Types: Holotype - CPC 1128A; paratypes - CPC 1128B-D (topotypes).

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Family DYSCRITELLIDAE Dunaeva & Morozova 1967

Genus **DYSCRITELLA** Girty 1911

Type species: *Dyscritella robusta* Girty 1911; OD.

Generic range: Devonian - Permian; North America, UK, USSR, Morocco, Japan, China, Timor, Australia.

Dyscritella adnascens Bassler 1929
(Plate 14 figs 1-2)

1929 *Dyscritella adnascens* Bassler: p.62, pl. 286(12) figs 3-5
1957 *Dyscritella adnascens* Bassler; Crockford: p.50

Diagnosis: Encrusting colonies of *Dyscritella* with angular zooecial apertures; large, angular exilazooecia; densly filled acanthopores at almost all corners of zooecial apertures; no diaphragms in zooecial tubes; maculae present.

Figured specimens: CPC 1172, 1173A-B, 1174A, F6592A.

Distribution and range: Wooramel River below Callytharra Springs, **Carnarvon Basin** - Callytharra Formation; Christmas Creek Station [5J], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation. Timor - ?Bitauni and Amarassi Beds.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian) in Western Australia. ?Late Artinskian - Kungurian to Chhidruan in Timor.

Abundance: Unknown.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Dyscritella? liveringa Crockford 1957
(Plate 14 fig. 8)

1957 *Dyscritella liveringa* Crockford: p.54, pl. 14 fig. 1; text figs 7, 8

Diagnosis: Thin, encrusting colonies of a trepostome with small zooecial apertures; numerous exilazooecia; large acanthopores, four to five around each zooecial aperture; small, numerous monticules.

Closest species: *Dyscritella spinulosa* Bassler which is a much coarser form.

Holotype: CPC 1181.

Type locality: Mount Hardman [38], northern Canning Basin.

Distribution and range: Type locality - Liveringa Group.

Age: Kungurian - Chhidruan.

Abundance: One specimen.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Dyscritella macrostoma Crockford 1957
(Plate 14 figs 9, 10)

1957 *Dyscritella macrostoma* Crockford: p.51-52, pl.13 figs 5-8

Diagnosis: Ramose colonies of *Dyscritella* with large circular apertures and abundant angular mesozooecia; numerous acanthopores of two sizes (Crockford, 1957).

Closest species: *D. adnascens* Bassler differs with its encrusting form, smaller apertures and fewer acanthopores.

Types: Holotype - CPC 1116C; paratypes - CPC 1111B, 1115C, 1176A, 1177, 1178, 1185C, 1251A.

Type locality: Christmas Creek Station [5A], northern Canning Basin.

Distribution and range: Christmas Creek Station [5C, 5J, 5S, 21], Mount Anderson Homestead area [17], Brutens Yard, Cherrabun Station [20], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Dyscritella spinigera (Bassler 1929)
(Plate 14 figs 3, 4)

1929 *Batostomella spinigera* Bassler: p.61, pl. 236(12) figs 6-11
1957 *Dyscritella spinigera* (Bassler); Crockford: p.51

Diagnosis: Dendroid colonies of *Dyscritella* with branches about 2 mm in diameter; small zooecial apertures; few, small exilazooecia; well developed distinct and numerous acanthopores; occasional diaphragms in outer region of zooecial tube; no monticules; inconspicuous maculae.

Closest species: *Orbipora ambiensis* Waagen & Wentzel from the Lower *Productus* Limestone at Amb, India (Crockford, 1957).

Figured specimens: CPC 1064C, 1079B, 1081B, 1110B, 1148, 1149A, 1151A, 1152B, 1153A, 1154A, 1155, 1156A, 1157A-B, 1166A, 1167A, 1290B, UWA 22342A.

Distribution and range: **Carnarvon Basin** - Callytharra Formation; Mount Wynne area [1], Christmas Creek Station [5C, 5J, 5R, 19], Brutens Yard, Cherrabun Station [8], Noonkanbah Station [14], Liveringa Station [15], Mount Anderson Homestead area [17], Little Flow [27], Mount Marmion [29A], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation. Timor - Basleo Beds.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian) in Western Australia. Chhidruan in Timor.

Abundance: Common.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Dyscritella tenuirama Crockford 1957
(Plate 14 figs 11-13)

1957 *Dyscritella tenuirama* Crockford: p.52-53, pl. 13 figs 1-2

Diagnosis: Fine, ramose colonies of *Dyscritella* with small zooecial apertures opening obliquely at the colony surface; four or five large acanthopores around each zooecial aperture; only a few mesozooecia, occasionally clustered to form tiny maculae; occasional diaphragms in zooecial tubes.

Closest species: Similar to *D. spinigera* (Bassler) but differs in its smaller size and internal structure.

Types: Holotype - CPC 1161; paratypes - CPC 1159A-B, 1160, 1162A, 1163A-B, 1165A, 1290D.

Type locality: Mount Anderson Homestead area [17], northern Canning Basin.

Distribution and range: Brutens Yard, Cherrabun Station [7B], Liveringa Station [15], Little Flow [27], Mount Hardman [38], northern **Canning Basin** - Noonkanbah Formation, Liveringa Group.

Age: Late Artinskian (Baigendzhinian) - Chhidruan.

Abundance: Common(?).

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Genus **DYSCRITELLINA** Morozova 1967

Type species: *Dyscritellina clivosa* Morozova 1967.

Generic range: Permian; USSR, China, Japan, Australia.

Dyscritellina? globosa (Crockford 1957)
(Plate 14 figs 14, 15)

1957 *Leioclema globosa* Crockford: p.55, pl. 15 figs 2-4

Diagnosis: Massive colonies of a trepostome with numerous, closely spaced diaphragms in the zooecial tubes; apparently mesozooecia with even more closely spaced diaphragms; large acanthopores about five around each zooecial aperture.

Closest species: No comparable species known.

Types: Holotype - CPC 1138; paratypes - CPC 1137, 1294.

Type locality: Mount Wynne [3], northern Canning Basin.

Distribution and range: Gogo Station [11, 14.4 km east-southeast from Cuncudgerie Hill, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone, ?Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - ?Artinskian (Baigendzhinian).

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Genus **PSEUDOBATOSTOMELLA** Morozova 1960

Type species: *Batostomella spinulosa* Ulrich 1890.

Generic range: Early Carboniferous - Permian; North America, Canada, UK, USSR, China, Japan, Australia.

Pseudobatostomella bruteni (Crockford 1957)
(Plate 14 figs 5-7)

1957 *Dyscritella bruteni* Crockford: p.53-54, pl. 13 figs 3, 4

Diagnosis: Dendroid colonies of *Pseudobatostomella* with general longitudinal alignment of zooecial apertures; numerous acanthopores generally of one size, forming usually one row, but occasionally up to three rows, in the lateral spaces between zooecial apertures; occasional exilazooecia.

Types: Holotype - CPC 1168A; paratypes - CPC 1084C, 1150B, 1169B, 1170A, 1175A/B.

Type locality: Christmas Creek Station [5N], northern Canning Basin.

Distribution and range: Christmas Creek Station [5J, 19], northern Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Pseudobatostomella? dickinsi (Ross 1963)
(Plate 15 figs 6-9)

1963 *Stenopora dickinsi* Ross: p.73-75, pl. 8 figs 1-3, 5-8; pl. 9 figs 1-5, 7-9

Diagnosis: Dendroid colonies of a trepostome with oval, longitudinally aligned zooecial apertures; large, prominent acanthopores and also some small acanthopores; rare exilazooecia; rare diaphragms; zooecial walls with low, broad monilae.

Closest species: Not closely similar to other Australian species. It has some similarity with *Stenopora gracilis* (Dana) (Crockford, 1943a) and *Stenopora parallela* Crockford 1945b.

Types: Holotype - CPC ML109-2; paratypes - CPC ML109-1, ML109-3, ML106-1 to ML106-5, ML90-2, ML90-4.

Type locality: Lyndon River area, Carnarvon Basin.

Distribution and range: Type locality - Lyons Group (upper part).

Age: ?Asselian - Sakmarian (Tastubian).

Abundance: Common.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Pseudobatostomella? fisheri (Ross 1963)
(Plate 15 figs 1-3)

1963 *Stenopora fisheri* Ross: p.75-76, pl. 8 fig. 4; pl. 10 figs 1-9

Diagnosis: Denroid colonies of a trepostome with large zooecia, large exilazooecia, and numerous, large acanthopores; zooecial walls with narrow, elongate monilae.

Closest species: *P.? dickinsi* which however has smaller zooecial openings, smaller acanthopores and lacks numerous, large exilazooecia.

Types: Holotype - CPC ML107-4; paratypes - CPC ML107-2, ML107-5, ML107-8, ML109-4.

Type locality: Lyndon River area, Carnarvon Basin.

Distribution and range: Type locality - upper part of Lyons Group.

Age: ?Asselian - Early Sakmarian (Tastubian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Pseudobatostomella? lyndoni (Ross 1963)
(Plate 16 figs 4-6)

1963 *Stenopora lyndoni* Ross: p.76-77, pl. 11 figs 1-3, 6-10

Diagnosis: Dendroid colonies of a trepostome with small zooecial openings, large prominent acanthopores and exilazooecia.

Closest species: *P.? lyndoni* differs from *P.? dickinsi* in its smaller zooecial openings and in having small exilazooecia.

Types: Holotype - CPC ML90-1; paratype - CPC ML90-3.

Type locality: Lyndon River area, Carnarvon Basin.

Distribution and range: Type locality - Lyons Group.

Age: ?Asselian - Early Sakmarian (Tastubian).

Abundance: Rare.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Family STENOPORIDAE Waagen & Wentzel 1886

Genus **STENOPORA** Lonsdale 1844

Type species: *Stenopora tasmaniensis* Lonsdale 1844; OD.

Generic range: Mississippian - Permian; North America, Canada, UK, USSR, Mongolia, China, India, Pakistan, Japan, Greenland, Australia.

Stenopora hemispherica Waagen & Wentzel 1886
(Plate 15 figs 4, 5)

1886 *Stenopora hemispherica* Waagen & Wentzel: p.891, pl. 106 fig. 2
1957 *Stenopora hemispherica* Waagen & Wentzel; Crockford: p.39, pl. 10 figs 1, 2

Diagnosis: Small, massive and rounded, and also slightly lobate, colonies of *Stenopora* with round zooecial apertures and acanthopores apparently restricted to angles of zooecial tubes; moniliform zooecial walls; rare diaphragm in zooecial tube; occasional angular exilazooecium.

Closest species: Superficially similar to the younger *S. crinita* Lonsdale but the present species is a much smaller form with far narrower zooecial tubes.

Types: Holotype - monotype from Lower *Productus* Limestone, Amb, northern India; other figured specimens - CPC 1119A-D, 1291A-E.

Distribution and range: Mount Wynne area [2, 2A], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone. Timor - Basleo Beds; India - Lower *Productus* Limestone.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Chhidruan in Timor.

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Stenopora lineata Crockford 1957
(Plate 15 figs 13-16)

1957 *Stenopora lineata* Crockford: p.43-44, pl. 10 figs 6-8

Diagnosis: Ramose colonies of *Stenopora*; zooecial apertures are irregular in size and shape and are arranged in discontinuous rows; numerous small acanthopores in short longitudinal rows; occasional large acanthopore and a few exilazooecia; small monticles.

Closest species: Internally different from all other stenoporids.

Holotype: CPC 1127.

Type locality: Christmas Creek Station [5C], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Stenopora punctata Crockford 1957
(Plate 15 figs 17, 18)

1957 *Stenopora punctata* Crockford: p.41-42, pl. 11 figs 6,7

Diagnosis: Colonies of flattened, frondescent branches of *Stenopora*; small round zooecial apertures separated by numerous exilazooecia; three to four acanthopores around each zooecial aperture.

Closest species: *S. magnopora* (Bassler) from the Bitauni Beds of Timor, but has much larger zooecial tubes and different zoarial form.

Types: Holotype - CPC 1130; paratypes - CPC 1131, 1132.

Type locality: Christmas Creek Station [19], northern Canning Basin.

Distribution and range: Cherrabun Station [9,13], northern Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Stenopora? sp. A Etheridge Jnr 1914
(Plate 16 figs 7, 8)

1914 *Stenopora* sp. A Etheridge Jnr: p.20-21, pl. 2 figs 5-6; pl. 8 figs 3-4

Diagnosis: Ramose, lobate, branched colony of *Stenopora* with oval to rounded zooecial apertures arranged in linear series and abutting each other; acanthopores when present located at zooecial angles; numerous exilazooecia; axial tubes polygonal, thin walled, with a few complete diaphragms; zooecia cylindrical and annular in mature region showing weak moniliform wall structure in the final growth stage (after Etheridge Jnr, 1914).

Closest species: *Stenopora ovata* Lonsdale has much stronger development of moniliform wall structure (Etheridge Jnr, 1914).

Types: Hypotype - GSWA F466; other figured specimens - AM F16413 (Slide AM 886) - formerly GSWA F10930.

Distribution and range: Mount Marmion, northern Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 3 specimens(?).

Value in correlation and dating: Not determined.

Sedimentary environment: Foreslope or open shelf.

Stenopora spicata var. **obtusa** Crockford 1957
(Plate 16 figs 1-3)

1957 *Stenopora spicata* (Bassler) var. *obtusa* Crockford: p.40-41, pl. 10 figs 3-5

Diagnosis: Erect and club-shaped colonies of *Stenopora* with small monticules of large, thick-walled zooecia and clusters of exilazooecia; round zooecial apertures surrounded by four or five large and extremely prominent acanthopores; small acanthopores in monticules; only slightly developed moniliform wall structure.

Closest species: *S. spicata* is very close but has differences in colony form which could possibly be the result of preservation.

Types: Holotype - CPC 1121; paratypes - CPC 1072B, 1120A, 1122A, 1123A-E, 1124A-B, 1125A, 1126A-B.

Type locality: Christmas Creek Station [5C], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 5J, 10, 21], Bohemia Downs Station [16], Ellendale Station on Bells Creek [23], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Genus **STENODISCUS** Crockford 1945

Type species: *Stenodiscus moniliformis* Crockford 1945b; OD.

Generic range: Carboniferous - Permian; USSR, Mongolia, China, North America, UK, Australia.

Stenodiscus hardmani Crockford 1957
(Plate 14 figs 16-18, 21)

1957 *Stenodiscus hardmani* Crockford: p.47-48, pl. 12 figs 4-6

Diagnosis: Dendroid colonies of *Stenodiscus* with only slightly developed moniliform wall structure; oval zooecial apertures surrounded by numerous large acanthopores; small, round exilazooecia

are less numerous than the zooecial apertures; diaphragms in inner and outer regions of colony.

Types: Holotype - CPC 1139A; paratypes - CPC 1139B-L, 1140, 1282B, 1293A.

Type locality: Mount Hardman [38], northern Canning Basin.

Distribution and range: Bucknalls Pinnacle [24], Barnetts Tank [26], Cherrabun Station [36], northern **Canning Basin** - Noonkanbah Formation and Liveringa Group.

Age: Late Artinskian (Baigendzhinian) - Chhidruan.

Abundance: Common(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Stenodiscus variabilis Crockford 1957
(Plate 14 figs 19-20)

1957 *Stenodiscus variabilis* Crockford: p.45-47, pl. 12 figs 1-3

Diagnosis: Ramose colonies of *Stenodiscus* with large zooecial apertures and exilazooecia; numerous acanthopores of two sizes with distinctive arrangement; one to rarely four large acanthopores around each zooecial aperture and between them is a single row of small and numerous acanthopores; two to three diaphragms in a zooecial tube in the outer region.

Closest species: In tangential section, it resembles *Tabulipora tenuinervis* Bassler from Timor but differs in vertical section from that species with its complete, non-perforated diaphragms.

Types: Holotype - CPC 1145; paratypes - CPC 1141-1143, 1144A, 1146A, 1147, 1235A.

Type locality: Mount Marmion, [29], northern Canning Basin.

Distribution and range: Christmas Creek Station [5H, 10, 19, 21, 37], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation and basal Liveringa Group.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Common.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Genus **TABULIPORA** Young 1883

Type species: *Cellepora urei* Fleming 1928.

Generic range: Carboniferous - Permian; North America, Canada, Greenland, UK, USSR, Morocco, China, Timor, Australia.

Tabulipora scissa Crockford 1957
(Plate 14 figs 22, 23)

1957 *Tabulipora scissa* Crockford: p.44-45, pl. 12 fig. 7; text fig. 6

Diagnosis: Dendroid colonies of *Tabulipora* with small zooecial apertures and occasional exilazooecia; one large acanthopore between successive zooecial apertures and numerous small acanthopores; commonly three or four diaphragms in a zooecial tube near the colony surface.

Closest species: *T. sustutensis* Fritz from the Early Permian of British Columbia differs in the generally smaller apertures and enlarged zooecia.

Types: Holotype - CPC 1133; paratype - CPC 1134A.

Type locality: Mount Anderson Homestead area [17], northern Canning Basin.

Distribution and range: Christmas Creek Station [22], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Two specimens (one not described).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Upper foreslope or open shelf.

Order CRYPTOSTOMATA Vine 1884
Suborder FENESTELLINA Astrova & Morozova 1956

Family FENESTELLIDAE King 1850

Genus **FENESTELLA** Lonsdale 1839

Type species: *Fenestella antiqua* Lonsdale 1839.

Generic range: Ordovician - Permian; worldwide.

Fenestella affluensa Bretnall 1926
(Plate 16 figs 10, 11)

1926 *Fenestella affluensa* Bretnall: p.16, pl. 1 fig. 8
1931 *Fenestella affluensa* Bretnall; Hosking: p.12-13
1936 *Fenestella spinulifera* Moore *(partim)*; Chapman *in* Raggatt: p.128 *(fide* Crockford, 1944b, p.158)

1944c *Fenestrellina affluensa* (Bretnall); Crockford: p.188-189, pl. 1 fig. 6
1944b *Fenestrellina affluensa* (Bretnall); Crockford: p.158, pl. 4 fig. 10
1967 *Fenestrellina affluensa* (Bretnall); Condon: p.70
1968a *Fenestella affluensa* Bretnall; Wass: p.57-60, 85-86, pl. 14 fig. 3

Diagnosis: *Fenestella* with three to four stabilized zooecia per fenestrule; fenestrules oval, short; carina slight, rounded; lateral slopes of branches steep accentuating height of carina; nodes large and widely spaced; zooecial bases pentagonal.

Closest species: *F. affluensa* is distinguished by its thick branches and large, widely spaced nodes (Crockford, 1944c); *F. loganensis* Wass has narrower branches and dissepiments; several comparable USSR species are listed by Wass (1968a).

Types: Holotype - GSWA 17 (Unlabelled specimens, now re-catalogued); lectotype (Crockford, 1944c) - GSWA 2/2405E; other figured specimens - CPC 302, UWA 8499G, UQGD 40567.

Type locality: East of Gascoyne - Wyndham River Junction, Carnarvon Basin.

Distribution and range: Wooramel River west of Callytharra Spring, Fossil Hill near Wyndham River, **Carnarvon Basin** - Callytharra Formation, between top of the Lyons Group and top of the Byro Group. Bowen Basin (Qld) - Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Queensland.

Abundance: Six described specimens.

Value in correlation and dating: One of the few species of *Fenestella* also recorded from eastern Australia. A useful guide to the age of the Lower Permian sedimentary rocks.

Sedimentary environment. Shallow water marine (30 - 50 m).

Fenestella alia (Crockford 1944)
(Plate 16 fig. 12)

[non] 1929 *Fenestella spinulifera* Moore: p.20, pl. 3 figs 3-5
1936 *Fenestella spinulifera* Moore *(partim)*; Chapman *in* Raggatt: p.128
1944b *Fenestrellina alia* Crockford: p.159, pl. 4 fig. 8
1967 *Fenestrellina alia* Crockford; Condon: p.70

Diagnosis: Coarse *Fenestella* with seven and a half to eight short, oval fenestrules in 10 mm and four unstabilized zooecia per fenestrule; branches broad, with low rounded median carina; nodes small and rarely developed; zooecial bases pentagonal.

Closest species: Lack of nodal development and thick dissepiments distinguish this species from all associated forms.

Holotype: CPC 301 (=786 Crockford, 1944b).

Type locality: West of Callytharra Spring on Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Two described specimens, one of which is lost.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water (30 - 50 m).

Fenestella amplia (Crockford 1944)
(Plate 16 fig. 9)

[non] 1929 *Fenestella spinulifera* Moore: p.20, pl. 3 figs 5
1936 *Fenestella spinulifera* Moore *(partim)*; Chapman *in* Raggatt: p.128
1944b *Minilya amplia* Crockford: p.159-160, pl. 4 fig. 7
1967 *Minilya amplia* Crockford; Condon: p.70
1968a *Fenestella amplia* (Crockford); Wass: p.58-60, 85-86, pl. 14 fig. 1

Diagnosis: *Fenestella* with seven short, oval fenestrules and 12 branches in 10 mm; three stabilized zooecia per fenestrule; small nodes placed in two rows on a poorly defined carina; zooecial bases pentagonal.

Closest species: *F. kukaensis* Bassler from the Amarassi Beds of Timor, which has more zooecia per fenestrule and closer spacing of its apertures (Crockford, 1944b); Wass (1968a) records some similarities with USSR species. Locally, only *F. princeps* (Crockford) and some specimens of *F. horologia* Bretnall have two rows of nodes and they are readily distinguished by their much finer meshwork.

Holotype: CPC 309 (=792 Crockford, 1944b; Wass, 1968a).

Type locality: West of Callytharra Springs, Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation. Bowen Basin (Qld) - *Eurydesma* Limestone, Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia.

Abundance: Rare.

Value in correlation and dating: A useful guide to Lower Permian correlation with Queensland.

Sedimentary environment: Shallow water (30 - 50 m).

Fenestella basleoensis Bassler 1929
(Plate 16 figs 13-15)

1929 *Fenestella basleoensis* Bassler: p.74, pl. 240(16) figs 5-9
1957 *Fenestella basleoensis* Bassler; Crockford: p.58

Diagnosis: Fenestrules short, quadrangular; four unstabilized zooecia per fenestrule with 14 branches and eight fenestrules per 10 mm; carina distinct; nodes sharp, elongated, three per fenestrule.

Closest species: *F. basleoensis* var. *limatula* Trizna from the Early Permian of the Ural Mountains has finer branches and larger fenestrules.

Figured specimens: UWA 20952E, 22342B; CPC 1065B, 1208, ?1225A, 1276A.

Distribution and range: Bohemia Downs Homestead [16], Christmas Creek Station [5A, 32], Ellendale Station [23], Mount Marmion [29A], northern Canning Basin - Noonkanbah Formation. Timor - Basleo Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Chhidruan in Timor.

Abundance: Relatively common in the Canning Basin.

Value in correlation and dating: Provides a stratigraphic link with Timor.

Sedimentary environment: Shallow water.

Fenestella cacuminatis (Crockford 1944)
(Plate 17 fig. 3)

1944a *Fenestrellina cacuminatus* Crockford: p.171, text fig. 1B
1957 *Fenestella cacuminatus* (Crockford); Crockford: p.58

Diagnosis: *Fenestella* with three unstabilized zooecia per fenestrule; fenestrules short and oval; slight carina; nodes small, sharp, evenly spaced; zooecial bases pentagonal.

Closest species: *F. pulchradorsalis* Bassler is smaller, has wider branches and dissepiments. *F. affluensa* Bretnall is a larger species.

Types: Holotype - UWA 20944A; other figured specimens - CPC 1213B (topotype).

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Fenestella chapmani (Crockford 1944)
(Plate 17 figs 1, 2)

[non] 1929 *Fenestella spinulifera* Moore: p.20, pl. 3 figs 3-5
1936 *Fenestella spinulifera* Moore *[partim]*; Chapman *in* Raggatt: p.128
1944b *Fenestrellina chapmani* Crockford: p.158-159, pl. 4 fig. 5
1967 *Fenestella chapmani* (Crockford); Condon: p.70

Diagnosis: Very coarse *Fenestella* with four to eight (five) large, widely spaced, unstabilized apertures and very large, distant nodes; zooecial bases pentagonal.

Closest species: *F. hindei* has a comparable coarse mesh but differs particularly in its nodal arrangement and zooecial spacing.

Types: Holotype - CPC 303 (=788 Crockford, 1944b); paratype - CPC 304 (=?789).

Type locality: West of and below Callytharra, Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Two recorded specimens.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water (30 - 50 m).

Fenestella columnaris (Crockford 1944)
(Plate 16 figs 16-18)

1944a *Fenestrellina columnaris* Crockford: p.170, pl. 2 fig. 3; text figs 1F, 1G
1957 *Fenestella columnaris* (Crockford); Crockford: p.58

Diagnosis: *Fenestella* with three stabilized zooecia per fenestrule; fenestrules short and oval; carina slight; nodes large and very high; zooecial bases pentagonal.

Closest species: *F. horologia* Bretnall is smaller, has fewer zooecia per fenestrule and smaller nodes. *F. pulchradorsalis* Bassler is a larger species lacking nodes (Crockford, 1944a).

Types: Holotype - UWA 20949; paratype - UWA 2757M; other figured specimens - CPC 1068K, 1174B, 1185F, 1186B, 1210, 1214-1217.

Type locality: Syncline on Minilya River, west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Type locality - Wandagee Formation; Christmas Creek Station [5A, 5C, 5J, 6, 19, 21, 22], Gogo Station [11], Mount Anderson Homestead area [17], St George Ranges [31], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Widespread in the Canning Basin.

Value in correlation and dating: Of value in correlation between the Canning and Carnarvon Basins. A comparable species is found in Queensland.

Sedimentary environment: Shallow water.

Fenestella disjecta (Crockford 1944)
(Plate 17 figs 4-6)

1944a *Fenestrellina disjecta* Crockford: p.168-169, pl. 1 fig. 2; text fig. 1E
1957 *Fenestella disjecta* (Crockford); Crockford: p.58

Diagnosis: *Fenestella* with four to five stabilized zooecia per fenestrule; fenestrules short and oval; carina slight; nodes very high, one per fenestrule placed at branch-dissepiment junction.

Closest species: Other local species of similar dimension lack the large, widely spaced nodes.

Types: Holotype - UWA 2793A-B; other figured specimens - CPC 1068L, 1196B, 1209A, 1237, 1238A, 1278B.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: **Carnarvon Basin** - Coolkilya Sandstone; Christmas Creek Station [5A, 21, 22], Ellendale Station [23], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Occurs in both basins but has been recorded mostly in the Canning Basin.

Value in correlation and dating: Locally of value for correlation at the top of the Permian sequence in both basins.

Sedimentary environment: Shallow water.

Fenestella hindei Crockford 1957
(Plate 17 fig. 7)

1957 *Fenestella hindei* Crockford: p.59-60, pl. 16 fig. 1; text fig. 10

Diagnosis: *Fenestella* with coarse-meshed zoarium, thin branches with six to eight unstabilized apertures per fenestrule; fenestrules long,

rectangular to oval in shape; nodes in single row more widely spaced than apertures; zooecial bases pentagonal (Crockford, 1957).

Closest species: *F. chapmani* (Crockford) has larger, more widely spaced zooecial apertures and wider spaced nodes on the carina.

Types: Holotype - UWA 2792 (missing); paratypes - UWA 2757L, CPC 1077L, 1078E/G, 1216C.

Type locality: St George Ranges [31], northern Canning Basin.

Distribution and range: Gogo Station [11], Cherrabun Station [12], Christmas Creek Station [19], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Moderate.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Fenestella horologia Bretnall 1926
(Plate 17 figs 8-14)

1926 *Fenestella horologia* Bretnall: p.15, pl. 1 fig. 6
1929 *Fenestella parviuscula* Bassler; p.76, pl. 241 figs 8-13
1931 *Fenestella horologia* Bretnall; Hosking: p.13, pl. 4 fig. 3
1936 *Fenestella pectinis* Moore *(partim)*; Chapman *in* Raggatt: p.128 *(fide* Crockford, 1944b, p.158)
1943a *Fenestrellina horologia* (Bretnall); Crockford: p.266
1944a *Fenestrellina horologia* (Bretnall); Crockford: p.167, pl. 1 figs 3, 6
1944b *Fenestrellina horologia* (Bretnall); Crockford: p.158
1944c *Fenestrellina horologia* (Bretnall); Crockford: p.189, pl. 1 fig. 1; pl. 2, fig. A
1944c *Minilya duplaris* Crockford: p.173, pl. 1 figs 5, 7; text figs 1C, 1D
1946 *Minilya duplaris* Crockford: p.132
1953 *Fenestrellina nodograciosa* Chronic; Chronic *in* Newell et al.: p.111, pl. 21, figs 4a,b
1957 *Fenestella horologia* Bretnall; Crockford: p.57
1957 *Minilya duplaris* Crockford; Crockford: p.67
1957 *Minilia duplaris (sic)* Crockford; Elias & Condra: p.65
1957 *Fenestella parviuscula* Bassler; Elias & Condra: p.108
1961 *Fenestella nomatae* Sakagami: p.34, pl. 15 fig. 3; text fig. 5
1966 *Fenestella horologia* Bretnall; Wass: p.92-94, pl. 2 figs 1-7
1967a *Fenestella horologia* Bretnall; Wass: p.166

Diagnosis: Fine-meshed *Fenestella* with hourglass fenestrules, two to three stabilized zooecia per fenestrule; nodes uniserial or biserial; zooecial bases trapezoidal.

Closest species: *F. subquadratopora* and *F. subvischerensei* Shulga-Nesterenko (Wass, 1966). The former differs in nodal arrangement and spacing and the latter has narrower branches and dissepiments with consequent change to the hourglass-shaped

fenestrules. Close in mesh dimensions to *F. columnaris* (Crockford) which differs significantly with its pentagonal zooecial bases.

Types: Holotype - GSWA 16/10930 (labelling destroyed); neotype (Crockford, 1944c) - GSWA 2/2405C; other figured specimens - (*F. horologia* - UWA 8499E, 20942, AM F17538, CPC 1073I, 1078F, 1084D, 1102C, 1185G, 1186C, 1187N, 1188C, 1213E, 1216B, 1220, 1221, 1224A, 1232, 1285, 1290O, 1291F, 7715, 7716) (*M. duplaris* - UWA 2793D, 22323, 41214, CPC 1102E, 1171B, 1179C-D, 1209B, 1210C, 1213C-D, 1233, 1236C, 1281A-B, 1287C).

Type locality: Fossil Hill Station, Gascoyne River district, Carnavon Basin.

Distribution and range: Type locality - Callytharra Formation, Byro Group; Lake Josceline, Mount Wynne area [2, 2A, 4], Christmas Creek Station [5A-C,J,N, 6, 19, 21, 22, 37], Cherrabun Station [13], Liveringa Station [15], Mount Anderson Homestead area [17], Little Flow [27], Mount Marmion [29], Barnetts Tank [28], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation, Lightjack Formation. Bowen Basin (Qld) - Cattle Creek Formation, Buffel Formation; Port Keats District (NT); Timor - Bitauni and Basleo Beds.

Age: Late Sakmarian (Sterlitamakian) - Kungurian, Chhidruan in Western Australia. Late Artinskian - Chhidruan in Timor.

Abundance: A very common species.

Value in correlation and dating: Very widespread Australian species - overall range rather too long for accurate correlation. A good Early Permian age indicator.

Sedimentary environment: Shallow water (30 - 50 m).

Fenestella lennardi (Crockford 1944)
(Plate 17 fig. 15)

1944a *Fenestrellina lennardi* Crockford: p.171, text fig. 1A
1967a *Fenestella lennardi* (Crockford); Wass: p.166-167, text fig. 1

Diagnosis: *Fenestella* with narrow branches and dissepiments; one aperture per fenestrule stabilized on dissepiments; carina slight, nodes small and numerous; zooecial bases triangular with flange becoming pentagonal in upper levels of branches (Wass, 1967a).

Closest species: Its small size and apertural arrangement are distinctively different from all associated species.

Types: Holotype - UWA 20948A; another figured specimen - CPC 7717.

Type locality: Southeast side of Mount Marmion [29], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation (top beds). Port Keats District (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: Rare.

Value in correlation and dating: Occurs only in the upper Noonkanbah Formation.

Sedimentary environment: Shallow water.

Fenestella princeps (Crockford 1944)
(Plate 17 fig. 18)

1944a *Minilya princeps* Crockford: p.174-175, pl. 1 fig. 1

Diagnosis: *Fenestella* with three stabilized zooecia per fenestrule; fenestrules short oval; nodes small, in two rows on the almost obsolete carina.

Closest species: *F. jabiensis* Waagen & Pichl from the Middle and Upper *Productus* Limestone of the Salt Range, India has more zooecia per fenestrule and a better defined keel and has the dissepiments on the obverse surface at a different level to that of the branches. *F. binodata* Condra has more fenestrules in 10 mm and more zooecia per fenestrule. *F. horologia (M. duplaris)* is a finer form with fewer zooecia per fenestrule (Crockford, 1944a).

Types: Holotype - UWA 20945; other figured specimens - CPC 1112, 1206A, 1246, 1290L.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A], Little Flow [27], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not common.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Fenestella ruidacarinata (Crockford 1944)
(Plate 17 figs 16, 17)

1944a *Fenestrellina ruidacarinata* Crockford: p.169, pl. 2 figs 1, 2

Diagnosis: *Fenestella* with three to four unstabilized zooecia per fenestrule; fenestrules short, oval; carina obsolete, completely covered with low, rounded contiguous nodes, five to six per fenestrule; zooecial bases pentagonal.

Closest species: The species is readily distinguished from all comparable forms by its low contiguous nodes. *F. inaequalis* Ulrich from the Upper Coal Measures of Illinois is similar in appearance but is larger, has extra zooecia per fenestrule, and more numerous nodes.

Holotype: UWA 2757A.

Type locality: St George Ranges [31], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: A very distinctive form of too rare occurrence to assess its potential as an index species.

Sedimentary environment: Shallow water.

Fenestella sparsigemmata (Crockford 1944)
(Plate 17 fig. 19)

[non] 1929 *Fenestella spinulifera* Moore: p.20, pl. 3 figs 3-5
1936 *Fenestella spinulifera* Moore *(partim)*; Chapman *in* Raggatt: p.128
1944b *Fenestrellina sparsigemmata* Crockford: p.159, pl. 4 fig. 9
1967 *Fenestella sparsigemmata* (Crockford); Condon: p.70

Diagnosis: Moderately coarse *Fenestella* with short, rounded fenestrules and broad branches; three to four stabilized zooecia per fenestrule; slight carina with large, very widely spaced blunt nodes; zooecial bases pentagonal.

Closest species: *F. affluensa* Bretnall which differs with its much wider nodal spacing.

Holotype: CPC 300 (=785 Crockford, 1944b).

Type locality: West of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitmakian).

Abundance: Rare.

Value in correlation and dating: A distinctive form found only in the Callytharra Formation.

Sedimentary environment: Shallow water (30 - 50 m).

Fenestella valentis (Crockford 1944)
(Plate 17 fig. 20)

1944a *Fenestrellina valentis* Crockford: p.169-170, pl. 1 fig.4
1957 *Fenestella valentis* (Crockford); Crockford: p.58

Diagnosis: *Fenestella* with very broad flattened branches; fenestrules short, oval; three to four unstabilized zooecia per fenestrule; median carina rounded, relatively low, with small rounded nodes; zooecial bases pentagonal.

Closest species: The broad, flattened branches and dissepiments are distinctive.

Types: Holotype - UWA 2793C (missing); other specimens - CPC 1213A, 1239, 1297A.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: Barnetts Tank on Sixty-Seven Mile Creek [26], northern Canning Basin - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: A characteristic species in the Noonkanbah Formation.

Sedimentary environment: Shallow water.

Genus **PENNIRETEPORA** D'Orbigny 1849

Type species: *Retepora pluma* Phillips 1836.

Generic range: Devonian - Permian; UK, North America, USSR, Australia.

Penniretepora fossata Crockford 1944
(Plate 20 fig. 1)

1944b *Penniretepora fossata* Crockford: p.163-164, pl. 5 fig. 6

Diagnosis: Flexuous *Penniretepora*, apertures large, three between the origins of successive branches; obverse and reverse surfaces ornamented by coarse ridges and grooves; carina usually replaced by three continuous ridges with no nodes developed.

Closest species: *P. flexuosa* (Moore) (Graham Formation of Texas) differs with its smaller size and strongly developed carina. The three described species from the Carnarvon Basin differ: in their apertural form (*P. fossata* - large, circular with high peristome; *P. granulata* - small and stellate; *P. triporosa* pyriform with nine apertural spines); in the number of apertures between side branches on the midrib; in the spacing of the side branches; in the existence of carinal nodes on only *P. triporosa* and in ornament variations including the replacement of the carina by three ridges in *P. fossata*. Crockford (1944b) reports that several hundred fragments of this genus (including several new species) were collected from the Callytharra region but that most were too poorly preserved for identification.

Holotype: CPC 306 (=803 Crockford, 1944b).

Type locality: West of Callytharra Spring on Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Abundant in the Callytharra region.

Value in correlation and dating: Crockford (1944b) notes that there is an abundance of specimens from the Callytharra Formation but that no specimens have been found from other formations in either the Carnarvon or Canning Basins.

Sedimentary environment: Shallow water (30 - 50 m).

Penniretepora granulata Crockford 1944
(Plate 20 fig. 3)

1944b *Penniretepora granulata* Crockford: p.163, pl. 5 fig. 9; text fig. 44
1967 *Penniretepora granulata* Crockford; Condon: p.70

Diagnosis: Fine *Penniretepora* with two zooecia between the origin of successive branches; slight carina marked by a row of fine granules but without nodes.

Closest species: See comments given with *P. fossata* Crockford.

Holotype: CPC 325 (=800 Crockford, 1944b).

Type locality: Below and west of Callytharra Springs, Wooramel River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Abundant only in the Callytharra region.

Value in correlation and dating: See comments for *P. fossata* Crockford.

Sedimentary environment: Shallow water (30 - 50 m).

Penniretepora triporosa Crockford 1944
(Plate 20 fig. 2)

[non] 1929 *Pinnatopora trilineata* Meek var. *texana* Moore: p.126, pl. 15 figs 6-9
1936 *Pinnatopora trilineata* Meek var. *texana* Moore; Chapman *in* Raggatt: p.128
1944b *Penniretepora triporosa* Crockford: p.161-162, pl. 5, fig. 4; text fig. 49
1967 *Penniretepora triporosa* Crockford; Condon: p.70
1968a *Penniretepora triporosa* Crockford; Wass: p.40-42 pl. 11 fig. 2

Diagnosis: Fine *Penniretepora*, three zooecia between the origins of successive branches, slight carina with distant nodes.

Closest species: *P. trilineata* var. *texana* (Moore) has closer spacing of the pinnae and different spacing of its apertures; the carina is also different. See comments given with *P. fossata* Crockford.

Types: Holotype - CPC 305 (=795 Crockford, 1944b) (CPC 305 label is erroneously attached to a slide of *Stenopora hirsuta* Crockford; the holotype is therefore apparently lost); paratypes - GSWA 2/2404B (missing); (note: Catalogue entry CPC 792 cited by Crockford, 1944b, has been reassigned to a different genus).

Type locality: West of Callytharra Springs, Carnarvon Basin.

Distribution and range: Below Callytharra Springs on Wooramel River, well on Daurie Creek, Gascoyne River area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common at Callytharra localities.

Value in correlation and dating: See comments for *P. fossata* Crockford. Species has also been recorded in the Bowen Basin extending over a longer range.

Sedimentary environment: Shallow water (30 - 50 m).

Genus **LYROPORELLA** Simpson 1895

Type species: *Fenestella (Lyropora) quincuncialis* Hall 1857.

Generic range: Mississippian - ?Permian; North America, Australia.

Lyroporella erkosoides (Etheridge Jnr 1926)
(Plate 18 fig. 3)

1926 *Lyropora? erkosoides* Etheridge Jnr *in* Bretnall: p.11-12, pl. 2 figs 1, 4
1944c *Lyropora erkosoides* Etheridge Jnr; Crockford: p.191-192, pl. 1 fig. 2; pl. 2 fig. B
1957 *Lyroporella erkosoides* (Etheridge Jnr); Crockford: p.70

Diagnosis: Flabellate *Lyroporella* with two rows of zooecia per branch; lateral supports diverge at 70°; two, normally unstabilized zooecia per fenestrule; fenestrules oval; carina slight; nodes sharp, high, evenly spaced.

Closest species: Bassler (1953) validated two allied genera, namely *Lyroporella* Simpson 1895 with two rows of zooecia per branch and *Lyropora* Hall 1857 with three or more rows per branch. The two genera are otherwise very similar in form (see Crockford, 1957, p.70).

Types: Holotype - GSWA 13 (two unlabelled specimens); lectotype (Crockford, 1944c) - GSWA F513 (formerly GSWA 2/2404).

Type locality: Well 20, Daurie Creek, Gascoyne River area, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Value in correlation and dating: Only found with *Lyropora* in the Callytharra Formation.

Sedimentary environment: Shallow water.

Family POLYPORIDAE Vine 1883

Genus **LYROPORA** Hall 1857

Type species: *Fenestella (Lyropora) subquadrans* Hall 1857.

Generic range: Mississippian - Permian; North America, Australia.

Lyropora joselina Crockford 1957
(Plate 18 figs 1, 2)

1957 *Lyropora joselina* Crockford: p.70, pl. 19 figs 1-3

Diagnosis: Flabellate *Lyropora* with a coarse fenestrate mesh, the branches bearing five rows of zooecia and about six zooecia per fenestrule; lateral supports asymmetrical and fenestrules very flexuous.

Closest species: No closely comparable species.

Types: Holotype - CPC 1256A; paratypes - CPC 1222, 1247, 1256B, 1257, 1258.

Type locality: Lake Josceline, Mount Wynne area [1A], northern Canning Basin.

Distribution and range: **Carnarvon Basin** - Callytharra Formation; Lake Josceline, Mount Wynne area [1], northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Moderate.

Value in correlation and dating: Strong correlation between the Nura Nura Member and the Callytharra Formation is suggested by the known range of this species.

Sedimentary environment: Occurs in coarse calcareous sedimentary rocks.

Genus **POLYPORA** M'Coy 1844

Type species: *Polypora dendroides* M'Coy 1844; OD.

Generic range: Ordovician - Permian; worldwide.

Polypora australis Hinde 1890
(Plate 19 figs 8, 9)

1890 *Polypora australis* Hinde: p.199, pl. 8a figs 3, 3a

Diagnosis: Flabellate *Polypora* with near straight, flattened branches, joined by dissepiments in the same plane; fenestrules elongate oval; zooecial apertures in five rows, arranged regularly in oblique rows; apertures circular, small, not exserted, separated by about their own diameter; apertures extend on to the dissepiments, leaving a very small unoccupied zone in most cases.

Closest species: Close to *P. fastuosus* de Koninck, differing in the narrower fenestrules and apertures on the dissepiments. This species is very close to having apertural arrangements as found in the genus *Protoretepora*.

Holotype: GSWA F59.

Type locality: Gascoyne River area, Carnarvon Basin.

Distribution and range: Type locality - ?Callytharra Formation.

Age: ?Late Sakmarian (Sterlitamakian).

Abundance: One fragmentary specimen.

Value in correlation and dating: Too rare to be of use.

Sedimentary environment: Shallow water.

Polypora bruteni Wass 1967
(Plate 18 fig. 4)

1957 *Polypora* sp. nov. Crockford: p.66, pl. 17 fig. 3
1967a *Polypora bruteni* Wass: p.168

Diagnosis: Straight branches; short rounded fenestrules with dissepiments of similar dimensions; five or six rows of zooecia with four or five zooecia per fenestrule; nodes present but indistinct.

Closest species: *Australopolypora fovea* (Crockford) differs in having a slightly coarser mesh with a different appearance. *Polypora macrops* Bassler is very close but differs in bearing only four rows of zooecia. *P. halliana* Prout and *P. stellispinata* Shulga-Nesterenko have narrower dissepiments than *P. bruteni*.

Types: Holotype - CPC 1250; paratype - CPC 7721; other figured specimens - CPC 1078H, 1229B.

Type locality: Christmas Creek Station [6], northern Canning Basin.

Distribution and range: Christmas Creek Station [5J, 19], northern **Canning Basin** - Noonkanbah Formation. Port Keats District (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: Infrequent.

Value in correlation and dating: A useful Early Permian species.

Sedimentary environment: Shallow water.

Polypora kimberleyensis Crockford 1957
(Plate 18 figs 7, 8)

1957 *Polypora kimberleyensis* Crockford: p.62-63, pl. 17 figs 1-2

Diagnosis: Coarse-meshed *Polypora* with flabellate growth form; elongate oval fenestrules and thin straight branches with normally five or six rows of small apertures, seven to ten per fenestrule; small nodes occasionally developed on the obverse surface; reverse surface smooth.

Closest species: *P. multiporifera* Crockford is a coarser species with fenestrules of more variable length; *P. linea* Crockford has apertures of much larger diameter and spacing and exhibits occasional, very large nodes.

Types: Holotype - CPC 1173; paratypes - CPC 1068M, 1073J, 1115D, 1171C, 1184C, 11870, 1191B, 1210B, 1213F-G, 1216D, 1224C, 1238D, 1240-1243, 1244A, 1245, 1246A, 1288.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A,C,J,N, 6, 10, 22], Gogo Station [11], Cherrabun Station [12, 13], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Useful for stratigraphic control in the Canning Basin.

Sedimentary environment: Shallow water.

Polypora lyndoni Ross 1963
(Plate 18 figs 13-15)

1963 *Polypora lyndoni* Ross: p.77-80, pl. 9 figs 6, 10-12; pl. 11 figs 4-5

Diagnosis: Characterized by a delicate, fenestrate meshwork of slender branches; three rows of zooecia across a branch; small fenestrules; fine capillaries of 0.01 mm diameter and occasional tubules at the junctions of zooecial walls.

Closest species: *P. pertinax* Laseron *(Eurydesma cordatum* Zone, Allandale Formation, NSW) has a smaller number of zooecial openings per fenestrule, and narrower dissepiments.

Types: Holotype - CPC ML107-20; paratypes - CPC ML107-21 to ML107-28, ML109-10 to ML109-16, ML6-5 to ML6-10, ML90-10 to ML90-15.

Type locality: Lyndon River area, north of Moogooree Homestead, Carnarvon Basin.

Distribution and range: Type locality - Lyons Group.

Age: ?Asselian - Sakmarian (Tastubian).

Abundance: A common species.

Value in correlation and dating: A valuable Lower Permian species.

Sedimentary environment: Shallow water.

Polypora megastoma (de Koninck 1863)
(Plate 18 figs 11, 12)

1863 *Fenestella megastoma* de Koninck: p.5, pl. 2 figs 2, 3
1885 *Polypora megastoma* (de Koninck); Waagen & Pichl: p.785, pl. 88 figs 3, 5-7; pl. 89 fig. 3
1957 *Polypora megastoma* (de Koninck); Crockford: p.61, pl. 16 figs 2, 3

Diagnosis: Obverse surface unavailable; branches and dissepiments wide and very thick, of sub-equal size, tapered on the reverse surface to form distinctive dished, elongate-oval fenestrules; reverse surface of branches with longitudinal ribbing; zooecial chambers in eight to ten rows set in a regular diagonal pattern which extends on to the dissepiments leaving only a very narrow unoccupied central sector.

Closest species: No local comparable species.

Figured specimens: UWA 20952C, 2973C (missing), CPC 1082B, 1207, 1218, 1219, 1226.

Distribution and range: Christmas Creek Station [5A, 5J, 32], Cherrabun Station [7B], Liveringa Station [15], Bohemia Downs Station [16], Mount Anderson Homestead area [17A], northern **Canning Basin** - Noonkanbah Formation. Salt Range, India - Middle *Productus* Limestone.

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: An apparently common species.

Value in correlation and dating: Of possible value in correlation with the Indian faunas.

Sedimentary environment: Shallow water.

Polypora multiporifera Crockford 1944
(Plate 18 figs 9, 10)

1944a *Polypora multiporifera* Crockford: p.177-178, pl. 3 fig. 4

Diagnosis: *Polypora* with five to six rows of zooecia and from 6 - 14 zooecia per fenestrule; branches slightly convex; fenestrules long, irregular in length and rather narrow; nodes small, fairly abundant.

Closest species: *P. magnafenestrata* Crockford lacks the numerous small nodes, the absence of any rounded surface cells, and short, broad zooecia.

Types: Holotype - AM F38441; other specimens - UWA 2757K, CPC 1268.

Type locality: Minilya River west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Type locality - Wandagee Formation; Christmas Creek Station [5A], St George Ranges [31], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not common.

Value in correlation and dating: Good for interbasinal correlation.

Sedimentary environment: Shallow water.

Polypora natalis Crockford 1957
(Plate 18 figs 16, 17)

1944a *Polypora* sp. indet. Crockford: p.178, pl. 2 fig.5
1957 *Polypora natalis* Crockford: p.64-65, pl. 18 figs 1, 2; text fig. 12

Diagnosis: Very coarse, flabellate *Polypora*, with very small zooecial apertures in seven to eight rows and with 9 - 15 apertures per fenestrule; fenestrules polygonal from reverse surface, on which both branches and dissepiments are sharply convex.

Closest species: *P. gigantea* Waagen & Pichl from the Middle *Productus* Limestone of Salt Range, India which lacks the narrower fenestrules, broader dissepiments and more frequent bifurcations.

Types: Holotype - CPC 1289; paratypes - UWA 20952A, CPC 1068D,N,O, 1084F, 1195E, 1248, 1249.

Type locality: Cherrabun Station [8B], northern Canning Basin.

Distribution and range: Cherrabun Station [12], Christmas Creek Station [5C, 5N, 22, 32], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Moderate.

Value in correlation and dating: A distinctive form with considerable stratigraphic potential.

Sedimentary environment: Shallow water.

Polypora obesa Crockford 1957
(Plate 19 figs 1, 2)

1957 *Polypora obesa* Crockford: p.67, pl. 19 fig.4

Diagnosis: Coarse flabellate *Polypora*, with broad branches and dissepiments and very narrow oval fenestrules; five to nine rows of zooecia and usually seven apertures per fenestrule; obverse surface finely granular and occasional tiny nodes.

Types: Holotype - CPC 1255; paratypes - CPC 1111D, 1229C, 1247B.

Type locality: Christmas Creek Station [6], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Not common.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Polypora retificis Crockford 1944
(Plate 19 figs 5, 7)

1944a *Polypora retificis* Crockford: p.176-177, pl. 2 fig. 4
1967a *Polypora rectifis (sic)* Crockford; Wass: p.167

Diagnosis: *Polypora* with three to four rows of zooecia and three to four zooecia per fenestrule; narrow branches and fenestrules; dissepiments of similar width to fenestrules; nodes very large but infrequently developed.

Closest species: *P. woodsi* (Etheridge Jnr) has many more numerous and much smaller nodes.

Types: Holotype - UWA 20951; another figured specimen - CPC 7718.

Type locality: Syncline on Minilya River west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Type locality - Wandagee Formation. Port Keats area (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: Rare.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Polypora wadei Crockford 1957
(Plate 19 fig. 5)

1957 *Polypora wadei* Crockford: p.65-66, pl. 17 fig. 4
1967a *Polypora wadei* Crockford; Wass: p.167-168

Diagnosis: Moderately coarse *Polypora* with straight branches and oval to rectangular fenestrules with narrow dissepiments; five to six rows of apertures per branch and six to seven apertures per fenestrule; nodes not developed.

Closest species: *Polypora fovea* Crockford is finer and has a different number of rows of zooecia and of apertures to a fenestrule. *P. timorensis* Bassler has only four rows of apertures, and five to six tiny apertures per fenestrule.

Types: Holotype - CPC 1080B; paratypes - CPC 1116E, 1247A, 1252-1254; other figured specimens - CPC 7719, 7720.

Type locality: Cherrabun Station [12], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 6, 19], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation. Port Keats area (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Abundance: Not common.

Value in correlation and dating: Widespread occurrence; provides good stratigraphic control in the northern province.

Sedimentary environment: Shallow water.

Polypora woodsi (Etheridge Jnr 1892)
(Plate 19 figs 3, 4)

1877 *Protoretepora ampla* (Lonsdale); de Koninck: p.42, pl. 8, figs 5a-c
1880 *Protoretepora* sp. indet. Etheridge Jnr: p.278
1892 *Protoretepora ampla* var. *woodsi* Etheridge Jnr *in* Jack & Etheridge: p.222, pl. 8 fig. 12
1918 *Polypora tumula* Laseron: p.191, pl. 7 fig. 3; pl. 9
1929 *Polypora tripliseriata* Bassler: p.79, pl. 242(18) figs 14-16
1937 *Polypora tripliseriata* Bassler; Elias: p.331
1941 *Polypora woodsi* (Etheridge Jnr); Crockford: p.414, pl. 18 fig. 1; pl. 19 fig. 1
1944a *Polypora woodsi* (Etheridge Jnr); Crockford: p.177, pl. 3 fig. 2
1946 *Polypora woodsi* (Etheridge Jnr); Crockford: p.133
1957 *Polypora woodsi* (Etheridge Jnr); Crockford: p.61
1968a *Polypora woodsi* (Etheridge Jnr); Wass: p.53-54, pl. 13 fig. 3

Diagnosis: Infundibuliform *Polypora* having three rows of zooecia per branch and three to four zooecia per fenestrule; nodes strongly developed in relationship to the mid zooecial row.

Closest species: *Polypora varsoviensis* Ulrich has shorter fenestrules and narrower dissepiments; *P. repens* Trizna, *P. punctata* Shulga-Nesterenko and *P. michalevensis* Shulga-Nesterenko differ in branch and dissepiment dimensions; *P. martis* (Fischer) has closer apertures and lacks nodes (Wass, 1968a).

Types: Holotype - lost; neotype (Crockford, 1941a) - SUGD 1408; other figured specimens - UWA 2757J, 20943, CPC 1153B, 1187E, 1231, 1234B, 1238C, 1290M.

Type locality: Sydney Basin, NSW.

Distribution and range: **Carnarvon Basin** - Callytharra Formation; Christmas Creek Station [5C, 19, 22], Mount Anderson Homestead area [17], Little Flow [27], St George Ranges [31], northern **Canning Basin** - Noonkanbah Formation. Bowen Basin, Rockhampton (Qld) - Cattle Creek Formation, Lakes Creek Beds; Sydney Basin (NSW) - Branxton Formation (*Fenestella* Shale), Conjola Formation; Tasmania - Berridale Limestone.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian) in Western Australia. Artinskian - Kungurian in New South Wales.

Abundance: Relatively common.

Value in correlation and dating: A widespread, characteristic Early Permian species.

Sedimentary environment: Shallow water.

Genus **AUSTRALOPOLYPORA** Engel 1979

Type species: *Polypora palenensis* Crockford 1949; OD.

Generic range: Late Visean - Permian; Australia.

Australopolypora fovea (Crockford 1944)
(Plate 18 figs 5, 6)

1944a *Polypora fovea* Crockford: p.175-176, pl. 3 figs 1, 3
1957 *Polypora fovea* Crockford: p.62

Diagnosis: A species of *Australopolypora* Engel with four to five rows of zooecia and four to five zooecia per fenestrule; zooecial peristomes raised and covered with a perforated plate; branches and dissepiments narrow; nodes small, infrequently developed.

Closest species: The species has strong affinities with *Australopolypora keppelensis keppelensis* (Crockford) from which it differs slightly in having a smaller zooecial diameter and longer fenestrules with more apertures per fenestrule; *P. virga* Laseron (Maitland Group, NSW) is larger and has three rows of zooecia.

Types: Holotype - UWA 20947; paratypes - UWA 20946; other figured specimens - CPC 1211 (topotype), 1227, 1228, 1229A.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: Minilya River, Wandagee Station, **Carnarvon Basin** - Wandagee Formation; Christmas Creek Station [6, 19], Bohemia Downs Station [16], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Infrequent.

Value in correlation and dating: Unknown but has some potential for interbasinal correlation.

Sedimentary environment: Shallow water.

Genus **PROTORETEPORA** de Koninck 1876

Type species *Fenestella ampla* Lonsdale 1844; OD.

Generic range: Carboniferous - Permian; Timor, India, Pakistan, Australia.

Protoretepora ampla (Lonsdale 1844)
(Plate 19 figs 13-16)

1844 *Fenestella ampla* Lonsdale: p.163
1845 *Fenestella ampla* Lonsdale: p.268, pl. 9 fig. 3b (only)
1877 *Protoretepora ampla* (Lonsdale); de Koninck: p.180, pl. 8 fig. 5
1941a *Protoretepora ampla* (Lonsdale); Crockford: p.406, pl. 19 fig. 4; text fig. 2a
1944b *Protoretepora ampla* (Lonsdale); Crockford: p.160
1957 *Protoretepora ampla* (Lonsdale); Crockford: p.68
1967a *Protoretepora ampla* (Lonsdale); Wass: p.168-169
1968a *Protoretepora ampla* (Lonsdale); Wass: p.55-56, pl. 13 fig. 4

Diagnosis: *Protoretepora* with wide branches connected by celluliferous dissepiments of similar width; oval fenestrules; zooecia in four to eight rows on the branches, two to three rows on the dissepiments; four to six zooecia per fenestrule (Wass, 1968a).

Types: Holotype - lost (no neotype from possible type locality in southern Tasmania is available); other figured specimens - UWA 22320, CPC 1259, 7722.

Type locality: Unknown locality in Tasmania.

Distribution and range: Christmas Creek Station [32], Mount Anderson Homestead area [17], northern **Canning Basin** - Noonkanbah Formation. Bowen Basin (Qld) - Cattle Creek Formation, Stanleigh Formation; Sydney Basin (NSW) - Branxton Formation; Port Keats District (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia. Artinskian in Queensland and New South Wales.

Abundance: Widespread but not common.

Value in correlation and dating: Has some potential for correlation with its Australian wide dispersal.

Sedimentary environment: Shallow water.

Protoretepora flexuosa Crockford 1957
(Plate 19 figs 10-12)

1957 *Protoretepora flexuosa* Crockford: p.69-70, pl. 18 figs 4-5

Diagnosis: *Protoretepora* with narrow, flexuous branches and broad celluliferous dissepiments, so arranged that the dissepiments do not always fall into distinct linear series; apertures usually in five rows, with seven to eight per fenestrule; branches and dissepiments rounded and fenestrules small and circular on the reverse surface.

Closest species: *P. jabiensis* (Waagen & Pichl) from the Upper *Productus* Limestone is distinguished by the lack of prominent and numerous nodes on the obverse surface.

Types: Holotype - CPC 1261; paratypes - CPC 1168D, 1174C, 1261, 1262A-B, 1263-1265, 1267, 1269.

Type locality: Christmas Creek Station [5C], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 5J, 5N], Brutens Yard area [7B], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Numerous specimens from the Canning Basin.

Value in correlation and dating: A good indicator of the age of Lower Permian strata.

Sedimentary environment: Shallow water.

Protoretepora robusta (Bassler 1929)
(Plate 19 fig. 17)

1929 *Phyllopora? robusta* Bassler: p.82, pl. 246(22) figs 3-6
1957 *Protoretepora robusta* (Bassler); Crockford: p.68

Diagnosis: Coarse network of robust, anastomosing branches with six to seven rows of zooecia arranged in a diagonal pattern; no pronounced surface ornament; reverse of branch composed of thick laminated tissue.

Remarks: In view of the inadequate state of preservation of the monotype from Timor, this identification must, at best, be considered conjectural.

Closest species: None recorded.

Figured specimens: CPC 1116D, 1260.

Distribution and range: Christmas Creek Station [5A], northern **Canning Basin** - Noonkanbah Formation. Timor - Bitauni Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Late Artinskian (Kungurian) in Timor.

Abundance: Rare.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Family SEPTOPORIDAE Morozova 1962

Genus **SEPTOPORA** Prout 1859

Type species: *Septopora cestriensis* Prout 1859.

Generic range: Mississippian - Permian; USSR, North America, Australia.

Septopora ornata Crockford 1944
(Plate 20 fig. 8)

1944b *Septopora ornata* Crockford: p.164-165, pl. 4 fig. 11; pl. 5 fig. 3

Diagnosis: *Septopora* with thick branches joined by short, thick celluliferous dissepiments; usually three to five apertures on the main stem between successive lateral branches or dissepiments; accessory pores about equal in number to apertures on obverse surface, few on reverse; carina slight with large distant nodes.

Types: Holotype - CPC 310 (=796 Crockford, 1944b); paratype - GSWA 2/2404B (missing).

Type locality: West of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Below Callytharra Spring, Wooramel River, Daurie Creek, Gascoyne River district, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Fairly abundant in Callytharra Formation.

Value in correlation and dating: Not known elsewhere in the Permian of Western Australia.

Sedimentary environment: Shallow water (30 - 50 m).

Genus **SYNOCLADIA** King 1849

Type species: *Retepora virgulacea* Phillips 1829.

Generic range: Mississippian - Permian; UK, Australia.

Synocladia spinosa Crockford 1944
(Plate 20 figs 4, 5)

1944b *Synocladia spinosa* Crockford: p.165-166, pl. 5 figs 1, 2

Diagnosis: *Synocladia* with broad thick branches and short, curved celluliferous dissepiments; apertures in three to five rows, five to six per fenestrule; 'accessory pores" about equal in number to apertures on obverse surface; nodes not numerous but very large; rows of zooecia not separated by carinae.

Closest species: *S. virgulacea* (Phillips) (Permian of England, Germany, India) differs in apertural arrangement, absence of carina and strongly developed nodes.

Types: Holotype - UWA 22134A; paratypes - UWA 22134B, 22321, 22322.

Type locality: Minilya River area, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality - Allego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: A reasonably common species.

Value in correlation and dating: Common and stratigraphically restricted.

Sedimentary environment: Shallow water.

Synocladia teicherti Crockford 1957
(Plate 20 figs 6, 7)

1957 *Synocladia teicherti* Crockford: p.72-73, pl. 17 fig. 5; pl. 18 fig. 3

Diagnosis: Coarse *Synocladia*, branches with usually four rows of zooecia, and seven apertures per fenestrule; dissepiments broad, not strongly arched, having three additional transverse rows of apertures, with up to five apertures in each row; small nodes fairly numerous on the obverse surface and occasional "accessory cells" on both obverse and reverse.

Closest species: *S. spinosa* Crockford differs in the number of rows of apertures and the development of nodes and "accessory cells".

Types: Holotype - CPC 1274; paratypes - CPC 1077K, 1205, 1215B, 1234A, UWA 20952D.

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 32], Cherrabun Station [12, 19], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Moderate.

Value in correlation and dating: Not determined.

Sedimentary environment: Shallow water.

Suborder RHABDOMESINA Astrova & Morozova 1956

Family RHABDOMESIDAE Vine 1884

Genus **RHABDOMESON** Young & Young 1874

Type species: *Millepora gracilis* Phillips 1841; OD.

Generic range: Middle Devonian - Late Permian; North America, USSR, Asia, Australia.

Rhabdomeson bispinosum (Crockford 1944)
(Plate 20 fig. 9)

1944b *Rhabdomeson bispinosa* Crockford: p.167, text fig. 47
1957 *Rhabdomeson bispinosum* Crockford: p.75
1967 *Rhabdomeson bispinosa* Crockford; Condon: p.70

Diagnosis: Fine dendroid colonies of *Rhabdomeson* with zooecial apertures in 14 to 16 longitudinal rows; zooecial apertures also in diagonal rows; two sizes of acanthopores; two large acanthopores in the longitudinal interspace between successive zooecial apertures; a few small acanthopores in the interspaces between zooecial apertures (Crockford, 1944b, p.167).

Closest species: *R. consimile* Bassler from Timor which is larger, has a larger axial tube, differs in the angle of divergence of the zooecia from the axial tube and possesses comparatively strong hemisepta (Crockford, 1944b, p.167).

Types: Holotype - GSWA 2/2405F (slide UWA 2/2405F); other figured specimens - UWA 22132B (missing), CPC 1077I, 1189A.

Type locality: Fossil Hill near Wyndham River, Carnarvon Basin.

Distribution and range: Type locality - Callytharra Formation; Cherrabun Station [12], Grant Range [33], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Three specimens.

Value in correlation and dating: Occurs in both basins.

Sedimentary environment: Foreslope or open shelf.

Rhabdomeson bretnalli Crockford 1957
(Plate 20 figs 10, 11)

1957 *Rhabdomeson bretnalli* Crockford: p.75-76, pl. 20 figs 4-7

Diagnosis: Dendroid colonies of *Rhabdomeson* with thick branches; small zooecial apertures in fairly regular longitudinal and diagonal rows; four to six large acanthopores in the angles of zooecial apertures; small acanthopores are slightly more numerous than large acanthopores (Crockford, 1957, p.75).

Closest species: *R. mammillatum* (see below) which differs in size and regularity of the apertural arrangement, by different proportions in the axial and mature zones, by the arrangement of large acanthopores and by the presence of small acanthopores (Crockford, 1957, p.76).

Types: Holotype - CPC 1189A; paratypes - CPC 1167B, 1187B-C, 1188A, 1190.

Type locality: Mount Anderson Homestead area [17], northern Canning Basin.

Distribution and range: Christmas Creek Homestead area [5R, 19, 22], Liveringa Station [15], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Rhabdomeson grande Bassler 1929
(Plate 20 fig. 12)

1929 *Rhabdomeson grande* Bassler: p.69-70, pl. 13 figs 9-14
1957 *Rhabdomeson grande* Bassler; Crockford: p.75, pl. 19 fig.5

Diagnosis: Large cylindrical stems of *Rhabdomeson* with a diameter of 6 mm; large zooecial apertures in longitudinal rows; each row is separated by a longitudinal line of large acanthopores; small acanthopores also form a single row around each zooecial aperture; central axial tube of 1 - 2 mm (Bassler, 1929).

Figured specimen: CPC 1144B.

Distribution and range: Christmas Creek Station [10], northern **Canning Basin** - Noonkanbah Formation. Timor - Bitauni Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Late Artinskian (Kungurian) in Timor.

Abundance: Rare.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Rhabdomeson mammillatum (Bretnall 1926)
(Plate 20 figs 13-15)

1926 *Rhombopora mammillata* Bretnall: p.24, pl. 1 fig. 2
[non] 1931 *Rhombopora mammillata* Bretnall; Hosking: p.14
1933 *Rhabdomeson shanse* Reed: p.113, pl. 2 fig. 3
1944b *Rhabdomeson mammillata* (Bretnall); Crockford: p.166-167, pl. 5 fig. 14; text figs 39-41
1957 *Rhabdomeson mamillatum* (Bretnall); Crockford p.73

Diagnosis: Dendroid colonies of *Rhabdomeson* with thick branches and wide axial cylinder; zooecial apertures regularly arranged in about 30 to 40 longitudinal rows and in steeply intersecting diagonal rows; one large acanthopore at each angle of each zooecial aperture; no small acanthopores (Crockford, 1957, p.166).

Closest species: See comparison under *R. bretnalli*.

Types: Holotype - GSWA 2/10930C (not marked) (slides UWA 41202-41204); other figured specimens - UWA 2757I, CPC 1077H, 1078D, 1113A, 1126C, 1182, 1283C.

Type locality: Mount Marmion [29], northern **Canning Basin**.

Distribution and range: Gogo Station [11], Cherrabun Station [13], Christmas Creek Station [19], Ellendale Station [23], St George Ranges [31], Pilots Camp [25], northern **Canning Basin** - Noonkanbah Formation.

Remarks: Crockford (1944b, p.142, 167) has concluded that there appears to be no record of *R. mammillatum* (Bretnall) in the Carnarvon Basin (Callytharra Formation) because: the species does not occur at Fossil Hill, Wyndham River, the determinations by Bretnall (1926) being wrong; the type material supposedly from the Gascoyne River area is actually from Mount Marmion in the northern Canning Basin; and the reference by Hosking (1931, p.14) to this species in the Wooramel District is also a misidentification.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Rhabdomeson mammillatum var. nov. Crockford 1957
(Plate 20 fig. 16)

1957 *Rhabdomeson mammillatum* var. nov.? Crockford: p.74, pl. 20 figs 1-3

Diagnosis: Dendroid colonies of *Rhabdomeson* with exceptionally thick branches and wide axial cylinder; large rhombic zooecial apertures regularly arranged in 25 to 35 longitudinal rows and also aligned in distinctive diagonal rows; one large acanthopore at each angle of each zooecial aperture; no small acanthopores.

Closest species: Distinguished from *R. mammillatum* by large branch size. Possibly represent basal fragments of *R. mammillatum*.

Figured specimens: CPC 1176B, UWA 22336D,E (CPC 1176B and UWA 22336D were nominated as the most typical specimens); other figured specimens - CPC 1146B, 1183A, 1184A, 1185A, 1186A, 1277, UWA 2757G-H, 22336F,G.

Distribution and range: Christmas Creek Station [5A, 5C, 21, 22, 37], Ellendale Station [23], St George Ranges [31], Duchess Ridge [35], northern **Canning Basin** - Noonkanbah Formation, basal Liveringa Group.

Age: Late Artinskian (Baigendzhinian) - basal Kungurian.

Abundance: Common(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Rhabdomeson? ramosa (Crockford 1957)
(Plate 20 fig. 21)

1957 *Callocladia? ramosa* Crockford: p.56-57, pl. 15 figs 1, 2; text fig. 9

Diagnosis: Dendroid colony with hollow axial cylinder; large rhomboid zooecial apertures; two types of acanthopores; monticules with occasional mesozooecia?.

Closest species: *Rhabdomeson mammillatum* (Bretnall) and *R. bretnalli* Crockford have zooecial apertures of more regular size and lack monticules with mesozooecia(?).

Holotype: CPC 1180.

Type locality: Mount Anderson Homestead [17], northern **Canning Basin**.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope and shoals.

Family RHOMBOPORIDAE Simpson 1895

Genus **RHOMBOPORA** Meek 1872

Type species: *Rhombopora lepidodendroides* Meek 1872; OD.

Generic range: ?Late Devonian, Early Mississippian - Late Permian; North America, Asia, South America, Australia, USSR.

Rhombopora? tenuis Hinde 1890
(Plate 20 figs 19, 20)

1890 *Rhombopora tenuis* Hinde: p.203, pl. 8a figs 4, 4a
1926 *Rhombopora tenuis* Hinde; Bretnall: p.23-24

Diagnosis: Zoarium cylindrical, branching; axial region with thin-walled polygonal tubes moderately divergent from axis; zooecia tubes bend roundly, becoming thickened and situated perpendicular to the surface; diaphragms not observed; stylets and metapores located between oval shaped apertures (after Hinde, 1890).

Closest species: *R. interporosa* Phillips.

Types: Holotype - Presumed lost; other figured specimens - GSWA 11/10930A-B, AM F17559.

Distribution and range: Gascoyne River area, **Carnarvon Basin** - Callytharra Formation; Mount Marmion [29], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Several fragments (Hinde, 1890, p.203)

Value in correlation and dating: Not determined.

Sedimentary environment: Foreslope or open shelf.

Genus **SAFFORDOTAXIS** Bassler 1952

Type species: *Rhombopora incrassata* Ulrich 1888; OD.

Generic range: Early Mississippian - ?Permian; North America, Australia.

Saffordotaxis castanea Crockford 1957
(Plate 21 fig. 1)

1957 *Saffordotaxis castanea* Crockford: p.78-79, pl. 21 figs 5, 6; text fig. 13

Diagnosis: Coarse, ramose colonies of *Saffordotaxis* with about 24 rows of zooecial apertures, regularly arranged longitudinally and diagonally; large acanthopores, all of one size, in single flexuous lines between adjacent rows of zooecial apertures; 8 to 10 acanthopores along each side of a zooecial aperture.

Closest species: Differs from *S. multigranulata* (Bretnall) in the arrangment of acanthopores (Crockford, 1957).

Types: Holotype - CPC 1073K; paratypes - CPC 1187D, 1202A, 1203.

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 22], Bohemia Downs Station [16], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Unknown.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope.

Saffordotaxis elegans Crockford 1957
(Plate 21 figs 2, 3)

1957 *Saffordotaxis elegans* Crockford: p.77-78, pl. 21 figs 1-4
1967a *Saffordotaxis elegans* Crockford; Wass: p.164-165

Diagnosis: Fine ramose colonies of *Saffordotaxis* with about 10 rows of large, oval, widely spaced zooecial apertures; numerous small acanthopores, usually in single flexuous lines between adjacent rows of zooecial apertures

Closest species: *S. multigranulata* (Bretnall) is a coarser form. Further differences exist in the spacing and arrangement of the zooecia and acanthopores.

Types: Holotype - CPC 1185E; paratypes - CPC 1061B, 1068F-J, 1077J, 1094D, 1103C-D, 1118B-E, 1122B, 1134B, 1146C, 1149B-F, 1169D-E, 1183B,D, 1184B, 1187I-M, 1195A-B, 1199A, 1276B, 7708-7709.

Type locality: Christmas Creek Station [21], northern Canning Basin.

Distribution and range: Christmas Creek Station [5A, 5C, 19, 22, 37], Cherrabun Station [12], Noonkanbah Station [14], Bohemia Downs Station [16], Ellendale Station [23], northern **Canning Basin** - Noonkanbah Formation, basal Liveringa Group. Port Keats district (NT).

Age: Late Artinskian (Baigendzhinian) - Kungurian in Western Australia.

Abundance: Common.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope.

Saffordotaxis multigranulata (Bretnall 1926)
(Plate 21 figs 5-9)

1926 *Rhombopora multigranulata* Bretnall: p.25, pl. 1 fig. 3
[non] 1931 *Rhombopora multigranulata* Bretnall; Hosking: p.14, pl. 4 fig. 2
1944b *Rhombopora multigranulata* Bretnall; Crockford: p.167-168, pl. 5 fig. 13; text figs 35-36
1957 *Saffordotaxis multigranulata* (Bretnall); Crockford: p.76

Diagnosis: Fine colonies of *Saffordotaxis* with long and oval zooecial apertures in 13 to 15 longitudinal rows; one to two rows of small and numerous acanthopores in wide spaces between zooecial apertures.

Closest species: *R. exigua* Ulrich from the Burlington Group of Iowa.

Types: Holotype - GSWA 3/10930C; paratypes - GSWA 3/10930A (smaller of two specimens; slide UWA 3/10930A); other figured specimens - UWA 2757P, 8499A/B, CPC 1156D, 1191A, 1192, 1193, 1266, (AM F17540, 36575 both missing).

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: **Carnarvon Basin** - Callytharra Formation; Christmas Creek Station [5R, 21], Brutens Yard [8], Mount Anderson Homestead area [17], St George Ranges [31], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope.

Saffordotaxis sp. cf. **S. wanneri** (Bassler 1929)
(Plate 21 fig. 4)

1929 *Rhombopora wanneri* Bassler: p.64, pl. 245(21) figs 7-9
1957 *Saffordotaxis* cf. *wanneri* (Bassler); Crockford: p.76-77

Diagnosis: Dendroid colony of *Saffordotaxis* with small zooecial apertures and broad interspaces; numerous, small, irregularly arranged acanthopores.

Closest species: *S.* cf. *wanneri* differs from *S. wanneri* in irregular zooecial spacing (Crockford, 1957).

Figured specimen: CPC 1204.

Distribution and range: Christmas Creek Station [5A], northern **Canning Basin** - Noonkanbah Formation. Timor - Basleo Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Chhidruan in Timor.

Abundance: One specimen.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Genus **MEGACANTHOPORA** Moore 1929

Type species: *Megacanthopora fallacis* Moore 1929; Monotypy.

Generic range: Pennsylvanian - ?Permian; North America, USSR, Australia.

Megacanthopora? scalariformis Crockford 1957
(Plate 14 figs 24-26)

1957 *Megacanthopora(?) scalariformis* Crockford: p.48-50, pl. 15 figs 3-6

Diagnosis: Fine, ramose colonies of a rhomboporid with abundant metapores(?) between zooecial apertures at the colony surface; abundant acanthopores are not prominent at the surface and are more numerous in deep tangential sections than the metapores(?), where they appear to replace the metapores(?).

Closest species: No close species. *M. fallacis* Moore shows some relationship in section and in its simulation of mesopores by enlarged megacanthopores.

Holotype: CPC 1129.

Type locality: Christmas Creek Station [5J], northern Canning Basin.

Distribution and range: Type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Family HYPHASMOPORIDAE Vine 1886

Genus **OGBINOPORA** Shishova 1965

Type species: *Ogbinopora armeniensis* Shishova 1965; OD.

Generic range: Permian; USSR, Southeast Asia, Australia.

Ogbinopora? etheridgei (Bretnall 1926)
(Plate 21 figs 11-13)

1926 *Streblotrypa etheridgei* Bretnall: p.23 *[non* pl. 1 fig. 7]
1944b *Streblotrypa etheridgei* Bretnall; Crockford: p.169-170, pl. 4 fig. 12; text figs 37-38

Diagnosis: Dendroid colonies of hyphasmoporid with central bundle of axial tubes; rows of oval zooecial apertures are not separated by well-developed longitudinal ridges; about 11 to 13 metapores in the longitudinal area between zooecial apertures and one large metapore distal to each zooecial aperture; inferior and superior hemisepta; zooecia diverge from the axial region at an angle of about 25 to 30 degrees.

Closest species: *S. marmionensis* is smaller and has different surface characters. No other species can be closely compared.

Types: Holotype - AM F17550; paratypes - GSWA 5/10930C [other paratypes of Bretnall excluded]; other figured specimens - UWA 22336A.

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: Duchess Ridge [35], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Unknown.

Value in correlation and dating: Distinctive form; value not determinable at present.

Sedimentary environment: Foreslope or open shelf .

Genus **STREBLOTRYPA** Vine 1885

Type species: *Streblotrypa nicklisi* Vine 1885; Monotypy.

Generic range: Late Mississippian - Late Permian; Europe, Asia, Australia, North America, South America.

Streblotrypa sp. cf. **S. minutula** Bassler 1929
(Plate 21 fig. 14)

1929 *Streblotrypa minutula* Bassler: p.67, pl. 239 (15) figs 11-15
1957 *Streblotrypa minutula* Bassler; Crockford: p.79

Diagnosis: Tiny, dendroid colonies, 0.35 - 0.5 mm in diameter, of *Streblotrypa (Streblotrypa)* with minute oval zooecial apertures; numerous metapores; no distinct axial bundle of tubes.

Figured specimens: CPC 1068E, 1116E, 1169A, 1179A, 1183C, 1185D, 1200A, 1201A.

Distribution and range: Christmas Creek Station [5A, 5C, 19, 21, 22], northern **Canning Basin** - Noonkanbah Formation. Timor - Amarassi Beds.

Age: Late Artinskian (Baigendzhinian) in Western Australia. Chhidruan in Timor.

Abundance: Common(?).

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

Subgenus **STREBLASCOPORA** Bassler 1952

Type species: *Streblotrypa fasciculata* Bassler 1929; OD.

Generic range: Early Carboniferous - Late Permian; USSR, Southeast Asia, Japan, Australia, North America.

Streblotrypa (Streblascopora) marmionensis (Etheridge Jnr 1926)
(Plate 21 figs 15-22)

1926	*Steblotrypa marmionensis* Etheridge Jnr *in* Bretnall: p.22, pl. 1 fig. 11; pl. 2 fig. 3
?1929	*Streblotrypa germana* Bassler: p.67, pl. 239 (15) figs 6-10
1931	*Streblotrypa marmionensis* Etheridge Jnr; Hosking: p.14-15, pl. 4 fig. 1; text fig. 1
1944b	*Streblotrypa marmionensis* Etheridge Jnr; Crockford: p.168, pl. 5 figs 10, 11; text figs 31-34
1957	*Streblascopora marmionesis (sic)* (Etheridge Jnr); Crockford: p.80
1967	*Streblascopora marmionensis* (Etheridge Jnr); Condon p.70
1967a	*Streblascopora marmionensis* (Etheridge Jnr); Wass: p.165-167, pl. 1
1968a	*Streblascopora marmionensis* (Etheridge Jnr); Wass: p.36-37, pl. 10 figs 2-7

Diagnosis: Denroid colonies of *Streblotrypa (Streblascopora)* with 16 to 20 rows of zooecial apertures; numerous metapores set off by longitudinal ridges; 4 to 12 metapores in the longitudinal space between successive zooecial apertures; small inferior hemiseptum in zooecial tube.

Closest species: *Ogbinopora etheridgei* (Bretnall).

Types: Holotype - AM F17458 (destroyed); neotype - AM F17551 (Crockford, 1957, p.90); paratypes - AM F17539, 17541, 17542, 17547, 17549, (slides UWA 41205-41207, T202); other figured specimens - CPC 146, 1223A/B, 1293B-C, 7710-7714, UWA 8499C, 98599.

Type locality: Mount Marmion [29], northern Canning Basin.

Distribution and range: Fossil Hill near Wyndham River, Gascoyne River district, **Carnarvon Basin** - Callytharra Formation, Byro Group; Mount Wynne [1], Cherrabun Station [36], Christmas Creek Station [37], most fossil localities in the northern **Canning Basin** - Nura

Nura Member of the Poole Sandstone, Noonkanbah Formation, basal Liveringa Group. Bowen Basin (Qld) - Cattle Creek Formation; Port Keats District (NT).

Age: Late Sakmarian (Sterlitamakian) - basal Kungurian in Western Australia. Artinskian in Queensland.

Abundance: Abundant.

Value in correlation and dating: Widespread.

Sedimentary environment: Foreslope or open shelf.

UNCERTAIN PLACING

Genus **RHOMBOCLADIA** Rodgers 1900

Type species: *Rhombocladia delicata* Rodgers 1900.

Generic range: Pennsylvanian - Permian; North America, USSR, Australia.

Rhombocladia minor Crockford 1944
(Plate 20 fig. 17)

1944b *Rhombocladia minor* Crockford: p.171, pl. 5 fig. 5; text figs 45, 46
1967 *Rhombocladia minor* Crockford; Condon: p.70

Diagnosis: Fine, irregularly reticulate colonies of *Rhombocladia* with usually three rows of zooecial apertures on the obverse surface of a branch; numerous and small acanthopores; flat reverse surface.

Closest species: *R. delicata* is a larger species.

Holotype: CPC 307 (=805 Crockford, 1944b).

Type locality: Below Callytharra Spring, Carnarvon Basin.

Distribution and range: West of Callytharra Spring, Wooramel River district, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Many small fragments.

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Rhombocladia spinulifera Crockford 1944
(Plate 20 fig. 18)

1944b *Rhombocladia spinulifera* Crockford: p.171-172; text fig. 48
1967 *Rhombocladia spinulifera* Crockford; Condon: p.70

Diagnosis: Irregularly reticulate colonies of *Rhombocladia* with four to six rows of zooecial apertures on the obverse surface of a branch; numerous and small acanthopores in a single row form a ridge between zooecial apertures.

Types: Holotype - UWA 20944B; other figured specimens - UWA 2757N, CPC 1275.

Type locality: North of Mount Anderson Homestead [17], northern Canning Basin.

Distribution and range: **Carnarvon Basin** - Callytharra Formation; Mount Marmion [29], St George Ranges [31], northern **Canning Basin** - Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: Rare(?).

Value in correlation and dating: Not determinable at present.

Sedimentary environment: Foreslope or open shelf.

Genus **STREBLOCLADIA** Crockford 1944

Type species: *Strebiocladia excavata* Crockford 1944.

Generic range: Permian; Australia.

Strebiocladia excavata Crockford 1944
(Plate 21 fig. 10)

1944b *Strebiocladia excavata* Crockford: p.172, pl. 5 fig. 7; text figs 42-43
1967 *Strebiocladia excavata* Crockford; Condon: p.70

Diagnosis: Fine, bifurcating colonies of *Strebiocladia* with zooecial apertures in generally three, less commonly two, rows; shallow metapores form irregular pits between zooecial apertures; no acanthopores.

Holotype: CPC 308 (= 806 Crockford, 1944b).

Type locality: West of Callytharra Springs, Wooramel River area, Carnarvon Basin - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen.

Value in correlation and dating: Not determinable.

Sedimentary environment: Foreslope or open shelf.

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Brachiopods

BRACHIOPOD GENERA AND SPECIES

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BRACHIOPOD GENERA AND SPECIES

Class INARTICULATA Huxley 1869
Order LINGULIDA Waagen 1885
Superfamily LINGULACEA Menke 1828

Family LINGULIDAE Menke 1828
Subfamily LINGULINAE Menke 1828

Genus **SEMILINGULA** Egorov & Popov 1990

Type species: *Lingula arctica* Miloradovich 1936; OD. 1801.

Semilingula occidentaustralis (Archbold 1981)
(Plate 22 figs 1-3)

1951 *Lingula* sp. Teichert: p.81
1981c *Lingula occidentaustralis* Archbold: p.172-173, pl. 14 figs 1-15

Diagnosis: Elongate species with lateral margins of shell almost straight and parallel in mature individuals; muscle scars weakly impressed.

Closest species: *Semilingula miloradovichi* (Ifanova 1972), which has strongly impressed muscle scars.

Types: Holotype - MUGD 5181; paratypes - MUGD 5177-5180, 5182-5190, UWA 88098, 88099.

Type locality: Coolkilya Flat south of Garden Road, Wandagee Station, Carnarvon Basin.

Distribution and range: Coolkilya Flat area, **Carnarvon Basin** - Quinnanie Shale.

Age: Late Artinskian (Late Baigendzhinian).

Abundance: Relatively common (23+ specimens).

Value in correlation and dating: Limited value because of environmental constraints.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water probably subject to salinity fluctuations; silty to very fine sand, organic-rich substrate.

Class ARTICULATA Huxley 1869
(*sensu* Cooper & Grant 1974)
Superfamily ORTHOTETACEA Waagen 1884
(*sensu* Cooper & Grant 1974)

Family SCHUCHERTELLIDAE Williams 1953
(*sensu* Cooper & Grant 1974 *non* Manankov 1984)
Subfamily DERBYOIDINAE Thomas 1958

Genus **PERMORTHOTETES** Thomas 1958

Type species: *Permorthotetes callytharrensis* Thomas 1958; OD.

Permorthotetes callytharrensis Thomas 1958
(Plate 22 figs 14-17; Plate 23 figs 1, 2)

1958b *Permorthotetes callytharrensis* Thomas: p. 84-89, pl. 4 figs 1-8; pl. 5 figs 1-4; pl.6 fig. 6; pl. 18 figs 3-5; pl. 20 figs 1a-k, 2a-m
1965 *Orthotetes callytharrensis* (Thomas); Muir-Wood & Williams: p.H410, figs 268, 1 e-g
1967 *Permorthotetes callytharrensis* Thomas; Condon: p.70
1971 *Permothotetes callytharrensis* Thomas; Waterhouse: p.391

Diagnosis: Large thin-walled species (largest specimen 9 cm wide and 6.5 cm long), wider than long with ratio decreasing with growth, maximum width at half shell length generally; ventral valve usually convex, (rarely flat), short septum less than one-third shell length; secondary spondylium short and symmetrical; dorsal valve unevenly convex (maximum tumidity usually nearer hinge line), sulcate; cardinal process long in large forms; costellae fine, (9-10 in 5 mm); rugae often strongly developed (Modified after Thomas, 1958b p.84).

Closest species: *P. lindneri* is smaller and more symmetrical with flatter ventral valve and more rounded front margin; *P. teicherti* has a less convex and more symmetrical ventral valve; *P. guppyi* is thicker shelled and with a less pronounced secondary spondylium; *P. crespinae* has a wider apical angle.

Types: Holotype - CPC 1473; paratypes - CPC 1474-1477, 1485, 1486; other figured specimens - CPC 1478-1483, 1532.

Type locality: About 9 km at 335° from Lyons River Homestead, Carnarvon Basin.

Distribution and range: Lyons River Station; Callytharra Springs, Lyndon River, and Arthur River areas; Towrana, Williambury, Mount Sandiman, and Middalya Stations, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Numerous moulds, casts and isolated valves.

Value in correlation and dating: Common and useful; confined to Callytharra Formation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; calcilutite to calcarenite, occasionally sandy substrate.

Permorthotetes camerata Thomas 1958
(Plate 23 figs 3, 4)

1958b *Permorthotetes camerata* Thomas; p.102-105, pl. 6 figs 1-5
1967 *Permorthotetes camerata* Thomas; Condon: p.70

Diagnosis: Large fairly thin walled species (maximum 9 cm wide and 7-8 cm long, isolated brachial valve 12 cm wide); wider than long, maximum width shifts to front with growth (one specimen only); ventral valve flat to slightly concave; interarea high and convex in longitudinal profile, secondary spondylium long, septum long, nearly half shell length; dorsal valve variable in convexity, cardinal process long; costellae widely spread and coarse (5-7 per 5 mm); rugae broad and gentle; fine concentric ornament between costellae (modified after Thomas, 1958b, p.102).

Closest species: Distinct from other species.

Types: Holotype - CPC 1514; paratype - CPC 1515; other figured specimens - CPC 1516-1518.

Type locality: About 6.4 km at 330° from Mingenew Outcamp, Bidgemia Station, Carnarvon Basin.

Distribution and range: Bidgemia, Mount Sandiman, Towrana and Williambury Stations, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Not abundant, incomplete shells and moulds from five localities.

Value in correlation and dating: Known only in Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; calcilulite to calcarenite substrate.

Permorthotetes sp. aff. **P. camerata** Thomas 1958

1958b *Permorthotetes* sp. aff. *P. camerata* Thomas: p.105-106

Distribution and range: South of the Grant Range, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: A few incomplete shells.

Value in correlation and dating: Uncertain; rare.

Permorthotetes crespinae Thomas 1958
(Plate 22 figs 11-13)

1958 *Permorthotetes crespinae* Thomas (gen. et sp. nov. *in press*); Dickins & Thomas: p.124
1958b *Permorthotetes crespinae* Thomas: p.89-92, pl. 1 figs 5, 6; pl. 2 figs 4-8
1959 *Permorthotetes crespinae* Thomas; Dickins & Thomas: p.71, 77
1959 *Permorthotetes* sp. Dickins & Thomas: p.71
1969 *Permorthotetes crespinae* Thomas: p.220

Diagnosis: Medium to large thin walled species (maximum 8 cm wide 6.8 cm long), most specimens nearly symmetrical, wider than long, front margin straight, ventral and dorsal valves nearly equal in size; ventral valve flat to gently convex, apical angle very wide, interarea nearly catacline usually; dorsal valve gently convex, slightly or non-sulcate; costellae 7 - 9 in 5 mm, rugae gentle and uneven (modified after Thomas, 1958b p. 89).

Closest species: *P. callytharrensis* has narrower apical angle and valves less equidimensional; the dorsal valve is more convex and sulcate.

Types: Holotype - CPC 1487; paratypes - CPC 1488-1492.

Type locality: About 0.4 km east of Winderie Homestead, Carnarvon Basin.

Distribution and range: Winderie Station, **Carnarvon Basin** - upper part of the Lyons Group.

Age: Latest Asselian to Early Sakmarian (Tastubian).

Abundance: 12 isolated valves, internal moulds, and numerous incomplete shell impressions.

Value in correlation and dating: Found only at one locality.

Climate: Found in sedimentary rocks that were deposited under cold-water conditions.

Sedimentary environment: Moderately shallow neritic; fine sandy substrate.

Permorthotetes guppyi Thomas 1958
(Plate 23 figs 5-8)

1914 *Derbyia* sp. Etheridge Jnr: p.35, pl. 7 figs 1, 2
?1926 *Derbyia* sp. cf. *senilis* (Phillips); Glauert: p.46
1932 *Derbyia* cf. *D. senilis* Phillips; Hosking: p.44, pl. 5 figs 6, 7
1958b *Permorthotetes guppyi* Thomas: p.96-100, pl. 7 figs 1-3; pl. 8 figs 1-4; pl. 18 fig. 2; pl. 21 figs 1a-c, 2a-g, 3a-e; pl. 22 figs 1a-c, 2a-e, 4
1958 *Permorthotetes guppyi* Thomas; Guppy et al.: p.48, 52
1961 *Permorthotetes guppyi* Thomas; Dickins *in* Veevers & Wells: p.286

Diagnosis: Large usually thick walled species (maximum size 8.0 cm long and 6.8 cm wide), mostly nearly symmetrical, some very distorted; undistorted ventral valves with wide oval outline, concave to flat, high interarea, maximum width nearly twice hinge-line, septum long up to half shell length, secondary spondylium variable may be obliterated by shell thickening; dorsal valve gently to moderately convex and usually not sulcate, cardinal process with short lobes and deep wide diductor grooves; costellae fine, 9 - 13 in 5 mm; rugae slight (modified after Thomas, 1958b, p.96).

Closest species: *P. callytharrensis* and *P. lindneri* have thinner shells, shorter septa, better developed secondary spondylia, and more convex dorsal valves.

Types: Holotype - CPC 1503; paratype - CPC 1504; other figured specimens - CPC 1505-1511, 1513, 1519, 1520.

Type locality: Approximately 2.5 km at 255° from Bruten Hill, Cherrabun Station, northern Canning Basin - upper part of Noonkanbah Formation.

Distribution and range: South of Grant Range, Mount Anderson and Cherrabun Stations, Mount Marmion, Shore Range, northern **Canning Basin** - Noonkanbah Formation, Lightjack Formation.

Age: Late Artinskian (late Baigendzhinian) to Kungurian.

Abundance: Numerous isolated valves from many localities in Noonkanbah Formation; rare in Lightjack Formation.

Value in correlation and dating: Wide range in Noonkanbah Formation and Lightjack Formation.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; silty to fine sandy substrate.

Permorthotetes sp. aff. **?P. guppyi** Thomas 1958

1958b *Permorthotetes* sp. aff. *?P. guppyi* Thomas: p.106-107, pl. 7 fig. 4; pl. 8 fig. 5 (*not* pl. 6 fig. 3)

Distribution and range: Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Two ventral valves.

Permorthotetes lindneri Thomas 1958
(Plate 22 figs 4-10)

1958b *Permorthotetes lindneri* Thomas: p.92-96, pl. 1 figs 1-4; pl. 2 figs 1-3; pl. 3 figs 1-6
1958 *Permorthotetes lindneri* Thomas; Guppy et al.: p.54



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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S.K. Skwarko

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Brachiopods
(continued)

Diagnosis: Medium to large thin-walled species (maximum 6.5 cm long and 5.5 cm wide), more or less symmetrical, outline rounded including front margin, wider than long, maximum width about mid length occasionally nearer hinge-line; ventral valve nearly flat with short septum less than two fifths of shell length; secondary spondylium usually small; dorsal valve strongly and unevenly convex with maximum nearer hinge line; sulcate or non sulcate, cardinal process short; costellae fine (7 - 9 in 5 mm); often with strong rugae and step-like lamellae (modified after Thomas, 1958b, p.92).

Closest species: *P. callytharrensis*, which is larger and less symmetrical with more convex ventral valve and less rounded front margin. Thinner shelled than *P. guppyi* which has a longer septum.

Types: Holotype - CPC 1494a,b; paratypes - CPC 1495-1502, 1521, 1522.

Type locality: 25.6 km at 120° from Mount Tuckfield, southern part of Saint George Ranges, northern Canning Basin.

Distribution and range: Type locality only, northern **Canning Basin** - basal Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Numerous moulds and external impressions from one locality.

Value in correlation and dating: Limited by its occurrence.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow neritic; sandy substrate.

Permorthotetes spp.

1958b *Permorthotetes* spp. Thomas: p.107
1967 *Permorthotetes* sp. Condon: p.149

Distribution and range: Callytharra Springs - Wooramel Group; near Dairy Creek Homestead - transitional beds between Wooramel Group and Byro Group; near Cundlego Crossing on Minilya River - base of Cundlego Formation; near Mia Mia Homestead - Coyrie Formation. All the above occurrences are in the **Carnarvon Basin.**

Age: Early Permian.

Abundance: "A number of small nondescript collections" (Thomas, 1958b, p.107).

Permorthotetes? spp.

?1890 *Orthotetes crenistria* (Phillips); Foord: p.154
?1903 *Orthotetes crenistria* (Phillips); Etheridge Jnr: p.18
?1926 *Orthotetes crenistria* (Phillips); Glauert: p.46
?1926 *Orthotetes* sp. Glauert: p.46

?1967 *Permorthotetes* sp. Condon: p.102
?1976 *Permorthotetes* sp. Playford et al.: p.110

Remarks: Indeterminate species, represented by few specimens only; or field determination only, with specimens not retained in collections.

Distribution and range: Irwin River area, **Perth Basin** - Carynginia Formation; Gascoyne and Minilya River areas, and Fossil Hill near Wyndham River, **Carnarvon Basin** - Callytharra Formation, Moogooloo Formation; Canning Stock Route, southern **Canning Basin.**

Age: Early Permian.

Permorthotetes teicherti Thomas 1958
(Plate 23 figs 9-11)

1958b *Permothotetes teicherti* Thomas: p.101-102, pl. 8 figs 6-8; pl. 22 figs 3a-d
1967 *Permorthotetes teicherti* Thomas; Condon: p.173, 184
?1967 *Derbyia* sp. Condon: p.184
1975 *Permorthotetes teicherti* Thomas; Playford et al.: p.288

Diagnosis: Large symmetrical thin-walled species (maximum 9.5 cm wide and 7.3 cm long); ventral valve wide, flat to slightly concave, without pronounced rugae; dorsal valve gently convex, sulcate; costellae 7 - 12 in 5 mm (modified after Thomas, 1958b, p.101).

Closest species: *P. callytharrensis* and *P. lindneri* from which it differs by its flat non-rugose ventral valve and gently convex dorsal valve.

Types: Holotype - UWA 28045A; paratypes - UWA 28045B, 28036.

Type locality: Coolkily Flat, near Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, Birdrong Spring, Hill Spring Station, **Carnarvon Basin** - ?Baker Formation, Coolkilya Sandstone.

Age: ?Early to Middle Kungurian.

Abundance: Rare, 5 specimens only.

Value in correlation and dating: Rare and known only in Carnarvon Basin.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately shallow neritic; silty to fine sandy substrate.

Superfamily DERBYIACEA Stehli 1954

Family STREPTORHYNCHIDAE Stehli 1954

Genus KIANGSIELLA Grabau & Chao 1927

Type species: *Orthotetes tingi* Grabau 1924; OD.

Kiangsiella condoni Thomas 1958
(Plate 24 figs 5-12)

1958b *Kiangsiella condoni* Thomas: p.68-73, pl. 9 figs 1-7; pl. 10 figs 1,5,6,8,9; pl. 18 fig. 1; text figs 12b, 13
1965 *Kiangsiella condoni* Thomas; Muir-Wood & Williams: p.H409 fig. 267, 3
1967 *Kiangsiella condoni* Thomas; Condon: p.131
1975 *Kiangsiella condoni* Thomas; Playford et al.: p.284

Diagnosis: Large species, (maximum size 5.6 cm and 4.3 cm long), wider than long; ventral valve unevenly convex and concentrically rugose, maximum convexity near umbo, auriculate, pseudodeltidium wide with small anterior convexity in middle of front margin and growth lines; dorsal valve strongly and unevenly convex, maximum near hinge-line, sulcate; plication well developed, but tending to obliteration on inner layers; muscle scars strongly impressed in both valves (modified after Thomas, 1958b, p.68)

Closest species: *Kiangsiella pectiniformis* (Davidson 1862) from the Salt Range, Pakistan.

Types: Holotype - CPC 1450; paratypes - CPC 1451-1459, 1465.

Type locality: Lyndon River area, 13.6 km at 82° from Mia Mia Homestead, Carnarvon Basin.

Distribution and range: Lyndon, Gascoyne and Wooramel River areas, **Carnarvon Basin** - Coyrie Formation, lower Byro Group.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Fairly common.

Value in correlation and dating: Restricted stratigraphical distribution; useful in basin correlation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic conditions; silty to sandy substrate.

Kiangsiella sp. cf. K. condoni Thomas 1958

1958b *Kiangsiella* sp. cf. *condoni* Thomas: p.73
1958 *Kiangsiella* cf. *condoni* Thomas; Guppy et al.: p.48

Distribution and range: Mount Anderson Station, northern **Canning Basin** - lower half of the Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Few specimens only.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic; silty to sandy substrate.

Kiangsiella sp. A
(Plate 24 fig. 13)

1958 *Kiangsiella* sp. nov. Dickins & Thomas: p.124
1958b *Kiangsiella* sp. A Thomas: p.73-74, pl. 10 figs 2a,b, 3a,b, 4
1959 *Kiangsiella* sp. nov. Dickins & Thomas: p.73, 77

Figured specimens: CPC 1460-1462.

Distribution and range: Arthur River Station, **Carnarvon Basin** - fairly low in the Lyons Group.

Age: Asselian to Early Sakmarian (Tastubian).

Abundance: Several incomplete valves.

Climate: Found in sedimentary rocks that were deposited under cold-water conditions.

Sedimentary environment: Medium to coarse sandy substrate.

Kiangsiella sp. B
(Plate 24 fig. 14)

1958b *Kiangsiella* sp. B Thomas: p.74-76, pl. 9 fig. 8; pl. 10 figs 7, 10, 11
1958 *Kiangsiella* sp. Guppy et al.: p.48

Figured specimens: CPC 1463-1466.

Distribution and range: Cherrabun, Mount Anderson and Gogo Stations, northern **Canning Basin** - upper half of the Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Numerous fragmentary valves and impressions.

Genus **STREPTORHYNCHUS** King 1850

Type species: *Terebratulites pelargonatus* von Schlotheim 1816; OD.

Streptorhynchus costatus Thomas 1958
(Plate 25 figs 8-10)

1958b *Streptorhynchus costatus* Thomas: p.49-52, pl. 15 figs 1-7; pl. 19 fig. 5; pl. 22 fig. 5; text figs 12c,d
1958 *Streptorhynchus costatus* Thomas; Guppy et al.: p.48

Diagnosis: Large species, thin-walled; symmetrical, wider than long (largest dorsal valve 7.5 cm wide and 5.1 cm long); symmetrical, ventral valve variable in convexity, some specimens with median fold, interarea moderately high; dorsal valve moderately and evenly convex, sulcate; costellae rather coarse and widely spaced (5 - 7 in 5 mm at 3 - 4 cm from umbo) (modified after Thomas, 1958b, p.49).

Closest species: Distinctive species.

Types: Holotype - CPC 1419; paratypes - CPC 1420-1422; other figured specimens - CPC 1423, 1424, 1523, 1539.

Type locality: In section of Noonkanbah Formation 12.8 km southwest of Mount Anderson Homestead, south of Grant Range, northern Canning Basin.

Distribution and range: South of Grant Range, northern Canning Basin - lower part of Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Fairly common in restricted area.

Value in correlation and dating: Known only in Noonkanbah Formation.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic; silty to sandy substrate.

Streptorhynchus hoskingae Thomas 1958
(Plate 25 figs 3-7)

1958b *Streptorhynchus hoskingae* Thomas: p. 52-55, pl. 12 figs 6, 7, 9; pl. 13 figs 1-6; text figs 11a, b
1967 *Streptorhynchus hoskingae* Thomas; Condon: p.169

Diagnosis: Medium-sized thin-walled species (maximum size 4.7 cm wide and 4 cm long); front margin usually straight or concave; ventral valve variable in convexity; (some specimens resupinate, others gently convex, others with slight median fold, generally slightly asymmetric, some auriculate), interarea apsacline and in some concave; dorsal valve strongly convex, maximum near hinge line, slightly sulcate low dorsal area; costellae fine (10 per 5 mm); some specimens rugose (modified after Thomas, 1958b, p.52).

Closest species: *S. johnstonei*, which is larger and more symmetrical with a more varible convex ventral valve. *S. perfidiabadensis* is smaller and with a more apsacline interarea.

Types: Holotype - CPC 1425; paratypes - CPC 1426-1429; other figured specimens - UWA 28188, 33359/1, 33360, 33360/2.

Type locality: West limb of Minilya Syncline, north of Minilya River, about 2.4 km southwest of Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Lyons River, Wandagee, and Williambury Stations, **Carnarvon Basin** - Cundlego Formation, Quinnanie Shale, Wandagee Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Many shells and internal moulds from a number of areas.

Value in correlation and dating: Fairly wide stratigraphical range; known only in Carnarvon Basin.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic; silty to sandy substrate, partly non-oxidizing environment (Quinnanie Shale).

Streptorhynchus johnstonei Thomas 1958
(Plate 25 figs 14, 15, 17, 18)

1958b *Streptorhynchus johnstonei* Thomas: p.55-57, pl. 14 figs 1-6, text fig. 12a

Diagnosis: Small thin-walled species (maximum 2.8 cm wide, 2.3 cm long), bilaterally symmetrical, wider than long; ventral valve flat to gently concave, not auriculate; interarea flat at a variable apsacline angle; dorsal valve strongly and unevenly convex with maximum nearer hinge line, sulcate, no area; costellae fine (12 - 15 in 5 mm) (modified after Thomas, 1958b, p.55).

Closest species: *S. hoskingae* which is larger, less symmetrical, with a more convex ventral valve, a dorsal area, and possibly auriculate.

Types: Holotype - CPC 1430; paratypes - CPC 1431, 1432; another figured specimen - UWA WH7.

Type locality: 1.2 km south of Southern Cross Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya, Wandagee, and Jimba Jimba Stations, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Numerous external and internal moulds; rare shells.

Value in correlation and dating: Known only in Coolkilya Sandstone.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Fairly shallow neritic; silty to fine sandy substrate.

Streptorhynchus luluigui Hosking 1933
(Plate 25 figs 12, 21-24)

1932 *Streptorhynchus luluigui* Hosking: p.45-48, pl. 4 figs 1-7; pl. 5 figs 1-4
1957 *Streptorhynchus* cf. *luluigui* Hosking; Thomas: p.181 1958a
1958a *Streptorhynchus* aff. *S. luluigui* Hosking; Thomas: p.3
1958b *Streptorhynchus luluigui* Hosking; Thomas: p.62-65, pl. 8 figs 9-10; pl. 17 figs 1-5; pl. 19 figs 3, 6; text fig. 11c
1961 *Streptorhynchus* sp. Dickins *in* Veevers & Wells: p. 284, 287
1958 *Streptorhynchus luluigui* Hosking; Guppy et al.: p.54
1969 *Streptorhynchus luluigui* Hosking; Thomas: p.221

Diagnosis: Large thin-walled species (maximum 5.5 cm long and 5.5 cm wide), bilaterally symmetrical, many specimens as wide as long; ventral valve usually flat to gently convex, rarely auriculate; dorsal valve strongly and unevenly convex with maximum nearer hinge line, no area; costellae fine and even (13 in 5 mm); surface commonly with numerous lamellae which are closer nearer the front (modified after Thomas, 1958b, p.62).

Closest species: *S. hoskingae*, which is smaller and relatively wider and less symmetrical; larger and more symmetrical than *S.* sp. cf. *S. pelargonatus* (Schlotheim).

Types: Lectotype - UWA 3040L; other figured specimens - CPC 1445, 1447, 1448, UWA 2772N,O, 2773C,G.

Type locality: Near Luluigui Homestead, northern Canning Basin.

Distribution and range: Luluigui Homestead area, Nerrima, Mount Cedric, Noonkanbah, Myroodah, and Calwynyardah Stations, Millyit Range, northern **Canning Basin** - Hardman Formation. Port Keats area, Bonaparte Basin (NT) - "Upper Marine Beds" of the Port Keats Group.

Age: Chhidruan.

Abundance: Numerous shells and internal and external moulds.

Value in correlation and dating: Useful as index fossil for Hardman Formation and correlates.

Climate: Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Moderately shallow neritic; silty to fine sandy substrate.

Streptorhynchus sp. cf. **S. pelargonatus** (Schlotheim 1816)
(Plate 25 figs 11, 13, 16)

cf. 1816 *Terebratulites pelargonatus* Schlotheim: p.28, pl. 7 fig. 21
1958b *Streptorhynchus* sp. cf. *pelargonatus* (Schlotheim); Thomas: p.60-62, pl. 16 figs 1-9; text fig. 11h
1958 *Streptorhynchus* sp. cf. *S. pelargonatus* Guppy et al.: p.54
1965 *Streptorhynchus* sp. cf. *S. pelargonatus* (Schlotheim); Muir-Wood & Williams: p.H409, fig. 267, 1
1969 *Streptorhynchus* sp. cf. *S. pelargonatus* (Schlotheim); Thomas: p.221

Diagnosis: Small to medium thin-walled species (maximum size 3.5 cm wide and 3.1 cm long, majority rather less), many specimens longer than wide, highly asymmetric with high-pointed twisted interarea, not auriculate; dorsal valve gently and unevenly convex, maximum width near hinge-line, low area, some sulcate; costellae fine, 13 in 5 mm; some ventral valves rugose (modified after Thomas, 1958b, p.60).

Closest species: *S. luluigui* from which it differs because of its high twisted interarea and smaller size.

Figured specimens: CPC 1436-1443.

Type locality: Mount Hardman, northern Canning Basin.

Distribution and range: Type locality only - Hardman Formation.

Age: Chhidruan.

Abundance: 15 valves and incomplete shells in original description.

Value in correlation and dating: Known only from one location.

Climate. Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Moderately shallow neritic; silty to fine sandy substrate.

Streptorhynchus perfidiabadensis (Etheridge Jnr 1907)
(Plate 25 figs 19, 20)

1895 *Orthotetes* or *Streptorhynchus* Etheridge Jnr: p.33
1897b *Orthotetes* sp. Etheridge Jnr: p.15, pl. 1 fig. 5
1897b *Rhipidomella australis* Etheridge Jnr: p.14, pl. 1 fig. 2
1906 *Orthotetes perfidiabadensis* Etheridge Jnr: p.41
1907c *Orthotetes perfidiabadensis* Etheridge Jnr: p.6, pl. 2 figs 1-9; pl. 5 figs 3-4
1916 *Orthotetes perfidiabadensis* Etheridge Jnr; Basedow: pl. F fig. 1
1958b *Streptorhynchus* sp. aff. *S. perfidiabadensis* (Etheridge Jnr); Thomas: p.58-59, pl. 15 figs 8a,b, 9a,b, 10a,b; text fig. 11g

Diagnosis: Small to medium thin-walled species (typical size 3.2 cm wide, 2.7 cm long); wider than long, somewhat asymmetric; ventral valve unevenly convex, low-pointed interarea with strongly apsacline to catacline inclination; dorsal valve strongly and evenly convex without sulcus; costellae fine, 11 in 5 mm (modified after Thomas, 1958b, p.58).

Closest species: Smaller than *S. hoskingae* and with non auriculate catacline interarea; *S. johnstonei* is smaller and more symmetrical with flat ventral valve and sulcate dorsal valve.

Types: Syntype - SAM (one specimen only, P2156), others need to be located; other figured specimens - CPC 1433-1435.

Type locality: Treachery Bay, Port Keats area, NT.

Distribution and range: Shore Range, northern **Canning Basin** - Lightjack Formation. Treachery Bay (NT) - "Lower Marine Beds", Port Keats Group.

Age: Middle Kungurian.

Abundance: Fairly uncommon.

Value in correlation and dating: Useful but rare.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Fairly shallow neritic; silty to fine sandy substrate.

Streptorhynchus spp.

1958 *Streptorhynchus* sp. ind. Guppy et al.: p.46
1958b *Streptorhynchus* sp. indet. Thomas: p.66
1962 *Streptorhynchus?* sp. Thomas: p.33
1967 *Streptorhynchus* sp. Condon: p.102, 149

Distribution and range: Small undetermined collections from **Carnarvon Basin** - Moogooloo Sandstone and Coyrie Formation; and northern **Canning Basin** - Nura Nura Member of the Poole Sandstone and Noonkanbah Formation (Meda 1).

Age: Various - Sterlitamakian, Baigendzhinian.

Streptorhynchus? sp. nov.
(Plate 24 fig. 21)

1958 *Streptorhynchus* sp. Dickins & Thomas: p.124
1958b *Streptorhynchus* sp. nov. A Thomas: p.66, pl. 12 fig. 8
1959 *Streptorhynchus* sp.nov. Dickins & Thomas: p.70, 72, 77
1975 *Streptorhynchus* sp. nov. Playford et al.: p.279
1976 *Streptorhynchus* sp. nov. Thomas: p.319

Remarks: Possibly conspecific with the large species *Grumantia costellata* from the Early Permian of Tasmania, described by Clarke (1990).

Distribution and range: Williambury Station, **Carnarvon Basin** - two localities in Lyons Group, numerous localities in basal conglomerate of Callytharra Formation.

Age: Asselian to Tastubian.

Streptorhynchus variabilis Thomas 1958
(Plate 24 figs 24, 25)

1958b *Streptorhynchus variabilis* Thomas: p.47-49, pl. 10 figs 12, 13; pl. 11 figs 7-10; pl. 19 fig. 1; text figs 11 d,e

Diagnosis: Medium-sized, thin-walled species (maximum size 5 cm long and 4.1 cm wide), asymmetric, very variable in shape and proportions; ventral valve gently and unevenly convex, not auriculate; dorsal valve sulcate to non-sulcate; costellae fine (11 - 15 in 5 mm) with stouter ones at irregular intervals (modified after Thomas, 1958b, p.47).

Closest species: Distinctive species.

Types: Holotype - CPC 1413; paratypes - CPC 1414, 1415, 1418; other figured specimens - CPC 1416, 1417.

Type locality: About 3.2 km at 255° from Brutens Old Yard, Cherrabun Station, northern Canning Basin.

Distribution and range: Cherrabun and Christmas Creek Stations, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Numerous, usually incomplete, specimens from several beds in Noonkanbah Formation.

Value in correlation and dating: Known only in Noonkanbah Formation.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; silty to fine sandy substrate.

Genus **ARCTITRETA** Whitfield 1908
(= **GRUMANTIA** Ustritsky 1963)

Type species: *Arctitreta pearyi* Whitfield 1908; OD.

Arctitreta? crassimurus (Thomas 1958)
(Plate 24 figs 22, 23, 26; Plate 25 figs 1, 2)

1958b *Streptorhynchus crassimurus* Thomas: p.44-46, pl. 12 figs 1-5, 10; pl. 19 fig 4; text fig. 11i
1958 *Streptorhynchus crassimurus* Thomas; Guppy et al.: p.48
1969 *Grumantia? crassimurus* (Thomas); Thomas: p.223
1971 *Arctitreta crassimurus* (Thomas); Waterhouse: p.391

Diagnosis: Small to medium size; (maximum 3.5 cm wide, 3.3 cm long); most specimens wider than long; thick walled; both valves gently convex, not auriculate; dorsal valve with long cardinal process and stout socket ridges (dentifers); distinct dorsal area; costellae fine and rounded; strong concentric lamellae (modified after Thomas, 1958b, p.44).

Closest species: *?A. plicatilis* Hosking, which lacks a dorsal area and dentifers and has uneven costellae, is smaller and auriculate.

Types: Holotype - CPC 1407; paratypes - CPC 1408-1412.

Type locality: 4 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin.

Distribution and range: Cherrabun Stations, northern **Canning Basin** - middle Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Numerous shells in a coquinite.

Value in correlation and dating: Known only from one bed at one locality in Noonkanbah Formation.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic; shell bed.

Arctitreta? plicatilis (Hosking 1933)
(Plate 24 figs 15-20)

1932 *Streptorhynchus plicatilis* Hosking: p.48-49, pl. 5 figs 5a,b
1958b *Streptorhynchus plicatilis* Hosking; Thomas: p.41-44 pl. 11 figs 1-6; pl. 18 fig. 7; text fig. 11f
1969 *Grumantia? plicatilis* (Hosking); Thomas: p.223
1971 *Arctitreta plicatilis* (Hosking); Waterhouse: p.391

Diagnosis: Small more or less bilaterally symmetrical species, (maximum size 2.2 cm long and 2.1 cm wide); thick walled; both valves gently convex, length about equal to width; hinge line auriculate; dorsal valve with short cardinal process, no area or socket ridges (dentifers); costellae vary in size and number (7 - 15 in 5 mm); costellae flat and uneven and widening to the front and multiplying by division and intercalation; shell with thick secondary deposits in maturity and old age (modified after Thomas, 1958b, p.41).

Closest species: *A. crassimurus*, from which it differs in that the costellae are more uneven and flat, dorsal area and socket ridges are absent, and auriculation.

Types: Holotype - GSWA 1/4972; paratypes - CPC 1400-1406, 1535.

Type locality: Callytharra Formation, type section area, 0.8 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Wooramel River area west of Callytharra Springs, Donnellys Well area on Williambury Station, Dairy Creek and Gascoyne River areas, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 24 shells and isolated valves from various localities.

Value in correlation and dating: Known only in Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow neritic; calcilutite to calcarenite substrate.

Family DERBYIIDAE Stehli 1954
Subfamily DERBYIINAE Stehli 1954

Genus **DERBYIA** Waagen 1884

Type species: *Derbyia regularis* Waagen 1884; OD.

Derbyia hardmani Thomas 1958
(Plate 24 figs 1-4)

1958b *Derbyia hardmani* Thomas: p.78-81, pl. 5 figs 5-9; pl. 18 fig. 6; pl. 19 fig. 2
1958 *Derbyia hardmani* Thomas; Guppy et al.: p.54
1969 *Derbyia hardmani* Thomas: p.221
1975 *Derbyia hardmani* Thomas; Playford et al.: p.342

Diagnosis: Large species (maximum 7.8 cm long, 5.7 cm wide); ventral valve flat to gently convex, interarea low to moderate in height; dorsal valve gently convex in lateral and transverse profile; non-sulcate and oval in outline; costellae fine (12 in 5 mm); concentric rugae; cardinal process short with projecting socket ridges (dentifers) (modified after Thomas, 1958b, p.78).

Closest species: Distinct species.

Types: Holotype - CPC 1467; paratypes - CPC 1468-1471, 1537; another figured specimen - CPC 1472.

Type locality: Mount Hardman, northern Canning Basin.

Distribution and range: Type locality - Hardman Formation.

Age: Chhidruan.

Abundance: Six valves and some fragments.

Value in correlation and dating: Known only in Hardman Formation.

Climate: Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Moderately shallow neritic; silty to fine sandy substrate.

Derbyia? sp. A

1958b *Derbyia?* sp. A Thomas: p.81
1967 *Derbyia* sp. Condon: p.184

Distribution and range: Carnarvon Basin - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Fragments and one incomplete dorsal valve.

Value in correlation and dating: None.

Derbyia? sp. B

1967 *Derbyia* sp. Condon: p.90
1975 *Derbyia* sp. Playford et al.: p.282

Closest species: Uncertain affinities, field determination only; possibly referable to *Permorthotetes*.

Distribution and range: Carnarvon Basin - Jimba Jimba Calcarenite Member of the Billidee Formation.

Age: Artinskian.

Order PRODUCTIDA Sarycheva & Sokolskaya 1959
Suborder CHONETIDINA Muir-Wood 1955
Superfamily CHONETACEA Bronn 1862

Family ANOPLIIDAE Muir-Wood 1962
Subfamily ANOPLIINAE Muir-Wood 1962

Genus **TORNQUISTIA** Paeckelmann 1930

Type species: *Leptaena (Chonetes) polita* M'Coy 1852; OD.

Tornquistia gregoryi Archbold 1981
(Plate 26 figs 5, 9, 13)

1981b *Tornquistia gregoryi* Archbold: p.8-11, pl. 3 figs 1-28; text figs 1, 2

Diagnosis: Ventral valve invariably with incipient development of a ventral fold posteriorly; ventral valve strongly arched anteriorly; maximum width of mature shells commonly anterior of hinge line.

Closest species: *T. magna* Archbold, a larger species with no incipient ventral fold.

Types: Holotype - NMV 60709; paratypes - NMV 60700, 60702, 60705-60710, 60712, 60713, 60715-60718, 60725.

Type locality: Northwest side of syncline, north of Minilya River, west of Cookilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation.

Age: Latest Artinskian (late Baigendzhinian).

Abundance: Relatively rare (25 specimens, mostly isolated valves).

Value in correlation and dating: Useful but limited by relative rarity of species.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Moderately deep quiet water; silty-fine sandy substrate.

Tornquistia magna Archbold 1980
(Plate 26 figs 6-8)

1980b *Tornquistia magna* Archbold: p.186, pl. 25 figs 5-13

Diagnosis: Species of large size combined with highly convex ventral valve, and strongly inflated mesial portion of ventral valve.

Closest species: *T. gregoryi* Archbold, a smaller species with incipient ventral fold.

Types: Holotype - CPC 19137; paratypes - CPC 19134-19136, 19138, 19139, 19141-19143.

Type locality: 12.0 km south of west of Moogooree Homestead (24°05'S, 115°06'E), Carnarvon Basin.

Distribution and range: Moogooree and Mia Mia Homestead areas, **Carnarvon Basin** - Coyrie Formation, Bulgadoo Shale.

Age: Middle Artinskian (early Baigendzhinian).

Abundance: Several hundred specimens available.

Value in correlation and dating: Useful, restricted in stratigraphic range.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep-water, quiet environment with restricted circulation; silt substrate.

Tornquistia occidentalis Archbold 1980
(Plate 26 figs 1-4)

1980b *Tornquistia occidentalis* Archbold: p.185, pl. 25 figs 1-4; text figs 2, 3

Diagnosis: Distinctly concavo-convex species of moderate size for genus with distinct growth lines.

Closest species: *T. magna* Archbold 1980, a larger and more strongly concavo-convex shell.

Types: Holctype - CPC 19127; paratypes - GSWA F10996, 10997, MUGD 5191.

Type locality: Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs area, and Bidgemia Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (late Sterlitamakian).

Abundance: 19 specimens, mostly conjoined shells.

Value in correlation and dating: Useful but limited by rarity of specimens.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Mostly deep water; calcilutite to calcarenite substrate.

Torniquistia sp. aff. **T. tropicalis** Grant 1976

cf. 1976 *Tornquistia tropicalis* Grant: p.68-71, pl. 14 figs 1-11
1980b *Tornquistia* aff. *tropicalis* Archbold: p.186-188, pl. 25 figs 14-16

Diagnosis: Small- to medium-sized ventral valves with low convexity; mesial portion of valve slightly inflated; growth lines weakly developed.

Closest species: *T. tropicalis* Grant, a smaller species.

Figured specimens: CPC 19128-19130.

Distribution and range: Middalya Homestead area, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (latest Baigendzhinian).

Abundance: Rare (3 isolated ventral valves).

Value in correlation and dating: Limited because of rarity.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; silty to fine sandy substrate.

Genus **DEMONEDYS** Grant 1976

Type species: *Demonedys fastigiata* Grant 1976; OD.

Demonedys granti Archbold 1980
(Plate 26 figs 10-12)

1980b *Demonedys granti* Archbold: p.188-189, pl. 25 figs 17-19; text fig. 4

Diagnosis: Medium-sized species with rounded outline at maturity, distinct ventral fold and strongly concave dorsal valve.

Closest species: *D. fastigiata* Grant, a smaller species with triangular outline.

Types: Holotype - CPC 19131; paratypes - CPC 19132, 19133.

Type locality: Minilya River, approximately 14.6 km southwest of Middalya Homestead; 0.2 km northwest of well, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Cundlego Formation. Report from Wandagee Formation (Archbold, 1980b), not confirmed (Archbold, 1981b, p.11).

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare (3 conjoined shells).

Value in correlation and dating: A distinctive species but use limited because of rarity.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; silty to fine sandy substrate.

Family RUGOSOCHONETIDAE Muir-Wood 1962
Subfamily RUGOSOCHONETINAE Muir-Wood 1962

Genus **NEOCHONETES** Muir-Wood 1962

Type species: *Chonetes dominus* King 1938; OD.

Subgenus **SOMMERIELLA** Archbold 1982
(= **SOMMERIA** Archbold 1981)

Type species: *Chonetes prattii* Davidson 1859; OD.

Neochonetes (Sommeriella) afanasyevae Archbold 1981
(Plate 26 figs 22, 23, 25)

1906 *Chonetes* sp.(*?C. pratti*); Etheridge Jnr: p.41
1907c *Chonetes* sp. (*?C. pratti*); Etheridge Jnr: p.7, pl. 6 fig. 9
1909 *Chonetes pratti*(?) Basedow: p.325
1952 *Chonetes pratti* Guppy et al.: p.111

1957 *Chonetes* sp. Thomas: p.180
1958a *Chonetes* sp. Thomas: p.2
1981d *Neochonetes (Sommeria) afanasyevae* Archbold: p.125-126, fig. 10A-V, 11

Diagnosis: Planar-convex, sulcus obsolescent, ventral and dorsal septa distinct but thin and sharp.

Closest species: *Neochonetes sp.* (Bamber & Waterhouse, 1971, pl. 19 figs. 13-18) from the Kungurian of the Yukon.

Types: Holotype - CPC 19902A; paratypes - CPC 19887A-D, 19888A-D, 19889A,B, 19900, 19901A-C, 19902B-E, 19903, 19904A-D, 19905A,B, 19906, 19907A-D, 19908A,B.

Type locality: Liveringa Ridge, northern Canning Basin.

Distribution and range: Middalya Station, **Carnarvon Basin** - Coolkilya Sandstone; Liveringa Ridge and Homestead area, northern **Canning Basin** - Lightjack Formation. Port Keats Mission (NT) - "Lower Marine Beds", Port Keats Group.

Age: Middle Kungurian.

Abundance: Relatively common (23 specimens).

Value in correlation and dating: Valuable for interbasinal correlation and dating.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty to fine sandy substrate.

Neochonetes (Sommeriella) pratti (Davidson 1859)
(Plate 26 figs 14-17)

1859 *Chonetes prattii* Davidson: p.116, pl. 4 figs 9-12
1890 large *Chonetes* Etheridge Jnr: p.239
1892 *Chonetes pratti* Davidson; Newton: p.468, 542, pl. 14 figs 1-12
1893 *Chonetes pratti* Davidson; Newton: p.725
1903 *Chonetes pratti* Davidson; Etheridge Jnr: p.23
1907b *Chonetes pratti* Davidson; Etheridge Jnr: p.31, pl.8 fig. 2; pl. 9 fig. 7; pl. 10 fig. 2
1910 *Chonetes pratti* Davidson; Glauert (*partim*): p.86
1926 *Chonetes pratti* Davidson; Glauert (*partim*): p.46
1931 *Chonetes pratti* Davidson; Hosking: p.19-20
1952 *Chonetes pratti* Davidson; Guppy et al.: p.110
1958 *Chonetes* sp. Konecki et al.: p.27
1958 *Chonetes* cf. *pratti* Davidson; Guppy et al.: p.45, 46
1958 *Chonetes* sp. nov. Guppy et al.: p.46
1962 *Neochonetes pratti* (Davidson); Muir-Wood: p.13, pl. 11 figs 7-8
1975 *Neochonetes pratti* (Davidson); Playford et al.: p.281, 282
1975 *Neochonetes* cf. *pratti* (Davidson); Playford et al.: p.340
1976 *Neochonetes pratti* (Davidson); Playford et al.: p.94, 95, 116

1981d *Neochonetes (Sommeria) pratti* (Davidson); Archbold: p.114-119, figs 4A-S, 5A-W, 6A-T

Diagnosis: "Large *Neochonetes (Sommeriella)*. Ventral sulcus well developed; dorsal fold low but distinct. External ornament of fine capillae, on average 4 per mm at 1 and 3 cm from umbones" (Archbold, 1981d, p.116).

Closest species: *N.(S.) tenuicapillatus* Archbold which has finer capillae.

Holotype: BM(NH) BB41082.

Type locality: Probably Fossil Cliff on Irwin River (Archbold, 1981d), Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member and Woolaga Limestone Member of the Holmwood Shale; Callytharra Springs, Glenburgh, and the type section of the Jimba Jimba Calcarenite Member of the Billidee Formation, **Carnarvon Basin** - Callytharra Formation; Paradise Homestead area and Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Sakmarian - Early Artinskian (late Tastubian to Aktastinian).

Abundance: Common.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; silty, marly, fine sandy substrate; rare in coarse sandstone.

Neochonetes (Sommeriella) robustus Archbold 1981
(Plate 26 figs 18-20)

?1912 *Chonetes pratti* Glauert: p.75
1965 *Chonetes pratti* Edgell: p.65, pl. 34 fig. 2
?1976 *Neochonetes* sp. Playford et al.: p.110
1976 *Neochonetes pratti* Playford et al.: p.116
1981d *Neochonetes (Sommeria) robustus* Archbold: p.119-122, figs 7A-T, 8

Diagnosis: "Small for subgenus, strongly convex ventral valve, weakly convex dorsal valve; sulcus weak to absent. Shell outline subquadrate, globular, length of shell between 0.67 and 0.75 maximum width" (Archbold, 1981d, p.119).

Closest species: An undescribed species from the Sirius Formation, Bowen Basin, Queensland (Dear, 1972).

Types: Holotype - CPC 19886M; paratypes - CPC 19885A-C, CPC 19886A-L, N-P, GSWA F5285, F5287, F5288.

Type locality: 3.5 km north of Monument Bore, Carnarvon Basin.

Distribution and age: Arrino area, **Perth Basin** - Mingenew Formation, ?Carynginia Formation; Keogh Hill and Monument Bore areas, **Carnarvon Basin** - Coyrie Formation. Bonaparte Basin (NT) - "Lower Marine Beds", Port Keats Group.

Age: Early Late Artinskian (early Baigendzhinian).

Abundance: 22 external and internal moulds (not well collected).

Value in correlation and dating: Potentially valuable, although range of variability not well known; useful for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep water; silty, sandy substrate.

Neochonetes (Sommeriella) sp. nov. A

1959 *Chonetes* sp. Dickins *in* Playford: p.19
1976 *Neochonetes* sp. Playford et al.: p.100

Diagnosis: Large species for subgenus; recalls *N.(S.) pratti* but generally larger and flatter. The species will be described fully elsewhere by one of us (N.W.A.).

Closest species: *N.(S.) prattii* (Davidson) a smaller species generally with a greater ventral convexity.

Distribution and range: Woolaga Creek area, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: Relatively common.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Fine sandy substrate; relatively shallow water.

Neochonetes (Sommeriella) sp. nov. B
(Plate 26 fig. 30)

1958 *Chonetes* sp. nov. Guppy et al.: p.54
1981d *Neochonetes (Sommeria)* sp. A Archbold: p.126, figs 12A-C

Diagnosis: Species with coarse capillae and distinct sulcus; rarely of large size.

Closest species: *N.(S.) wageri* (Muir-Wood *in* Muir-Wood & Oakley, 1941) from the Himalayas.

Figured specimens: CPC 19882-19884.

Distribution and range: Mount Hardman, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Relatively common but sporadic.

Value in correlation and dating: When described the species will be indicative of the Hardman fauna.

Climate: Species found in sedimentary rocks that were deposited under warm temperate and subtropical conditions.

Sedimentary environment: Relatively shallow water; fine sand substrate.

Neochonetes (Sommeriella) tenuicapillatus Archbold 1981
(Plate 26 figs 21, 24)

[illegible]*netes pratti* Etheridge Jnr: p.36
1918 *Chonetes pratti* Etheridge Jnr: p.25
1926 *Chonetes pratti* Glauert (*partim*): p.46
1958 *Chonetes pratti* and *Chonetes* sp. Guppy et al.: p.48
1981d *Neochonetes (Sommeria) tenuicapillatus* Archbold: p.122-125, figs 9A-Y

Diagnosis: A combination of very fine and delicate external capillae and size average for the genus.

Closest species: *N.(S.) frederickksi* Archbold 1979 which has slightly coarser capillae.

Types: Holotype - NMV P60731; paratypes - CPC 19870-19879, NMV P60726-P60730, P60732-P60736.

Type locality: Minilya River on Wandagee Station, Carnarvon Basin.

Distribution and range: Donnellys Well, Minilya River, Middalya Homestead and Wandagee Hill areas, **Carnarvon Basin** - Bulgadoo Shale, Cundlego Formation, Quinnanie Shale, Wandagee Formation, Nalbia Sandstone; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Artinskian (late Baigendzhinian) to earliest Kungurian.

Abundance: Relatively common (about 20 specimens).

Value in correlation and dating: Of value in interbasinal correlation; relatively restricted time range.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate and humid conditions.

Sedimentary environment: Moderately deep to moderately shallow marine environment, with silty to sandy substrate.

Genus **CHONETINELLA** Ramsbottom 1952

Type species: *Chonetes flemingii* Norwood & Pratten 1855; OD.

Chonetinella sp.

1981d *Chonetinella* sp. Archbold: p.127, fig. 12D

Diagnosis: Ventral valve strongly convex with a deep sulcus.

Figured specimen: UWA 88108.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Extremely rare (1 decorticated valve).

Value in correlation and dating: Of no value at present.

Climate: Species associated with sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Fine sandy substrate.

Subfamily SVALBARDIINAE Archbold 1982

Genus **SVALBARDIA** Berkhatova 1970

Type species: *Chonetes capitolinus* Toula 1875; OD.

Svalbardia narelliensis Archbold 1981
(Plate 26 figs 28, 29, 32)

1981d *Svalbardia narelliensis* Archbold: p.110-111, figs 2A-Y
1984 *Neochonetes* sp. Yeates et al.: p.36, fig. 17

Diagnosis: Relatively small species for genus; normally non-sulcate; brachial ridges with weakly raised anterior extremites for genus.

Closest species: *S. thomasi* Archbold, a smaller species with prominent brachial ridges.

Types: Holotype - CPC 19167U; paratypes - CPC 19167A-Z, CPC 19168A-E.

Type locality: 1.2 km south of Narelli Rockhole, northern Canning Basin.

Distribution and range: Balgo Mission and Narelli Rockhole areas, northern **Canning Basin** - Upper Noonkanbah Formation.

Age: Late Artinskian (latest Baigendzhinian) to earliest Kungurian.

Abundance: Several hundred specimens.

Value in correlation and dating: Useful; restricted in stratigraphical range.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Depth shallower than normal for articulate brachiopods; possibly in gently agitated water above wave base; occurs in masses, to virtual exclusion of other species; silty to fine sandy substrate.

Svalbardia thomasi Archbold 1981
(Plate 26 figs 26, 27, 31)

1981a *Svalbardia thomasi* Archbold: p.6-7, figs 1, 2A-S
1983 Chonetid brachiopod Moore & Hocking: p.326, fig. 9

Diagnosis: "Small species of genus. Rarely feebly sulcate. Brachial ridges distinct in mature individuals with raised recurved anterior extremities. Lateral septa and median septum well developed. Ventral valve coarsely pseudopunctate" (Archbold, 1981a, p.6).

Closest species: *S. narelliensis* Archbold, a slightly larger species with less prominent brachial ridges.

Types: Holotype - CPC 19161B; paratypes - CPC 19161C,D,G,K,P,Q,R, 19162A,C, 19163A, 19164A-C, 19165A; NMV P60696, P60697.

Type locality: Northwest of Paddys Outcamp, Carnarvon Basin.

Distribution and range: Paddys Outcamp area and Wandagee Station, **Carnarvon Basin** - Nalbia Sandstone, Baker Formation.

Age: Early Kungurian.

Abundance: 60+ specimens (Moore and Hocking, 1983).

Value in correlation and dating: Useful, restricted in stratigraphic range.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately to very shallow water, marine, at times above wave base; silty to fine sand substrate.

Subfamily QUINQUENELLINAE Archbold 1981

Genus **QUINQUENELLA** Waterhouse 1975

Type species: *Quinquenella glabra* Waterhouse 1975; OD.

Quinquenella australis Archbold 1981
(Plate 27 figs 1-3)

1981e *Quinquenella australis* Archbold: p.208-209, pl. 1 figs 1-15; text fig. 2

Diagnosis: Typical size for genus with distinct long ventral septum, and distinct dorsal accessory and lateral septa with short medi septum.

Closest species: *Q. magnifica* Archbold (1982a), a species with a lower ventral interarea, large alveolus, and shorter ventral septum.

Types: Holotype - UWA 88100; paratypes - UWA 88101-88107, CPC 19158-19160.

Type locality: Wandagee Station area, UWA (C. Teichert) locality C38.10, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common but poorly collected (22+ specimens).

Value in correlation and dating: Useful because of limited stratigraphical range.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate environment.

Sedimentary environment: Moderately shallow water; silt to very fine sand substrate.

Suborder STROPHALOSIIDINA Waterhouse 1975
Superfamily STROPHALOSIACEA Schuchert 1913

Family STROPHALOSIIDAE Schuchert 1913
Subfamily STROPHALOSIINAE Schuchert 1913

Genus **STROPHALOSIA** King 1844

Type species: *Strophalosia gerardi* King 1846; SD Muir-Wood & Cooper (1960).

Strophalosia irwinensis Coleman 1957
(Plate 27 figs 4, 7, 8)

1943 *Strophalosia* sp. cf. *gerardi* King; Prendergast: p.46, pl. 5 figs 14, 15
1943 *Strophalosia tenuispina* Prendergast: p.52, pl. 6 fig. 9
1957 *Strophalosia (Heteralosia) irwinensis* Coleman: p.122-124, pl. 20 figs 1-6
1957 *Strophalosia (Heteralosia) tenuispina* Coleman: p.130, pl. 20 figs 36, 37
1967 *Strophalosia prideri* Condon: p.70
1976 *Strophalosia (Heteralosia) irwinensis* Coleman; Playford et al.: p. 95
1986 *Strophalosia irwinesis* Coleman; Archbold: p.99-102, Fig 1A-Z, 4A-I

Diagnosis: Small to medium size for genus; moderately convex ventral valve; dorsal valve with ill-defined dimples, well-developed growth lamellae, radial capillae and no spines; ventral valve with row of hingespines and variably defined rows of body spines; spines low angled and recumbent; cicatrix of variable size.

Closest species: A new, undescribed species from the Jimba Jimba Calcarenite, Carnarvon Basin.

Types: Holotype - UWA 23441a; paratypes - UWA 12399, 23441b, 34463-34466, 34466a, 34467.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Bilung Creek, Coordewandy Station and Gap Creek, **Carnarvon Basin** - Callytharra Formation; Scott Bluff, east side of Lake Blanche, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A common fossil (35 specimens).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty, sandy and calcarenite substrates.

Strophalosia jimbaensis Archbold 1986
(Plate 27 figs 5, 6)

1986 *Strophalosia jimbaensis* Archbold: p.102-104, Fig. 2A-G

Diagnosis: Medium to large sized for genus; dorsal valve with well-defined dimples, growth lamellae and radial capillae; ventral valve with shallow median sulcus.

Closest species: *Strophalosia irwinensis* Coleman 1957.

Types: Holotype - CPC 24405; paratypes - MUGD F6596-6598.

Type locality: Type section of Jimba Jimba Calcarenite Member, Jimba Jimba Station (see Condon 1967, p.89), Carnarvon Basin.

Distribution and range: Jimba Jimba Calcarenite Member, Carnarvon Basin.

Age: Aktastinian (Early Artinskian).

Abundance: Relatively uncommon.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; calcarenite substrate.

Strophalosia sp. cf. **S. jimbaensis** Archbold 1986

1986 *Strophalosia* sp. cf. *S. jimbaensis* Archbold: p.104 fig. 2H-O

General comment: Large specimens recalling *Strophalosia jimbaensis* have been recorded from the base of the "One Gum Formation", Carnarvon Basin. Additional details of morphology are required for confident assignment of the species.

Figured specimens: CPC 24431-24438.

Age: Aktastinian (Early Artinskian).

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Shallow water, sandy substrate.

Genus **HETERALOSIA** King 1938

Type species: *Heteralosia slocomi* King 1938; OD.

Heteralosia complectens (Etheridge Jnr 1918)
(Plate 27 fig. 11)

1914 *Strophalosia* sp. Etheridge Jnr: p.34, pl. 5 figs 16-18
1918 *Strophalosia complectens* Etheridge Jnr: p.253, pl. 40 figs 11-12
1926 *Strophalosia complectens* Etheridge Jnr; Glauert: p.46
1943 *Etheridgina muirwoodae* Prendergast: p.54, pl. 6 figs 14, 15
1957 *Etheridgina(?) muirwoodae* Prendergast; Coleman: p. 109, pl. 17 figs 6-11
1958 *Etheridgina(?) muirwoodae* Pendergast; Guppy et al.: p.48
1958 *Strophalosia (Heteralosia) prendergastae* Coleman; Guppy et al.: p.48

?1962 *Strophalosia* sp. Thomas: p.33
1967 *Strophalosia (Heteralosia) etheridgei* Prendergast; Condon: p.169
?1967 *Strophalosia (Heteralosia) tenuispina* Coleman; Condon: p.169
1967 *Etheridgina muirwoodae* Prendergast; Condon: p.169
1986 *Heteralosia complectens* (Etheridge Jnr) Archbold: p.109-110, fig. 4J-O

Diagnosis: Small *Heteralosia*, adherent by most of ventral valve and by coarse, long adherent ventral spines; well developed interareas and teeth.

Closest species: A distinctive Western Australian species with an adherent ventral valve.

Lectotype: Entire specimen on AM F16699, chosen by Coleman (1957, p.109).

Type locality: Mount Marmion, northern Canning Basin.

Distribution and range: Minilya River, Wandagee Station and southwest of Mooka Station Homestead, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian)

Abundance: Relatively common.

Value in correlation and dating: Useful for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates; normally attached to larger shells.

Heteralosia etheridgei (Prendergast 1943)
(Plate 27 figs 9, 10)

1943 *Strophalosia etheridgei* Prendergast: p.43-45, pl. 5 figs 5-12
1943 *Strophalosia* sp. ind. A Prendergast: p.51-52, pl. 6 figs 10-12
1943 *Strophalosia* cf. *Strophalosia beecheri* Prendergast: p.41, pl. 5 figs 1-3
1957 *Strophalosia (Heteralosia) etheridgei* Prendergast; Coleman: p.120-122, pl. 19 figs 30-32
1957 *Strophalosia (Heteralosia) prendergastae* Coleman (*partim*): p.127, pl. 20 figs 25-28 only
1967 *Strophalosia (Heteralosia) etheridgei* Prendergast; Condon: p.70
1976 *Strophalosia (Heteralosia) etheridgei* Prendergast; Playford et al.: p.95
1976 *Strophalosia (Heteralosia) prendergastae* Playford et al.: p.95
1986 *Heteralosia etheridgei* (Prendergast) Archbold: p.105-107, fig. 3A-Z, AA-BB

Diagnosis: Small *Heteralosia*; elongate to circular outline; cicatrix of variable size; exterior ornament or pronounced concentric lamellae and widely spaced, usually relatively coarse, ventral spines; dorsal exterior with fine capillae and rare dimples.

Closest species: *H. prendergastae* (Coleman), a somewhat larger species with a denser ventral spine arrangement.

Lectotype: GSWA 1/5242a (chosen by Coleman, 1957, p.120)

Type locality: 0.8 km west of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Over 30 mostly single pedicle valves.

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Water of variable depth; silty and calcarenite substrates; commonly attached to larger shells.

Heteralosia prendergastae (Coleman 1957)
(Plate 27 figs 12, 13)

1957 *Strophalosia* (*Heteralosia*) *prendergastae* Coleman (*partim*): p.127-130, pl. 20 figs 20-24 (*non cet.*)
1986 *Heteralesia prendergastae* Coleman; Archbold: p.107-109, fig. 4 P-R.

Diagnosis: Small *Heteralosia*, not attached as adults, with numerous fine ventral spines and irregularly dimpled dorsal exterior; cicatrix prominent.

Closest species: *H. iphia* Grant (1976), a species of comparable size.

Types: Holotype - UWA 28444a; paratype - UWA 28444b (now lost).

Type locality: 315m west of fence between Barrabiddy and Weer Paddocks, 1980m south of gate in that fence, south of Wandagee Homestead, **Carnarvon Basin** - Cundlego Formation.

Distribution and range: Type locality only.

Age: Lake Artinskian (late Baigendzhinian).

Abundance: Extremely rare.

Value in correlation and dating: Of little value at present; probably diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Heteralosia spp.

1907c *Strophalosia* sp. Etheridge Jnr: p.7, pl. 6 fig. 8; pl. 7 figs 2-4
1958 *Strophalosia (Heteralosia) prendergastae*: Guppy et al.: p.53
1958 *Etheridgina? muirwoodae*: Guppy et al.: p.53
1986 *Heteralosia* spp. A & B Archbold: p.110-111, fig. 4S-Z,AA-BB

General comment: The above reports appear to indicate small species of strophalosiid brachiopods. We confirm the existence of poorly know *Heteralosia* from the "Madeline Formation" (now Coyrie Formation) of the Carnarvon Basin and the Lightjack Formation of the Canning Basin. Material to hand is inadequate for full description.

Genus **WYNDHAMIA** Booker 1929

Type species: *Wyndhamia dalwoodensis* Booker 1929; OD.

Wyndhamia multispinifera (Prendergast 1943)
(Plate 27 figs 15, 16, 19)

1943 *Strophalosia clarkei* Prendergast: p.43, pl. 5 fig. 4
1943 *Strophalosia multispinifera* Prendergast: p.50, pl. 5 figs 6-8
1957 *Strophalosia multispinifera* Prendergast; Coleman: p.114-116, pl. 18 figs 3-14
1958 *Strophalosia multispinifera* Prendergast; Guppy et al.: p.48
1967 *Strophalosia multispinifera* Prendergast; Condon: p.169

Diagnosis: Moderately large *Wyndhamia*, transverse to subcircular in outline; ventral valve with median flattening and abundant, fine closely spaced body spines with radially elongate spine bases; dorsal valve gently concave with flattish or slightly internally convex visceral disc; sharply geniculate.

Closest species: *Wyndhamia colemani* which has coarser ventral spines and a distinctly concave dorsal valve.

Holotype: UWA 20458.

Type locality: Scarp 3.2 km east of Christmas Creek Homestead, northern Canning Basin.

Distribution and range: Northeast of Walbarune Peak, Coolkilya Pool area, Lyons River Homestead area, Binthabooka Creek area and Minilya River area, **Carnarvon Basin** - Wandagee Formation, Cundlego Formation and Nalbia Sandstone; Grant Range, Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian) to earliest Kungurian.

Abundance: Relatively common although sporadic in occurrence (31 specimens).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrate.

Wyndhamia colemani Archbold 1987
(Plate 27 figs 20, 21)

1967 *Strophalosia* sp. nov. Condon: p.149
1981d *Wyndhamia* sp. nov. Archbold: p.121
1987 *Wyndhamia colemani* Archbold: p.20-25, figs 1A-P, 2A-N, 3A-F

Diagnosis: Large *Wyndhamia*, transversely oval to subquadrate in outline; ventral value evenly convex or rarely with sulcus; abundant body spines; spines moderately coarse with relatively short spine bases; dorsal valve concave with distinctly convex internally, visceral disc; distinctly geniculate with a rounded trail.

Closest species: *W. multispinifera* (Prendergast) which has finer ventral spines and a flattish dorsal valve.

Types: Holotype - CPC 26416; paratypes - CPC 24413, 24414, 26417-26428.

Type locality: BMR locality WB169, 6.6 km on a bearing of 205° from Mount Madeline, upper member of "Madeline Formation" (now Coyrie Formation), Carnarvon Basin.

Distribution and range: Near Mount Madeline, **Carnarvon Basin** - Coyrie Formation. Kuriyippi Hills, Bonaparte Basin (NT) - unnamed limestone, Port Keats Group.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common (some 25 specimens known).

Value in correlation and dating: Potentially valuable for dating and interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and calcarenite substrates.

Wyndhamia? sp.

1976 *Strophalosia* sp. Playford et al.: p.116

General comment: Assignment of the two available specimens to *Wyndhamia* is provisional. Indications are that the dorsal valve is thickened and wedge-shaped but the evidence for dorsal spines is equivocal. The dorsal median septum of the species is relatively short - a distinctive feature of the species.

Distribution and range: 4.8 km west of Arrino township, **Perth Basin** - Mingenew Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Of little value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrate.

Genus **ECHINALOSIA** Waterhouse 1967

Type species: *Strophalosia maxwelli* Waterhouse 1964; OD.

Echinalosia prideri (Coleman 1957)
(Plate 28 figs 1-3, 8)

1943 *Strophalosia jukesi* Prendergast: p.47, pl. 5 figs 1-20
1957 *Strophalosia prideri* Coleman: p.116-119, pl. 18 figs 15, 16; pl. 19 figs 1-19
1967 *Strophalosia prideri* Coleman; Condon: p.149
1971 *Echinalosia prideri* (Coleman); Waterhouse: p.384
1976a *Echinalosia prideri* (Coleman); Waterhouse: p.99
1986 *Echinalosia* (*Echinalosia*) *prideri* (Coleman); Archbold: p.113-114, fig. 5A-Z

Diagnosis: Large for genus, transversely oval to subtrigonal in outline; ventral spines abundant, coarse and erect; dorsal spines scattered and relatively coarse; ventral umbo prominent and pointed; hinge narrow in mature specimens.

Closest species: *E. prideri* is a distinctive species with a narrow hinge.

Types: Holotype - CPC 1018; paratypes - CPC 1019-1027, UWA 34460-34462.

Type locality: Right bank of Lynder River, 14.4 km east of Mia Mia Homestead, Carnarvon Basin.

Distribution and range: Mia Mia Homestead area and southeast of Keogh Hill, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: 150+ specimens.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep-water; silty to fine sandy substrate.

Subgenus **NOTOLOSIA** Archbold 1986

Type species: *Echinalosia* (*Notolosia*) *dickinsi* Archbold 1986; OD.

Echinalosia (Notolosia) dickinsi Archbold 1986
(Plate 27, figs 14, 17, 18)

1957 *Strophalosia* (*Heteralosia*) *prendergastae* Coleman (*partim*): p.127, pl. 20, figs 29-35 (*non cet.*)
1958 *Strophalosia* (*Heteralosia*) *prendergastae* Coleman: Guppy et al.: p.54
1961 *Strophalosia* sp. Dickins *in* Veevers & Wells: p.285, 287
1986 *Echinalosia* (*Notolosia*) *dickinsi* Archbold; p.116-118, Figs 6A-Q, 7A-S

Diagnosis: Small- to medium-sized shells with narrow hinge line and transversely oval outline in maturity; cicatrix large; ventral exterior ornament of concentric lamellae and fine, abundant, scattered to subconcentrically arranged spines; dorsal exterior with minute, scattered spines, dimples and growth lamellae.

Closest species: No other species is known to possess the subgeneric features.

Types: Holotype - CPC 24451; Paratypes - CPC 24452-24472.

Type locality: Mount Hardman, about 40 m below top of hill.

Distribution and range: Mount Hardman and Lat. 19°06'39"S, Long. 123°11'27"E, northern **Canning Basin**, Hardman Formation.

Age: Chhidruan.

Abundance: A common species.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical conditions.

Sedimentary environment: Shallow water; fine sandy substrate.

Genus **LIALOSIA** Muir-Wood & Cooper 1960

Type species: *Strophalosia kimberleyensis* Prendergast 1943; OD.

Lialosia kimberleyensis (Prendergast 1943)
(Plate 28 figs 4-7)

1890 *Strophalosia clarkei* Foord: p.103, pl. 5 figs 7-8; text fig. 6
1903 *Strophalosia* sp.ind. Etheridge Jnr: p.20, pl. 1 figs 10-12
1926 *Strophalosia* spp. Glauert: p.46
1943 *Strophalosia kimberleyensis* Prendergast: p.47-50, pl. 6 figs 1-5
1954 *Strophalosia kimberleyensis* Prendergast; Condon: p.87
1957 *Strophalosia* (*Heteralosia*) *kimberleyensis* Prendergast; Coleman: p.124-127, pl. 20 figs 7-19
1958 *Strophalosia* (*Heteralosia*) *kimberleyensis* Prendergast; Guppy et al.: p.48
1960 *Lialosia kimberleyensis* (Prendergast); Muir-Wood & Cooper: p.86, pl. 4 figs 14-24
1961 *Strophalosia kimberleyensis* Prendergast; Dickins *in* Veevers & Wells: p.286
1967 *Strophalosia* (*Heteralosia*) *kimberleyensis* Prendergast; Condon: p.169, 173
1975 *Strophalosia* (*Heteralosia*) *kimberleyensis* Prendergast; Playford et al.: p.287

Diagnosis: Hemispherical to subquadrate *Lialosia*. Interareas relatively low; cicatrix normally small, rarely distinct; external ornament of concentric lamellae, more pronounced on dorsal valve, faint capillation and row of ventral hinge spines; spines absent elsewhere.

Closest species: No other species known with just a single row of spines along the cardinal margin of the pedicle valve.

Types: Holotype - UWA 20452; paratypes - UWA 20455, 20460.

Type locality: North of Hill C, south side of Grant Range, northern Canning Basin.

Distribution and range: Cookilya Pool area on the Minilya River and Wandagee Station, northeast of Walbarune Peak, **Carnarvon Basin** - Wandagee Formation, Nalbia Sandstone, Baker Formation; Grant Range, Cherrabun Station and Noonkanbah Homestead area, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian) to Early Kungurian.

Abundance: Several hundred specimens.

Value in correlation and dating: Valuable for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate environment.

Sedimentary environment: Transitional zone-mid shoreline environment; silty and sandy subtrates.

Genus **LIVERINGIA** Archbold 1987

Type species: *Liveringia magnifica* Archbold 1987; OD.

Liveringia magnifica Archbold 1987
(Plate 28 figs 9, 11)

1958 *Strophalosia* sp. nov. Guppy et al.: p.54
1987 *Liveringia magnifica* Archbold: p.32-34, figs 6A-L, 7A-L
1988 *Liveringia magnifica* Archbold; Archbold: p.29, fig. 5A-J

Diagnosis: Large transverse *Liveringia*. Ventral exterior with fine erect body spines and fine, prominent hinge spines; dorsal exterior with shallow, elongate dimples, arranged in quincunx, and fine persistent capillae.

Closest species: No other species of genus known.

Types: Holotype - CPC 26450; paratypes - CPC 24422-24424, 26445-26449, 26451-26455.

Type locality: Near mouth of Nerrima Creek, Canning Basin; Kirkby Range Member of Hardman Formation.

Distribution and range: Northern **Canning Basin** - Kirkby Range Member of Hardman Formation.

Age: Chhidruan.

Abundance: Several hundred specimens.

Value in correlation and dating: Diagnostic of age.

Climate: Subtropical environment.

Sedimentary environment: Shallow water, sandy substrate.

Strophalosiid gen. et sp. indet.

General comment: Strophalosiids have been reported from the Carynginina Formation of the Perth Basin (Playford et al., 1976, p.110) and the Moogooloo Sandstone of the Carnarvon Basin (Condon, 1967, p.85). The reports cannot be verified because specimens have not been retained in collections.

Subfamily MINGENEWIINAE Archbold 1980

Genus **MINGENEWIA** Archbold 1980

Type species: *Mingenewia anomala* Archbold 1980; OD.

Mingenewia anomala Archbold 1980
(Plate 28 figs 12-15)

1904 *Chonetes* sp. indet. Etheridge Jnr *in* Maitland: p.20
1907a *Chonetes* sp. indet. Etheridge Jnr: p.22, pl. 4 fig. 5
1910 *Chonetes* sp. indet. Campbell: p.51
1910 *Chonetes* spp. (*non C. pratti*) Glauert: p.86
1912 *Chonetes* sp. indet. Maitland: p.22
1919 *Chonetes* sp. indet. Maitland: p.37
1980a *Mingenewia anomala* Archbold: p.255-257, pl. 1 figs 1-20

Diagnosis: Strophalosiid with non-spinose ventral valve and lamellose dorsal valve; cicatrix absent; ventral valve productiform in shape and convexity.

Closest species: Monotypic.

Types: Holotype - CPC 19145; paratypes - CPC 19145 - 19156.

Type locality: Fossil Hill, Mingenew area, Perth Basin.

Distribution and range: Mingenew area, **Perth Basin** - Mingenew Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common at type locality (15 specimens).

Value in correlation and dating: No correlation value at present; diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; silty fine sandy substrate.

Superfamily AULOSTEGACEA Muir-Wood & Cooper 1960

Family AULOSTEGIDAE Muir-Wood & Cooper 1960
Subfamily AULOSTEGINAE Muir-Wood & Cooper 1960

General comments: The subfamily Aulosteginae is widely developed in the Permian faunas of Western Australia (Coleman, 1957). The present review represents the results of a survey of the group undertaken by one of us (N.W.A.) based on a review of all pertinent Western Australian literature and an examination of extensive collections from the Carnarvon and Canning Basins that are housed in the Commonwealth Palaeontological Collection. The present review has highlighted the following points which a detailed revision of the group should address. Particular attention should be given to

aspects of ontogeny (for example, the ontogeny of dorsal internal structures) and to variation within species (for example, variations in the height and development of the ventral interarea).

It is anticipated that species such as *Aulosteges spinosus*, *Taeniothaerus cookiliensis*, and *Taeniothaerus miniliensis* may prove to be immature or submature examples of other species but such a conclusion requires an assessment of large collections. The value of the group for local and, at times, regional biostratigraphy is in no way decreased by the inclusion of all available specific names in the present review.

Genera in the subfamily are reasonably well understood (see Parfrey, 1983 for a recent review). Most of the generic assignments made by Coleman (1957) are retained and *Megasteges* Waterhouse is now recognized from Western Australia (anticipated by Waterhouse, 1975). However, *Taeniothaerus subquadratus* (Morris 1845), the type species of that genus, which has been widely reported from Western Australia (see synonymies herein and Parfrey, 1983), does not in fact occur in the State.

Genus **AULOSTEGES** von Helmersen 1847

Type species: *Orthis wangenheimi* de Verneuil 1845 (= *Aulosteges variabilis* von Helmersen 1847); OD.

Aulosteges baracoodensis Etheridge Jnr 1903
(Plate 28 figs 16, 17)

1903 *Aulosteges baracoodensis* Etheridge Jnr: p.22, pl. 2 figs 1-2a
1910 *Aulosteges baracoodensis* Etheridge Jnr; Glauert: p.86
1926 *Aulosteges baracoodensis* Etheridge Jnr; Glauert (*partim*): p.46
1933c *Aulosteges baracoodensis* Etheridge Jnr; Hosking: p.32-35, pl. 1 figs 1a-c; pl. 2 figs a,b
1957 *Aulosteges baracoodensis* Etheridge Jnr; Coleman: p.36-38, pl. 1 figs 1,3,4,6
1957 *Aulosteges lyndonensis* Coleman (*partim*): pl. 4 figs 9, 10 (*non cet.*)
1967 *Aulosteges baracoodensis* Etheridge Jnr; Condon: p.70
1975 *Aulosteges baracoodensis* Etheridge Jnr; Playford et al.: p.281
1976 *Aulosteges baracoodensis* Etheridge Jnr; Playford et al.: p.95

Diagnosis: Large-sized *Aulosteges* species, subquadrate outline with low, wide, ventral area; ornamentation of elongated, relatively fine, spine bases, reclined or erect; cardinal process massive (modified after Coleman, 1957, p.37).

Closest species: *A. lyndonensis* Coleman, a species with coarser ornament and a larger ventral area.

Type: Lectotype - AM F36218; other figured specimens - UWA 10496, CPC 1956.

Type locality: Wooramel River, Carnarvon Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Wooramel, Minilya, and Gascoyne River areas, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Only a few specimens.

Value in correlation and dating: Diagnostic of age, valuable in interbasinal correlation but relatively rare.

Climate: Species associated with sedimentary rocks that were deposited in a cool-temperate environment.

Sedimentary environment: Relatively shallow water; silty and calcarenite substrate.

Aulosteges ingens Hosking 1931
(Plate 29 figs 4-7)

1931 *Aulosteges ingens* Hosking: p.15, pl. 5 figs 1a-c; pl. 6 figs 2a-c
1933c *Aulosteges ingens* Hosking: p.37
1943 *Aulosteges ingens* Hosking; Prendergast: p.37
1957 *Aulosteges ingens* Hosking; Coleman (*partim*): p.43, pl. 3 figs 1-4, 6, 8 (*non cet.*)
1957 *Aulosteges spinosus* Coleman (*partim*): pl. 5 figs 1-3 (*non cet.*)
1967 *Aulosteges ingens* Hosking; Condon: p.131
1975 *Aulosteges ingens* Hosking; Playford et al.: p.284
1976 *Aulosteges spinosus* Playford et al.: p.95
1976a *Aulosteges ingens* Hosking; Waterhouse: p.99
1976 *Aulosteges* sp. cf. *A. ingens* Hosking; Playford et al.: p.98
?1976 *Aulosteges* sp. indet. Playford et al.: p.98

Diagnosis: Subquadrate *Aulosteges* species with pointed twisted umbo; ventral area large, wide as hinge, with prominent ridged pseudodeltidium.

Closest species: *A. lyndonensis* Coleman, a larger species, at times with twisted ventral umbo.

Types: Lectotype - GSWA 1/5000; paratype - GSWA 1/4955.

Type locality: Bed in bank of Wooramel River, 4.8 km above Station R 20, Carnarvon Basin.

Distribution and range: Woolaga Creek, Mingenew area, **Perth Basin** - High Cliff Sandstone; type locality, **Carnarvon Basin** - Coyrie Formation.

Age: Artinskian (Aktastinian, early Baigendzhinian).

Abundance: Relatively rare (particularly from High Cliff Sandstone).

Value in correlation and dating: Potentially valuable for interbasinal correlation (when better understood); diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Additional comment: The specimens from the Port Keats District attributed to Hosking's species by Coleman (1957) are herein referred to *Megasteges septentrionalis* (Etheridge Jnr).

Aulosteges lyndonensis Coleman 1957
(Plate 29 figs 8, 9)

1907a *Productus subquadratus* Etheridge Jnr: p.21, pl. 3 figs 6, 7
1957 *Aulosteges lyndonensis* Coleman: p.46-49, pl. 4 figs 1-8 (*non cet.*)
1965 *Aulosteges baracoodensis* Edgell: p.66, pl. 34 fig. 3
1967 *Aulosteges lyndonensis* Coleman; Condon: p.131
1975 *Aulosteges lyndonensis* Coleman; Playford et al.: p.284
1976 *Taeniothaerus miniliensis* Playford et al.: p.116

Diagnosis: Large shallow *Aulosteges* species, quadrate outline with large area co-planar with brachial valve and ornamentation of coarse spines (modified after Coleman, 1957, p.46).

Closest species: *A. baracoodensis* Etheridge Jnr, a species with finer ornamentation and a lower ventral area.

Types: Holotype - CPC 1001; paratypes - CPC 1002-1007; other figured specimens - UWA 34431, 34432.

Type locality: North bank of Lyndon River, north of Round Hill, 13.5 km east of Mia Mia Homestead, Carnarvon Basin.

Distribution and range: Mingenew area, **Perth Basin** - Mingenew Formation; type locality, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common fragmentary specimens.

Value in correlation and dating: Diagnostic of age; potentially valuable for interbasinal correlation; Mingenew occurrences require modern analysis.

Climate: Associated with sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep-water; silty to fine sandy substrate.

Aulosteges reclinis Coleman 1957
(Plate 29 fig. 10; Plate 30 figs 1-2, 4)

1957 *Aulosteges reclinis* Coleman (*partim*): p.38-40, pl. 1 figs 2, 5, 7, 8-10; pl. 2 figs 1-4; *non* pl. 6 fig.1
1958 *Aulosteges reclinis* Coleman; Guppy et al.: p.54

1958a *Aulosteges reclinis* Coleman; Thomas: p.3
1969 *Aulosteges reclinis* Coleman; Thomas: p.221

Diagnosis: *Aulosteges* or possibly *Megasteges* species with subtriangular outline; ventral valve not strongly geniculated; ventral area large, triangular and reclined (modified after Coleman 1957, p.38).

Closest species: *Megasteges fairbridgei* Coleman which has relatively coarser ventral spine bases.

Types: Holotype - UWA 31190; paratypes - UWA 29106, 29106a, 29109, CPC 21043.

Type locality: 6.4 km north of Mount James on boundary fence between Nerrima and Kalyeeda Stations, northern Canning Basin.

Distribution and range: Nerrima - Kalyeeda Stations, Selection Homestead, and Nerrima Creek area, northern **Canning Basin** - Hardman Formation. Port Keats Mission area Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Relatively common (30+ specimens).

Value in correlation and dating: Diagnostic of age and valuable for interbasinal correlation.

Climate: Species associated with sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Aulosteges sp. indet. A

1957 *Aulosteges* sp. ind. A Coleman: p.51-52, pl. 5 figs 19-21
1967 *Aulosteges* sp. Condon: p.184

Diagnosis: A poorly known species, known only from a juvenile specimen, with distinct ventral area, twisted umbo, and relatively coarse ventral spines.

Figured specimen: UWA 28114A.

Distribution and range: Minilya River area southwest of Wandagee Hill, **Carnarvon Basin** - Coolkilya Sandstone, ?Baker Formation.

Age: Kungurian.

Abundance: Rare.

Value in correlation and dating: Of no value at present.

Climate: Species associated with sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow-water; sandy substrate.

Aulosteges spp.

General comment: In addition to the above verified reports, Condon (1967, p.102, 152) has recorded, based on field identifications, *Aulosteges* spp. from the Moogooloo Formation and the Mallens Sandstone of the Carnarvon Basin; specimens are not available for verification.

Aulosteges spinosus Hosking 1931
(Plate 29 figs 1-3)

1910 *Aulosteges* sp. Campbell: p.52
1931 *Aulosteges spinosus* Hosking: p.17-19, pl. 3 figs 7a-d
1933c *Aulosteges spinosus* Hosking; Hosking: p.37
1933c *Aulosteges* sp. Hosking: p.35
1943 *Aulosteges spinosus* Hosking; Prendergast: p.36, pl. 4 figs 7-10
1957 *Aulosteges spinosus* Hosking; Coleman: p.49-51, pl. 5 figs 7-9 (*non cet.*)
1967 *Aulosteges spinosus* Hosking; Condon: p.70

Diagnosis: Small sized *Aulosteges*, not inflated, with sharp recurvature of the ventral area along the cardinal margin; ornamentation of fine spines (modified after Coleman, 1957, p.50)

Closest species: Hosking's species is probably based on juvenile material of an aulostegid species such as *Taeniothaerus irwinensis*.

Holotype: GSWA 1/4687.

Type locality: South bank of Wooramel River, below Callytharra Springs, Carnarvon Basin.

Distribution and range: ?Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale; type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare (only 1 specimen reliably known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; calcarenite substrate.

Additional comment: Specimens referred by Coleman (1957) to Hosking's species from Woolaga Creek, Perth Basin are now known to be from the High Cliff Sandstone and are referred herein to *A. ingens* Coleman. Guppy et al. (1958, p.48) and Playford et al. (1975, p.340) have reported *Aulosteges* sp. cf. *A. spinosus* Hosking from the Nura Nura Member, Canning Basin; again, specimens are not available for verification.

Genus **TAENIOTHAERUS** Whitehouse 1928

Type species: *Productus subquadratus* Morris 1845; OD.

Taeniothaerus coolkiliensis Coleman 1957
(Plate 30 figs 7, 8, 10, 11)

1957 *Taeniothaerus coolkiliensis* Coleman (*partim*): p.89-91, pl. 11 figs 7-10 (*non cet.*)
1957 *Aulosteges spinosus* Hosking; Coleman (*partim*): p.49, pl. 5 figs 4-6 11, 12 (*non cet.*)
1967 *Taeniothaerus coolkiliensis* Coleman; Condon: p.169

Diagnosis: Species of medium size, characterized by pointed, attenuated umbo, projecting above plane of dorsal valve, not incurved, usually twisted, with high triangular suberect area (modified after Coleman, 1957, p.89).

Closest species: *T. miniliensis* Coleman, a species with larger, more convex and less frequently distorted ventral valve, and less prominent umbo.

Types: Holotype - UWA 27444; paratype - UWA 34430.

Type locality: Northeast side of syncline, north of Minilya River, west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare (only 4 specimens known).

Value in correlation and dating: Of little value at present.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep water; silty to fine sandy substrate.

Additional comment: Specimens from the High Cliff Sandstone (Woolaga Creek) referred by Coleman (1957) to this species are herein referred to *Taeniothaerus* sp. nov.

Taeniothaerus fletcheri Coleman 1957
(Plate 32 figs 1, 4)

1957 *Taeniothaerus(?) fletcheri* Coleman: p.91-93, pl. 9 figs 15-19; pl. 10 figs 1-7
1958 *Taeniothaerus? fletcheri* Coleman; Guppy et al.: p.521

Diagnosis: Species with low wide area, swollen incurved umbo and ornamentation of numerous coarse reclined spines from elongated spine

bases; often with rows of interspersed finer spines towards anterior margin of ventral valve (modified after Coleman, 1957, p.91).

Closest species: *T. miniliensis* Coleman, a species with finer spines and less swollen ventral umbo.

Types: Holotype - CPC 1950; paratypes - UWA 29427b, 29438, 29440, 34444, CPC 1951.

Type locality: Mount Hardman, northern Canning Basin.

Distribution and range: Mount Hardman, Bells Homestead and Nerrima Creek areas, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Relatively common (20+ specimens).

Value in correlation and dating: Diagnostic of age.

Climate: Species associated with sedimentary rocks that were deposited under sub-tropical conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Taeniothaerus irwinensis Coleman 1957
(Plate 30 figs 3, 5, 6, 9)

1890 *Productus subquadratus* Foord: p.16, pl. 17 fig. 5
1907b *Productus subquadratus* Etheridge Jnr: p.30, pl. 7 figs 2-4; pl. 8 fig. 1
1910 *Productus subquadratus* Glauert: p.87
1943 *Taeniothaerus subquadratus* (Morris); Prendergast: p.27, pl. 4 figs 1-6
1957 *Taeniothaerus irwinensis* Coleman: p.93-96, pl. 11 figs 13, 14; pl. 12 figs 1-6
?1958 *Taeniothaerus irwinensis* Coleman (doubtful); Guppy et al.: p.46
1976 *Taeniothaerus irwinensis* Coleman; Playford et al.: p.95
1983 *Taeniothaerus subquadratus* (Morris); Parfrey: p.242 (*partim, non figs*)

Diagnosis: *Taeniothaerus* species of medium size and moderate convexity, with small ventral cardinal area; ornament of fine subquincuncially arranged suberect and erect spines with no coarse spines on alar extremities (modified after Coleman, 1957, p.93).

Closest species: *T. miniliensis* Coleman, which has a different spine arrangement.

Types: Holotype - UWA 32044; paratypes - UWA 4786, 10932, 12396 (2 specimens), 23437.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Known from the type locality only, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively rare (11 specimens).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty substrate.

Additional comment: Coleman (1957) recorded this species from Woolaga Creek (High Cliff Sandstone). That report is transferred herein to *Taeniothaerus* sp. nov.

Taeniothaerus miniliensis Coleman 1957
(Plate 31 figs 5-7)

1914 *Aulosteges baracoodensis* Etheridge Jnr: p.33, pl.4 figs 11-13
1926 *Aulosteges baracoodensis* Etheridge Jnr; Glauert (*partim*): p.46
1957 *Taeniothaerus miniliensis* Coleman: p.96-101, pl. 12 figs 7-11; pl. 13 figs 1-9; pl. 14 figs 1-8
1957 *Taeniothaerus* sp. aff. *miniliensis* Coleman: p.101, pl. 14 figs 9-11
1958 *Taeniothaerus miniliensis* Coleman: Guppy et al.: p.48
?1961 *Taeniothaerus* sp. Dickins *in* Veevers & Wells: p.286
1967 *Taeniothaerus miniliensis* Coleman; Condon: p.169
1967 *Aulosteges baracoodensis* Etheridge Jnr; Condon: p.169
1975 *Taeniothaerus miniliensis* Coleman; Playford et al.: p.341
1975 *Aulosteges baracoodensis* Playford et al.: p.287

Diagnosis: Large-sized species with ventral area of variable size; ornament of medium to fine spines, quincuncial in arrangement becoming finer towards margin; large spines on alar extremeties; cardinal process large (modified after Coleman, 1957, p.96).

Closest species: *T. irwinensis* Coleman, a species without large spines on alar extremities.

Types: Holotype - UWA 34445; paratypes - UWA 27116, 27134, 27328, 27358, 27384, 27406, 27406a, 27408, 27454, 27454a, 27545, 27600, 22712, 33001, 33023.

Type locality: West side of syncline, south bank of Minilya River, west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Extremely common - over 500 specimens.

Value in correlation and dating: Diagnostic of age and valuable for interbasinal correlation.

Climate: Species associated with sedimentary rocks that were deposited under cool- to warm-water conditions.

Sedimentary enviornment: Relatively deep to relatively shallow-water marine; silty and sandy substrates.

Taeniothaerus sp. nov.
(Plate 32 fig. 6)

1957 *Taeniothaerus irwinensis* Coleman (*partim*): p.93
1957 *Taeniothaerus* sp. cf. *subquadratus* Coleman: p.102, pl. 15 figs 8-12
1957 *Taeniothaerus coolkiliensis* Coleman (*partim*): p.89, pl. 11 figs 11, 12
1976 *Taeniothaerus coolkiliensis* Playford et al.: p.95

Diagnosis: Large and massive shells with highly convex ventral valves and flat dorsal valves.

Figured specimens: UWA 32042, 32043, 32316a, 34451.

Distribution and range: All specimens come from Woolaga Creek, Mingenew District, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: Relatively common (30+ specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Additional comment: This species, to be described by one of us (N.W.A.) elsewhere, unites reports of taeniothaerids from the Woolaga Creek area, shown by Playford (1959) to be from the basal High Cliff Sandstone.

Taeniothaerus teicherti Coleman 1957
(Plate 31 figs 1-4)

1957 *Taeniothaerus teicherti* Coleman: p.104-108, pl. 16 figs 1-8; pl. 17 figs 1-5
1960 *Taeniothaerus subquadratus* Muir-Wood & Cooper (*partim*): p.97, pl. 11 figs 1, 3-6; pl. 12 figs 6, 7
1965 *Taeniothaerus subquadratus* Muir-Wood: p.H454, Figs 1a-d
1967 *Taeniothaerus teicherti* Coleman; Condon: p.169
1975 *Taeniothaerus teicherti* Coleman; Playford et al.: p.287

Diagnosis: Large species with massive shell, widest at hinge; ventral cardinal area low; dorsal valve excessively thickened at maturity (modified after Coleman, 1957, p.104).

Closest species: *T. miniliensis* Coleman, a smaller species with narrower hinge, relatively higher ventral area and less thickening of the dorsal valve.

Types: Holotype - CPC 1008; paratypes - CPC 1009-1017, UWA 34447-34449.

Type locality: 0.8 km east of Calvary Spring, 11.2 km southeast of Mooka Station Homestead, Wandagee area, Carnarvon Basin.

Distribution and range: Wandagee area, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water. Coarse sandy substrate.

Genus **MEGASTEGES** Waterhouse 1975

Type species: *Megasteges nepalensis* Waterhouse 1975; OD.

Megasteges fairbridgei (Coleman 1957)
(Plate 32 figs 2,3,5,8)

1933c *Aulosteges* sp. Hosking: p.37, pl. 1 figs 2a-b
1957 *Aulosteges fairbridgei* Coleman: p.40-43, pl. 2 figs 5-12
1958a *Aulosteges fairbridgei* Coleman; Thomas: p.3
1958 *Aulosteges fairbridgei* Coleman; Guppy et al.: p.54
1969 *Wyatkina fairbridgei* (Coleman); Thomas: p.221

Diagnosis: *Megasteges* with large shallow visceral cavity, large reclined area, attenuated umbo, and very regular ornamentation of elongate spine bases (Coleman, 1957, p.41).

Closest species: *M. septentrionalis* (Etheridge Jnr) which may be a senior synonym of this species.

Types: Holotype - UWA 29348f; paratypes - UWA 29438a,b,e, AM F44722, F44778, F44781, F44827.

Type locality: Near Tutu Windmill, Nerrima Creek, Luluigui - Myrooda area, northern Canning Basin.

Distribution and range: Type locality, Mount Cedric, northern **Canning Basin** - Hardman Formation. Port Keats area, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Abundant species (70 internal and external moulds.)

Value in correlation and dating: Diagnostic of age, valuable for interbasinal correlation.

Climate: Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Megasteges septentrionalis (Etheridge Jnr 1907)
(Plate 32 figs 7, 10, 11)

1907c *Aulosteges baracoodensis* var. *septentrionalis* Etheridge Jnr: p.6, pl. 1 figs 1-5
1907c *Strophalosia?* sp. Etheridge Jnr: p.6, pl. 1 fig. 6
1933c *Aulosteges baracoodensis* var *septentrionalis* Etheridge Jnr: Hosking: p.35
1957 *Aulosteges ingens* Hosking; Coleman (*partim*): p.43, pl. 3 figs 5, 7, 9, 10 (*non cet.*)
1957 *Aulosteges reclinis* Coleman (*partim*): p.38, pl. 6 fig. 1 (*non cet.*)
1986 *Megasteges septentrionalis* (Etheridge Jnr); Archbold: p.49-51, fig. 1A-F

Diagnosis: Large *Megasteges* with variable outline; sulcus gentle; shell outline rounded in maturity; ventral spine bases elongate and coarse; ventral muscle field huge at maturity.

Closest species: *M. fairbridgei* (Coleman), a somewhat smaller species with a shallow ventral sulcus which may represent submature representative of Etheridge's species.

Lectotype: SAM P2135 (selected by Archbold, 1986).

Type locality: Cape Dombey, Port Keats area, Bonaparte Basin, NT.

Distribution and range: East of Mount Cedric, northern **Canning Basin** - Hardman Formation. Cape Dombey and Port Keats Mission, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Sporadic distribution as presently understood.

Value in correlation and dating: Potentially valuable for interbasinal correlation; diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Suborder OLDHAMINIDINA Williams 1953
Superfamily LYTTONIACEA Waagen 1883

Family LYTTONIIDAE Waagen 1883

Genus **LEPTODUS** Kayser 1883
(= **LYTTONIA** Waagen 1883)

Type species: *Leptodus richthoferi* Kayser 1883; OD.

Leptodus sp. aff. **L. nobilis** (Waagen 1883)
(Plate 32 figs 9, 12)

cf. 1883 *Lyttonia nobilis* Waagen: p.398, pl. 29 figs 1-3; pl. 30 figs 1-2, 5-6, 8, 10-11
1957 *Leptodus* cf. *nobilis* (Waagen); Thomas: p.177-18, pl. 20 figs 1-6
1969 *Leptodus nobilis* (Waagen); Thomas: p.223

Remarks: Incomplete ventral valves of large flat *Leptodus* species, with lateral extensions posteriorly, a median septum, inclined to which is an apparatus of curved lateral ridges.

Closest species: Agrees with *L. nobilis* (Waagen 1883) in form but incompletely known.

Figured specimens: CPC 1526-1531.

Type locality: Tchindi Beach about 14.5 km southwest of Port Keats Mission, NT.

Distribution and range: Known from two localities in Upper Marine Member of Port Keats Group (NT).

Age: Chhidruan.

Abundance: Rare ferruginized valves.

Value in correlation and dating: Valuable but rare; *L. nobilis* is a widespread late Permian species (Thomas, 1957).

Climate: Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Moderately shallow neritic; silty to fine sandy substrate.

Suborder PRODUCTIDINA Waagen 1883
Superfamily PRODUCTELLACEA Schuchert & LeVene 1929

?Family PRODUCTELLIDAE Schuchert & LeVene 1929

Genus **STICTOZOSTER** Grant 1976

Type species: *Stictozoster leptus* Grant 1976; OD.

Stictozoster senticosa (Hosking 1933)
(Plate 33 figs 1-3)

1933b *Pustula senticosa* Hosking: p.47-49, pl. 3 figs 2, 3
1937 *Pustula senticosa* Hosking; Raggatt & Fletcher: p.176
1943 *Krotovia senticosa* (Hosking); Prendergast: p.30
1957 *Krotovia senticosa* (Hosking); Coleman: p.63-64, pl. 7 figs 11-15
1967 *Krotovia senticosa* (Hosking); Condon: p.70
1984b *Stictozoster senticosa* (Hosking); Archbold: p.83, fig. 1 A-H

Diagnosis: Large *Stictozoster* with coarse spines widely spaced on both valves; dorsal interior characteristic for genus.

Closest species: Distinct from all other species of the genus because of the coarse spines.

Lectotype: GSWA 1/4970a1 (Chosen by Coleman, 1957, p.63).

Type locality: Creek 0.75 km west of Callytharra Springs, Wooramel River, Carnarvon Basin.

Distribution and range: Type area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare (only 3 specimens known).

Value in correlation and dating: Of limited value but diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environemt: Moderate shallow water; calcarenite substrate.

Family OVERTONIIDAE Muir-Wood & Cooper 1960
Subfamily OVERTONIINAE Muir-Wood & Cooper 1960

Genus **COMUQUIA** Grant 1976

Type species: *Comuquia modesta* Grant 1976; OD.

Comuquia australis Archbold 1984
(Plate 33 figs 4-6)

1984b *Comuquia australis* Archbold: p.86, figs 1 K-Z, AA-BB

Diagnosis: Small *Comuquia* species with distinct lamellae and sparsely spinose ventral valve.

Closest species: *C. himalayaenis* Jing & Sun (1981, pl. 4 figs 17-26) with a less curved ventral valve.

Types: Holotype - GSWA F11050; other figured specimens - GSWA F11187-11191, CPC 19930A,B.

Type locality: Callytharra Springs area, Carnarvon Basin.

Distribution and range: Only known from type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare (only 8 specimens known).

Value in correlation and dating: Of limited value but diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; calcilutite and calcarenite substrates.

Genus **LETHAMIA** Waterhouse 1973

Type species: *Lethamia ligurritus* Waterhouse 1973; OD.

Lethamia? obscurus Archbold 1984
(Plate 33 figs 7, 8)

1957 *Krotovia* sp. ind. A Coleman: p.67, pl. 9 figs 22, 23
1984b *?Lethamia obscurus* Archbold: p.86, Figs 1 I-J

Diagnosis: Shell with transversely oval outline; dorsal valve lacks dimples; both valves with very fine spines of uniform size and closely spaced.

Closest species: *L. ligurritus* Waterhouse (1973) which has somewhat coarser spines.

Holotype: CPC 1952.

Type locality: Pells Range, 24 km northwest of Towrana Homestead, Carnarvon Basin.

Distribution and range: Known only from type locality, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare (holotype the only specimen known).

Value in correlation and dating: Of limited value but diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; calcarenite substrate.

Genus **DYSCHRESTIA** Grant 1976

Type species: *Dyschrestia spodia* Grant 1976; OD.

Dyschrestia colemani Archbold 1984
(Plate 33 figs 9, 12, 13)

1943 *Krotovia spinulosa* Prendergast: p.30, pl. 4 figs 11-13
1957 *Krotovia spinulosa* Coleman: p.65, pl. 7 figs 19-24
?1958 *Krotovia* sp. Guppy et al.: p.48
1967 *Krotovia spinulosa* Condon: p.169
1984b *Dyschrestia colemani* Archbold: p.90, Figs 3A-Q

Diagnosis: Average sized species of *Dyschrestia*; distinguished by distinctly developed dorsal median septum and muscle pads.

Closest species: *D. spodia* (Grant 1976) which has less well developed dorsal internal structures.

Holotype: AM F38446.

Type locality: Wandagee Station, Minilya River, Carnarvon Basin.

Distribution and range: Minilya River, Wandagee Station, **Carnarvon Basin** - Wandagee Formation. The occurrence from the northern **Canning Basin** (Guppy et al., 1958) cannot be confirmed - the specimens were probably lost in the 1953 Bureau of Mineral Resources fire.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively uncommon (about 10 specimens are known).

Value in correlation and dating: Of moderate value for dating; diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet water; silty to fine sandy substrate.

Dyschrestia micracantha (Hosking 1933)
(Plate 33 figs 10, 11)

1933b *Pustula micracantha* Hosking: p.49-50, pl. 4 figs 4a,b
1937 *Pustula micracantha* Hosking; Raggatt & Fletcher: p.176
1943 *Krotovia micracantha* (Hosking); Prendergast: p.30
1957 *Krotovia micracantha* (Hosking); Coleman: p.61-63, pl. 7 figs 16-18; pl. 9 figs 20-21
1967 *Krotovia micracantha* (Hosking); Condon: p.70
1984b *Dyschrestia micracantha* (Hosking); Archbold: p.88, figs 2 A-O

Diagnosis: Large species of genus distinguished by high dorsal median septum which is raised anteriorly; small beak and less crowded spines on the ventral valve.

Closest species: *D. colmani* Archbold which has weaker concentric ornament and less well developed internal structures.

Lectotype: GSWA 1/4970b1, chosen by Coleman (1957, p.61).

Type locality: Creek, 1.25 km west of Callytharra Springs, Wooramel River, Carnarvon Basin.

Distribution and range: Callytharra Springs area, and Pells Range, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively uncommon, sporadic (about 12 specimens).

Value in correlation and dating: Of moderate value for dating; diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; calcarenite substrate.

Dyschrestia sp.

1957 *Krotovia spinulosa* Coleman (*partim*): p.65, *non illus.*
1967 *Krotovia spinulosa* Condon: p.184
1975 *Krotovia spinulosa* Playford et al.: p.288
1984b *Dyschrestia* sp. Archbold: p.91, Figs 4A-G

Diagnosis: Characterized by highly convex ventral valve and fine spines arranged concentrically on ventral valve.

Figured specimens: UWA 28145a, b.

Locality: A few hundred metres southwest of Wandagee Hill, Mungadan Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Hill area, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Extremely rare (2 specimens known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were laid down under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty to fine sandy substrate.

Superfamily PRODUCTACEA Gray 1840

Family MARGINIFERIDAE Stehli 1954
Subfamily PAUCISPINIFERINAE Muir-Wood & Cooper 1960

Genus **RETIMARGINIFERA** Waterhouse 1970

Type species: *Retimarginifera perforata* Waterhouse 1970; OD.

Retimarginifera perforata Waterhouse 1970
(Plate 33 figs 14-16, 19)

1943 *Dictyoclostus gratiosus* Prendergast: p.17-18, pl. 2 figs 5-7
1957 *Marginifera gratiodentalis* Coleman: p.79-81, pl. 9 figs 1-14
1958 *Marginifera gratiodentalis* Guppy et al.: p.48
1967 *Marginifera gratiodentalis* Condon: p.169
1969 *Kozlowskia* n. sp. Waterhouse: p.232
1970a *Retimarginifera perforata* Waterhouse: p.125-127, pl. 2 figs 1-12; text fig. 3
1984a *Retimarginifera perforata* Waterhouse; Archbold: p.116, figs 2A-X,AA

Diagnosis: Average size for genus with deep sulcus anteriorly, distinct ears, low costae, distinct rugae posteriorly; one or two pairs of halteroid spines on anterior flanks of ventral valve.

Closest species: *R. waterhousei* Archbold which has coarser costae and a shallower sulcus.

Holotype: UWA 59282.

Type locality: Horizon northeast of syncline on north bank of Minilya River, west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Minilya River area, Wandagee Station, **Carnarvon Basin** - Cundlego and Wandagee Formations. Reports of the species from other formations in Carnarvon Basin have not been confirmed (Archbold, 1984a). The report from the Noonkanbah Formation, northern **Canning Basin** (Guppy et al., 1958), can now be confirmed (cf. Archbold, 1984a) because the specimens have been recently located by one of us (N.W.A.) in the Bureau of Mineral Resources collections.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common (some 60+ specimens known).

Value in correlation and dating: Significant value because diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep, quiet water; silty to fine sandy substrate.

Retimarginifera waterhousei Archbold 1984
(Plate 33 figs 17, 18, 20, 21)

1967 *Marginifera gratiodentalis* Condon: p.184
1984a *Retimarginifera waterhousei* Archbold: p.118, Figs 3A-Y

Diagnosis: Shell with shallow to moderately deep, broad, U-shaped sulcus; ears small, weakly ornamented; rugae low; costae prominent and coarse.

Closest species: *R. perforata* Waterhouse which has finer costae and a deeper sulcus.

Holotype: UWA 88129.

Type locality: East of Wandagee Hill, Malbia Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: East of Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Relatively common but sporadic (some 25 specimens known).

Value in correlation and dating: Significant value because diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty substrate.

Family WAAGENOCONCHIDAE Muir-Wood & Cooper 1960

Genus **WAAGENOCONCHA** Chao 1927

Type species: *Productus humboldti* d'Orbigny 1842; OD.

Waagenoconcha imperfecta Prendergast 1935
(Plate 33 figs 22-25)

1924 *Productus subquadratus* Chapman: p.36
1926 *Productus subquadratus* Glauert: p.46
1935 *Waagenoconcha imperfecta* Prendergast: p.15, pl. 4 figs 1-3
1943 *Waagenoconcha imperfecta* Prendergast: p.25, pl. 3 figs 7-9
1943 *Waagenoconcha vagans* Prendergast: p.26-27, pl. 3 fig. 6
1957 *Waagenoconcha imperfecta* Prendergast; Coleman: p.82-85, pl. 10 figs 8-14; pl. 11 figs 1-6
1957 *Waagenoconcha imperfecta* Hosking (*sic*) Thomas: p.181
1958 *Waagenoconcha imperfecta* Prendergast; Guppy et al.: p.54
1958a *Waagenoconcha imperfecta* Hosking (*sic*) Thomas: p.3
1961 *Waagenoconcha* sp. ind. Dickins *in* Veevers & Wells: p.285
1969 *Waagenoconcha imperfecta* Prendergast; Thomas: p.221
cf. 1974 *Waagenoconcha imperfecta* Prendergast; Tazawa: p.127, pl. 1 figs 4-6; pl. 2 figs 2-7; pl. 3 figs 1-3; pl. 4 figs 1-4, 7

Diagnosis: *Waagenoconcha* species distinguised principally by the overall fineness of the spinose ornamentation, and by the frequent presence of strongly developed lines of growth (Coleman, 1957, p.83).

Closest species: *Productus waageni* (*sensu* Broili, 1916, pl. 14 figs 1-5) and *Waagenoconcha imperfecta* (*sensu* Tazawa), both species with fine ornament.

Holotype: UWA 3044.

Type locality: Luluigui Station, northern Canning Basin.

Distribution and range: Luluigui Station, Mount Hardman, and Mount Cedric, northern **Canning Basin** - Hardman Formation. Port Keats Mission area, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Common (50+ specimens).

Value in correlation and dating: A significant fossil for dating the Hardman fauna.

Climate: Species found in sedimentary rocks that were deposited under warm-temperate to subtropical conditions.

Sedimentary environment: Moderately shallow warm water; silty fine sand substrate.

Family DICTYOCLOSTIDAE Stehli 1954

Genus **CALLYTHARRELLA** Archbold 1985

Type species: *Dictyoclostus callytharrensis* Prendergast 1943; OD.

Callytharrella callytharrensis (Prendergast 1943)
(Plate 34 figs 1-5)

1902 *Productus semireticulatus* Etheridge Jnr, *in* Maitland: p.12
1903 *Productus semireticulatus* Maitland, *in* Fraser: p.iv
1903 *Productus semireticulatus* Etheridge Jnr: p.18, pl. 2 figs 3-5
1904 *Productus semireticulatus* Maitland: p.619
1907b *Productus semireticulatus* Etheridge Jnr: p.29
1910 *Productus semireticulatus* Glauert: p.87
1912 *Productus semireticulatus* Maitland: p.23, 26
1919 *Productus semireticulatus* Maitland: p.34, 38
1924 *Productus semireticulatus* Chapman: p.36
1924 *Productus semireticulatus* Maitland: p.34
1926 *Productus semireticulatus* Glauert: p.46
1931 *Productus semireticulatus* Hosking: p.8, 22
1936 *Productus semireticulatus* Chapman *in* Raggatt: p.128
1937 *Productus semireticulatus* Clarke: p.429
1937 *Productus semireticulatus* Raggatt & Fletcher: p.168, 169, 174
1937 *Productus* cf. *spiralis* Raggatt & Fletcher: p.169, 174
1937 *Productus* cf. *indicus* Raggatt & Fletcher: p.169, 174

1943 *Dictyoclostus callytharrensis* Prendergast: p.13, pl. 1 figs 1-7; pl. 2 fig. 1
1943 *Dictyoclostus spiralis* Prendergast: p.18, pl. 2 figs 8, 9
1952 *Dictyoclostus callytharrensis* Prendergast; Teichert: p.117, 121, 122
1957 *Dictyoclostus (?Antiquatonia) callytharrensis* Prendergast; Coleman: p.54, pl. 6 figs 3-14
1957 *Dictyoclostus (?Antiquatonia) magnus* Coleman: p.57, pl. 7 figs 1-6
1958 *?Dictyoclostus callytharrensis* Prendergast; Guppy et al.: p.46
1958 *Dictyoclostus magnus* Coleman; Guppy et al.: p.46
1967 *Dictyoclostus callytharrensis* Prendergast; Condon: p.70
1967 *Dictyoclostus magnus* Coleman; Condon: p.70
1967 *Dictyoclostus* Condon: p.90
1969 *Costiferina callytharrensis* (Prendergast); Thomas: p.220
1971 *Reticulatia callytharrensis* (Prendergast); Waterhouse: p.391
1971 *?Reticulatia magnus* (Coleman); Waterhouse: p.391
1975 *Dictyoclostus callytharrensis* Prendergast; Playford et al.: p.233, 281, 282
1975 *Dictyoclostus magnus* Coleman; Playford et al.: p.340
1976 *Costiferina callytharrensis* (Prendergast); Playford et al.: p.95
1976 *Costiferina magnus* (Coleman); Playford et al.: p.95
1985 *Callytharrella callytharrensis* (Prendergast); Archbold: p.19-24, figs 1A-T, 2A-F, 3A-H

Diagnosis: Huge for genus; ornamentation fine for size of species, ears distinct; costae grouped into weak fasciculae on weak folds of trail; ventral sulcus distinct, dorsal fold developed anteriorly.

Closest species: *C. sinensis* (Sun 1983) from the Early Artinskian of Tibet, a smaller species the ears of which are unknown.

Lectotype: GSWA 1/4967b (chosen by Coleman, 1957, p.54).

Type locality: 0.8 km west of Callytharra Spring, Wooramel River District, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Wyndham Gap, Callytharra Springs, Arthur River, Bidgemia Station, and Jimba Jimba Station, **Carnarvon Basin** - Callythara Formation and Jimba Jimba Calcarenite Member of the Billidee Formation; reported from **Canning Basin** but not confirmed - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian), Early Artinskian (Aktastinian).

Abundance: An abundant fossil.

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to relatively shallow water; silty, sandy, and calcarenite substrates.

Genus **COSTIFERINA** Muir-Wood & Cooper 1960

Type species: *Productus indicus* Waagen 1884; OD.

Costiferina thomasi Archbold 1985
(Plate 34 figs 10-12)

1957 *Dictyoclostus* sp. Thomas: p.181
1958a *Dictyoclostus* sp. Thomas: p.3
1969 *Costiferina* sp. nov. Thomas: p.221
1985 *Costiferina thomasi* Archbold: p.26-28, figs 5A-K

Diagnosis: Moderately large for genus; well-developed reticulate ornament on dorsal visceral disc; costae on trail relatively fine for genus; dorsal fold well developed on trail; ears prominent on mature specimens.

Closest species: *Costiferina* spp. Shimizu 1981, poorly known species with extensive dorsal reticulate ornament.

Types: Holotype - CPC 24332; other figured specimens - CPC 24333-24337.

Type locality: On coast, approximately 13.5 km north of Cape Dombey, Port Keats area, Bonaparte Basin (NT).

Distribution and range: Type locality and Tchindi Beach, Port Keats area, Bonaparte Basin(NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Relatively rare (6 specimens known).

Value in correlation and dating: Diagnostic of age; an important element of the Chhidruan fauna.

Climate: Found in sedimentary rocks that were deposited under tropical conditions.

Sedimentary environment: Shallow water; sandy substrate.

Costiferina wadei (Prendergast 1943)
(Plate 34 figs 6-9)

1937 *Productus semireticularis* Wade: p.94
1943 *Dictyoclostus callytharrensis* var. *wadei* Prendergast: p.16, pl. 2 figs 2-4
1957 *Dictyoclostus wadei* Prendergast; Coleman: p.59, pl. 7 figs 7-10
1958 *Dictyoclostus wadei* Prendergast; Guppy et al.: p.48
1971 *Costiferina wadei* (Prendergast); Waterhouse: p.391
1975 *Dictyoclostus wadei* Prendergast; Playford et al.: p.341
1985 *Costiferina wadei* (Prendergast); Archbold: p.24-26, Fig. 4A-L

Diagnosis: Average size for genus with coarse ornamentation; ears large, quadrate; costae broad, bifurcating anteriorly of spines; sulcus distinct, dorsal fold distinct.

Closest species: *C. indica* (Waagen 1884), a generally smaller species with less prominent ears.

Holotype: UWA 20453.

Type locality: 3.2 km east, 10° south of Mount Nicholson, northern Canning Basin.

Distribution and range: South of Trig. Station 243, Christmas Creek, and southeast of Mount Anderson Homestead, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common but sporadic.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Superfamily LINOPRODUCTACEA Stehli 1954
Family LINOPRODUCTIDAE Stehli 1954

Subfamily LINOPRODUCTINAE Stehli 1954

Genus **LINOPRODUCTUS** Chao 1927

Type species: *Productus cora* d'Orbigny 1842; OD.

Linoproductus sp.
(Plate 35 fig. 1)

1983b *Linoproductus* sp. Archbold: p.238, Figs 1A,B

Diagnosis: Transversely oval outline with rugae on ears only and fine costellae.

Figured specimen: GSWA F11192.

Distribution and range: **Carnarvon Basin** - Lyons Group.

Age: Asselian, Early Sakmarian (Tastubian).

Abundance: Extremely rare (1 specimen only).

Value in correlation and dating: Of little value at present.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Moderately shallow water; silty substrate.

Genus **CANCRINELLA** Frederiks 1928

Type species: *Productus cancrini* de Verneuil 1842; OD.

Cancrinella bella (Etheridge Jnr 1918)
(Plate 35 figs 5-7)

1914 *Productus* sp. Etheridge Jnr: p.36, pl. 1 fig. 11; pl. 5 figs 14-15
1918 *Productus bellus* Etheridge Jnr: p.254, pl. 39, figs 4, 5; pl. 40, fig. 6
1926 *Productus bellus* Etheridge Jnr; Glauert (*partim*): p.46
1935 *Linoproductus cancriniformis* (Tschernyschew); Prendergast (*partim*): p.14, pl. 2 figs 11-12 (*non cet.*)
1943 *Linoproductus cancriniformis* (Tschernyschew); Prendergast (*partim*): p.3
1957 *Linoproductus cancriniformis* (Tschernyschew); Coleman (*partim*): p.69, pl. 8 figs 2-9 (*non cet.*)
1958 *Linoproductus cancriniformis* Guppy et al.: p.48
?1962 *Linoproductus?* sp. Thomas: p.33
1967 *Linoproductus cancriniformis* (Tschernyschew); Condon: p.169
1975 *Linoproductus cancriniformis* Playford et al.: p.287
1983b *Cancrinella bella* (Etheridge Jnr) Archbold: p.241, figs 1Q-X, 2A,B

Diagnosis: Small to medium size for genus; rugae strongly developed on ears but weak to absent across venter; costellae coarse; dorsal valve flat on visceral disc, distinctly geniculate.

Closest species: *C. coolkilyaensis* Archbold which has coarser rugae and a strongly convex ventral valve.

Lectotype: AM F16742, chosen by Archbold (1983b, p.241).

Type locality: Mount Marmion, northern Canning Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Valuable for interbasinal correlation and dating.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep to moderately shallow water; silty and fine sand substrates.

Cancrinella coolkilyaensis Archbold 1983
(Plate 35 figs 8-10)

1957 *Linoproductus cancriniformis* Coleman (*partim*): p.69, pl. 8 fig. 1 (*non cet.*)
1967 *Linoproductus cancriniformis* Condon: p.184
1975 *Linoproductus cancriniformis* Playford et al.: p.288
1983b *Cancrinella coolkilyaensis* Archbold; p.241-242, figs 2C-O

Diagnosis: Medium size for genus; strongly convex ventral valve; weakly rugose shell with coarse rugae, costellae coarse, spines fine; dorsal valve strongly geniculate.

Closest species: *C. bella* (Etheridge Jnr) which has weaker rugae and a less convex ventral valve.

Holotype: CPC 19920A.

Type locality: 2.4 km southeast of Wandagee Hill Trig., Carnarvon Basin.

Distribution and range: Southeast and east of Wandagee Hill, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Moderately common although sporadic in occurrence.

Value in correlation and dating: Valuable for dating.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty to fine sandy substrate.

Cancrinella irwinensis Archbold 1983
(Plate 35 figs 2-4)

1890 *Productus undatus* Foord: p.152, pl. 7 fig. 6
1907b *Productus undatus* Etheridge Jnr: p.30
1910 *Productus undatus* Glauert: p.87
1926 *Productus bellus* Glauert (*partim*): p.46
1931 *Productus undatus* Hosking: p.8, 22
1935 *Linoproductus cancriniformis* Prendergast (*partim*): p.14, pl. 2 figs 7-10 (*non cet.*)
1943 *Linoproductus cancriniformis* Prendergast (*partim*): p.23
1957 *Linoproductus cancriniformis* Coleman (*partim*): p.69
1957 *Linoproductus lyoni* Coleman (*partim*): p.76
1967 *Linoproductus cancriniformis* Condon: p.70
1967 *Linoproductus lyoni* Condon: p.70
1976 *Cancrinella cancriniformis* Playford et al.: p.95
1983b *Cancrinella irwinensis* Archbold: p.241, figs 1C-P

Diagnosis: Medium- to large-sized *Cancrinella*; strongly convex ventral valve, strongly but finely rugose and costellate shell with fine spines on ventral valve; dorsal valve relatively weakly geniculate.

Closest species: The widely reported *C. cancriniformis* group (see Archbold, 1983b).

Holotype: CPC 19915A.

Type locality: Carynginia ully, 2.8 km at 297° from Carynginia Well, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; widely distributed in **Carnarvon Basin** - Callytharra Formation; Scott Bluff, Lake Blanche, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A very common species.

Value in correlation and dating: Valuable for interbasinal correlation and dating.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Moderately deep to moderately shallow water; silty to sandy to calcarenite substrates.

Cancrinella sp. A

1967 *Linoproductus cancriniformis* Condon: p.131
1967 *Linoproductus (Cancrinella)* sp. Condon: p.149
1975 *Linoproductus cancriniformis* Playford et al.: p.284
1983b *Cancrinella* sp. A Archbold: p.242, figs 2P-R

Diagnosis: Rugae irregular on ventral valve, not strongly raised; dorsal valve with fine costellae and shallow, elongate dimples.

Closest species: *C. irwinensis* Archbold, which has distinct, regular rugae.

Figured specimens: CPC 19921A,B, GSWA F11093A.

Distribution and range: Southeast of Dairy Creek Homestead, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (early Baigendzhinian)

Abundance: Rare (few specimens retained in collections).

Value in correlation and dating: Of little value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep, quiet water; silt substrate.

Cancrinella sp. B

1976a *Cancrinella* sp. Waterhouse: p.124
1983b *Cancrinella* sp. B Archbold: p.242, figs 2S-V

Diagnosis: Ventral valve highly convex with strong, coarse rugae over trail.

Closest species: *C. magniplica* (Campbell 1953), a much larger species with a less strongly convex ventral valve.

Figured specimens: CPC 19922A,B.

Distribution and range: Minilya Syncline, north side of Minilya River, 5 km west of Cundlego Well, **Carnarvon Basin** - Nalbia Sandstone.

Age: Latest Baigendzhinian - earliest Kungurian.

Abundance: Rare (only 2 specimens known at present).

Value in correlation and dating: Potentially valuable for dating as the species is highly distinctive.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; fine sandy substrate.

Cancrinella sp. C

1957 *Linoproductus lyoni* Prendergast; Coleman (*partim*): p.76, pl. 8 figs 16-19, 22 (*non cet.*)
1959 *Linoproductus* (*Cancrinella*) cf. *lyoni* Dickins *in* Playford: p.19
1959 *Linoproductus* (*Cancrinella*) sp. Dickins *in* Playford: p.19
1959 *Linoproductus* (*Cancrinella*) sp. ind. Dickins *in* Playford: p.19
1976 *Cancrinella lyoni* (Prendergast); Playford et al.: p.95
1976 *Cancrinella* sp. cf. *C. lyoni*, *Cancrinella* sp., and *Cancrinella* sp. indet., Playford et al.: p.98
1983b *Lyonia lyoni* (Prendergast); Archbold (*partim*): p.244 (*non illus.*)

Diagnosis: A large flattish species with relatively fine rugae; dorsal valve weakly geniculate; comparison with the genus *Platycancrinella* Waterhouse 1983 is required.

Figured specimens: UWA 32025, 32028 (see Coleman, 1957, pl. 8 figs 16-19, 22). From the regional mapping by Playford (1959) and an examination of the 2 specimens figured by Coleman, the specimens can be confidently assigned to the basal High Cliff Sandstone fauna (to be described elsewhere by N.W.A.).

Distribution and range: Glendevon Homestead, Woolaga Creek area, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: Relatively uncommon (about 12 specimens are known).

Value in correlation and dating: Potentially valuable in dating.

Sedimentary environment: Relatively shallow water; sandy substrate.

Cancrinella spp.

General comment: This genus has been widely reported (often under the name *Linoproductus*) from the Western Australian Permian. Many reports cannot be verified because specimens have been lost, destroyed by fire or never retained (i.e. field identifications only were made). A check list of these unverified reports is given below providing reference and stratigraphical details only.

1967 *Linoproductus* sp. Condon: p.102

Stratigraphical unit: Moogooloo Sandstone, Carnarvon Basin.

Age: Early Artinskian (Aktastinian).

1967 *Linoproductus* sp. Condon: p.90
1975 *Linoproductus* sp. Playford et al.: p.282

Stratigraphical unit: Jimba Jimba Calcarenite Member of the Billidee Formation, Carnarvon Basin.

Age: Early Artinskian (Aktastinian).

1976 *Cancrinella* sp. Playford et al.: p.116

Stratigraphical unit: Mingenew Formation, Perth Basin.

Age: Late Artinskian (early Baigendzhinian).

1958 *Linoproductus cancriniformis*: Guppy et al.: p.46
1975 *Linoproductus cancriniformis*: Playford et al.: p.340

Stratigraphical unit: Nura Nura Member of the Poole Sandstone, Canning Basin.

Age: Late Sakmarian (Sterlitamakian).

1958 *Linoproductus cancriniformis*: Guppy et al.: p.53
1976 *Linoproductus cancriniformis*: Playford et al.: p.343

Stratigraphical unit: Lightjack Formation, Canning Basin.

Age: Kungurian.

Genus **LYONIA** Archbold 1983

Type species: *Linoproductus cancriniformis* var. *lyoni* Prendergast 1943; OD.

Lyonia lyoni (Prendergast 1943)
(Plate 35 figs 11-15)

1943 *Linoproductus cancriniformis* var. *lyoni* Prendergast: p.24, pl. 3 figs 1,2
1957 *Linoproductus lyoni* Prendergast; Coleman (*partim*): p.76, pl. 8 figs 20, 21 (*non cet.*)
1958 *Linoproductus* (*Cancrinella*) *lyoni* Prendergast; Dickins & Thomas: p.124
1958 *Linoproductus* (*Cancrinella*) *lyoni* Prendergast; Condon: p.145
1959 *Linoproductus* (*Cancrinella*) *lyoni* Prendergast; Dickins & Thomas: p.66, 71, 72, 74
1967 *Linoproductus* (*Cancrinella*) *lyoni* Prendergast; Condon: p.35, 42, 48, 55
1969 *Cancrinella? lyoni* (Prendergast); Thomas: p.220
1975 *Linoproductus lyoni* Prendergast; Playford et al.: p.279
1982b *Cancrinella lyoni* (Prendergast); Archbold: p.269
1983b *Lyonia lyoni* (Prendergast); Archbold: p.244, Figs 3A-P

Diagnosis: Large, relatively gently concavo-convex shells; cardinal process distinctive, low and squat; ventral valve with scattered body spines and single row of curved hinge spines; dorsal valve with fine spines anteriorly.

Closest species: No close species reliably known.

Holotype: AM F36530.

Type locality: 0.2 km northwest of Gnarrea Pool near Winning Station, Carnarvon Basin.

Distribution and range: Gascoyne River, Minilya - Williambury, Lyndon River, Moogooree Homestead areas, Winning Station, **Carnarvon Basin** - Lyons Group.

Age: Early Sakmarian (Tastubian) possibly ranging down to Late Asselian.

Abundance: Relatively common.

Value in correlation and dating: A diagnostic fossil of the Lyons Group fauna.

Climate: Found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Moderately shallow water; silty and sandy substrates.

General comment: The removal of Coleman's (1957) Fossil Cliff specimens (now know to be from High Cliff Sandstone) from *Lyonia lyoni* restricts the occurrence of Prendergast's species to the Lyons Group of the Carnarvon Basin.

Subfamily STEPANOVIELLINAE Waterhouse 1975

Genus **GLOBIELLA** Muir-Wood & Cooper 1960

Type species: *Productus hemisphaerium* Kutorga 1844; OD.

Globiella flexuosa (Waterhouse 1970)
(Plate 35 figs 23, 25, 26)

1970b *Stepanoviella flexuosa* Waterhouse: p.45, pl. 14 figs 1-8, 15-16
1971 *Stepanoviella flexuosa* Waterhouse: p.391
1976a *Stepanoviella flexuosa* Waterhouse: p.95
1983b *Globiella flexuosa* (Waterhouse); Archbold: p.252, figs 40-Z, AA-BB

Diagnosis: Medium-sized *Globiella*; often transverse in outline; ornament of radial costellae coarse for genus.

Closest species: *Globiella flexuosa* (*sensu* Jing & Sun, 1981, pl. 5 figs 7, 8) is a somewhat more globular species.

Types: Holotype - CPC 8661; paratypes - CPC 8662-8672.

Type locality: 15 km west of Jimba Jimba Homestead (Lat. 25°02'75"S; Long. 114°58'8"E), Jimba Jimba Station, Carnarvon Basin.

Distribution and range: As above and 15 km west of Jimba Jimba Homestead, **Carnarvon Basin** - type section of Jimba Jimba Calcarenite Member of the Billidee Formation.

Age: Early Artinskian (Aktastinian).

Abundance: Relatively common (some 35 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; calcarenite substrate.

Globiella foordi (Etheridge Jnr 1903)
(Plate 35 figs 16-22, 24)

1890 ***Productus tenuistriatus*** **Foord: p.171, pl. 7 figs 4, 4a**
1903 ***Productus tenuistriatus*** **de Verneuil(?) var. *foordi* Etheridge Jnr: p.19, pl. 1 figs 3, 4; pl. 5 fig. 22**
1907b ***Productus tenuistriatus*** **var. *foordi* Etheridge Jnr: p.30 pl. 9 figs 4-6**
1910 ***Productus tenuistriatus*** **var. *foordi* Etheridge Jnr; Glauert: p.87**
1926 ***Productus tenuistriatus*** **var. *foordi* Etheridge Jnr; Glauert: p.46**

1931 *Productus tenuistriatus* var. *foordi* Etheridge; Hosking: p.8, 22
1933b *Linoproductus* cf. *Linoproductus tenuistriatus* var. *foordi* (Etheridge Jnr); Hosking: p.47, pl. 4 fig. 3
1937 *Linoproductus tenuistriatus* var. *foordi* (Etheridge Jnr); Raggatt & Fletcher: p.175
1943 *Linoproductus cora* var. *foordi* (Etheridge Jnr); Prendergast: p.22, pl. 3 figs 3-5
1957 *Linoproductus cora foordi* (Etheridge Jnr); Coleman: p.74, pl. 8 figs 10-15
1967 *Linoproductus cora foordi* (Etheridge Jnr); Condon: p.70
1969 *Linoproductus cora foordi* (Etheridge Jnr); Thomas: p.220
1970b *Stepanoviella foordi* (Etheridge Jnr); Waterhouse: p.38,39
1971 *Stepanoviella foordi* (Etheridge Jnr); Waterhouse: p.391
1975 *Linoproductus cora foordi* (Etheridge Jnr); Playford et al.: p.233
1976 *Linoproductus cora foordi* (Etheridge Jnr); Playford et al.: p.95
1982b *Globiella foordi* (Etheridge Jnr); Archbold: p.269
1983b *Globiella foordi* (Etheridge Jnr); Archbold: p.248, figs 5A-Z, AA-GG

Diagnosis: Small to large *Globiella*, transverse to elongate; ventral valve rarely with rugae, row of hinge spines, no body spines; radial costellae relatively coarse for genus.

Closest species: *G. flexuosa* (Waterhouse 1970) which has coarser costellae.

Lectotype: GSWA F156B, chosen by Crespin (1964, p.68).

Type locality: Fossil Hill near Wyndham River, Carnarvon Basin.

Distribution and range: Irwin River area and Carynginia Gully, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Fossil Hill and widely throughout **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely common (hundreds of specimens known).

Value in correlation and dating: Very valuable for interbasinal correlation; diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; silty to sandy (calcarenite) substrates.

Order RHYNCHONELLIDA Kuhn 1949
Superfamily STENOSCISMATACEA Oehlert 1887 (1883)

Family STENOSCISMATIDAE Oehlert 1887 (1883)

Genus **STENOSCISMA** Conrad 1839

Type species: *Terebratula schlotheimii* von Buch 1835; OD.

Stenoscisma? sp. nov. A

1907b *Seminula subtilita?* Etheridge Jnr: p.28, pl.8 figs 3-6
1935 *Seminula globulina* (Phillips); Prendergast: p.17-18, pl. 2 figs 16-18; text fig. 2
1976 *Seminula globulina* (Phillips); Playford et al.: p.95

Figured specimen: UWA 10370.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Value in correlation and dating: Limited by rarity.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Stenoscisma? sp. nov. B

1958 *Camerophoria* (*Stenoschisma*) spp. nov. Guppy et al.: p.48

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Unknown.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep, quiet neritic.

Stenoscisma sp. nov.

1969 *Stenoscisma* sp. nov. cf. *S. purdoni* (Waagen) (*sic*); Thomas: p.228

Closest species: *S. purdoni* (Davidson 1862).

Distribution and range: Widespread in **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Numerous specimens.

Value in correlation and dating: Known only from Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; calcilutite to calcarenite; occasionally sandy substrate.

Stenoscisma? sp. nov.

1958 *Camerophoria* sp. Guppy et al.: p.46

Distribution and range: Northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Family ATRIBONIIDAE Grant 1965

Genus **CAMERISMA** Grant 1965

Type species: *Camerisma prava* Grant 1965; OD.

Camerisma? callytharrensis (Hosking 1933)
(Plate 36 figs 1, 2, 4-7)

?1903 *Seminula* sp. ind. Etheridge Jnr: p.17, 18, pl. 1 fig. 5; pl. 3 fig. 21
1933b *Seminula callytharrensis* Hosking: p.50, 51 pl. V, figs 2-5, text fig. 2a,b
1969 *Camerisma? callytharrensis* (Hosking); Thomas: p.228

Diagnosis: Medium-size species, biconvex, maximum width anterior of midlength; commissure uniplicate, fold variable smooth, no costae; ventral interior with spondylium, supported anteriorly by median septum; dorsal interior with duplex camerophorium supported in part by median septum; hinge plate divided; intercamerophorial plate reduced.

Closest species: Differs from *C. prava* Grant 1965 by presence of divided hinge plate and reduced inter-camerophorial plate.

Holotype: GSWA F1/4979a.

Type locality: Creek, 0.8 km west of Callytharra Spring, Carnarvon Basin.

Distribution and range: Widespread in **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Fairly numerous, usually complete shells.

Value in correlation and dating: Useful, known only from Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; calcilutite to calcarenite occasionally sandy substrate.

Superfamily RHYNCHOPORACEA Muir-Wood 1955

Family RHYNCHOPORIDAE Muir-Wood 1955

Genus **RHYNCHOPORA** King 1865

Type species: *Terebratula geinitziana* de Verneuil 1845; OD.

Rhynchopora sp. nov.

1969 *Rhynchopora* sp. nov. Thomas: p.228

Closest species: *Rhynchopora lobjaensis* (Tolmachev 1912).

Distribution and range: Williambury Station, **Carnarvon Basin** - Lyons Group.

Age: Latest Asselian to Early Sakmarian (Tastubian).

Abundance: Rare.

Value in correlation and dating: Limited; distribution not known.

Climate: Found in sedimentary rocks that were deposited under cold-water conditions.

Sedimentary environment: Moderately shallow neritic; sandy substrate.

Order SPIRIFERIDA Waagen 1883
Suborder SPIRIFERIDINA Waagen 1883
Superfamily SYRINGOTHYRIDACEA Frederiks 1926
(*sensu* Ivanova 1972)

Family LICHAREWIIDAE Slyusareva 1958
(*sensu* Grigoryeva 1977)

Genus **MYODELTHYRIUM** Thomas 1985

Type species: *Pseudosyringothyris dickinsi* Thomas 1971; OD.

Myodelthyrium dickinsi (Thomas 1971)
(Plate 36 figs 3, 8-10)

?1890 *Syringothyris exsuperans* (de Koninck); Foord: p.14
1897b *Syringothyris exsuperans* (de Koninck); Etheridge Jnr: p.46-47; text figs A-C (*pars*)
?1903 *Spirifera* sp. ind. Etheridge Jnr: p.15-16, pl. 1 fig. 9; pl. 2 fig. 6
1956 cf. *Pseudosyrinx* sp. nov. Dickins & Thomas: p.52
1958 *Pseudosyrinx* sp. Guppy et al.: p.45
1969 *Pseudosyrinx* sp. nov. Thomas: p.106
1971 *Pseudosyringothyris dickinsi* Thomas: p.140-148, pl. 10 figs 1-5; pl. 11 figs 1-2; pl. 12 figs 1-4; pl. 13 fig. 3; pl. 29 fig. 7; text figs 53-56
1985 *Myodelthyrium dickinsi* (Thomas); Thomas: p.164.

Diagnosis: Large species, ventral interarea high, flat to slightly concave, inclination 80 to 85°; delthyrial angle narrow (18-22°); perideltidial angle wide (71-82°); stegidium present; sulcus deep, rounded, fastigium simple and prominent; lateral costae rounded 15-18 on each flank; ornament of pustules and short radial striae; pair of prominent adductor muscle scars on inner surface of delthyrial plate; finely punctate.

Closest species: Possibly *Permosyringothyris borealis* Gobbett 1964 which has a lower area, wider sulcus, and less numerous lateral costae.

Types: Holotype - CPC 1636; other figured specimens - CPC 1634, 1635, 1637, 1639-1641, 1643, 1645-1647.

Type locality: About 1.3 km at 270° from Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs, Towrana Station, Williambury Station, Lyons River Station, and elsewhere, **Carnarvon Basin** - widespread in Callytharra Formation; Saint George Ranges, northern **Canning Basin** - base of Poole Sandstone; Well 27, south central **Canning Basin** - Cuncudgerie Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Numerous specimens, mostly separate valves.

Value in correlation and dating: Valuable because abundant, widespread, and of restricted time range.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; calcilutite, calcarenite and fine sandy substrates.

Genus **PUNCTOCYRTELLA** Plodowski 1968

Type species: *Punctocyrtella spinosa* Plodowski 1968; OD.

Punctocyrtella australis (Thomas 1971)
(Plate 36 figs 11-13)

1958 *Pseudosyrinx* sp. nov. Dickins & Thomas: p.24
1959 *Pseudosyrinx* sp. nov. Dickins & Thomas: p.70, 72, 76, 80
1969 *Pseudosyrinx nagmargensis* (Bion) subsp. nov. Thomas: p.220
1971 *Cyrtella nagmargensis australis* Thomas: p.151-155, pl. 11 figs 3-6; pl. 27 fig. 2; text figs 57-58
1976 *Pseudosyrinx* Playford et al.: p.279
1976 *Cyrtella nagmargensis australis* Thomas; Thomas: p.319
1982b *Cyrtella nagmargensis australis* Thomas; Archbold: p.271, 273

Diagnosis: Large wide species attaining 10 cm in width, interarea high, slightly concave to flat, inclined at about 90°, apical angle 120-130°, perideltidial angle 98° (one specimen), delthyrial angle 33°, wide shallow sulcus, slightly concave ventral flanks, very sinuous front commissure with prominent median tongue; dorsal valve with prominent fastigium with median groove of variable depth; short ventral adminicula; 14-15 round to flattened costae on each flank; finely punctate.

Closest species: *P. nagmargensis* (Bion 1928) from which it is distinguished by the more sinuous front commissure, by the projecting sulcal tongue and shorter ventral adminicula.

Types: Holotype - CPC 1653; figured specimens - CPC 1649-1653.

Type locality: 1.34 km at 270° from Callytharra Springs, Carnarvon Basin.

Distribution and range: Coyango Well area on Williambury Station, Callytharra Springs area, **Carnarvon Basin** - upper Lyons Group, lower part of Callytharra Formation; numerous localities in basal conglomerate of Callytharra Formation in Merlinleigh Sub-basin.

Age: Latest Asselian to Sakmarian (Tastubian to Sterlitamakian).

Abundance: Fairly abundant especially in basal beds of Callytharra Formation.

Value in correlation and dating: Useful, characteristic fossil for upper Lyons Formation and lower Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow to moderately deep neritic; silty to sandy and calcareous substrate.



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Brachiopods
(continued)

Genus **PSEUDOSYRINX** Weller 1914

Type species: *Pseudosyrinx missouriensis* Weller 1914; OD.

Pseudosyrinx? sinuosa Thomas 1971
(Plate 36 figs 14-19)

1967 *Pseudosyrinx* sp. Condon: p.149
1971 *Pseudosyrinx? sinuosa* Thomas: p.155-177, pl. 13 figs 1-2; pl. 30 figs 6-8; text fig. 59

Diagnosis: Large wide species, wide apical angle 130°, moderately high interarea, wide delthyrial angle (43-50°); ventral sulcus shallow wide and rounded; fastigium simple and moderate, lateral swelling on each dorsal flank; very sinuous front commissure, 12 rounded simple costae on each flank, micro-ornament of short striae.

Types: Holotype - CPC 1654; paratypes - CPC 1655-1658.

Type locality: About 5.5 km at 212° from Keogh Hill, Carnarvon Basin.

Distribution and range: Near Keogh Hill and Winderie Station, **Carnarvon Basin** - Coyrie Formation.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Rare, originally about 5 specimens and fragments.

Value in correlation and dating: Possibly useful but rare.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep neritic; silty to fine sandy substrate.

Licharewiid gen. nov. A et sp. nov.

1907a *Spirifera avicula* Etheridge Jnr: p.19, pl. 3 figs 2, 7
1914 *Syringothyris*-like *Spirifera* Etheridge Jnr: p.29-30, pl. 6 figs 6-8
1976 *Pseudosyrinx?* sp. cf. *P.? sinuosa* Thomas; Playford et al.: p.116

Distribution and range: Mingenew District, **Perth Basin** - Mingenew Formation.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Originally one internal mould; other specimens are now available.

Value in correlation and dating: Potentially useful.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow neritic; sandy substrate.

Licharewiid gen. nov. B et sp. nov. A

1907a *Spirifera* sp. ind. Etheridge Jnr: p.20-21, pl. 3 figs 3-5; pl. 6 fig. 6

Type locality: Near Mingenew, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Mingenew Formation.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Internal moulds common; external impressions are now available.

Value in correlation and dating: Potentially useful.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow neritic; sandy substrate.

Licharewiid gen. nov. B et sp. nov. B

1958 Spiriferid gen. et sp. nov. A, spinose, Guppy et al.: p.48

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Licharewiid gen. et sp. indet.

1907b *Spirifera* sp. Etheridge Jnr: p.29, pl. 10 fig. 1

Distribution and range: Irwin River area, **Perth Basin.**

Abundance: 1 specimen.

Superfamily SPIRIFERACEA King 1846

Family SPIRIFERIDAE King 1846
Subfamily SPIRIFERINAE King 1846

Genus **LATISPIRIFER** Archbold & Thomas 1985

Type species: *Latispirifer callytharrensis* Archbold & Thomas 1985; OD.

Latispirifer amplissimus Archbold & Thomas 1985
(Plate 37 figs 7, 8)

1958 Spiriferid gen. et sp. nov. Guppy et al.: p.54
1985b *Latispirifer amplissimus* Archbold & Thomas: p.273-278 figs 4A-H, 5A-F, 6A-G

Diagnosis: Large, highly transverse species, ventral interarea of medium height, sulcal tongue short, U-shaped.

Closest species: *L. callytharrensis* Archbold & Thomas.

Types: Holotype - CPC 24296; paratypes - CPC 24297-24308.

Type locality: 280 m west of Mount Hardman windmill on side of hill, northern Canning Basin.

Distribution and range: Mount Hardman and central Millyit Range, northern **Canning Basin** - Hardman Formation. Port Keats area, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Relatively common (over 25 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Latispirifer callytharrensis Archbold & Thomas 1985
(Plate 37 figs 1, 2, 5)

1985b *Latispirifer callytharrensis* Archbold & Thomas: p.271-273, Figs 1A-C, 2A-E, 3A-G

Diagnosis: Large species, transverse, ventral interarea high; sulcus narrow with sulcal tongue; fastigium high, sharp crested; plications indistinct near umbones, absent on lateral flanks of shell; delthyrial plate prominent; ventral muscle field elongate.

Closest species: *L. amplissimus* Archbold & Thomas, a highly transverse form with a lower ventral interarea.

Types: Holotype - CPC 24292; paratypes - CPC 24293-24295, MUGD F6557-F6561.

Type locality: Near Thambrong Pool, Williambury Station, south side of Minilya River, Carnarvon Basin.

Distribution and range: Williambury Station, and northwest of Lyons River Homestead, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively uncommon (about 15 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; calcilutite substrate.

Subfamily NEOSPIRIFERINAE Waterhouse 1968

Genus NEOSPIRIFER Frederiks 1924

Type species: *Spirifer fasciger* von Keyserling 1846; OD.

Neospirifer amplus Archbold & Thomas 1986
(Plate 38 fig. 12; Plate 39 figs 1, 2)

1889 *Spirifera* (*partim*) Etheridge Jnr: p.208
?1914 *Spirifera musakheylensis* Etheridge Jnr: p.23
1914 *Spirifera marcoui* Etheridge Jnr: p.23, pl. 1 figs 5-6; pl. 2 figs 8-9
?1918 *Spirifera musakheylensis* Etheridge Jnr: p.253
1918 *Spirifera marcoui* Etheridge Jnr: p.253
1919 *Spirifera marcoui* Maitland: p.31
1926 *Spirifera marcoui* and *Spirifer* cf. *marcoui* Glauert: p.47
?1926 *Spirifera musakheylensis* Glauert: p.47
1948 *Neospirifer ravana* Branson (*partim*): p.430
1958 *Neospirifer* sp. nov. aff. *N. marcoui* (Waagen); Guppy et al.: p.48
1961 *Neosprifer* sp. Dickins *in* Veevers & Wells: p.286
1964 *Spirifera marcoui* Etheridge Jnr; Crespin: p.71
1969 *Neospirifer* sp. nov. aff. *N. marcoui* (Waagen); Thomas: p.221, 224
1971 *Neospirifer* aff. *marcoui* (Waagen); Waterhouse: p.31
1976a *Neospirifer marcoui* (Waagen); Waterhouse: p.99
1986a *Neospirifer amplus* Archbold & Thomas. p.140-143, Figs 8A-D, 9A-C, 10A-G

Diagnosis: Large, transverse strongly inflated *Neospirifer*; broad, high fastigium, broad, deep sulcus; lateral plications weaken anteriorly; maximum width of shell normally at or close to hinge.

Closest species: *N. marcoui* (Waagen 1884), a smaller species with distinct sulcal and lateral plication characters.

Types: Holotype - UWA 27130; paratypes - UWA 27187, 88143-88144, CPC 24352, 24353, MUGD F6566.

Type locality: North of Cattle Pit on the Woolshed - Middalya Road on east fence of Mungadan Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station area and Minilya River area, **Carnarvon Basin** - Wandagee Formation; Mount Marmion and Cherrabun Station, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common (30+ specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and fine sandy substrates.

Neospirifer foordi Archbold & Thomas 1986
(Plate 38 figs 1-3)

1958 *Neospirifer* sp. nov. Guppy et al.: p.46
1986a *Neospirifer foordi* Archbold & Thomas: p.132-133, Figs 4A-D

Diagnosis: Transverse *Neospirifer;* distinct lateral plications; sulcus relatively narrow; costae relatively fine.

Closest species: A distinctive Western Australian species.

Types: Holotype - MUGD F6565; paratype - CPC 24339.

Type locality: Measured section of Callytharra Formation located southwest of Williambury Homestead, Carnarvon Basin.

Distribution and range: Williambury Station, **Carnarvon Basin** - Callytharra Formation; Nura Nura Ridge, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare.

Value in correlation and dating: Potentially of value for interbasinal correlation providing rarity reflects inadequate collecting.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy and calcarenite substrates.

Neospirifer grandis Archbold & Thomas 1986
(Plate 39 figs 7, 8)

1954 *Neospirifer* sp. Thomas: p.6
1954 *Neospirifer* Thomas & Dickins: p.221
1957 *Neospirifer* sp. nov. Thomas: p.181
1958a *Neospirifer* sp. nov. Thomas: p.3
1958 *Neospirifer* sp. nov. Guppy et al.: p.54
1969 *Neospirifer* sp. nov. cf. *N. ravana* (Diener); Thomas: p.221
1971 *Neospirifer* cf. *ravana* Waterhouse: p.391

1976a *Neospirifer ravana* (Diener) Waterhouse: p.156
1986a *Neospirifer grandis* Archbold & Thomas: p.143-148 Figs 11A-F, 12A-E, 13A-D

Diagnosis: Large to gigantic, strongly inflated *Neospirifer*; high ventral interarea, wide delthyrium; lateral plications low, fade anteriorly; maximum width of shell normally at or close to hinge.

Closest species: *N. ravana* (Diener 1897) and allies, large forms with differing details of outline, interarea and plications.

Types: Holotype - CPC 24354; paratypes - CPC 24355-24361.

Type locality: 3.3 km at 95° from Luluigui Homestead, Canning Basin.

Distribution and range: Type locality, and near Tutu Bore, Nerrima Station, and Mount Hardman, northern **Canning Basin** - Hardman Formation. Port Keats area, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Relatively common (over 25 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation, and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; silty and sandy substrates.

Neospirifer hardmani (Foord 1890)
(Plate 37 figs 3, 4, 6)

1890 *Spirifera hardmani* Foord: p.146, pl. 7 figs 1, 1a
1890 *Spirifera musakheylensis* Davidson var. *australis* Foord: p.147, pl. 7 fig 2; ?pl. 5 fig 12
1891 *Spirifer hardmani* Foord; Woodward: p.16
1891 *Spirifer musakheylensis* var. *australis* Foord; Woodward: p.16
1903 *Spirifera hardmani* Foord, Etheridge Jnr: p.14, pl. 1 figs 6-7; pl. 2 figs 7-9
1910 *Spirifera hardmani* Foord; Glauert: p.90
1924 *Spirifera hardmani* Foord; Maitland: p.35
1931 *Spirifer hardmani* Foord; Hosking: p.23
1933b *Spirifer* sp. Hosking: p.52, pl. 5 fig. 1
1948 *Neospirifer hardmani* (Foord); Branson: p.428
1951 *Neospirifer hardmanni* (*sic*) (Etheridge Jnr, *sic*); Teichert: p.81
1964 *Spirifera hardmani* Foord; Crespin: p.71
1964 *Spirifera musakheylensis* var. *australis* Foord; Crespin (*partim*): p.72
1967 *Neospirifer* and *Neospirifer* sp. Condon: p.70, 90
1969 *Neospirifer hardmani* (Foord); Thomas: p.223
1971 *Neospirifer hardmani* (Foord); Waterhouse: p.391

1976 *Neospirifer fasciger* Playford et al.: p.95
1986a *Neospirifer hardmani* (Foord); Archbold & Thomas: p.128-132, Figs 1A-N, 2A-I, 3A-I

Diagnosis: Subquadrate *Neospirifer*; growth changes from rounded, to transverse, to moderately transverse with attenuated ears, to subquadrate and inflated; lateral plications vary from weakly to moderately strongly developed; sulcus broad, moderately shallow with long sulcal tongue; shells thickened in old age.

Closest species: *N. plicatus* Archbold & Thomas which has a deeper sulcus and pronounced lateral plications.

Types: Lectotype - specimen figured by Foord (1890, pl. 7 fig. 1), designated by Waterhouse (1964), now lost; remaining syntype, GSWA F10078 (Foord, 1890, pl. 7 fig 1a).

Type locality: Gascoyne River, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Williambury Station, northwest of Lyons River Homestead, Fossil Hill near Wyndham River, Callytharra Springs and Jimba Jimba Station, **Carnarvon Basin** - Callytharra Formation, Jimba Jimba Calcarenite Member of the Billidee Formation.

Age: Late Sakmarian (Sterlitamakian) to Early Artinskian (Aktastinian).

Abundance: A common fossil.

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate environment.

Sedimentary environment: Relatively deep to shallow water; silty, calcilutite, and calcarenite substrates.

Neospirifer plicatus Archbold & Thomas 1986
(Plate 38 figs 4-7)

1967 *Neospirifer* and *Neospirifer* spp. nov. Condon: p.131, 149
1981d *Neospirifer* sp. nov. Archbold: p.121
1986a *Neospirifer plicatus* Archbold & Thomas; p.133-136, Figs 5A-K, 6A-I

Diagnosis: Subquadrate, robust *Neospirifer*; growth changes from transverse to very transverse to more rounded to subquadrate and inflated with attenuated ears; lateral plictions strongly developed; sulcus broad, deep, V-shaped with long sulcal tongue; fastigium high and sharp.

Closest species: *N. postplicatus* Archbold & Thomas, a larger species with distinctive sulcal and lateral plication characters.

Types: Holotype - CPC 24340; paratypes - CPC 24341-24350.

Type locality: 13.1 km on a bearing of 82° from Mia Mia Homestead, north bank of Lyndon River, Carnarvon Basin.

Distribution and range: Type locality; 2.4 km southeast of Mount Madeline, and 3.5 km southwest of Keogh Hill, **Carnarvon Basin** - Coyrie Formation. Kuriyippi Hills, Bonaparte Basin (NT) - unnamed limestone, Port Keats Group.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common (some 30 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty and calcarenite substrates.

Neospirifer postplicatus Archbold & Thomas 1986
(Plate 38 figs 8-11)

1958 *Neospirifer* sp. cf. *N. hardmani* Guppy et al.: p.48
1986a *Neospirifer postplicatus* Archbold & Thomas: p.136-139, figs 7A-H

Diagnosis: Robust *Neospirifer* with ontogenetic stages as for *N. plicatus*; sulcus moderately deep and V-shaped in cross-section; 2 pairs of strong lateral plications on ventral valve; 3rd pair absent or weakly developed.

Closest species: Allied to the *N. hardmani* group but distinguished by details of the lateral plicati[illegible].

Types: Holotype - CPC 24351; paratypes - UWA 27286, 27690.

Type locality: 3.5 km at 288° from Brutens Old Yard, Cherrabun Station, Canning Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation; Cherrabun Station, **Canning Basin** - Noonkanbah Formation

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively rare (7 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep water; silty and fine sandy substrates.

Neospirifer sp. A

1986a *Neospirifer* sp. A Archbold & Thomas: p.148-150, Fig. 14A

Diagnosis: *Neospirifer* specimen with a high, sharp fastigium, very faint lateral plications, and fine and equidimentional coastae.

Closest species: A distinctive Western Australia shell.

Figured specimen: MUGD F6567.

Distribution and range: Bidgemia Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; calcarenite substrate.

Neospirifer sp. B

1967 *Neospirifer* sp. Condon: p.114
1986a *Neospirifer* sp. B Archbold & Thomas: p.150, Figs 14B-C

Diagnosis: Specimen with high fastigium, pronounced lateral plications, and relatively coarse equidimensional coastae.

Closest species: *N. plicatus* Archbold & Thomas which possesses finer costae.

Figured specimen: CPC 24362.

Distribution and range: West of Keogh Hill, **Carnarvon Basin** - Moogooloo Sandstone or Keogh Formation.

Age: Early Artinskian (Aktastinian).

Abundance: Rare.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrate.

Neospirifer sp. nov.

1959 *Neospirifer* sp. nov. A Dickins *in* Playford: p.19
1976 *Neospirifer* n. sp. Playford et al.: p.100

Diagnosis: A species intermediate in type between *N. hardmani* (Foord) and *N. plicatus*; of large size with relatively coarse, equidimensional costae.

Distribution and range: Woolaga Creek area, Mingenew District, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: Common at Woolaga Creek.

Value in correlation and dating: Diagnostic of age.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrate.

Comment: This species will be described by one of us (N.W.A.) as part of the description of the High Cliff Sandstone fauna.

Neospirifer spp.

General comment: In addition to the verified reports above, the genus *Neospirifer*, in the broad sense has been reported from a number of additional rock units in the Perth and Carnarvon Basins (Condon, 1967; Playford et al., 1975; Playford et al., 1976), often based on field identifications with no specimens being retained. Ranges of known species may be extended or new species may be indicated by these reports.

Genus **FUSISPIRIFER** Waterhouse 1966

Type species: *Spirifer nitiensis* Diener 1897; OD.

Fusispirifer byroensis (Glauert 1912)
(Plate 40 figs 1-3)

1912 *Spirifera byroensis* Glauert: p.75
1914 *Spirifera byroensis* Glauert; Etheridge Jnr: p.25, pl. 4 fig. 10; pl. 5 fig. 5; pl. 6 figs 1-5
1926 *Spirifer byroensis* Glauert (*partim*): p.47
1931 *Spirifera byroensis?* Glauert; Hosking: p.23
1965 *Neospirifer musakheylensis* var. *australis* Edgell: p.66, pl. 34 fig. 1
1967 *Neospirifer byroensis* (Glauert); Condon: p.149, 152
1969 *Fusispirifer byroensis* (Glauert); Thomas: p.224
1975 *Neospirifer byroensis* (Glauert); Playford et al.: p.286
1976 *Neospirifer musakheylensis* var. *australis*: Playford et al.: p.116

Diagnosis: Moderately large *Fusispirifer* with low plicae, coarse subequal ribs, a broad median sulcal rib, and a characteristic "curling up" of the alar extremities of the dorsal valve.

Closest species: *Fusispirifer wandageensis* Archbold & Thomas (1987) from the Wandagee Formation, a species that lacks the "curling up" of the alar extremities.

Types: Holotype - WAM F1650, designated by L. Glauert (Crespin, 1964); other figured specimens - GSWA F482-485, F5292.

Type locality: Northwest of Bogadi Outcamp, Carnarvon Basin.

Distribution and range: Near Arrino, Mingenew, **Perth Basin** - Mingenew Formation; east of Keogh Hill, and between Callytharra Springs and Gap Creek, **Carnarvon Basin** - Coyrie Formation, and "Bogadi Greywacke", now Mallens Sandstone.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Fusispirifer carnarvonensis Archbold & Thomas 1987

?1890 *Spirifera lata* Foord: p.145, pl. 6
1903 *Spirifera lata* Etheridge Jnr: p.15, pl. 1 fig. 8
1926 *Spirifer latus* Glauert: p.47
1987 *Fusispirifer carnarvonensis* Archbold & Thomas: p.177-181, figs 1A-I, 2A-H

Diagnosis: Medium-sized, transverse *Fusispirifer*. Sulcus broad, shallow; lateral plicae weak to indistinct.

Closest species: *Fusispirifer kedonensis* (Einor *in* Kashirtsev, 1959).

Types: Holotype - MUGD F6608; paratypes - MUGD F6609-F6609, CPC 24473-24477.

Type locality: 4 km bearing 342° from Thambrong Well, Williambury Station, 49.5 m below top of Callytharra Formation, Carnavon Basin.

Distribution and range: Type locality, Lyons River, and Fossil Hill, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively uncommon.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrates.

Fusispirifer spp.

1926 *Spirifer byroensis* Glauert (*partim*): p.47
1958 *Neospirifer* sp. cf. *N. byroensis* (Glauert); Guppy et al.: p.48
1961 *Neospirifer* cf. *byroensis* (Glauert); Dickins *in* Veevers & Wells: p.286
1967 *Neospirifer byroensis* Condon: p.169
1969 *Fusispirifer* spp. Thomas: p.224
1975 *Neospirifer byroensis* Playford et al.: p.287

General comment: In addition to the two species discussed above, five other species are known from Artinskian to Middle Kungurian of *Fusispirifer* units in the Carnarvon and Canning Basins. These have been described by Archbold and Thomas (1987) and Archbold and Skwarko (1988) and are not figured or discussed herein. The above synonymy indicates reports referring to these species.

Genus **COSTATISPIRIFER** Archbold & Thomas 1985

Type species: *Costatispirifer gracilis* Archbold & Thomas 1985; OD.

Costatispirifer gracilis Archbold & Thomas 1985
(Plate 39 figs 3-6)

1958 Spiriferid gen. et sp. nov. Guppy et al.: p.52
1985b *Costatispirifer gracilis* Archbold & Thomas: p.280, figs 7A-N

Diagnosis: Transverse shells with ornament of fine costae; plications variably developed, often weak; distinct, rounded fastigium; sulcus broad, shallow, terminates in U-shaped sulcal tongue.

Closest species: Close to no known species.

Types: Holotype - CPC 24309; paratypes - CPC 24310-24318.

Type locality: 4.2 km at 70° from the Shore Range Trig. Point, Canning Basin.

Distribution and range: Known only from the type locality, **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Relatively common at type locality.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under warm-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Genus **CRATISPIRIFER** Archbold & Thomas 1985

Type species: *Cratispirifer nuraensis* Archbold & Thomas 1985; OD.

Cratispirifer nuraensis Archbold & Thomas 1985
(Plate 40 figs 4, 5)

1985b *Cratispirifer nuraensis* Archbold & Thomas: p.280-282 figs 8A-F

Diagnosis: Transverse shells with high ventral interareas, narrow sulcus, narrow, relatively high fastigium and coarse equidimensional costae.

Closest species: No known close species.

Types: Holotype - CPC 24319; paratypes - CPC 24320, 24321.

Type locality: West of Mount Wynne Trig. Point, southwest of Paradise Homestead, Nura Nura Ridge, Canning Basin.

Distribution and range: Type locality area only, northern Canning Basin - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare (only 3 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; medium to coarse sandy substrate.

Genus **CRASSISPIRIFER** Archbold & Thomas 1985

Type species: *Spirifer rostalinus* Hosking 1931; OD.

Crassispirifer? kimberleyensis (Foord 1890)
(Plate 41 figs 3-5)

1890 *Spirifera kimberleyensis* Foord; p.105, pl. 5 fig 11
1891 *Spirifer kimberleyensis* Foord; Woodward: p.16
1910 *Spirifera kimberleyensis* Foord; Glauert: p.90
1964 *Spirifera kimberleyensis* Foord; Crespin: p.71
1985b *Crassispirifer? kimberleyensis* (Foord); Archbold & Thomas p.290, Figs 14B-D,G,H

Diagnosis: A small specimen, broken on one flank and damaged during growth on the other. Costal and sulcal details consistent with those of *Crassispirifer*.

Closest species: No species is particularly close.

Holotype: GSWA F10077.

Type locality: Gascoyne River, Carnarvon Basin.

Distribution and range: Only the holotype is known and the locality is poorly fixed - **Carnarvon Basin.**

Age: Early Permian.

Abundance: Only the holotype is known.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Not known.

Crassispirifer pinguis Archbold & Thomas 1985
(Plate 40 fig. 10; Plate 41 figs 1, 2, 6)

1958 *Neospirifer* sp. cf. *N. rostalinus* (Hosking); Guppy et al.: p.48
1985b *Crassispirifer pinguis* Archbold & Thomas; p.288-290, Figs 11A-C, 12A-D, 13A-E, 14A,E-F,I

Diagnosis: Large for genus; thick shells, fastigium high and rounded; sulcus deep, broad; plications distinct, strong, broadly rounded, up to 6 pairs on ventral valve; costae broad, low, fasciculation distinct.

Closest species: *C. striatiformis* (Chang *in* Chang & Ching 1976) a large species, the dorsal characters of which are unknown.

Types: Holotype - UWA 27382; paratypes - UWA 27382, 27395, 27670, CPC 24329-24331.

Type locality: Northeast of cattle pit on the Woolshed - Middalya Road on the east fence of Mungadan Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality, and region of syncline on Minilya River, **Carnarvon Basin** - Wandagee Formation; Cherrabun Station, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Valuable for interbasinal correlations and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Crassispirifer rostalinus (Hosking 1931)
(Plate 40 figs 6-9)

1914 Spirifera casts Etheridge Jnr: p.28, pl. 3 figs 2, 3; pl. 5 figs 3, 4
1931 *Spirifer rostalinus* Hosking: p.24, pl. 8 fig. 3; pl. 8A fig. 4; pl. 11 figs 1, 2
1931 *Spirifer rostalinus auritus* Hosking: p.24, pl. 8A figs 5-7a-c; pl. 10 figs 1a-c
1931 *Spirifer rostalinus crassus* Hosking: p.24, pl. 8 figs 1-2; pl. 8A fig. 8; pl. 9 figs 1a-d
1936 *Spirifer rostalinus* Hosking; Prendergast: p.129
1936 *Spirifer rostalinus auritus* Hosking; Prendergast: p.129
1936 *Spirifer rostalinus tumidus* Prendergast: p.129
1948 *Neospirifer rostalinus* (Hosking); Branson: p.430
1948 *Neospirifer rostalinus auritus* (Hosking); Branson: p.430
1948 *Neospirifer rostalinus tumidus* (Prendergast); Branson: p.430
1967 *Neospirifer rostalinus* (Hosking); Condon: p.149, 152
1971 *Paeckelmanella rostalinus* (Hosking); Waterhouse: p.391
1985b *Crassispirifer rostalinus* (Hosking); Archbold & Thomas: p.285-288, Figs 9A-G, 10A-J

Diagnosis: Medium-sized species, transverse at juvenile stages, subquadrate at full maturity; fold and fastigium distinct with rounded cross-section; plications distinct, costellae moderately coarse.

Closest species: *C. pinguis* Archbold & Thomas, a much larger species.

Types: Holotype - GSWA 1/4949x (selected by Hosking; Prendergast, 1936).

Type locality: Wooramel District, Carnarvon Basin.

Distribution and range: Northwest of Keogh Hill and region of Bogadi Outcamp, Wooramel River district, **Carnarvon** - Coyrie Formation and Mallens Sandstone.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to shallow water; silty and sandy substrates.

Subfamily TRIGONOTRETINAE Schuchert 1893

Genus **TRIGONOTRETA** Koenig 1825

Type species: *Trigonotreta stokesii* Koenig 1825; SD Buckman (1908).

Trigonotreta dickinsi Archbold & Thomas 1986
(Plate 41 figs 7, 8)

1986a *Trigonotreta dickinsi* Archbold & Thomas: p.156-158, Figs 18A-X

Diagnosis: Moderately transverse small *Trigonotreta*; costae unequal; bundles of costae normally with 3 to 4 costae, rarely 5; growth lamellae prominent.

Closest species: *T. lightjacki* Archbold & Thomas a species with coarser costae.

Types: Holotype - CPC 24370; paratypes - CPC 24370-24387.

Type locality: 3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin.

Distribution and range: Minilya River, Wandagee Station, **Carnarvon Basin** - Wandagee Formation. Type locality and the Shore Range, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Valuable for interbasinal correlation despite rarity.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Trigonotreta lightjacki Archbold & Thomas 1986
(Plate 41 figs 11, 12)

1986a *Trigonotreta lightjacki* Archbold & Thomas: p.158-159, Figs 19 A-O

Diagnosis: Small robust *Trigonotreta*; costae coarse, unequal; anterior margin rounded at maturity; costae in bundles of three.

Closest species: *T. dickinsi*, a form with finer costae.

Types: Holotype - CPC 24388; paratypes - CPC 24389-24400.

Type locality: 4.2 km at 70° from the Shore Range Trig. Point, Canning Basin.

Distribution and range: Type locality only, northern **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Relatively rare (15 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Found in sedimentary rocks that were deposited under warm-temperate condition.

Sedimentary environment: Shallow water; sandy substrate.

Trigonotreta lyonsensis Archbold & Thomas 1986
(Plate 41 figs 9, 10)

1958 *Neospirifer* sp. nov. Dickins & Thomas: p.124
1959 *Neospirifer* sp. Dickins & Thomas: p.70-72, 74, 76
1967 *Neospirifer* sp. ind. Condon: p.25, 42
1969 *Neospirifer* sp. nov. Thomas: p.220
1971 *Neospirifer* sp. Waterhouse: p.391
1975 *Neospirifer* Playford et al.: p.279
1986a *Trigonotreta lyonsensis* Archbold & Thomas: p.151-152 figs 15A-F

Diagnosis: Transverse *Trigonotreta*; ontogeny changing from rounded to transverse; fastigium high; costae subequal.

Closest species: A distinctive species.

Types: Holotype - CPC 24363; paratypes - CPC 24364-24368.

Type locality: 2.8 km northwest of Coyango Well, Williambury Station, Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Lyons Group.

Age: Asselian, Early Sakmarian (Tastubian).

Abundance: Relatively uncommon.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Shallow water; sandy substrate.

Trigonotreta neoaustralis Archbold & Thomas 1986
(Plate 41 figs 12, 13)

?1903 *Spirifera musakheylensis* Etheridge Jnr: p.12
1931 *Spirifer musakheylensis* Davidson var. *australis* Foord; Hosking: p.23, pl. 7 figs 1-3
1969 *Grantonia* sp. Thomas: p.226
1986a *Trigonotreta neoaustralis* Archbold & Thomas: p.152-156, figs 16A-J, 17A-L

Diagnosis: Transverse *Trigonotreta*; costae unequal, central costa of bundle remains coarser, number of costae in bundle variable up to 7;

growth lamellae prominent and impart tegulate ornament to shell; sulcus with prominent median costa.

Closest species: A distinctive species.

Types: Holotype - GSWA 1/4963A; paratypes - GSWA 1/4963B, F11204, F11205, 11206, MUGD F6568-6576, CPC 24369.

Type locality: Creek 0.8 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Fossil Cliff and near Carynginia (No. 1) Well, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Coordewandy Station, Bidgemia Station, Fossil Hill and Jimba Jimba Station, **Carnarvon Basin** - Callytharra Formation, Jimba Jimba Calcarenite Member of the Billidee Formation.

Age: Late Sakmarian (Sterlitamakian) and Early Artinskian (Aktastinian).

Abundance: Relatively uncommon (some 18 specimens are known).

Value in correlation and dating: Valuable for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to relatively shallow water; silty, sandy and calcarenite substrates.

Genus **BRACHYTHYRINELLA** Waterhouse & Gupta 1977

Type species: *Spirifer narsarhensis* Reed 1928; OD.

Brachythyrinella occidentalis (Thomas 1971)
(Plate 42 figs 1-4)

1958 *Trigonotreta* sp. nov. allied to *T. narsarhensis* (Reed); Dickins & Thomas: p.123
1959 *Trigonotreta* sp. nov. Dickins & Thomas: p.70-72, 74
1967 *Trigonotreta* sp. nov. Condon: p.48, 62
1969 *Trigonotreta narsarhensis* (Reed) subsp. nov. Thomas: p.220
1971 *Trigonotreta narsarhensis* (Reed) *occidentalis* Thomas: p.108, pl. 19 figs 1-6, 9-13; text figs 38-40
1975 *Trigonotreta* Playford et al.: p.279
1976 *Trigonotreta occidentalis* Thomas: p.319
1982b *Brachythyrinella occidentalis* (Thomas); Archbold: p.268

Diagnosis: Medium-sized species, wider than long, rarely equidimensional; maximum width at midlength; 5 - 7 costae in sulcus; 5 - 7 plications with 6 - 10 superimposed costae on each lateral slope.

Closest species: *B. narsarhensis* (Reed 1928), which is somewhat smaller and thinner shelled.

Types: Holotype - CPC 1682; other figured specimens - CPC 1683, 1684, 11147-11149, 11152-11155.

Type locality: 4.8 km at 45° from Round Hill Well and 1.3 km west of Kialiwabri Creek Crossing, Winning Station, Carnarvon Basin.

Distribution and range: Gascoyne River area, Minilya River area, Lyndon River area, Mount Sandiman, Williambury, Middalya, Winning Stations, **Carnarvon Basin** - upper part of Lyons Group, basal conglomeratic beds of Callytharra Formation.

Age: Early Sakmarian (Tastubian).

Abundance: Relatively common (over 100 specimens known).

Value in correlation and dating: Valuable for intercontinental correlation (Archbold, 1982b, 1984c).

Climate: Species found in sedimentary rocks that were deposited under cold-temperate conditions.

Sedimentary environment: Moderately shallow water; silty to sandy substrates.

Subfamily SPIRIFERELLINAE Waterhouse 1968

Genus **SPIRIFERELLA** Chernyshev 1902

Type species: *Spirifer saranae* de Verneuil 1845; OD.

Spiriferella australasica (Etheridge Jnr 1889)
(Plate 42 figs 10-14, 18, 20)

1889 *Cyrtina carbonaria* var. *australasica* Etheridge Jnr: p.210, pl. 17 figs 6-8
1910 *Cyrtina carbonaria* var. *australasica* Etheridge Jnr: Glauert (*part im*): p.89
1914 *Spiriferella? australasica* Etheridge Jnr: p.30, pl. 5 figs 6-13
1918 *Spiriferella? australasica* Etheridge Jnr: p.253
1926 *Spiriferella? australasica* (Etheridge Jnr); Glauert: p.47
1933a *Spiriferella australasica* (Etheridge Jnr); Hosking: p.459
1958 *Spiriferella australasica* (Etheridge Jnr); Guppy et al.: p.48
1967 *Spiriferella* Condon: p.269
1969 *Spiriferella australasica* (Etheridge Jnr); Thomas: p.226
1975 *Spiriferella australasica* (Etheridge Jnr); Playford et al.: p.341
1976a *Spiriferella australasica* (Etheridge Jnr); Waterhouse: p.124
1985a *Spiriferella australasica* (Etheridge Jnr); Archbold & Thomas: p.39-42, figs 1BB-HH, 2A-M

Diagnosis: Medium to large species, highly elongate in maturity with narrow U-shaped sulcus; dorsal fold with median groove; costae coarse, branch within 2 cm of umbones, imparting fasciculate appearance to anterior of large shells.

Closest species: *S. cundlegoensis* Archbold & Thomas, a smaller species.

Types: Lectotype, specimen figured by Etheridge Jnr (1889, pl. 17 fig. 7) apparently lost; chosen by Archbold & Thomas (1985a).

Type locality: Mount Marmion, about 1.6 km at 22° from Kimberley Downs Homestead, northern Canning Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common (over 60 specimens known).

Value in correlation and dating Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow to relatively deep water; silty and sandy substrates.

Spiriferella cundlegoensis Archbold & Thomas 1985
(Plate 42 figs 5-9)

1978 *Spiriferella australasica* Waterhouse et al. (*partim*): pl. 1 figs 9, 10 (*non cet.*)
1985a *Spiriferella cundlegoensis* Archbold & Thomas: p.37-39, figs 1A-Z, AA

Diagnosis: Small- to medium-sized species, elongate, auriculate, with low, broad, V-shaped in cross-section sulcus; fold low with median groove; costae simple or bifurcating once.

Closest species: *S. australasica* (Etheridge Jnr), a larger and more elongate species.

Types: Holotype - UWA 28180A; paratypes - UWA 28180B-28180M.

Type locality: Wandagee Station, UWA (C. Teichert) locality C37.1, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Cundlego Formation, Quinnanie Shale.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Common (over 40 specimens known).

Value in correlation and dating: Valuable in dating because of restricted stratigraphical range.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Closest species: *Fusispirifer wandageensis* Archbold & Thomas (1987) from the Wandagee Formation, a species that lacks the "curling up" of the alar extremities.

Types: Holotype - WAM F1650, designated by L. Glauert (Crespin, 1964); other figured specimens - GSWA F482-485, F5292.

Type locality: Northwest of Bogadi Outcamp, Carnarvon Basin.

Distribution and range: Near Arrino, Mingenew, **Perth Basin** - Mingenew Formation; east of Keogh Hill, and between Callytharra Springs and Gap Creek, **Carnarvon Basin** - Coyrie Formation, and "Bogadi Greywacke", now Mallens Sandstone.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Fusispirifer carnarvonensis Archbold & Thomas 1987

?1890 *Spirifera lata* Foord: p.145, pl. 6
1903 *Spirifera lata* Etheridge Jnr: p.15, pl. 1 fig. 8
1926 *Spirifer latus* Glauert: p.47
1987 *Fusispirifer carnarvonensis* Archbold & Thomas: p.177-181, figs 1A-I, 2A-H

Diagnosis: Medium-sized, transverse *Fusispirifer*. Sulcus broad, shallow; lateral plicae weak to indistinct.

Closest species: *Fusispirifer kedonensis* (Einor *in* Kashirtsev, 1959).

Types: Holotype - MUGD F6608; paratypes - MUGD F6609-F6609, CPC 24473-24477.

Type locality: 4 km bearing 342° from Thambrong Well, Williambury Station, 49.5 m below top of Callytharra Formation, Carnavon Basin.

Distribution and range: Type locality, Lyons River, and Fossil Hill, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively uncommon.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrates.

Fusispirifer spp.

1926 *Spirifer byroensis* Glauert (*partim*): p.47
1958 *Neospirifer* sp. cf. *N. byroensis* (Glauert); Guppy et al.: p.48
1961 *Neospirifer* cf. *byroensis* (Glauert); Dickins *in* Veevers & Wells: p.286
1967 *Neospirifer byroensis* Condon: p.169
1969 *Fusispirifer* spp. Thomas: p.224
1975 *Neospirifer byroensis* Playford et al.: p.287

General comment: In addition to the two species discussed above, five other species are known from Artinskian to Middle Kungurian of *Fusispirifer* units in the Carnarvon and Canning Basins. These have been described by Archbold and Thomas (1987) and Archbold and Skwarko (1988) and are not figured or discussed herein. The above synonymy indicates reports referring to these species.

Genus **COSTATISPIRIFER** Archbold & Thomas 1985

Type species: *Costatispirifer gracilis* Archbold & Thomas 1985; OD.

Costatispirifer gracilis Archbold & Thomas 1985
(Plate 39 figs 3-6)

1958 Spiriferid gen. et sp. nov. Guppy et al.: p.52
1985b *Costatispirifer gracilis* Archbold & Thomas: p.280, figs 7A-N

Diagnosis: Transverse shells with ornament of fine costae; plications variably developed, often weak; distinct, rounded fastigium; sulcus broad, shallow, terminates in U-shaped sulcal tongue.

Closest species: Close to no known species.

Types: Holotype - CPC 24309; paratypes - CPC 24310-24318.

Type locality: 4.2 km at 70° from the Shore Range Trig. Point, Canning Basin.

Distribution and range: Known only from the type locality, **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Relatively common at type locality.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were laid down under warm-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Genus **CRATISPIRIFER** Archbold & Thomas 1985

Type species: *Cratispirifer nuraensis* Archbold & Thomas 1985; OD.

Cratispirifer nuraensis Archbold & Thomas 1985
(Plate 40 figs 4, 5)

1985b *Cratispirifer nuraensis* Archbold & Thomas: p.280-282 figs 8A-F

Diagnosis: Transverse shells with high ventral interareas, narrow sulcus, narrow, relatively high fastigium and coarse equidimensional costae.

Closest species: No known close species.

Types: Holotype - CPC 24319; paratypes - CPC 24320, 24321.

Type locality: West of Mount Wynne Trig. Point, southwest of Paradise Homestead, Nura Nura Ridge, Canning Basin.

Distribution and range: Type locality area only, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare (only 3 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; medium to coarse sandy substrate.

Genus **CRASSISPIRIFER** Archbold & Thomas 1985

Type species: *Spirifer rostalinus* Hosking 1931; OD.

Crassispirifer? kimberleyensis (Foord 1890)
(Plate 41 figs 3-5)

1890 *Spirifera kimberleyensis* Foord; p.105, pl. 5 fig 11
1891 *Spirifer kimberleyensis* Foord; Woodward: p.16
1910 *Spirifera kimberleyensis* Foord; Glauert: p.90
1964 *Spirifera kimberleyensis* Foord; Crespin: p.71
1985b *Crassispirifer? kimberleyensis* (Foord); Archbold & Thomas p.290, Figs 14B-D,G,H

Diagnosis: A small specimen, broken on one flank and damaged during growth on the other. Costal and sulcal details consistent with those of *Crassispirifer*.

Closest species: No species is particularly close.

Holotype: GSWA F10077.

Type locality: Gascoyne River, Carnarvon Basin.

Distribution and range: Only the holotype is known and the locality is poorly fixed - **Carnarvon Basin.**

Age: Early Permian.

Abundance: Only the holotype is known.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Not known.

Crassispirifer pinguis Archbold & Thomas 1985
(Plate 40 fig. 10; Plate 41 figs 1, 2, 6)

1958 *Neospirifer* sp. cf. *N. rostalinus* (Hosking); Guppy et al.: p.48
1985b *Crassispirifer pinguis* Archbold & Thomas; p.288-290, Figs 11A-C, 12A-D, 13A-E, 14A,E-F,I

Diagnosis: Large for genus; thick shells, fastigium high and rounded; sulcus deep, broad; plications distinct, strong, broadly rounded, up to 6 pairs on ventral valve; costae broad, low, fasciculation distinct.

Closest species: *C. striatiformis* (Chang *in* Chang & Ching 1976) a large species, the dorsal characters of which are unknown.

Types: Holotype - UWA 27382; paratypes - UWA 27382, 27395, 27670, CPC 24329-24331.

Type locality: Northeast of cattle pit on the Woolshed - Middalya Road on the east fence of Mungadan Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality, and region of syncline on Minilya River, **Carnarvon Basin** - Wandagee Formation; Cherrabun Station, **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Valuable for interbasinal correlations and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Crassispirifer rostalinus (Hosking 1931)
(Plate 40 figs 6-9)

1914 Spirifera casts Etheridge Jnr: p.28, pl. 3 figs 2, 3; pl. 5 figs 3, 4
1931 *Spirifer rostalinus* Hosking: p.24, pl. 8 fig. 3; pl. 8A fig. 4; pl. 11 figs 1, 2
1931 *Spirifer rostalinus auritus* Hosking: p.24, pl. 8A figs 5-7a-c; pl. 10 figs 1a-c
1931 *Spirifer rostalinus crassus* Hosking: p.24, pl. 8 figs 1-2; pl. 8A fig. 8; pl. 9 figs 1a-d
1936 *Spirifer rostalinus* Hosking; Prendergast: p.129
1936 *Spirifer rostalinus auritus* Hosking; Prendergast: p.129
1936 *Spirifer rostalinus tumidus* Prendergast: p.129
1948 *Neospirifer rostalinus* (Hosking); Branson: p.430
1948 *Neospirifer rostalinus auritus* (Hosking); Branson: p.430
1948 *Neospirifer rostalinus tumidus* (Prendergast); Branson: p.430
1967 *Neospirifer rostalinus* (Hosking); Condon: p.149, 152
1971 *Paeckelmanella rostalinus* (Hosking); Waterhouse: p.391
1985b *Crassispirifer rostalinus* (Hosking); Archbold & Thomas: p.285-288, Figs 9A-G, 10A-J

Diagnosis: Medium-sized species, transverse at juvenile stages, subquadrate at full maturity; fold and fastigium distinct with rounded cross-section; plications distinct, costellae moderately coarse.

Closest species: *C. pinguis* Archbold & Thomas, a much larger species.

Types: Holotype - GSWA 1/4949x (selected by Hosking; Prendergast, 1936).

Type locality: Wooramel District, Carnarvon Basin.

Distribution and range: Northwest of Keogh Hill and region of Bogadi Outcamp, Wooramel River district, **Carnarvon** - Coyrie Formation and Mallens Sandstone.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to shallow water; silty and sandy substrates.

Subfamily TRIGONOTRETINAE Schuchert 1893

Genus **TRIGONOTRETA** Koenig 1825

Type species: *Trigonotreta stokesii* Koenig 1825; SD Buckman (1908).

Trigonotreta dickinsi Archbold & Thomas 1986
(Plate 41 figs 7, 8)

1986a *Trigonotreta dickinsi* Archbold & Thomas: p.156-158, Figs 18A-X

Diagnosis: Moderately transverse small *Trigonotreta*; costae unequal; bundles of costae normally with 3 to 4 costae, rarely 5; growth lamellae prominent.

Closest species: *T. lightjacki* Archbold & Thomas a species with coarser costae.

Types: Holotype - CPC 24370; paratypes - CPC 24370-24387.

Type locality: 3.5 km at 288° from Brutens Old Yard, Cherrabun Station, northern Canning Basin.

Distribution and range: Minilya River, Wandagee Station, **Carnarvon Basin** - Wandagee Formation. Type locality and the Shore Range, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Valuable for interbasinal correlation despite rarity.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Trigonotreta lightjacki Archbold & Thomas 1986
(Plate 41 figs 11, 14)

1986a *Trigonotreta lightjacki* Archbold & Thomas: p.158-159, Figs 19 A-O

Diagnosis: Small robust *Trigonotreta*; costae coarse, unequal; anterior margin rounded at maturity; costae in bundles of three.

Closest species: *T. dickinsi*, a form with finer costae.

Types: Holotype - CPC 24388; paratypes - CPC 24389-24400.

Type locality: 4.2 km at 70° from the Shore Range Trig. Point, Canning Basin.

Distribution and range: Type locality only, northern **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Relatively rare (15 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Found in sedimentary rocks that were deposited under warm-temperate condition.

Sedimentary environment: Shallow water; sandy substrate.

Trigonotreta lyonsensis Archbold & Thomas 1986
(Plate 41 figs 9, 10)

1958 *Neospirifer* sp. nov. Dickins & Thomas: p.124
1959 *Neospirifer* sp. Dickins & Thomas: p.70-72, 74, 76
1967 *Neospirifer* sp. ind. Condon: p.25, 42
1969 *Neospirifer* sp. nov. Thomas: p.220
1971 *Neospirifer* sp. Waterhouse: p.391
1975 *Neospirifer* Playford et al.: p.279
1986a *Trigonotreta lyonsensis* Archbold & Thomas: p.151-152 figs 15A-F

Diagnosis: Transverse *Trigonotreta*; ontogeny changing from rounded to transverse; fastigium high; costae subequal.

Closest species: A distinctive species.

Types: Holotype - CPC 24363; paratypes - CPC 24364-24368.

Type locality: 2.8 km northwest of Coyango Well, Williambury Station, Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Lyons Group.

Age: Asselian, Early Sakmarian (Tastubian).

Abundance: Relatively uncommon.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Shallow water; sandy substrate.

Trigonotreta neoaustralis Archbold & Thomas 1986
(Plate 41 figs 12, 13)

?1903 *Spirifera musakheylensis* Etheridge Jnr: p.12
1931 *Spirifer musakheylensis* Davidson var. *australis* Foord; Hosking: p.23, pl. 7 figs 1-3
1969 *Grantonia* sp. Thomas: p.226
1986a *Trigonotreta neoaustralis* Archbold & Thomas: p.152-156, figs 16A-J, 17A-L

Diagnosis: Transverse *Trigonotreta*; costae unequal, central costa of bundle remains coarser, number of costae in bundle variable up to 7;

growth lamellae prominent and impart tegulate ornament to shell; sulcus with prominent median costa.

Closest species: A distinctive species.

Types: Holotype - GSWA 1/4963A; paratypes - GSWA 1/4963B, F11204, F11205, 11206, MUGD F6568-6576, CPC 24369.

Type locality: Creek 0.8 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Fossil Cliff and near Carynginia (No. 1) Well, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Coordewandy Station, Bidgemia Station, Fossil Hill and Jimba Jimba Station, **Carnarvon Basin** - Callytharra Formation, Jimba Jimba Calcarenite Member of the Billidee Formation.

Age: Late Sakmarian (Sterlitamakian) and Early Artinskian (Aktastinian).

Abundance: Relatively uncommon (some 18 specimens are known).

Value in correlation and dating: Valuable for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to relatively shallow water; silty, sandy and calcarenite substrates.

Genus **BRACHYTHYRINELLA** Waterhouse & Gupta 1977

Type species: *Spirifer narsarhensis* Reed 1928; OD.

Brachythyrinella occidentalis (Thomas 1971)
(Plate 42 figs 1-4)

1958 *Trigonotreta* sp. nov. allied to *T. narsarhensis* (Reed); Dickins & Thomas: p.123
1959 *Trigonotreta* sp. nov. Dickins & Thomas: p.70-72, 74
1967 *Trigonotreta* sp. nov. Condon: p.48, 62
1969 *Trigonotreta narsarhensis* (Reed) subsp. nov. Thomas: p.220
1971 *Trigonotreta narsarhensis* (Reed) *occidentalis* Thomas: p.108, pl. 19 figs 1-6, 9-13; text figs 38-40
1975 *Trigonotreta* Playford et al.: p.279
1976 *Trigonotreta occidentalis* Thomas: p.319
1982b *Brachythyrinella occidentalis* (Thomas); Archbold: p.268

Diagnosis: Medium-sized species, wider than long, rarely equidimensional; maximum width at midlength; 5 - 7 costae in sulcus; 5 - 7 plications with 6 - 10 superimposed costae on each lateral slope.

Closest species: *B. narsarhensis* (Reed 1928), which is somewhat smaller and thinner shelled.

Types: Holotype - CPC 1682; other figured specimens - CPC 1683, 1684, 11147-11149, 11152-11155.

Type locality: 4.8 km at 45° from Round Hill Well and 1.3 km west of Kialiwibri Creek Crossing, Winning Station, Carnarvon Basin.

Distribution and range: Gascoyne River area, Minilya River area, Lyndon River area, Mount Sandiman, Williambury, Middalya, Winning Stations, **Carnarvon Basin** - upper part of Lyons Group, basal conglomeratic beds of Callytharra Formation.

Age: Early Sakmarian (Tastubian).

Abundance: Relatively common (over 100 specimens known).

Value in correlation and dating: Valuable for intercontinental correlation (Archbold, 1982b, 1984c).

Climate: Species found in sedimentary rocks that were deposited under cold-temperate conditions.

Sedimentary environment: Moderately shallow water; silty to sandy substrates.

Subfamily SPIRIFERELLINAE Waterhouse 1968

Genus **SPIRIFERELLA** Chernyshev 1902

Type species: *Spirifer saranae* de Verneuil 1845; OD.

Spiriferella australasica (Etheridge Jnr 1889)
(Plate 42 figs 10-14, 18, 20)

1889 *Cyrtina carbonaria* var. *australasica* Etheridge Jnr: p.210, pl. 17 figs 6-8
1910 *Cyrtina carbonaria* var. *australasica* Etheridge Jnr: Glauert (*partim*): p.89
1914 *Spiriferella? australasica* Etheridge Jnr: p.30, pl. 5 figs 6-13
1918 *Spiriferella? australasica* Etheridge Jnr: p.253
1926 *Spiriferella? australasica* (Etheridge Jnr); Glauert: p.47
1933a *Spiriferella australasica* (Etheridge Jnr); Hosking: p.459
1958 *Spiriferella australasica* (Etheridge Jnr); Guppy et al.: p.48
1967 *Spiriferella* Condon: p.269
1969 *Spiriferella australasica* (Etheridge Jnr); Thomas: p.226
1975 *Spiriferella australasica* (Etheridge Jnr); Playford et al.: p.341
1976a *Spiriferella australasica* (Etheridge Jnr); Waterhouse: p.124
1985a *Spiriferella australasica* (Etheridge Jnr); Archbold & Thomas: p.39-42, figs 1BB-HH, 2A-M

Diagnosis: Medium to large species, highly elongate in maturity with narrow U-shaped sulcus; dorsal fold with median groove; costae coarse, branch within 2 cm of umbones, imparting fasciculate appearance to anterior of large shells.

Closest species: *S. cundlegoensis* Archbold & Thomas, a smaller species.

Types: Lectotype, specimen figured by Etheridge Jnr (1889, pl. 17 fig. 7) apparently lost; chosen by Archbold & Thomas (1985a).

Type locality: Mount Marmion, about 1.6 km at 22° from Kimberley Downs Homestead, northern Canning Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively common (over 60 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow to relatively deep water; silty and sandy substrates.

Spiriferella cundlegoensis Archbold & Thomas 1985
(Plate 42 figs 5-9)

1978 *Spiriferella australasica* Waterhouse et al. (*partim*): pl. 1 figs 9, 10 (*non cet.*)
1985a *Spiriferella cundlegoensis* Archbold & Thomas: p.37-39, figs 1A-Z, AA

Diagnosis: Small- to medium-sized species, elongate, auriculate, with low, broad, V-shaped in cross-section sulcus; fold low with median groove; costae simple or bifurcating once.

Closest species: *S. australasica* (Etheridge Jnr), a larger and more elongate species.

Types: Holotype - UWA 28180A; paratypes - UWA 28180B-28180M.

Type locality: Wandagee Station, UWA (C. Teichert) locality C37.1, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Cundlego Formation, Quinnanie Shale.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Common (over 40 specimens known).

Value in correlation and dating: Valuable in dating because of restricted stratigraphical range.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Water of variable depth, often shallow; silty and sandy substrates.

Spiriferella etheridgei Archbold & Thomas 1985

1978 *Spiriferella* n. sp. Waterhouse et al.: pl. 1 figs 1, 2
1985a *Spiriferella etheridgei* Archbold & Thomas: p.42-43, Figs 2N-V

Diagnosis: Medium- to large-sized species, variably elongate; dorsal fold sharp - no median groove; costae coarse.

Closest species: The *S. polaris* (Wiman 1914) lineage of *Spiriferella* (see Archbold & Thomas, 1985a).

Types: Holotype - UWA 28049; paratypes - UWA 28025, 28052A-28052D.

Type locality: UWA (C. Teichert) locality WF 9.7, near fence of Shed Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Only known from type locality area, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Relatively common (about 18 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty to fine sandy substrate.

Spiriferella sp.

?1907a *Cyrtina carbonaria* var. *australasica* Etheridge Jnr: p.21
?1910 *Cyrtina carbonaria* var. *australasica* Etheridge Jnr; Glauert (*partim*): p.89
1985a *Spiriferella* sp. A Archbold & Thomas: p.49, Figs 2W-X

Diagnosis: Strongly convex ventral valve with moderately high interarea; ventral sulcus broad, V-shaped in cross-section; coarse, simple costae on posterior of valve.

Closest species: *S. cundlegoensis* Archbold & Thomas, a less robust and smaller species.

Figured specimen: CPC 24241.

Distribution and range: Possibly Mingenew, Irwin River area, **Perth Basin** - ?Mingenew Formation; southeast of Mount Madeline, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Extremely rare.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty substrate.

Genus **ELIVINA** Frederiks 1924

Type species: *Spirifer tibetanus* Diener 1897; OD.

Elivina hoskingae Archbold & Thomas 1985
(Plate 42 figs 15, 16, 21, 22)

1931 *Spiriferella australasica* Hosking: p.29
1935 *Spiriferella australasica* Prendergast: p.22
1967 *Spiriferella* Condon: p.70
1976 *Spiriferella australasica* Playford et al.: p.95
1978 *Elivina* sp. Waterhouse et al.: pl. 3 figs 8-11
1985a *Elivina hoskingae* Archbold & Thomas: p.44, Figs 3A-Y

Diagnosis: Average sized elongate species; sulcus broad, gentle, U-shaped; dorsal fold very low; costae simple and branching producing low fascicles of 3 costae in some specimens.

Closest species: *E. occidentalis* (Schellwien 1900), a form with finer costae and a distinctly convex dorsal valve.

Types: Holotype - GSWA F9187; paratypes - GSWA F18, F9188, MUGD F6036-6046.

Type locality: Callytharra Springs, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs and throughout the outcrop of the Callytharra Formation, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely common (thousands of specimens known).

Value in correlation and dating: Valuable for interbasinal correlation, and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Water of variable depth; silty, calcilutite and calcarenite substrates.

Superfamily RETICULARIACEA Waagen 1883

Family ELYTHIDAE Frederiks 1924
Subfamily ELYTHINAE Frederiks 1924

Genus **SPIRELYTHA** Frederiks 1924

Type species: *Spirelytha pavlovae* Archbold & Thomas 1984 (= *Spirifer scheii* Tschernyschew 1916, *non Spirifer scheii* Meyer 1913); OD.

Spirelytha fredericksi Archbold & Thomas 1984
(Plate 42 figs 23-26)

1890 *Reticularia lineata* Martin, sp.; Foord: p.153
1890 *Reticularia crebristria* Morris, sp.; Foord: p.153
1903 *Reticularia lineata* Martin, sp.; Etheridge Jnr: p.16
1907b *Reticularia lineata* Martin; Etheridge Jnr: p.29
1910 *Reticularia lineata* Glauert: p.89
1910 *Reticularia crebristria* Glauert: p.89
1931 *Reticularia lineata* Martin; Hosking: p.22
1935 *Phricodothyris lineata* (Martin); Prendergast: p.23, pl. 3 figs 6-8
1967 *Phricidothyris* (*sic*) Condon: p.70
1976 *Phricidothyris lineata* (Martin)(*sic*); Playford et al.: p.95
1984 *Spirelytha fredericksi* Archbold & Thomas: p.314, figs 1 A-R, 2A-K

Diagnosis: Medium to large for genus; sulcus broad, distinct, shallow; fold low and broad; ventral adminicula and median septum prominent; anterior commissure uniplicate.

Closest species: *S. miloradovichi* Archbold & Thomas which is characterized by a higher ventral interarea and pronounced sulcus.

Types: Holotype - CPC 19931; paratypes - CPC 19932-19936, UWA 10927, GSWA F11197-11199, MUGD F6031-6035.

Type locality: 1.6 km slightly south of west of Callytharra Springs, Byro Station, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, Wooramel River and Bidgemia Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively common although sporadic in occurrence.

Value in correlation and dating: Valuable for interbasinal correlation and restricted in age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to moderately shallow water; silty calcilutite and calcarenite substrates.

Spirelytha sp. cf. **S. fredericksi** Archbold & Thomas 1984

1984 *Spirelytha* sp. cf. *S. fredericksi* Archbold & Thomas: p.322 figs 4 S-W

Diagnosis: Large for genus with strongly developed sulcus and fold; parasulcate commissure; ventral umbo and interarea relatively low.

Closest species: *S. fredericksi* Archbold & Thomas which has less well developed sulcus and fold.

Figured specimens: CPC 24226, 24227.

Distribution and range: Scott Bluff, east side of Lake Blanche, southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare (only 2 specimens known).

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrate.

Spirelytha miloradovichi Archbold & Thomas 1984
(Plate 42 figs 27-30)

1914 *Reticularia* sp. Etheridge Jnr: p.33, pl. 1 figs 8-9
1926 *Reticularia* sp. Glauert: p.47
?192- *Spirifer* cf. *lineatus* Glauert: p.47
1958 *Phricidothyris* spp. nov. (*sic*) Guppy et al.: p.48
1967 *Phricidothyris* (*sic*) Condon: p.169
1984 *Spirelytha miloradovichi* Archbold & Thomas: p.318, Figs 2L-Z, AA-BB, 3, 4A-E

Diagnosis: Medium size for genus; sulcus broad, deep; fold distinct, rises sharply from lateral slopes; anterior commissure normally parasulcate; dorsal valve of some specimens carry minute adminicula.

Closest species: *S. fredericksi* Archbold & Thomas (see above).

Types: Holotype - CPC 19938; paratypes - CPC 19937, 19939, 24224, 24225, UWA 27510, 27517, 27874, 88133, 88140.

Type locality: Right bank of the Minilya River, 13.6 km west of Wandagee Homestead at Lat. 23°44'S; Long. 114°77'E, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation, Nalbia Sandstone; south of Grant Range, and Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Latest Artinskian (late Baigendzhinian) to earliest Kungurian.

Abundance: Sporadic, some 20 specimens known.

Value in correlation and dating: Valuable for interbasinal correlation and restricted in age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep to shallow water; silty to fine sandy substrates.

Spirelytha sp. A

1984 *Spirelytha* sp. A Archbold & Thomas: p.322, Figs 4BB-DD

Diagnosis: Moderate size for genus with low ventral umbo and coarse concentric lamellae.

Closest species: *S. fredericksi* Archbold & Thomas, which has a less well-developed dorsal fold.

Figured specimens: CPC 24228-24300.

Distribution and range: Bogadi Outcamp and south branch of Bush Creek, **Carnarvon Basin** - "Madeline Formation" (now Coyrie Formation).

Age: Late Artinskian (early Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Of little value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; fine sandy substrate.

Spirelytha sp. B

1984 *Spirelytha* sp. B Archbold & Thomas: p.322, Figs 4X-Z,AA

Diagnosis: Equally convex valves with ventral interarea at high angle to the plane of the dorsal valve.

Closest species: A distinctive species.

Figured specimen: CPC 24231.

Distribution and range: Northeast of Hill Springs Homestead, **Carnarvon Basin** - Quinnanie Shale.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Very rare.

Value in correlation and dating: A distinctive species potentially valuable in dating.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Water of variable depth; silty substrate.

Spirelytha spp.

General comment: In addition to the above verified reports of *Spirelytha*, elythids have been reported as indicated below. Collections are not available for verification; identifications were field based.

1967 *Phricidothyris* (*sic*) sp. Condon: p.102

Stratigraphic unit: Moogooloo Sandstone, Carnarvon Basin.

Age: Early Artinskian (Aktastinian).

1967 *Phricidothyris* (*sic*) sp. Condon: p.90
1975 *Phricidothyris* (*sic*) sp. Playford et al.: p.282

Stratigraphic unit: Jimba Jimba Calcarenite Member of the Billidee Formation, Carnarvon Basin.

Age: Early Artinskian (Aktastinian).

Spirelytha stepanoviana Archbold & Thomas 1984
(Plate 43 figs 1-4)

1984 *Spirelytha stepanoviana* Archbold & Thomas: p.320, Figs 4F-R

Diagnosis: Small for genus; sulcus broad, moderately deep; fold broad, rounded, low; anterior commissure weakly to distinctly parasulcate.

Closest species: *S. miloradovichi* Archbold & Thomas which is larger, with a high ventral interarea.

Types: Holotype - UWA 88134; paratypes - UWA 88135-88139.

Type locality: Nalbia Paddock, east of Wandagee Hill, Wandagee Station, Carnarvon Bassin.

Distribution and range: Restricted to region of type locality, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: Relatively rare (about 10 specimens known).

Value in correlation and dating: Valuable for dating although value reduced by rarity.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty to very fine sandy substrates.

Genus **PHRICODOTHYRIS** George 1932

Type species: *Phricodothyris lucerna* George 1932; OD.

Phricodothyris occidentalis Archbold & Thomas 1984
(Plate 43 figs 5-8)

1969 *Neophricadothyris* sp. Thomas: p.227
1984 *Phricodothyris occidentalis* Archbold & Thomas: p.323, Figs 4EE-KK

Diagnosis: Small species with circular shell outline, rectimarginate commissure, low interareas.

Closest species: *P. tschernyschewi* (Frederiks 1912) group of species (Archbold & Thomas, 1984).

Types: Holotype - CPC 24232; paratype - GSWA F192.

Type locality: Callytharra Springs, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare.

Value in correlation and dating: Of limited value but diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty and calcilutite substrates.

Superfamily uncertain

Family INGELARELLIDAE Campbell 1959
Subfamily INGELARELLINAE Campbell 1959

Genus **TOMIOPSIS** Benediktova 1956

Type species: *Brachythyris kumpani* Yanishevskiy 1935; OD.

Tomiopsis balgoensis Archbold & Thomas 1986
(Plate 43 figs 28-30)

1964 *Martiniopsis* sp. Dickins: p.48
1986b *Tomiopsis balgoensis* Archbold & Thomas: p.597, figs 7.5-7.12

Diagnosis: Medium-sized species, width greater than length; sulcus shallow, broad, ill-defined; dorsal fold low and broadly arched; shell thin.

Closest species: A distinctive form with no close species.

Types: Holotype - CPC 24270; another figured specimen - CPC 24271.

Type locality: Lat. 21°28'S, Long. 128°06'E, Canning Basin.

Distribution and range: Type locality and Lat. 21°49'S, Long. 127°58'E, northeast **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Rare (only 2 specimens known).

Value in correlation and dating: Indicative of age.

Climate: Species found in sedimentary rocks that were deposited under warm-temperate conditions.

Sedimentary environment: Shallow water, sandy substrate.

Tomiopsis globosus Archbold & Thomas 1986
(Plate 43 figs 31-35)

1958 Martiniopsid gen. et sp. nov. C Guppy et al.: p.52
1986b *Tomiopsis globosus* Archbold & Thomas: p.595, figs 6.14-6.21, 7.1-7.4

Diagnosis: Small species, width almost equal to length or only slightly greater; ventral interarea very low; fold and sulcus broad and low; lateral slopes often smooth; ventral adminicula long, very thin, close to parallel; shell thin.

Closest species: Not close to any known species.

Types: Holotype - CPC 24286; other figured specimen - CPC 24287-24291.

Type locality: 3.7 km at 70° from the Shore Range Trig. Point, Canning Basin.

Distribution and range: Nalbia Paddock, east of Wandagee Hill, **Carnarvon Basin** - Coolkilya Sandstone; type locality, and other localities in the Shore Range, **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Relatively uncommon (about 15 specimens known).

Value in correlation and dating: Valuable for interbasinal correlation and dating.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Tomiopsis hardmani Archbold & Thomas 1986
(Plate 43 figs 36, 37)

1957 *Martiniopsis* sp. nov. Thomas: p.181
1958a Martiniopsid gen. et sp. nov. Thomas: p.3
1958 Martiniopsid gen. et sp. nov. D Guppy et al.: p.54
1986b *Tomiopsis hardmani* Archbold & Thomas: p.599, figs 7.13-7.20, 8.1-8.17

Diagnosis: Small- to medium-sized species; sulcus broad and rounded with variably developed median sulcal groove; fold prominent, flat on crest, rises sharply from lateral slopes; lateral slopes of valves with up to 5 gentle plicae per flank.

Closest species: *T. himalayanicus* (Waterhouse 1978), a similar species externally except for micro-ornamental characters.

Types: Holotype - CPC 24273; figured specimens - CPC 24272, 24274-24283.

Type locality: 3 km west of Mount Goodwin, Port Keats area, Bonaparte Basin, NT.

Distribution and range: Mount Hardman, Nerrima Station and Millyit Range, northern **Canning Basin** - Hardman Formation. Port Keats area, Bonaparte Basin (NT) - "Upper Marine Beds", Port Keats Group.

Age: Chhidruan.

Abundance: Relatively common (some 20 specimens are known).

Value in correlation and dating: Valuable for interbasin and intercontinental correlation and dating.

Climate: Species found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Tomiopsis notoplicatus Archbold & Thomas 1986
(Plate 43 figs 9-11)

1958 *Martiniopsis* sp. nov. Dickins & Thomas: p.124
1959 Martiniopsid gen. et sp. nov. Dickins & Thomas: p.69, 74, 75
1986b *Tomiopsis notoplicatus* Archbold & Thomas: p.586, figs 3.1-3.11

Diagnosis: Medium-sized species; fold moderately rounded, somewhat flatter on crest, sulcus with two delicate radial plicae; lateral slopes with three to four prominent plicae; ventral adminicula long, parallel in mature shells.

Closest species: A number of non-Western Australian species are close (Archbold & Thomas, 1986b).

Types: Holotype - CPC 24245; other figured specimens - CPC 24242-24244, MUGD F6047.

Type locality: 1.4 km west of Callytharra Spring, Byro Station, Carnarvon Basin.

Distribution and range: West of Callytharra Springs, Lyndon River area and Williambury Station, **Carnarvon Basin** - Lyons Group, Carandibby Formation, and conglomerate at the base of the Callytharra Formation.

Age: Early Sakmarian (Tastubian) possibly ranging down to Asselian.

Abundance: Relatively uncommon (some 10 specimens known).

Value in correlation and dating: Indicative of age. Useful for international correlation (see Dickins & Shah, 1979).

Climate: Species found in sedimentary rocks that were deposited under cold-temperate conditions.

Sedimentary environment: Moderately to very shallow water; silty, sandy, and gravelly substrates.

Tomiopsis pauciplicatus Archbold & Thomas 1986
(Plate 43 figs 21-24)

1967 Martiniopsid Condon: p.149
1967 *Martiniopsis* sp. Condon: p.152
1986b *Tomiopsis pauciplicatus* Archbold & Thomas: p.590, figs 4.6-4.16, 5.1-5.11

Diagnosis: Medium-sized species; lateral slopes of valves smooth or very gently plicate (from one to three plicae on each flank); strong, thin ventral adminicula diverge at small angle in mature shells.

Closest species: *T. woodwardi* Archbold & Thomas, a species with more strongly developed plicae.

Types: Holotype - CPC 24253; other figured specimens - CPC 24254-24260.

Type locality: 8.8 km at 150° from Mount Madeline, Carnarvon Basin.

Distribution and range: Southwest of Bogadi Outcamp, southeast of Mount Madeline, northeast of Keogh Hill and southeast of Dairy Creek Homestead, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively uncommon (some 15 specimens known).

Value in correlation and dating: Valuable in dating.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty to fine sandy substrates.

Tomiopsis rarus Archbold & Thomas 1986
(Plate 43 figs 16-20)

1959 *Martiniopsis* sp. A Dickins *in* Playford: p.19
1969 *Ingelarella branxtonensis* Runnegar: p.88, pl. 1 figs 6-8 (*non cet.*)
1970 *Ingelarella plana* Dickins: p.22
1976 *Martiniopsis* sp. A Playford et al.: p.100
1986b *Tomiopsis rarus* Archbold & Thomas: p.590, figs 4.1-4.5

Diagnosis: Large-sized species; pronounced fold, flat topped and smooth; ventral valve with 5 weakly developed lateral plicae on each flank; strong, long, thin, parallel ventral adminicula; shell unthickened.

Closest species: *T. woodwardi* Archbold & Thomas with a lower dorsal fold and a smaller number of lateral plicae.

Holotype: UWA 34319.

Type locality: Woolaga Creek, Irwin River area, Perth Basin.

Distribution and range: Restricted to type locality, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: Rare (only 2 specimens known).

Value in correlation and dating: Valuable in dating despite rarity.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrates.

Tomiopsis? sp.

1986b *Tomiopsis?* sp. A Archbold & Thomas: p.600, Figs 8, 18

Diagnosis: A large specimen with smooth lateral slopes and a high ventral interarea.

Figured specimen: MUGD F6050.

Distribution and range: 8.4 km at 226° from Coondoo Outcamp, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow water; calcarenite substrate.

Tomiopsis teicherti Archbold & Thomas 1986
(Plate 43 figs 25-27)

1958 Martiniopsid gen. et sp. nov. B Guppy et al.: p.48
?1961 *Martiniopsis* sp. Dickins *in* Veevers & Wells: p.286
1986b *Tomiopsis teicherti* Archbold & Thomas: p.593, figs 6.1-6.13

Diagnosis: Small species; sulcus broad, deep, gently rounded at base with two distinct sulcal plicae and extended into prominent, flattened sulcal tongue; fold high, sharply steepened from lateral slopes; distinct valleys demarcate fold; lateral slopes with two plicae per flank.

Closest species: *T. pauciplicatus* Archbold & Thomas which differs substantially in details of plicae, sulcus and fold.

Types: Holotype - CPC 24261; other figured specimens - CPC 24262-24268.

Type locality: Right bank of Minilya River, 13.6 km west of Wandagee Homestead, Carnarvon Basin.

Distribution and range: Wandagee Station, Bidgemia Station and northeast of Black Hill Well, **Carnarvon Basin** - Wandagee Formation; south of Narelli Rockhole, Shore Range, Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Relatively uncommon (about 12 specimens known).

Value in correlation and dating: Valuable in interbasinal correlation despite rarity.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty and sandy substrates.

Tomiopsis woodwardi Archbold & Thomas 1986
(Plate 43 figs 12-15)

?1910 *Spirifera (Martiniopsis) subradiata* Glauert: p.90
?1910 *Spirifera* sp. (or *Martiniopsis* sp.) Glauert: p.90
1958 Martiniopsid gen. et sp. nov. A Guppy et al.: p.45, 46
1986b *Tomiopsis woodwardi* Archbold & Thomas: p.589, Figs 3.12-3.28

Diagnosis: Small- to medium-sized species; interareas low; normally three broad, flattened plicae on lateral slopes; ventral adminicula long, thin, straight and close to parallel in mature shells.

Closest species: *T. notoplicatus* Archbold & Thomas which has stronger and more numerous lateral plicae.

Types: Holotype - CPC 24246; other figured specimens - CPC 24247-24252, MUGD F6048, F6049, GSWA F11200.

Type locality: Callytharra Springs, Carnarvon Basin.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs and Coondoo Outcamp, Bidgemia Station, **Carnarvon Basin** - Callytharra Formation; southwest of Paradise Homestead and southeast of Mount Tuckfield, Saint Georges Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Relatively common although sporadic in distribution.

Value in correlation and dating: Valuable for interbasinal correlation, and diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately deep to shallow water; silty, sandy and calcarenite substrates.

Genus **FREDERICKSIA** Paeckelmann 1931

Type species: *Spiriferina (Mentzelia) simensis* Chernyshev 1902; OD.

Fredericksia? sp. nov. A
(Plate 43 figs 38, 39)

1986b *Fredericksia?* n. sp. A Archbold & Thomas: p.601, Figs 8.9-8.21

Diagnosis: Shell small; delthyrium broad; sulcus poorly developed; lateral slopes with at least 4 low plicae on each flank; ventral adminicula thin, close together, nearly parallel.

Figured specimen: MUGD F6556.

Distribution and range: 6.5 km at 39° from Tallangatta Well, Bidgemia Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Extremely rare (only 1 specimen known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; calcarenite substrate.

Fredericksia? sp. nov. B
(Plate 43 figs 40-42)

1986b *Fredericksia?* n. sp. B Archbold & Thomas: p.602, Figs 8.22-8.24

Diagnosis: Shell small with small, pointed, high ventral umbo; sulcus poorly developed; lateral slopes of valve with delicate plicae; ventral adminicula thin, long.

Figured specimen: CPC 24285.

Distribution and range: 2 km east of Middle Well, Middalya, **Carnarvon Basin** - Bulgadoo Shale.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Extremely rare (only 1 specimen known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep water, silty substrate.

Order SPIRIFERINIDA Cooper & Grant 1976
Suborder SPIRIFERINIDINA Ivanova 1972
Superfamily SPIRIFERINACEA Davidson 1884

Family RETICULARIINIDAE Waterhouse 1975
Subfamily GJELISPINIFERINAE Ivanova 1975

Genus **GJELISPINIFERA** Ivanova 1975

Type species: *Gjelispinifera gerasimovi* Ivanova 1975; OD.

Gjelispinifera decipiens (Hosking 1933)
(Plate 44 figs 1-3)

1933b *Spiriferina cristata* (Schlotheim); Hosking: p.52-53, pl. 4 fig. 5
1933b *Spiriferina cristata* var. *decipiens* Hosking: p.53, pl. 4 figs 6, 7
1969 cf. *Altiplecus* sp. Thomas: p.227
1981 *Gjelispinifera* sp. nov. Thomas: p.65

Diagnosis: Medium-sized species, biconvex, moderately transverse maximum width at hinge line; commissure plicated, prominent fastigium; 2-3 plications on each flank; growth lamellae strong, irregularly spaced; growth lines fine; hollow spines on surface,

widely spaced usually inclined anteriorly, commonly arranged radially on crests and flanks of plications and floor of sinus; punctate.

Closest species: Type species *G. gerasimovi* Ivanova 1975 is larger, more transverse and has more plications. *G. "cristata"* (Hamlet 1928), from Basleo, Timor, is also larger and with one more plication.

Lectotype: GSWA 1/4971c1, herein selected.

Type locality: 0.75 km west of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Widespread in **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common, usually isolated valves.

Value in correlation and dating: Useful; common fossil known only in Callytharra Formation.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow neritic; calcilulite to calcarenite substrate.

Family PUNCTOSPIRIFERIDAE Waterhouse 1975

Genus **LAMNAESPINA** Waterhouse 1976

Types species: *Lamnaespina transennata* Waterhouse 1976; OD.

Lamnaespina papilionata (Hosking 1933)
(Plate 44 figs 4-8)

1933b *Spiriferina papilionata* Hosking: p.54, pl. 6 figs 1-2
1969 cf. *Liriplica* sp. Thomas: p.227
1981 *Lamnaespina papilionata* (Hosking); Thomas: p.65

Diagnosis: Medium to large species, biconvex, transverse, maximum width at hinge line; commissure plicated, fastigium and sinus distinct, 2-3 weak plications on each flank; growth lamellae prominent, irregularly spaced; micro-ornament of fine concentric growth lines crossed by fine radial lirae; punctate.

Closest species: Differs from type species *L. transennata* Waterhouse 1976b by being larger, having fewer plications and less dense punctae.

Lectotype: GSWA 1/4971(b)1, herein selected.

Type locality: Creek 0.75 km west of Callytharra Spring, Wooramel River, Carnarvon Basin.

Distribution and range: Widespread in **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common species; usually isolated valves.

Value in correlation and dating: Useful, known only in Carnarvon Basin; similar species in Nura Nura Member.

Climate: Found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Moderately shallow neritic; calcarenite to calcilutite substrate.

Family PARASPIRIFERINIDAE

Genus **CALLISPIRINA** Cooper & Muir Wood 1951

Type species: *Spiriferina ornata* Waagen 1883; OD.

Callispirina sp. nov.

1969 *Spiriferellina?* sp. Thomas: p.227
1981 *Callispirina* sp. nov. Thomas: p.65

Distribution and range: Carnarvon Basin - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Fairly common, usually isolated valves.

Suborder RETZIIDINA Boucot, Johnson & Staton 1966
Superfamily RETZIACEA Waagen 1883

Family RETZIIDAE Waagen 1883

Genus **HUSTEDIA** Hall & Clarke 1893

Type species: *Terebratula mormoni* Marcou 1858; OD.

Hustedia? basedowi (Etheridge Jnr 1918)
(Plate 44 figs 9-13)

1918 *Rhynchopora basedowi* Etheridge Jnr: p.256, pl. 40, figs 7-10
1926 *Rhynchopora basedowi* (Etheridge Jnr); Glauert: p.47
1951 *Hustedia basedowi* (Etheridge Jnr); Teichert: p.82
1958 *Hustedia basedowi* (Etheridge Jnr); Guppy et al.: p.48
1958 *Hustedia* sp. Guppy et al.: p.48
1969 *Hustedia basedowi* (Etheridge Jnr); Thomas: p.227

Diagnosis: Medium to large species for *Hustedia*; biconvex, transversely oval in outline, wider than long in maturity, prominent ventral umbo with terminal foramen; strongly plicate with up to 12 plications or costae on each valve, outer ones faint; strongly

uniplicate with 3 costae on fastigium and two weaker costae on sulcus, stronger plications marginal to sulcus and fastigium, fine concentric growth lines; internally with retziid spiralia; densely punctate.

Closest species: Distinctive; differs from *H. mormoni* Marcou 1858 by stonger and uneven plications and uniplication; may belong to new genus.

Types: Location of syntypic specimens to be confirmed, possibly in Australian Museum.

Type locality: Mount Marmion, northern Canning Basin.

Distribution and range: **Carnarvon Basin** - Wandagee Formation; northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Fairly rare.

Value in correlation and dating: Of some value in interbasinal correlation, but rare.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Moderately deep quiet neritic; silty to fine sandy substrate.

Hustedia sp. nov. cf. **H. grandicosta** (Davidson 1862)

cf. 1862 *Retzia radialis grandicosta* Davidson: p.28, pl. 1 fig. 5
1958 *Hustedia* cf. *grandicosta* (Waagen *sic*); Guppy et al.: p.54
1969 *Hustedia* sp. cf. *H. grandicosta* (Waagen *sic*); Thomas: p.227

Distribution and range: Mount Hardman, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Rare.

Hustedia sp. nov.

1969 *Hustedia* sp. nov. Thomas: p.227

Remarks: Very small species.

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Order ATHYRIDIDA Dagys 1974
Suborder ATHYRIDIDINA Boucot, Johnson & Staton 1964
Superfamily ATHYRIDACEA M'Coy 1844

Family ATHYRIDIDAE M'Coy 1844
Subfamily ATHYRIDINAE M'Coy 1844

Genus **CLEIOTHYRIDINA** Buckman 1906

Type species: *Cleiothyridina pectinifera* Sowerby 1840; SD, validated by the ICZN (1976).

General comment: *Cleiothyridina* and its allies are abundant genera in the Permian of Western Australia. Species have been described by Etheridge Jnr (1889, 1903) and Prendergast (1935). Up to six species may be present in the Western Australian Permian faunas as indicated by Thomas (1969, p.227-228). No species has been described in modern terms but we are in the process of assembling material for a review of the entire group. Modern studies of the group (e.g. Grunt, 1980) have to be assessed to ensure correct generic placing of the species. As a result it should be noted that the name *Cleiothyridina* is used here in a broad sense. We do not figure the species discussed and diagnoses are provisional, pending our review. The synonymies provided herein are the result of a rapid literature survey by one of us (N.W.A.).

Cleiothyridina baracoodensis (Etheridge Jnr 1903)

1890 *Athyris macleayana* Etheridge Jnr; Foord: p.149, pl. 7 fig. 3; text figs A, B, C
1903 *Cleiothyris macleayana* Etheridge Jnr: p.16, pl. 3 figs 10-20
1903 *Cleiothyris macleayana* var. *baracoodensis* Etheridge Jnr: p. 17, pl. 3 figs 5-9
1910 *Cleiothyris (Athyris)* spp. Glauert (*partim*): p.88
1931 *Cleiothyris macleayana* (Etheridge Jnr); Hosking: p.20
1969 *Cleiothyridina baracoodensis* Etheridge Jnr; Thomas: p.227
1976 *Cleiothyridina macleayana* (Etheridge Jnr); Playford et al.: p.95

Diagnosis: Medium-sized species, transverse at maturity; moderately inflated shell.

Types: Lectotype - GSWA F179A (Selected by Crespin, 1964, p.63); syntypes - GSWA F179B,C.

Type locality: Baragooda Pool, Arthur River, Carnarvon Basin.

Distribution and range: Widespread in Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; and in the **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A common species.

Value in correlation and dating: When described in modern terms the species will be valuable for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep to shallow water; silty, sandy and calcarenite substrates.

Cleiothyridina macleayana (Etheridge Jnr 1889)

1889 *Athyris macleayana* Etheridge Jnr: p.208, pl. 17 figs 1-5
1914 *Cleiothyris macleayana* Etheridge Jnr: p.23, pl. 1 fig. 7
1926 *Cleiothyris macleayana* (Etheridge Jnr); Glauert: p.47
1958 *Cleiothyridina macleayana* (Etheridge Jnr); Guppy et al.: p.48
1958 *Cleiothyridina* sp. nov. Guppy et al.: p.48
?1958 cf. *Composita* sp. nov. Guppy et al.: p.48
1969 *Cleiothyridina macleayana* (Etheridge Jnr); Thomas: p.227

Diagnosis: Shell circular or transversely oval in outline; plano-convex or slightly concavo-convex; weak sulcus with sulcal tongue; thick-shelled species strongly inflated.

Types: Lectotype, the specimen figured by Etheridge Jnr (1889, pl. 17 figs 1-4) herein selected. The specimen has not yet been located in either the Macleay Museum (University of Sydney) or the Australian Museum, Sydney.

Type locality: Mount Marmion, northern Canning Basin.

Distribution and range: Widely distributed in the **Carnarvon Basin** - Wandagee Formation, Baker Formation, Coolkilya Sandstone; type locality, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian) and Kungurian.

Abundance: Relatively common.

Value in correlation and dating: The species will probably prove of value for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Water of variable depths; silty and sandy substrates.

Cleiothyridina penta (Prendergast 1935)

1924 *Athyris* aff. *A. roysii* Chapman: p.36
1926 *Cleiothyris* cf. *roysii* Glauert: p.47
1926 *Cleiothyris* cf. *lamellosa* Glauert: p.47
1927 *Athyris* aff. *roysii* Blatchford: p.19
1927 *Athyris* aff. *lamellosa* Blatchford: p.19
1935 *Cleiothyris roysii* var. *penta* Prendergast: p.24, pl. 2 figs 13-15
1958 *Cleiothyridina penta* (Prendergast); Guppy et al.: p.54
1969 *Cleiothyridina* sp. nov. cf. *C. subexpansa* (Waagen); Thomas: p.221

Diagnosis: Moderately large shell, strongly transverse and sulcate with strongly uniplicate anterior commissure.

Holotype: UWA 3039.

Type locality: Luluigui Station, northern Canning Basin.

Distribution and range: Type locality and Mount Hardman, northern Canning Basin - Hardman Formation.

Age: Chhidruan.

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical to temperate conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Cleiothyridina sp. nov

1958 *Cleiothyridina* sp. nov. Guppy et al.: p.54
1969 *Cleiothyridina* sp. nov. *cf. C. gerardi* (Diener); Thomas: p.221

Diagnosis: Huge shells with flat ventral valve, rounded circular outline.

Closest species: *C. gerardi* (Diener 1899), a smaller species.

Distribution and range: Mount Hardman and elsewhere in the northern Canning Basin - Hardman Formation.

Age: Chhidruan.

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under subtropical conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Cleiothyridina spp.

1907a *Cleiothyris macleayana* Etheridge Jnr: p.21
1958 *Cleiothyridina* sp. Guppy et al.: p.52
1961 *Cleiothyridina* sp. Dickins *in* Veevers & Wells: p.284, 287
1967 *Cleiothyridina* sp. Condon: p.90, 114, 149
1967 *Cleiothyridina* sp. nov. Condon: p.70
1969 *Cleiothyridina* sp. nov. Thomas: p.227
1975 *Cleiothyridina* sp. Playford et al.: p.282
1976 *Phricodothyris* sp. Playford et al.: p.100

General comment: The above reports indicate the presence of *Cleiothyridina*. Most reports can be verified and will form part of our review of the group. Ages of the specimens vary from Late Sakmarian to Artinskian; the prevailing climate was possibly cool temperate.

Distribution and range: Woolaga Creek and Mingenew District, Irwin River area, **Perth Basin** - High Cliff Sandstone and Mingenew Formation; widespread in **Carnarvon Basin** - Jimba Jimba Calcarenite Member of the Billidee Formation, Callytharra Formation, Coyrie Formation.

Order TEREBRATULIDA Waagen 1883
Suborder TEREBRATULIDINA Waagen 1883
Superfamily TEREBRATULACEA Waagen 1883

Family DIELASMATIDAE Schuchert 1913
Subfamily DIELASMATINAE Schuchert 1913

Genus **FLETCHERITHYRIS** Campbell 1965

Type species: *Atrypa biundata* M'Coy 1847 (= *Terebratula amygdala* Dana 1847, *non Terebratula amygdala* Catullo 1846); OD.

Fletcherithyris hardmani Campbell 1965
(Plate 44 figs 14-18)

1957 *Dielasma* sp. Thomas: p.181
1958a *Dielasma* sp. Thomas: p.3
1958 *Dielasma* sp. aff. *D. elongata* Schlotheim; Guppy et al.: p.54
1965 *Fletcherithyris hardmani* Campbell: p.45, pl. 9 figs 22-32; pl. 16 figs 2-6, 8, 9
1969 *Fletcherithyris hardmani* Campbell; Thomas: p.221
1975 *Fletcherithyris hardmani* Campbell; Playford et al.: p.342

Diagnosis: Shell small, globose, shallow sulcus on anterior of ventral valve; dental lamellae short; septalium supported on high median septum; crural points high; loop short with posteriorly directed V-shaped transverse band.

Closest species: Specimens compared with this species (below) from Early Permian Western Australian formations.

Types: Holotype - CPC 5329; paratypes - CPC 5230-5234.

Type locality: Mount Hardman, northern Canning Basin.

Distribution and range: Type locality, northern **Canning Basin** - Hardman Formation. **Port Keats area** (NT) - "Upper Marine Beds", Port Keats Group

Age: Chhidruan.

Abundance: Common.

Value in correlation and dating: Of value in dating the Hardman fauna.

Climate: Species found in sedimentary rocks that were deposited under sub-tropical to tropical condtions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Fletcherithyris sp. cf. **F. hardmani** Campbell 1965
(Plate 45 figs 6-8)

1907b *Dielasma* sp. Etheridge Jnr: p.28, pl. 8 figs 7-9
1931 *Dielasma* sp. Hosking: p.21
?1958 "*Dielasma*" sp. nov. Guppy et al.: p.45
1965 *Fletcherithyris* cf. *hardmani* Campbell: p.47, pl. 16 figs 2-5
1967 *Fletcherithyris* cf. *hardmani* Condon: p.70

Diagnosis: Larger and more transverse shells than *F. hardmani* and shells with smaller pedicle foramen than that of *F. hardmani*.

Figured specimens: CPC 5353-5355.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs, **Carnarvon Basin** - Callytharra Formation; Saint Georges Ranges and Cherrabun Station, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) and late Artinskian (Baigendzhinian).

Abundance: Sporadic.

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Water of variable depth; variable substrates.

Fletcherithyris? sp.
(Plate 44 fig. 30)

1965 *?Fletcherithyris farleyenis* Campbell: p.130, pl. 9 fig. 48

Diagnosis: A report based on an incomplete single internal mould of a conjoined shell.

Figured specimen: CPC 5305.

Distribution and range: Carnarvon Basin - Coyrie Formation.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Extremely rare (only 1 specimen known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively deep water; silty substrate.

Genus **YOCHELSONIA** Stehli 1961

Type species: *Yochelsonia thomasi* Stehli 1961; OD.

Yochelsonia stehlii Campbell 1965
(Plate 44 figs 19-22)

1958 *Dielasma* sp. Guppy et al.: p.52
1965 *Yochelsonia stehlii* Campbell: p.51, pl. 10 figs 22-26

Diagnosis: Shell moderate in size; fold on ventral valve high, well rounded; sulcus on dorsal valve shallow with high tongue anteriorly; outer hinge plates narrow; inner hinge plates broad, forming a spondylium extending to mid-point of valve.

Closest species: *Y. thomasi* Stehli which is a smaller species.

Type: Holotype - CPC 5228; paratypes - CPC 5229-5240.

Type locality: 4.2 km bearing 70° from Shore Range Trig. Point, Canning Basin.

Distribution and range: Two localities east of the Shore Range Trig. Point, **Canning Basin** - Lightjack Formation.

Age: Middle Kungurian.

Abundance: Common at type locality.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Yochelsonia thomasi Stehli 1961
(Plate 44 figs 23-26)

1958 *Dielasma* sp. nov. Guppy et al.: p.48
1961 *Yochelsonia thomasi* Stehli: p.454, pl. 61 figs 17, 18, 23-25
1965 *Yochelsonia thomasi* Stehli; Campbell: p.49, pl.9 figs 5-21; text fig. 18

Diagnosis: Shell small; shape variable owing to range in amount of marginal inflexion; median fold on ventral valve high; outer hinge plates narrow; loop short with a V-shaped transverse band; crura points high.

Closest species: *Y. stehlii* Campbell, a larger species with a shallower dorsal sinus.

Types: Holotype - USNM 179056; other figured specimens - CPC 5219, 5223, 5224, 5227, UWA 28079.

Type locality: Mungadan Paddock, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Wandagee Formation, Coolkilya Sandstone; Christmas Creek Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian) possibly to Middle Kungurian.

Abundance: Relatively common.

Value in correlation and dating: Valuable for interbasinal correlation.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; silty and sandy substrates.

Genus **HOSKINGIA** Campbell 1965

Type species: *Dielasma trigonopsis* Hosking 1933; OD.

Hoskingia grandis Campbell 1965
(Plate 44 figs 27-29)

1954 cf. *Dielasma latouchei* Diener; Thomas & Dickins: p.221
1958 *Terebatuloid* gen. et sp. nov. aff. *Dielasma latouchei* Diener; Guppy et al.: p.54
1965 *Hoskingia grandis* Campbell: p.67, pl. 10 figs 16-21; pl. 11 figs 1-5
1969 *Hoskingia grandis* Campbell; Thomas: p.221

Diagnosis: Shell very large; greatest width forward of mid-length; broad ventral sulcus with narrow median fold; dorsal median fold; dorsal median sulcus narrow; inner hinge plates form sessile septalium almost to mid-point of valve, anterior edge of septalium deeply concave near crural bases, drawn out in front.

Closest species: *H. wandageensis* Campbell resembles young individuals of this species.

Types: Holotype - CPC 5265; paratypes - CPC 5266-5271.

Type locality: 7.8 km at 339° from Moffetts Bore, Nerrima Station, Canning Basin.

Distribution and range: Nerrima Station, Mount Hardman and Millyit Range, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under warm to subtropical temperate conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Hoskingia sp. cf. **H. grandis** Campbell 1965

?1958 Terebratuloid gen. et sp. nov. A & B, Guppy et al. (*partim*): p.48
1965 *Hoskingia* cf. *grandis* Campbell: p.69

Diagnosis: Large shells with a more markedly triangular outline and a position of maximum width farther forward than in *H. grandis*.

Distribution and range: Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Hoskingia kennediensis Campbell 1965
(Plate 45 figs 1-3)

1965 *Hoskingia kennediensis* Campbell: p.65, pl. 12 figs 1-3; text fig. 26

Diagnosis: Shell of moderate size, ovate outline, generally equally biconvex; broad, shallow ventral sulcus; foramen small; dental lamellae short; inner hinge plates form sessile septalium 0.25-0.30 length of dorsal valve; outer hinge plates well separated from inner socket ridges.

Closest species: A distinctive species.

Types: Holotype - UWA 17162a; paratypes - UWA 17162b-d, 17616.

Type locality: Minilya River area, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Bulgadoo Shale, Cundlego Formation.

Age: Late Artinskian (Baigendzhinian)

Abundance: Relatively uncommon.

Value in correlation and dating: Indicative of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Water of variable depth; silty and sandy substrates.

Hoskingia nobilis (Etheridge Jnr 1907)
(Plate 45 figs 4, 5, 9 - 11)

1907a *Dielasma nobilis* Etheridge Jnr: p.19, pl. 4 figs 2-4; pl. 6 figs 1, 2
1910 *Dielasma (Terebratula) nobilis* Etheridge Jnr; Glauert: p.89
1965 *Hoskingia nobilis* (Etheridge Jnr); Campbell: p.59, pl. 12 figs 8-13
1976 *Hoskingia nobilis* (Etheridge Jnr); Playford et al.: p.116

Diagnosis: Shell large; anterior commissure strongly sulciplicate; ventral valve evenly convex with evenly rounded fold; dental lamellae slender and widely spaced; outer hinge plates joined to shell wall; inner hinge plates form sessile septalium; crural points high, recurve posteriorly; descending lamellae V-shaped in transverse section; no transverse band.

Closest species: *H. grandis* Campbell is a more elongate species.

Types: Lectotype - GSWA F229A, chosen by Crespin (1964); other figured specimens - UWA 29908a,b, GSWA F229B.

Type locality: Mingenew, Irwin River district, Perth Basin.

Distribution and range: Eregulla Springs Station near Mingenew, **Perth Basin** - Mingenew Formation.

Age: Late Artinskian (early Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Relatively shallow water; sandy substrate.

Hoskingia trigonopsis (Hosking 1933)
(Plate 45 figs 12-16)

1931 *Dielasma cymbaeformis* Hosking: p.21, pl. 6 figs 1a-d
1933b *Dielasma trigonopsis* Hosking: p.44, pl. 3 figs 1a-e; pl. 4 figs 1a-b, 2
1965 *Hoskingia trigonopsis* (Hosking); Campbell: p.55, pl. 12 fig.14; pl. 13 figs 1-8; text figs 20-22
1967 *Hoskingia trigonopsis* (Hosking); Condon: p.149, 152

Diagnosis: Large trigonal shells; broad, deep ventral sulcus; large foramen; dorsal valve strongly domed in lateral profile; dental lamellae widely separated; septalium sessile; crural bases strong;

crura short; crural points high, descending lamellae comma-shaped in cross-section with no transverse band.

Closest species: A distinctive Western Australian species.

Types: Lectotype - GSWA 1/4950; other figured specimens - CPC 5245, 5247, 5258a, 5260, GSWA 1/4611.

Type locality: 3.1 km east of Survey Station R20, Wooramel River, Carnarvon Basin.

Distribution and range: Wooramel River area, **Carnarvon Basin** - Coyrie Formation and Mallens Sandstone.

Age: Early Artinskian (early Baigendzhinian).

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Probably deep to shallow water; silty and sandy substrates.

Hoskingia wandageensis Campbell 1965
(Plate 45 figs 17-20)

1965 *Hoskingia wandageensis* Campbell: p.61, pl. 10 figs 1-15; pl. 12 figs 5-7; text figs 23-25
1967 *Hoskingia wandageensis* Campbell; Condon: p.169
1975 *Hoskingia wandageensis* Campbell; Playford et al.: p.287

Diagnosis: Shell of moderate size; outline sub-triangular; profiles flattened, broad, shallow sulcus in ventral valve with weak median furrow; labrum short, foramen large; dental lamellae short; septalium sessile, very shallow.

Closest species: Young individuals of *H. grandis* Campbell.

Types: Holotype - UWA F27301a; paratypes - CPC 5189-5207, 5214, UWA 27557a-c.

Type locality: West side of syncline, south of Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River, Wandagee Station, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (late Baigendzhinian)

Abundance: Relatively common.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Relatively deep water; silty and fine sandy substrates.

Hoskingia sp. cf. **H. wandagoensis** Campbell 1965

1965 *Hoskingia* cf. *wandageensis* Campbell: p.65

Diagnosis: Similar in outline to *H. wandageensis* but flatter and slightly less plicate.

Distribution and range: Lat. 24°12'01"S, Long. 114°40'27"E and Lyndon River, **Carnarvon Basin** - Coyrie Formation, Wandagee Formation or Nalbia Sandstone, south of Grant Range, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (early and late Baigendzhinian).

Abundance: Rare.

Value in correlation and dating: Of little value.

Climate: Found in sedimentary rocks that were deposited under cool- to warm-temperate conditions.

Sedimentary environment: Variable water depth and substrates.

Family GILLEDIIDAE Campbell 1965
Subfamily GILLEDIINAE Campbell 1965

Genus **GILLEDIA** Stehli 1961

Type species: *Terebratula cymbaeformis* Morris 1845; OD.

Gilledia sp. cf. **G. homevalensis** Campbell 1965
(Plate 45 figs 22, 23, 26)

1965 *Gilledia* cf. *homevalensis* Campbell: p.79, pl. 9 figs. 33-41
1967 *Gilledia* cf. *homevalensis* Campbell; Condon: p.169

Diagnosis: Shells with larger hinge plates than normal for the species and lacking fine radial external ornament; some shells are more transverse than the species.

Figured specimens: CPC 5304-5307; UWA 33359/4.

Distribution and range: Eregulla Springs Station near Mingenew, **Perth Basin** - Mingenew Formation; Minilya River, Wandagee Station, west of Lyons River Homestead, northeast of Walbarune Peak, and southwest of Boolirdi Well, Jimba Jimba Station, **Carnarvon Basin** - Wandagee, Cundlego and Coyrie Formations; Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Sporadic.

Value in correlation and dating: Potentially of correlation value.

Climate: Species found in sedimentary rocks that were deposited under cool to warm-temperate conditions.

Sedimentary environment: Water of variable depths; silty and sandy substrates.

Gilledia woolagensis Campbell 1965
(Plate 45 figs 21, 24, 25)

1959 *Dielasma* sp. nov. A and sp. nov. B Dickins *in* Playford: p.19
1965 *Gilledia woolagensis* Campbell: p.82, pl. 9 figs 42-47
1976 *Gilledia woolagensis* Campbell; Playford et al.: p.100, 116

Diagnosis: Externally similar to *G. homevalensis*; interior of ventral umbo unthickened; outer hinge plates joined to socket plates only at posterior extremity; inner hinge plates close to and normally shorter than outer plates; socket plates slender and usually shorter than hinge plates.

Closest species: *G. homevalensis* Campbell which has a different hinge plate structure and external fine radial grooving.

Type: Holotype - UWA 31563a; paratypes - UWA 31563b-h and 31564a-j.

Type locality: Woolaga Creek, Mingenew District, Irwin River area, Perth Basin.

Distribution and range: Type locality, and near entrance to Eregulla Springs Station, **Perth Basin** - High Cliff Sandstone and Mingenew Formation.

Age: Artinskian (Aktastinian to early Baigendzhinian).

Abundance: Abundant at type locality.

Value in correlation and dating: Diagnostic of age.

Climate: Species found in sedimentary rocks that were deposited under cool-temperate conditions.

Sedimentary environment: Shallow water; sandy substrate.

Subfamily HEMIPTYCHININAE Campbell 1965

Genus **HEMIPTYCHINA** Waagen 1882

Type species: *Terebratula himalayensis* Davidson 1862; OD.

Hemiptychina? sp. Campbell 1965
(Plate 45 fig. 27)

1958 Terebratuloid gen. et sp. nov. A & B Guppy et al. (*partim*): p.48
1965 *Hemiptychina* sp. Campbell: p.104, pl. 16 fig. 1

Diagnosis: Dorsal valve gently convex with an inflected margin; surface smooth except for anterior third which carries about eight low, rounded folds; hinge plates join floor of valve independently - do not form septalium.

Figured specimen: CPC 5969.

Distribution and range: Brutens Old Yard area, Cherrabun Station, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (late Baigendzhinian).

Abundance: Rare (only 1 specimen known).

Value in correlation and dating: Of no value at present.

Climate: Species found in sedimentary rocks that were deposited under warm-temperate conditions.

Sedimentary environment: Relatively shallow water; fine sandy substrate.

Terebratuloid indet.

General comment: In addition to the above documented terebratulids, *?Dielasma* sp. has been reported by Condon (1967, p.102) from the "Congo Formation" of the Carnarvon Basin.

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Subclass PALAEOTAXODONTA Korobkov 1954
Order NUCULOIDA Dall 1889
Superfamily NUCULACEA Gray 1824

Family NUCULIDAE Gray 1824

Genus **NUCULOPSIS** Girty 1911

Type species: *Nucula ventricosa* Hall 1858; OD.

Nuculopsis bangarraensis Dickins 1963
(Plate 46 figs 1, 2)

1956 *Nucula* sp. A Dickins & Thomas: p.52
1963 *Nuculopsis (Nuculanella) bangarraensis* Dickins: p.31-32, pl. 1 figs 7-12
1976 *Nuculopsis (Nuculanella) bangarraensis* Dickins; Playford et al.: p.96
1979 *Nuculopsis (Nuculanella) bangarraensis* Dickins; Dickins & Shah: p.12

Diagnosis: "Outline triangular; umbones situated towards the back, almost upright except in early growth stages and only slightly inturned and pointing towards the back. Posterior part of shell projecting only slightly behind umbones" (Dickins, 1963, p.31).

Types: Holotype - UWA 45348; paratypes - UWA 45380, CPC 3862.

Type locality: Fossil Ridge on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone; Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, base of the Poole Sandstone. Badhaura, India.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 4+ specimens.

Value in correlation and dating: Important; the same or similar species occurs in the Arabian Peninsula and India.

Climate: Found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Nuculopsis darlingensis Dickins 1963
(Plate 46 figs 3, 4)

1956 *Nucula* sp. B Dickins & Thomas: p.52
1963 *Nuculopsis (Nuculopsis) darlingensis* Dickins: p.29-30, pl. 1 figs 1-6
1976 *Nuculopsis (Nuculopsis) darlingensis* Dickins; Playford et al.: p.96

Diagnosis: "Nuculoid shell, more or less triangular rather than oval but with the umbones inrolled and turned distinctly towards the back. Posterior teeth fewer in number and larger than anterior" (Dickins, 1963, p.29).

Types: Holotype - CPC 3859; paratypes - CPC 3860, 3861.

Type locality: 0.7 km at 334° from Carynginia Well, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone; southwestern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 15+ specimens.

Value in correlation and dating: Valuable.

Climate: Found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Associated with finer-grained sedimentary rocks.

Nuculopsis (Nuculopsis) sp. A

1967 *Nuculopsis (Nuculopsis)* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water not far from land.

Nuculopsis (Nuculopsis) sp. B

1967 *Nuculopsis (Nuculanella)* sp. Condon: p.97

Distribution and range: **Mount Sandiman Woolshed, Carnarvon Basin** - [illegible] **Formation.**

Age: [illegible]**ly Artinskian (Aktastinian).**

Sedimentary environment: **Moderately deep water.**

Nuculopsis (Nuculanella) sp.

1967 *Nuculopsis (Nuculanella)* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baighendzhinian).
Sedimentary environment: Moderately deep water not far from land.

Genus **QUADRATONUCULA** Dickins 1963

Type species: *Quadratonucula australiensis* Dickins 1963; OD.

Quadratonucula australiensis Dickins 1963
(Plate 46 fig. 14)

1963 *Quadratonucula australiensis* Dickins: p.33-34, pl. 1 figs 16-24; text fig. 7
1976 *Quadratonucula australiensis* Dickins; Playford et al.: p.96

Diagnosis: "Umbones about two-thirds of shell length from front, rather small and not markedly turned towards the back or inrolled. Length and height about equal. Anterior umbonal ridge distinct, marking off a flattish area of the front of the shell" (Dickins, 1963, p.33).

Types: Holotype - CPC 3863; paratypes - CPC 3864-3867.

Type locality: 0.7 km at 334° from Carynginia Well, Irwin River area, Perth Basin.

Distribution and range: Irwin river area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; ?southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone; ?northern **Canning Basin** - ?Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 20+ specimens.

Value in correlation and dating: Limited until distribution confirmed.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Superfamily NUCULANACEA H. Adams & A. Adams 1858

Family MALLETIIDAE Adams & Adams 1858

Genus PALAEONEILO Hall & Whitfield 1869

Type species: *Nuculites constricta* Conrad 1842; SD Hall 1885.

Palaeoneilo sp.

1967 *Anthraconeilo* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water not far from land.

Palaeoneilo sp. nov.
(Plate 46 figs 12, 13)

1963 *Anthraconeilo* sp. nov. Dickins: p.35-36, pl. 1 figs 25-29; text fig. 7
1976 *Anthraconeilo* sp. nov. Playford et al.: p.95

Figured specimens: UWA 45349, 45350.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 3+ specimens.

Value in correlation and dating: A rare species limited to Irwin River area.

Climate: Species found in sedimentar_ rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Family NUCULANIDAE Adams & Adams 1858

Genus **GLYPTOLEDA** Fletcher 1945

Type species: Glyptoleda reidi Fletcher; OD.

Glyptoleda coleyi Fletcher 1945
(Plate 46 figs 20, 24)

1945 *Glyptoleda coleyi* Fletcher: p.294, 301-302, pl. 19 figs 7-9

Diagnosis: Shell moderately elongated and inflated at the front; umbonal area upright; V-shaped ornament well developed.

Types: Holotype - UWA 42060 [original sample no. UWA J35(2)]; paratype - UWA 42061 [original sample no. UWA T168]; another figured specimen - UWA 36432.

Type locality: Barrabiddy Creek, 380 m upstream from the fence between Weir and Barrabiddy Paddocks, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Glyptoleda sp. cf. **G. glomerata** Fletcher 1945

1963 *Glyptoleda* cf. *glomerata* Dickins: Table 5
1967 *Glyptoleda* cf. *glomerata* Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow water.

Glyptoleda sp.
(Plate 46 fig. 7)

1956 *Glyptoleda* sp. Dickins: p.11-12, pl. 1 figs 3, 4

Figured specimens: CPC 740, 741.

Distribution and range: Merlinleigh Homestead area, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 2 specimens.

Glyptoleda sp. nov.

1967 *Glyptoleda* sp. nov. Condon: p.149

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Climate: Specimen found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus NUCULANA Link 1807

Type species: *Arca rostrata* Chemnitz 1774; OD.

"Nuculana" sp.

1967 *Nuculana* sp. Condon: p.97



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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S.K. Skwarko

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Bivalves

(continued)

Distribution and range: **Carnarvon Basin** - Billidee Formation.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Moderately deep water (100 m and shallower).

Genus **NUCUNDATA** Waterhouse 1965

Type species: *Nucundata undata* Waterhouse 1965; OD.

Nucundata undulostriata (Fletcher 1945)
(Plate 46 fig. 5)

1907c *Nuculana waterhousei* Etheridge Jnr (?) var.: p.6, pl. 5 figs 10, 11
1945 *Nuculana undulostriata* Fletcher: p.309-310

Holotype: L36(3) missing (repository unknown).

Type locality: Southern bank of Minilya River near Bulgadoo Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Bulgadoo Shale. Treachery Bay (NT).

Age: Late Artinskian (Baigendzhinian) in Western Australia.

Climate: Species found in sedimentary rocks that were found under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PHESTIA** Chernyshev 1951

Type species: *Leda inflatiformis* Chernyshev 1939; OD.

Phestia basedowi (Etheridge Jnr 1907)
(Plate 46 figs 16, 19)

1907c *Nuculana basedowi* Etheridge Jnr: p.8, pl. 6 fig. 6
1945 *Nuculana basedowi* Etheridge Jnr; Fletcher: p.294, 310-311, pl. 22 figs 6, 7
1958 *Nuculana basedowi* Etheridge Jnr; Guppy et al.: p.53
1967 *Phestia basedowi* (Etheridge Jnr); Condon: p.169
1975 *Phestia basedowi* (Etheridge Jnr); Playford et al.: p.287

Holotype: Missing (repository unknown).

Figured specimens: L.36(1), L.36(2).

Type locality: Fossil Head, Treachery Bay, NT.

Distribution and range: Minilya River area, **Carnarvon Basin** - Bulgadoo Shale; northern **Canning Basin** - Lightjack Formation, Treachery Bay, (NT).

Age: Kungurian (Irenian) in Western Australia. Kungurian elsewhere.

Abundance: 6+ specimens

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Phestia darwini (de Koninck 1877)
(Plate 46 figs 10, 15)

1877 *Tellinomya darwini* de Koninck: p.147, pl. 16 fig. 9
1945 *Nuculana darwini* (de Koninck); Fletcher: p.306, pl. 21 figs 1, 2; pl. 22 figs 1, 2
1957 *Nuculana darwini* (de Koninck); Dickins: p.18-21, pl. 2 figs 1-6 (*cum syn*)
1959 *Nuculana darwini* (de Koninck); Dickins & Thomas: p.69, 77
1963 *Phestia darwini* (de Koninck); Dickins: p.38-39, pl. 2 figs 4-11
1967 *Phestia darwini* (de Koninck); Condon: p.61
1979 *Phestia darwini* (de Koninck); Dickins & Shah: p.12

Diagnosis: Moderately elongate and anterior part moderately inflated; ornament of numerous fine closely spaced ribs.

Types: Holotype - destroyed; neotype - AM F41409 (designated by Fletcher, 1945, p.306); hypotypes - CPC 2201-2204, 3873-3875, 3877, UWA 45351.

Distribution and range: Byro Station area, **Carnarvon Basin** - Carrandibby Formation; Paradise Homestead area, and Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone; southwestern **Canning Basin** - Nura Nura Member of the Poole Sandstone. Upper Marine Series, NSW. Badhaura, India.

Age: Sakmarian (Tastubian, Sterlitamakian) in Western Australia.

Abundance: 30+ specimen.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Phestia lyonsensis (Dickins 1956)
(Plate 46 figs 8, 9)

1956 *Nuculana lyonsensis* Dickins: p.8-10, pl. 1 figs 7-9
1959 *Nuculana lyonsensis* Dickins; Dickins & Thomas: p.73, 77
1963 *Phestia lyonsensis* (Dickins); Dickins: p.37-38 pl. 2 figs 12-18
1976 *Phestia lyonsensis* (Dickins); Playford et al.: p.96

Diagnosis: "Elongated with posterior part much produced and anterior margin inflated and uniformly rounded; umbones not projecting

conspicuously; external ornament of numerous ribs, either concentric or forming a shallow "V" beneath the umbo" (Dickins, 1963, p.37).

Closest species: Appears close to *P. thompsoni* (Reed, 1932, p.43, pl.10 fig. 11) from Agglomeratic Shale of Kashmir.

Types: Holotype - CPC 734; paratypes - CPC 735, 736; hypotypes - CPC 3868-3870, 3872.

Type locality: Railway Cutting between Maitland and Stony Creek, NSW.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Moogooree Homestead area, **Carnarvon Basin** - Lyons Group; Paradise Homestead area and Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, and near the base of the Poole Sandstone; southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Asselian - Late Sakmarian (Sterlitamakian).

Abundance: 20+ specimens.

Value in correlation and dating: Valuable.

Climate: Species found in sedimentary rocks that were deposited under cold to temperate conditions.

Sedimentary environment: Shallow water.

Phestia thomasi (Dickins 1956)
(Plate 46 fig. 6)

1956 *Nuculana thomasi* Dickins: p.10, pl. 1 figs 1-2, 10
1967 *Phestia thomasi* (Dickins); Condon: p.173, 184
1979 *Phestia thomasi* (Dickins); Dickins & Shah: p.12

Diagnosis: "*N. thomasi* belongs to a group of Permian Nuculanids which are small, not greatly elongated, and possess fine concentric ribbing. The length of this species is less than twice the height, the umbones are upright, and the outer surface is moderately convex. The posterior part of the dorsal margin is not markedly concave" (Dickins, 1956, p.10).

Closest species: Possibly related to *P. ovata* (Laseron, 1910, p.219, pl. 15 figs 5-7) from the Maitland Group (Upper Marine Series).

Types: Holotype - CPC 737; paratypes - CPC 738, 739.

Type locality: 2.7 km southeast of Muderong Base, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station area, **Carnarvon Basin** - Nalbia Sandstone, Cookilya Sandstone.

Age: Early - Late Kungurian.

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water marine.

Subclass CRYPTODONTA Neumayr 1884
Order SOLEMYOIDA Dall 1889
Superfamily SOLEMYACEA Adams & Adams 1857

Family SOLEMYIDAE Adams & Adams 1857

Genus **SOLEMYA** Lamarck 1818

Type species: *Solemya mediterranea* Lamarck 1818; SD Children, 1823.

"Solemya" holmwoodensis Dickins 1963
(Plate 49 figs 13, 14)

1963 "*Solemya*" *holmwoodensis* Dickins: p.59-60, pl. 7 figs 1-9; pl. 8 figs 17-18
1976 "*Solemya*" *holmwoodensis* Dickins; Playford et al.: p.94

Diagnosis: "Transversely elongated, equivalved, and tubular. Umbo not prominent. Umbonal ridge of short side rounded and more distinct than the poorly developed ridge of the long side. External surface ornamented with concentric growth-lines and poorly developed rugae which are more distinct towards the rear. Character of external radial ornament not clear" (Dickins, 1963, p.59).

Types: Holotype - UWA 45384; paratype - UWA 45385-45387.

Type locality: Woolaga Creek, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale.

Age: Sakmarian (Tastubian, Sterlitamakian).

Abundance: 4 specimens.

Climate: Cold.

Sedimentary environment: Shallow to moderately deep water

Subclass PTERIOMORPHA Beurlen 1944
Order ARCOIDA Stoliczka 1871
Superfamily ARCACEA Lamarck 1809

Family PARALLELODONTIDAE Dall 1898
Subfamily PARALLELODONTINAE Dall 1898

Genus **PARALLELODON** Meek & Worthen 1866

Type species: *Macrodon rugosus* Buckmann 1845; OD.

Parallelodon bimodoliratus Dickins 1963
(Plate 46 fig. 17)

1963 *Parallelodon bimodoliratus* Dickins: p.40-41, pl. 3 figs 6-14
1967 *Parallelodon bimodoliratus* Dickins; Condon: p.71
1976 *Parallelodon bimodoliratus* Dickins; Playford et al.: p.96

Diagnosis: "Radial and concentric ornament distinctly developed in well preserved specimens. Shell divided into two parts by a distinct posterior carina. Ribs on posterior area more widely spaced and in most specimens more distinct than on rest of shell. Posterior area distinctly concave and ventral margin arcuate and not subparallel to dorsal margin as in *Parallelodon subtilistriatus*" (Dickins, 1963, p.40).

Types: Holotype - UWA 45352; paratypes - CPC 3878, UWA 45353-45357.

Type locality: Fossil Ridge on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Curbur Homestead area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 100+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water marine at least locally.

Parallelodon sp. cf. P. **bimodoliratus** Dickins 1963

1976 *Parallelodon* sp. cf. *P.bimodoliratus* Dickins; Playford et al.: p.100

Distribution and range: **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Parallelodon sp. A

1931 Genus *Parallelodon* de Koninck; Hosking: p.36

Distribution and range: Wooramel River area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen.

Value in correlation and dating: Insignificant at present.

Parallelodon sp. B

1967 *Parallelodon* sp. Condon: p.82

Distribution and range: **Carnarvon Basin** - Moogooloo Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow sea with stable bottom.

Parallelodon sp. indet.

1956 *Parallelodon* sp. indet. Dickins & Thomas: p.52

Distribution and range: Southwestern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Value in correlation and dating: None at present.

Sedimentary environment: Shallow water.

Parallelodon subtilistriatus Wanner 1922
(Plate 46 fig. 18)

1922 *Parallelodon subtilistriatus* Wanner: p.72, pl. 4 fig. 4
1940 *Parallelodon subtilistriatus* Wanner: p.388, pl. 1 fig. 9
1954 *Parallelodon subtilistriatus* Wanner; Thomas & Dickins: p.222
1956 *Parallelodon subtilistriatus* Wanner; Dickins: p.12-13, pl. 1 figs 5-6, 11
1958 *Parallelodon subtilistriatus* Wanner; Guppy et al.: p.53
1967 *Parallelodon subtilistriatus* Wanner; Condon: p.184

Closest species: Related to a number of species as outlined by Wanner (1922, p.73; 1940, p.381).

Hypotypes: CPC 742, 743.

Type locality: 0.8 km northwest of Muderong Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station, **Carnarvon Basin** - Coolkilya Sandstone; northern **Canning Basin** - Lightjack Formation. Amarassi Beds and Basleo Beds of Timor.

Age: Middle Kungurian (Irenian) in Western Australia. Chhidruan in Timor.

Abundance: Several hundred specimens.

Value in correlation and dating: Valuable age indicator.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Order MYTILOIDA Ferussac 1822
Superfamily MYTILACEA Rafinesque 1815

Family MYTILIDAE Rafinesque 1815
Subfamily LITHOPHAGINAE Adams & Adams 1857

Genus **LITHOPHAGA** Roding 1798

Type species: *Lithophaga mytuloides* Roding 1798; Monotypy.

Lithopaga? sp.

1963 *Lithopaga?* sp. Dickins: p.63, pl. 8 figs 1-4

Figured specimens: CPC 3902-3904.

Distribution and range: Saint George Ranges, northern **Canning Basin** - near base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Subfamily MODIOLINAE Keen 1958

Genus **MODIOLUS** Lamarck 1799

Type species: *Mytilus modiolus* Linne 1758; SD Gray, 1847.

Modiolus koneckii Dickins 1963
(Plate 46 fig. 11)

1963 *Modiolus koneckii* Dickins: p.61-62, pl. 8 figs 6-11; text fig. 9
1964 *Modiolus koneckii* Dickins; Dickins: p.44
1967 *Modiolus koneckii* Dickins; Condon: p.71
1976 *Modiolus koneckii* Dickins; Playford et al.: p.95

Diagnosis: "Shell not particularly oblique to the cardinal margin; anterior lobe well developed. Ventral margin distinctly concave; umbonal ridge marked, although rounded. External surface with radial ornament" (Dickins, 1963, p.61).

Types: Holotype - UWA 45388; paratypes - UWA 45389, 45390 CPC 3899-3901.

Type locality: Beckett Gully, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Curbur Homestead area, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges, northern **Canning Basin** - near base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5+ specimens.

Value in correlation and dating: Value somewhat diminished by small number of specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water marine.

"Modiolus" sp. A

1967 "*Modiolus*" sp. Condon: p.169, 173

Distribution and range: **Carnarvon Basin** - Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian - Early Kungurian.

Sedimentary environment: Shallow water.

"Modiolus" sp. B

1976 "*Modiolus*" sp. Playford et al.: p.117

Distribution and range: **Perth Basin** - Mingenew Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow water.

"Modiolus" sp. C

1976 *Modiolus* sp. Dickins *in* Towner et al.: p.101

Distribution and range: Scott Bluff area, southern **Canning Basin** - Triwhite Sandstone.

Age: Kungurian.

Modiolus? sp. indet.
(Plate 46 fig. 22)

1907a *Modiola?* sp. ind. Etheridge Jnr: p.23-24, pl. 5 fig. 4 (5 in plate caption); pl. 6 fig. 5

Distribution and range: Irwin River area, **Perth Basin** - range not known.

Age: Early Permian.

Value in correlation and dating: None.

Modiolus sp. nov.

1958 *Modiola* sp. nov. Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Order PTERIOIDA Newell 1965
Suborder PTERIINA Newell 1965
Superfamily AMBONYCHIACEA S.A. Miller 1877

Family AMBONYCHIIDAE S.A. Miller 1877

Genus **PSEUDOMYALINA** Dickins 1956

Type species: *Pseudomyalina obliqua* Dickins 1956; OD.

Pseudomyalina mingenewensis (Etheridge Jnr 1907)

1907a *Myalina? mingenewensis* Etheridge Jnr: p.24-25, pl. 5 fig 5 (4 in plate caption); pl. 6 figs 3, 4
1954 *Myalina? mingenewensis* Etheridge Jnr; Thomas & Dickins: p.219
1958 *?Myalina mingenewensis* Etheridge Jnr; Guppy et al.: p.47
1963 *Pseudomyalina mingenewensis* (Etheridge Jnr); Dickins: p.70
1967 *Pseudomyalina mingenewensis* (Etheridge Jnr); Condon: p.169
1975 *Pseudomyalina mingenewensis* (Etheridge Jnr); Playford et al.: p.287

Diagnosis: Shell subquadrate-oblique rather than oblique; umbones almost terminal; ornament of radiating ribs.

Types: Holotype - not selected; figured specimens not numbered.

Type locality: "Mingenew", Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Mingenew Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 7 specimens, mostly internal casts.

Value in correlation and dating: Valuable.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water marine.

Pseudomyalina obliqua Dickins 1956
(Plate 46 figs 25, 34)

1956 *Pseudomyalina obliqua* Dickins: p.26-28, pl. 3 figs 1-7; text fig. 2
1964 *Pseudomyalina obliqua* Dickins; Dickins: p.44
1967 *Pseudomyalina obliqua* Dickins; Condon: p.184

1975 *Pseudomyalina obliqua* Dickins; Playford et al.: p.288

Diagnosis: "...distinguished by the marked elongation of the shell oblique to the hinge line. Both valves are rather inflated, although the right valve is less convex and fits inside the left. No anterior auricle is present, although in some internal impressions there appears to be an auricle, which represents an infilling of matrix between the two valves" (Dickins, 1956, p.26).

Types: Holotype - CPC 756; paratypes - CPC 757-762.

Type locality: 1 km east of south of Muderong Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian (Irenian).

Abundance: 5+ specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water with abundant sand and mud.

Pseudomyalina sp. A
(Plate 46 fig. 28)

1963 *Pseudomyalina* sp. Dickins: p.69-70, pl. 10 figs 10-15.

Remarks: "....less convex and oblique than *Pseudomyalina obliqua* from considerably younger beds..." (Dickins, 1963, p.70).

Figured specimens: CPC 3915, 3916, UWA 45391.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, Mingenew Formation; Lyons River Homestead area, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: 6 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, marine.

Pseudomyalina sp. B

1967 *Pseudomyalina* sp. Condon: p.149

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water.

Superfamily PTERIACEA Gray 1847

Family PTERINEIDAE Miller 1877

Genus **LEPTODESMA** Hall 1883

Type species: *Leptodesma potens*; SD Miller 1889.

Subgenus **LEIOPTERIA** Hall 1883

Type species: *Leiopteria dekayi* Hall 1883; SD Fischer 1887.

Leiopteria? carrandibbiensis Dickins 1957
(Plate 46 figs 31, 32)

1957 *Leiopteria? carrandibbiensis* Dickins: p.30-32, pl. 4 figs 13-17; text fig. 4
1959 *Leiopteria? carrandibbiensis* Dickins; Dickins & Thomas: p.69
1967 *Leiopteria? carrandibbiensis* Dickins; Condon: p.61
1975 *Leiopteria? carrandibbiensis* Dickins; Playford et al.: p.280
1979 *Merismopteria carrandibbiensis* Dickins, Dickins & Shah: p.12

Diagnosis: "Shell oblique, pteroid in shape, apparently edentulous. Left valve slightly more convex than right. A small vertical ridge ("clavicle") present under the anterior end of the umbo. Hinge composed of an elongated ligament area with a number of fine longitudinal ligament grooves. External ornament of thin concentric lamellae" (Dickins, 1957, p.30-31).

Closest species: *L.? dutoiti* Harrington (1955, p.120, pl. 21 figs 5-11) and *L. bonaerensis* Harrington (1955, p.120, pl. 24 fig. 10) from the Permian Bonete Formation of Argentina.

Types: Holotype - CPC 2224; paratypes - CPC 2225-2227.

Type locality: 1.6 km west of Callytharra Springs Middalya Station, Carnarvon Basin.

Distribution and range: Callytharra Springs area and Wooramel River area, **Carnarvon Basin** - top part of Lyons Group and Carrandibby Formation. Badhaura, India.

Age: Late Asselian, Early Sakmarian (Tastubian).

Abundance: 20+ specimens.

Climate: Species found in sedimentary rocks that were deposited under cold water conditions.

Sedimentary environment: Quiet, moderately deep to shallow marine.

Family INOCERAMIDAE Griebel 1852

Genus **ATOMODESMA** von Beyrich 1864

Type species: *Atomodesma exarata* von Beyrich 1864; SD Wanner, 1922 p.63.

Atomodesma exarata Beyrich 1864
(Plate 46 figs 26, 30)

1864 *Atomodesma exarata* Beyrich: p.71, pl. 3 figs 4a-b
1892 *Atomodesma exarata* Beyrich; Rothpletz: p.85
1922 *Atomodesma exarata* Beyrich; Wanner: p.68, pl. 3 figs 8, 9a-b, 10
1940 *Atomodesma exarata* Beyrich; Wanner: p.377
1956 *Atomodesma exarata* Beyrich; Dickins: p.23-25, pl. 4 figs 2-5
1958 *Atomodesma exarata* Beyrich; Guppy et al.: p.53

Diagnosis: "This species is distinguished by the presence of a single groove on the anterior part of the shell, running from the lower margin towards the umbo. The external surface is ornamented with coarse grooves or rugae" (Dickins, 1956, p.23).

Types: Holotype - CPC 753; second figured hypotype destroyed in fire.

Hypotype locality: 1.2 km southeast of Southern Cross Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station; and Wandagee Station, **Carnarvon Basin** - Baker Formation and Coolkilya Sandstone; northern **Canning Basin** - lower Liveringa Group (Lightjack Formation). Timor.

Age: Middle Kungurian (Irenian) in Western Australia.

Abundance: Several hundred specimens.

Value in correlation and dating: Important in Australia-wide and international correlation.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow sea with abundant sand and mud.

Atomodesma (Atomodesma) mytiloides Beyrich 1864
(Plate 46 figs 21, 23)

1864 *Atomodesma mytiloides* Beyrich: p.72, pl. 3 fig. 3
1892 *Atomodesma mytiloides* Beyrich; Rothpletz: p.85
?1922 *Atomodesma* cf. *mytiloides* Beyrich; Wanner: p.64, pl. 153(3) fig. 1
1963 *Atomodesma (Atomodesma) mytiloides* Beyrich; Dickins: p.67-68, pl. 9 figs 1-7, 9
1967 *Atomodesma (Atomodesma) mytiloides* Beyrich; Condon: p.71, 131, 136, 169
1975 *Atomodesma (Atomodesma) mytiloides* Beyrich; Playford et al.: p.284, 287

1976 *Atomodesma (Atomodesma) mytiloides* Beyrich; Playford et al.: p.95
1976 *Atomodesma mytiloides* Beyrich; Dickins *in* Towner et al.: p.101-102

Diagnosis: Lacking radiating grooves more or less upright, umbonal area moderate in size.

Figured specimens: CPC 3905-3908.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Lyons River, Curbur, and Moogooree Homestead areas, **Carnarvon Basin** - Callytharra Formation, Byro Group, Coyrie and Wandagee Formations· Saint George Ranges, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, and near base of the Poole Sandstone, Noonkanbah Formation; Scott Bluff area and Triwhite Hills, southern **Canning Basin** - Triwhite Sandstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian), Early - Middle Kungurian.

Abundance: A common species.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Moderate deep water and shallow water marine.

Atomodesma (Atomodesma) mytiloides Beyrich 1864 var. nov.

1954 *Atomodesma* cf. *A. mytiloides* Beyrich; Thomas & Dickins: p.219
1958 *Atomodesma* cf. A. *mytiloides* Beyrich; Guppy et al.: p.47, 49
1963 *Atomodesma (Atomodesma) mytiloides* var. nov. Dickins: p.68
1967 *Atomodesma (Atomodesma) mytiloides* Beyrich; Condon: p.136, 173
1975 *Atomodesma (Atomodesma) mytiloides* Beyrich; Playford et al.: p.281
1976 *Atomodesma mytiloides* Beyrich; Dickins *in* Towner et al.: p.101

Closest species: It can be distinguished from other species by its large size.

Figured specimens: CPC 3912-3914.

Distribution and range: Minilya syncline on Wooramel River, **Carnarvon Basin** - Callytharra Formation, Mallens Sandstone, Wandagee Formation and Nalbia Sandstone; northern **Canning Basin** - Nura Nura Member, and the base of the Poole Sandstone, upper Noonkanbah Formation; Scott Bluff area, southern **Canning Basin** - Triwhite Sandstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian), Early - Middle Kungurian.

Abundance: Common, particularly in the Wandagee Formation.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Atomodesma (Atomodesma) sp. cf. **A.(A.) semiplicata** Reed 1944

1958 *Atomodesma* cf. *semiplicata* Reed; Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Atomodesma (Atomodesma) sp. cf. **A.(A.) timorense** (Wanner 1922)
(Plate 46 fig. 29)

1963 *Atomodesma (Atomodesma)* cf. *timorense* (Wanner); Dickins: p.69, pl. 9 fig 8, 10-12
1967 *Atomodesma (Atomodesma)* cf. *timorense* (Wanner); Condon: p.71

Remarks: Like *A.(A.) mytiloides* but with valves more convex and umbones more tumid and standing above the hinge line.

Figured specimens: CPC 3909-3911.

Distribution and range: Lyons River Homestead area, **Carnarvon Basin** - Callytharra Formation; Mount Wynne area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Family EURYDESMIDAE Reed 1932

Genus **EURYDESMA** Morris 1845

Type species: *Eurydesma cordatum* Morris 1845; OD.

Eurydesma playfordi Dickins 1957
(Plate 46 figs 27, 33)

1957 *Eurydesma playfordi* Dickins: p.33-36, pl. 5 figs 1-11; pl. 10 figs 1, 2, 5; text figs 5, 6
1959 *Eurydesma playfordi* Dickins; Dickins & Thomas: p.69-71, 78
1962 *Eurydesma playfordi* Dickins; Sahni & Duttin: p.661, pl. 26 figs 2, 6, 6a
1967 *Eurydesma playfordi* Dickins; Condon: p. 61
1975 *Eurydesma playfordi* Dickins; Playford et al.: p.280
1979 *Eurydesma playfordi* Dickins; Dickins and Shah: p.4, 24

Diagnosis: "Medium-sized *Eurydesma* with beak placed anteriorly and only moderately flexed towards the front: anterior margin not markedly concave. Right dental process well developed" (Dickins, 1957, p.33).

Closest species: *Eurydesma mytiloides* (Reed, 1932, p.50, pl. 11 figs 1-36) from the Agglomeratic Slate of Kashmir and *Eurydesma hobartense* (Johnston, 1888, pl. 16 fig. 2) from eastern Australia.

Types: Holotype - CPC 2228; paratypes - CPC 2229-2237.

Type locality: 1.6 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: West of Callytharra Springs, Byro and Bidgemia Stations, **Carnarvon Basin** - Carrandibby Formation. India - Manendragath fauna; Kashmir.

Age: Early Sakmarian (Tastubian).

Abundance: 10+ specimens.

Value in correlation and dating: Useful for continental and international correlation.

Climate: Species found in sedimentary rocks that were laid down under cold water conditions.

Sedimentary environment: Shallow water.

Eurydesma sp.

1975 *Eurydesma* Playford et al.: p.279

Distribution and range: **Carnarvon Basin** - Lyons Group.

Age: Asselian - Early Sakmarian (Tastubian).

Sedimentary environment: Shallow water.

Eurydesma sp. indet.

1959 *Eurydesma* sp. ind. Dickins & Thomas: p.72

Distribution and range: Lyndon River area, **Carnarvon Basin** - upper Lyons Group.

Age: Early Sakmarian (Tastubian).

Value in correlation and dating: Nil.

Eurydesma? sp. indet.

1976 *Eurydesma?* sp. ind. Dickins *in* Crowe & Towner: p.9

Distribution and range: 18°39'36"S, 124°58'36"E, northern **Canning Basin** - Wye Worry Member of the Carolyn Formation.

Age: Early Sakmarian (Tastubian).

Superfamily PECTINACEA Rafinesque 1815

Family AVICULOPECTINIDAE Meek & Hayden 1864
Subfamily AVICULOPECTININAE Meek & Hayden 1864

Genus **ACANTHOPECTEN** Girty 1903

Type species: *Pecten carboniferus* Stevens 1858.

Acanthopecten? sp.
(Plate 47 figs 10, 11, 19)

1963 *Acanthopecten?* sp. Dickins: p.86-87, pl. 13 figs 5-9
1967 *Acanthopecten?* sp. Condon: p.71
1976 *Acanthopecten?* sp. Playford et al.: p.95

Figured specimens: CPC 3926, 3927, UWA 45399, 45400.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Curbur Homestead area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 4 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, marine, at least locally.

Genus **ETHERIPECTEN** Waterhouse 1963

Type species: *Etheripecten striatura* Waterhouse 1963; OD.

Etheripecten sp. A

1907b *Aviculopecten* sp. Etheridge Jnr: p.33, pl. 10 fig. 3

Figured specimen: Unnumbered in publication.

Distribution and range: Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 imperfect internal cast.

Value in correlation and dating: Insignificant.

Etheripecten sp. B

1967 *Aviculopecten* sp. Condon: p.97

Distribution and range: **Carnarvon Basin** - Billidee Formation.

Age: Early Artinskian (Aktastinian).

Value in correlation and dating: Moderately deep water (100 m).

Etheripecten sp. C

1967 *Aviculopecten* sp. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow water.

Etheripecten sp. D

1976 *Etheripecten* sp. Dickins *in* Towner et al.: p.101

Distribution and range: Scott Bluff area, southern **Canning Basin** - Triwhite Sandstone.

Age: Late Artinskian (Baigendzhinian) to Kungurian.

Etheripecten? sp.
(Plate 47 fig. 1)

1963 *Aviculopecten?* sp. Dickins: p.84, pl. 13 figs 10-11

Figured specimen: CPC 3924.

Distribution and range: Saint George Ranges, northern **Canning Basin** - base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A single left valve.

Value in correlation and dating: Nil.

Etheripecten spp.

1958 *Aviculopecten* sp. Guppy et al.: p.49

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water.

1967 *Aviculopecten* spp. Condon: p.131
1975 *Aviculopecten* spp. Playford et al.: p.284

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water not far from land.

Etheripecten? sp. indet. A

1956 *Aviculopecten?* sp. indet. Dickins & Thomas: p.53

Distribution and range: Southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Nil.

Etheripecten sp. indet. B

1959 *Aviculopecten* sp. indet. Dickins & Thomas: p.72

Distribution and range: **Carnarvon Basin** - upper Lyons Group.

Age: Early Sakmarian (Tastubian).

Value in correlation and dating: Nil.

Etheripecten sp. nov.

1967 *Aviculopecten* sp. nov. Condon: p.136, 139

Distribution and range: **Carnarvon Basin** - Mallens Sandstone, Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Value in correlation and dating: Nil.

Sedimentary environment: Shallow water, marine.

Etheripecten sp. cf. E. subquinquelineatus Etheridge Jnr 1907

1954 *Aviculopecten* cf. *A. subquinquelineatus* Etheridge Jnr; Thomas & Dickins: p.219
1958 *Aviculopecten* cf. *A. subquinquelineatus* Etheridge Jnr; Guppy et al.: p.47
1967 *Aviculopecten* cf. *subquinquelineatus* M'Coy; Condon: p.149
1976 *Aviculopecten* sp. cf. *A. subquinquelineatus* (M'Coy); Playford et al.: p.236

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, Mingenew Formation; **Carnarvon Basin** - Callytharra Formation, Coyrie Formation; northern **Canning Basin** - Nura Nura Member, and the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Abundance: Numerous specimens.

Value in correlation and dating: See *E. tenuicollis*.

Climate: Found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Etheripecten tenuicollis (Dana 1847)
(Plate 47 figs 2, 4, 8, 9)

1847 *Pecten tenuicollis* Dana: p.160
1849 *Pecten tenuicollis* Dana: p.705, pl. 9 figs 7, 7a
1878 *Aviculopecten tenuicollis* (Dana); Etheridge Jnr: p.6
1887 *Aviculopecten sprenti* Johnston: p.9
?1888 *Aviculopecten tenuicollis* (Dana); Etheridge Jnr: p.203-204
1888 *Aviculopecten sprenti* Johnston: p.127, pl. 14 fig. 11 (fig. 8 in error)
1890 *Aviculopecten tenuicollis* Dana; Foord: p.7-8, pl. 5 fig. 9
1903 *Aviculopecten tenuicollis* Dana sp.; Etheridge Jnr: p.23-24, pl. 3 figs 3, 4
1906 *Aviculopecten tenuicollis* (Dana); Etheridge Jnr & Dun: p.13, pl. 13 figs 10-12; pl. 14 fig. 5
1906 *Aviculopecten sprenti* Johnston; Etheridge Jnr & Dun: p.15, pl. 2 figs 6, 7; pl. 13 figs 1, 9; pl. 16 figs 5, 6
1907b *Aviculopecten sprenti* Johnston; Etheridge Jnr: p.32-33, pl. 7 figs 5, 6
1957 *Aviculopecten tenuicollis* (Dana); Dickins: p.45-46, pl. 6 figs 7-9
1959 *Aviculopecten tenuicollis* (Dana); Dickins & Thomas: p.70, 73, 78
1963 *Aviculopecten tenuicollis* (Dana); Dickins: p.82-84, pl. 11 fig. 5; pl. 13 figs 12-17; pl. 14 fig. 1
1967 *Aviculopecten sprenti* (Dana); Condon: p.61, 71
1975 *Aviculopecten sprenti* (Dana); Playford et al.: p.281
1976 *Aviculopecten sprenti* (Dana); Playford et al.: p.95
1979 *Aviculopecten tenuicollis* (Dana); Dickins & Shah: p.12

Closest species: *Etheripecten subquinquelineatus* (M'Coy) (1847, p.298, pl. 17 fig. 1) from the Early Permian Allandale Formation of the Sydney Basin. *E. subquinquelineatus* may be a synonym of *E. tenuicollis*; the types of both are from Harpers Hill, NSW.

Hypotypes: CPC 2253, 2254, 3922, 3923, UWA 45393-45396.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, High Cliff Sandstone; Wooramel and Minilya River areas, **Carnarvon Basin** - Lyons Group, Carrandibby and Callytharra Formations; Liveringa Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone. Originally described from Dalwood Group, NSW. Badhaura, India.

Age: Asselian - Sakmarian (Tastubian, Sterlitamakian).

Abundance: Numerous specimens.

Value in correlation and dating: Useful in continental and international correlation.

Climate: Species found in sedimentary rocks that were deposited under cold to temperate conditions.

Sedimentary environment: Shallow water, marine, at least in places.

Etheripecten sp. cf. **E. tenuicollis** (Dana 1847)

1976 *Aviculopecten* sp. cf. *A. tenuicollis* (Dana); Playford et al.: p.100
1976 *Etheripecten* cf. *tenuicollis* (Dana); Dickins *in* Towner et al.: p.99
1976 *Etheripecten* cf. *tenuicollis* (Dana); Dickins *in* Crowe & Towner: p.9

Distribution and range: **Perth Basin** - High Cliff Sandstone; Scott Bluff, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone; 18°39'36"S, 124°58'36"E, northern **Canning Basin** - Wye Worry Member of the Carolyn Formation.

Age: Sakmarian.

Sedimentary environment: Shallow water.

Remarks: The references are not necessarily to the same species.

Genus **GIRTYPECTEN** Newell 1939

Type species: *Aviculopecten sublaqueatus* Girty 1908; OD.

Girtypecten ovalis Dickins 1963
(Plate 17 figs 6, 7)

1963 *Girtypecten ovalis* Dickins: p.85-86, pl. 13 figs 1-4
1967 *Girtypecten ovalis* Dickins; Condon: p.71
1967 *Girtypecten ovalis* Dickins; Playford et al.: p.95

Diagnosis: "Shell prosocline with well developed ears. Umbonal folds poorly developed and in left valve cardinal margin almost as long as shell. External surface ornamented with a relatively large number of radiating ribs and concentric ridges. A number of fine concentric filae between each prominent ridge" (Dickins, 1963, p.85).

Types: Holotype - UWA 45397; paratypes - CPC 3925, UWA 45398.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Curbur Homestead area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Not numerous, but widespread in both formations.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, marine, at least locally.

Girtypecten? sp.

1967 *Girtypecten?* sp. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water.

Genus **HETEROPECTEN** Kegel & da Costa 1951

Type species: *Aviculopecten (Deltopecten) catherinae* Cowper Reed 1930; OD.

Heteropecten comptus (Dana 1847)
(Plate 47 figs 18, 20)

1931 *Deltopecten subquinquelineatus* M'Coy var. *comptus* Dana; Hosking: p.32-36, pls 12, 13; text figs

Remarks: These specimens appear to represent an unnamed species belonging to the genus *Heteropecten* Kegel & da Costa 1951.

Figured specimens: GSWA 1/4643, 1/4948, UWA 8476, 8482.

Distribution and range: Mingenew, **Perth Basin** - Mingenew Formation; Wooramel River area, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 20 specimens.

Value in correlation and dating: Important for Australian and international correlation.

Subfamily STREBLOCHONDRIINAE Newell 1938

Genus **STREBLOCHONDRIA** Newell 1938

Type species: *Aviculopecten sculptilis* Miller 1891.

Streblochondria sp.

1967 *Streblochondria* sp. Condon: p.149

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water.

Streblochondria sp. nov

1956 *Streblochondria* sp. nov. Dickins & Thomas: p.53

Distribution and range: Cuncudgerie Hill area, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone, and the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Sedimentary environment: Shallow water, marine.

Genus **STREBLOPTERIA** M'Coy 1851

Type species: *Meleagrina laevigata* M'Coy 1844; SD Meek & Worthen, 1886.

Streblopteria sp.
(Plate 47 fig 3)

1963 *Streblopteria* sp. Dickins: p.88, pl. 14 figs 9-12
1967 *Streblopteria* sp. Condon: p.71, 184
1976 *Streblopteria* sp. Dickins *in* Crowe & Towner: p.9

Figured specimens: CPC 3932, 3933, UWA 45401, 45402.

Distribution and range: Woolaga Creek and Fossil Ridge, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, High Cliff Sandstone; Mount Sandiman area, **Carnarvon Basin** - Callytharra Formation, Wandagee Formation, Coolkilya Sandstone; 18°39'36"S, 124°58'36"E, and Saint George Ranges, northern **Canning Basin** - near the base of the Poole Sandstone, Wye Worry Member of the Carolyn Formation.

Age: Early Sakmarian (Tastubian), Late Artinskian (Baigendzhinian).

Abundance: 4 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Streblopteria? sp.

1963 *Streblopteria?* sp. Dickins: p.88-89, pl. 14 fig. 17

Figured specimen: UWA 45403.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Single incomplete specimen.

Value in correlation and dating: Nil.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Streblopteria? sp. nov. A

1958 *Streblopteria?* sp. nov. Guppy et al.: p.49

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep.

Streblopteria? sp. nov. B

1967 *Streblopteria?* sp. nov. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep.

Subfamily EUCHONDRIINAE Newell 1938

Genus **EUCHONDRIA** Meek 1874

Type species: *Pecten neglectus* Geinitz; Monotypy.

Euchondria callytharraensis Dickins 1963
(Plate 47 figs 5, 16)

1963 *Euchondria callytharraensis* Dickins: p.89-91, pl. 14 figs 2-8
1967 *Euchondria callytharraensis* Dickins; Condon: p.71

Diagnosis: "Slightly prosocline to acline; external ornament in left valve of numerous radiating ribs or costae and fine closely spaced concentric lines or filae; in right valves radiating ornament confined to auricles. Hinge length considerably less than length of valves and auricular sinuses and subauricular notch in right valves of moderate depth" (Dickins, 1963, p.89).

Closest species: *Euchondria weiensis* Wanner (1940, p.378, pl. 1 fig. 2) from the Permian of Tae Wei, Timor.

Types: Holotype - CPC 3928; paratypes - CPC 3929-3931.

Type locality: 9 km at 335° from Lyons River Homestead, Carnarvon Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Lyons River Homestead area, **Carnarvon Basin** - Callytharra Formation; northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 20+ specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water marine, at least locally.

Family DELTOPECTINIDAE Dickins 1957

Genus **DELTOPECTEN** Etheridge Jnr 1892

Type species: *Pecten illawarensis* Morris 1845; OD.

Deltopecten lyonsensis Dickins 1957
(Plate 47 fig. 14)

1957 *Deltopecten lyonsensis* Dickins: p.41-44, pl. 7 figs 1-5, 9; pl. 8 figs 11-13; pl. 9 fig. 12; pl. 10 figs 3-4; text fig. 9
1959 *Deltopecten lyonsensis* Dickins; Dickins & Thomas: p.70-72, 78
1967 *Deltopecten lyonsensis* Dickins; Condon: p.61
1975 *Deltopecten lyonsensis* Dickins; Playford et al.: p.279
1976 *Deltopecten lyonsensis* Dickins; Dickins *in* Crowe & Towner: p.9
1979 *Deltopecten lyonsensis* Dickins; Dickins & Shah: p.4, 9, 12, 24

Diagnosis: "Biconvex with right valve less convex than the left; very similar to *D. illawarensis* and *D. mitchelli* but distinguished by the more slender character of the ligament area. Also differs from *D. illawarensis* in having a lesser number of ribs and lacking the posterior fold of the specimen figured by Etheridge Jnr & Dun (1906, pl. 2 fig. 2). The fold is not clearly shown in the figure" (Dickins, 1957, p.42).

Types: Holotype - CPC 2244; paratypes - CPC 2245-2252.

Type locality: 1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin.

Distribution and range: Winning and Bidgemia Stations, and Minilya - Williambury area, **Carnarvon Basin** - upper part of the Lyons Group, Carrandibby Formation; 18°39'36"S, 124°58'36"E, northern **Canning Basin** - Wye Worry Member of the Carolyn Formation. Umaria, Badhaurna, Manendragath, India; Kashmir.

Age: Asselian - Early Sakmarian (Tastubian).

Abundance: 6 specimens.

Value in correlation and dating: The same species occurs in India and apparently also in Argentina.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Shallow water.

Deltopecten sp.

1963 *Deltopecten* sp. Dickins: p.81, pl. 12 fig. 4

Figured specimen: UWA 45392.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: A single specimen.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

"Deltopecten" sp. nov.

1967 *Deltopecten* sp. nov. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep marine.

Deltopecten waterfordi Dickins 1963
(Plate 47 figs 15, 21)

?1883 *Aviculopecten illawarensis* Hudleston: p.588
1933 *Deltopecten illawarensis* (Morris); Hosking: p.55-56, pl. 6 fig 4
1963 *Deltopecten waterfordi* Dickins: p.79-81, pl. 12 figs 5-11
1967 *Deltopecten waterfordi* Dickins; Condon: p.71

Diagnosis: "Shell sometimes large, primary ribs coarse - smaller secondary ribs may be intercalated between primaries; primary ribs flattened on top, with a tendency to divide in two. Ligament area robust and bow-shaped, with shallow longitudinal grooves parallel to the base of the ligament area; no distinctly marked-off chondrophore, but a broad shallow depression under the umbo" (Dickins, 1963, p.79).

Closest species: *Deltopecten illawarensis* (Morris 1845) from the Early Permian Allandale Formation of the Sydney Basin.

Types: Holotype - CPC 3918; paratypes - CPC 3919-3921.

Type locality: 19.2 km south of Lyons River Homestead, Carnarvon Basin.

Distribution and range: Doubtful in the **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale; Gascoyne River area and Moogooree Homestead, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Abundant in the Callytharra Formation.

Value in correlation and dating: Significant in Australian and international correlations.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water, marine, at least in places.

Family PSEUDOMONOTIDAE Newell 1938

Genus **PSEUDOMONOTIS** von Beyrich 1862

Type species: *Gryphytes speluncarius* von Schlotheim 1820.

Pseudomonotis sp.

1967 *Pseudomonotis* sp. Condon: p.136, 149
1975 *Pseudomonotis* sp. Playford et al.: p.284

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water, marine.

Subgenus **TREMATICONCHA** Newell & Boyd 1970

Type species: *Pseudomonotis (Trematiconcha) wandageensis* Newell & Boyd 1970; OD.

Pseudomonotis (Trematiconcha) wandageensis Newell & Boyd 1970
(Plate 47A figs 1, 2)

1970 *Pseudomonotis (Trematiconcha) wandageensis* Newell & Boyd: p.246-249, Figs 2F-H, 14A-C

Diagnosis: "Large, thick-shelled, more or less equilateral, with protruding left umbo, conspicuous exhalent lobe, and small, rounded-quadrate posterior auricle; left valve externally deeply convex, with relatively smooth unbo and 20 to 30 coarse, squamose costae over mature three-quarters of shell; right valve more rugose, irrugularly concave, marked over juvenile shell by three or more ranks of fine costellae; markedly prosogyre in early growth, with procrescent acceleration of anterior margin followed at maturity by more ventral, infracrescent, or slightly backward, retrocrescent, growth; resilifers approximately bilaterally symmetrical." (Newell and Boyd, 1970, p.249).

Types: Holotype - UWA 27123; paratypes - UWA 27409, 27453.

Type locality: Northeast side of syncline, north bank of Minilya River west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Minilya River, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common in Wandagee Formation.

Value in correlation and dating: Limited because of paucity of specimens.

Superfamily LIMACEA Rafinesque 1815

Family LIMIDAE Rafinesque 1815

Genus **ELIMATA** Dickins 1963

Type species: *Elimata guppyi* Dickins 1963; OD.

Elimata guppyi Dickins 1963
(Plate 47 fig. 17)

1963 *Elimata guppyi* Dickins: p.94, pl. 15 figs 6-13

Diagnosis: "Rather convex, ornamented externally by concentric growth-lines. Radial ornament absent or possibly very fine" (Dickins, 1963, p.94).

Types: Holotype - CPC 3939; paratypes - CPC 3940-3943.

Type locality: 25.6 km at 120° from Mount Tuckfield, southern Saint George Ranges, northern Canning Basin.

Distribution and range: Saint George Ranges, northern **Canning Basin** - near the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Abundant at one locality.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PALAEOLIMA** Hind 1903

Type species: *Pecten simplex* Phillips 1836.

Palaeolima sp. nov.
(Plate 47 fig. 13)

1963 *Palaeolima* sp. nov. Dickins: p.92, pl. 14 figs 13-16
1976 *Palaeolima* sp. nov. Playford et al.: p.96

Figured specimens: CPC 3934, UWA 45404.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PLAGIOSTOMA** J Sowerby 1814

Type species: *Plagiostoma giganteum* J Sowerby 1814; SD Stoliczka 1871.

Plagiostoma? sp. nov.
(Plate 47 fig. 12)

1962 *Plagiostoma?* sp. nov. Dickins: p.93, pl. 15 figs 1-5
1967 *Plagiostoma?* sp. nov. Condon: p.71
1976 *Plagiostoma?* sp. nov. Playford et al.: p.96

Figured specimens: CPC 3935-3938.

Distribution and range: Fossil Ridge on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Lyons River Homestead and Callytharra Springs areas, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 6 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow-water, at least locally.

Order TRIGONIOIDA Dall 1889
Superfamily TRIGONIACEA Lamarck 1819

Family MYOPHORIIDAE Bronn 1849

Genus **SCHIZODUS** de Verneuil & Murchison 1844

Type species: *Axinus obscurus* J. Sowerby 1821.

Schizodus crespinae Dickins 1957
(Plate 48 figs 1, 2)

1957 *Schizodus crespinae* Dickins: p.38-39, pl. 6 figs 1-6
1959 *Schizodus crespinae* Dickins; Dickins & Thomas: p.72
1975 *Schizodus crespinae* Dickins; Playford et al.: p.279

Diagnosis: "Shell small, compared with other Australian Permian species. Valves inflated and external surface gently rounded; a rounded carina divides the shell into two parts. Nearly as high as long" (Dickins, 1963, p.38).

Types: Holotype - CPC 2241; paratypes - CPC 2242, 2243.

Type locality: 4.8 km northeast of Round Hill Well, 1.6 km west of Kialawibri Creek road crossing, Winning Station, Carnarvon Basin.

Distribution and range: Winning Station and Lyndon River area, **Carnarvon Basin** - upper part of the Lyons Group.

Age: Early Sakmarian (Tastubian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Shallow water.

Schizodus fitzroyensis Dickins 1963
(Plate 48 fig. 6)

1963 *Schizodus fitzroyensis* Dickins: p.100-101, pl. 17 figs 10-19; text fig. 12A.

Diagnosis: "Shell triangular with a distinct carina extending from umbo to posterior angle; cardinal teeth small with posterior cardinal tooth rather elongated. A small buttress extends downward from front part of hinge-plate" (Dickins, 1963, p.100).

Types: Holotype - CPC 3945; paratypes - CPC 3946-3950.

Type locality: 25.6 km at 120° from Mount Tuckfield, southern Saint George Ranges, northern Canning Basin.

Distribution and range: Saint George Ranges and Paradise Homestead area, northern **Canning Basin** - Nura Nura Member, and near the base, of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common at the Saint George Ranges locality.

Value in correlation and dating: The same or similar species occur in India, the Arabian Peninsula, Tibet, and western Argentina.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Schizodus sp. cf. **S. fitzroyensis** Dickins 1963

1976 *Schizodus* sp. cf. *S. fitzroyensis* Dickins; Playford et al.: p.100

Distribution and range: Irwin River area, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Schizodus kennedyensis Dickins 1956
(Plate 48 fig. 5)

1956 *Schizodus kennedyensis* Dickins: p.30-31, pl. 5 figs 1-10
1958 *Schizodus kennedyensis* Dickins; Guppy et al.: p.53
1967 *Schizodus kennedyensis* Dickins; Condon: p.131, 169, 173, 184
1975 *Schizodus kennedyensis* Dickins; Playford et al.: p.284, 287, 288

Diagnosis: "The shell has a triangular appearance with a prominent carina extending from the umbo to the posterior angle, forming a flattened area dorsally and a sharp posterior angle; the hinge plate extends in front of the anterior muscle scar to form a rudimentary buttress ridge" (Dickins, 1956, p.30).

Types: Holotype - CPC 764; paratypes - CPC 777-780, AM F38393.

Type locality: 1.2 km south of Southern Cross Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station and Minilya River area, **Carnarvon Basin** - ?Coyrie Formation, Wandagee Formation, Nalbia Sandstone, Coolkilya Sandstone; northern **Canning Basin** - Lightjack Formation.

Age: Late Artinskian (Baigendzhinian), Kungurian.

Abundance: Numerous specimens.

Value in correlation and dating: Valuable.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

?Schizodus kennedyensis Dickins 1956

1976 *Schizodus kennedyensis*? Dickins; Dickins *in* Towner et al.: p.101

Distribution and range: Scott Bluff area, southern **Canning Basin** - Triwhite Sandstone.

Age: Kungurian.

Schizodus sp. cf. **S. kennedyensis** Dickins 1956

1967 *Schizodus* cf. *kennedyensis* Dickins; Condon: p.97, 169

Distribution and range: **Carnarvon Basin** - Billidee and Wandagee Formations.

Age: Artinskian (Aktastinian, Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water (100 m).

Schizodus sp. cf. **S. obscurus** King

1958 *Schizodus* cf. *obscura* King; Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Sedimentary environment: Shallow water.

Schizodus sandimanensis Dickins 1963
(Plate 48 fig. 4)

1963 *Schizodus sandimanensis* Dickins: p.101-102, pl. 17 figs 1-9; text fig. 12B
1964 *Schizodus sandimanensis* Dickins; Dickins: p.44
1967 *Schizodus sandimanensis* Dickins; Condon: p.71
1976 *Schizodus sandimanensis* Dickins; Playford et al.: p.96

Diagnosis: "Shell quadrate with a prominent carina; produced posteriorly to form a distinct area which gives the squarish shape. Teeth small, posterior cardinal apparently poorly developed" (Dickins, 1963, p.101).

Types: Holotype - UWA 45471; paratypes - CPC 3951-3954, UWA 45418.

Type locality: 3.5 km south of Mount Sandiman Woolshed, Carnarvon Basin.

Distribution and range: Carynginia Gully and Fossil Ridge, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Mount Sandiman Woolshed, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges and Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, and the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 20+ specimens.

Value in correlation and dating: Valuable -- the same or a similar species is known from the Arabian Peninsula and India (Dickins and Shah, 1979).

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water, at least locally.

Schizodus sp. A

1963 *Schizodus* sp. Dickins: p.102, pl. 17 fig. 20

Figured specimen: CPC 4018.

Distribution and range: Saint George Ranges, northern **Canning Basin** - base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Schizodus sp. B

1967 *Schizodus* sp. Condon: p.136, 149

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water.

Schizodus sp. nov. A

1958 *Schizodus* sp. nov. Guppy et al.: p.54

Distribution and range: **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Schizodus sp. nov. B

1957 *Schizodus* sp. nov. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Genus **NEOSCHIZODUS** Giebel 1855

Type species: *Lyrodon laevigatum* Goldfuss 1837.

Neoschizodus johnstonei (Dickins 1956)
(Plate 48 fig. 3)

1956 *Middalya johnstonei* Dickins: p.36-38, pl. 6 figs 1-7; text fig. 3
1967 *Middalya johnstonei* Dickins; Condon: p.184
1975 *Middalya johnstonei* Dickins; Playford et al.: p.288

Diagnosis: "Shell rounded, subquadrangular, ornamented only with concentric growth lines and with a slight umbonal ridge running to the posterior ventral margin. The anterior adductor muscle is deeply impressed and bounded at the rear by a ridge running down from the hinge plate" (Dickins, 1956, p.36).

Types: Holotype - CPC 1301; paratypes - CPC 1302-1305.

Type locality: 4 km west-northwest of Bakers Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station area, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Abundance: 4 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water with abundant supply of sand and mud.

Subclass HETERODONTA Neumayr 1884
Superfamily CRASSATELLACEA Ferussac 1822

Family ASTARTIDAE d'Orbigny 1844
Subfamily ASTARTINAE d'Orbigny 1844

Genus **ASTARTELLA** Hall 1858

Type species: *Astartella vera* Hall 1858; SD Miller 1889.

Astartella obliqua Dickins 1963
(Plate 48 figs 8, 11)

1963 *Astartella obliqua* Dickins: p.104-105, pl. 16 figs 2-9; text fig. 13
1967 *Astartella obliqua* Dickins; Condon: p.71
1976 *Astartella obliqua* Dickins; Playford et al.: p.95

Diagnosis: "Shell distinctly inequilateral, produced anteriorly and ventrally; external surface lacking strong lamellae" (Dickins, 1963, p.104).

Types: Holotype - UWA 45419; paratypes - CPC 3959-3961.

Type locality: 3.5 km south of Mount Sandiman Woolshed, Carnarvon Basin.

Distribution and range: Carynginia Well area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Mount Sandiman Woolshed, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges and Paradise Homestead area, northern **Canning Basin** - Nura Nura Member, and near the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 10 specimens.

Value in correlation and dating: The same or a similar species is recorded from the Arabian Peninsula (Dickins and Shah, 1979).

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, at least locally.

Astartella sp. nov.

1958 *Astartella* sp. nov. Guppy et al.: p.54

Distribution and range: **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Sedimentary environment: Shallow water.

Astartella? sp. nov.

1956 *Astartella*? sp. nov. cf. *Astartella?* sp. nov. Dickins & Thomas: p.53

Distribution and range: Saint George Ranges, northern **Canning Basin** - Nura Nura Member, and from near the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Nil.

Family CRASSATELLIDAE Ferussac 1822
Subfamily CRASSATELLINAE Ferussac 1822

Genus **ORIOCRASSATELLA** Etheridge Jnr 1907

Type species: *Oriocrassatella stokesi* Etheridge Jnr 1907; Monotypy.

Oriocrassatella sp.
(Plate 48 figs 10, 13)

1958 *Procrassetella* sp. Guppy et al.: p.54
1963 *Oriocrassatella* sp. Dickins: p.103, pl. 18 figs 1-5
1967 *Oriocrassatella* sp. Condon: p.71, 97, 131
1976 *Oriocrassatella* sp. Dickins *in* Towner et al.: p.99

Figured specimens: CPC 3955-3958.

Distribution and range: Woolaga Creek, Irwin River area, **Perth Basin** - High Cliff Sandstone; Monument Bore area, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges and Paradise Homestead area, northern **Canning Basin** - Nura Nura Member, and near the base of the Poole Sandstone; Helen Hill, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian) - Early Artinskian (Aktastinian).

Abundance: 8+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water locally; moderately deep (100 m) elsewhere.

Oriocrassatella stokesi Etheridge Jnr 1907
(Plate 48 figs 15-17)

1897 *Edmondia* sp. Etheridge Jnr: p.15, pl. 1 fig. 10
1907c *Oriocrassatella stokesi* Etheridge Jnr: p.9, pl. 6 figs 2-5
1924 cf. *Protoschizodus* Chapman: p.36
1935 *Oriocrassatella stokesi* Etheridge Jnr; Prendergast: p.25, pl. 2 figs 19-20
1954 *Oriocrassatella stokesi* Etheridge Jnr; Thomas & Dickins: p.221
1956 *Oriocrassatella stokesi* Etheridge Jnr; Dickins: p.33-35, pl. 6 figs 8-14
1958 *Oriocrassatella stokesi* Etheridge Jnr; Newell: p.1, 3, fig. 2
1958 *Oriocrassatella stokesi* Etheridge Jnr; Guppy et al.: p.53
1967 *Oriocrassatella stokesi* Etheridge Jnr; Condon: p.173, 184
1975 *Oriocrassatella stokesi* Etheridge Jnr; Playford et al.: p.288

Diagnosis: "Shell oval, evenly rounded for shells of the genus; moderately elongate, posterior carina rather evenly rounded; lateral teeth not particularly distinct.

Closest species: *Oriocrassatella plana* (Wanner) (1940, p.390, pl. 1 figs 10, 10a) from the Basleo Beds of Timor, see Dickins (1956, p.35).

Types: Hypotypes - UWA 10665, 27886a,b, 33922-33925, and CPC 781-784.

Distribution and range: ?Wandagee and Middalya Stations, **Carnarvon Basin** - Nalbia and Coolkilya Sandstones; Saint George Ranges, northern **Canning Basin** - Lightjack Formation. Originally described from Treachery Bay (NT).

Age: Middle Kungurian.

Abundance: Several hundred specimens.

Value in correlation and dating: Valuable.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Oriocrassatella sp. cf. **O. stokesi** Etheridge Jnr 1907

1967 *Oriocrassatella* cf. *stokesi* Etheridge Jnr; Condon: p.136

Distribution and range: **Carnarvon Basin** - Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow water.

Remarks: These specimens appear to represent an unnamed species.

Family CARDINIDAE Zittel 1881

Genus **CYPRICARDINIA** Hall 1859

Type species: *Cypricardinia halli* Beuschausen 1897; OD.

Cypricardinia? elegantula Dickins 1963
(Plate 48 figs 14, 18, 20)

1963 *Cypricardinia? elegantula* Dickins: p.98, pl. 16 figs 10-19
1967 *Cypricardinia? elegantula* Dickins; Condon: p.71

Diagnosis: "Shells equivalve, varying from almost oval to modiliform, becoming more modiliform with age. In the adult, external surface without marked changes in convexity, but in the young shell posterior umbonal ridge distinctly developed, so that youthful part of the shell more humped than adult part. Two distinct cardinal teeth and two or three posterior laterals in each valve." (Dickins, 1963, p.98).

Closest species: The species is separable from other described species of *Cypricardina* by the details of the dentition.

Types: Holotype - UWA 45411; paratypes - UWA 45412-45416.

Type locality: Fossil Cliff on the Irwin River, Perth Basin.

Distribution and range: Type locality, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Coordewandy Station and ?south of Mount Sandiman Woolshed, **Carnarvon Basin** - Callytharra Formation; Saint George Ranges, northern **Canning Basin** - ?Cuncudgerie Sandstone and basal part of Poole Sandstone; ?southwestern **Canning Basin** - Nura Nura Member of Poole Sandstone, ?basal part of Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water, at least locally.

Abundance: Abundant only in the Fossil Cliff Member.

Value in correlation and dating: Valuable because of widespread distribution.

Cypricardinia? sp. A

1967 *Cypricardinia?* sp. Condon: p.169, 173

Distribution and range: **Carnarvon Basin** - Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian (Filippovian).

Sedimentary environment: Shallow to moderately deep water.

Cypricardinia? sp. B

1976 *Cypricardinia?* sp. Playford et al.: p.100

Distribution and range: **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Subclass ANOMALODESMATA Dall 1889
Order PHOLADOMYOIDA Newell 1965
Superfamily EDMONDIACEA King 1850

Family EDMONDIIDAE King 1950

Genus **EDMONDIA** de Koninck 1841

Type species: *Isocardia unioniformis* Phillips 1936; OD.

Edmondia prichardi Dickins 1963
(Plate 48 fig. 19)

1963 *Edmondia prichardi* Dickins: p.43-44, pl. 3 figs 15-23; pl. 4 figs 15, 16
1967 *Edmondia prichardi* Dickins; Condon: p.71
1975 *Edmondia prichardi* Dickins; Playford et al.: p.281
1976 *Edmondia prichardi* Dickins; Playford et al.: p.95

Diagnosis: "Oval to subquadrate shells with umbo towards front and not particularly prominent. Outer surface of shell rounded from front to rear and lacking distinctly developed anterior and posterior umbonal ridges. External ornament of low regularly spaced concentric growth ridges" (Dickins, 1963, p.43).

Types: Holotype - UWA 45361; paratypes - UWA 45362-45366, CPC 3879.

Type locality: Fossil Ridge on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Mount Sandiman Woolshed area and Byro Station, **Carnarvon Basin** - Callytharra Formation; northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: About 10 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Superfamily PHOLODOMYACEA Gray 1847

Family ORTHONOTIDAE S.A. Miller 1877

Genus **PALAEOSOLEN** Hall 1885

Type species: *Orthonota siliquoidea* Hall 1870; OD.

Palaeosolen? badgeraensis Dickins 1963
(Plate 48 fig. 21)

1963 *Palaeosolen? badgeraensis* Dickins: p. 57-58, p.6 figs 1-9
1976 *Palaeosolen? badgeraensis* Dickins; Playford et al.: p.96

Diagnosis: "Umbo inconspicuous; cardinal margin in front of and behind umbo, almost forming a straight line. Posterior umbonal ridge carinate, reaching external margin at junction of ventral and posterior margins. Several fine radiating ridges behind and above carina" (Dickins, 1963, p.57).

Types: Holotype - CPC 3894; paratypes - CPC 3895-3898.

Type locality: 0.75 km at 334° from Caryngina Well, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area and Saint George Ranges, northern **Canning Basin** - Nura Nura Member, and ?base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5+ specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Palaeosolen? sp. A

1967 *Palaeosolen?* sp. Condon: p.131, 169, 173

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian.

Sedimentary environment: Shallow to moderately deep water but not far from land.

Palaeosolen? sp. B

1976 *Palaeosolen?* sp. Playford et al.: p.100

Distribution and range: **Perth Basin** - High Cliff Sandstone

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Family MEGADESMIDAE Vokes 1967

Genus **MEGADESMUS** Sowerby 1839

Type species: *Megadesmus globosus*; Sowerby 1839; SD Woodward 1854.

Megadesmus sp.
(Plate 48 fig. 22)

1963 *Megadesmus* sp. Dickins: p.45, pl. 4 figs 1-3
1967 *Megadesmus* sp. Dickins; Condon: p.71

Figured specimen: CPC 3880.

Distribution and range: Coordewandy Station area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow-water.

Megadesmus sp. A

1931 *Cardiomorpha* n. sp. Hosking: p.31, pl. 7 fig. 6

Figured specimen: GSWA 1/4701.

Distribution and range: Wooramel district, **Carnarvon Basin** - range not known.

Age: 'Permian'.

Abundance: One imperfect specimen.

Value in correlation and dating: Nil.

Megadesmus? sp. B

1957 *Pachydomus?* sp. Dickins: p.26-27, pl. 4 figs 1-4, fig. 3

1976 *Megadesmus* sp. Dickins *in* Towner et al.: p.99

Figured specimen: CPC 2218.

Distribution and range: Moogooree Homestead and Winning Station, **Carnarvon Basin** - top part of the Lyons Group; Helen Hill, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Early - Late Sakmarian (Tastubian - Sterlitamakian.

Abundance: 13+ specimens.

Value in correlation and dating: Nil.

Genus **ASTARTILA** Dana 1847

Type species: *Astartila intrepida* Dana 1847; SD Stoliczka 1871, p.19.

Astartila blatchfordi (Hosking 1931)
(Plate 48 fig. 23)

1914 Undetermined bivalve (*Pachydomus*?) Etheridge Jnr: p.36, pl. 7 fig 3
1931 *Cardiomorpha blatchfordi* Hosking: p.30-31, pl. 7 figs 4a-b, [illegible]
1933 *Cardiomorpha blatchfordi* Hosking: p.55, pl. 6 fig. 3
1954 *Astartila blatchfordi* (Hosking); Thomas & Dickins: p.219
1956 *Astartila blatchfordi* (Hosking); Dickins: p.19-20, pl. 2 figs 10-11
1956 *Astartila blatchfordi* (Hosking); Dickins & Thomas: p.51
1958 *Astartila blatchfordi* (Hosking); Guppy et al.: p.49
1967 *Astartila blatchfordi* (Hosking); Condon: p.131, 136 169, 173
1975 *Astartila blatchfordi* (Hosking); Playford et al.: p.284, 287
1976 *Astartila blatchfordi* (Hosking); Dickins *in* Towner et al.: p.101
1979 *Astartila blatchfordi* (Hosking); Dickins & Shah: p.12

Types: Hypotypes - UWA 29345, GSWA 1/4951, 1/4999.

Distribution and range: Wooramel and Minilya Rivers areas, **Carnarvon Basin** - Coyrie Formation, Mallens Sandstone, Wandagee Formation and Nalbia Sandstone; southwest, southern and northern **Canning Basin** - upper Noonkanbah Formation or lower Liveringa Group, Triwhite Sandstone. Badhaura, India.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian.

Abundance: Many specimens.

Value in correlation and dating: Useful in Western Australia.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water and moderately deep water but not far from land.

Astartila sp. cf. **A. blatchfordi** (Hosking 1951)

1976 *Astartila* cf. *blatchfordi* (Hosking); Dickins *in* Towner et al.: p.101

Distribution and range: Triwhite Hills, southern **Canning Basin** - Triwhite Sandstone.

Age: Early - Middle Kungurian (Filippovian - Irenian).

Astartila condoni Dickins 1957
(Plate 48 fig. 25)

1957 *Astartila condoni* Dickins: p.23-24, pl. 3 figs 7-11
1959 *Astartila condoni* Dickins; Dickins & Thomas: p.69, 72
1967 *Astartila condoni* Dickins; Condon: p.61
1975 *Astartila condoni* Dickins; Playford et al.: p.279

Diagnosis: "Astartilid shell with external ornament of coarse concentric ribs or rugae. Only a few ribs added posteriorly; ribs increasing in size towards the rear. Beak distinctly prosogyre; greatest convexity of the shell is about one-third of the shell-length from the rear" (Dickins, 1957, p.23).

Types: Holotype - CPC 2212; paratypes - CPC 2213, 2214.

Type locality: 1.6 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs and Moogooree Homestead areas, **Carnarvon Basin** - top of Lyons Group, Carrandibby Formation.

Age: Early Sakmarian (Tastubian).

Abundance: Numerous specimens.

Climate: Cold.

Sedimentary environment: Shallow water.

Astartila sp. cf. **A. danai** (de Koninck 1877)

1956 *Astartila* cf. *A. danai* (de Koninck); Dickins & Thomas: p.53

Distribution and range: Southwestern **Canning Basin** - Nura Nura Member of the Poole Sandstone. NSW - "Upper Marine Series".

Age: Late Sakmarian (Sterlitamakian) in Western Australia.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Astartila fletcheri Dickins 1956
(Plate 48 figs 24, 26)

1956 *Astartila fletcheri* Dickins: p.17-19, pl. 2 figs 3-9; text fig. 1

1958 *Astartila fletcheri* Dickins; Guppy et al.: p.53
1967 *Astartila fletcheri* Dickins; Condon: p.169, 184

Diagnosis: "The umbones are only slightly prominent, and are inrolled towards the front. The outline, seen from the front, is sub-ovate with the greatest convexity closer to the dorsal side of the shell than to the ventral. The external surface is ornamented with concentric rugae (coarse ribs). Between these is interpolated another series of rugae which is only present in the posterior part of the shell" (Dickins, 1956, p.17).

Types: Holotype - CPC 750; paratypes - CPC 751-753.

Type locality: 1.2 km southeast of Southern Cross Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station and Lyons River Station, **Carnarvon Basin** - Wandagee Formation, Coolkilya Sandstone; northern **Canning Basin** - Lightjack Formation.

Age: Late Artinskian (Baigendzhinian), Middle Kungurian.

Abundance: Numerous specimens.

Value in correlation and dating: Valuable.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water with plentiful sand and mud.

Astartila? obscura Dickins 1957
(Plate 48 fig. 27)

1957 *Astartila? obscura* Dickins: p.25-27, pl. 3 figs 1-6
1959 *Astartila? obscura* Dickins; Dickins & Thomas: p.69
1967 *Astartila? obscura* Dickins; Condon: p.61
1975 *Astartila? obscura* Dickins; Playford et al.: p.280

Diagnosis: "An *Astartila*-shaped shell without rugae and with comparatively smooth external surface. Umbo very prominent, very distinct posterior umbonal ridge" (Dickins, 1957, p.25).

Types: Holotype - CPC 2215; paratypes - CPC 2216, 2217.

Type locality: 1.6 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Byro Station, Wooramel River area, **Carnarvon Basin** - top of Lyons Group, Carrandibby Formation.

Age: Early Sakmarian (Tastubian).

Abundance: 6+ specimens.

Climate: Species found in sedimentary rocks that were laid down under cold conditions.

Sedimentary environment: Shallow water.

Astartila sp.

1974 *Astartila* sp. C Dickins & Jell: p.2

Distribution and range: Namalook Rockhole, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Astartila? sp. A
(Plate 48 fig. 31)

1963 *Astartila?* sp. Dickins: p.47, pl. 4 figs 11-14

Figured specimens: UWA 45371-45373.

Distribution and range: Irwin River area, **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Abundance: 4 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Astartila? sp. B

1967 *Astartila?* sp. Condon: p.102

Distribution and range: **Carnarvon Basin** - Moogooloo Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Astartila? sp. nov.

1958 *Astartila?* sp. nov. Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Astartila? tumida Dickins 1963
(Plate 48 fig. 28)

1963 *Astartila? tumida* Dickins: p.46-47, pl. 4 figs 4-10
1976 *Astartila? tumida* Dickins; Playford et al.: p.95

Diagnosis: "Shell transversely oval with length greater than height. A distinct rounded posterior umbonal swelling or ridge forms a wide area, dorsal and posterior to the swelling. Umbo prominent; distinct external ornament of concentric rugae, poorly developed behind the umbonal swelling" (Dickins, 1963, p.46).

Closest species: *Astartila? obscura* Dickins 1957 from the Carrandibby Formation of the Carnarvon Basin.

Types: Holotype - UWA 45367; paratypes - UWA 45368-5370.

Type locality: Becketts Gully or Fossil Ridge, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5 specimens.

Climate: Species found in sedimentary rock. that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Genus **MYONIA** Dana 1847

Type species: *Myonia elongata* Dana 1847; SD Fletcher 1932.

Myonia carinata (Morris 1845)

1845 *Pachydomus carinatus* Morris, *in* Strzelecki: p.273, pl. 11 figs 3, 4
?1890 *Pachydomus carinatus* Morris; Foord: p.19

Distribution and range: Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale.

Age: ?Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Nil.

Myonia sp. nov.
(Plate 48 fig. 30)

1963 *Myonia* sp. nov. Dickins: p.50, pl. 5 figs 13-19
1967 *Myonia* sp. nov. Dickins; Condon: p.71
1976 *Myonia* sp. nov. Playford et al.: p.96

Figured specimens: UWA 45375-45378, CPC 3891.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Lyons River Homestead area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, at least locally.

Genus **PACHYMYONIA** Dun 1932

Type species: *Pachymyonia morrissi* Etheridge Jnr 1919; OD.

Pachymyonia occidentalis Dickins 1957
(Plate 48 fig. 32)

1957 *Pachymyonia occidentalis* Dickins: p.28, pl. 4 figs 5-9
1959 *Pachymyonia occidentalis* Dickins; Dickins: p.69, 77
1967 *Pachymyonia occidentalis* Dickins; Condon: p.61

Diagnosis: "Shell not particularly transversely elongated but strongly inflated and with a very distinct carina running from the umbo back towards the junction of the posterior and ventral margins" (Dickins, 1957, p.28).

Types: Holotype - CPC 2221; paratype - CPC 2222.

Type locality: 1.6 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Byro Station and Wooramel River areas, **Carnarvon Basin** - top part of Lyons Group, Carrandibby Formation.

Age: Early Sakmarian (Tastubian).

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were deposited under cold conditions.

Sedimentary environment: Shallow water.

Pachymyonia sp. cf. **P. occidentalis** Dickins 1957

1963 *Pachymyonia* cf. *occidentalis* Dickins: p.50, pl. 5 figs 20, 21
1976 *Pachymyonia* sp. cf. *P.occidentalis* Dickins; Playford et al.: p.96

Figured specimen: UWA 45379.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: One specimen.

Family PHOLADOMYIDAE Gray 1847

Genus **CHAENOMYA** Meek 1864

Type species: *Allorisma? leavenworthensis* Meek & Hayden 1858; Monotypy.

Chaenomya? nuraensis Dickins 1963
(Plate 49 fig. 1)

1957 *Chaenomya* sp. nov. Dickins: p.29-30, pl.4 figs 10-12
1959 *Chaenomya* sp. nov. Dickins; Dickins & Thomas: p.69
1963 *Chaenomya? nuraensis* Dickins: p.52-53, pl. 6 figs 10-14
1965 *Chaenomya nuraensis* Dickins; Edgell: p.67
1967 *Chaenomya nuraensis* Dickins; Condon: p.61
1976 *Chaenomya? nuraensis* Dickins; Playford et al.: p.117

Diagnosis: "Shell transversely elongated with posterior part of cardinal margin concave and reflexed so that back rises to about height of umbo. Umbo more or less upright and not inrolled at the front; passes gradually into anterior margin with only slight identation in outline. Dorsal part of anterior margin less rounded than ventral part and at an angle to hinge-line. Probably gaping slightly at rear" (Dickins, 1963, p.52).

Types: Holotype - CPC 3883; paratype - CPC 3884; figured specimen - CPC 2223.

Type locality: 1.6 km west of Callytharra Spring, Carnarvon Basin.

Distribution and range: Arrino area, **Perth Basin** - Mingenew Formation; Byro Station, **Carnarvon Basin** - Carrandibby Formation; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Early - Late Sakmarian (Tastubian - Sterlitamakian).

Abundance: 12 specimens.

Climate: Species found in sedimentary rocks that were deposited under cold to temperate conditions.

Sedimentary environment: Shallow water.

Chaenomya sp. A

1967 *Chaenomya* sp. Condon: p.149

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water.

Chaenomya sp. B
(Plate 49 fig. 2)

1963 *Chaenomya* sp. Dickins: p.51-52, pl. 8 figs 12-16
1967 *Chaenomya* sp. Condon: p.71
1976 *Chaenomya* sp. Playford et al.: p.95

Figured specimens: UWA 45474, CPC 3881, 3882.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Lyons River Homestead area, **Carnarvon Basin** - Callytharra Formation; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 3 specimens.

Value in correlation and dating: Limited by its rarity and uncertain identity.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water, at least in places.

Genus **VACUNELLA** Waterhouse 1956

Type species: *Allorisma curvatum* Morris 1845; OD.

Vacunella sp. nov.

1967 *Allorisma* sp. nov. Condon: p.136

Distribution and range: **Carnarvon Basin** - Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow water.

Vacunella? sp. nov.

1956 *Allorisma?* sp. nov. Dickins: p.21, 22, pl. 2 figs 1-2

Figured specimen: CPC 754.

Distribution and range: Williambury Station, **Carnarvon Basin** - top of Mallens Sandstone or bottom of Bulgadoo Shale.

Age: Late Artinskian (Baigendzhinian).

Abundance: One left valve.

Family SANGUINOLITIDAE Miller 1884

Genus **MYOFOSSA** Waterhouse 1969

Type species: *Myonia subarbitrata* Dickins 1963; OD.

Myofossa subarbitrata (Dickins 1963)
(Plate 48 fig. 29)

1963 *Myonia subarbitrata* Dickins: p.48-49, pl. 5 figs 2-12, 22
1976 *Myonia subarbitrata* Dickins; Playford et al.: p.96

1976 *Myonia?* sp. nov. (*Myonia subarbitrata* Dickins); Dickins *in* Towner et al.. p.98

Diagnosis: "Shell only moderately convex; posterior carina distinct; more or less rounded and convex near the umbo but slightly concave towards the ventro-posterior margin. Between the carina and the ridge forming the edge of the ligament groove, a sharp groove forms a distinct escutcheon" (Dickins, 1963, p.48).

Types: Holotype - CPC 3885; paratypes - CPC 3886-3890, 4017.

Type locality: 2.3 km southwest of Paradise Homestead, northern Canning Basin.

Distribution and range: Carynginia Well area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone; near Well 27 and Scott Bluff on Canning Stock Route, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 42 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus PALAEOCOSMOMYA Fletcher 1946

Type species: *Palaeocosmomya teicherti* Fletcher 1946; OD.

Cosmomya (Palaeocosmomya) aplatum Fletcher 1946
(Plate 49 fig. 12)

1946 *Palaeocosmomya aplatum* Fletcher: p.403-404, pl. 35 figs 7, 8
1965 *Cosmomya (Palaeocosmomya) aplata* Fletcher; Dickins & Shah: p.258, pl. 17 figs 11, 22

Diagnosis: Combination of strongly compressed posteriorly and ventrally shape with anteriorly placed and elevated umbones, and the ratio of height to length.

Types: Monotype - UWA 42059.

Type locality: East limb of syncline north bank of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Quinnanie Shale, Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One specimen.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Cosmomya (Palaeocosmomya) sp. cf. **C.(P.) aplatum** Fletcher 1946

1967 *Palaeocosmomya* cf. *aplatum* Condon: p.64

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep.

Cosmomya (Palaeocosmomya) teicherti Fletcher 1946
(Plate 49 fig. 5)

1946 *Palaeocosmomya teicherti* Fletcher: p.402-403, pl. 34 figs 7, 8; pl. 35 figs 4-6
1965 *Cosmomya (Palaeocosmomya) teicherti* Fletcher; Dickins & Shah: p.256, 258, pl. 17 figs 1-4
1967 *Palaeocosmomya teicherti* Fletcher; Condon: p.169

Diagnosis: Combination of characteristic ornamentation with the broad unornamented escutcheon and the widely gaping posterior margins with thicked edges.

Types: Holotype - UWA 42056; paratypes - UWA 42057.

Type locality: East limb of syncline, north bank of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Quinnanie Shale, Wandagee Formation, Baker Formation.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian (Irenian).

Abundance: Many specimens.

Climate: Species found in sedimentary rocks deposited under temperate conditions.

Sedimentary environment: Shallow to moderately deep water.

Cosmomya (Palaeocosmomya) sp. cf. **C.(P.) teicherti** Fletcher 1946

1965 *Cosmomya (Palaeocosmomya)* sp. cf. *C.(P.) teicherti* Fletcher; Dickins & Shah: pl. 17 figs 5-7

Figured specimen: CPC 6971.

Distribution and range: Minilya River area, **Carnarvon Basin** - Quinnanie Shale.

Age: Late Artinskian (Baigendzhinian).

Abundance: 2 incomplete specimens.

Cosmomya (Palaeocosmomya) sp.

1976 *Palaeocosmomya* sp. Playford et al.: p.96

Distribution and range: **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Sedimentary environment: Shallow water.

Cosmomya (Palaeocosmomya) sp. nov.
(Plate 49 fig. 4)

1963 *Palaeocosmomya* sp. nov. Dickins: p.56-57, pl. 6 figs 21, 22
1965 *Cosmomya (Palaeocosmomya)* sp. nov. Dickins & Shah: p.256, 258

Figured specimens: UWA 45483, CPC 3893.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PRAEUNDULOMYA** Dickins 1957

Type species: *Praeundulomya concentrica* Dickins 1957; OD.

Praeundulomya concentrica Dickins 1957
(Plate 49 figs 3, 8)

1957 *Praeundulomya concentrica* Dickins: p.11-13, pl. 1 figs 1-11; text fig. 2
1965 *Praeundulomya concentrica* Dickins; Dickins & Shah: p.258, pl. 17 fig 8
1967 *Praeundulomya concentrica* Dickins; Condon: p.131

Diagnosis: "Shell not greatly produced in front of umbos; rugae or ribs and growth lines not parallel. Ribs increase in number towards the rear in such a way that in some specimens continuous ribs coming from the front truncate a number of ribs on the back part of the shell" (Dickins, 1957, p.11).

Types: Holotype - CPC 2193; paratypes - CPC 2194-2200.

Type locality: 8 km southwest of Moogooree Homestead, Carnarvon Basin.

Distribution and range: Moogooree Homestead area and Donnellys Well, **Carnarvon Basin** - Coyrie Formation, Bulgadoo Shale.

Age: Late Artinskian (Baigendzhinian).

Abundance: Many specimens in both formations.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow to moderately deep water, but not far from land.

Praeundulomya sp. cf. **P. concentrica** Dickins 1957

1974 *Praeundulomya* cf. *concentrica* Dickins; Dickins & Jell: p.2

Distribution and range: Namalook Rockhole, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Praeundulomya elongata Dickins 1957
(Plate 49 fig. 7)

1957 *Praeundulomya elongata* Dickins: p.36-37, pl. 6 figs 10-14; text fig. 7
1965 *Praeundulomya elongata* Dickins; Dickins & Shah: p.258
1959 *Praeundulomya elongata* Dickins; Dickins & Thomas: p.69
1967 *Praeundulomya elongata* Dickins; Condon: p.61
1975 *Praeundulomya elongata* Dickins; Playford et al.: p.280

Diagnosis: "Shell distinctly produced in front of the umbones. Ribbing predominently concentric over whole external surface and only a few extra ribs added at the rear. Ligament area not distinctly tucked under umbos at front. Posterior grooves and ridge only poorly developed" (Dickins, 1957, p.36).

Types: Holotype - CPC 2238; paratypes - CPC 2239, 2240.

Type locality: 1.6 km west of Callytharra Spring, Carnarvon Basin.

Distribution and range: Byro Station area, **Carnarvon Basin** - top of the Lyons Group, Carrandibby Formation.

Age: Early Sakmarian (Tastubian).

Abundance: 3 specimens and a number of fragments.

Climate: Species found in sedimentary rocks that were deposited under cold water environment.

Sedimentary environment: Shallow water.

Praeundulomya sp.

1967 *Praeundulomya* sp. Condon: p.71

Distribution and range: **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Sedimentary environment: Shallow water.

Praeundulomya subelongata Dickins 1963
(Plate 49 fig. 6)

1963 *Praeundulomya subelongata* Dickins: p.54-55, pl. 6 figs 15-20; text fig. 8
1965 *Praeundulomya subelongata* Dickins; Dickins & Shah: p.258
1976 *Praeundulomya subelongata* Dickins; Playford et al.: p.96

Diagnosis: "Shell elongate, ribbing concentric but lacking the complexity of *Praeundulomya concentrica* Dickins 1957; two posterior grooves distinct, particularly in the middle part of the shell. Especially distinguished by the development of the posterior umbonal ridge in the younger part of the shell" (Dickins, 1963, p.54).

Types: Holotype - UWA 45381; paratype UWA 45382, CPC 3892.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 4 specimens and a number of fragments.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Genus **UNDULOMYA** Fletcher 1946

Type species: *Undulomya pleiopleura* Fletcher 1946; OD.

Undulomya pleiopleura Fletcher 1946
(Plate 49 figs 9, 11)

1946 *Undulomya pleiopleura* Fletcher: p.399-400, pl. 34 figs 1-5; pl. 35 fig. 1
1956 *Undulomya pleiopleura* Fletcher; Dickins: p.29, pl. 4 figs 6-8
1965 *Undulomya pleiopleura* Fletcher; Dickins & Shah: p.255, 258, pl. 16 figs 9, 10; pl. 17 fig. 10
1967 *Undulomya pleiopleura* Fletcher; Condon: p.184

Types: Holotype - UWA 42050; paratype - UWA 42049; hypotype - CPC 763.

Type locality: West limb of syncline, north of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Wandagee Formation, Baker Formation, ?Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian (Irenian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Undulomya rugulata Fletcher 1946
(Plate 49 fig. 10)

1946 *Undulomya rugulata* Fletcher: p.400-401, pl. 34 fig. 6; pl. 35 figs 2, 3
1965 *Undulomya rugulata* Fletcher; Dickins & Shah: p.255, 258, pl. 17 fig. 9
1967 *Undulomya rugulata* Fletcher; Condon: p.169

Diagnosis: The more vertical orientation of the independent posterior ribs and their attenuation combined with the greater height in relation to length and strong posterior development of the shell.

Types: Holotype - UWA 42055; another figured specimen - UWA 16746.

Type locality: East limb of syncline, north bank of Minilya River, west of Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River area, **Carnarvon Basin** - Wandagee Formation; Mount Marmion, northern **Canning Basin** - top part of Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 2 incomplete specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Undulomya sp. A

1958 *Undulomya* sp. Guppy et al.: p.49

Distribution and range: **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow to moderately deep water.

Undulomya sp. B

1967 *Undulomya* sp. Condon: p.102

Distribution and range: **Carnarvon Basin** - Moogooloo Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Sanguinolitidae gen. et sp. nov.

1958 Sanguinolitidae gen. et sp. nov. Guppy et al.: p.54

Distribution and range: **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Sedimentary environment: Shallow water.

Subclass ANOMALODESMATA Dall 1889
Order PHOLADOMYOIDA Newell 1965
Superfamily PHOLADOMYACEA King 1844

Family PERMOPHORIDAE Van de Poel 1959
Subfamily MYOCONCHINAE Newell 1957

Genus **STUTCHBURIA** Etheridge Jnr 1900

Type species: *Orthonota? costata* Morris 1845; OD.

Stutchburia hoskingae Dickins 1963
(Plate 48 fig. 7)

1907b *Stutchburia* sp. Etheridge Jnr: p.33, pl. 7 figs 7-9, ?10
1963 *Stutchburia hoskingae* Dickins: p.96-98, pl. 15 figs 16-23
1964 *Stutchburia hoskingae* Dickins; Dickins: p.44
1976 *Stutchburia hoskingae* Dickins; Playford et al.: p.96

Diagnosis: "Shell expanded towards the rear; without a distinct sinus in the ventral margin or a distinct sulcus running down from the umbo. Radial ribbing variable; confined to back part of shell" (Dickins, 1963, p.96).

Closest species: *Stutchburia randsi* (Etheridge Jnr) from Queensland.

Types: Holotype - UWA 45405; paratypes - UWA 45406-45409, CPC 3944.

Type locality: "Irwin River", Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Abundant.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Stutchburia muderongensis Dickins 1956
(Plate 48 fig. 9)

1956 *Stutchburia muderongensis* Dickins: p.14-16, pl. 1 figs 12-17
1958 *Stutchburia muderongensis* Dickins; Guppy et al.: p.53
1967 *Stutchburia muderongensis* Dickins; Condon: p.173, 184
1976 *Stutchburia muderongensis* Dickins; Playford et al.: p.288

Diagnosis: "Shells of oval shape with the umbones rising very slightly above the hinge line. The valve extends in front of the umbo forming a readily distinguishable anterior lobe, so that the anterior muscle scar is situated more or less in front of the umbo, and the buttress ridge behind the anterior adductor is approximately vertical. The angle between the anterior and posterior parts of the cardinal margin in mature specimens averages 135 degrees" (Dickins, 1956, p.14).

Types: Holotype - CPC 747; paratypes - CPC 748, 749 (paratypes C & D destroyed in fire).

Type locality: 23 km southeast of Muderong Bore, Middalya Station, Carnarvon Basin.

Distribution and range: Middalya Station area, **Carnarvon Basin** - Nalbia and Coolkilya Sandstones; northern **Canning Basin** - Lightjack Formation.

Age: Early - Middle Kungurian (Filippovian - Irenian).

Abundance: Numerous specimens.

Climate: Species found in sedimentary rocks that were deposited under temperate conditions.

Sedimentary environment: Shallow water.

Stutchburia sp.

1958 *Stutchburia* sp. Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Sedimentary environment: Shallow water.

Stutchburia? sp.

1933 *Stutchburia*? Hosking: p.57, pl. 5 fig. 7

Figured specimen: GSWA 1/4957.

Distribution and range: Wooramel River area, **Carnarvon Basin**.

Age: Early Permian.

Stutchburia sp. nov.

1967 *Stutchburia* sp. nov. Condon: p.97, 131, 136, 149, 169, 173

Distribution and range: Carnarvon Basin - Billidee and Coyrie Formations, Mallens Sandstone, Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Sedimentary environment: Shallow water to moderately deep water.

Stutchburia? sp. nov. cf. **Stutchburia** sp. nov.

1956 *Stutchburia?* sp. nov. cf. *Stutchburia* sp. nov. Dickins & Thomas: p. 53

Distribution and range: Saint George Ranges, northern **Canning Basin** - near the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Nil.

Stutchburia variabilis Dickins 1957
(Plate 48 fig. 12)

1957 *Stutchburia variabilis* Dickins: p.21-22, pl. 2 figs 7-14
1959 *Stutchburia variabilis* Dickins; Dickins & Thomas: p.69-72, 77
1963 *Stutchburia variabilis* Dickins: p.96, pl. 15 fig. 24
1967 *Stutchburia variabilis* Dickins; Condon: p.61, 71
1975 *Stutchburia variabilis* Dickins; Playford et al.: p.279-281

Diagnosis: "Rather elongated transversely with greatest thickness of valve nearer rear of shell than front -- about half-way between umbo and rear. Anterior adductor approximately parallel to front part of ventral margin: buttress ridge set at about 45° to cardinal margin. Rounded ridge from umbo to posterior margin forms distinct area on posterior dorsal part of shell. Posterior radial ribbing variable; in some specimens confined to dorsal flanks, in others extending down over ventral flanks, and in some specimens possibly absent altogether" (Dickins, 1957, p.21).

Types: Holotype - CPC 2205; paratypes - CPC 2206-2211; hypotype - UWA 45410.

Type locality: 2.9 km south of west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Minilya, Lyndon, and Wooramel River areas, **Carnarvon Basin** - top beds of the Lyons Group, Carrandibby Formation.

Age: Sakmarian (Tastubian, Sterlitamakian).

Abundance: 9 specimens.

Climate: Species found in sedimentary rocks that were deposited under cold to temperate conditions.

Sedimentary environment: Shallow water, at least locally.

Stutchburia sp. cf. **S. variabilis** Dickins 1957

1976 *Stutchburia* sp. cf. *S. variabilis* Dickins; Playford et al.: p.100
1976 *Stutchburia* cf. *variabilis* Dickins; Dickins *in* Towner et al.: p.99

Distribution and range: Irwin River area, **Perth Basin** - High Cliff Sandstone; Helen Hill, Scott Bluff, southern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Sedimentary environment: Shallow water.

Remarks: The two occurrences are not of the same species.

Order CONOCARDIOIDA Neumayr 1891
Superfamily CONOCARDIACEA Miller 1889

Family CONOCARDIIDAE Miller 1889

Conocardium sp. A

1963 *Conocardium* sp. Dickins: p.105-106, pl. 16 fig. 1
1976 *Conocardium* sp. Playford et al.: p.95

Figured specimen: UWA 45420.

Distribution and range: **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Single incomplete specimen.

Conocardium sp. B

1907a Genus *Conocardium* Bronn; Etheridge Jnr: p.33

Distribution and range: Irwin River area, **Perth Basin** - range not known.

Abundance: One internal cast.

Value in correlation and dating: Nil.

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Ammonoids

AMMONOID GENERA AND SPECIES

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Class CEPHALOPODA
Subclass AMMONOIDEA
Order GONIATITIDA Hyatt 1884
Superfamily GONIATITACEAE de Haan 1825

Family AGATHICERATIDAE Arthaber 1911

Genus **AGATHICERAS** Gemmellaro 1887

Type species: *Agathiceras suessi* Gemmellaro 1887; OD.

Discussion: *Agathiceras* comprises the most advanced species of a singularly conservative family. These species are characterized by complete isolation of the three external lateral lobes and by rounded inflated form of all external sutural elements. More primitive species, in which the external lateral lobes are incompletely isolated, are grouped in *Proshumardites*: they range from Lower to Middle Carboniferous (Namurian to Bashkirian). *Agathiceras* extends from the Middle Carboniferous (Moscovian) to the basal Upper Permian (Wordian). It is abundant throughout the Lower Permian and Wordian, with extinction of the entire family before the Capitanian.

Agathiceras applanatum Teichert 1944
(Plate 50 figs 1, 2; Figure 8A)

1944 *Agathiceras applanatum* Teichert: p.85-87, pl. 17 figs 6, 7; text fig. 1
1961 *Agathiceras applanatum* Teichert; Glenister & Furnish: p.696-697, pl. 80 figs 6, 7; text fig. 5A
1980 *Agathiceras applanatum* Teichert; Cockbain: p.102

Discussion: The morphologically simple and conservative nature of *Agathiceras* does not warrant the large number of species proposed for the genus. Confident comparison of the Western Australian species is precluded by inadequate representation, but closest overall similarity seems to be to *A. tornatum* Gemmellaro (1887) from the Wordian of Sicily.

Holotype: UWA 21451.

Type locality: East side of Wandagee Hill, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Roadian.

Abundance: 1 specimen.

Value in correlation and dating: Species of *Agathiceras* do not serve effectively for restricted age assignment, but occurrence of the genus suggests strongly that parent strata are no younger than Wordian.

Superfamily GONIOLOBOCERATACEAE Spath 1934

Family GONIOLOBOCERATIDAE Spath 1934

Discussion: Gonioloboceratidae are involute, discoidal to lenticular ammonoids with biconvex growth lines. Septa are closely spaced, and the eight-lobed suture is characterized by high relief of elements, a broad ventral lobe whose flanks diverge strongly adorally, and by a first lateral saddle that became progressively more acutely angular during phylogeny. Most are from Middle and Upper Pennsylvanian strata, but one distinctive genus, *Mescalites*, is known from the basal Permian as well as the uppermost Pennsylvanian Gzhelian Stage (Kullman & Ramos, 1980).

Genus **MESCALITES** Furnish & Glenister 1971

Type species: *Goniolaboceras discoidale* Böse 1920; OD.

Discussion: *Mescalites* was proposed for thinly lenticular involute goniolaboceratids (width/diameter ratio 0.3) with a venter that is shallowly furrowed in large specimens. The suture is similar to those of other advanced members of the family except that an additional pair of lobes developed during later ontogeny near the crest of the secondary ventral saddle. In the type species this element exists as a mere crenulation at 25 mm conch diameter, but had developed into a shallow pointed lobe by 50 mm diameter. The single known named species is from lowermost Permian strata (Asselian) in New Mexico and Oklahoma (Furnish & Glenister, 1971), although a closely similar form is now known to occur in the uppermost Pennsylvanian (Gzhelian).

cf. **Mescalites** sp.
(Plate 51 figs 1-4; Figure 12C)

1980 *Mescalites* sp. Cockbain: p.103

Discussion: Five limonitized internal moulds from the Callytharra Formation were referred to us for identification and reported on by Cockbain (1980). They are specifically indeterminate juveniles, the largest achieving a diameter of 13 mm including three-quarters volution of body chamber. At this diameter the conch is involute (umbilicus/diameter ratio 0.15) and discoidal (width/diameter ratio 0.4), with narrowly rounded ventrolateral flanks and venter. The most notable features of the suture (Fig. 13C) are the great breadth of the ventral lobe and the obtuse forward divergence of its flanks.

Not even generic characters are present in such small specimens. However, from known early growth stages it can be presumed that the mature shell would be characterized by combination of thinly discoidal involute conch form and an unusually broad, divergent ventral lobe in the suture. In Late Palaeozoic ammonoids, this combination of characters is confined to the Goniolaboceratidae, whose only known Permian representative is *Mescalites*.

The juvenile Australian representatives bear a general similarity to comparable-sized specimens of *Mescalites discoidalis*. However, they

cannot be conspecific, as the Australian specimens are proportionately narrower and lack the shallow ventral sinus in the constrictions displayed by the type species. Despite these differences, comparison with *Mescalites* is most appropriate. "Were mature specimens available, they would probably warrant proposal of a new genus" (W.M. Furnish & B.F. Glenister, pers. comm., 1976 to G.A. Thomas).

Figured specimens: MUGD F6667, F6668.

Distribution and range: Bidgemia Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5 specimens.

Value in correlation and dating: Uncertainty in taxonomic assignment precludes utilization in age refinement.

Superfamily ADRIANITACEAE Schindewolf 1931

Family ADRIANITIDAE Schindewolf 1931

Discussion: The Family Adrianitidae originated in the Late Carboniferous (Desmoinesian) and constitutes a low diversity but common, cosmopolitan element of ammonoid faunas through the Lower Artinskian Aktastinian Substage. Moderate diversification occurred in the Late Artkinskian (Baigendzhinian) when *Neocrimites* evolved from the ancestral stock. Greatest adrianitid diversity and relative abundance characterizes the basal Upper Permian Wordian Stage, from which twelve genera are known, mostly descendants of *Neocrimites*. Almost all of these genera disappeared at the end of the Wordian, but *Neocrimites* continued as a rare element into the Capitanian, and *Epadrianites* into the Amarassian. No adrianitids are known to have survived into the Dzhulfian.

Genus **NEOCRIMITES** Ruzhentsev 1940

Type species: *Adrianites fredericksi* Emelyantsev 1929; OD.

Neocrimites sp.
(Plate 50 figs 8, 9; Plate 54 figs 1, 2; Figure 8B)

1961 *Neocrimites* sp. Glenister & Furnish: p.729-731, pl. 83 figs 7, 8; pl. 86 figs 4, 5; text fig. 16B
1980 *Neocrimites* sp. Glenister & Furnish; Cockbain: p.103

Discussion: Sutural detail permits confident assignment to *Neocrimites*, but poor preservation and paucity of material preclude specific reference.

Figured specimens: CPC 1776, 1777.

Distribution and range: Mount Sandiman Station (CPC 1776) and Moogooree Station (CPC 1777), **Carnarvon Basin** - Billidee and Coyrie Formations respectively.

Age: Late Artinskian (Baigendzhinian).

Abundance: 2 specimens.

Value in correlation and dating: Occurrence of *Neocrimites* may be presumed to indicate Baigendzhinian or younger age, with greatest probability at the lower limit of the generic range.

Superfamily CYCLOLOBACEAE Zittel 1895

Family CYCLOLOBIDAE Zittel 1895

Discussion: The Cyclolobaceae comprises complex Goniatitina that are characterized by tripartition of the primary external lateral, umbilical, and internal lateral lobes. Advanced cyclolobaceans with numerous extensively denticulate lobes, each with subparallel flanks, are referred to the family Cyclolobidae. During phylogenesis of the family, the prongs of the ventral lobe became strongly expanded, the number of external lobes across the flanks to the umbilical shoulder increased from three pairs to twelve pairs, and the sutural trace became strongly arched forward. Stratigraphic documentation of these trends (Furnish & Glenister, 1970) provides one of the most reliable guides for correlation of marine strata ranging in age from late Early Permian (Roadian) through latest Late Permian (Changhsingian).

Several different lineages probably are included within the Cyclolobidae (Glenister et al., 1979; Zhao, 1980). However, there seems to be complete intergradation within the common Late Permian sequence from *Waagenoceras* (Wordian - Capitanian) through *Timorites* (Capitanian - Amarassian) to *Cyclolobus* (Amarassian - Dzhulfian).

Genus **CYCLOLOBUS** Waagen 1879

Type species: *Phylloceras oldhami* Waagen 1872; OD.

Discussion: *Cyclolobus* intergrades with its ancestor, *Timorites* Haniel (1915), but may be differentiated on conch form, ornament, and suture. The conch is commonly 10 to 20 cm in diameter at maturity, compressed, and possesses a narrow umbilicus (umbilicus/diameter ratio 0.1 to 0.2). Growth lines and ribs are biconvex; ribs and constrictions are conspicuous in juveniles but are generally absent or subdued in large specimens. Mature modifications comprise slight geniculation and formation of a deep subterminal constriction with accentuated hyponomic and ocular sinuses. All sutural elements are strongly denticulate, and the genus is characterized by a tertiary subdivision near the crest of the first external lateral saddle. Prongs of the ventral lobe are wide; nine to twelve pairs of external lateral lobes diminish in size to the umbilical shoulder, and the sutural trace is strongly arched.

Several other generic names have been proposed for groups of advanced cyclolobids. However, evaluation of all available material suggests

that these taxa are best regarded as synonyms of *Cyclolobus* (Furnish & Glenister, 1970). *Timorites* intergrades with *Cyclolobus*, but has a broader conch that commonly retains ribs to maturity. The suture of *Timorites* has eight to eleven pairs of external lateral lobes to the umbilical shoulder, and it lacks the tertiary subdivision at the crest of the first external lateral saddle.

Cyclolobus is known from the type Dzhulfian (Ruzhentsev & Sarycheva, 1965) where it is associated with diverse araxoceratids. It also occurs abundantly in the Salt Range (Pakistan), Himalayas and Madagascar (Furnish & Glenister, 1970) and is known from rare occurrences in East Greenland (Nassichuk et al., 1966), central Iran (Bando, 1979), Kashmir (Furnish et al., 1973), Soviet Far Eastern Maritime Province (Zakharov, 1983), and Timor (Furnish & Glenister, 1970). These occurrences are approximately synchronous (Sweet, 1979). However, the Soviet Maritime occurrence is in precisely the same location and stratigraphic horizon as *Timorites* (Zakharov, 1983, p.126; pers. comm., 1985), and in Timor *Cyclolobus* and *Timorites* are recovered from the regolith in immediate geographic proximity. These latter two associations suggest pre-Dzhulfian age, specifically the Amarassian Stage. *Timorites* survived briefly into the range zone of *Cyclolobus*, just as *Waagenoceras* overlaps the lower range of *Timorites* in both the American Southwest (Miller & Furnish, 1940) and Mexico (Miller, 1944).

Cyclolobus persulcatus Rothpletz 1892
(Plate 51 figs 14, 15; Figure 9C)

1892 *Cyclolobus persulcatus* Rothpletz: p.88-89, pl. 9 fig. 5
1970 *Cyclolobus persulcatus* Rothpletz; Furnish & Glenister: p.155-161, 164, pl. 4 figs A-G; fig. 1C

Diagnosis: A species of *Cyclolobus* distinguished by combination of proportionally large umbilicus (umbilicus/diameter ratio approximately 0.2 above 20 mm conch diameter), retention of broad conspicuous umbilical ribs on the internal mould to a diameter of at least 125 mm, and location of the ninth or tenth external lateral lobe on the umbilical shoulder at 100 mm conch diameter. Most diagnostically, the lobe that divides the first lateral saddle is asymmetrically situated on the dorsal flank of the saddle's crest and is smaller than or subequal to the adjacent subdivisions.

Discussion: *Cyclolobus persulcatus* was established for a single specimen from near Soefa, Amarassi District, southwest Timor. Imperfect preservation of the holotype precludes detailed comparison, but the specific concept is firmly established by reference to numerous topotypes from Amarassi and elsewhere in Timor (Furnish & Glenister, 1970). A single well-preserved representative of *Cyclolobus* that falls within the morphologic range of *C. persulcatus* is now known from the Cherrabun Member of the Hardman Formation (Glenister et al., this bulletin).

Representatives of several of the described species of *Cyclolobus* are so few and so poorly preserved as to preclude confident comparison. This applies to *Godthaabites kullingi* Frebold 1932 (Nassichuk et al., 1966) from the Foldvik Creek Formation of central East Greenland, *Cyclolobus* sp. indet. (Bando, 1979) from the lower part of the Abadeh Formation of central Iran, and *Godthaabites ruznencevi* Zakharov 1983

(Ruzhentsev & Sarycheva, 1965) from the *Araxoceras* and *Vedioceras* beds (Dzhulfian) of Transcaucasia. However, all of these forms are similar to *C. persulcatus* in possession of a wide umbilicus and in retention of ribs and constrictions to large size (Furnish & Glenister, 1970). *Cyclolobus teicherti* Furnish & Glenister (1970) is based on a well-preserved, large specimen from near the top of the Chhidru Formation in the Salt Range of Pakistan. It closely resembles *C. persulcatus* in conch form and ornament but differs in possession of a deeper and more asymmetrically situated subdivision of the first external lateral saddle. The two common species of *Cyclolobus* and their subjective synonyms (Furnish & Glenister, 1970) differ from the group of species considered above in both conch form and in deeper subdivision of the sutural elements, especially the first external lateral saddle. *Cyclolobus oldhami* is from the Chhidru Formation and possibly also from the underlying uppermost Wargal Limestone of the Salt Range (Pakistan). *Cyclolobus walkeri* occurs widely throughout the Himalayas and the Salt Range, and is abundant in the *Ambilobe* beds of Madagascar. *Cyclolobus kiselevae* Zakharov (1983) is based on three specimens from the Lyudyanza Formation of Neizvestnaya Bay, Southern Primor'ye, Soviet Far Eastern Maritime Province. Although known specimens are inadequately preserved, their figured sutures suggest comparison with *C. walkeri*. Direct association with *Timorites* may be interpreted as indicating Amarassian age.

Hypotype: CPC 25340.

Distribution and range: Top of the outcrop in the syncline of the Kirkby Range (Lat. 19°05'36"S, Long. 125°09'45"E), northern **Canning Basin** (R.R. Towner, pers. comm. 1985) - lower part of the Cherrabun (upper) Member of the Hardman Formation. Locality data for Timorian *Cyclolobus persulcatus* were cited by Furnish and Glenister (1970).

Age: Amarassian, or less probably Dzhulfian.

Abundance: 1 specimen.

Value in correlation and dating: *Cyclolobus* is known to range through the middle part of the Upper Permian, Amarassian through Dzhulfian. It is unknown in the uppermost Permian Changhsingian Stage. Type and other representatives of *Cyclolobus persulcatus* from Timor are elements of the "Amarassi fauna" (Furnish & Glenister, 1970). However, they do not occur in objective stratigraphic succession, so that Dzhulfian age is possible although less probable. Occurrence of *C. persulcatus* in Western Australia thus suggests middle Upper Permian, most probably Amarassian.

Superfamily NEOICOCERATACEAE Hyatt 1900

Family **METALEGOCERATIDAE Plummer & Scott** 1937

Discussion: The Metalegoceratidae comprises a cosmopolitan group of ammonoids that constitutes a dominant faunal element in the Lower Permian of the Urals, Timor, and Western Australia. The group is characterized by ontogenetic tripartition of the primary umbilical lobe, which is repeated during phylogeny to transform the number of lobes from eight in the ancestral stock to sixteen in the most

advanced late Early Permian forms. Subfamilies are distinguished on conch form and relative width of the prongs of the ventral lobe. Three of the four genera of the Metalegoceratinae are represented in objective stratigraphic succession in the Permian of Western Australia, therefore making this the most important reference for metalegoceratin evolution.

Metalegoceratinae achieve conch diameters as large as 60 cm, making them the largest ammonoids known from the Palaeozoic. They range in conch form from subdiscoidal to globular, and narrowly umbilicate to openly evolute. Growth lines and constrictions are transverse (rectiradiate) or form a shallow ventral sinus. Excepting the genus *Bransonoceras* (Miller & Parizek 1948) they are smooth shelled at maturity. Genera are based primarily on the relative size, position and number of sutural elements; lobes range in number from twelve to sixteen. Width of the ventral prongs is two-thirds or less that of the corresponding external lateral lobe. Metalegoceratins are exclusively Lower Permian, ranging from Asselian through Baigendzhinian.

Genus **JURESANITES** Maximova 1940

Type species: *Juresanites primitivus* Maximova 1940; OD.

Discussion: Ancestral metalegoceratids are referred to *Juresanites*, a genus characterized by incomplete subdivision of the primary umbilical lobe. At maturity, the outer subdivision of the umbilical lobe lies close to the umbilical shoulder, and is less than one-half the area of the primary element; the dorsal subdivision is a shallow crenulation that formed ontogenetically after the outer subdivision, and is centred on the umbilical wall or seam. *Juresanites* is sporadically abundant in the basal Lower Permian (Glenister et al., 1973). It appeared first in the Asselian Stage, achieved greatest abundance in the succeeding Tastubian Substage but did not survive beyond into the Sterlitamakian Substage of the Upper Sakmarian.

Juresanites jacksoni (Etheridge Jnr 1907)
(Plate 52 figs 1-5; Figure 11A)

1907 *Gastrioceras jacksoni* Etheridge Jnr: p.36-37; pl. 9 figs 1-3
1923 *Gastrioceras jacksoni* Etheridge Jnr; Dun & David: p.249-252, pls 11-13; text figs 2-4
1929 *Paralegoceras jacksoni* (Etheridge Jnr); Thomas: p.946-948
1932 *Metalegoceras jacksoni* (Etheridge Jnr); Miller: p.433-442, pl. 1; text figs 2, 3
1942 *Metalegoceras jacksoni* (Etheridge Jnr); Teichert: p.229-230, text fig. 6B
1952 *Metalegoceras jacksoni* (Etheridge Jnr); Teichert & Glenister: p.16-18, pl. 3 figs 1-6; pl. 4 fig. 1; text figs 3A-D
1952 *Metalegoceras campbelli* Teichert & Glenister: p.18-20, pl. 3 figs 7-9; text fig. 3E
1961 *Juresanites campbelli* (Teichert & Glenister); Glenister & Furnish: p.704-705, pl. 79 figs 1-3; text fig. 8A
1961 *Juresanites jacksoni* (Etheridge Jnr); Glenister & Furnish: p.705-706, pl. 81 figs 1, 2; text fig. 8B
1973 *Juresanites jacksoni* (Etheridge Jnr); Glenister et al., p.1033-1035; pl. 2 figs 2, 3; text fig. 1D

Diagnosis: A species of *Juresanites* characterized by a combination of small umbilicus (umbilicus/diameter ratio approximately 0.35 at 75 mm conch diameter), narrow whorls (width/diameter 0.55 at 75 mm conch diameter), and uniformly rounded venter and flanks.

Discussion: This distinctive species of *Juresanites* has been known for over 75 years from abundant, well-preserved material derived from the Holmwood Shale of the Irwin River area, Perth Basin. It remains by far the most common species of Permian ammonoid known from Australia. Most representatives are from the monospecific ammonoid coquina in the Beckett Member approximately 370 m below the top of the Holmwood Shale (Glenister et al., 1973). Specimens from the Beckett Member commonly exceed 150 mm conch diameter, and one representative probably achieved a diameter in excess of 300 mm (Teichert & Glenister, 1952). Seven diminutive specimens from higher in the Holmwood Shale, the largest of 12 mm diameter, formed the basis for erection of *Metalegoceras campbelli* Teichert & Glenister (1952). Normal size of the associated fauna, and uniform diameter of the ammonoids led these authors to regard their material as mature. However, they noted the virtual identity between metalegoceratids from the Beckett Member and similar-sized representatives from higher in the formation. Subsequent discoveries of rare larger specimens in the upper Holmwood Shale render untenable the supposed distinction between *J. jacksoni* and *J. campbelli*, and necessitate suppression of the latter as a junior subjective synonym (Glenister et al., 1973).

Types: Holotype - UWA 11980; hypotypes - UWA 32030a-d, 35779, 37512, and YPM 13823.

Type locality: Near Woolaga Creek in the Irwin River area, north of Mingenew, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Beckett Member and Woolaga Limestone Member of the Holmwood Shale.

Age: Early Sakmarian (Tastubian), and/or less probably Asselian.

Abundance: Most abundant Australian Permian ammonoid.

Value in correlation and dating: The range of *Juresanites* is well established as Asselian through the Tastubian Substage of the Sakmarian. Closest affinities of *J. jacksoni* appear to be with Tastubian forms (Glenister et al., 1973), thus suggesting correlation with the Lower Sakmarian. However, an Asselian age cannot be precluded on ammonoid evidence.

Genus **METALEGOCERAS** Schindewolf 1931

Type species: *Paralegoceras sundaicum* form. *evoluta* Haniel 1915; OD.

Discussion: Smooth-shelled, twelve-lobed metalegoceratids with relatively narrow ventral prongs and full isolation of the three divisions of the primary umbilical lobe are referred to *Metalegoceras*. Both the ventral (external) and dorsal (internal) subdivisions of the primary umbilical lobe are subequal in size to the original element, which lies between them on the umbilical wall.



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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Ammonoids

(continued)

Thus seven lobes are external, and five are internal. The genus is intermediate between its progenitor, *Juresanites*, in which the subdivisions of the primary umbilical lobe are incompletely isolated, and the descendant *Pseudoschistoceras* which underwent a second tripartition of the primary umbilical lobe to produce forms with sixteen lobes.

Bransonoceras Miller & Parizek (1948) may well be polyphyletic, but is used for rare twelve-lobed metalegoceratins that retain strong transverse ribs to maturity. *Bransonoceras* is known from the Lower Permian of the western United States and south China (Glenister et al., 1979). We do not regard *Parametalegoceras* Bogoslovskaya et al. (1982) as sufficiently distinctive to warrant generic differentiation; affinities of the referred species are considered herein under the specific heading of *Metalegoceras australe*.

Metalegoceras australe (Smith 1927)
(Plate 53 figs 7-14; Figure 11C)

1927 *Paralegoceras australe* Smith: p.31-32, pl. 8 figs 1-3; non pl. 8 figs 4-6 [= *Pseudoschistoceras gigas* (Smith 1927)]
1936 *Metalegoceras clarkei* Miller: p.687-688, pl. 92 figs 1-7
1957 *Metalegoceras hudsoni* Miller & Furnish: p.1049-1050, pl. 132 figs 1-3; text fig. 6B
1961 *Metalegoceras clarkei* Miller; Glenister & Furnish: p.707-709, pl. 79 figs 4-7; pl. 80 figs 1-5; text fig. 8D
1973 *Metalegoceras australe* (Smith); Glenister et al.: p.1039-1040, pl. 5 figs 1, 2

Diagnosis: A species of *Metalegoceras* characterized by combination of a small umbilicus (umbilicus/diameter less than 0.25 at conch diameters greater than 25 mm), high secondary ventral saddle (two-thirds or more the height of the adjacent first lateral saddle), and wide prongs (only slightly narrower than the corresponding primary lateral lobe).

Discussion: *Metalegoceras australe* belongs in a group of species characterized by narrow umbilicus, high secondary ventral saddle, and relatively wide ventral prongs. In addition to *M. australe* and its synonyms, which range from Sakmarian through probable Upper Artinskian (Baigendzhinian), the group includes *Parametalegoceras arcticum* Bogoslovskaya et al., (1982) from the Sakmarian of Novaya Zemlya, *Metalegoceras* n. sp. of Glenister and Furnish (1961) from the Callytharra Formation of the Carnarvon Basin, and possibly *M. tschernyschewi* (Karpinsky 1889) from the Artinskian (Baigendzhinian) of the Urals. Bogoslovskaya has proposed *Parametalegoceras* (type species *P. arcticum*) for the group; she considered them as a small side-branch derived from *Juresanites* that did not survive beyond the Sakmarian. We acknowledge that these forms represent morphologic extremes within the diverse *Metalegoceras* stock, but concur with Ruzhentsev (1956, p.145) that too few reliable data are available to allow confident comparison of these forms. Note for example that *M. hudsoni*, *M.* n. sp., and *P. arcticum* are each known from a single specimen; the problem is compounded by ontogenetic variation, as exemplified by changes in proportion of elements in the ventral lobe of *M. tschernyschewi* (Ruzhentsev, 1956,

fig. 41). Consequently, we do not consider that *Parametalegoceras* represents a useful concept.

Glenister et al. (1973) suggested that the Artinskian genus *Sverdrupites* Nassichuk (1970) may have been derived from a form with broad prongs and narrow umbilicus such as *Metalegoceras australe* or *M.* n. sp. of Glenister and Furnish (1961). Bogoslovskaya questioned this proposed relationship by citing a purported stratigraphic gap between the two groups and the occurrence with type *Sverdrupites* of *S.* sp. (Nassichuk, 1970), a form resembling *Juresanites* in its incompletely isolated subdivisions of the umbilical lobe. In the present analysis we present evidence that no stratigraphic gap exists. Direct association of advanced and primitive forms of *Sverdrupites*, perhaps, suggests polyphyletic origin, although it may represent a simple case of dimorphism (Nassichuk, 1970).

Metalegoceras australe resembles *M. tschernyschewi* in most features, but the ratio of umbilicus/conch diameter in the circum-Indian Ocean forms is consistently 10% smaller. *Metalegoceras* n. sp. of Glenister and Furnish (1961) possesses a distinctly arcuate apex on the second lateral lobe, and the holotype of *M. arcticum* is unique in possession of a secondary ventral saddle that is almost as high as the adjacent lateral saddles.

Types: Holotype - MTHD 12709; hypotypes - SUI 5994 (holotype of *M. hudsoni*), UWA 19985, 19986, 35776 (cotypes and hypotype of *M. clarkei*), CPC 1767, 1768, F21624A-J, F21625A-E (hypotypes of *M. clarkei*).

Type locality: Bitauni, Timor, Indonesia.

Distribution and range: Mount Wynne area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone. Bitauni beds of Timor; Lower Permian of Oman.

Age: Late Sakmarian (Sterlitamakian) in Australia.

Abundance: 28 specimens.

Value in correlation and dating: The generic range of *Metalegoceras* is firmly established as Lower Sakmarian (Tastubian) through Upper Artinskian (Baigendzhinian). *Metalegoceras australe* does not allow refinement within these limits.

Metalegoceras kayi Glenister, Windle & Furnish 1973
(Plate 53 figs 5, 6; Figure 10D)

1973 *Metalegoceras kayi* Glenister et al.: p.1040-1043, pl. 4 figs 1, 2; text fig. 1E

Diagnosis: A species of *Metalegoceras* distinguished by the combination of evolute form (umbilicus/diameter ratio 0.7 at 30 mm conch diameter) with a ventral lobe that is almost twice the depth of the corresponding lateral lobe.

Discussion: Closest overall affinities of *Metalegoceras kayi* are with *M. distale* Ruzhentsev, a rare ancestral representative of the genus known only from the upper Tastubian of the Urals (Ruzhentsev,

1952, p.40). Sutural similarities are striking, especially in the disproportionate depth of the ventral lobe, and in the situation of the shallow dorsal subdivision of the primary umbilical lobe close to the umbilical seam. Conch proportions serve to distinguish the two species. A second comparable species, *M. noinskyi* Ruzhentsev (1952), is a rare direct associate of *M. distale* in the upper Tastubian and continues to relative abundance in the overlying Sterlitamakian Substage. The suture of this latter form is distinctly more advanced in all features than that of *M. kayi* (Glenister et al., 1973). *Metalegoceras striatum* Teichert (1942) from the Nura Nura Member of the Poole Sandstone resembles *M. kayi* in its evolute form, but has a much more advanced suture.

Holotype: UWA 45246.

Type locality: Type section of the Fossil Cliff Member of the Holmwood Shale at Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Type locality only, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Sakmarian (probably Sterlitamakian).

Abundance: 1 specimen.

Value in correlation and dating: Primitive nature of the suture of *Metalegoceras kayi* suggests a Sakmarian age assignment near the ancestry of the genus, possibly late Tastubian but more probably Sterlitamakian.

Metalegoceras sp. nov. Glenister & Furnish 1961
(Plate 54 fig. 11; Figure 10C)

1954 cf. *Metalegoceras* Condon: p.52
1954 *Metalegoceras* cf. *M. clarkei* Miller; Thomas & Dickins: p.219
1961 *Metalegoceras* n. sp. Glenister & Furnish: p.709-710, pl. 83 fig. 9; text fig. 9
1973 *Metalegoceras* n. sp. Glenister & Furnish; Glenister et al.: p.1040
1980 *Metalegoceras* n. sp. Glenister & Furnish; Cockbain: p.103

Diagnosis: A species of *Metalegoceras* characterized by a combination of small umbilicus (umbilicus/diameter 0.2 at 100 mm conch diameter), mature ventral prongs that are 0.85 the size of the lateral lobe, and a hooked, narrowly attenuate second lateral lobe.

Discussion: Affinities are considered under the heading of *Metalegoceras australe*.

Figured specimen: CPC 1770.

Distribution and range: Lyons River Station, **Carnarvon Basin** - base of the Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen.

Metalegoceras striatum Teichert 1942
(Plate 53 figs 1-4; Figure 11B)

1942 *Metalegoceras striatum* Teichert: p.230-231, pl. 35 fig. 1; text fig. 6C
1961 *Metalegoceras striatum* Teichert; Glenister & Furnish: p.706-707, pl. 79 figs 8-11; text fig. 8C
1973 *Metalegoceras striatum* Teichert; Glenister et al.: p.1042

Discussion: Paucity and poor preservation of known material preclude close comparison of *Metalegoceras striatum* with species from the reference sections of the southern Urals. However, it differs from other Australian metalegoceratids, except *M. kayi* in its strongly evolute conch form. It may be distinguished from *M. kayi* by its more advanced suture, strong reticulate ornament, and significantly smaller umbilicus (Glenister et al., 1973, p.1042).

Types: Holotype - UWA 20508; hypotype - UWA 1769.

Type locality: Nura Nura Ridge near Paradise Homestead, northern Canning Basin.

Distribution and range: Nura Nura Ridge, Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Sakmarian (probably Sterlitamakian).

Abundance: 2 specimens.

Value in correlation and dating: Occurrence of *Metalegoceras* suggests a range of Sakmarian (late Tastubian) into the Artinskian Baigendzhinian Substage. Sutural development is incompatible with a Tastubian assignment, but is consistent with an age within the range of Upper Sakmarian (Sterlitamakian) to Upper Artinskian (Baigendzhinian).

Genus **PSEUDOSCHISTOCERAS** Teichert 1944

Type species: *Pseudoschistoceras simile* Teichert 1944; OD.

Discussion: These most advanced metalegoceratins are characterized by a second tripartition of the primary umbilical lobe to form a total of sixteen lobes at maturity, nine of them external. The conch is relatively narrow for the family (width/diameter ratio 0.4 - 0.5) with small umbilicus (minimum umbilical dimension/diameter ratio 0.2 - 0.4). All occurrences are considered to be of Artinskian age, probably Aktastinian as well as Baigendzhinian (Glenister et al., 1983).

Pseudoschistoceras simile Teichert 1944
(Plate 52 fig. 6; Plate 54 figs 3-10; Figure 11D)

1944 *Pseudoschistoceras simile* Teichert: p.88-89, pl. 17 figs 1-5; text fig. 4
1961 *Pseudoschistoceras simile* Teichert; Glenister & Furnish: p.711-712, pl. 83 figs 1-6; text-fig. 8F
1980 *Pseudoschistoceras simile* Teichert; Cockbain: p.104

Diagnosis: An advanced species of *Pseudoschistoceras* in which the third external lateral lobe is at least one-third the size of the corresponding primary umbilical lobe at 50 mm conch diameter. The umbilicus is relatively large (minimum umbilical dimension/diameter 0.35 at 75 mm conch diameter).

Discussion: *Pseudoschistoceras simile* closely resembles the Irian Jayan species *P. irianense* in advanced sutural development, but is distinguished by its larger umbilicus (Glenister et al., 1983). Timorian *P. gigas* has a much simpler suture, the third external lateral lobe forming only a shallow crenulation in even the largest specimens.

Types: Holotype - UWA 21326; paratypes - UWA 21327-21329, 21440, 39097, 39098; hypotype - GSWA F10163.

Type locality: Northeast of Round Hill at Lat. 23°21'S, Long. 114°39'E, Carnarvon Basin - type section of the Cordalia Sandstone (GSWA F10163 only).

Distribution and range: North of Round Hill and south of Barrabiddy Dam on Wandagee Station, **Carnarvon Basin** - Cordalia Sandstone, Coyrie Formation.

Age: Artinskian (Baigendzhinian and possibly Aktastinian).

Abundance: 8 specimens.

Value in correlation and dating: Little is known of the detailed stratigraphic distribution of representatives of *Pseudoschistoceras*, thus precluding designation of a restricted age within the generic limits.

Family **PARAGASTRIOCERATIDAE** Ruzhentsev 1951

Discussion: Paragastrioceratidae comprise one of the most abundant families of Permian ammonoids, occurring commonly from the basal Permian Asselian Stage through the uppermost Permian Changhsingian Stage, and being at least represented in all of the faunal realms. All bear eight-lobed sutures. Subdivision of Paragastrioceratidae into subfamilies is based primarily on possession of either a salient or sinus in the ribs and constrictions as they cross the venter.

The family can be separated into two diverse subfamilies; rare, thinly discoidal paragastrioceratids with wide umbilicus and prominent flank ribs constitute a third subfamily, the Atsabitinae (Furnish, 1966), but will not be considered further. Paragastrioceratinae are exclusively Lower Permian (Asselian - Roadian) and are characterized by a ventral salient in the growth lines and constrictions; they are ubiquitous, but are especially characteristic of the Boreal Realm of the Ural Mountains and Arctic North America. Upper Permian paragastrioceratids display a shallow to deep hyponomic sinus and are assigned to the Pseudogastrioceratinae (Furnish, 1966). Ancestry of this subfamily is in the Lower Permian Tastubian Substage of the Sakmarian, where derivation is believed to have been from the ancestral paragastrioceratid genus *Svetlanoceras* Ruzhentsev (1974).

Pseudogastrioceratins constitute a relatively minor element in the Lower Permian, but diversified to relative abundance throughout most of the Upper Permian. They are reported to extend as a rare relict into the lowermost Lower Triassic "mixed-fauna" of south China (Sheng et al., 1984).

Genus **SVETLANOCERAS** Ruzhentsev 1974

Type species: *Uraloceras serpentinum* Maximova 1948; OD.

Discussion: Small, discoidal paragastrioceratins characterized by depressed whorls (height/width ratio less than 0.8) and ventral sutural prongs that are narrower and deeper than the corresponding lateral lobe have been segregated as *Svetlanoceras*. This taxon includes species that are transitional to the other common paragastrioceratin genera, *Paragastrioceras* (Tchernow 1907) and *Uraloceras* (Ruzhentsev 1936). However, when these three taxa are differentiated they provide excellent stratigraphic discrimination for the Lower Permian. *Svetlanoceras* dominates the basal Permian Asselian Stage in the Boreal Realm of the southern Urals to the almost total exclusion of other Paragastrioceratidae (Ruzhentsev, 1952). It extends to relative rarity in the succeeding Tastubian Substage of the Sakmarian and is unknown in the type Sterlitamakian Substage. By contrast, *Paragastrioceras* s.s. is extremely rare in the Asselian, and *Uraloceras* is unknown before the Tastubian: both diversify throughout the Sakmarian and Artinskian to maximum abundance and eventual extinction in the Baigendzhinian Substage of the Artinskian (Ruzhentsev, 1952, 1956).

Svetlanoceras is reviewed herein from Sakmarian (probably as young as Sterlitamakian) and possibly Asselian strata from Western Australia. It is also known from strata of comparable age in the Yukon Territory of Canada (Nassichuk, 1971), through an undescribed new species from West Texas, and possibly also from Arunachal Pradesh in the Eastern Himalaya (Singh, 1978).

Svetlanoceras irwinense (Teichert & Glenister 1952)
(Plate 51 figs 5, 6; Figure 8C)

1952 *Uraloceras irwinense* Teichert & Glenister: p.21-22, pl. 4 figs 2-7
1961 *Uraloceras irwinense* Teichert & Glenister; Glenister & Furnish: p.715-716, pl. 84 figs 8-11; text-figs 11A, 12
1976 *Uraloceras (Svetlanoceras) irwinense* Teichert & Glenister; Thomas: p.319
1980 *Svetlanoceras irwinense* (Teichert & Glenister); Cockbain: p.104

Diagnosis: An advanced species of *Svetlanoceras* characterized by slightly depressed to equidimensional whorls and relatively small umbilicus (minimum umbilical dimension/diameter 0.3 - 0.5).

Discussion: *Svetlanoceras irwinense* was originally assigned to *Uraloceras*, but with the subsequent segregation of primitive paragastrioceratins it is better reassigned. However, it is atypical of *Svetlanoceras* and is clearly transitional to *Uraloceras*. The closest similarities are probably with *Paragastrioceras ultaganense*

Ruzhentsev (1951) from the Sterlitamakian of the southern Urals. Detailed comparison is difficult, as factors ranging from conch form through ornament to sutural pattern change significantly throughout even later stages of ontogeny. To a large extent, the diagnostic features of typical *Svetlanoceras* reflect small mature diameter. *Svetlanoceras irwinense* was probably mature at 22 mm diameter, and most other representatives of the genus were mature at approximately 25 mm. By contrast, *P. ultaganense* exceeds 50 mm at maturity and such features as the relative asymmetry of the lateral lobe and its approximate alignment with the ventral prongs may be largely a function of this larger size.

Types: Holotype - UWA 32036; paratypes - UWA 32037-32040; hypotypes - SUI 51333, 51334 (all preceding listings from the Holmwood Shale); hypotypes - MUGD F6672, F6673 (from the Callytharra Formation).

Type Locality: West of Nangetty - Holmwood boundary fence, 1.6 km northwest of Priders Lookout, Irwin River area, Perth Basin.

Distribution and range: Almost all known representatives are from the Irwin River area, **Perth Basin** - Woolaga Limestone Member of the Holmwood Shale. However, two specimens (MUGD F6672, F6673) are now known from a locality 8.2 km at 225° from Coondoo Outcamp, Bidgemia Station, **Carnarvon Basin** - lowest fossiliferous member of the Callytharra Formation (G.A. Thomas, pers. comm., 1975).

Age: Sakmarian.

Abundance: About 25 specimens.

Value in correlation and dating: The type species of *Svetlanoceras* and closely related species such as *S. strigosum* are confined to the Asselian and the Tastubian Substage of the Sakmarian. However, transitional species like *P. ultaganense*, which *S. irwinense* resembles, occur in the Upper Sakmarian Sterlitamakian Substage. Occurrence of *S. irwinense* is thus compatible with any age assignment within the range from Asselian through Sakmarian.

Genus **PARAGASTRIOCERAS** Tchernow 1907

Type species: *Goniatites jossae* de Verneuil 1845; SD Ruzhentsev, 193

Discussion: Numerous Lower Permian species are referred to *Paragastrioceras*, a distinctive genus characterized by a large, thickly discoidal conch (width/diameter ratio commonly 0.4 - 0.6), wide umbilicus (minimum umbilical dimension/diameter ratio greater than one-third) and depressed whorls (height/width ratio commonly two-thirds). Pronounced nodes or laterally attenuate ribs are generally retained on the umbilical shoulder to maturity. Strong longitudinal strigae and weaker convex growth lines produce a reticulate sculpture. Prongs of the ventral lobe are characteristically much narrower than the corresponding lateral lobe: both the prongs and the lateral lobe are attenuate adapically and constricted adorally.

Undoubtedly valid occurrences of *Paragastrioceras* s.s. occur in the Asselian of the southern Urals, but representation there is extremely sparse (Ruzhentsev, 1952). Abundance and diversity are higher in the Sakmarian, but it is not until the Artinskian that *Paragastrioceras* becomes a dominant faunal element, especially in the Baigendzhinian Substage (Ruzhentsev, 1956). It is known from the type Kungurian, but ammonoid evidence suggests that this occurrence is correlative with the Upper Artinskian Baigendzhinian Substage (Bogoslovskaya, 1976). *Paragastrioceras* is a distinctive element of Boreal Early Permian faunas, and occurrences elsewhere are sporadic and represented by few specimens (Nassichuk et al., 1966).

Svetlanoceras is ancestral to *Paragastrioceras*, differing in its smaller size, more primitive suture, and dominance of transverse ribs. *Uraloceras* is thinner than *Paragastrioceras*, usually more evolute, has equidimensional whorls and does not retain umbilical ribs to maturity; prongs of the ventral lobe are proportionately wider in *Uraloceras*, being equal to or wider than the corresponding lateral lobe.

Paragastrioceras wandageense Teichert 1942
(Plate 51 figs 7-9; Figure 10B)

1942 *Paragastrioceras wandageense* Teichert: p.226-227, pl. 35 figs 9, 10
1961 *Paragastrioceras wandageense* Teichert; Glenister & Furnish: p.713-714, pl. 84 figs 5-7; text fig. 10A
1980 *Paragastrioceras wandageense* Teichert; Cockbain: p.103

Diagnosis: A poorly known species of *Paragastrioceras* perhaps distinguishable by the nearly symmetrical form of the external lateral lobe.

Discussion: Small size and indifferent preservation of the single known representative preclude confident comparison, especially of conch form. Most species of *Paragastrioceras* display greater asymmetry of the lateral lobe. Closest similarities in this feature are with the Baigendzhinian species from the southern Urals, *P. jossae* and *P. rauserae* (Ruzhentsev, 1956), and from the correlative type Kungurian (i.e. Baigendzhinian) of the central Cisurals (Bogoslovskaya, 1976).

Holotype: UWA 20142.

Type locality: North of road north of Wandagee Hill, west side of syncline, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Nalbia Sandstone.

Age: Roadian.

Abundance: 1 specimen.

Value in correlation and dating: Occurrence of *Paragastrioceras* affords the basis for a Lower Permian assignment, Asselian through Roadian; Baigendzhinian is most probable when abundance only is

considered. Poor preservation of *P. wandageense* precludes positive designation from specific affinities.

Genus **DAUBICHITES** Popow 1963

Type species: *Daubichites orientalis* Popow 1963; OD.

Discussion: With virtual extinction of the Paragastrioceratinae in the Baigendzhinian, the family is primarily represented in younger Permian strata by forms with a ventral sinus, the Pseudogastrioceratinae. Some ten species have been segregated from *Pseudogastrioceras* s.l. as the genus *Daubichites*. They are characterized by subdiscoidal shell (width :iameter ratio commonly 0.5) and small umbilicus (minimum umbilical dimension/diameter ratio 0.2 - 0.3). Ribs are invariably present on the umbilical shoulder of juveniles, and may persist to maturity. Growth lines and constrictions form a shallow to deep hyponomic sinus. The suture displays a high secondary ventral saddle (approximately three-quarters the height of the first lateral saddle) and prongs that are almost symmetrical and 75-100% the width of the corresponding lateral lobe.

Daubichites has broad geographic distribution, occurring in the Verkhoyan and Primor'ye Region of the Soviet Union, in North America at numerous locations extending from Texas to the Canadian Arctic Archipelago, south China, Timor, and Western Australia. It is thus a ubiquitous genus that occurs commonly in both the Boreal and the Tethyan Realms, and, therefore, serves importantly for correlation. In all locations that can be dated precisely it is restricted to the uppermost Lower Permian Roadian Stage (e.g. Bogoslovskaya et al., 1982).

Daubichites goochi (Teichert 1942)
(Plate 55 figs 1-9; Figure 10A)

1942 *Pseudogastrioceras goochi* Teichert: p.227-229, pl. 35 figs 12-16
1942 *Pseudogastrioceras* sp. Teichert: p.229, pl. 35 fig. 8 (see Glenister & Furnish, 1961, p.721)
1960 *Pseudogastrioceras fortieri* Harker; Harker & Thorsteinsson: p.75, pl. 24 figs 3-5; pl. 25 figs 1-3 (see Nassichuk, 1970, p.84)
?1961 *Pseudogastrioceras goochi* Teichert; Glenister & Furnish: p.719-722, pl. 84 figs 1-4; pl. 85 figs 1, 2, 5-7; text-figs 14A-C
1970 *Daubichites goochi* (Teichert); Nassichuk: p.82
1980 *Daubichites goochi* (Teichert); Cockbain: p.103

Diagnosis: A species of *Daubichites* characterized by combination of equidimensional whorls, umbilical ribs that are restricted to juvenile stages, and ventral prongs that approach 90% the width of the lateral lobe.

Discussion: *Daubichites goochi* most closely resembles *D. fortieri* (Harker & Thorsteinsson, 1960; see Nassichuk et al., 1966) and *D. texanum* (Clifton, 1942) in narrowly discoidal shape and in

restriction of umbilical nodes to juvenile stages. These species may perhaps be differentiated on minor differences in conch form.

An additional fragment from Wandagee Station (UWA 20507), now considered to have come from the Nalbia Sandstone (Cockbain, 1980), was described by Teichert (1942, p.229, pl. 35 fig. 8) as *Pseudogastrioceras* sp. and referred with reservation to *P. goochi* by Glenister and Furnish (1961). The holotype of *Paragastrioceras wandageense* was collected from the same general horizon and locality. Determination of the precise stratigraphic relationships between these two specimens would be significant, as *Paragastrioceras* and *Daubichites* respectively characterize the Artinskian and Roadian stages.

One further specimen, a well-preserved phragmacone of 53 mm diameter (Geologisch Instituut der Universiteit van Amsterdam T896) is available from the Bitauni area of Timor. It is indistinguishable from the Australian represenatives of *Daubichites goochi*.

Types: Holotype - UWA 20504; paratypes - UWA 20505, 20506; hypotypes - UWA 20507, 35777, CPC 1771, 1772.

Type locality: Near mouth of northeastern gully of Wandagee Hill, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone (UWA 20504-20506, 35777), and Nalbia Sandstone (UWA 20507); Duchess Ridge, northern **Canning Basin** - Lightjack Formation (CPC 1771, 1772).

Age: Roadian.

Abundance: 7 specimens.

Value in correlation and dating: Generic identity warrants a Roadian assignment, and occurrence in both Carnarvon and Canning Basins suggests general correlation of the Coolkilya Sandstone and the Lightjack Formation.

Superfamily POPANOCERATACEAE Hyatt 1900

Family POPANOCERATIDAE Hyatt 1900

Discussion: Popanoceratidae are small (less than 75 mm diameter), narrowly discoidal (width/diameter ratio 0.2 - 0.4), involute ammonoids that form a deep, narrow hyponomic sinus. They are characterized particularly by unique features of sutural ontogeny. Saddles are rounded, the dorsal lobe trifid, and most lateral lobes are strongly denticulate, especially in advanced forms. Evolutionary trends included increase in relative width of the ventral prongs, addition of lateral lobes and increase in denticulation, which afforded bases for generic differentiation. Ancestral Asselian representatives are rare, but the family diversified to great abundance throughout the remaining Early Permian, with extinction after the Wordian.

Genus **PROPOPANOCERAS** Toumanskaya 1938

Type species: *Popanoceras lahuseni* Karpinskiy 1889; OD.

Discussion: Seven species of primitive popanoceratid, some of which are common in the Boreal Realm of the southern Urals, are referred to as *Propopanoceras*. Like the ancestral popanoceratid, *Protopopanoceras* Ruzhentsev (1938), *Propopanoceras* is characterized by bidentate ventral prongs that are narrower than the corresponding first lateral lobe. Younger popanoceratid genera have prongs that are equal to or wider than the first lateral. *Propopanoceras* differs from its ancestor in development of four or five external lateral lobes, at least one of which is tridentate or quadridentate.

There is no known statigraphic overlap of Lower Permian popanoceratid genera. *Protopopanoceras* is confined to the Asselian, *Propopanoceras* is equally abundant in the two substages of the Sakmarian, and *Popanoceras* ranges from the basal Artinskian Aktastinian Substage into the Roadian.

Propopanoceras ruzhencevi Glenister & Furnish 1961
(Plate 50 fig 7; Plate 51 figs 11-13; Figure 9A)

1954 cf. *Popanoceras indo-australicum* Haniel; Thomas & Dickins: p.221
1961 *Propopanoceras ruzhencevi* Glenister & Furnish: p.723-725; pl. 86 figs 1-3; Figure 15A

Diagnosis: An advanced species of *Propopanoceras* characterized by strongly divided external lateral lobes.

Discussion: Although represented by only two rather small specimens, *Propopanoceras ruzhencevi* appears distinctive in possession of lateral lobes that are more strongly denticulate than any named species of the genus. The closest sutural similarities are with the imperfectly known *Propopanoceras* sp. nov. of Ruzhentsev (1951, p.173-174) from the Sterlitamakian of the southern Urals.

Types: Holotype - CPC 1773; paratype - CPC 1774.

Type locality: 2.6 km southwest of Paradise Homestead, northern Canning Basin.

Distribution and range: Paradise Homestead area, northern **Canning Basin** - near the top of the Nura Nura Member of the Poole Sandstone.

Age: Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Value in correlation and dating: Generic identity alone affords a reliable basis for assignment to the Sakmarian. Both the advanced form of the suture and specific comparison suggest an age near the top of the generic range (i.e. Sterlitamakian). However, paucity of material and small size of known Australian representatives preclude fully satisfactory characterization of the species, thus limiting the biostratigraphic utility.

Genus **POPANOCERAS** Hyatt 1884

Type species: *Goniatites sobolewskianus* de Verneuil 1845; SD Gemmellaro, 1887.

Discussion: A large number of species of advanced popanoceratids are referred to *Popanoceras*. The genus is characterized by prongs on the ventral lobe that are equal to, or wider than, those on the adjacent lateral lobe, and bifid to quadrifid. The four or five external lateral lobes are more strongly denticulate than in *Propopanoceras*.

Popanoceras is a widespread and common genus known from the Soviet Union (Urals, Crimea, Pamirs, Trans Alai, Darwaz and Verkhoyan), Indonesia (Timor), Western Australia, United States (Texas and Arizona), and the Canadian Arctic. The genus ranges from the lower Artinskian Aktastinian Substage through the Roadian.

Popanoceras sp. indet.
(Plate 51 fig. 10)

1961 *Popanoceras* sp. indet. Glenister & Furnish: p.725, pl. 83 fig. 10
1980 *Popanoceras* sp. indet. Glenister & Furnish; Cockbain: p.103-104

Discussion: Cross-section, surface sculpture, and form of the suture in the single specimen from Western Australia refer it to the Popanoceratidae. The form of the saddles indicates that the lateral lobes are fan-shaped; this, along with the localized nature of the constrictions, suggests an advanced species of *Popanoceras* (see Ruzhentsev, 1951, p.161).

Figured specimen: CPC 1775.

Distribution and range: Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Roadian.

Abundance: 1 specimen.

Value in correlation and dating: Generic identity indicates an Artinskian or Roadian age, and advanced features suggest the upper part of this range.

Superfamily THALASSOCERATACEAE Hyatt 1900

Family THALASSOCERATIDAE Hyatt 1900

Discussion: Uncertainty remains as to the scope of the Thalassoceratidae, but the removal of *Yinoceras* Zhao 1954 (Frest et al., 1981) leaves the family composed largely of a closely knit evolving complex that ranges from the Middle Pennsylvanian (Desmoinesian) through the Lower Guadalupian Wordian Stage. Evolutionary trends that are sustained throughout include widening of the prongs of the ventral lobe, reduction in the height of the

secondary ventral saddle, and increase in denticulation of lobes and saddles.

Thalassoceras is characterized by a first lateral saddle that is narrower than the lateral lobe and approximately one-third higher than the secondary ventral saddle. The external saddles are denticulate to more than one-half, characteristically to three-quarters, their height. *Thalassoceras* appears in the Lower Sakmarian Tastubian Substage and is moderately common from the Sterlitamakian Substage through the Wordian.

Thalassoceras wadei Miller 1936
(Plate 50 figs 3-6; Plate 52 fig. 7; Figure 9B)

1936 *Thalassoceras wadei* Miller; p.685-687, pl. 92 figs 8-12
1942 *Thalassoceras wadei* Miller; Teichert: p.231, pl. 35 fig. 11; Figure 7
1951 *Thalassoceras multifidum* Ruzhentsev: p.106-107, pl. 6 figs 8, 9; Figure 28
1961 *Thalassoceras wadei* Miller; Glenister & Furnish: p.699-700, pl. 78 figs 1-5; text figs 6, 7

Diagnosis: An incompletely characterized species of *Thalassoceras*, perhaps distinguishable by combination of the following sutural features: lateral lobe three-quarters the width of the ventral prong; and first lateral saddle nearly parallel-sided and at mid-height less than three-quarters the width of the lateral lobe.

Discussion: Although Australian representatives are inadequate for full characterization of *Thalassoceras wadei*, it seems probable that this is a valid and distinctive species. In a comprehensive review of the entire family, Beinert (1971) concluded that the closest affinities of the Australian material are with Upper Sakmarian specimens from the southern Urals, for which Ruzhentsev (1951) proposed the new species *T. multifidum*.

Types: Lectotype (designated herein) - UWA 19988; paralectotype - UWA 19987; hypotypes - UWA 20143, CPC 1766, F21626.

Type locality: Nura Nura Ridge, Paradise Homestead area, northern Canning Basin.

Distribution and range: Nura Nura Ridge and Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Upper Sakmarian (Sterlitamakian).

Abundance: 6 specimens.

Value in correlation and dating: Thalassoceratid taxa are long-ranging in comparsion with many other Permian ammonoids. Probable identity of Australian representatives with Sterlitamakian specimens from the southern Urals supports, but does not confirm, the Upper Sakmarian assignment of the Nura Nura Member.

Order PROLECANITIDA Miller & Furnish 1954
Superfamily MEDLICOTTIACEAE Karpinskiy 1889

Family MEDLICOTTIIDAE Karpinskiy 1889

Genus **BAMYANICERAS** Termier & Termier 1970

Type species: *Bamyaniceras bouyxi* Termier & Termier 1970; OD.

Discussion: The group of species now assigned to *Bamyaniceras* resembles *Propinacoceras* Gemmellaro (1887) in the broadly discoidal shell form and general configuration of the mature suture. However, sutural ontogenies differ markedly, and when the generic distinction is established on this basis, *Bamyaniceras* is a dominantly Lower Permian (Artinskian) taxon whereas *Propinacoceras* is confined to the Upper Permian Wordian Stage.

Although *Bamyaniceras* is characteristic of the Artinskian, it extends as a rare element into the basal Upper Permian Wordian Stage. The one area in which the genus is relatively abundant is the Artinskian (Leonardian = Baigendzhinian) of west Texas and Nevada, where it occurs almost to the exclusion of other ammonoids and is represented by *B. simile* (Haniel 1915), *B. knighti* (Miller & Furnish 1940), and several new species. *Bamyaniceras* is extremely rare in the Urals, but is represented there in the Late Artinskian (Baigendzhinian) by *B. ajense* (Maximova 1935) and *B. aktubense* (Ruzhentsev 1939). Similarly, *B. simile* (Haniel 1915), a species closely comparable with the Australian *B. australe*, is one of the rare elements of the Artinskian Bitauni fauna of Timor.

Bamyaniceras australe (Teichert 1942)
(Plate 50 figs 10-17; Figure 12B)

1942 *Propinacoceras australe* Teichert: p.224-226, pl. 35 figs 2-7; text fig. 3C
1961 *Propinacoceras australe* Teichert; Glenister & Furnish: p.691-694, pl. 78 figs 6-13; text fig. 3A
1980 *Bamyaniceras australe* (Teichert); Cockbain: p.102

Diagnosis: A species of *Bamyaniceras* characterized by combination of two adventitious subdivisions across the crest and one prominent bifid subdivision on the dorsal flank of the first external lateral saddle, and external lateral lobes that are all bifid at maturity.

Discussion: *Bamyaniceras australe* belongs in the group of *B. simile* (Haniel 1915) but differs from that species in deeper and more pervasive subdivision of the lateral lobes. *Bamyaniceras* n. sp. of Glenister and Furnish (1961) is distinguishable in possession of three subdivisions on the crest of the first lateral saddle. At maturity, Upper Permian (Wordian) representatives of the genus, such as *Bamyaniceras galilaei* (Gemmellaro 1887), have the first adventitious element situated on the crest rather than the dorsal flank of the first lateral saddle.

Types: Holotype - UWA 20145; hypotypes - CPC 1763, 1764, UWA 20144a, b, 20509, 20510.

Type locality: West limb of syncline north of Wandagee Hill, north of Wandagee Road, Carnarvon Basin.

Distribution and range: Wandagee Station (UWA 20145 and one other specimen, UWA 20144a,b, 20509, 20510, CPC 1763, F21628, F21629A-D), Coolkilya Pool (UWA 23237), and Donellys Well (CPC 1764), **Carnarvon Basin** - Nalbia Sandstone (UWA 20145 plus the addition specimen), Wandagee Formation (UWA 20144a,b, 20509, 20510, CPC 1763, F21628), Quinnanie Shale (UWA 23237), and Bulgadoo Shale (CPC 1764, F21629A-D); Christmas Creek Homestead, northern **Canning Basin** - basal Liveringa Group (UWA 2555); other occurrences of "*Propinacoceras*" (commonly misspelled "*Propinoceras*"), presumably also *Bamyaniceras*, were listed in Condon (1954, 1967) and Dickins (1956). These are from the upper part of the type section of the Billidee Formation, from Moogooree Homestead and from Keogh Hill, all in the **Carnarvon Basin** - Billidee Formation and Mallens Sandstone.

Age: Artinskian through Roadian.

Abundance: At least 16 specimens identified to species level.

Value in correlation and dating: Range of *Bamyaniceras* is Artinskian through Wordian. However, the group of *B. simile*, including *B. australe*, is confined to the Lower Permian, Artinskian (Aktastinian) through Roadian.

Bamyaniceras sp. nov. Glenister & Furnish 1961
(Plate 50 figs 18, 19; Figure 12A)

1961 *Propinacoceras* n. sp. Glenister & Furnish: p.694-695, pl. 78 figs 14, 15; text fig. 4
1980 *Bamyaniceras* n. sp. Glenister & Furnish; Cockbain: p.102-103

Discussion: Only the ventral and adjacent ventrolateral portions of the suture of *Bamyaniceras* sp. nov. are known. The first lateral saddle differs from that of *B. australe* in possession of three flexures across the crest rather than two. Rounded nodes on the ventrolateral shoulder also distinguish the new species.

Figured specimen CPC 1765. Other specimens CPC F21627, GSWA F11077/1 (latter *fide* Cockbain, 1980).

Distribution and range: Donellys Well area on Moogooree Station, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 3 specimens.

Value in correlation and dating: Limited by inadequate morphologic and distributional data, but resembles Lower Permian species.

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Gastropods

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GASTROPOD GENERA AND SPECIES

Class GASTROPODA Cuvier 1797
Subclass PROSOBRANCHIA Milne Edwards 1848
Order ARCHAEOGASTROPODA Thiele 1925
Suborder BELLEROPHONTINA Ulrich & Schofield 1897
Superfamily BELLEROPHONTACEA M'Coy 1851

Family SINUITIDAE Dall 1913
Subfamily EUPHEMITINAE Knight 1956

Genus **EUPHEMITES** Warthin 1930

Type species: *Bellerophon urii* Fleming 1928; SD Waagen, 1880.

Euphemites sp.

1967 *Euphemites* sp. Condon: p.131
1975 *Euphemites* sp. Playford et al.: p.284

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Shallow and moderately deep water.

Euphemites sp. nov.

1967 *Euphemites* sp. nov. Condon: p.169, 184

Distribution and range: **Carnarvon Basin** - Wandagee Formation, Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian.

Sedimentary environment: Shallow and moderately deep-water.

Euphemites wynnensis Dickins 1963
(Plate 56 figs 7, 8, 12)

1963 *Euphemites wynnensis* Dickins: p.107-109, pl. 21 figs 1-9; text fig. 15

Diagnosis: "A rather inflated species of *Euphemites*; outer whorl surface evenly rounded; spiral lirae not particularly prominent" (Dickins, 1963, p.107).

Closest species: No very closely related species described.

Types: Holotype - CPC 3986; paratypes - CPC 3987-3991.

Type locality: 2.0 km southwest of Paradise Homestead, northern Canning Basin.

Distribution and range: Type locality only, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 137 specimens.

Value in correlation and dating: Relationships outside Canning Basin not clear.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Genus **WARTHIA** Waagen 1880

Type species: *Warthia brevisinuata* Waagen 1880; SD de Koninck, 1882.

Warthia? carinata Dickins 1963
(Plate 56 figs 6, 10, 11)

1963 *Warthia? carinata* Dickins: p.110-111, pl. 22 figs 1-8

Diagnosis: "Inflation moderate; distinguished by keeled shell with slit-band forming a flat area at periphery" (Dickins, 1963, p.110).

Closest species: None known.

Types: Holotype - UWA 45432; paratypes - UWA 45433-45435.

Type locality: Mount Wynne, from beds overlying the limestone of the Nura Nura Member, 2.1 km east of Nura Ridge, northern Canning Basin.

Distribution and range: Type locality, and Paradise Homestead area only, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 15 specimens.

Climate: Species occurs in sedimentary rocks that were laid down in temperate climate.

Sedimentary environment: Shallow water.

Warthia intermedia Dickins 1963
(Plate 56 figs 1-3)

1963 *Warthia intermedia* Dickins: p.109-110, pl. 21 figs 10-19

Diagnosis: "Inflation moderate; outer whorl cross-section rounded and with a very slight keel" (Dickins, 1963, p.109).

Closest species: Somewhat similar to *W. perspecta* Fletcher (1958, p.149) from Ravensfield Sandstone of the Permian of New South Wales.

Types: Holotype - CPC 3979; paratypes - CPC 3980-3983.

Type locality: 2.0 km southwest of Paradise Homestead, northern Canning Basin.

Distribution and range: Paradise Homestead area, ?Saint George Range, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 20+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Warthia sp. A cf. **W. micromphala** (Morris 1845)
(Plate 56 figs 4, 5)

1956 *Warthia* cf. *micromphala* (Morris); Dickins & Thomas: p.51
1958 *Warthia* cf. *micromphala* (Morris); Guppy et al.: p.53
1963 *Warthia* cf. *micromphala* (Morris); Dickins: pl. 22 figs 9-12

Distribution and range: Dry Corner Syncline, Lake Dora area, southwestern **Canning Basin**, and Luluigui Station, northern **Canning Basin** - upper Noonkanbah Formation or lower Liveringa Group, Lightjack Formation (upper Liveringa Group); southern **Canning Basin** - Triwhite Sandstone.

Age: Late Artinskian (Baigendzhinian) - Chhidruan.

Warthia sp. B cf. **W. micromphala** (Morris 1845)

1967 *Warthia* cf. *micromphala* Condon: p.173, 184

Distribution and range: **Carnarvon Basin** - Nalbia and Coolkilya Sandstones.

Age: Late Artinskian (Baigendzhinian) - Kungurian (Filippovian - Ufimian).

Sedimentary environment: Shallow water.

Warthia sp. A

1967 *Warthia* sp. Condon: p.97, 131

Distribution and range: Mount Sandiman woolshed area and elsewhere in the **Carnarvon Basin** - Billidee and Coyrie Formations.

Age: Artinskian (Aktastinian, Baigendzhinian).

Sedimentary environment: Shallow and moderately deep water.

Warthia sp. B

1976 *Warthia* sp. Playford et al.: p.96

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Sedimentary environment: Shallow water.

Warthia sp. C

1958 *Warthia* sp. Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Sedimentary environment: Shallow water.

Warthia? sp. indet.

1956 *Warthia?* sp. indet. Dickins & Thomas: p.53

Distribution and range: Cuncudgerie Hill area, southwestern **Canning Basin** - ?Nura Nura Member of the Poole Sandstone.

Age: ?Late Sakmarian (Sterlitamakian).

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Genus **STACHELLA** Waagen 1880

Type species: *Bellerophon pseudohelix* Stache 1877; SD de Koninck 1883.

Stachella crucilirata Dickins 1963
(Plate 56 figs 9, 13-15)

1963 *Stachella crucilirata* Dickins: p.116-117, pl. 20 figs 1-13
1976 *Stachella crucilirata* Dickins; Playford et al.: p.96

Diagnosis: "Shells of moderate size, not particularly asymmetrical; spiral lirae all of similar size, closely spaced and fine" (Dickins, 1963, p.116).

Closest species: None known.

Types: Holotype - CPC 3972; paratypes - CPC 3973-3976.

Type locality: Becketts Gully, 0.64 km above road crossing, Irwin River area, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 100 specimens, mainly from the Fossil Cliff Member of the Holmwood Shale.

Value in correlation and dating: Useful for correlation between Canning and Perth Basins.

Climate: Species occurs in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Stachella sp.

1967 *Stachella* sp. Condon: p.149

Distribution and range: Carrandibby Range area, **Carnarvon Basin** - Coyrie Formation; southwest **Canning Basin** - Triwhite Sandstone.

Age: Kungurian.

Sedimentary environment: Moderately deep water.

Stachella sp. nov.

1967 *Stachella* sp. nov. Condon: p.131, 169

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Wandagee Formation.

Age: Baigendzhinian.

Sedimentary environment: Shallow water.

Family BELLEROPHONTIDAE M'Coy 1851
Subfamily BELLEROPHONTINAE M'Coy 1851

Genus **BELLEROPHON** Montfort 1808

Type species: *Bellerophon vasulites* Montfort 1808.

Bellerophon costatus Sowerby 1834
(Plate 56 figs 16, 17, 22)

1834 *Bellerophon costatus* J. de C. Sowerby: p.110, pl. 470 fig. 4
1907 *Bellerophon costatus* J. de C. Sowerby, var.; Etheridge Jnr: p.35-36, pl. 7 figs 11-15
1914 *Bellerophon costatus* J. de C. Sowerby; Etheridge Jnr: p.37

Distribution and range: Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale; Mount Marmion area, northern **Canning Basin** - Noonkanbah Formation.

Age: ?Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Abundance: 5 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Bellerophon? decussatus Fleming 1828

1328 *Bellerophon decussatus* Fleming: p.328
1890 *Bellerophon decussatus?* Fleming; Foord: p.154

Distribution and range: Irwin River area, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale.

Age: ?Late Sakmarian (Sterlitamakian).

Abundance: Several internal casts.

Value in correlation and dating: Relationships not known.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Bellerophon formani Dickins 1963
(Plate 56 figs 18-21)

1963 *Bellerophon formani* Dickins: p.111-112, pl. 19 figs 14-22

Diagnosis: "Non-umbilicate at adult stage; height about equal to width; slit-band rather narrow; concentric growth ornament of fine lines" (Dickins, 1963, p.111).

Closest species: None known.

Types: Holotype - CPC 3966; paratypes - CPC 3967-3971.

Type locality: 25.6 km at 120° from Mount Tuckfield in the southern part of the Saint George Range, northern Canning Basin.

Distribution and range: Type locality only - near the base of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 50+ specimens.

Value in correlation and dating: Not known.

Climate: Found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Bellerophon sp. cf. **B. formani** Dickins 1963
(Plate 56 figs 23, 24)

1963 *Bellerophon* cf. *formani* Dickins: p.112-113, pl. 19 figs 5-13
1976 *Bellerophon* sp. cf. *B. formani* Dickins; Playford et al.: p.96, 100

Figured specimens: UWA 45422-45427.

Distribution and range: Becketts Gully, Woolaga Creek and Fossil Cliff on Irwin River, **Perth Basin** - High Cliff Sandstone, Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian) - early Artinskian (Aktastinian).

Abundance: Many specimens in Fossil Cliff Member of the Holmwood Shale.

Bellerophon sp.

1967 *Bellerophon* sp. Condon: p.149
1963 *Bellerophon* sp. Dickins: chart (fig. 5)

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale; **Carnarvon Basin** - Coyrie Formation.

Age: Sakmarian - Late Artinskian (Baigendzhinian).

Sedimentary environment: Moderately deep water.

Bellerophon sp. indet.

1956 *Bellerophon* sp. indet. Dickins & Thomas: p.53

Distribution and range: Cuncudgerie Hill area, southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Bellerophon sp. nov. A
(Plate 56 figs 26, 27)

1963 *Bellerophon* sp. nov. Dickins: p.113, pl. 19, figs 1-4
1976 *Bellerophon* n. sp. Playford et al.: p.96

Figured specimens: UWA 45427, 45428.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, High Cliff Sandstone.

Age: Late Sakmarian (Sterlitamakian) - Early Artinskian (Aktestinian).

Abundance: 5 specimens.

Bellerophon sp. nov. B

1967 *Bellerophon* sp. nov. Condon: p 169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Climate: Species found in sedimentary rocks which accumulated under temperate conditions.

Sedimentary environment: Shallow water.

Bellerophontidae gen. indet.

1956 Bellerophontidae gen. indet. Dickins & Thomas: p.53

Distribution and range: Cuncudgerie Hill area, southwestern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Bellerophontids

1958 Bellerophontids Guppy et al.: p.49, 54
1967 Bellerophontid Condon: p.97

Distribution and range: Moogooree Homestead area, **Carnarvon Basin** - Billidee Formation; northern **Canning Basin** - Noonkanbah Formation, Hardman Formation.

Age: Early Artinskian (Aktastinian) - Chhidruan.

Subfamily KNIGHTITINAE Knight 1956

Genus **RETISPIRA** Knight 1945

Type species: *Retispira bellireticulata* Knight 1945; OD.

"Retispira" clarkei Dickins 1963
(Plate 56 figs 25, 28)

1963 *"Retispira" clarkei* Dickins: p.114-115, pl. 20 figs 14-19
1976 *"Retispira" clarkei* Dickins; Playford et al.: p.96

Diagnosis: "Shell flaring only slightly towards aperture; slit-band without distinct bounding lirae and with many spiral lirae. Spiral lirae on surface of whorl closely spaced, of differing prominence and with nodes along their length formed by intersection of less prominent transverse growth ornament" (Dickins, 1963, p.114).

Closest species: None known.

Types: Holotype - CPC 3977; paratype - CPC 3978.

Type locality: Carynginia Gully, about 0.8 km on a bearing of 334° from Carynginia (No. 1) Well, Irwin River area, **Perth Basin**.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Value in correlation and dating: Nil.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Retispira emerii (Etheridge Jnr 1907)

1958 *Bucanopsis emerii* (Etheridge Jnr); Guppy et al.: p.53

Distribution and range: Northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Sedimentary environment: Shallow water.

Retispira sp. cf. **R. emerii** (Etheridge Jnr 1907)

1967 *Retispira* cf. *emerii* Condon: p.169, 173

Distribution and range: **Carnarvon Basin** - Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian (Filippovian).

Sedimentary environment: Shallow water.

Retispira irwinensis Dickins 1963
(Plate 56 figs 29-31)

1963 *Retispira irwinensis* Dickins: p.114, pl. 20 figs 20-24
1976 *Retispira irwinensis* Dickins; Playford et al.: p.96

Diagnosis: "Shell wide; spiral and transverse ornament fine and closely spaced; spiral lirae more prominent at irregular intervals, the stronger lirae separated by several finer ones. A narrow external umbilicus" (Dickins, 1963, p.114).

Closest Species: Not known.

Types: Holotype - UWA 45429; paratypes - UWA 45430, 45431.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterli kian).

Abundance: 9 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Superfamily EUOMPHALACEA de Koninck 1881
Family EUOMPHALIDAE de Koninck 1881

Genus **STRAPAROLUS** Montfort 1810

Type species: *Straparolus dionyso* Montfort 1810.

Subgenus **EUOMPHALUS** J. Sowerby 1814

Type species: *Euomphalus pentangulatus* J. Sowerby 1814; SD Meek & Worthen, 1866.

Straparolus (Euomphalus) sp.

1967 *Straparolus (Euomphalus)* sp. Condon: p.169

Distribution and range: **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Subgenus **LEPTOMPHALUS** Yochelson 1956

Type species: *Straparolus (Leptomphalus) micidus* Yochelson 1956

Straparolus (Leptomphalus) besselensis Dickins 1963
(Plate 56 fig. 38)

1963 *Straparolus (Leptomphalus) besselensis* Dickins: p.129-130, pl. 24 figs 1-4

Diagnosis: "Discoidal and completely lacking a spire. Basal umbilicus wide and shallow; sutures distinct and whorl cross-section completely rounded" (Dickins, 1963, p.129).

Closest species: Not known.

Types: Holotype - CPC 4010; paratypes - CPC 4011-4013.

Type locality: 2.57 km southwest of Paradise Homestead, northern **Canning Basin**.

Distribution and range: Type locality only, **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 30+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Straparolus (Leptomphalus) sp.

1967 *Straparolus (Leptomphalus)* sp. Condon: p.131. 169

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Straparolus? sp.

1967 *Straparolus?* sp. Condon: p.184

Distribution and range: **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian (Irenian).

Genus **KEENEIA** Etheridge Jnr 1902

Type species: *Keeneia platyschismoides* Etheridge Jnr 1902.

Keeneia carnarvonensis Dickins 1957
(Plate 56 Figs 36, 39)

1957 *Keeneia carnarvonensis* Dickins: p.50-51, pl. 9 figs 9 -11
1959 *Keeneia carnarvonensis* Dickins; Dickins & Thomas: p.70-72, 78
1975 *Keeneia carnarvonensis* Dickins; Playford et al.: p.279

Diagnosis: "Small *Keeneia* with periphery slightly but distinctly above lowest part of whorl. Aperture more rounded than in *K. platyschismoides* or *K. ocula*" (Dickins, 1957, p.50).

Closest species: Undescribed species from Permian Allandale Formation of New South Wales.

Types: Holotype - CPC 2264; paratype - CPC 2265.

Type locality: 4.8 km northeast of Round Hill Well, Winning Station, Carnarvon Basin.

Distribution and range: Winning, Williambury and Jimba Jimba Stations, **Carnarvon Basin** - upper part of the Lyons Group in Minilya - Williambury and Lyndon River areas ("Thambrong Formation", "Mundarie Siltstone"), Carrandibby equivalent in the Jimba Jimba area.

Age: Early Sakmarian (Tastubian).

Abundance: 5 species.
Value in correlation and dating: Indicates early Early Permian; useful for correlation between western and eastern Australia.

Climate: Species found in sedimentary rocks that were laid down under cold conditions.

Sedimentary environment: Shallow water.

Keeneia? sp. nov.
(Plate 56 figs 35, 37)

1963 *Straparolus (Leptomphalus)* sp. nov. Dickins: p.130, pl. 25 figs 1-3

Figured specimens: UWA 45449.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Suborder PLEUROTOMARIINA Cox & Knight 1960
Superfamily PLEUROTOMARIACEA Swainson 1840

Family SINUOPEIDAE Wenz 1938
Subfamily PLATYSCHISMATINAE Knight 1956

Genus **PLATYSCHISMA** M'Coy 1844

Type species: *Ampullaria helicoides* J. de C. Sowerby 1826; SD de Koninck (1881, p.107).

Platyschisma? sp. nov
(Plate 56 fig. 40)

1957 *Platyschisma?* sp. nov. Dickins: p.51, pl. 8 fig. 8
1959 *Platyschisma?* sp. Dickins & Thomas: p.71

Figured specimen: CPC 2266.

Distribution and range: Minilya - Williambury area, **Carnarvon Basin** - upper part of the Lyons Group.

Abundance: 3 specimens.

Age: Early Sakmarian (Tastubian).

Climate: Species found in sedimentary rocks that were deposited mainly under cold conditions.

Sedimentary environment: Shallow water.

Family **PLEUROTOMARIIDAE** Swanson 1840

Genus **BAYLEA** de Koninck 1883

Type species: *Trochus yvanii* Leveille 1835; OD.

Baylea perthensis Dickins 1963
(Plate 56 figs 32-34)

1963 *Baylea perthensis* Dickins: p.127-128, pl. 26 figs 10-16
1976 *Baylea perthensis* Dickins; Playford et al.: p. 96

Diagnosis: "Upper surface divided into two distinct parts; peripheral part concave. Slit-band relatively broad, forming junction of upper and outer whorl surfaces and ornamented with spiral lirae. Distinct concave area on outer surface, immediately below slit-band" (Dickins, 1963, p.127).

Closest species: No close species known.

Types: Holotype - UWA 45446; paratypes - UWA 45447, 45448.

Type locality: Fossil Cliff on Irwin River, **Perth Basin**.

Distribution and range: Fossil Cliff, High Cliff, Becketts Gully and Woolaga Creek, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 7+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Baylea? sp.

1967 *Baylea?* sp. Condon: p.149

Distribution and range: Carrandibby Range area, **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Baylea? sp. nov.

1958 *Baylea?* sp. nov. Guppy et al.: p.49

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Genus **MOURLONIA** de Koninck 1883

Type species: *Helix carinatus* J. Sowerby 1812; OD.

Subgenus **MOURLONIA** de Koninck 1883

Mourlonia (Mourlonia) lyndonensis Dickins 1957
(Plate 57 figs 3, 6)

1957 *Mourlonia? lyndonensis* Dickins: p.46-47, pl. 8 figs 1-5
1959 *Mourlonia? lyndonesis* Dickins; Dickins & Thomas: p.72
1963 *Mourlonia (Mourlonia) lyndonensis* Dickins: p.119, pl. 24, figs 5, 6
1967 *Mourlonia (Mourlonia) lyndonesis* Dickins; Condon: p.61
1975 *Mourlonia lyndonensis*; Playford et al.: p.279, 280

Diagnosis: "Pleurotomariid gastropods with slit-band (selenizone) bounded on either side by a carina, distinct parallel ornament, spire turbinate and cross-section oval; an umbilicus is present" (Dickins, 1957, p.46).

Closest species: Not known to closely resemble any described species.

Types: Holotype - CPC 2255; paratypes - CPC 2256-2258; hypotype - CPC 4008

Type locality: About 4.8 km northeast of Round Hill Well, Winning Station, Carnarvon Basin.

Distribution and range: Winning and Byro Stations, Lyndon River area, **Carnarvon Basin** - upper part of the Lyons Group ("Thambrong Formation"), Carrandibby Formation.

Age: Early Sakmarian (Tastubian).

Abundance: 12 specimens.

Value in correlation and dating: The species appears to indicate equivalence of upper part of the Lyons Group and the Carrandibby Formation to which its occurrence is limited in Western Australia. Similar specimens, however, have been recorded by Dickins and Shah (1979) from Badhaura, Rajasthan, Peninsular India.

Climate: Species found in sedimentary rocks that were deposited under cold to moderately warm conditions.

Sedimentary environment: Shallow water.

Mourlonia (Mourlonia) sp.

1967 *Mourlonia (Mourlonia)* sp. Condon: p.184

Distribution and range: **Carnarvon Basin** - Coolkilya Sandstone; southern **Canning Basin** - Triwhite Sandstone.

Age: Early - Middle Kungurian (Irenian - Ufimian)

Sedimentary environment: Shallow water, marine.

Mourlonia (Mourlonia) sp. nov. A
(Plate 57 figs 2, 9)

1963 *Mourlonia (Mourlonia)* sp. nov. Dickins: p.119, pl 23 figs 18-21
1967 *Mourlonia (Mourlonia)* sp. nov. Condon: p.71

Figured specimen: CPC 3992.

Distribution and range: Curbur Homestead area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water (35 - 50 m).

Mourlonia (Mourlonia) sp. nov. B

1967 *Mourlonia (Mourlonia)* sp. nov. Condon: p.131, 169, 173

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian (Filippovian).

Sedimentary environment: Shallow water.

Subgenus **PSEUDOBAYLEA** Dickins 1963

Type species: *Pseudobaylea freneyensis* Dickins 1963

Mourlonia (Pseudobaylea) freneyensis Dickins 1963
(Plate 57 fig. 1)

1959 *Baylea?* sp. Dickins *in* Playford: p.19
1963 *Mourlonia (Pseudobaylea) freneyensis* Dickins: p.121-122, pl. 23 figs 1-11
1976 *Mourlonia (Pseudobaylea) freneyensis* Dickins; Playford et al.: p.96
1979 *Mourlonia (Pseudobaylea) freneyensis* Dickins; Dickins & Shah: p.24

Diagnosis: "Shell of moderate height, steplike upper whorl surface of mature shell slightly convex and meeting outer whorl surface at an angle at which slit-band is situated. Ornament simple, composed of fine numerous transverse and spiral lirae; spiral lirae, except the two bounding slit-band, of almost equal prominence" (Dickins, 1963, p.121).

Closest species: *Pleurotomaria* aff. *conglobata* Wanner, Reed (1932) from the Agglomeratic Slate of Kashmir and *Pleurotomaria nuda* Dana, Waagen (1891) from the Speckled Sandstone of the Salt Range, Pakistan.

Types: Holotype - CPC 3995; paratypes - CPC 4000-4006.

Type locality: 2.8 km southwest of Paradise Homestead, northern **Canning Basin**.

Distribution and range: Carynginia Well area, Becketts Gully and ?Woolaga Creek, Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area and Saint George Range, northern **Canning Basin** - Nura Nura Member, and near the base, of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Particularly abundant in the Nura Nura Member (150+ specimens).

Value in correlation and dating: Valuable because of its abundance and wide geographic distribution; as well as being closely related to specimens from formerly India (now Pakistan), comparable forms have been recorded from northwest Tibet (Lin and Lui, 1983).

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Mourlonia (Pseudobaylea) sp. cf. **M.(P.) freneyensis** Dickins 1963

1976 *Mourlonia (Pseudobaylea)* sp. cf. *M.(P.) freneyensis* Dickins; Playford et al.: p.100

Distribution and range: **Perth Basin** - High Cliff Sandstone.

Age: Early Artinskian (Aktastinian).

Sedimentary environment: Shallow water.

Mourlonia (Pseudobaylea?) sp. nov.

1967 *Mourlonia (Pseudobaylea?)* sp. nov? Condon: p.97, 131

Distribution and range: **Carnarvon Basin** - Billidee Formation (Mount Sandiman Woolshed area) and Coyrie Formation.

Age: Early to Late Artinskian (Aktastinian - Baigendzhinian).

Sedimentary environment: Shallow water to moderately deep water.

Subgenus **WOOLNOUGHIA** Dickins 1963

Type species: *Woolnoughia angulata* Dickins 1963.

Mourlonia (Woolnoughia) angulata Dickins 1963
(Plate 57 figs 5, 11)

1963 *Mourlonia (Woolnoughia) angulata* Dickins: p.123, pl. 23 figs 12-17
1976 *Mourlonia (Woolnoughia) angulata* Dickins; Playford et al.: p.96

Diagnosis: "Spire rather high. In mature whorls, slit-band raised slightly above surface of rest of shell and marked on either side by a lira more prominent than other spiral lirae; slit-band slightly above periphery on last whorl and with one distinct spiral lira on it and apparently another two faint lirae, one on either side on the main lira" (Dickins, 1963, p.123).

Types: Holotype - UWA 45436; paratypes - UWA 45437-45439.

Type locality: Fossil Cliff on Irwin River, Perth Basin.

Distribution and range: The type locality only, **Perth Basin** Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 8 specimens.

Climate: Species associated with sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Mourlonia? obscura Dickins 1963
(Plate 57 figs 7, 10)

1963 *Mourlonia? obscura* Dickins: p.124, pl. 22 figs 13-21

Diagnosis: "Shell of moderate height, whorls ratner well rounded. External ornament of obscure growth-lines and a large number of fine, closely spaced spiral lirae of about equal prominence. No definite slit-band" (Dickins, 1963, p.124).

Types: Holotype - CPC 3993; paratypes - CPC 3994-3998.

Type locality: Carynginia Gully, about 0.8 km on a bearing of 334° from Carynginia (No. 1) Well, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Paradise Homestead area, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 6 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Mourlonia sp.

1967 *Mourlonia (Platyteichum?)* sp. Condon: p.184

Distribution and range: **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian (Irenian).

Genus **PTYCHOMPHALINA** Fischer 1885

Type species: *Helix? striatus* J. Sowerby 1817.

Ptychomphalina maitlandi Etheridge Jnr 1903
(Plate 57 fig. 4)

1903 *Ptychomphalina maitlandi* Etheridge Jnr: p.24, pl. 1 figs 13-15
1914 *Ptychomphalina maitlandi* Etheridge Jnr: p.37
1931 *Ptychomphalina maitlandi* Etheridge Jnr; Hosking: p.36
1956 *Ptychomphalina maitlandi* Etheridge Jnr; Dickins & Thomas: p.51
1958 *Ptychomphalina maitlandi* Etheridge fil.; Guppy et al.: p.49
1963 *Ptychomphalina maitlandi* Etheridge Jnr; Dickins: p.126, pl. 24 fig. 9-11
1967 *Ptychomphalina maitlandi* Etheridge fil.; Condon: p.149, 152
1967 *Ptychomphalina* cf. *maitlandi* Etheridge; Condon: p.169
1975 *Ptychomphalina maitlandi* Playford et al.: p.287
1976 *Ptychomphalina maitlandi* Etheridge Jnr; Playford et al.: p.117

Diagnosis: Spire conical, moderately high, rather straight sided; upper whorl surface cross-section relatively strong and making a distinct angle with the lower whorl surface; ornament mainly of numerous fine (colabral) lirae.

Types: Lectotype - GSWA F169A; hypotypes - UWA 28292, 45443-45445; another figured specimen - GSWA F169B.

Distribution and range: Mingenew and Arrino areas, **Perth Basin** - Mingenew Formation; Minilya River and Wooramel area, **Carnarvon Basin** - Coyrie Formation, Mallens Sandstone, Bulgadoo Shale or Cundlego Formation, Wandagee Formation; northern **Canning Basin** - Noonkanbah Formation; southern **Canning Basin** - Triwhite Sandstone.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Abundant in both Carnarvon and Canning Basins.

Value in correlation and dating: An indicator for Byro Group and Noonkanbah Formation.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water and deeper water.

Ptychomphalina sp.

1967 *Ptychomphalina* sp. Condon: p.131, 184

Distribution and range: **Carnarvon Basin** - Coyrie Formation, Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian (Irenian).

Sedimentary environment: Shallow to moderately deep water, but not far from land.

Ptychomphalina sp. nov.

1956 *Ptychomphalina* sp. nov. Dickins & Thomas: p.53
1958 *Ptychomphalina* sp. nov. Guppy et al.: p.49

Distribution and range: Cuncudgerie Hill area, southwestern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian) - Late Artinskian (Baigendzhinian).

Ptychomphalina talboti Dickins 1963
(Plate 57 figs 8, 12, 13)

1963 *Ptychomphalina talboti* Dickins: p.125-126, pl. 24, figs 12-19
1976 *Ptychomphalina talboti* Dickins; Playford et al.: p.96

Diagnosis: "Spire conical; whorl cross-section very angular at mature stage with slit-band situated at periphery" (Dickins, 1963, p.125).

Types: Holotype - CPC 4007; paratypes - UWA 45440-45442, UQGD F27126.

Type locality: Fossil Ridge, Irwin River area, **Perth Basin**.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 15+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PLATYTEICHUM** Campbell 1953

Type species: *Platyteichum costatum* Campbell 1953; OD.

Platyteichum johnstonei Dickins 1961
(Plate 57 figs 15, 16)

1961 *Platyteichum johnstonei* Dickins: p.134-135, pl. 17, figs 9-12

Diagnosis: "Similar to *P.costatum...*, distinguished by having the slit-band slightly higher above the periphery and the whorl cross-section slightly more rounded, lacks the slight but distinct changes in direction of the outline at the bottom of the slit-band and below the slit-band" (Dickins, 1961, p.134).

Closest species: *P. costatum* Campbell 1953 from the Ingelara Formation of Queensland.

Types: Holotype - CPC 108; paratypes - UWA 42115-42117.

Type locality: 7.2 km west of south of Merlinleigh Homestead, Carnarvon Basin.

Distribution and range: Merlinleigh Homestead area, Barrabiddy Creek and Coolkilya Pool areas, **Carnarvon Basin** - top of Bulgadoo Shale and bottom of Cundlego Formation, Wandagee Formation, Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian (Filippovian).

Abundance: 5 specimens.

Value in correlation and dating: Useful for indicating upper Artinskian.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

?Platyteichum johnstonei Dickins 1961
(Plate 57 figs 24, 27, 28)

1961 *?Platyteichum johnstonei* Dickins: p.135, pl. 17 figs 1-3

Figured specimen: CPC 109.

Distribution and range: Middalya Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian (Irenian).

Abundance: 1 specimen.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Platyteichum sp.

1967 *Mourlonia (Platyteichum)* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Platyteichum? sp. nov.
(Plate 57 figs 22, 23)

1961 *Platyteichum?* sp. nov. Dickins: p.136, pl. 17 figs 7, 8
1967 *Mourlonia (Platyteichum?)* sp. nov. Condon: p.173

Figured specimens: CPC 110-112.

Distribution and range: Merlinleigh Homestead, Walbarune Peak, and Middalya Station areas, **Carnarvon Basin** - Nalbia Sandstone, Coolkilya Sandstone.

Age: Early to Middle Kungurian (Filippovian - Irenian).

Abundance: 3 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow sea with abundant supply of sand and mud.

Genus **PERUVISPIRA** Chronic 1949

Type species: *Peruvispira delicata* Chronic (*in* Newell, Chronic & Roberts, 1949, p.147; 1953, p.139, pl. 28, figs 9-12); OD.

Peruvispira umariensis (Reed 1928)
(Plate 57 figs 17, 18)

1928 *Pleurotomaria umariensis* Reed: p.389, pl. 34 fig. 12; pl. 35, figs 11-13
1957 *Ptychomphalina umariensis* (Reed); Dickins: p.47-49 pl. 9 figs 1-5
1959 *Peruvispira umariensis* (Reed); Dickins & Thomas: p.70, 72, 78
1967 *Peruvispira umariensis* (Reed); Condon: p.61
1975 *Peruvispira umariensis*; Playford et al.: p.279, 280
1979 *Peruvispira umariensis* (Reed); Dickins & Shah: p.4, 8

Hypotypes: CPC 2259-2263.

Type locality: First described from India.

Distribution and range: Winning and Byro Stations, Lyndon and Wooramel River areas, **Carnarvon Basin** - Carrandibby Formation, upper part of the Lyons Group. Umaria, Manedragarh, India.

Age: Early Sakmarian (Tastubian).

Abundance: Numerous specimens.

Value in correlation and dating: Important, particularly for the intercontinental correlation.

Peruvispira sp. cf. **P. umariensis** (Reed 1928)
(Plate 57 figs 14, 19)

1963 *Peruvispira* cf. *umariensis* (Reed); Dickins: p.126-127, pl. 24 figs 7, 8

Figured specimen: CPC 4009.

Distribution and range: Carynginia Well area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Genus **PLEUROTOMARIA** Defrance 1826

Type species: *Trochus anglicus* J. Sowerby 1818; SD S.P. Woodward 1825.

Pleurotomaria sp.

1967 *Pleurotomaria* sp. Condon: p.97

Distribution and range: Carynginia (No. 1) Well area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Climate: Found in sedimentary rocks that were laid down under temperate conditons.

Sedimentary environment: Shallow water.

Pleurotomariids

1958 Pleurotomariids Guppy et al.: p.54

Distribution and range: Northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Pleurotomariidae gen. indet.

1956 Pleurotomaridae gen. indet. Dickins & Thomas: p.53

Distribution and range: Southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: ?Late Sakmarian (Sterlitamakian).

Superfamily PLATYCERATACEA Hall 1859

Family PLATYCERATIDAE Hall 1859

Genus **PLATYCERAS** Conrad 1840

Type species: *Pileopsis vetusta* J. de C. Sowerby 1829.

Platyceras sp. cf. **P. abundans** (Wanner 1922)
(Plate 57 figs 26, 29-31)

cf. 1922 *Capulus abundans* Wanner: p.48, pl. 152(2) figs 8-10c
1922 *Capulus deformis* Wanner: p.47, pl. 152(2) fig. 7
1928 *Capulus abundans* Hamlet: p.91, pl. 11 figs 10-11
1928 *Capulus wanneri* Hamlet: p.94, pl. 11 figs 12-13, 18
1942 *Platyceras varians abundans* Wanner: p.198, pl. 3 figs 19a, b
1963 *Platyceras* cf. *abundans* (Wanner); Dickins: p.131-132 pl. 25, figs 7-18
1967 *Platyceras* cf. *abundans* (Wanner); Condon: p.71
1976 *Platyceras* sp. cf. *P. abundans* (Wanner); Playford et al.: p.96

Figured specimens: UWA 45450-45454.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Byro Station, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 5+ specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Platyceras sp.

1956 *Platyceras* sp. Dickins & Thomas: p.53

Distribution and range: Southwest **Canning Basin** - ?Nura Nura Member of the Poole Sandstone.

Age: ?Late Sakmarian (Sterlitamakian).

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Platyceras sp. nov.
(Plate 57 fig. 25)

1963 *Platyceras* sp. nov. Dickins: p.133, pl. 25 figs 4-6
1967 *Platyceras* sp. nov. Condon: p.71

Figured specimens: CPC 4014, 4015.

Distribution and range: Winning and Williambury Stations, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 3 specimens.

Superfamily SUBULITACEA Lindstrom 1884

Family SUBULITIDAE Lindstrom 1884

Genus **MACROCHILINA** Bayle 1880

Type species: *Buccinum acutum* J. de C. Sowerby 1827.

Macrochilina sp.

1967 *Macrochilina* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Billidee Formation, Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Macrochilina winensis Dickins 1963
(Plate 57 figs 21, 32, 33)

1963 *Macrochilina winensis* Dickins: p.134, pl. 26 figs 1-7
1976 *Macrochilina winensis* Dickins; Playford et al.: p.96

Diagnosis: "Height of spire variable but moderate for *Macrochilina*; growth-lines very fine" (Dickins, 1963, p.134).

Types: Holotype - UWA 45455; paratypes - UWA 45456-45458.

Type locality: Fossil Ridge on Irwin River, Perth Basin.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 12 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Suborder NERITOPSINA Cox & Knight 1960
Superfamily NERITACEA Rafinesque 1815

Family NERITOPSIDAE Grey 1844
Subfamily NERITOPSINAE S.A. Miller 1889

Genus **NATICOPSIS** M'Coy 1844

Type species: *Naticopsis phillipsii;* SD Meek & Worthen 1866.

Naticopsis? sp.

1967 *Naticopsis?* sp. Condon: p.131

Distribution and range: **Carnarvon Basin** - Coyrie Formation.

Age: Late Artinskian (Baigendzhinian).

Naticopsis? sp. nov.
(Plate 57 fig. 20)

1963 *Naticopsis?* sp. nov. Dickins: p.135, pl. 26 figs 8-9

Figured specimens: UWA 45459, 45460.

Distribution and range: Fossil Cliff and Woolaga Creek area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale, basal High Cliff Sandstone.

Age: Late Sakmarian (Sterlitamakian) - Early Artinskian (Aktastinian)

Abundance: 2 specimens.

Climate: Species found in sedimentary rocks that were laid down under temperate conditions.

Sedimentary environment: Shallow water.

Baylea perthensis Dickins 1963 13
Baylea? sp. 13
Baylea? sp. nov. 13
Bellerophon costatus Sowerby 1834 5
Bellerophon? decussatus Fleming 1828 6
Bellerophon formani Dickins 1963 6
Bellerophon sp. cf. *B. formani* Dickins 1963 7
Bellerophon sp. 7
Bellerophon sp. indet. 7
Bellerophon sp. nov. A 7
Bellerophon sp. nov. B 8
Bellerophontidae gen. indet. 8
Bellerophontids 8

Euphemites sp. 1
Euphemites sp. nov. 1
Euphemites wynnensis Dickins 1963 1

Keeneia carnarvonensis Dickins 1957 11
Keeneia? sp. nov. 12

Macrochilina sp. 24
Macrochilina winensis Dickins 1963 24
Mourlonia (Mourlonia) lyndonensis Dickins 1957 14
Mourlonia (Mourlonia) sp. 14
Mourlonia (Mourlonia) sp. nov. A 15
Mourlonia (Mourlonia) sp nov. B 15
Mourlonia (Pseudobaylea) freneyensis Dickins 1963 15
Mourlonia (Pseudobaylea) sp. cf. *M.(P.) freneyensis* Dickins 1963 . 16
Mourlonia (Pseudobaylea?) sp. nov. 16
Mourlonia (Woolnoughia) angulata Dickins 1963 17
Mourlonia? obscura Dickins 1963 17
Mourlonia sp. 18

Naticopsis? sp. 25
Naticopsis? sp. nov. 25

Peruvispira umariensis (Reed 1928) 21
Peruvispira sp. cf. *P. umariensis* (Reed 1928) 22
Platyceras sp. cf. *P. abundans* (Wanner 1922) 23
Platyceras sp. 23
Platyceras sp. nov. 24
Platyschisma? sp. nov. 12
Platyteichum johnstonei Dickins 1961 20
?Platyteichum johnstonei Dickins 1961 20
Platyteichum sp. 21
Platyteichum? sp. nov. 21
Pleuratomariidae gen. indet. 22
Pleurotomaria sp. 22
Pleurotomariids 22
Ptychomphalina maitlandi Etheridge Jnr 1903 18
Ptychomphalina sp. 19
Ptychomphalina sp. nov. 19
Ptychomphalina talboti Dickins 1963 19

"*Retispira*" *clarkei* Dickins 1963 8
Retispira emerii (Etheridge Jnr 1907) 9
Retispira sp. cf. *R. emerii* (Etheridge Jnr 1907) 9
Retispira irwinensis Dickins 1963 9

Stachella crucillrata Dickins 1963 4
Stachella sp. 5
Stachella sp. nov. 5
Straparolus (Euomphalus) sp. 10
Straparolus (Leptomphalus) besselensis Dickins 1963 10
Straparolus (Leptomphalus) sp. 11
Straparolus? sp. 11

Warthia? carinata Dickins 1963 2
Warthia intermedia Dickins 1963 2
Warthia sp. A 3
Warthia sp. A cf. *W. micromphala* (Morris 1845) 3
Warthia sp. B 3
Warthia sp. B cf. *W. micromphala* (Morris 1845) 3
Warthia sp. C 4
Warthia? sp. indet. 4

Conulariids

CONULARIID GENERA AND SPECIES

CONTENTS

Conulariidae 1
Paraconularia sp. nov. 1
Paraconularia sp. A 2
Paraconularia sp. B 2
Paraconularia sp. C 2
Paraconularia sp. D 2
Paraconularia sp. E 2
Paraconularia spp. 2
Paraconularia sp. cf. *P. warthi* (Waagen 1889) 3

CONULARIID GENERA AND SPECIES

Class CONULATA Moore & Harrington 1956
Order CONULARIIDA Miller & Gurley 1896
Suborder CONULARIINA Miller & Gurley 1896
Family CONULARIIDAE Walcott 1886
Subfamily PARACONULARIINAE Sinclair 1952

Genus **PARACONULARIA** Sinclair 1940

Type species: *Conularia inaequicostata* de Koninck 1883

Paraconularia sp. nov.
(Plate 58 figs 6-9)

1957 *Conularia* sp. Thomas: p.180
1969 *Paraconularia* sp. nov. Thomas: p.1285
1979 *Paraconularia* Waterhouse: p.476

Diagnosis: Large elongate species, cross section nearly square to rectangular, ratio of width of faces 0.85 to 0.98; transverse costae spaced at 7 - 12 per cm, interspaces smooth; angle of taper of sides (apical angle) 11.5 - 14.5°; strong median longitudinal septum on inside of each face.

Closest species: *Paraconularia derwentensis* (Johnston), from the Permian of Tasmania (Parfrey, 1982) is equally large but has a more obtuse apical angle and lacks the median septa. In recent years Chinese authors have described several small new septate genera of Carboniferous and Permian conulariids. The writer prefers to retain *Paraconularia*.

Types: Holotype - AM F45107; paratypes - AM F45102, CPC 24401-24404.

Type locality: Airstrip, Port Keats Mission, Bonaparte Basin, N.T.

Distribution and Range: Type locality - "Upper Marine Beds", Port Keats Group. A specimen (UWA 65934) from the Nalbia Formation, Carnarvon Basin, is similar in form and may belong to the species but the presence of the septa needs confirmation.

Age: Chhidruan for the type locality, but may range down to the Kungurian.

Abundance: Five fairly complete and three incomplete moulds, two incomplete external impressions.

Value in correlation and dating: Uncertain, known definitely only from type locality.

Climate: Found in sedimentary rocks that were deposited under subtropical to tropical conditions.

Sedimentary environment: Moderately shallow neritic, silty to fine sandy substrate.

Paraconularia sp. A

1956 *Conularia* sp. Dickins & Thomas: p.53

Distribution and range: Cuncudgerie Hill area, southwest **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen?

Paraconularia sp. B

1958 *Conularia* Dickins & Thomas: p.126
1959 *Conularia* sp. Dickins & Thomas: p.72

Distribution and range: Lyndon River area, **Carnarvon Basin** - upper part of the Lyons Group.

Age: Early Sakmarian (Tastubian).

Abundance: 1 specimen.

Paraconularia sp. C

1952 *Conularia* Teichert: p.130

Distribution and range: **Carnarvon Basin** - Coolkilya Sandstone.

Age: Middle Kungurian.

Paraconularia sp. D

1952 *Conularia* Guppy et al.: p.111

Distribution and range: Northern **Canning Basin** - lower Liveringa Group.

Age: Kungurian.

Paraconularia sp. E

1951 *Conularia*; Clarke et al.: p.51, 78
1952 *Conularia*; Fairbridge: p.140

Distribution and range: Irwin River area, **Perth Basin** - upper Holmwood Shale.

Age: Early Sakmarian (Tastubian).

Paraconularia spp.

1967 *Conularia* sp. Condon: p.48, 119, 131, 149, 152, 161, 170

Distribution and range: **Carnarvon Basin** - Lyons Group, Keogh Formation, Coyrie Formation, Mallens Sandstone, Bulgadoo Shale Cundlego Formation, Wandagee Formation.

Age: Early Sakmarian (Tastubian) - Late Artinskian (Baigendzhinian).

Abundance: Uncertain.

Paraconularia sp. cf. **P. warthi** (Waagen 1889)
(Plate 58 figs 1-5)

cf. 1886 *Conularia* cf. *irregularis* (Kon.); Waagen: p.26, pl.1 fig. 2 (*non Conularia irregularis* de Koninck)
cf. 1891 *Conularia warthi* Waagen: p.126, pl. 4 figs 6a-d; pl. 5 figs 1a-b
1912 *Conularia* sp. nov. (?) cf. *C. warthi* (Waagen); Glauert: p.76-77
1931 *Conularia* cf. *C. warthi* (Waagen); Hosking: p.36-37, pl. 11 figs 3-6
1933 *Conularia warthi* Waagen; Hosking: p.57
1936 *Conularia warthi* Waagen; Raggatt: p.123
1937 *Conularia warthi* Waagen; Raggatt & Fletcher: p.168-170, 178
1938 *Conularia warthi* Waagen; Fletcher: p.243-244, pl. 24 figs 10-11
1948 *Paraconularia warthi* Waagen; Branson: p.758
1951 *Conularia warthi* Waagen; Teichert: p.79
1958 *Conularia* Konecki et al.: p.47

Figured or cited specimens: UWA 8478; GSWA 1/4645, 1/4695, AM (not stated).

Remarks: A small group of specimens (4) was placed by Hosking (1931, 1933) in *Conularia warthi* Waagen. This species from the Talchir Boulder Beds of the Salt Range, Pakistan, possesses a very distinctive ornament of large intercostal tubercles at the margin of the corner grooves, crenulations on the interspaces, small tubercles on the costae and an apical angle of 12°. Hosking (1931) figured three specimens of a medium-sized species, none showing the distinctive micro-ornament but this is said to be present in an unfigured specimen -- 1/4695 Hosking (1933) which is apparently not now available. Hosking's specimens come from the Wooramel River area. From associated faunas they are probably from the Coyrie Formation and/or Mallens Sandstone. Fletcher (1938) agreed with the identification but his figures also do not show the appropriate micro-ornament. More extensive collections are needed to confirm the identity with *P. warthi*. Hosking's extant specimens are rhombic in cross-section (possibly the result of crushing), have an apical angle of 13° rather than (16 - 20°) as stated by Hosking and a rib spacing of 10 - 11 per cm. The longest specimen (incomplete) is 8.5 cm. Fletcher's specimens are fragmentary.

Type locality: Byro Station, near survey station R20, Wooramel River, Bogadi Outcamp, Carnarvon Basin.

Distribution and range: Wooramel River area, Gascoyne Junction, Windalia Outcamp, Lyndon River, **Carnarvon Basin** - Lyons Group, Callytharra Formation, Coyrie Formation(?), Mallens Sandstone, Wandagee Formation.

Age: Asselian, Early Sakmarian (Tastubian) to Late Artinskian (Baigendzhinian).

Abundance: Uncertain.

Value in correlation and dating: Uncertain.

Climate: As reported, cold to warm temperate.

Sedimentary environment: Varied.

Ostracods

OSTRACOD GENERA AND SPECIES

CONTENTS

Hollinidae 1
Hollina sp. 1
Hollinella sp. 1
Hollinella? sp. 1
Kirkbyidae 1
Kirkbya sp. 2
Kirkbyacean? sp. indet. A 2
Kirkbyacean? sp. indet. B 2
Amphissitidae 2
Amphissites sp. 2
Scrobiculidae 3
Roundyella ludbrookae Fleming 1985 3
Bairdiidae 3
Bairdia sp. 3
Bairdia sp. A 4
Bairdia sp. B 4
Bythocypris sp. 4
Cyprididae 4
Cypris sp. 4
Healdiidae 5
Healdia chapmani Crespin 1945 5
Healdia grayi (Crespin 1945) 5
Healdia irwinensis Fleming 1985 6
Healdia sp. 6
Healdia spp. A and B 6
Healdioides sp. 7
Healdiacean indet. 7
Bairdiocyprinidae 7
Bairdiocyprinidae indet. 7
Healdianella? sp. 8
?Cavellinidae 8
Cavellina sp. 8
Cavellinidae indet. 8
Quasillitidae 8
Graphiadactyllis alveiformis Fleming 1985 9
Cytherellidae 9
Cytherella sp. 9
Thlipsuridae 9
Zarinia ludbrookae Fleming 1985 10
Nomina dubia 10
cf. *Jonesina* 10
Unknown identity 10
Ostracods indet. 10
Ostracoda gen. indet. 11
Index 12

Subclass OSTRACODA Latreille 1806
Order PALAEOCOPIDA Henningsmoen 1953
Suborder BEYRICHICOPINA Scott 1961
Superfamily HOLLINIDEA Swartz 1936

Family HOLLINIDAE Swartz 1936

Genus **HOLLINA** Ulrich & Bassler 1908

Type species: *Ctenobolbina insolens* Ulrich 1908.

Hollina sp.

1958 *Hollina* sp. Crespin *in* Guppy et al.: p.110, 113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Genus **HOLLINELLA** Coryell 1928

Type species: *Hollinella dentata* Coryell 1928.

Hollinella sp.

1958 *Hollinella* sp. Crespin *in* Guppy et al.: p.113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Hollinella? sp.
(Plate 59 fig. 1)

1985 *Hollinella?* sp. Fleming *in* Foster et al.: p.99, pl. 10 fig. 1

Figured specimen: WAM 83.2753.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Superfamily KIRKBYACEA Ulrich & Bassler 1906

Family KIRKBYIDAE Ulrich & Bassler 1906

Genus **KIRKBYA** Jones 1859

Type species: *Dithyrocaris permiana* Jones 1850.

Kirkbya sp.

1958 *Kirkbya* sp. Crespin *in* Guppy et al.: p.113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Kirkbyacean? sp. indet. A
(Plate 59 fig. 2)

1985 Kirkbyacean? indet. sp. A Fleming *in* Foster et al.: p.99, pl. 10 fig. 2

Figured specimen: WAM 83.2754.

Abundance: One fragment only.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Kirkbyacean? sp. indet. B
(Plate 59 fig. 3)

1985 Kirkbyacean? indet. sp. B Fleming *in* Foster et al.: p.99, pl. 10 fig. 3

Figured specimen: WAM 83.2755.

Abundance: Two specimens.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Family AMPHISSITIDAE Knight 1928

Genus **AMPHISSITES** Girty 1910

Type species: *Amphissites rugosus* Girty 1910.

Amphissites sp.

1958 *Amphissites* sp. Crespin *in* Guppy et al.: p.109, 113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Family SCROBICULIDAE Posner 1951

Genus **ROUNDYELLA** Bradfield 1935

Type species: *Amphissites simplicissimus* Knight 1928 (see Sohn, 1954).

Roundyella ludbrookae Fleming 1985
(Plate 59 figs 4-6)

1985 *Roundyella ludbrookae* Fleming *in* Foster et al.: p.97, pl. 10 figs 4-7

Diagnosis: Ornament of fine reticulate ridges, topped by single rows of tubercles; well marked kirkbyan pit; intensity of ornament less near margins, where there are a few low spines (Foster et al., 1985, p.97).

Closest species: *R. simplicissima* (Knight) from the Pennsylvanian of the USA, is similar in ornamentation and shape.

Types: Holotype - WAM 83.2722; other figured specimens - WAM 83.2723, 83.2724.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Order PODOCOPIDA Muller 1894
Suborder PODOCOPINA Sars 1866
Superfamily BAIRDIACEA Sars 1888

Family BAIRDIIDAE Sars 1888

Genus **BAIRDIA** M'Coy 1844

Type species: *Bairdia curta* M'Coy 1844; SD Ulrich & Bassler (1923).

Bairdia sp.

1951 *Bairdia* sp. Clarke et al.: p.55
1952 *Bairdia* sp. Guppy et al.: p.110
1958 *Bairdia* sp. Guppy et al.: p.47, 109, 110, 113

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale; PKO Nerrima 1, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), late Artinskian Baigendzhinian).

Remarks: These records may not necessarily refer to the same even similar ostracods.

Bairdia sp. A
(Plate 59 figs 7-10)

1985 *Bairdia* sp. A Fleming *in* Foster et al.: p.97, pl. 1 figs 8-14

Figured specimens: WAM 83.2725-83.2731.

Remarks: All Fleming's specimens differ in appearance from each other.

Abundance: Seven specimens.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Bairdia sp. B
(Plate 59 fig. 11)

1985 *Bairdia* sp. B Fleming *in* Foster et al.: p.97, pl. 11 fig. 4

Figured specimen: WAM 83.2732.

Abundance: One specimen only.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Genus **BYTHOCYPRIS** Brady 1880

Type species: *Bythocypris reniformis* Brady 1880.

Bythocypris sp.

1958 *Bythocypris* sp. Crespin *in* Guppy et al.: p.109

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Superfamily CYPRIDACEA Baird 1845

Family CYPRIDIDAE Baird 1845
Subfamily CYPRIDINAE Baird 1845

Genus **CYPRIS** O.F. Muller 1776

Type species: *Cypris pubera* Muller 1776; SD Baird, 1846.

Cypris sp.

1958 *Cypris* sp. Guppy et al.: p.50

Distribution and range: Northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Suborder METACOPINA Sylvester-Bradley 1961
Superfamily HEALDIACEA Harlton 1933

Family HEALDIIDAE Harlton 1933

Genus **HEALDIA** Roundy 1926

Type species: *Healdia simplex* Roundy 1926; OD.

Healdia chapmani Crespin 1945
(Plate 60 figs 1, 2)

1945 *Healdia chapmani* Crespin: p.32-33, pl. 4 figs 3a,b, 4, 5
1985 *Healdia chapmani* Crespin; Fleming *in* Foster et al.: p.98, pl. 11 figs 16, 17

Types: Holotype - CPC 263; paratypes - CPC 264, 265; other figured specimens - WAM 83.2738, 83.2739.

Type locality: Cattle Creek below waterfall 22.4 km southeast of Springsure, Qld.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale. Denison Trough (Qld) - Upper Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian in Queensland.

Value in correlation and dating: Suggests correlation between Perth and Bowen Basins.

Healdia grayi (Crespin 1945)
(Plate 60 fig. 3)

1945 *Bairdia grayi* Crespin: p.32, pl. 4 figs 1a,b
1985 *Healdia grayi* (Crespin); Fleming *in* Foster et al.: p.98, pl. 11 fig. 10

Closest species: No closely similar species known.

Types: Holotype - CPC 261; another figured specimen - WAM 83.2740.

Type locality: Cattle Creek below waterfall, 22.4 km southeast of Springsure, Qld.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale. Denison Trough (Qld) - Upper Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian in Queensland.

Value in correlation and dating: Suggests correlation between Denison Trough and Perth Basin.

Healdia irwinensis Fleming 1985
(Plate 59 figs 12-15)

1985 *Healdia irwinensis* Fleming *in* Foster et al.: p.97, 98, pl. 11 figs 11-15

Diagnosis: "Smooth, elongate, with distinct ventral sinus. Anterior and posterior margins evenly and broadly rounded. Dorsal and ventral posteriorly-directed spines placed almost at rear margin. Hinge and marginal structures very fine. Muscle attachment healdioid, central" (Foster et al., 1985, p.98)

Closest species: *Healdia chapmani* Crespin 1945, which, however, has higher profile, comparatively smaller elongation, thicker spines, less centrally placed muscle scar, and thicker shell.

Types: Holotype - WAM 83.2733; other figured specimens WAM 83.2734-83.2737.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Healdia sp.

1951 *Healdia* sp. Clarke et al.: p.55
1952 *Healdia* sp. Guppy et al.: p.110
1958 *Healdia* sp. Guppy et al.: p.47, 110, 113

Distribution and range: Irwin River area, **Perth Basin** - Holmwood Shale; FKO Nerrima 1, northern **Canning Basin** - Nura Nura Member of the Poole Sandstone, Noonkanbah Formation.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Remarks: These records may not necessarily refer to the same or even similar ostracods.

Healdia spp. A and B
(Plate 59 figs 16-20)

1985 *Healdia* spp. A and B Fleming *in* Foster et al.: p.98, pl. 11 figs 5, 6(A), 7-9(B).

Figured specimens: WAM 83.2741(spp. A), 83.2742-83.2744(spp. B)

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Genus **HEALDIOIDES** Coryell & Rozanski 1942

Type species: *Healdioides diversus* Coryell & Rozanski 1942.

Healdioides sp.
(Plate 60 fig. 4)

1985 *Healdioides* sp. Fleming *in* Foster et al.: p.98, pl. 11 fig. 11

Figured specimen: WAM 83.2745.

Closest species: Pennsylvanian *Healdia cara* (Cooper, 1946, pl. 11 figs 37, 38) seems comparable to this specimen.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Healdiacean indet.
(Plate 60 figs 5, 9)

1985 Healdiacean indet. Fleming *in* Foster et al.: p.99 pl. 12 figs 1, 2

Figured specimens: WAM 83.2756, 83.2757.

Remarks: "A very elongate specimen with broadly convex ventral margin, weak marinal structures, and a large circular muscle attachment area with multiple scars" (Foster et al., 1985, p.99).

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Family BAIRDIOCYPRINIDAE Shaver 1961

Bairdiocyprinidae indet.
(Plate 60 fig. 8)

1985 Bairdiocyprinidae indet. Fleming *in* Foster et al.: p.99, pl. 12 fig. 3

Figured specimen: WAM 83.2758.

Remarks: The specimen is very small and thin shelled, and thus may be an instar (Fleming *in* Foster et al., 1985, p.99).

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Genus **HEALDIANELLA** Posner 1951

Type species: *Healdianella darwinulinoides* Posner 1951.

Healdianella? sp.
(Plate 60 fig. 7)

1985 *Healdianella?* sp. Fleming *in* Foster et al.: p.99, pl. 12 fig. 5

Figured specimen: WAM 83.2760.

Remarks: The crushed specimen is strongly inequivalve with an unknown interior (Foster et al., 1985, p.99)

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

?Family CAVELLINIDAE Egorov 1950

Genus **CAVELLINA** Coryell 1928

Type species: *Cavellina puchella* Coryell 1928.

Cavellina sp.

1958 *Cavellina* sp. Crespin *in* Guppy et al.: p.113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Cavellinidae indet.
(Plate 60 fig. 6)

1985 Cavellinidae indet. Fleming *in* Foster et al.: p.99, pl. 12 fig. 4

Figured specimen: WAM 83.2759.

Remarks: A strongly inequivalve specimen (Foster et al., 1985, p.99).

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Superfamily QUASILLITACEA Coryell & Malkin 1936

Family QUASILLITIDAE Coryell & Malkin 1936

Genus **GRAPHIADACTYLLIS** Roth 1929

Type species: *Kirkbya lindahli arkansana* Girty 1910; OD.



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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S.K. Skwarko

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Ostracods

(continued)

Graphiadactyllis alveiformis Fleming 1985
(Plate 60 figs 10-13)

1985 *Graphiadactyllis alveiformis* Fleming *in* Foster et al.: p.98, pl. 12 figs 6-10

Diagnosis: "Smooth to slightly pustulose; hinge line long and straight; left valve a little larger than right; front and rear margins rounded, venter slightly concave centrally; front and rear hinge teeth finely ridged; marginal flange pronounced and flat internally; marginal contact with strong ridge and groove; muscle attachment healdioid, variable in detail and placement" (Foster et al., 1985, p.98).

Closest species: *Graphiadactyllis arkansana* (Girty 1910).

Types: Holotype - WAM 83.2746; other figured specimens - WAM 83.2747-83.2749.

Distribution and range: Irwin River area, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale. ?Denison Trough (Qld) - Upper Cattle Creek Formation.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Artinskian in Queensland.

Value in correlation and dating: Suggests correlation between Perth Basin and Denison Trough.

Suborder PLATYCOPINA Sars 1866

Family CYTHERELLIDAE Sars 1866

Genus **CYTHERELLA** Jones 1849

Type species: *Cytherina ovata* Roemer 1840; SD Ulrich 1894.

Cytherella sp.

1958 *Cytherella* sp. Crespin *in* Guppy et al.: p.110, 113

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Superfamily THLIPSURACEA Ulrich 1894

Family THLIPSURIDAE Ulrich 1894

Genus **ZARINIA** Fleming 1985

Type species: *Zarinia ludbrookae* Fleming 1985.

Zarinia ludbrookae Fleming 1985
(Plate 60 figs 14-17)

1985 *Zarinia ludbrookae* Fleming *in* Foster et al.: p.99, pl. 12 figs 11-14

Diagnosis: "Shape trapezoid, hinge line straight, hinge simple ridge and groove; smooth marginal border around ends and dorsum not present ventrally; main ornament reticulate, surface appearing deeply pitted except over muscle attachment area; reticulate area separated from border and completely surrounded by smooth, flat ridge; muscle attachment roseate, with five distinct scars" (Foster et al., 1985, p.99).

Types: Holotype - WAM 83.2750; other figured specimens - WAM 83.2751, 88.2752.

Distribution and range: Fossil Cliff, **Perth Basin** - Fossil Cliff Member of Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

NOMINA DUBIA

Genus **JONESINA** Ulrich & Bassler 1908

Type species: *Beyrichia fastigiata* Jones & Kirkby 1867.

cf. **Jonesina**

1958 cf. *Jonesina* Crespin *in* Guppy et al.: p.110

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

UNKNOWN IDENTITY

Ostracods indet.

1952 Ostracods Guppy et al.: p.110
1958 Ostracods McWhae et al.: p.77
1967 Ostracods Condon: p.142

Distribution and range: ?Fossil Cliff on Irwin River, **Perth Basin** - ?Fossil Cliff Member of the Holmwood Shale; Minilya area, **Carnarvon Basin** - Bulgadoo Shale; northern **Canning Basin** - Poole Sandstone.

Age: Late Sakmarian (Sterlitamakian), Late Artinskian (Baigendzhinian).

Remarks: These records may not necessarily refer to the same or even similar ostracods.

Ostracoda gen. indet.

1958 Ostracoda gen. indet. Guppy et al.: p.50

Distribution and range: FKO Nerrima 1, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

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Trilobites

TRILOBITE GENERA AND SPECIES

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TRILOBITE GENERA AND SPECIES

Class TRILOBITA Walch 1771
Order PTYCHOPARIIDA Swinnerton 1915
Suborder ILLAENINA Jaanusson 1959
Superfamily PROETACEA Salter 1864

Family PHILLIPSIIDAE Oehlert 1886

Genus **DITOMOPYGE** Newell 1931

Type species: *Ditomopyge lansingensis* Newell 1931.

Generic range: Pennsylvanian - Lower Permian; worldwide.

Ditomopyge meridionalis Teichert 1944
(Plate 61 figs 1-5)

1944 *Ditomopyge meridionalis* Teichert: p.458-461, pl. 77 figs 1-5, 7-12
1952 *Ditomopyge meridionalis* Teichert; Teichert: p.130
1966 *Ditomopyge meridionalis* Teichert; Grant: p.68
1970 *Ditomopyge meridionalis* Teichert; Hahn & Hahn: p.178

Diagnosis: Glabella inflated, pyriform, bounded by posteriorly convergent dorsal furrows; median preoccipital lobe separated from glabella by distinct, shallow groove; lateral preoccipital lobes subtriangular; occipital furrow as wide as the narrow, strongly convex, occipital ring; tuberculate ornament on posterolateral region of glabella. Facial sutures sinuous with strong palpebral lobes; eyes large, elevated, rising near vertically from free cheeks which bear short, rather blunt, genal spines. Pygidium semicircular, convex with strongly elevated axis which reaches almost to end of pygidium; with 8 to 11 axial rings and 7 rib pairs.

Closest species: *Ditomopyge meridionalis* is closely related to *D. artinskiensis* (Weber) differing from the Russian species in indistinctly defined median preoccipital lobe, the glabella nodes arranged in the posterolateral corners of the glabella, the shorter genal spines, and fewer pygidial segments (*D. artinskiensis* has 11 - 12 rings and 8 rib pairs).

Types: Holotype - UWA 21331; paratypes - UWA 21332-21338.

Type locality: Near Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality, **Carnarvon Basin** - Wandagee Formation, and also in the Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian.

Abundance: 10 specimens.

Value in correlation and dating: A useful Early Permian indicator.

Ditomopyge sp. Stubblefield 1944

1944 *Ditomopyge* sp. Stubblefield in Teichert: p.462
1949 *Ditomopyge* sp. Stubblefield; Clarke et al.: p.55
1970 *Ditomopyge* sp. Stubblefield; Hahn & Hahn: p.187

Diagnosis: Cephalon with median preoccipital lobe, straight preoccipital furrow and other features of *Ditomopyge* Newell. Pygidium with flattened crest; 11 to 12 axial rings and 6 to 8 rib pairs. [Stubblefield (1944) notes that it is not clear if all of the material belongs to one species.]

Closest species: *D. artinskiensis* (Weber) has similar pygidial form but differs in cephalic details.

Distribution and range: Becketts Gully, Irwin River area, **Perth Basin** - unit not known.

Age: ?Sakmarian.

Abundance: 1 external dorsal shield, 2 pygidia.

Value in correlation and dating: Not established.

Ditomopyge sp. Teichert 1944
(Plate 61 fig. 6)

1944 *Ditomopyge* sp. Teichert: p.461-462, pl. 77 fig. 6
?1958 *Ditomopyge* sp. Teichert; McWhae et al.: p.77
1970 *Ditomopyge* sp. Teichert; Hahn & Hahn: p.187
?1976 *Ditomopyge* sp. Teichert; Playford et al.: p.96

Diagnosis: Glabella prominent, flat topped in transverse section with sides sloping towards dorsal furrows; median preoccipital lobe low, indistinct, bearing a narrow, sharp, almost tuberculate ridge; lateral preoccipital lobes triangular and more distinct than median lobe. Occipital furrow narrow and sharply incised; occipital ring wide, flat, rising to maximum elevation at its posterior margin. Facial sutures sinuous with strong palpebral lobes. Pygidium unknown.

Closest species: This cranidium is comparable with that of *D. meridionalis* but differs in the glabellar ornament, the shape of the preoccipital lobes and the width and shape of the occipital ring. The presence of furrows on the lateral preoccipital furrows (Teichert, 1944, pl. 77 fig. 6) would suggest that this cranidium may be related to the genus *Timoraspis* Hahn and Hahn, which is known only by one species from the Basleo Beds of East Timor. Further material is required before a positive diagnosis can be made.

Figured specimen: WAM F4860.

Distribution and range: Fossil Cliff on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 cranidium.

Value in correlation and dating: Not established.

Ditomopyge? sp.

1956 *Ditomopyge* sp. McWhae et al.: p.67, 70
1967 *?Ditomopyge* sp. Condon: p.131

Distribution and range: Unspecified locality in the **Carnarvon Basin** - Coyrie Formation, Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Middle Kungurian.

Abundance: Not known.

Value in correlation and dating: Not established.

Trilobite (Genus and species unknown)
Etheridge Jnr 1892

1892 apparently a *Phillipsia* sp. Etheridge Jnr: p.125
?1910 *Phillipsia grandis* Glauert: p.95
1944 *?Phillipsia* sp. Teichert: p.456

Diagnosis: Pygidium indistinct, but appears to possess seven or more axial segments (Etheridge Jnr, 1892, p.126)

Material: Teichert (1944, p.456) records the confused history of this specimen which was apparently misnamed by Glauert (1910). The location of the material is not known, and until it has been re-examined, it is not possible to make a taxonomic assignment. The genus *Phillipsia* Portlock occurs only in rocks of Visean age and hence is not an appropriate taxon.

Distribution and range: Carrandibby Range, Wooramel River, **Carnarvon Basin** - Byro Group.

Age: Late Artinskian (Baigendzhinian), Early Kungurian.

Abundance: 1 pygidium.

Value in correlation and dating: Not established.

Asteroids

ASTEROID GENERA AND SPECIES

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Monasteridae..... 1
Monaster carnarvonensis Kesling 1969 1
Monaster wandageensis Kesling 1969 1
?Monaster wandageensis Kesling 1969 2
Neopalaeasteridae..... 2
Permaster grandis Kesling 1969 2

All taxa reviewed come from the Wandagee Formation of the Late Artinskian (Baigendzhinian) age from near Coolkilya Pool in the Carnarvon Basin.

Class STELLEROIDEA Lamarck 1816
Subclass ASTEROIDEA de Blainville 1830
Order PLATYASTERIDA Spencer 1951
Suborder TUMULOSINA Spencer & Wright 1966
Family MONASTERIDAE Schuchert 1915

Genus **MONASTER** Etheridge Jnr 1892

Type species: *Palaeaster clarkei* de Koninck 1877; SD Schuchert (1915).

Monaster carnarvonensis Kesling 1969
(Plate 62 figs 3, 6, 7, 11)

1969 *Monaster carnarvonensis* Kesling: p.370-372, pl. 1 figs 7, 8; pl. 3 figs 5, 6; text figs 3, 4

Diagnosis: Monomarginaline Pustulosida with rather strongly tapered arms and a large disk. Adambulacrals much more numerous than overlying inferomarginals; arm radials small and alternating with inferomarginals. Coronet dominated by large first radials, subquadrate with distal corners protuberant and rounded, arranged in a circlet surrounding depressed central area (probably containing centrodorsal and other plates). Two circlets of superomarginals, the first large but strongly overlapped by first radials, one surrounding the madreporite; second superomarginals smaller, less conspicuous, but each bearing a central blunt spine. Mouth-frame adambulacral. Surface pustulose.

Closest species: *M. clarkei* (de Koninck), which seems to have shorter arms and more interbrachial spread.

Holotype: UWA 26992d (plastoholotype - UMMP 57467)

Abundance: Rare.

Monaster wandageensis Kesling 1969
(Plate 62 figs 1, 2, 8)

1969 *Monaster wandageensis* Kesling: p.367-370, pl. 1 figs 1, 2; pl. 3 figs 2-4; text figs 1, 2

Diagnosis: Monomarginaline Pustulosida with rather strongly constricted disk and long straight arms consisting of numerous graduated adambulacrals with remarkably flat oral surfaces, inferomarginals aboral but projecting over edges of adambulacrals slightly, and a tapering row of small but prominent radials alternating with the inferomarginals. Coronet prominent, made especially so because of large quadrate first radials, each bearing a strongly elevated node or proturberance and orally spread over the

first (of only 2) superomarginals. Madreporite large, set within a superomarginal. Mouth frame adambulacral. Surface pustulose.

Closest species: *M. clarkei* (de Koninck), which has less straight arms and less numerous arm plates.

Types: Holotype - UWA 26992a (plastoholotype - UMMP 57466).

Abundance: Rare.

?Monaster wandageensis Kesling 1969
(Plate 62 fig. 9)

1969 *?Monaster wandageensis* Kesling: p.370, pl. 1 figs 3-6; pl. 3 fig. 1

Figured specimens: UWA 26992b,c.

Abundance: Rare.

Family NEOPALAEASTERIDAE Schuchert 1915

Genus **PERMASTER** Kesling 1969

Type species: *Permaster grandis* Kesling 1969

Permaster grandis Kesling 1969
(Plate 62 figs 4, 5, 10, 12)

1969 *Permaster grandis* Kesling: p.373-374, pl. 1 figs 9-11; pl. 2 figs 1-6; text figs 5 6

Diagnosis: Monomarginaline Pustulosida lacking radials atop arms, the median aboral surface instead developed as a trough occupied by irregular ossicles. Coronet prominent, consisting largely of large first radials and first superomarginals, the latter strongly overlapped by the former. Madreporite enclosed by three superomarginals. A pair of large subcircular plates associated with each first radial, one closely appressed against each distal corner. Arms long, tapering very gradually, their sides subparallel; adambulacrals and ambulacrals more numerous than large overlying inferomarginals. Mouth-angle plates very large and prominent, each provided with torus; axillaries very small, circular. Surface coarsely pustulose; pustules of first radials and bordering extraneous plates tending to be aligned in anastomosing ridges.

Holotype: UWA 26992e (plastoholotype - UMMP 57468).

Abundance: Rare.

Blastoids

BLASTOID GENERA AND SPECIES

CONTENTS

Neoschismatidae 1
Neoschisma australe Breimer & Macurda 1972 1
Notoblastus stellaris Breimer & Macurda 1972 1
Notoblastus sp. 2
Thaumatoblastus longiramus Wanner 1924 2
Pentremitidae 2
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BLASTOID GENERA AND SPECIES

Class Blastoidea Say 1825
Order FISSICULATA Jaekel 1918

Family NEOSCHISMATIDAE Wanner 1940

Genus **NEOSCHISMA** Wanner 1924

Type species: *Neoschisma verrucosum* Wanner 1924; OD.

Neoschisma australe Breimer & Macurda 1972
(Plate 63 figs 1,2,7,10,11,16; Plate 64 figs 3,5)

1972 *Neoschisma australe* Breimer & Macurda: p.31-33, 251, 252, 254, pl. 19 figs 1-4, 6-8; text fig. 81
1973 *Neoschisma australe* Breimer & Macurda; Macurda: pl. 1 figs 7, 8; pl. 6 figs 1-5; pl. 8 figs 2-4

Diagnosis: "A species of *Neoschisma* with a conical theca, flat vault rather than scalloped, numerous closely shaped hydrospire slits, and hydrospire slits developed on both the epi- and hypodeltoid" (Breimer and Macurda, 1972, p.32).

Types: Holotype - UMMP 58682; other figured specimens - BMR GW137, GSWA F5714A, UMMP 60500, 60501.

Type locality: South bank of Wooramel River, 0.8 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Value in correlation and dating: Limited by its distribution.

Genus **NOTOBLASTUS** Brown 1942

Type species: *Notoblastus brevispinus* Brown 1942; OD.

Notoblastus stellaris Breimer & Macurda 1972
(Plate 63 figs 3, 9, 12)

1972 *Notoblastus stellaris* Breimer & Macurda: p.34-35, 235-253; pl. 20 fig. 1; pl. 21 figs 1, 2, 7, 8; text fig. 82

Diagnosis: "A species of *Notoblastus* with a cup-shaped theca, slightly convex vault, with well developed radial prongs, the lower part of the radial is convex, and an extremely pronounced ridge divides the ad- and aboral parts of the deltoid" (Breimer and Macurda, 1972, p.34).

Types: Holotype - UMMP 58683; other figured specimens - UWA 5714E.

Type locality: Outcrops on south bank of Wooramel River, 0.8 km west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Notoblastus sp.
(Plate 63 figs 4, 5, 14, 15)

1972 *Notoblastus* sp. Breimer & Macurda: pl. 21 figs 4, 5, 9

Figured specimens: UMMP 59726-59729.

Distribution and range: Near junction of Wooramel River and Bilung Creek, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Genus **THAUMATOBLASTUS** Wanner 1914

Type species: *Thaumatoblastus longiramus* Wanner 1914; OD.

Thaumatoblastus longiramus Wanner 1924
(Plate 63 figs 6, 8, 13)

1972 *Thaumatoblastus longiramus* Wanner; Breimer & Macurda: pl. 25

Some of the figured specimens: BMR ML87, UT 23193.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation. Timor.

Age: Late Sakmarian (Sterlitamakian) in Australia.

Order SPIRACULATA Jaekel 1918

Family PENTREMITIDAE d'Orbigny 1851

Genus **RHOPALOBLASTUS** Wanner 1924

Type species: *Rhopaloblastus timorensis* Wanner 1924.

Rhopaloblastus sp.
(Plate 64 figs 1,2,4,6,7)

1973 *Rhopaloblastus* sp. Macurda: p.70, pl. 1 figs 1-6; pl. 2 figs 1-4; pl. 3 figs 1-3, 5; pl. 4 figs 1-6; pl. 5; pl. 7 figs 1-3; pl. 8 fig 1

Figured specimens: UMMP 60497-60499.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Crinoids

CRINOID GENERA AND SPECIES

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Subclass CAMERATA Wachsmuth & Springer 1885
Order MONOBATHRIDA Moore & Laudon 1943
Suborder COMPSOCRININA Ubaghs 1978
Superfamily PERIECHOCRINACEA Bronn 1849

Family ACTINOCRINITIDAE Austin & Austin 1842
Subfamily ACTINOCRINITINAE Austin & Austin 1842

Genus **ACTINOCRINITES** Miller 1821

Type species: *Actinocrinites triacontadactylus* Miller 1821; SD Wachsmuth & Springer, 1881.

Actinocrinites sp. cf. **A. brouweri** (Wanner 1924)
(Plate 65 figs 1-3)

1987 *Actinocrinites* cf. *A. brouweri* (Wanner); Webster: p.99, figs 3A-E

Diagnosis: A large *Actinocrinites* with coarse spinose ornament on the basal circlet, radials and interradial plates.

Closest species: *A.* cf. *A. brouweri* is known only from disarticulated plates which show the characteristic coarse spinose ornament of *A. brouweri*. Until articulated specimens are found the thecal shape and oral plates cannot be determined for unquestioned identification.

Types: Figured and other specimens - WAM 84.633-84.635, UMMP 61852-61857.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare, 2 basal circlets, 19 radial and 3 interradial plates.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate.

Superfamily HEXACRINITACEA Wachsmuth & Springer 1885

Family DICHOCRINIDAE S.A. Miller 1889

Genus **CAMPTOCRINUS** Wachsmuth & Springer 1897

Type species: *Camptocrinus myelodactylus* Wachsmuth & Springer 1897; OD.

Camptocrinus sp. cf. **C. indoaustralicus** (Wanner 1924)
(Plate 65 figs 14-16)

1987 *Camptocrinus* cf. *C. indoaustralicus* Wanner; Webster: p.102, figs 5J-M

Diagnosis: Heteromorphic stem with columnals changing from slightly elliptical to strongly elliptical to subrectangular distally; crenularium of coarse culmina and crenellae; nodals paired; stem enrolled.

Closest species: The changing nature of the stem distally is similar to that of *Camptocrinus indoaustralicus*; however, the cup is unknown from the Callytharra Springs locality. Disarticulated columnals and pleuricolumnal segments provide the morphologic detail.

Types: Figured and other specimens - WAM 84.641, UMMP 61974-61976.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Moderately common, over 300 nodals and internodals known.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate.

Suborder GLYPTOCRININA Moore 1952
Superfamily PLATYCRINITACEA Austin & Austin 1842

Family PLATYCRINITIDAE Austin & Austin 1842

Genus **PLATYCRINITES** Miller 1821

Type species: *Platycrinites laevis* Miller 1821; SD Meek & Worthen 1865, p.160.

Platycrinites wrighti (Marez-Oyens 1940)
(Plate 65 figs 4-6)

1940a *Platycrinus tuberculatus* Marez-Oyens: p.300, pl. 1 fig. 2
1940b *Platycrinus wrighti* Marez-Oyens: p.253, unfigured
1943 *Platycrinites wrighti* (Marez-Oyens); Bassler & Moodey: p.629, unfigured
1986 *Platycrinites wrighti* (Marez-Oyens); Webster: p.99, figs 3F-I

Diagnosis: A large *Platycrinites* with numerous discrete, moderately sized nodes on all thecal plates; angustary radial facets; round stem impression.

Closest species: There are several species of *Platycrinites* in the Carboniferous that have granular ornamentation; however, none have the discrete nodes of *P. wrighti*.

Types: Holotype - Geological Institute, Amsterdam University, The Netherlands; figured and other specimens - UMMP 61858-61861, GSWA F7861.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Basleo Beds.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Abundance: Rare, known from 5 basal circlets, 8 radials, 7 tegmen plates.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate; may be reef associated in Timor.

Subclass INADUNATA Wachsmuth & Springer 1885
Order DISPARIDA Moore & Laudon 1943
Superfamily ALLAGECRINACEA Carpenter & Etheridge Jnr 1881

Family CATILLOCRINIDAE Wachsmuth & Springer 1886

Genus **NOTIOCATILLOCRINUS** Willink 1978

Type species: *Notiocatillocrinus oakiensis* Willink 1978.

Notiocatillocrinus callytharraensis (Webster 1987)
(Plate 65 figs 24-27)

1987 *Notiocatillocrinus callytharraensis* Webster: p.109, figs 6A-J

Diagnosis: A monocyclic catillocrinoid with flattened cone-shaped cup, elliptical in outline, 1-3 basals, A and D radials multifaceted, B, C, and E bear only one facet each with C radial also bearing anal X; arms slender, strongly convex laterally, unbranched, increase in number with size, approximately 37 in larger individuals; tegmen horseshoe-shaped in cross-section with open side above E radial, five ridges with laterally projecting spines (anal series may be a double row of spines) along length.

Closest species: *N. callytharraensis* is most closely related to *N. nerimberae* differing by possessing less protuberant radials, a slightly concave cup wall and having the distal tips of the basals visible in side view.

Types: Holotype - GSWA F7861; paratypes - UMMP 61882-61888, GSWA F5622, WAM 84.649-84.650, and UWA 6545.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common, known from two crowns, 15 cups, and several hundred cup and tegmen plates.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate.

Superfamily BELEMNOCRINACEA S.A. Miller 1883

Family SYNBATHOCRINIDAE S.A. Miller 1889

Genus **SYNBATHOCRINUS** Phillips 1836

Type species: *Synbathocrinus conicus* Phillips 1836; Monotypy.

Synbathocrinus campanulatus (Wanner 1916)
(Plate 65 figs 7-10)

1916 *Symbathocrinus campanulatus* Wanner: p.16, pl. 96 figs 5, 6; text-figs 3, 4
1987 *Synbathocrinus campanulatus* (Wanner); Webster: p.114 figs 7A-L

Diagnosis: A *Synbathocrinus* with gentle to moderately convex cup walls, basals barely to distinctly visible in lateral view, and lacking ornamentation or with fine granulations; cup sutures not impressed.

Closest species: *S. campanulatus* is most similar to *S. constrictus* with which it is commonly found. *S. campanulatus* is distinguished by the convex walls without impressed sutures. These two species may be two general phenotypes of one variable species.

Types: Holotype - University of Bonn, West Germany; paratypes and topotypes - University of Bonn, West Germany, and Delft Technical School, The Netherlands; figured and other specimens - UMMP 61893-61898, WAM 84.652-84.653, GSWA F5613, F5616, F7861, and UWA 6571.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Late Permian.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Abundance: Moderately abundant, 2 crowns, 13 cups and several hundred disarticulated brachials and radials.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate in Western Australia; may be reef associated in Late Permian of Timor.

Synbathocrinus constrictus (Wanner 1916)
(Plate 65 figs 11-13)

1916 *Symbathocrinus constrictus* Wanner: p.21, pl. 96 figs 9-13
1986 *Synbathocrinus constrictus* (Wanner); Webster: p.115, figs 7M-W

Diagnosis: A *Synbathocrinus* with gently to moderately concave walls, and slightly to moderately impressed sutures, with or without

ornamentation; ornamentation varies from moderately tumid plates to sharply ridged (one to three) plates with or without nodes on the ridges.

Closest species: *S. campanulatus* which may grade into *S. constrictus* is distinguished by the concave walls and impressed sutures.

Types: Holotype - University of Bonn, West Germany; paratypes and other specimens - UMMP 61889-61905, WAM 84.654-84.655, GSWA F5611-F5614, and UWA 6571, 27012.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Basleo Beds.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Abundance: Moderately abundant, 37 cups and several hundred disarticulated radials and brachials.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate in Western Australia; may be reef associated in Late Permian of Timor.

Order CLADIDA Moore & Laudon 1943
Suborder CYATHOCRININA Bather 1899
Suborder POTERIOCRININA Jaekel 1918
Superfamily ERISOCRINACEA Wachsmuth & Springer 1886

Family GRAPHIOCRINIDAE Wachsmuth & Springer 1886

Genus **TAPINOCRINUS** Webster 1986

Type species: *Tapinocrinus macurdai* Webster 1987.

Tapinocrinus ingrami Webster 1987
(Plate 66 figs 5-8)

1986 *Tapinocrinus ingrami* Webster: p.120, figs 8E-L

Diagnosis: A low bowl-shaped cup with small infrabasals and basals; radials weakly upflaring; facets plenary slope outwards; one anal in cup.

Closest species: *T. ingrami* is associated with *T. macurdai* which has a discoid shape with a basal concavity.

Types: Holotype - WAM 84.658; paratypes - UMMP 61914-61915.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare, 3 cups.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate.

Tapinocrinus macurdai Webster 1987
(Plate 66 figs 1-4)

1987 *Tapinocrinus macurdai* Webster: p.118, figs 8M-DD

Diagnosis: A low bowl-shaped to discoid cup with a basal concavity; infrabasals restricted to basal concavity; basals small confined to base; radials large, proximally in basal plane; plenary radial facets slope steeply outward; none or one anal in cup; fine granular ornamentation.

Closest species: *T. macurdai is* closely related to *T. ingrami* which, however, lacks the basal cavity.

Types: Holotype - WAM 84.656; paratypes - WAM 84.657, UMMP 61907-61911.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare, 8 cups.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate.

Superfamily CODIACRINACEA Bather 1890

Family CODIACRINIDAE Bather 1890
Subfamily CODIACRININAE Bather 1890

Genus **CYDONOCRINUS** Bather 1913

Type species: *Cydonocrinus parvulus* Bather 1913; OD.

Cydonocrinus sp. cf. **C. turbinatus** (Wanner 1916)
(Plate 65 figs 20-23)

1987 *Cydonocrinus* cf. *C. turbinatus* Wanner; Webster: p.116, figs 8A-D

Diagnosis: Cup truncate conical, infrabasals visible in lateral view; basals and radials steeply upflared; radial facet angustary, anal opening on side of cup at base of radials.

Closest species: This form is closely related to *C. turbinatus* and probably conspecific. It differs by having slightly lower infrabasal circlet and the anal opening is slightly lower on the side of the cup, both features are probably variation.

Figured specimen: UWA 27026.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare, 1 cup.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna, probably warm-temperate to temperate.

Superfamily APOGRAPHIOCRINACEA Moore & Laudon 1943

Family APOGRAPHIOCRINIDAE Moore & Laudon 1943

Genus **APOGRAPHIOCRINUS** Moore & Plummer 1940

Type species: *Apographiocrinus typicalis* Moore & Plummer 1940; OD.

Apographiocrinus pumilus (Wanner 1916)
(Plate 66 figs 16-18)

1916 *Delocrinus verbeeki* var. *pumila* Wanner: p.194, pl. 12 fig 10; pl. 13 fig 2
1940 *Apographiocrinus pumilus* (Wanner); Moore & Plummer: p.116
1949 *Graphiocrinus pumilus* (Wanner); Wanner: p.14, pl. 1 figs 9-15
1987 *Apographiocrinus pumilus* (Wanner); Webster: p.121, figs 9A-J

Diagnosis: An *Apographiocrinus* with moderately deep basal impression; downflared infrabasals; tumid basals forming base of cup; tumid radials; peneplenary radial facets; one anal in cup; sutures impressed with dimples at apices of basals and radials; fine to medium granular ornamentation; 10 uniserial arms with first primibrachial axillary.

Closest species: *A. pumilus* is most similar to *A. exsculptus* and *A. facetus* but differs by having granular ornamentation and more tumid radials and basals.

Types: Holotype and paratype - Delft Technical School, The Netherlands; figured and other specimens - UMMP 61917-61927, WAM 84.659-84.662, UWA 5619, 5625, 7861, and GSWA F5677.

Distribution and range: Callytharra Springs areas, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Basleo Beds.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Abundance: Moderately common, known from 3 cups and numerous radial and primibrachial plates.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate; may be reef associated in Timor.

Superfamily ZEACRINITACEA Bassler & Moodey 1943

Family TIMORECHINIDAE Jaekel 1918

Genus **PARABURSACRINUS** Wanner 1924

Type species: *Bursacrinus procerus* Wanner 1916; OD.

ParaburSacrinus granulatus (Wanner 1949) (*nom transl.*)
(Plate 66 figs 9-12)

1949 *Parabursacrinus magnificus* var. *granulata* Wanner: p.35, pl. III figs 1-3
1987 *Parabursacrinus granulatus* Wanner; Webster: p.124, figs 10A-D

Diagnosis: *A Parabursacrinus* with 40 or more arms; low disc-shaped cup; bulbous radials and primibrachial plates; sutures between radials in broad depression; granular ornamentation.

Closest species: *P. granulatus* is similar to *P. magnificus*, except it has granular ornamentation.

Types: Holotype - Bonn University, West Germany; figured and other specimens - WAM 84.665, UMMP 61934, 61935.

Distribution and range: 800 m west of Callytharra Spring on One Gum Creek, 450 m upstream from its junction with the Wooramel River, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Basleo Beds.

Abundance: Rare, 3 cups.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate; may be reef associated in Timor.

Parabursacrinus magnificus (Wanner 1916)
(Plate 66 figs 13-15)

1916 *Bursacrinus magnificus* Wanner: p.177, pl. 106 figs 6A-C
1949 *Parabursacrinus magnificus* (Wanner); Wanner: p.34, pl. 2 figs 28, 29
1987 *Parabursacrinus magnificus* (Wanner); Webster: p.123, figs 10I-Q

Diagnosis: A *Parabursacrinus* with 40 or more arms; sutures between radials in a broad depression; no ornamentation on cup plates; low disc-shaped cup; very bulbous radials and primibrachial plates.

Closest species: The closest related species is *P. granulatus* which has granular ornamentation on the cup plates and proximal brachials.

Types: Holotype - Bonn University, West Germany; figured and other specimens - WAM 84.663-84.664, UWA 6569, GSWA F5621, F5626, and UMMP 61928-61933.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation. Basleo, Timor - Basleo Beds.

Abundance: Common, 3 dorsal cups, nearly 600 radials, and 75 primibrachials.

Age: Late Sakmarian (Sterlitamakian) in Western Australia. Dzhulfian in Timor.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate to temperate; may be reef associated in Timor.

Suborder POTERIOCRININA Jaekel 1918
Superfamily CALCEOLISPONGIACEA Teichert 1954

Cup large to small, base concave to flat, distinguished mainly by prominent spine- or spade-like projections of basals in most species, arms five obliqui-uniserial (Lane *in* Moore and Teichert, 1978, p.754).

Remarks: The family Calceolispongiidae Teichert (1954) was upgraded to superfamily status by Moore and Strimple (1973). After dicovery of species of *Calceolispongia* that show no significant thickening of the basals, Willink (1979b) suspects that this family might just be a specialized end branch of the Texacrinacea Strimple 1971.

Range and distribution: Permian; Australia (WA, NSW, Tasmania), Indonesia (Timor), India (Kashmir, Umaria).

Family CALCEOLISPONGIIDAE Teichert 1954

Cup large, bowl-shaped, with shallow basal invagination; infrabasals small, concealed by stem, not visible from side; basals large, in most species spinose or tuberculate; radial arm facets wide, inclined outward-upward; one anal plate in cup, separating radials. Arms uniserial, unbranched, pinnulate. Stem small, relative to cup size (Lane *in* Moore and Teichert, 1978, p.755).

Range and distribution: As for the superfamily.

Genus **CALCEOLISPONGIA** Etheridge Jnr 1915
(Synonym: **Dinocrinus** Wanner 1916)

Type species: *Calceolispongia hindei* Etheridge Jnr 1915.

Cup large to small, bowl-shaped, with shallow to deep basal concavity and indented basal-radial sutures; infrabasals small, diamond-shaped, not visible or largely visible from side; basals hexagonal, except for CD basal truncated by anal X; basals greatly thickened and expanded into large, horn-like, or spade-shaped projections, or unthickened and ornamented by tubercles or spines; radials pentagonal, shorter than basals, separated by anal X in CD interray; radial arm facets occupying full width of plates, inclined outward

and upward, muscle area long. Arms unbranched, uniserial, pinnulate, coiling; proximal two brachials large and trapezoidal, distal brachials cuneiform. Brachial articulations predominantly muscular. Stem small, relative to cup size, circular in section, having long, slender cirri (very slightly modified after Willink, 1979b, p.164)

Distribution and range: Permian, Australia (WA, Queensland, NSW), Indonesia (Timor), India (Punjab Himalaya, Umaria, though possibly a new genus).

Calceolispongia abundans Teichert 1949
(Plate 67 figs 1-15)

1949 *Calceolispongia abundans* Teichert: p.54-59, pl. 1 figs 2, 7, 12, 21; pl. 6 figs 21, 22; pl. 8 fig. 2; pl. 9; pl. 10 figs 1-10, 13-38; pl. 11; pl. 12

Diagnosis: Medium-sized, diameter of cup when measured from distal ends of basal plates about 70 mm, but ventral lumen only some 30 mm across; basals of moderate size, maximum about 5 cm^3 by volume, bearing 10 to 20, usually well-defined, tubercles. First brachials never strongly ornamental, many smooth; second brachials shorter than usual for genus, mature plates with up to 4 spinose tubercles on each side of median depression.

Closest species: *C. elegantula* Teichert which is somewhat smaller, with basal plates tending to be pointed.

Types: Holotype - WAM G8501; topotypes - UWA 22245-22247. 22276, 22278-22281, and WAM F8430, F8433, F8440-F8422, F8484, F8485, F8666-F8742, F17044.

Type locality: In syncline with axis 1.3 km west of Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - 25 to 35 m above base of the Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Abundant (original description based on more than 20 cups, 400 basals, 100 radials, 50 first brachials, 30 second brachials, 20 infrabasals, stems, arms).

Sedimentary environment: Occurs in calcareous sandstone and siltstone, probably shallow shelf in warm-temperature latitude.

Calceolispongia acuminata Teichert 1949
(Plate 68 figs 1, 2, 9, 10, 22)

1949 *Calceolispongia acuminata* Teichert: p.59-60, pl. 3 figs 8-35

Diagnosis: Moderately sized cups, known from disarticulated plates only; maximum size of basals 3.3 cm^3 by volume; basals varying greatly in appearance, except that nearly all of them taper distally to point, some plates tending to hook-shape in side view; upper side of basals either smooth or bearing few (up to 10 or 12), low tubercules.

Closest species: Some types of basals resemble basals of *C. truncata*, others are more like the smooth variety of *C. hindei*.

Types: Holotype - UWA 21538; topotypes and other material - UWA 21539-21543; also in the Bureau of Mineral Resources Collections, Canberra.

Type locality: South bank of Minilya River, near Bulgadoo Pool, about 5 km northwest of Wandagee Homestead, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee and Byro Stations, **Carnarvon Basin** - uppermost part of the Bulgadoo Shale, ?Mallens Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare (35 basals, 1 radial, 3 second brachials).

Sedimentary environment: "Fairly deep, quiet water with restricted circulation and with a reducing environment" (Condon, 1967, p.144), but associated fauna of corals, bryozoans, brachiopods, and molluscs not well known.

Calceolispongia barrabiddiensis Teichert 1949
(Plate 68 figs 3-8)

1939 *Calceolispongia barrabiddiensis* Teichert: p.60-61, pl. 3 figs 1-7

Diagnosis: Moderately sized cups, maximum size of basals 3.2 cm^3 by volume; in lateral view, profiles of both upper and lower side of basals almost perfectly straight; upper side of immature basals smooth, larger plates have surfaces covered with swelling of irregular delineation and size.

Closest species: Some basals of *C. truncata* may look similar, but tend to thicken more suddenly.

Types: Holotype - UWA 21523; paratypes - UWA 21521, 21524.

Type locality: On east limb of Barrabiddy Anticline, 400 - 800 m south of Barrabiddy Dam, Wandagee Station, Carnarvon Basin - Coyrie Formation (see Condon, 1967, p.131), associated with *Pseudoschistoceras simile* Teichert.

Distribution and range: Type locality only, **Carnarvon Basin** - Coyrie Formation, associated with *Pseudoschistoceras simile*.

Age: Late Artinskian (Baigendzhinian).

Abundance: Rare, (1 fragmentary crown, 7 basals).

Environment of deposition: Open shelf.

Calceolispongia digitata Teichert 1949
(Plate 65 fig. 17; Plate 68 figs 11-21, 27-29)

1949 *Calceolispongia digitata* Teichert: p.61-63, pl. 2 figs 1-45
1951 *Calceolispongia digitata* Teichert; Clarke et al.: p.55
1987 *Calceolispongia digitata* Teichert; Webster: p.125, fig. 11F

Diagnosis: One of smallest species of genus, largest basal only 0.21 cm^3 by volume; basals strongly compressed laterally, distal ends projected into several short spines, arranged in dorsoventral median plane of plate, their number varying between 2 and 7; surface of basals smooth. Second brachials bearing 2 to 4 very prominent spines. Radials without median depression.

Closest species: *C. spinosa* Teichert, distinguishable by the granulose surface of its plates.

Types: Holotype - UWA 21526; topotypes - UWA 21527-21532, UMMP 61938, WAM 84.667.

Type locality: About 800 m west of Callytharra Springs on One Gum Creek, 450 m upstream from its junction with the Wooramel River, Carnarvon Basin.

Distribution and range: Fossil Cliff and Fossil Ridge on Irwin River, **Perth Basin** - Fossil Cliff Member of the Holmwood Shale; Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Common, known from more than 300 basals, radial, primibrachials and secundo brachial plates.

Environment of deposition: Shallow shelf, associated with rich invertebrate fauna; probably warm-temperate.

Calceolispongia elegantula Teichert 1949
(Plate 68 figs 23-26, 30-41, 44)

1949 *Calceolispongia elegantula* Teichert: p.63-71, pl. 1 figs 1, 8, 13; pl. 5 figs 14-16; pl. 6 figs 1-20, 23-80; pl. 7; pl. 8 fig. 1

Diagnosis: Medium-sized cups with large basals usually in 1.5 to 3.0 cm^3 range by volume, with few posterior basals ranging up to 7 cm^3; basals less variable in appearance than in most other species of genus, upper surfaces bearing not more, usually less, than 15 broad, low tubercles; immature basals pointed, mature ones blunt at distal end. Radial plates rather small with one or two prominent tubercles on each side of median depression. Anal X either smooth or with small number of tubercles. Second brachials with deep median depression, flanked by prominent tubercles. Surface of all plates characteristically granular. Stem better known than in any other species, nodals separated by from 5 to 18 internodals, 2 or 3 cirri attached to each nodal.

Closest species: *C. abundans*, from which *C. elegantula* differs in somewhat smaller size and the granular surface of its plates.

Types: Holotype - UWA 22060a; topotypes - UWA 22060-22082, 22084-22097, 22099-22103, 22105.

Type locality: East limb of syncline with axis 1.3 km west of Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Minilya River syncline, Wandagee Station, **Carnarvon Basin** - lowermost 25 m of Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Abundant, original description based on 20 dorsal cups and large numbers of detached infrabasals, basals, radials, anals, brachial (including pinnulate portion of arms), and stems (up to 84 mm long).

Sedimentary environment: Open shelf, well below wave base; warm-temperate belt.

Calceolispongia hindei Etheridge Jnr 1915
(Plate 68 figs 42, 43, 45-52, 54-57)

1915 *Calceolispongia hindei* Etheridge Jnr: p.9-13, pl. 4 figs 1-9; pl. 7 figs 5, 6
1949 *Calceolispongia hindei* Etheridge Jnr: p.71-75, pl. 21 figs 1-33; pl. 22 figs 1-20; pl. 23 figs 1-12, 22-31.

Diagnosis: Very large cup, with basals up to 22 cm^3 in volume; lateral sides of basals almost parallel, distal ends blunt, upper sides carrying about 50 low tubercles with tendency towards fusion into subparallel, transverse ridges; general shape very variable and some basals almost smooth. Radial plates with deep depresson and little ornamentation. Other parts of crown unknown.

Closest species: *Calceolispongia spectabilis*, in which, however, the tubercles of the basals are never fused; *C. cornuta* (Wanner) from the Bitauni beds of Timor, in which the tubercles of the basals also are never fused and which probably has a somewhat smaller overall size.

Types: Lectotype - GSWA F10930-F10931; 4 paratypes in the same collection; topotypes - UWA 20773, 20774, 21465; additional material - UWA 21466-21468.

Type locality: Southeast corner of Mount Marmion, close to foot of slope, northern Canning Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - lowest beds of the Coolkilya Sandstone; Mount Marmion, northern **Canning Basin** - near top of the Noonkanbah Formation.

Age: Latest Artinskian (Baigendzhinian) to Kungurian.

Abundance: Probably common in places in the Canning Basin; rare in the Carnarvon Basin.

Sedimentary environment: Mostly calcareous sandstone, siltstone, and shale, indicating shallow shelf, presumably temperate belt. The associated invertebrate faunas as yet incompletely known.

Calceolispongia multiformis Teichert 1949
(Plate 69 figs 1-9, 11-16, 19, 20)

1949 *Calceolispongia multiformis* Teichert: p.75-80, pl. 1 figs 3, 5, 6, 10, 11, 14, 15, 17, 18, 23, 24; pls 13-16

Diagnosis: Large cups, with mature basals reaching 6 to 7, exceptionally 9 cm^3 in volume; upper surface of basals always bears tubercles which, however, vary greatly in number, arrangement, shape, and size; maximum tubercle number is upward of 20, but there may be as few as 10. Radial plates with shallow median depression and one prominent tubercle on each side of it. Second brachials with deep median depression flanked on each side by row of about 3 prominent tubercles that tend to become spinose. Anal plates carrying up to 12 tubercles.

Closest species: *C. abundans*, which is somewhat smaller and whose basals are less strongly tuberculated.

Types: Holotype - UWA 22143; topotypes - UWA 22144-22148, 22166, 22197, 22199-22201; additional material - UWA 22149-22165, 22167, 22198, 22202-22103, 22218.

Type locality: Syncline on Minilya River with axis 1.3 km west of Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - 50 - 56 m above base of Wandagee Formation; northern **Canning Basin** - Noonkanbah Formation. Chimlo de Gali and Tramavala (Kapoor, 1973) - Tramavala Formation, Bhallesh Group, in Punjab Himalaya.

Age: Late Artinskian (Baigendzhinian) in Western Australia. In Kashmir, "earliest Permian" (Kapoor, 1973).

Abundance: Nearly 3000 individual plates (including 1300 basals) reported from type locality; rare elsewhere in Carnarvon Basin and in Kashmir; doubtfully present in the Canning Basin.

Environment of deposition: In the Canning Basin, shallow shelf in temperate belt. Jeffrey et al. (1955) studied the C^{12}/C^{13} composition of plates of *C. multiformis* from the Wandagee Formation with inconclusive results as to environmental interpretation.

Calceolispongia robusta Teichert 1949
(Plate 69 figs 10, 25)

1949 *Calceolispongia robusta* Teichert: p.80-83, pl. 24

Diagnosis: Largest species of genus, with basals ranging to 65 - 70 cm^3, one posterior basal to 85 cm^3, in volume; ventral lumen of cup of holotype 65 mm in diameter; diameter of crown, measured from tips of basal plates, 130 mm. Infrabasals heavy and large, 17 - 18 mm long. Basals wedge-shaped, distal ends forming thin end of wedge; surface, ornamentation almost non-existent, except for

small elevated area near upper margin of plate, an easily recognizable specific feature. Radial plates poorly known; other parts unknown.

Closest species: *C. robusta* marks the last appearance of the genus and is not closely similar to any of the older species.

Types: Holotype - UWA 21476; paratype - UWA 21469; additional material - UWA 21470-21475.

Type locality: Near southwest corner of Wandagee Hill, Wandagee Station, Carnarvon Basin (Teichert, 1949, p.82).

Distribution and range: Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone [exact position in Coolkilya Sandstone unknown; the vertical range of probably 900 feet (275 m) given by Teichert (1949, p.82) is certainly wrong, because the thickness of the formation around Wandagee Hill is only about 700 feet (213 m) (Condon, 1967, p.183). On the basis of data supplied by Dickins (1963, p.147) the highest occurrence seems to be in the middle part of the Coolkilya Sandstone].

Age: Kungurian.

Abundance: Rare (2 dorsal cups and several detached basal and radial plates).

Calceolispongia rotundata Teichert 1949
(Plate 69 figs 17, 18, 21-24, 26, 27)

1949 *Calceolispongia rotundata* Teichert: p.83-85, pl. 4 figs 25-42; pl. 5 figs 1-13

Diagnosis: Moderately sized cups with relatively short basals rarely longer than high, having volume of as much as 2 cm^3; their surface covered with greatly varying number of tubercles; mature basal plates have between 15 and 25 tubercles of differing degrees of prominence; tubercles near distal end tend to be elongated into short spines. Entire outer surface finely granulated. Radials without median depression, outer surface covered with irregularly distributed tubercles.

Closest species: *C. mammeata* (Wanner) from Basleo Beds in Timor which differs in that its basals are not tuberculated.

Types: Holotype - UWA 21504; paratype - UWA 21505; topotypes and additional material - UWA 21506-21516, 22083, 22098, 22104, 22117-22119.

Type locality: Syncline in Minilya River with axis 1.3 km west of Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - throughout lower 50 m of Wandagee Formation; Noonkanbah Homestead area, northern **Canning Basin** - indeterminate horizon in the Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Fairly common in type locality, original material consisting of 2 cups, 72 basals, 32 radials, 1 second brachial; rare in the Noonkanbah Formation, Canning Basin.

Sedimentary environment: Shallow shelf in temperate climate.

Calceolispongia rubra Teichert 1949
(Plate 70 figs 1-4, 10-12, 28, 29, 36-38, 40)

1949 *Calceolispongia rubra* Teichert: p.85-89, pl. 10 figs 11, 12; pl. 17; pl. 18 figs 1-36, 44-47

Diagnosis: Large cups, with basals approaching 8 cm^3, one posterior basal 10.1 cm^3, in volume; basals varying greatly in proportions from small and slender to large and broad, but ornamentaton rather uniformly consisting of well-spaced, low, broady swollen eminences; slight tendency towards fusion of neighboring eminences, but no tendency towards spinosity. Radials have shallow median depression, generally smooth surface. Second brachials always with pronounced median depression and as many as five tubercles on each side.

Closest species: *C. multiformis* Teichert has very nearly the same stratigraphic range as *C. rubra*, both species occupying mutually exclusive habitats. Both species, while of similar size, differ greatly in the ornamentation of the basals. *C. cornuta* (Wanner) from the Bitauni Beds of Timor has basals that are similar in shape and size, but have smaller, better defined tubercles.

Types: Holotype - UWA 22206; topotypes - UWA 22207-22213, 22217; additional material - UWA 22214, 22215.

Type locality: In small syncline about 500 m south of Minilya River and 800 m southeast of Curdamuda Well, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - about 45 - 55 m above base of Wandagee Formation; Noonkanbah Homestead area, northern **Canning Basin** - indeterminate horizon in the Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Abundant in type locality and elsewhere on Wandagee Station; rare in the Canning Basin.

Sedimentary environment: Shallow shelf in temperate climate.

Calceolispongia spectabilis Teichert 1949
(Plate 70 figs 17-22, 27, 30, 31, 41-44, 48, 49)

1949 *Calceolispongia spectabilis* Teichert: p.89-92, pl. 1 fig. 9; pl. 18 figs 37-43, 48; pl. 19; pl. 20

Diagnosis: Large species, known almost entirely from basal plates only which attain as much as 30.5 cm^3 in volume; basals in side view with upper side either flat or slightly concave, lower side slightly convex; their upper surface covered with tubercles generally evenly

spaced and of more or less equal size; basals vary in proportions from long and slender to short and broad. Radials with narrow median depression, with 5 or 6 tubercles on each side. Second brachials with deep median depression with U-shaped profile, strongly elevated tubercles on each side.

Closest species: *C. hindei* Etheridge which is considerably smaller, but with basals resembling those of *C. spectabilis*, except for the tendency of tubercles to fuse laterally into ridges. The two species are easily distinguished by the different profiles of their basals in lateral view.

Types: Holotype - UWA 21519; paratypes - UWA 22141a-e; topotypes - UWA 22135, 22137-22140, WAM F8486-F8494; additional material - UWA 21517, 21518, 22136.

Type locality: Syncline with axis 1.3 km west of Coolkilya Pool, Minilya River, Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - 60 to 145 m above base of Wandagee Formation; **?Canning Basin** - ?Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Abundant in type locality, rare elsewhere.

Sedimentary environment: Shallow shelf in temperate latitude.

Calceolispongia spinosa Teichert 1949
(Plate 65 figs 18, 19; Plate 70 figs 5-9, 13-16, 23-25)

1949 *Calceolispongia spinosa* Teichert: p.92-93, pl. 2 figs 46-72
1987 *Calceolispongia spinosa* Teichert; Webster: p.126, figs 11G-H

Diagnosis: Small species characterized by basals that carry from two to four obliquely upward-directed spines; outer surface granulose. Radials with median depression, without tubercles or spines. Second brachials carrying two prominent spines.

Closest species: *C. spinosa* is easily distinguished from the comtemporary *C. digitata* by the granulose surface of its cup plates. Radial plates are similar to those of *C. bifurca* (Wanner) from the Basleo Beds of Timor, but basals are very different.

Types: Holotype - UWA 21533; paratypes and topotypes - UWA 21534-21536, 22287.

Type locality: 800 m west of Callytharra Springs on One Gum Creek, 450 m upstream from its junction with the Wooramel River, Carnarvon Basin.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: Rare.

Sedimentary environment: Shallow shelf, associated with rich invertebrate fauna, probably warm-temperate.

Calceolispongia truncata Teichert 1949
(Plate 70 figs 32, 35, 39)

1949 *Calceolispongia truncata* Teichert: p.93-95, pl.3 figs 36-56; pl. 4 figs 1-21

Diagnosis: Medium-sized species known from basals only, ranging to 6.4 cm^3 in volume, with one single basal of 11.2 cm^3; in general, basals short, heavy, and box-shaped, but different trends exist; all carry fairly large, regularly arranged tubercles; these grade into types with smaller tubercles and tend to be pointed.

Closest species: *C. truncata* is not closely similar to any other species, except for the variety with pointed basals which somewhat resembles certain types of *C. acuminata*.

Types: Holotype - UWA 21545; topotype - UWA 21546; additional material - UWA 21547-21549, 21525.

Type locality: South side of Minilya River, 1 km southeast of Coolkilya Pool, Minilya River Wandagee Station, Carnarvon Basin.

Distribution and range: Wandagee Station, **Carnarvon Basin** - about 120 m below top of Cundlego Formation, but vertical range not well established.

Age: Late Artinskian (Baigendzhinian).

Abundance: Uncommon.

Sedimentary environment: Very shallow shelf, probably above wave base in temperate belt.

Calceolispongia sp. indet. A
(Plate 70 figs 50, 53)

1949 *Calceolispongia* sp. ind. A Teichert: p.95-96, pl. 1 figs 19, 20; pl. 23 figs 13-16

Diagnosis: Stout, large basal plates, similar in shape to *Calceolispongia robusta*, but upper surface ornamented with large rounded eminences.

Figured specimens: UWA 21475, 21500-21501.

Distribution and range: Wandagee Station, **Carnarvon Basin** - Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Rare.

Calceolispongia sp. indet. B
(Plate 70 figs 51, 52)

1949 *Calceolispongia* sp. ind. B Teichert: p.96, pl.23 figs 17, 18

Diagnosis: One large basal plate associated with *Calceolispongia robusta*, but distal part strongly flattened, giving the plate a shape somewhat like a duckbill; might represent strongly aberrant variety of *C. robusta*.

Figured specimen: UWA 21498.

Distribution and range: Southeastern part of Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Kungurian.

Calceolispongia sp. indet. C
(Plate 68 figs 53, 58)

1949 *Calceolispongia* sp. ind. C Teichert: p.96, pl. 23 figs 19-21

Diagnosis: Large basal plate of alate shape, expanding laterally into thin flanges. No comparable plates found elsewhere.

Figured specimen: UWA 21499.

Distribution and range: As for *Calceolispongia* sp. indet. B.

Age: Kungurian.

Calceolispongia sp. indet. D

1949 *Calceolispongia* sp. ind. D Teichert: p.96-97

Diagnosis: Basal plate roughly cylindrical in shape proximally, expanding laterally in distal end; unlike any other plate known.

Distribution and range: Southeast limb of syncline west of Coolkilya Pool on Minilya River, Wandagee Station, **Carnarvon Basin** - Baker Formation.

Age: Kungurian.

Abundance: One specimen only.

Calceolispongia sp. indet. E
(Plate 70 figs 26, 33, 34)

1949 *Calceolispongia* sp. ind. E Teichert: p.97, pl. 4 figs 22-24

Diagnosis: Relatively small basal plate with wedge-shaped distal end; upper side with few indistinct elevations or undulations; unlike any other known plates.

Figured specimen: UWA 21520.

Distribution and range: Nalbia Paddock, 1800 m due east of northeast corner of Mungadan Paddock, Wandagee Station, **Carnarvon Basin** - Quinnanie Shale.

Age: Late Artinskian (Baigendzhinian).

Calceolispongia sp. indet. F
(Plate 70 figs 45-47)

1949 *Calceolispongia* sp. ind. F Teichert: p.97, pl. 2 figs 73-76

Diagnosis: Relatively small basal plates, hook-shaped, with upper side convex, lower side concave in side view; upper side with few, irregularly distributed tubercles.

Figured specimens: UWA 21522a,b.

Distribution and range: On east limb of Barrabiddy Anticline, 400 - 800 m south of Barrabiddy Dam, Wandagee Station, **Carnarvon Basin** - Coyrie Formation (associated with *Calceolispongia barrabiddiensis*).

Age: Late Artinskian (Baigendzhinian).

Calceolispongia sp. indet. G

1967 *Calceolispongia* sp. Condon: p.35

Diagnosis: None published.

Distribution and range: 0.6 - 1.25 km west of Coyango Well, Williambury Station, **Carnarvon Basin** (ML6) - Lyons Group. This may be the oldest recorded species of Calceolispongiidae.

Age: Asselian - Early Sakmarian (Tastubian).

Sedimentary environment: In siltstone "deposited in sea water from icebergs derived from a continental ice sheet" (Condon, 1967, p.36).

Calceolispongia sp. indet. H

1967 *Calceolispongia* sp. Condon: p.42

Diagnosis: None published.

Distribution and range: Northeastern corner of Mundarie Paddock, Middalya Station, **Carnarvon Basin** (MG 158) - Lyons Group.

Age: Asselian - Early Sakmarian (Tastubian).

Sedimentary environment: In fairly deep water in siltstone deposited "directly from icebergs derived from a continental icesheet" (Condon, 1967, p.43).

Calceolispongia sp. indet. I

1967 *Calceolispongia* Condon: p.97

Diagnosis: None published; cup and brachials reported.

Distribution and range: 7.25 km west of Moogooree Homestead and 800 m north of road from Moogooree to Donellys Well, **Carnarvon Basin** (TP 323) - upper part of Billidee Formation.

Age: Late Artinskian (Baigendzhinian).

Calceolispongia sp. indet. J

1967 *Calceolispongia* Condon: p.136

Diagnosis: None published.

Distribution and range: Unspecified locality, **Carnarvon Basin** - Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Calceolispongia sp. indet. K

1967 *Calceolispongia* sp. Condon: p.165

Diagnosis: None published.

Distribution and range: Unspecified locality in Carnarvon Basin, probably on Wandagee Station - Quinnanie Shale.

Age: Late Artinskian (Baigendzhinian).

Calceolispongia sp. indet. L

1967 *Calceolispongia* Condon: p.173

Diagnosis: None published.

Distribution and range: Unspecified locality on either Williambury, Middalya, or Wandagee Station, **Carnarvon Basin** - Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Calceolispongia sp. indet. M

1950 *Calceolispongia* sp. ind. Guppy et al.: p.8

Diagnosis: None published.

Distribution and range: Northern flank of Nerrima Dome, Nerrima Station, northern **Canning Basin** - Unspecified horizon (Sample N17) in Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Calceolispongia spp. nov.

1967 *Calceolispongia* spp. nov. Dickins *in* Condon: p.152

Diagnosis: None published.

Distribution and range: Unspecified locality in southern part of the **Carnarvon Basin** - Mallens Sandstone.

Age: Late Artinskian (Baigendzhinian).

Genus **JIMBACRINUS** Teichert 1954

Type species: *Jimbacrinus bostocki* Teichert 1954.

Diagnosis: Cup large bowl-shaped with shallow invagination below; basals very large, hexagonal, mammillate; radials pentagonal, equal, smaller than basals, separated in CD interray by anal X, radial arm facets from entire upper surface of plates, inclined outward-upward; anal X quadrangular, height equal to lateral radial facets. Individual cup plates commonly ornamented with one or more tubercles. Arms uniserial, pinnulate coiling, primibrachs 1 and 2 trapezoidal, distal brachials cuneiform. Stem small relative to cup size with alternating long and short columnals (modified after Lane *in* Moore and Teichert, 1978, by Willink, 1979b, p.181).

Range and distribution: Early Permian in Western Australia, and Tasmania.

Jimbacrinus bostocki Teichert 1954
(Plate 71 figs 1-14)

1954 *Jimbacrinus bostocki* Teichert: p.71-75, pl. 13 figs 1-7; pl. 14 figs 1-11

Diagnosis: Infrabasals convex, visible in side view. Basals large, outer side greatly swollen and produced into one or more spines directed upward at an angle of about 45 degrees, greatest swelling near upper (vertical) side of plate. Surface of radials weakly convex, most bearing one or more prominent tubercles. Radianal bears short anal sac of two rows of seven small rectangular plates. First brachials bear 1 to 3 tubercles in row. Second brachials featureless, near rectangular. Arms beyond second brachial uniserial, with one pinnule attached to broad side of each plate. Stem long, slender, cylindrical, without cirri.

Closest species: The only other species referred to *Jimbacrinus* is *Dinocrinus noetlingi* Sieverts-Doreck from the Early Permian of Tasmania which, however, has a cirriferous stem (Willink, 1979b, p.182).

Types: Holotype - CPC 326; paratypes - CPC 327, 329; hypotypes - CPC 330-334; additional material CPC 17586.

Type locality: South side of Gascoyne River, 3.5 km east of Jimba Jimba Homestead, Jimba Jimba Station, Carnarvon Basin.

Distribution and range: Jimba Jimba Station, **Carnarvon Basin** - unspecified horizon in the Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Abundant (60 complete cups and crowns, many dissociated plates).

Sedimentary environment: Outer shelf with restricted circulation.

Jimbacrinus minilyaensis Webster 1990

1990 *Jimbacrinus minilyaensis* Webster: p.70-71, pl. 3 figs 2, 3

Diagnosis: A *Jimbacrinus* with granular ornamentation on all cup plates and first primibrachs, basals bulbous to bluntly spinose, no coarse nodes on radials.

Closest species: *J. minilyaensis* lacks the coarse nodes or spines on the radials and is much smaller than the only other described species, *J. bostocki*.

Types: Holotype - UWA 83763; paratype - UWA 83764.

Type locality: Northeast side of syncline north of Minilya River, east of Coolkilya Pool, Carnarvon Basin.

Distribution and range: East of Coolkilya Pool, **Carnarvon Basin** - unspecified horizon in the Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Only two specimens known.

Sedimentary environment: Shallow shelf in temperate climate.

Calceolispongiidae gen. et sp. nov. A

1959 Calceolispongidae sp. nov. Dickins & Thomas: p.78
1967 Calceolispongidae gen. et sp. nov. Condon: p.61

Diagnosis: None published; cup plates and columnals reported.

Closest species: Said to be "very close to or identical with" *Calceolispongia* sp. from Umaria, India (Dickins and Shah, 1979, p.9).

Type locality: South side of Wooramel River, 1600 m west of Callytharra Springs, Carnarvon Basin.

Distribution and range: Callytharra Springs area and Lyndon River area, **Carnarvon Basin** - type Carrandibby Formation, uppermost Lyons Group.

Age: Early Sakmarian (Tastubian).

Calceolispongiidae gen. et sp. nov. B

1956 Calceolispongidae sp. nov. Dickins & Thomas: p.126

Diagnosis: "Closely allied to calceolispongid plates from the Umaria beds [India], described by Reed (1928) as dermal tubercles of fish" (Dickins & Thomas, 1959).

Closest species: Some of the plates described by Reed (1928) were refigured by Teichert (1949, pl. 25 figs 19-22). Nothing like these plates has ever been described from anywhere in Western Australia.

Distribution and range: Unspecified locality (or localities) in the southern half of **Carnarvon Basin** - unspecified horizon in the Lyons Group.

Age: Asselian - Early Sakmarian (Tastubian).

Calceolispongiidae gen. indet. sp. nov. A

1967 Calceolispongidae sp. nov. Condon: p.48

Diagnosis: None published.

Distribution and range: Right bank of Kialawibri Creek, 2.4 - 3.6 km upstream from its junction with Lyndon River, **Carnarvon Basin** - unspecified horizon in the Lyons Group.

Age: Asselian - Early Sakmarian (Tastubian).

Calceolispongiidae gen. indet. sp. nov. B

1977 Calceolispongidae sp. nov. Dickins et al.: p.277, pl. 1 figs 1-3

Diagnosis: No description published; known only from second brachial which has a median protuberance instead of a median depression.

Distribution and range: Northwestern part of Saint George Range, northern Canning - Millajiddee Member of the Carolyn Formation.

Age: Asselian - Early Sakmarian (Tastubian).

Calceolispongiidae? gen. et sp. indet. A

1987 Calceolispongiidae? sp. Webster: p.127, fig. 15a,b.

Diagnosis: Brief description published.

Figured specimen: UWA 62836.

Distribution and range: Callytharra Springs area, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian)

Family et gen. indet.

1990 Family and genus indeterminate Webster: p.70-71, pl. 2 fig. 14.

Diagnosis: Brief description published.

Figured specimen: UWA 83762.

Distribution and range: South of Barrabiddy Dam, Wandagee Station, **Carnarvon Basin** - red claystone in Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

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PALYNOMORPH GENERA AND SPECIES

ACRITARCHS

Genus **BRAZILEA** Tiwari & Navale 1967

Type species: *Brazilea punctata* Tiwari & Navale 1967; OD. Early Permian; Brazil.

Brazilea plurigenus (Balme & Hennelly) Foster 1979
(Plate 72 fig. 2)

1956a *Pilasporites plurigenus* Balme & Hennelly: p.65, pl. 3 figs 57-59
1979 *Brazilea plurigenus* (Balme & Hennelly); Foster 1979: p.11? pl. 40 figs 6,7

Synopsis: Small, alete, circular to subcircular outline; exine relatively thick, often with an oval or irregular rupture, smooth or faintly granulate.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 3 fig. 58).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Sanders & Ingram, 1964).

Age: Early Permian (Sanders & Ingram, 1964).

Brazilea scissa (Balme & Hennelly) Foster 1975
(Plate 72 fig. 3)

1956a *Laevigatosporites scissus* Balme & Hennelly: p.56, pl. 1 figs 6-9
1967 *Schizosporis scissus* (Balme & Hennelly); Segroves: p.292, pl. 1 figs 5, 6
1975 *Brazilea scissus* (Balme & Hennelly); Foster: p.156, pl. 8 figs 12, 13

Synopsis: Small to medium, alete, outline circular to oval; exine divided partially or completely into two symmetrical halves along a sharply defined line of weakness; smooth or faintly punctate.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 1 fig. 6).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972); Perth Basin (Balme & Hennelly, 1956a; Segroves, 1967; Sanders & Ingram, 1964); Carnarvon Basin (MacLeod, 1973).

Age: Early to Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **CIRCULISPORITES** de Jersey 1962

Type species: *Circulisporites parvus* de Jersey 1962; OD. Triassic; Qld., Australia.

Circulisporites parvus de Jersey 1962
(Plate 72 fig. 1)

1962 *Circulisporites parvus* de Jersey: p.15, pl. 5 figs 13-15
1967 *Circulisporites parvus* de Jersey; Segroves: p.295, pl. 2 fig. 7

Synopsis: Small, subspheroidal, exine splits into two symmetrical halves along a well-defined equatorial line of weakness; each half bearing low, circular, or spiral, more or less concentric ridges.

Holotype: GSQ Slide 212, OD de Jersey (1962, pl. 5 figs 13, 14).

Distribution: Collie Basin (Segroves, 1967; Glikson, 1972; Robertson, 1979); Perth Basin (Segroves, 1967).

Age: Early to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **HAPLOCYSTIA** Segroves 1967

Type species: *Haplocystia pellucida* Segroves 1967; OD. Late Permian; WA, Australia.

Haplocystia pellucida Segroves 1967
(Plate 72 fig. 13)

1967 *Haplocystia pellucida* Segroves: p.297, pl. 2 figs 1-6

Synopsis: Small, alete, subspheroidal, wall two-layered: inner layer dark, outer layer bearing narrow grooves that form a negative reticulum.

Types: Holotype - UWA 55627, OD Segroves (1967, pl. 2 figs 3-4); paratypes - UWA 55628, 55629, Segroves (1967, pl. figs 1-2; pl. 3 figs 5-6).

Distribution: Perth Basin (Segroves, 1967).

Age: Early to Late Permian (*Haplocystia* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **MACULATASPORITES** Tiwari 1964

Type species: *Maculatasporites indicus* Tiwari 1964; OD. Early Permian; India.

Maculatasporites amplus Segroves 1967
(Plate 72 figs 20, 23)

1967 *Maculatasporites amplus* Segroves: p.300, pl. 3 figs 15-18

Synopsis: Cavate, outline circular or sub-circular, alete: intexine thin, exoexine reticulate, with 100 - 500 rounded lumina.

Types: Holotype - UWA 55622, OD Segroves (1967, pl. 3 fig. 18); paratypes - UWA 55623, 55624, Segroves (1967, pl. 3 fig. 15; pl. 3 fig. 17).

Distribution: Perth Basin (Segroves, 1967; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Segroves, 1967; Powis, 1979).

Age: Early Permian (*Quadrisporites* Assemblage to *Acanthotriletes* Assemblage: Segroves, 1970b).

Maculatasporites gondwanensis Tiwari 1965

1965 *Maculatasporites gondwanensis* Tiwari: p.205, pl. 8 figs 191, 192
1985 *Maculatasporites gondwanensis* Tiwari; Foster et al.: p.66, pl. 1 fig. 3

Synopsis: Small, circular, alete: coarsely reticulate with polygonal lumina and narrow muri.

Holotype: OD Tiwari (1965, pl. 8 fig. 192).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian (*Quadrisporites* Assemblage: Foster et al., 1985).

Maculatasporites minimus Segroves 1967
(Plate 72 fig. 18)

1967 *Maculatasporites minimus* Segroves: p.298, pl. 3 figs 11-14

Synopsis: Small, cavate, circular: exoexine coarsely reticulate with 30 - 100 rounded lumina, intexine thin.

Types: Holotype - UWA 55619, OD Segroves (1967, pl. 3 figs 11-12); paratypes - UWA 55620, 55621, Segroves (1967, pl. 3 fig. 13; pl. 3 fig. 14).

Distribution: Perth Basin (Segroves, 1967); Canning Basin (Segroves, 1967; Powis, 1979).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **MEHLISPHAERIDIUM** Segroves 1967

Type species: *Mehlisphaeridium fibratum* Segroves 1967; OD. Early Permian; WA, Australia.

Mehlisphaeridium fibratum Segroves 1967
(Plate 72 figs 21, 22, 24)

1967 *Mehlisphaeridium fibratum* Segroves: p.296, pl. 2 figs 8-14; text fig. 2

Synopsis: Small to large, alete, circular or subcircular, wall two-layered: outer layer expanded into evenly or unevenly disposed conical processes, which are supported by elongate, longitudinal fibres.

Types: Holotype - UWA 55601, OD Segroves (1967, pl. 2 figs 13-14); paratypes - UWA 55603, 55602, 55604, Segroves (1967, pl. 2 fig 8; pl. 2 fig 10; pl. 2 figs 11, 12).

Distribution: Perth Basin (Segroves, 1967); Canning Basin (Segroves, 1967).

Age: Early Permian *(Haplocystia* Assemblage: Segroves, 1970a).

Mehlisphaeridium irregularae Anderson 1977

1977 *Mehlisphaeridium irregularae* Anderson: p.3, pl. 1 figs 31-52
1985 *Mehlisphaeridium irregularae* Anderson; Foster et al.: p.66, pl. 1 figs 1, 2

Synopsis: Small, circular, alete, wall two-layered: outer layer expanded into short irregularly shaped processes.

Holotype: OD Anderson (1977, pl. 1 fig. 50).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian *(Quadrisporites* Assemblage: Foster et al., 1985).

Genus **PELTACYSTIA** Balme & Segroves 1966

Type species: *Peltacystia venosa* Balme & Segroves 1966; OD. Late Permian; WA, Australia.

Peltacystia calvitium Balme & Segroves 1966
(Plate 72 fig. 12)

1966 *Peltacystia calvitium* Balme & Segroves: p.30, figs 31-o, 4a

Synopsis: Small to medium, alete, flattened oblate, exine; splits into two symmetrical halves along a well-defined equatorial line of weakness: each half bearing a clearly defined circumpolar ridge about half-way between the pole and equator, and weakly defined, radial, marginal striae.

Types: Holotype - UWA 54001, OD Balme & Segroves (1966, fig. 3n); paratypes - UWA 54002, 54003, Balme & Segroves (1966, figs 3m, 3o).

Distribution: Collie Basin (Balme & Segroves, 1966); Perth Basin (Balme & Segroves, 1966; Segroves, 1967); Canning Basin (Segroves, 1967).

Age: Late Permian *(Dulhuntyispora* Assemblage: Segroves, 1970b).

Peltacystia galeoides Segroves 1967
(Plate 72 fig. 8)

1967 *Peltacystia galeoides* Segroves: p.294, pl. 3 figs 3-5

Synopsis: Small to medium, alete, oblate, exine; splits into two symmetrical halves along a well-defined, equatorial line of weakness: each half bearing a poorly defined circumpolar ridge, slightly closer to equator than the pole.

Types: Holotype - UWA 55607, OD Segroves (1967, pl. 3 fig. 3); paratype - UWA 55608, Segroves (1967, pl. 3 fig. 5).

Distribution: Perth Basin (Segroves, 1967).

Age: Early to Late Permian *(Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Peltacystia monile Balme & Segroves 1966
(Plate 72 fig. 7)

1966 *Peltacystia monile* Balme & Segroves: p.28, figs 3a-e, 4b

Synopsis: Small, alete, oblate, exine; splits into two symmetrical halves along a well-defined equatorial line of weakness: each half bearing a ring of papillate processess, concentric with the margin.

Types: Holotype - UWA 43996, OD Balme & Segroves (1966, fig. 3b); paratypes - UWA 53997, 53998, Balme & Segroves (1966, figs 3d, 3e).

Distribution: Collie Basin (Balme & Segroves, 1966; Glik[illegible] 1972); Perth Basin (Balme & Segroves, 1966; Segroves, 1967), Canning Basin (Segroves, 1967).

Age: Late Permian *(Dulhuntyispora* Assemblage: Segroves, 19[illegible]b).

Peltacystia venosa Balme & Segroves 1966
(Plate 72 figs 9-11

1966 *Peltacystia venosa* Balme & Segroves: p.27, figs 1a-b, 2a-f, 3f-k

Synopsis: Small to medium, alete, flattened oblate, exine; splits into two symmetrical halves along a sharply defined equatorial line of weakness: each half bearing one or more ridges, concentric with the equator, and supporting small papillate or capitate processes; concentric ridges linked by additional sub-radial ridges forming a reticulate pattern.

Types: Holotype - UWA 53992, OD Balme & Segroves (1966, fig. 3k); paratypes - UWA 53993, 53994, 53995, Balme & Segroves (1966, figs 3h-j).

Distribution: Collie Basin (Segroves, 1967; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Segroves, 1966; Segroves, 1967); Canning Basin (Segroves, 1967).

Age: Early to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **PYRAMIDOSPORITES** Segroves 1967

Type species: *Pyramidosporites cyathodes* Segroves 1967; OD. Late Permian; WA, Australia.

Pyramidosporites cyathodes Segroves 1967
(Plate 72 fig. 25)

1967 *Pyramidosporites cyathodes* Segroves: p.292, pl. 1 figs 13-15

Synopsis: Medium to large, alete, occurring in obligate tetrahedral tetrads; individual spores joined by heavy thickenings; distal faces of spores invaginated and concave.

Types: Holotype - UWA 55598, OD Segroves (1967, pl. 1 fig. 14); paratypes - UWA 55599, 55600, Segroves (1967, pl. 1 fig. 13; pl. 1 fig. 15).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1967).

Age: Late Permian (*Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **QUADRISPORITES** Hennelly *ex* Potonié & Lele 1961

Type species: *Quadrisporites horridus* Hennelly *ex* Potonié & Lele 1961; SD Potonié & Lele, 1961. Late Permian; NSW., Australia.

Quadrisporites horridus Hennelly *ex* Potonié & Lele 1961
(Plate 72 figs 15, 19)

1958 *Quadrisporites horridus* Hennelly *nom. nud.*: p.364, pl.5 figs 6, 7
1961 *Quadrisporites horridus* (Henn.); Potonié & Lele: p.26, pl. 1 figs 26-36
1967 *Quadrisporites* sp. cf. *Q. horridus* Hennelly; Segroves: p.291, pl. 1 fig. 8

Synopsis: Medium, alete, occurring in obligate, tetrahedral, tetrads: distal surface baculate or spinose.

Lectotype: SD Potonié & Lele (1961) (Hennelly, 1958, pl. 5 fig. 7).

Distribution: Collie Basin (Glikson, 1972); Wilga Basin (Glikson, 1972); Perth Basin (Segroves, 1967); Carnarvon Basin (MacLeod, 1973).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage): Segroves, 1970b).

Genus **SCHIZOSPORIS** Cookson & Dettmann 1959

Type species: *Schizosporis reticulatus* Cookson & Dettmann 1959; OD. Late Cretaceous; SA, Australia.

Schizosporis dejerseyi Segroves 1967
(Plate 72 figs 16, 17)

1967 *Schizosporis dejerseyi* Segroves: p.293, pl. 1 figs 9-12

Synopsis: Small to medium, alete, subspheroidal, splitting into two symmetrical halves along a well-defined equatorial line of weakness: exine thick, surface bearing faint rugulae and verrucae.

Types: Holotype - UWA 55613 OD Segroves (1967, pl. 1 figs 10, 11); paratypes - UWA 55615, 55614 Segroves (1967, pl. 1 fig. 9; pl. 1 fig. 12).

Distribution: Perth Basin (Segroves, 1967).

Age: Early to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **SPHERIPOLLENITIES** Couper 1958

Type species: *Spheripollenites scabratus* Couper 1958; OD. Middle Jurassic; UK.

Spheripollenites sp. cf. **S. psilatus** Couper 1958
(Plate 72 fig. 14)

1958 cf. *Spheripollenites psilatus* Couper: p.159, pl. 31 figs 4-8
1967 *Spheripollenites* sp. cf. *S. psilatus* Couper; Segroves: p.291, pl. 1 fig. 7

Synopsis: Small to medium, alete, outline circular to oval, often ruptured along an irregular line: thin, smooth or punctate surface.

Distribution: Perth Basin (Segroves, 1967, 1970b).

Age: Late Carboniferous - Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **SPONGOCYSTIA** Segroves 1967

Type species: *Spongocystia eraduica* Segroves 1967; OD. Early Permian; WA, Australia.

Spongocystia eraduica Segroves 1967
(Plate 72 figs 4, 5)

1967 *Spongocystia eraduica* Segroves: p.297, pl. 3 figs 6-10

Synopsis: Small, alete, spheroidal to flattened oblate, wall two-layered: outer layer of wall with fine, close-packed foveolae, diameter of foveolae decreasing with depth.

Types: Holotype - UWA 55616, OD Segroves (1967, pl. 3 figs 6, 7); paratypes - UWA 55618, 55617, Segroves (1967, pl. 3 figs 8, 9; pl. 3 fig. 10).

Distribution: Perth Basin (Segroves, 1967; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **TETRAPORINA** Naumova 1950

Type species: *Tetraporina antiqua* Naumova 1950; SD Potonié, 1960. Early Carboniferous; USSR.

Tetraporina horologia (Staplin) Playford 1963
(Plate 72 fig. 6)

1960 *Azcnotetraporina(?) horologia* Staplin: p.6, pl. 1 figs 4, 6
1963 *Tetraporina horologia* (Staplin); Playford: p.659, pl. 95 figs 14, 15
1967 *Tetraporina horologia* (Staplin); Segroves: p.302, pl. 3 fig. 21

Synopsis: Small, alete, outline rounded quadrilateral, sides slightly convex to concave: exine thin, psilate, invaginated folds often present at each corner of the quadrilateral exine.

Holotype: IMP 1707, Slide 1, OD Staplin (1960, pl. 1 fig. 4).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1967).

Age: Early to Late Permian (Glikson, 1972; Segroves, 1970b).

Genus **ACANTHOTRILETES** Naumova *ex* Potonié & Kremp 1954

Type species: *Spinososporites ciliatus* Knox 1950; SD Potonié & Kremp (1954). Late Carboniferous; UK.

Acanthotriletes tereteangulatus Balme & Hennelly 1956
(Plate 74 fig. 1)

1956b *Acanthotriletes tereteangulatus* Balme & Hennelly: p.247, pl. 2 figs 27-29
1970a *Acanthotriletes teretiangulatus* Balme & Hennelly; Segroves: p.57, pl. 4 figs E, F

Synopsis: Small, concavo-triangular, simple, trilete spore: exine with small, irregularly disposed, spines and coni.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 2 fig. 29).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972; Robertson, 1979); Wilga Basin (Balme & Hennelly, 1956b); Perth Basin (Balme & Hennelly, 1956b; Segroves, 1970a; Sanders & Ingram, 1964; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous (Powis, 1979) to Late Permian (Units II - VIII: Kemp et al., 1977).

Genus **APICULATISPORIS** Potonié & Kremp 1956

Type species: *Apiculatisporites aculeatus* Ibrahim 1933; OD. Late Carboniferous; Germany.

Apiculatisporis cornutus (Balme & Hennelly)
Høeg & Bose 1960
(Plate 74 figs 2, 3)

1956b *Apiculatisporites cornutus* Balme & Hennelly: p.247, pl. 2 figs 24-26
1960 *Apiculatisporis cornutus* (Balme & Hennelly); Høeg & Bose: p.77, pl. xxxi figs 4, 5
1970a *Apiculatisporis cornutus* (Balme & Hennelly); Segroves: p.58, pl. 4 figs G-I

Synopsis: Small to medium, simple, circular to strongly convexo-triangular, trilete spore: exine relatively thick with heavy, irregularly disposed, broad-based coni or mamilloid processes.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 2 fig. 24)

Distribution: Perth Basin (Segroves, 1970a); Collie Basin (Glikson, 1972); Canning Basin (Kemp et al., 1977; Powis, 1979); Carnarvon Basin (MacLeod, 1973).

Age: Early Permian (Units II - IV: Kemp et al., 1977).

Genus **BIPARTITISPORIS** Segroves 1970

Type species: *Bipartitisporis tumulosus* Segroves 1970a; OD. Late Permian; WA, Australia.

Bipartitisporis tumulosus Segroves 1970
(Plate 74 fig. 4)

1970a *Bipartitisporis tumulosus* Segroves: p.57, pl. 5 figs C-D; pl. 6 fig. D

Synopsis: Large, simple, circular to sub-circular, trilete spore: exine thick, intexine dark and unstructured, exoexine translucent, exine intrapunctate, intragranulose and intrabaculate, sculptured with bacula and pila.

Types: Holotype - UWA 58615, OD Segroves, (1970a, pl. 6 fig. D); paratype - UWA 58616, Segroves (1970a, pl. 5 figs C, D).

Distribution: Perth Basin (Segroves, 1970a).

Age: Late Permian (*Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **BREVITRILETES** Bharadwaj & Srivastava 1969

Type species: *Brevitriletes communis* Bharadwaj & Srivastava 1969: OD. Early Permian; India.

Brevitriletes levis (Balme & Hennelly)
Bharadwaj & Srivastava 1969
(Plate 74 figs 5-7)

1956b *Apiculatisporites levis* Balme & Hennelly: p.246, pl. 2 figs 19-21
1969a *Brevitriletes levis* (Balme & Hennelly); Bharadwaj & Srivastava: p.226, pl. 1 figs 13-15
1970a *Apiculatisporis levis* (Balme & Hennelly); Segroves: p.59, pl. 5 fig. I

Synopsis: Small, simple, circular to strongly convexo-triangular, trilete, spore. Exine sculptured distally with small coni; sculpture reduced on proximal face; *curvaturae imperfectae* often present.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 2 fig. 20).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Hennelly, 1956b; Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous - early Late Permian (Unit II - VII: Kemp et al., 1977).

Genus **CALAMOSPORA** Schopf, Wilson & Bentall 1944

Type species: *Calamospora hartungiana* Schopf, Wilson & Bentall 1944; OD. Pennsylvanian; USA.

Calamospora sp. cf. **C. microrugosa** (Ibrahim) Schopf, Wilson & Bentall 1944
(Plate 74 fig. 10)

1933 cf. *Sporonites microrugosus* Ibrahim: p.447, pl. 14 fig. 9
1944 cf. *Calamospora microrugosa* (Ibrahim); Schopf et al.: p.52
1970a *Calamospora* sp. cf. *C. microrugosa* (Ibrahim); Segroves: p.48, pl. 1 fig. F

Synopsis: Medium, simple, circular (usually distorted), trilete spore. Exine thin, laevigate, punctate, finely rugulose or finely granulose; contact area slightly darkened.

Distribution: Perth Basin (Segroves, 1970a); Canning Basin (Powis, 1979).

Age: Late Carboniferous - Late Permian (Segroves, 1970b; Powis, 1979). NB. Similar forms recorded from Late Devonian of Canning Basin (Balme & Hassell, 1962).

Genus **CONVERRUCOSISPORITES** Potonié & Kremp 1954

Type species: *Converrucosisporites triquetrus* (Ibrahim) Potonié & Kremp 1954; OD. Late Carboniferous; Germany.

Converrucosisporites microverrucosus Marques-Toigo 1974

1974 *Converrucosisporites microverrucosus* Marques-Toigo: p.602, pl. 1 figs 2, 3
1985 *Converrucosisporites microverrucosus* Marques-Toigo; Foster et al.: p.65, pl. 1 fig. 7

Synopsis: Small, triangular, trilete spore. Exine thin, sculptured distally with closely spaced rounded verrucae on polygonal bases.

Holotype: Slide MP-P-606 (92.8, 24.0), OD Marques-Toigo (1974, pl. 1 fig. 2).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian (*Quadrisporites* Assemblage: Foster et al., 1985).

Genus **DENSOISPORITES** Weyland & Krieger 1953

Type species: *Densoisporites velatus* Weyland & Krieger 1953; OD. Late Cretaceous; Germany.

Densoisporites solidus Segroves 1970
(Plate 74 figs 8, 9)

1970a *Densoisporites solidus* Segroves: p.62, pl. 5 figs E-H

Synopsis: Small to medium, cavate, cingulate, circular to strongly convexo-triangular, trilete spore. Exoexine spongeous distally and proximally, cingulum smooth and structureless.

Types: Holotype - UWA 58635, OD Segroves (1970a, pl. 5 figs E, F); paratype - UWA 58636, Segroves (1970a, pl. 5 fig. H).

Distribution: Perth Basin (Segroves, 1970a; Foster et al., 1985).

Age: Early Permian (*Microbaculispora* Assemblage to *Quadrisporites* Assemblage: Segroves, 1970b).

Genus **DENSOSPORITES** Berry 1937

Type species: *Densosporites covensis* Berry 1937; OD. Pennsylvanian; USA.

Densosporites rotundidentatus Segroves 1970
(Plate 74 figs 11, 12)

1970a *Densosporites rotundidentatus* Segroves: p.62, pl. 6 fig. C; pl. 7 figs D-F

Synopsis: Medium, cavate, cingulate, subcircular to convexo-triangular, trilete spore. Cingulum thickened at ends of rays of laesura and of uneven width; distal surface smooth, sub-reticulate or with broad verrucae.

Types: Holotype - UWA 58637, OD Segroves (1970a, pl. 6 fig. C); paratype - UWA 58638, Segroves (1970a, pl. 7 fig. E).

Distribution: Perth Basin (Segroves, 1970a); Canning Basin (Powis, 1979).

Age: Early Permian (*Microbaculispora* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **DIATOMOZONOTRILETES** Naumova *ex* Playford 1963

Type species: *Reinchospora saetosus* Hacquebard & Barss 1957; OD. Playford, 1963. Mississippian; Canada.

Diatomozonotriletes townrowii Segroves 1970
(Plate 74 figs 13, 14)

1970a *Diatomozonotriletes townrowii* Segroves: p.54, pl. 3 figs D-G
1977 *Diatomozonotriletes* sp. Kemp et al.: fig. 9E

Synopsis: Small to medium, coronate, triangular to convexo-triangular, trilete spore. Exine bearing a single row of bacula along each inter-radial section of the equator.

Types: Holotype UWA 58606, OD Segroves, (1970a, pl. 3 fig. F); paratypes - UWA 58608, 58607, Segroves (1970a, pl. 3 figs D, E; pl. 3 fig. G).

Distribution: Perth Basin (Segroves, 1970a; Foster et al., 1981); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Early Permian (Units III - VI: Kemp et al., 1977; *Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **DICTYOTRILETES** Naumova *ex* Ischenko 1952

Type species: *Sporonites bireticulatus* Ibrahim 1932; SD Potonié & Kremp, 1954. Late Carboniferous; Germany.

Dictyotriletes aules Rigby 1977
(Plate 74 figs 15, 16)

1970a *Dictyotriletes* sp. cf. *D. bireticulatus* (Ibrahim); Segroves: p.59, pl. 8 fig. F
1977 *Dictyotriletes aules* Rigby *in* Rigby & Hekel: p.15, pl. 6 fig. 8

Synopsis: Medium to large, simple, circular to convexo-triangular, trilete spore. Exine distally reticulate, lumina coarse, rounded polygonal to sub-circular.

Holotype: Slide GSQ 54252 (40.7, 100.1), OD Rigby & Hekel (1977, pl. 6 fig. 8).

Distribution: Perth Basin (Segroves, 1970a); Collie Basin (Glikson, 1972).

Age: Late Early to Late Permian *(Haplocystia* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **DIDECITRILETES** Venkatachala & Kar 1965

Type species: *Didecitriletes horridus* Venkatachala & Kar 1965; OD. Early Permian; India.

Didecitriletes ericianus (Balme & Hennelly) Venkatachala & Kar 1965
(Plate 74 figs 17-19)

1956b *Acanthotriletes ericianus* Balme & Hennelly: p.238, pl. 3 figs 30-33
1965 *Didecitriletes ericianus* (Balme & Hennelly); Venkatachala & Kar: p.338
1970a *Anapiculatisporites ericianus* (Balme & Hennelly); Segroves: p.57, pl. 6 fig. E

Synopsis: Medium, cheilocardioid, triangular to slightly convexo-triangular, trilete spore. Exine sculptured, principally distally,

with acicular to acuminate, variably disposed spines: proximal sculpture reduced or absent.

Lectotype: SD Venkatachala & Kar (1965) (Balme & Hennelly, 1956b, pl. 3 fig. 30).

Distribution: Perth Basin (Segroves, 1970a); Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Canning Basin (Kemp et al., 1977).

Age: Late Permian (Unit VII to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

Genus **DULHUNTYISPORA** Potonié 1956

Type species: *Dulhuntyispora dulhuntyi* Potonié 1956; OD. Late Permian; NSW, Australia.

Dulhuntyispora dulhuntyi Potonié 1956
(Plate 73 fig. 8)

1956 *Dulhuntyispora dulhuntyi* Potonié: p.37, pl. 4 fig. 38
1956b *Tholosporites egregius* Balme & Hennelly: p.254, pl. 9 figs 72-75

Synopsis: Medium to large, scutulate, sub-circular to strongly rounded triangular, trilete spore. Scutula prominent; proximal and distal polar areas sculptured with anastomosing muri which enclose polygonal to rounded lumina; three sets of radial ridges extend from scutula and merge with reticulate sculpture.

Types: Holotype - OD Dulhunty (1945, pl. 7 fig. 21); neotype - APG S3917/1, Price (1983, pl. 9 figs 1, 2).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972; Perth Basin (Segroves, 1970a); Canning Basin (Balme & Hennelly, 1956b; Kemp et al., 1977).

Age: Late Permian (Units VII - VIII: Kemp et al., 1977).

Dulhuntyispora granulata Price 1983
(Plate 75 figs 3-5)

1977 *Dulhuntyispora dulhuntyi* "Forma 296" of Price (unpubl.); Kemp et al.: figs 10P,R,T
1983 *Dulhuntyispora granulata* Price: p.173, pl. 8 figs 1-12

Synopsis: Medium to large, scutulate, triangular to convexo-triangular, trilete spore: scutula prominent, relatively high and inflated; exine apart from scutula sculptured with grana, coni or occasionally small clava; scutula with little sculpture.

Holotype: APG S1220/1 OD, Price (1983, pl. 8 figs 1, 2, 4, 5, 10).

Distribution: Canning Basin (Kemp et al., 1977).

Age: Late Permian (Units VII - VIII: Kemp et al., 1977).

Dulhuntyispora inornata Segroves 1970
(Plate 73 fig. 11)

1970a *Dulhuntyispora inornata* Segroves: p.60, pl. 7 figs A-C

Synopsis: Medium to large, scutulate, triangular to convexo-triangular, trilete spore. Scutula strongly inflated; distal surface bearing three sets of radial, low, narrow muri which anastomose to enclose predominantly fusiform lumina; proximal surface similarly sculptured or bearing an imperfect reticulum.

Types: Holotype - UWA 58632, OD Segroves (1970a, pl. 7 fig. C); paratype - UWA 58633, Segroves (1970a, pl. 7 fig. A).

Distribution: Perth Basin (Segroves, 1970a); Canning Basin (Price, 1983).

Age: Late Early to Late Permian (Stage 5: Price, 1983; Units VI - VII: Kemp et al., 1977).

Dulhuntyispora maewestae Price 1983
(Plate 75 figs 8, 9)

1983 *Dulhuntyispora maewestus* Price: p.175, pl. 14 figs 1-9

Synopsis: Medium to large, rounded triangular, scutulate, trilete spore. Scutula highly inflated with infra-exinal, more or less radial thickenings; surface unsculptured; remainder of exine regularly or imperfectly reticulate; muri relatively wide, flattened; lumina mainly irregular in shape and of variable size.

Holotype: APG S3457/1, OD Price (1983, pl. 14 figs 1-3, 6, 9).

Distribution: Canning Basin (Price, 1983).

Age: Late Permian (Upper Stage 5b: Price, 1983).

Dulhuntyispora omasi Price 1983
(Plate 75 figs 10-12)

1983 *Dulhuntyispora omasi* Price: p.175, pl. 13 figs 1-8

Synopsis: Large, rounded triangular, scutulate, trilete spore. Scutula inflated, smooth; remainder of exine reticulate, lumina small, more or less circular.

Holotype: APG 3496/7, OD Price (1983, pl. 13 figs 1-4, 7).

Distribution: Canning Basin (Price, 1983).

Age: Late Permian (Stage 5: Price, 1983).

Dulhuntyispora parvithola (Balme & Hennelly) Pontonié 1960
(Plate 73 fig. 9)

1956b *Tholosporites parvitholus* Balme & Hennelly: p.255, pl. 10 figs 76-80
1960 *Dulhuntyispora parvithola* (Balme & Hennelly); Pontonié: p.44
1970a *Dulhuntyispora parvithola* (Balme & Hennelly); Segroves: p.60, pl. 6 figs A, B

Synopsis: Medium, scutulate, convexo-triangular, trilete spore. Scutula relatively small, scarcely developed in some specimens; exine finely reticulate, muri 1 - 3 um in diameter, lumina slightly radially elongate near bases of scutula.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 10 fig. 76).

Distribution: Perth Basin (Segroves, 1970a); Canning Basin (Balme & Hennelly, 1956b; Kemp et al., 1977).

Age: Late Permian (Unit VII: Kemp et al., 1977; Stage 5: Price, 1983).

Dulhuntyispora spongia Price 1983
(Plate 75 figs 6, 7)

1983 *Dulhuntyispora spongia* Price: p.175, pl. 12 figs 1-3, 6, 9; pl. 13 fig. 9

Synopsis: Large, rounded triangular, scutulate, trilete spore. Exine spongeous except for scutula which are more or less hyaline.

Holotype: APG S3459/2, OD Price (1983, pl. 12 figs 1, 2, 6).

Distribution: Canning Basin (Price, 1983).

Age: Late Permian (Stage 5: Price, 1983).

Dulhuntyispora stellata Price 1983
(Plate 73 fig. 10)

1977 *Dulhuntyispora* sp. "forma 312" of Price (unpubl.); Kemp et al.: fig. 10T
1983 *Dulhuntyispora stellata* Price: p.174, pl. 12 figs 4-5, 7

Synopsis: Medium to large, scutulate, convexo-triangular, trilete spore. Exine scabrate or punctate with three sets of widely spaced, non-anastomosing ridges, which radiate from near the bases of the scutula towards poles.

Holotype: APG S3496/10, OD Price (1983, pl. 12 fig. 4).

Age: Late Permian (Upper Stage 5: Kemp et al., 1977).

Genus **GONDISPORITES** Bharadwaj 1962

Type species: *Gondisporites raniganjensis* Bharadwaj 1962; OD. Late Permian. India.

Gondisporites imbricatus Segroves 1970
(Plate 73 figs 6, 7)

1970a *Gondisporites imbricatus* Segroves: p.63, pl. 8 figs A-C

Synopsis: Medium, cavate, zonate, convexo-triangular, trilete spore. Exoexine proximally and distally intragranulate; distal surface, conate, spinose or sub- baculate.

Types: Holotype - UWA 58639, OD Segroves (1970a, pl. 8 fig. A); paratypes - UWA 58640, 58641, Segroves (1970a, pl. 8 figs B, C).

Distribution: Perth Basin (Segroves, 1970a).

Age: Late Early to Late Permian (*Haplocystia* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **GRANDISPORA** Hoffmeister, Staplin & Malloy
emend. Neves & Owens 1966

Types species: *Grandispora spinosa* Hoffmeister, Staplin & Malloy 1955; OD. Early Carboniferous; USA.

Grandispora segrovesii Foster 1979

1979 *Grandispora segrovesii* Foster: p.59, pl. 18 figs 3, 4
1985 *Grandispora segrovesii* Foster; Foster et al.: p.64, pl. 2 fig. 9

Synopsis: Medium, cavate, zonate, circular to sub-triangular, trilete spore. Exoexine minutely punctate; distal surface conate or spinose.

Holotype: UQGD Preparation F241/14 (31.6, 115.3) Y.2644, OD Foster (1979, pl. 18 fig. 3).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian (*Quadrisporites* Assemblage: Foster et al., 1985).

Genus **GRANULATISPORITES** Ibrahim 1933

Type species: *Granulatisporites granulatus* Ibrahim 1933; OD. Late Carboniferous; Germany.

Granulatisporites confluens Archangelsky & Gamerro 1979

1979 *Granulatisporites confluens* Archangelsky & Gamerro: p.422, pl. 1 figs 5, 6
1985 *Granulatisporites confluens* Archangelsky & Gamerro; Foster et al.: p.65, pl. 1 fig. 12

Synopsis: Medium, triangular, trilete. Exine sculptured distally with small closely spaced verracae; sculpture reduced or absent in proximal face.

Holotype: Slide P.m. 482 (41.9, 106.3), OD Archangelsky & Gamerro (1979, pl. 1 figs 5, 6).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian *(Quadrisporites* Assemblage: Foster et al., 1985).

Granulatisporites quadruplex Segroves 1970
(Plate 73 fig. 5)

1970a *Granulatisporites quadruplex* Segroves: p.50, pl. 2 figs I-K

Synopsis: Medium, frequently in tetrads; triangular, trilete. Exine sculptured distally with flat-topped verrucae; sculpture reduced or absent on proximal face.

Types: Holotype - UWA 58595, OD Segroves (1970a, pl. 2 fig. I); paratypes - UWA 58596, 58597, Segroves (1970a, pl. 2 figs J, K).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early Permian *Acanthotriletes* Assemblage: Segroves, 1970b).

Genus **HORRIDITRILETES** Bharadwaj & Salujha 1964

Type species: *Horriditriletes curvibaculosus* Bharadwaj & Salujha 1964; OD. Late Permian; India.

Horriditriletes ramosus (Balme & Hennelly) Bharadwaj & Salujha 1964
(Plate 73 figs 3, 4)

1956b *Acanthotriletes ramosus* Balme & Hennelly: p.249, pl. 3 figs 39-41
1964 *Horriditriletes ramosus* (Balme & Hennelly); Bharadwaj & Salujha: p.193
1970a *Horriditriletes ramosus* (Balme & Hennelly); Segroves: p.55, pl. 2 fig. H

Synopsis: Small to medium, concavo-triangular, trilete. Exine sculptured with widely spaced coarse spines or bacula, sometimes bifurcate at their extremities and joined at their bases.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 3 fig. 39).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Balme & Hennelly, 1956b; Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (Balme & Hennelly, 1956b; MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous - Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **INDOSPORA** Bharadwaj 1962

Type species: *Indospora clara* Bharadwaj 1962; OD. Late Permian; India.

Indospora clara Bharadwaj 1962
(Plate 73 fig. 2)

1962 *Indospora clara* Bharadwaj: p.83, pl. 3 figs 54, 55
1970a *Indospara clara* Bharadwaj: Segroves: p.59, p.5 fig. B

Synopsis: Small to medium, triangular, convexo-triangular, or slightly concavo-triangular, trilete. Exine punctuate, baculate, conate or verrucate; exine bears distal tapering muri, which form a perfect or imperfect reticulum.

Holotype: OD Bharadwaj (1962, pl. 3 fig. 54).

Distribution: Canning Basin (Kemp et al., 1977); Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1970a).

Age: Late Early to Late Permian (Unit V to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977.

Indospora laevigata Bharadwaj & Salujha 1964
(Plate 73 fig. 1)

1964 *Indospora laevigata* Bharadwaj & Salujha: p.195, pl. 2 figs 51-53
1970a *Indospora laevigata* Bharadwaj & Salujha; Segroves: p.60, pl. 5 fig. A

Synopsis: Small, triangular to convexo- or concavo-triangular, trilete. Distal surface bears muri, which arise at the apices and form a perfect or imperfect reticulum in the region of the distal pole; surface otherwise laevigate.

Holotype: OD Bharadwaj & Salujha (1964, pl. 2 fig. 51).

Distribution: Perth Basin (Segroves, 1970a).

Age: Late Permian (*Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **INDOTRIRADITES** Tiwari 1964

Type species: *Indotriradites korbaensis* Tiwari 1964; OD. Early Permian; India.

Indotriradites enormis (Segroves) Foster 1979
(Plate 76 figs 10, 11)

1970a *Kraeuselisporites enormis* Segroves: p.67, pl. 8 fig. G; pl. 9 figs A, B
1979 *Indotriradites enormis* (Segroves); Foster: p.56, pl. 16 fig. 4

Synopsis: Small to medium, zonate, cavate, trilete. Periphery of zona strongly dentate; distal surface conate and spinose, size of processes increasing towards the equator; proximal surface with reduced sculpture.

Types: Holotype - UWA 58653, OD Segroves (1970a, pl. 8 fig. G); paratypes - UWA 58655, 58654, Segroves (1970a, pl. 9 figs A, B).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early to Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Indotriradites splendens (Balme & Hennelly) Foster 1979
(Plate 76 figs 13, 16, 19)

1956b *Cirratriradites splendens* Balme & Hennelly: p.252, pl. 5 fig. 59; pl. 6 figs 60, 61
1970a *Kraeuselisporites splendens* (Balme & Hennelly); Segroves: p.65, pl. 9 figs F-H
1979 *Indotriradites splendens* (Balme & Hennelly); Foster: p.56, pl. 15 figs 1-9

Synopsis: Medium to large, zonate, cavate, trilete. Distal surface sculptured with large verrucae, mammillae or spines; elements may extend on to zona but do not protrude beyond periphery; proximal surface scabrate or with greatly reduced sculpture.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 6 fig. 60).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Segroves, 1970a; Foster et al., 1985); Carnarvon Basin (Balme & Hennelly, 1956b; MacLeod, 1973); Canning Basin (Balme & Hennelly, 1956b; Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous - Late Permian (Segroves, 1970b), (Unit III - VII: Kemp et al., 1977; Powis, 1979).

Genus **INTERRADISPORA** Price 1979

Type species: *Interradispora versus* Price 1979; OD Price *in* Foster, 1979. Permian; SA, Australia.

Interradispora versus Price 1979
(Plate 77 figs 6, 7)

1977 "*Granulatisporites* sp. 204" (Price, unpubl. data); Kemp et al.: figs 10K-M
1979 *Interradispora versus* Price *in* Foster: p.40, figs 18 (1-4)

Synopsis: Medium, cheilocardioid, slightly convexo-triangular, trilete. Exine sculptured with grana, verrucae or low bacula; sculptural elements differentiated on the proximal face to form a single interradial row of coarser elements about half to two-thirds the distance between the proximal pole and the equator.

Types: Holotype - APG S1222/12, OD Foster (1979, figs. 18 (1-3)); paratype - APG S1807/10, Foster (1979, fig. 18 (4)).

Distribution: Canning Basin (Kemp et al., 1977).

Age: Early Permian (Units II - VI: Kemp et al., 1977).

Genus **KRAEUSELISPORITES** Leschik 1955

Type species: *Kraeuselisporites dentatus* Leschik 1955; OD. Late Triassic; Switzerland.

Kraeuselisporites niger Segroves 1970
(Plate 76 figs 12, 14, 15)

1970a *Kraeuselisporites niger* Segroves: p.66, pl. 9 figs C-E

Synopsis: Medium, zonate, cavate, convexo-triangular, trilete. Distal surface scabrate and sculptured with relatively small elements, principally grana, verrucae, coni and spinae; proximal face laevigate.

Types: Holotype - UWA 58651, OD Segroves (1970a, pl. 9 fig. C); paratype - UWA 58652, Segroves (1970a, pl. 9 figs D, E).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early to Late Permian (*Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **LAEVIGATOSPORITES** Ibrahim 1933

Type species: *Laevigatosporites vulgaris* Ibrahim 1933; OD. Late Carboniferous; Germany.

Laevigatosporites colliensis (Balme & Hennelly) Venkatachala & Kar 1968
(Plate 76 figs 8, 9)

1956a *Laevigatosporites vulgaris* forma *colliensis* Balme & Hennelly: p.55, pl. 1 figs 1-5
1968 *Laevigatosporites colliensis* (Balme & Hennelly); Venkatachala & Kar: p.66, pl. 2 figs 48-50
1970a *Latosporites colliensis* (Balme & Hennelly); Segroves: p.70, pl. 10 fig. F

Synopsis: Medium, simple, elliptical, monolete. Exine laevigate, thin, usually folded.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956a, pl. 1 fig. 1).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972); Perth Basin (Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (MacLeod, 1973); Canning Basin (*Laevigatosporites vulgaris* Ibrahim of Powis, 1979).

Age: Late Carboniferous - Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Laevigatosporites flexus Segroves 1970a
(Plate 76 fig. 7)

1970a *Laevigatosporites flexus* Segroves: p.69, pl. 11 figs C,D

Synopsis: Small to medium, simple, elliptical, monolete. Proximal face strongly concave and distal strongly convex; exine laevigate or punctate.

Types: Holotype - UWA 58663, OD Segroves (1970a, pl. 11 fig. D); paratype - UWA 58664, Segroves (1970a, pl. 11 fig. C).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early Permian (*Acanthotriletes* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **LEIOTRILETES** Naumova *ex* Potonié & Kremp 1954

Type species: *Sporonites sphaerotriangulus* Loose 1932; SD Potonié & Kremp, 1954. Late Carboniferous; Germany.

Leiotriletes badamensis (Venkatachala & Kar) Foster 1975

1965 *Lacinitriletes badamensis* Venkatachala & Kar: p.339, pl. 1 figs 8-15
1975 *Leiotriletes badamensis* (Venkatachala & Kar); Foster: p.125, pl. 1 figs 20,21
1985 *Leiotriletes badamensis* (Venkatachala & Kar); Foster et al.: p.65, pl. 1 fig. 19

Synopsis: Medium, triangular, trilete. Exine laevigate or distally granulate.

Holotype: Slide 2435/8, OD Venkatachala & Kar (1965, pl. 1 fig. 7).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian (*Quadrisporites* Assemblage: Foster et al., 1985).

Leiotriletes directus Balme & Hennelly 1956
(Plate 77 figs 4, 5)

1956b *Leiotriletes directus* Balme & Hennelly: p.244, pl. 1 figs 1-4; text-figs 1(a)-1(f)

Synopsis: Small to medium, simple, triangular to convexo-triangular, trilete. Exine laevigate to faintly punctate.

Lectotype: SD Bharadwa (1962) (Balme & Hennelly, 1956b, pl. 2 fig. 47).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Wilga Basin (Balme & Hennelly, 1956b); Perth Basin (Balme & Hennelly, 1956b; Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (Balme & Hennelly, 1956b; Macleod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous - Late Permian (Powis, 1979; Segroves, 1970b).

Genus **LESCHIKISPORIS** Potonié 1958

Type species: *Punctatosporites aduncus* Leschik 1955; OD. Late Triassic; Switzerland.

Leschikisporis cestus Segroves 1970
(Plate 76 fig. 6)

1970a *Leschikisporis cestus* Segroves: p.52, pl. 3 figs A-C

Synopsis: Small to medium, simple, circular to sub-circular, trilete to dilete. One ray of laesura shorter than the other two; exine granulate, verrucate or rugulate.

Types: Holotype - UWA 58599, OD Segroves (1970a, pl. 3 fig. A); paratypes - UWA 58600, UWA 58601, Segroves (1970a, pl. 3 fig. B, C).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **LOPADIOSPORA** Price 1983

Type species: *Lopadiospora vermitholus* Price 1983; OD. Permian; SA, Australia

Lopadiospora vermitholus Price 1983
(Plate 75 figs 1, 2)

1983 *Lopadiospora vermitholus* Price: p.171, pl. 7 figs 2, 3, 5, 6, 8-10

Synopsis: Medium to large, rounded triangular, scutulate, trilete spores. Scutula low, proximo-equatorial, internally thickened with radially arranged ribs: distal surface granulate, conate or baculate; proximal surface, apart from scutula, granulate, conate or rugulate.

Holotype: APG S2816/1, OD Price (1983, pl. 7 figs 2, 3, 5, 6, 8).

Distribution: Canning Basin (Price, 1983).

Age: Late Early to Late Permian (Price, 1983).

Genus **LOPHOTRILETES** Naumova *ex* Potonié & Kremp 1954

Type species: *Verrucosisporites gibbosus* Ibrahim 1933; SD Potonié & Kremp, 1954. Late Carboniferous; Germany.

Lophotriletes sp. cf. **L. rarus** Bharadwaj & Salujha 1964
(Plate 76 fig. 2)

1964 cf. *Lophotriletes rarus* Bharadwaj & Salujha: p.193, pl. 2 figs 30-33
1970a *Lophotriletes* sp. cf. *L. rarus* Bharadwaj & Salujha; Segroves: p.55, pl. 3 figs H, I

Synopsis: Small, simple, concavo-triangular, trilete. Distal surface bearing sparsely distributed cones, sculpture reduced on proximal face.

Distribution: Perth Basin (Segroves, 1970a).

Age: Early Permian (*Acanthotriletes* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Lophotriletes scotinus Segroves 1970a
(Plate 76 figs 3, 4)

1970a *Lophotriletes scotinus* Segroves: p.55, pl. 4 figs A-D

Synopsis: Small, smooth, convexo-triangular, trilete. Exine sculptured distally with sparse, relatively large cones and bacula; proximal face smooth or punctate.

Types: Holotype - UWA 58612 OD Segroves (1970a, pl. 4 fig. D); paratypes - UWA 58613, 58614 Segroves (1970a, pl. 4 figs A, B; fig. C).

Distribution: Perth Basin (Segroves, 1970a).

Age: Early Permian (*Microbaculispora* Assemblage to *Acanthotriletes* Assemblage: Segroves, 1970b).

Genus **MICROBACULISPORA** Bharadwaj 1962

Type species: *Microbaculispora gondwanensis* Bharadwaj; OD. Late Permian; India.

Microbaculispora micronodosa (Balme & Hennelly) Anderson 1977
(Plate 77 fig. 3)

1956b *Granulatisporites micronodosus* Balme & Hennelly: p.245, pl. 1 figs 9,10
1977 *Microbaculispora micronodosa* (Balme & Hennelly); Anderson: p.45, pl. 50 figs 1-37

Synopsis: Medium, cheilocardioid, triangular to convexo-triangular, trilete. Exine thin, sculptured distally with rounded grana; sculpture reduced or absent on proximal face.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, p.245, pl. 1 fig. 9).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972; Robertson, 1979); Perth Basin (Segroves, 1970a); Carnarvon Basin (MacLeod, 1973); Canning Basin (Balme & Hennelly, 1956b; Powis, 1979).

Age: Late Carboniferous - Late Permian (Powis, 1979; Segroves, 1970b).

Microbaculispora tentula Tiwari 1965
(Plate 77 fig. 1)

1965 *Microbaculispora tentula* Tiwari: p.175, pl. 2 figs 35-37
1970a *Microbaculispora tentula* Tiwari; Segroves: p.51, pl. 2 figs D-G

Synopsis: Small, cheilocardioid, triangular, trilete: exine sculptured distally and proximo-equatorially with small, closely spaced, regularly disposed grana and low bacula.

Holotype: OD Tiwari (1965, pl. 2 fig. 35).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1970a); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous - Late Permian (Unit II - VII: Kemp et al., 1977).

Microbaculispora trisinus (Balme & Hennelly) Anderson 1977
(Plate 77 figs 13, 14)

1956b *Granulatisporites trisinus* Balme & Hennelly: p.244, pl. 1 figs 5-8
1977 *Microbaculispora trisina* (Balme & Hennelly); Anderson: p.46, pl. 51 figs 1-18

Synopsis: Medium to large, cheilocardioid, triangular to convexo-triangular, trilete. Exine sculptured distally with closely spaced, regularly distributed, similar-sized grana; sculpture reduced or absent on proximal surface.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 1 fig. 5).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Balme & Hennelly, 1956b; Segroves, 1970a), Carnarvon Basin (Balme & Hennelly, 1956b); Canning Basin (Balme & Hennelly, 1956b; Kemp et al., 1977).

Age: Early - Late Permian (Unit III to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

Microbaculispora villosa (Balme & Hennelly)
Bharadwaj 1962
(Plate 77 figs 15, 16)

1956b *Acanthotriletes villosus* Balme & Hennelly: p.248, pl. 3 figs 37, 38
1962 *Microbaculispora villosa* (Balme & Hennelly); Bharadwaj: p.81

Synopsis: Medium to large, cheilocardioid, triangular, trilete spore. Exine with close-packed, regularly disposed, bacula or spines; sculpture reduced towards proximal pole.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956b, pl. 3 fig. 38).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Segroves, 1970a; Glikson, 1972); Canning Basin (Kemp et al., 1977).

Age: Late Permian (Unit VII to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

Genus **MICRORETICULATISPORITES** Knox 1950

Type species: *Reticulatisporites lacunosus* Ibrahim 1933; SD Potonié & Kremp, 1954. Late Carboniferous; Germany.

Microreticulatisporites bitriangularis
Balme & Hennelly 1956
(Plate 77 fig. 2)

1956b *Microreticulatisporites bitriangularis* Balme & Hennelly: p.251, pl. 5 figs 53, 54

Synopsis: Small, triangular to slightly concavo- or convexo-triangular, trilete. Exine two-layered microreticulate, bearing one to three weak arcuate folds on the proximal surface.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 5 fig. 53).

Distribution: Perth Basin (Balme & Hennelly, 1956b); Canning Basin (Kemp et al., 1977).

Age: Late Permian (Unit VII - VIII: Kemp et al., 1977).

Genus **PHASELISPORITES** Price 1983

Type species: *Verrucososporites cicatricosus* Balme & Hennelly 1956a; OD. Early Permian; NSW, Australia.

Phaselisporites cicatricosus (Balme & Hennelly) Price 1983
(Plate 75 figs 13, 14)

1956a *Verrucososporites cicatricosus* Balme & Hennelly: p.57, pl. 1 figs 14-18
1956a *Verrucososporites hamatus* Balme & Hennelly: p.57, pl. 1 figs 19-21
1977 *Polypodiidites cicatricosus* (Balme & Hennelly); Kemp et al.: figs. 9Q,R
1983 *Phaselisporites cicatricosus* (Balme & Hennelly); Price: p.176, pl. 15 figs 1-15

Synopsis: Small to medium, monolete, amb oval, planoconvex in lateral view: exine sculptured distally with heavy, elongate, often confluent verrucae surmounted by 1 - 3 tapering recurved spines.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 1 fig. 14 .

Distribution: Collie Basin (Robertson, 1979); Canning Basin (Kemp et al., 1977).

Age: Early to Late Permian (Units IV - VII: Kemp et al., 1977).

Genus **PSEUDORETICULATISPORA** Bharadwaj & Srivastava 1969

Type species: *Pseudoreticulatispora barakarensis* Bharadwaj & Srivastava 1969; OD. Early Permian; India.

Pseudoreticulatispora pseudoreticulata (Balme & Hennelly) Bharadwaj & Srivastava 1969
(Plate 77 figs 10-12)

1956b *Verrucosisporites pseudoreticulatus* Balme & Hennelly: p.250, pl. 4 figs 42-44
1969a *Pseudoreticulatispora pseudoreticulata* (Balme & Hennelly); Bharadwaj & Srivastava: p.227

Synopsis: Medium to large, subcircular to convexo-triangular, labrate, trilete. Sculptured distally and proximo-equatorially with distally expanded elements, the extremities of which fuse to form a perforate pseudotectum; sculptural elements reduced or free towards proximal pole and towards apices.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956b, pl. 4 fig. 42).

Distribution: Collie Basin (Glikson, 1972; Robertson, 1969); Perth Basin (Sanders & Ingram, 1964; Segroves, 1970a; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous (Powis, 1979) - Early Permian (Units III - VI: Kemp et al., 1977).

Genus **PUNCTATISPORITES** Ibrahim 1933

Type species: *Punctatisporites punctatus* Ibrahim 1933; OD. Late Carboniferous; Germany.

Punctatisporites gretensis Balme & Hennelly 1956
(Plate 76 figs 17, 18)

1956b *Punctatisporites gretensis* Balme & Hennelly: p.245, pl. 2 figs 11-13
1970a *Punctatisporites gretensis* Balme & Hennelly; Segroves: p.48, pl. 1 fig. G

Synopsis: Medium to large, circular, trilete. Exine thick, smooth to faintly granulate; proximal polar area punctate-foveolate in some specimens.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956b, pl. 2 fig. 12).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Sanders & Ingram, 1964; Segroves, 1970a; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous (Powis, 1979) - Early Permian (*Microbaculispora* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **RETUSOTRILETES** Naumova 1953

Type species: *Retusotriletes simplex* Naumova 1953; OD. Middle Devonian; USSR.

Retusotriletes diversiformis (Balme & Hennelly) Balme & Playford 1967
(Plate 76 fig. 1)

1956b *Calamospora diversiformis* Balme & Hennelly: p.246, pl. 2 figs 14-18
1967 *Retusotriletes diversiformis* (Balme & Hennelly); Balme & Playford: p.181, pl. 1 fig. 3

Synopsis: Small to medium, circular, trilete. Exine smooth, contact areas delimited by incipient curvaturae and a darkened triangular area in the area of the proximal pole.

Lectotype: SD Tiwari (1965) (Balme & Hennelly, 1956b, pl. 2 fig. 14).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Hennelly, 1956b; Sanders & Ingram, 1964; Segroves, 1970a; Glikson, 1972); Carnarvon Basin (Balme

& Hennelly, 1956b; MacLeod, 1973); Canning Basin (Balme & Hennelly, 1956b; Powis, 1979).

Age: Late Carboniferous (Powis, 1979) - Late Permian *(Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **TUBERCULATOSPORITES** Imgrund 1956

Type species: *Tuberculatosporites anicystoides* Imgrund 1952; OD Imgrund *in* Potonié & Kremp, 1954. Early Permian; China.

Tuberculatosporites modicus Balme & Hennelly 1956
(Plate 76 fig. 5)

1956a *Tuberculatosporites modicus* Balme & Hennelly: p.56, pl. 1 figs 10-13

Synopsis: Small, oval, monolete. Exine bearing cones, spines, or small verrucate processes.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 1 fig. 10).

Distribution: Collie Basin (Balme & Hennelly, 1956b); Perth Basin (Balme & Hennelly, 1956b; Sanders & Ingram, 1964; Segroves, 1970a).

Age: Early to Late Permian *(Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **VERRUCOSISPORITES** Ibrahim 1933

Type species: *Sporonites verrucosus* Ibrahim 1932; OD. Late Carboniferous; Germany.

Verrucosisporites naumovae Hart 1963
(Plate 77 figs 8, 9)

1963a *Verrucosisporites naumovae* Hart: p.143, pl. 1 fig. 4
1970a *Verrucosisporites naumovae* Hart; Segroves: p.53, pl. 1 fig. K

Synopsis: Medium to large, convexo-triangular, labrate, trilete. Sculptured distally and proximo-equatorially with rounded to polygonal, flattened, close-packed, low verrucae; distal surface of verrucae sometimes slightly expanded but not fused.

Holotype: OD Hart (1963a, pl. 1 fig. 4: slide 77 -- lodged at the BM(NH)

Distribution: Perth Basin (Segroves, 1970a; Foster et al., 1985); Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) - Late Permian *(Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **ALISPORITES** Daugherty 1941

Type species: *Alisporites opii* Daugherty 1941; OD (monotypy). Late Triassic; USA

Alisporites gracilis Segroves 1969
(Plate 78 fig. 7)

1969 *Alisporites gracilis* Segroves: p.190, pl. 6 figs H-J

Synopsis: Medium to large, bisaccate, haploxylonoid: sacci semicircular or crescentic in polar view, corpus faint, cappa less than 1 µm thick; most specimens with a fine transverse, proximal plication extending across the full width of the corpus.

Types: Holotype - UWA 58693, OD Segroves (1969, pl. 6 fig. H); paratypes - UWA 58695, 58694, Segroves (1969, pl. 6 figs I, J).

Distribution: Perth Basin (Segroves, 1969; Foster et al., 1985).

Age: Early Permian (*Microbaculispora* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Alisporites indarraensis Segroves 1969
(Plate 78 fig. 1)

1969 *Alisporites indarraensis* Segroves: p.191, pl. 6 figs A-E

Synopsis: Small to medium, bisaccate, non-taeniate, haploxylonoid; to slightly diploxylonoid: sacci semicircular in polar view, corpus circular to sub-circular, cappa thickened, finely intramicroreticulate.

Types: Holotype - UWA 58696, OD Segroves (1969, pl. 6 figs A,B); paratypes - UWA 58697, 58698, Segroves (1969, pl. 6 figs C,D).

Distribution: Perth Basin (Segroves, 1969).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Alisporites splendens (Leschik) Foster 1979
(Plate 78 figs 2-4)

1956 *Sulcatisporites splendens* Leschik: p.137, pl. 22 fig. 10
1969 *Alisporites* sp. cf. *A. plicatus* Jizba; Segroves: p.189, pl. 1 figs E, F; pl. 6 fig. G
1969 *Sulcatisporites splendens* Leschik; Segroves: p.195, pl. 7 figs A-C
1979 *Alisporites splendens* (Leschik); Foster: p.73, pl. 25 figs 9, 10

Synopsis: Small to large, bisaccate, non-taeniate, haploxylonoid to slightly diploxylonoid, amb oval: corpus oval, sacci semicircular in polar view, cappula narrow.

Holotype: OD Leschik (1956, pl. 22 fig. 10).

Distribution: Perth Basin (Segroves, 1969).

Age: Early Permian *(Quadrisporites* Assemblage to *Acanthotriletes* Assemblage: Segroves, 1970b).

Genus **BARAKARITES** Bharadwaj & Tiwari 1964

Type species: *Barakarites indicus* Bharadwaj & Tiwari 1964; OD. Early Permian; India.

Barakarites rotatus (Balme & Hennelly) Bharadwaj & Tiwari 1964
(Plate 78 figs 12, 13)

1956b *Nuskoisporites rotatus* Balme & Hennelly: p.254, pl. 8 figs 68-71
1964 *Barakarites rotatus* (Balme & Hennelly); Bharadwaj & Tiwari: p.142
1969 *Barakarites rotatus* (Balme & Hennelly); Segroves: p.185, pl. 3 fig. C

Synopsis: Medium to large, monosaccate, circular to subcircular, trilete. Intexine thin, saccus relatively narrow with an extremely fine and even intrastructure. A distal ring tenuitas often present on the corpus adjacent to the base of the saccus.

Lectotype: SD Potonié & Lele (1961) (Balme & Hennelly, 1956b, pl. 8 fig. 69).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Segroves, 1969; Sanders & Ingram, 1964); Carnarvon Basin (MacLeod, 1973).

Age: Early Permian *(Acanthotriletes* Assemblage to *Quadrisporites* Assemblage: Segroves, 1970b) to Late Permian (Glikson, 1972).

Genus **BASCANISPORITES** Balme & Hennelly 1956

Type species: *Bascanisporites undosus* Balme & Hennelly 1956; OD. Late Permian; NSW, Australia.

Bascanisporites undosus Balme & Hennelly 1956
(Plate 78 figs 5, 6)

1956b *Bascanisporites undosus* Balme & Hennelly: p.256, pl. 10 figs 81-83

Synopsis: Medium to large, monosaccate, alete; subcircular to rounded polygonal, periphery broadly undulating: corpus circular to subcircular, intexine relatively thick.

Lectotype: SD Potonié (1960) (Balme & Hennelly, 1956b, pl. 10 fig. 81).

Distribution: Collie Basin (Glikson, 1972); Canning Basin (Kemp et al., 1977).

Age: Late Permian (Unit VII - VIII: Kemp et al., 1977).

Genus **CORISACCITES** Venkatachala & Kar 1966

Type species: *Corisaccites alutas* Venkatachala & Kar 1966; OD. Early Permian; Pakistan.

Corisaccites alutas Venkatachala & Kar 1966
(Plate 78 figs 8, 9)

1966 *Corisaccites alutas* Venkatachala & Kar: p.108, pl. 1 figs 1-7; text-figs 1,2
1969 *Corisaccites alutas* Venkatachala & Kar; Segroves: p.202, pl. 9 fig. A; pl. 10 figs A, B

Synopsis: Medium to large, disaccate, taeniate, diploxylonoid to slightly haploxylonoid. Cappa with a single broad transverse polar cleft; sacci strongly inclined distally, with a very fine microreticulate intrastructure.

Types: Holotype - slide No. BSIP 2209, OD Venkatachala & Kar (1966, pl. 1 fig. 1); isotype - slide No. BSIP 2210, Venkatachala & Kar (1966, pl. 1 fig. 2).

Distribution: Perth Basin (Segroves, 1969); Canning Basin (Kemp et al., 1977).

Age: Early Permian (mainly Unit IV: Kemp et al., 1977).

Genus **CYCADOPITES** Wilson & Webster 1946

Type species: *Cycadopites follicularis* Wilson & Webster 1946; OD. Eocene; USA

Cycadopites cymbatus (Balme & Hennelly) Hart 1965
(Plate 78 figs 10, 11)

1956a *Entylissa cymbatus* Balme & Hennelly: p 63, pl. 3 figs 53-56
1965 *Cycadopites cymbatus* (Balme & Hennelly); Hart: p.110, text-fig. 265
1970a *Cycadopites cymbatus* (Balme & Hennelly); Segroves: p.72, pl. 11 fig. E

Synopsis: Small to medium, sometimes cavate, oval, monosulcate. Sulcus extending full length of exine; exoexine finely, closely and regularly columellate.

Lectotype: SD Potonié & Lele (1961) (Balme & Hennelly, 1956a, pl. 3 fig. 55).

Distribution: Perth Basin (Segroves, 1970a; Foster et al., 1985); Collie Basin (Glikson, 1972); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Late Carboniferous - Early Permian (Unit II - IV: Kemp et al., 1977).

Genus **DENSIPOLLENITES** Bharadwaj 1962

Type species: *Densipollenites indicus* Bharadwaj 1962; OD. Late Permian; India.

Densipollenites indicus Bharadwaj 1962
(Plate 80 fig. 6)

1962 *Densipollenites indicus* Bharadwaj: p.87, pl. 6 figs 103, 104
1969 *Densipollenites indicus* Bharadwaj; Segroves: p.187, pl. 3 fig. B

Synopsis: Medium to large, monosaccate, sub-circular to oval, alete. Intexine faint to barely discernible, often excentrically placed in relation to the periphery of the compressed exoexine, saccus exoexine intrareticulate with a limboid margin.

Holotype: OD Bharadwaj (1962, pl. 6 fig. 103).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1969; Glikson, 1972).

Age: Early to Late Permian (*Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Densipollenites pullus Segroves 1969
(Plate 80 fig. 8)

1969 *Densipollenites pullus* Segroves: p.187, pl. 4 figs A, B; pl. 5 figs B, C

Synopsis: Large, monosaccate, circular to subcircular, alete. Intexine circular to oval, relatively thick and clearly defined; exoexine and intexine completely detached equatorially and over one face; saccus intrareticulate.

Types: Holotype - UWA 58686, OD Segroves (1969, pl. 4 figs A, B); paratypes - UWA 58687, 58688, Segroves (1969, pl. 5 figs. B, C).

Distribution: Perth Basin (Segroves, 1969).

Age: Late Permian (*Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **DISTRIATITES** Bharadwaj 1962

Type species: *Distriatites bilateris* Bharadwaj 1956; OD. Late Permian; India.

Distriatites dettmannae (Segroves) Foster 1979
(Plate 79 figs 8, 9)

1969 *Hamiapollenites dettmannae* Segroves: p.204, pl. 11 figs D-G
1979 *Distriatites dettmannae* (Segroves); Foster: p.82, pl. 28 figs 10,11

Synopsis: Small to large, disaccate, diploxylonoid to haploxylonoid, taeniate. Cappa bearing 5 - 8 transverse taeniae separated by narrow clefts; cappula traversed by 2 - 5 taeniae, more or less orthogonal to those of cappa.

Types: Holotype - UWA 58731, OD Segroves (1969, pl. 1 fig. F); paratypes - UWA 58733, 58732, Segroves (1969, pl. 11 figs D-E; fig. G).

Distribution: Perth Basin (Segroves, 1969).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **FLORINITES** Schopf, Wilson & Bentall 1944

Type species: *Endosporites pellucidus* Wilson & Coe 1940 (*Florinites antiquus* Schopf, Wilson & Bentall 1944); OD. Pennsylvanian; USA

Florinites eremus Balme & Hennelly 1955
(Plate 79 figs 10, 11)

1955 *Florinites eremus* Balme & Hennelly (*part*): p.96, pl. 5 figs 45, 48 (*not* figs 46, 47)
1969 *Florinites eremus* Balme & Hennelly: Segroves: p.188, pl. 5 fig. A

Synopsis: Medium to large, monosaccate, subcircular to oval, alete. Corpus circular, distinct, saccus finely to coarsely intrareticulate.

Lectotype: (Here designated) Balme & Hennelly (1955, pl. 5 fig. 45).

Distribution: Collie Basin (Glikson, 1972); Wilga Basin (Glikson, 1972); Carnarvon Basin (MacLeod, 1973); Perth Basin (Sanders & Ingram, 1964; Segroves, 1969).

Age: Early Permian (*Acanthotriletes* Assemblage: Segroves, 1970b).

Genus **LIMITISPORITES** Leschik 1956

Type species: *Limitisporites rectus* Leschik; OD. Late Permian; Germany.

Limitisporites rectus Leschik 1956
(Plate 79 figs 5-7)

1956 *Limitisporites rectus* Leschik: p.133, pl. 21 fig. 15
1969 *Limitisporites* sp. cf. *L. rectus* Leschik; Segroves: p.198, pl. 8 figs C, D
1969 *Limitisporites moerensis* (Grebe); Segroves: p.197, pl. 8 figs A, B

Synopsis: Medium to large, disaccate or pseudomonosaccate, haploxylonoid, monolete or dilete; corpus distinct, usually darker than sacci, sacci semicircular in polar view.

Holotype: OD Leschik (1956, pl. 21 fig. 15)

Distribution: Perth Basin (Segroves, 1969; Foster et al., 1985); Canning Basin (Powis, 1979).

Age: Late Carboniferous - Early Permian (*Microbaculispora* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Genus **MARSUPIPOLLENITES** Balme & Hennelly 1956

Type species: *Marsupipollenites triradiatus* Balme & Hennelly 1956; OD. Late Permian; NSW, Australia.

Marsupipollenites striatus (Balme & Hennelly) Hart 1965
(Plate 79 fig. 4)

1956a *Marsupipollenites triradiatus* form *striatus* Balme & Hennelly: p.61, pl. 2 figs 36, 37
1965 *Marsupipollenites striatus* Balme & Hennelly); Hart: p.104, text-fig 250

Synopsis: Medium, sub-circular to oval, precolpate, trilete. Exoexine with low rugulae and small flattened verrucate elements which are arranged in subparallel rows on the proximal and disto-equatorial surfaces.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 2 fig. 36).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Hennelly, 1956a; Sanders & Ingram, 1964; Segroves, 1970a; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous to Late Permian (Powis, 1979); *Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage (Segroves, 1970b).

Marsupipollenites triradiatus Balme & Hennelly 1956
(Plate 79 figs 1-3)

1956a *Marsupipollenites triradiatus* Balme & Hennelly: p.60, pl. 2 figs 29-35
1970a *Marsupipollenites triradiatus* form *triradiatus* Balme & Hennelly; Segroves: p.70, pl. 11 fig. 4

Synopsis: Medium, sub-circular to oval, pericolpate, trilete. Exoexine with low, flattened, closely spaced rounded grana and small verrucae on the proximal and disto-equatorial surfaces.

Lectotype: SD Hart (1965) (Balme & Hennelly, 1956a, pl. 2 fig. 31).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Hennelly, 1956a; Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Early to Late Permian (Unit III to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

Genus **PARASACCITES** Bharadwaj & Tiwari 1964

Type species: *Parasaccites korbaensis* Bharadwaj & Tiwari 1964; OD. Early Permian; India.

Parasaccites bilateralis Tiwari 1965
(Plate 79 fig. 12)

1965 *Parasaccites bilateralis* Tiwari: p.183, pl. 4 fig. 73
1969 *Parasaccites bilateralis* Tiwari; Segroves: p.182, pl. 3 fig. A

Synopsis: Large, monosaccate, oval, trilete or without [illegible]d scar. Saccus width variable in polar view, corpus sub-circular to oval, surface characteristically finely wrinkled.

Holotype: BSIP Photo 317/7, OD Bharadwaj & Tiwari (1964, pl. 2 fig. 12).

Distribution: Perth Basin (Segroves, 1969).

Age: Early Permian (*Quadrisporites* Assemblage to *Haplocystia* Assemblage: Segroves, 1970b).

Parasaccites diffusus Tiwari 1965
(Plate 79 figs 13, 14)

1965 *Parasaccites diffusus* Tiwari: p.183, pl. 4 fig. 72
1969 *Parasaccites diffusus* Tiwari; Segroves: p. 182, pl. 2 fig. A

Synopsis: Large, monosaccate, circular, periphery undulating, trilete. Corpus circular, margins indistinct, sexine of corpus finely intramicroreticulate.

Holotype: BSIP photo 286/7, OD Bharadwaj & Tiwari (1964, pl. 2 fig. 11).

Distribution: Perth Basin (Segroves, 1969).

Age: Early to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **PLATYSACCUS** Naumova *ex* Potonié & Klaus 1954

Type species: *Platysaccus papilionis* Potonié & Klaus; OD Potonié & Klaus, 1954. Late Permian; Austria.

Platysaccus leschiki Hart 1960
(Plate 81 figs 14, 15)

1955 *Lueckisporites fusus* Balme & Hennelly (*parts*) pl. 1 fig. 6
1960 *Platysaccus leschiki* Hart: p.11, pl. 3 figs 37, 38
1969 *Platysaccus* sp. cf. *P. leschiki* Hart; Segroves: p.196, pl. 9 fig. C

Synopsis: Large, disaccate, strongly diploxylonoid. Corpus circular to oval, distinct with a thick cappa, sacci relatively large, subcircular in polar view, some specimens pseudomonosaccate.

Holotype: OD Hart (1960, pl. 3 fig. 38).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Segroves, 1969; Sanders & Ingram, 1964).

Age: Early to Late Permian (*Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **PLICATIPOLLENITES** Lele 1964

Type species: *Plicatipollenites indicus* Lele 1964, OD. Early Permian; India (*Cannanoropollis malabarensis* Potonié & Sah 1960).

Plicatipollenites gondwanensis (Balme & Hennelly) Lele 1964
(Plate 80 figs 9, 10)

1956b *Nuskoisporites gondwanensis* Balme & Hennelly (*parts*): p.253, pl. 7 figs 66, 67 (*not* pl. 6 figs 62-65)
1964 *Plicatipollenites gondwanensis* (Balme & Hennelly); Lele: p.154, pl. 2 fig. 11; text-figs 4a-c, 12b
1969 *Parasaccites gondwanensis* (Balme & Hennelly); Segroves: p.183, pl. 2 fig. B

Synopsis: Large, protomonosaccate, circular to subcircular, trilete. Corpus circular to subcircular, exoexine of corpus finely intramicroreticulate, intexine with conspicuous, polygonally arranged folds beneath the distal saccus base.

Lectotype: SD Potonié & Lele (1961) (Balme & Hennelly, 1956b, p.7 fig. 66).

Distribution: Collie Basin (Balme & Hennelly, 1956b; Glikson, 1972); Perth Basin (Sanders & Ingram, 1964; Segroves, 1970a); Carnarvon Basin (Balme & Hennelly, 1956b; MacLeod, 1973); Canning Basin (Balme & Hennelly, 1956b; Powis, 1979).

Age: Late Carboniferous - Early Permian (Powis, 1979; Segroves, 1970b).

Plicatipollenites malabarensis (Potonié & Sah) Foster 1975

1960 *Plicatipollenites malabarensis* Potonié & Sah: p.128, pl. 2 figs 19-21; pl. 3 fig. 22
1975 *Plicatipollenites malabarensis* (Potonié & Sah); Foster: p.142, pl. 5 fig. 1
1985 *Plicatipollenites malabarensis* (Potonié & Sah); Foster et al.: p.65, pl. 3 fig. 22

Synopsis: Large, monosaccate, circular, trilete. Corpus circular, exoexine of corpus intrareticulate, intexine with almost continuous circumpolar folds beneath distal saccus base.

Type: Slide 1/16, OD Potonié & Sah (1960, pl. 2 fig. 19).

Distribution: Perth Basin (Foster et al., 1985).

Age: Early Permian (*Quadrisporites* Assemblage; Foster et al., 1985).

Genus **POTONIEISPORITES** Bharadwaj 1954

Type species: *Potonieisporites novicus* Bharadwaj 1954; OD. Late Carboniferous; Germany.

Potonieisporites balmei (Hart) Segroves 1969
(Plate 80 fig. 5)

1960 *Vestigisporites balmei* Hart: p.14, pl. 2 fig. 21
1969 *Potonieisporites balmei* (Hart); Segroves: p.179, pl. 1 figs A-C

Synopsis: Large, monosaccate, oval, monolete: corpus circular to oval, exoexine intramicroreticulate, intexine usually with concentric marginal folds below the distal saccus base.

Holotype: OD Hart (1960, pl. 2 fig. 21).

Distribution: Perth Basin (Segroves, 1969).

Age: Early to ?Late Permian (Segroves, 1970b)

Genus **PRAECOLPATITES** Bharadwaj & Saluhja 1969

Type species: *Praecolpatites nidpurensis* Bharadwaj & Salujha 1969; OD. Late Permian (?earliest Triassic); India.

Praecolpatites sinuosus (Balme & Hennelly) Bharadwaj & Srivastava 1969
(Plate 80 figs 1, 2)

1956a *Marsupipollenites sinuosus* Balme & Hennelly: p.61, pl. 2 figs 25, 26
1969b *Praecolpatites sinuosus* (Balme & Hennelly); Bharadwaj & Srivastava: p.141, pl. 29 fig. 125

Synopsis: Medium to large, polyplicate, elongate oval; exine tegillate with a finely punctate surface, exoexine with 3 - 5 narrow longitudinal clefts that are associated in most specimens with exinal folds.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956a, pl. 2 fig. 25).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972; Robertson, 1979); Perth Basin (Segroves, 1970a); Canning Basin (Kemp et al., 1977; Price, 1983); Carnarvon Basin (MacLeod, 1973).

Age: Early to Late Permian (Unit V to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

Genus **PROTOHAPLOXYPINUS** Samoilovitch 1953

Type species: *Pemphygaletes latissimus* Luber 1941; OD. Permian; USSR.

Protohaploxypinus amplus (Balme & Hennelly) Hart 1963
(Plate 81 figs 17, 18)

1955 *Lueckisporites amplus* Balme & Hennelly (*parts*): p.93, pl. 3 figs 24-26, 28, (*not* fig. 27)
1963b *Protohaploxypinus amplus* (Balme & Hennelly); Hart: p.1179, text-fig. 10

Synopsis: Large, disaccate, taeniate, haploxylonoid to slightly diploxylonoid. Cappa exoexine intramicroreticulate, dissected into 8 - 16 (usually 8 - 10) transverse taeniae.

Lectotype: SD Potonié & Lele (1961) (Balme & Hennelly, 1955, pl. 3 fig. 24).

Distribution: Collie Basin (Balme & Hennelly, 1955; Glikson, 1972; Robertson, 1979); Perth Basin (Balme & Hennelly, 1955; Segroves, 1969; Glikson, 1972); Carnarvon Basin (MacLeod, 1973; Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Protohaploxypinus limpidus (Balme & Hennelly)
Balme & Playford 1967
(Plate 81 figs 7, 8)

1955 *Lueckisporites limpidus* Balme & Hennelly: p.94, pl. 3 figs 29-32; pl. 4 figs 33-35
1955 *Lueckisporites amplus* Balme & Hennelly (*parts*): pl. 3 fig. 27 (*not* pl. 3, figs 24-26, 28).
1967 *Protohaploxypinus limpidus* Balme & Hennelly); Balme & Playford: p.185, pl. 1 fig. 5
1969 *Protohaploxypinus limpidus* Balme & Hennely); Segroves: p.199, pl. 9 fig. B

Synopsis: Medium, disaccate, taeniate, haploxylonoid to slightly diploxylonoid. Exoexine of cappa dissected by narrow clefts into 6 - 10 transverse taeniae.

Lectotype: SD Balme & Playford (1967) (Balme & Hennelly, 1955, p.3 fig. 29).

Distribution: Collie Basin (Glikson, 1972); Perth Basin (Sanders & Ingram, 1964; Segroves, 1969; Glikson, 1972); Carnarvon Basin (Macleod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) - Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Protohaploxypinus rugatus Segroves 1969
(Plate 81 fig. 6)

1969 *Protohaploxypinus rugatus* Segroves: p.200, pl 7 figs G, H; pl. 9 figs D-I

Synopsis: Small, disaccate, taeniate, haploxylonoid: corpus circular to oval, cappa thin divided by tranverse clefts into 4 - 7 taeniae, cappula narrow.

Types: Holotype - UWA 58722, OD Segroves (1969, pl. 7 figs G, H); paratype - UWA 58723, Segroves (1979, pl. 9 figs D-F)

Distribution;: Perth Basin (Segroves, 1969); Collie Basin (Robertson, 1979).

Age: Early to Late Permian (*Quadrisporites* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **SCHEURINGIPOLLENITIES** Tiwari 1973

Type species: *Vesicaspora maxima* Hart 1960; OD. Early Permian; Tanzania.

Scheuringipollenites maximus (Hart) Tiwari 1973
(Plate 80 fig. 7)

1955 *Florinites eremus* Balme & Hennelly (*parts*): pl. 5 figs 46, 47 (*not* figs 45, 48)
1960 *Vesicaspora maxima* Hart: p.10, pl. 3 fig. 33
1969 *Sulcatisporites* sp. cf. *Pityosporites potoniei* Lakhanpal, Sah & Dube; Segroves: p.195, pl. 7 fig. F
1973 *Scheuringipollenites maximus* (Hart); Tiwari: p.107, pl. 2 figs 6, 7; text-fig. 2

Synopsis: Medium to large, bisaccate, haploxylonoid, amb sub-circular to oval: corpus usually indiscernible, sacci semi-circular in polar view, fairly coarsely intrareticulate, cappula narrow and slit-like.

Holotype: OD Hart (1960, pl. 3 fig. 33).

Distribution: Collie Basin (Balme & Hennelly, 1955; Glikson, 1972; Robertson, 1979); Wilga Basin (Balme & Hennelly, 1955); Perth Basin (Balme & Hennelly, 1955; Sanders & Ingram, 1964; Segroves, 1969); Carnarvon Basin (MacLeod, 1973); Canning Basin (Kemp et al., 1977; Powis, 1979).

Age: Early to Late Permian (Unit IV - VIII: Kemp et al., 1977).

Scheuringipollenites ovatus (Balme & Hennelly) Foster 1975
(Plate 80 figs 3, 4)

1955 *Florinites ovatus* Balme & Hennelly: p.96, pl. 5 figs 49-52
1969 *Sulcatisporites ovatus* (Balme & Hennelly); Segroves: p.194, pl. 7 figs D, E
1975 *Scheuringipollenites ovatus* (Balme & Hennelly); Foster: p.145, pl. 6 figs 5, 6

Synopsis: Small to medium, bisaccate, haploxylonoid; amb oval; sacci semi-elliptical in polar view; corpus longitudinally elongate oval, faint to indiscernible; cappula narrow, slit-like, extending full length of corpus.

Lectotype: SD Jansonius (1962) (Balme & Hennelly, 1955, pl. 5 fig. 50).

Distribution: Collie Basin (Balme & Hennelly, 1955); Glikson, 1972); Perth Basin (Sanders & Ingram, 1964; Segroves, 1969); Carnarvon Basin (MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) to Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **STRIATOABIEITES** Zoritscheva & Sedova *ex* Sedova 1956

Type species: *Striatoabieites brickii* Sedova 1956; OD. Late Permian, USSR.

Striatoabieites multistriatus (Balme & Hennelly) Hart 1963
(Plate 81 fig. 5)

1955 *Lueckisporites multistriatus* Balme & Hennelly: p.93, pl. 2 figs 16-20
1963b *Striatoabietites multistriatus* (Balme & Hennelly) Hart: p.1186, text-fig. 40
1969 *Striatoabietites multistriatus* (Balme & Hennelly); Segroves: p.201, pl. 11 figs A-C

Synopsis: Small to medium, disaccate, haploxylonoid to slightly diploxylonoid; sacci crescentic to semicircular, usually much smaller than corpus, corpus transversely elongate oval, cappa dissected by narrow clefts into numerous taeniae.

Lectotype: SD Hart (1963b) (Balme & Hennelly, 1955, pl. 2 fig. 17).

Distribution: Collie Basin (Glikson, 1972; Robertson, 1979); Perth Basin (Sanders & Ingram, 1964; Segroves, 1969; Foster et al., 1985); Carnarvon Basin (MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) to Late Permian (*Microbaculispora* Assemblage to *Dulhuntyispora* Assemblage· Segroves, 1970b).

Genus **STRIATOPODOCARPITES** Zoritscheva & Sedova *ex* Sedova 1956

Type species: *Striatopodocarpites tojmensis* Sedova 1956; OD. Late Permian; USSR.

Striatopodocarpites cancellatus (Balme & Hennelly) Hart 1963
(Plate 81 figs 9, 10)

1955 *Lueckisporites cancellatus* Balme & Hennelly: p.92, pl. 2 figs 11-15
1963b *Striatopodocarpites cancellatus* (Balme & Hennelly); Hart: p.10.
1969 *Striatopodocarpites* sp. cf. *S. cancellatus* (Balme & Hennelly); Segroves: p.206, pl. 12 figs F-H; pl. 13 fig. A

Synopsis: Small to medium, disaccate, taeniate, diploxylonoid; sacci oval to rounded quadrangular in polar view, corpus circular, clearly defined, cappa dissected into about 7 transverse taeniae, cappula relatively broad.

Lectotype: SD Hart (1963b) (Balme & Hennelly, 1955, pl. 3 fig. 11).

Distribution: Collie Basin (Glikson, 1972; Robertson, 1979); Perth Basin (Segroves, 1969); Carnarvon Basin (MacLeod, 1973); Canning Basin (Powis, 1979).

Age: Late Carboniferous (Powis, 1979) to Late Permian (*Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Striatopodocarpites fusus (Balme & Hennelly) Potonié 1958
(Plate 81 fig. 16)

1955 *Lueckisporites fusus* Balme & Hennelly: p.92, pl. 1 figs 7-10
1958 *Striatopodocarpites* (al. *Lueckisporites*) *fusus* (Balme & Hennelly); Potonié: p.54

Synopsis: Medium to large, disaccate, taeniate, diploxylonoid; corpus circular to oval, cappa strongly thickened, dissected into 5-7 poorly defined taeniae, sacci relatively large, rounded oval to flabelliform in polar view.

Lectotype: SD Hart (1964) (Balme & Hennelly, 1955, pl. 1 fig. 10).

Distribution: Collie Basin (Balme & Hennelly, 1955; Glikson, 1972); Wilga Basin (Balme & Hennelly, 1955); Perth Basin (Balme & Hennelly, 1955; Glikson, 1972); Canning Basin (Kemp et al., 1977).

Age: Early to Late Permian (Unit III - VIII: Kemp et al., 1977).

Striatopodocarpites gondwanensis
Lakhanpal, Sah & Dube 1960
(Plate 81 fig. 13)

1960 *Striatopodocarpites gondwanensis* Lakhanpal, Sah & Dube: p.114, pl. 1 figs 14-18
1969 *Striatopodocarpites raniganjensis* (Bharadwaj); Segroves: p.207, pl. 13 figs B-D

Synopsis: Medium to large, bisaccate, taeniate, diploxylonoid; sacci subcircular in polar view, corpus subcircular to oval, cappa dissected into 6 - 17 well-defined taeniae.

Holotype: BSIP M.G.T./20, slide no. 7/2, OD Lakhanpal et al. (1960, pl. 1 fig. 15).

Distribution: Perth Basin (Segroves, 1969).

Age: Early to Late Permian *(Acanthotriletes* Assemblage to *Dulhuntyispora* Assemblage: Segroves, 1970b).

Genus **VITTATINA** Luber *ex* Wilson 1962

Type species: *Vittatina subsaccata* Samoilovitch 1953; SD. Wilson, 1962. Late Permian; USSR.

Vittatina fasciolata (Balme & Hennelly) Bharadwaj 1962
(Plate 81 fig. 4)

1956a *Marsupipollenites fasciolatus* Balme & Hennelly: p.62, pl. 3 figs 42-45
1962 *Vittatina fasciolata* (Balme & Hennelly); Bharadwaj: p.100, pl. 5 fig. 94

Synopsis: Small to medium, sub-circular to oval, monosulcate, taeniate. Taeniae extending full width of proximal face and on to the distal surface where they are truncated by the margin of the sulcus.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956a, pl. 3 fig. 42).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972; Robertson, 1979); Perth Basin (Sanders & Ingram, 1964).

Age: Early to Late Permian (Collie Basin: Balme & Hennelly, 1956a; Glikson, 1972).

Vittatina scutata (Balme & Hennelly) Bharadwaj 1962
(Plate 81 figs 11, 12)

1956a *Marsupipollenites scutatus* Balme & Hennelly: p.62, pl. 2 figs 38-41
1962 *Vittatina scutata* (Balme & Hennelly); Bharadwaj: p.100, pl. 5 fig. 93

Synopsis: Small to medium, sub-circular to oval, taeniate, monosulcate. Taeniae extending full width of proximal surface and on to the distal surface where they break up into small flattened verrucae.

Lectotype: SD Bharadwaj (1962) (Balme & Hennelly, 1956a, pl. 2 fig. 39).

Distribution: Collie Basin (Balme & Hennelly, 1956a; Glikson, 1972): Canning Basin (Kemp et al., 1977).

Age: Early to Late Permian (Units III - VII: Kemp et al., 1977, in Canning Basin).

Genus **WEYLANDITES** Bharadwaj & Srivastava 1969

Type species: *Weylandites indicus* Bharadwaj & Srivastava 1969; OD. Late Permian (?earliest Triassic); India.

Weylandites lucifer (Bharadwaj & Salujha) Foster 1975
(Plate 81 figs 1-3)

1964 *Decussatisporites lucifer* Bharadwaj & Salujha: p.213, pl. 12 figs 169-171
1975 *Weylandites lucifer* (Bharadwaj & Salujha); Foster: p.153, pl. 7 fig. 2
1977 *Weylandites lucifer* (Bharadwaj & Salujha); Kemp et al.: fig. 9K

Synopsis: Small, monosulcate, amb subcircular to rounded quadrilateral; exine costate, ribs numerous, close-packed, transverse on the proximal face forming continuous loops so that they run longitudinally on the distal surface.

Holotype: OD Bharadwaj & Salujha (1964, pl. 12 fig. 169).

Distribution: Collie Basin (Glikson, 1972; Robertson, 1979); Perth Basin (Glikson, 1972); Canning Basin (Kemp et al., 1977).

Age: Late Early to Late Permian (Unit V to *Protohaploxypinus reticulatus* Assemblage: Kemp et al., 1977).

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Specimens are no longer available from some of the older collections, and these have been marked with an asterisk in the text to signify that the identification has not been confirmed. All specimens attributed to *Glossopteris browniana* that were examined, were found to belong to other species; specimens listed under **Glosscpteris browniana* may not belong this species, although the identification cannot be discounted.

Kingdom PLANTAE
Division TRACHEOPHYTA
Class LYCOPSIDA
Order LEPIDODENDRALES

Family LYCOPODIOPSIDACEAE

Genus **CYCLODENDRON** Kräusel 1928

Type species: *Cyclodendron leslii* (Seward 1903) Kräusel 1928.

Cyclodendron leslii (Seward 1903) Kräusel 1928
(Plate 83 figs. 1, 2, 4-6; Plate 91 fig. 2)

1890 *Lepidodendron* Kidston *in* Foord: p.102, pl. 4 figs 4, 4a
1890 *Stigmaria* Kidston *in* Foord: p.102, pl. 4 fig. 5
1903 *Bothrodendron leslii* Seward: p.87, pl. 11 figs 1, 1a-c, 4, 5
1928 *Cyclodendron leslii* (Seward) Kräusel & Range: p.18, figs 1, 3; pl. 1 figs. 3-8; *non* pl. 1 figs 7-8; pl. 2, fig. 1
1952 *Lycopodiopsis pedroanus* (Carruthers) Edwards: p.162, pl. 1, figs 1-4
1966 *Cyclodendron leslii* (Seward) Kräusel; Rigby: p.115, pl. 30 figs 2, 5
1976 *Lycopodiopsis pedroanus* (Carruthers) Edwards; White & Yeates: p.7-9, pl. 1 figs 2, 3; pl. 2 figs 4, 6-7
1980 *Lycopodiopsis derbyi* Renault; Lemoigne & Brown: p.555-577, pl. 1-8

Diagnosis: Stem with spirally arranged, needle- to scale-shaped leaves, each having a single vascular bundle; leaves are attached to the stem by a broad, rounded base; after leaf fall a more or less rounded scar remains (based on Kräusel, 1928).

Types and figured species: Holotype - South African Museum, Cape Town, no. XXI; BM(NH) V.25712, V.25713, V.25716, V.25719, UN 745, and CPC 2847, 30656-30658.

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Sakmarian and Artinskian.

Abundance: Common in the Nura Nura Member of the Poole Sandstone; rare elsewhere.

Value in correlation and dating: Preference for swamp and estuarine environments, hence valuable as an ecological indicator.

Cyclodendron sp.

1937 **Cyclodendron* sp. Wade: p.94
1951 **Bothrodendron* sp. Clarke et al.: p.61
1959 *Lepidodendron* sp. White: p.59-60, figs 5-12
1967 *Lepidodendron* sp. Condon: p.30-31

Distribution and range: **Perth Basin** - Irwin River Coal Measures; **Carnarvon Basin** - Lyons Group; northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Sakmarian - Artinskian.

Remarks: In view of the unsatisfactory state of the taxonomy of Gondwana lycopods, these records should be regarded as tentative.

?Cyclodendron sp.

1890 **Stigmaria* Kidston *in* Foord: p.102, pl. 4 fig. 5
1966 **?Cyclodendron* Rigby: p.147
1976 *?Lycopodiopsis* White & Yeates: p.8, pl. 2 fig. 4

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Genus **LYCOPODIOPSIS** Renault 1890

Type species: *Lycopodiopsis derbyi* Renault 1890.

Lycopodiopsis sp. cf. **L. derbyi** Renault 1890

1959 *Lepidodendron* White & Condon: p.61, figs 13-14

Description: Lycopod stem with discontinuous stele and irregular development of primary wood in cross section.

Figured specimen: CPC 30659.

Distribution and range: **Carnarvon Basin** - Lyons Group.

Age: Sakmarian.

Abundance: Rare.

Value in correlation and dating: It is necessary to cut sections for identification thus reducing the utility of members of this genus.

Genus **BRASILODENDRON** Chaloner, Lestikow & Hill 1979

Type species: *Brasilodendron pedroanum* (Carruthers 1869) Chaloner, Lestikow & Hill 1979.

?Brasilodendron pedroanum (Carruthers 1869)
Chaloner, Lestikow & Hill 1979

1961 **?*Lycopodiopsis pedroanus* Carruthers; White: p.294, 298*

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

Family LEPIDODENDRACEAE

Genus **LEPIDODENDRON** Sternberg 1820

Type species: *Lepidodendron aculeatum* Sternberg 1820.

Lepidodendron sp.

1937 **cf. *Lepidodendron* Wade: p.94*
1938 **Lepidodendron* sp. Walkom: p.1340*
1958 **Lepidodendron* spp. Guppy et al.: p.45*
1958 **Lepidodendron* sp. nov. Guppy et al.: p.45*

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Family BOTHRODENDRACEAE

Genus **BOTHRODENDRON** Lindley & Hutton 1833

Type species: *Bothrodendron punctatum* Lindley & Hutton 1833.

Bothrodendron sp.

1931 **Bothrodendron* sp. David & Süssmilch: p.109*
1937 **cf. *Bothrodendron* Wade: p.94*
1938 **Bothrodendron* sp. Walkom: p.1340*
1951 **Bothrodendron* sp. Clarke et al.: p.61*
1958 **Bothrodendron* sp. Guppy et al.: p.45*

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Poole Sandstone, ?Condren Sandstone, Liveringa Group.

Age: Artinskian - ?Kungurian.

LEPIDODENDRALES *incertae sedis*

Genus **STIGMARIA** Brongniart 1822

Type species: *Stigmaria ficoides* (Sternberg 1820) Brongniart 1822.

Stigmaria sp.

1958 **Stigmaria* sp. Guppy et al.: p.46*

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Lycopod gen. et sp. indet.

1959 *Lepidodendron* White & Condon: p.59-61, figs 5-12

Distribution and range: Northern **Canning Basin** - Lyons Group.

Age: Sakmarian.

Lycopod or sphenopsid leaves

1890 *Cyperites*-like leaf fragments, Kidston *in* Foord: p.103, pl. 4 figs 7-8a
1923 *?Phyllotheca* sp. Glauert: p.8 (part)
1966 Lycopod leaves, probably of *Cyclodendron leslii* Rigby: p.116, pl. 30 fig.8.

Figured specimens: UN 732, 754.

Distribution and range: Northern **Canning Basin; Collie Basin; Perth Basin** - Irwin River Coal Measures.

Abundance: Numerous leaves occur at a few localities.

Value in correlation and dating: None, as they may have been derived from many different host species.

Class SPHENOPSIDA
Order SPHENOPHYLLALES

Family SPHENOPHYLLACEAE Potonié 1897

Genus **SPHENOPHYLLUM** Koenig 1825

Type species: *Sphenophyllum emarginatum* (Brongniart 1822) Koenig 1825.

Sphenophyllum rhodesii Rigby 1966
(Plate 83 figs 7a, 8)

1951 *Sphenophyllum speciosum* (Royle); Clarke et al.. p.60, 61
1951 *Sphenophyllum* cf. *emarginatum* Brongniart; Clarke et al.: p.61
1966 *Sphenophyllum rhodesii* Rigby: p.126-128, pl. 33 figs 30-32; text fig. 2.
1983 *Sphenophyllum rhodesii* Rigby; Srivastava & Rigby: p.59

Diagnosis: "Slender ribbed stem bearing whorls of six approximately equal sized obcuneate leaves at enlarged nodes. Leaves almost as broad as long; distal margin entire, slightly rounded, base contracted, non-petiolate; leaves free. Venation repeatedly dichotomizing, arising from a single, stouter vein that enters leaf base; some veins intersect the apparent lateral margin of leaves, whereas the majority intersect the apical margin. Leaf whorls

separated by a distance of less than the whorl diameter. Fructification unknown" (after Rigby, 1966).

Types: Holotype - UWA 32684; paratype - UWA 32684; figured specimen - UWA 53779.

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Value in correlation and dating: This species will probably be an index species when more is known of its distribution.

Sphenophyllum sp.

1938 **Sphenophyllum* Walkom: p.1340
1951 **Sphenophyllum speciosum* (Royle); Clarke et al.: p.60
1951 **Sphenophyllum* cf. *emarginatum* Brongniart; Clarke et al.: p.61
1951 **Sphenophyllum* sp. Clarke et al.: p.61

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Order EQUISETALES
Family EQUISETACEAE

Genus **PHYLLOTHECA** Brongniart 1828

Type species: *Phyllotheca australis* Brongniart 1828.

Phyllotheca australis Brongniart 1828

1828 *Phyllotheca australis* Brongniart: p.150
1951 **Phyllotheca australis* Brongniart; Clarke et al.: p.60-61
1976 *Phyllotheca*; White & Yeates: p.11

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Condren Sandstone.

Age: Artinskian, Kazanian.

Phyllotheca sp.

1961 **Phyllotheca* sp.; White: p.293
1976 **Phyllotheca* sp.; White & Yeates: p.14

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

EQUISETALES *incertae sedis*

Genus **RANIGANJIA** Rigby 1963

Type species: *Raniganjia bengalensis* (Feistmantel 1876) Rigby 1963.

Raniganjia minima (Rigby 1966) Rigby comb. nov.
(Plate 83 fig. 3a; Plate 89 fig. 2c)

1966 *Umbellaphyllites minima* Rigby: p.118, pl. 31 figs 9, 17

Diagnosis: "Articulate foliage, whorl slightly elliptical, leaves 14-19 per whorl, united for 4/5 for their length, apex acuminate, leaf blade wrinkled with wrinkling approximately at right angles to the midrib; leaf bases united into a short cyclindrical sheath, length approximately equal to stem diameter at node, leaf length on expanded disc approximately five times stem diameter; whorls spaced at slightly less than whorl diameter apart: stem slender, of *Paracalamites* type; fructification unknown" (Rigby, 1966, p.118).

Closest species: This species differs from *Raniganjia bengalensis* in having acuminate leaf tips and a cylindrical leaf sheath.

Holotype: UWA 52986.

Distribution and range: **Perth Basin** - Wagina Sandstone.

Abundance: A number of fragments.

Age: Kazanian.

Value in correlation and dating: Not known from elsewhere.

Raniganjia sp.

1976 *Umbellaphyllites* sp. White & Yeates: p.10, pl. 3 fig. 12

Figured specimen: CPC 30655

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Abundance: 1 specimen.

Age: Kungurian.

SPHENOPSIDA *incertae sedis*

Genus **PARACALAMITES** Zalessky 1927

Type species: *Paracalamites striatus* (Schmalhausen 1879) Zalessky 1927.

Paracalamites australis Rigby 1966
(Plate 82)

1890 rachis of ferns(?) Kidston *in* Foord: p.102, pl. 4 figs 6-6a
1923 *?Phyllotheca* sp. Glauert: p.8 (part)
1931 *Phyllotheca* sp. or *Schizoneura* David & Süssmilch: p.509
1951 *Phyllotheca australis* Brongniart; Clarke et al.: p.60
1961 equisetalean stems; White: p.294
1961 *Phyllotheca* sp.?; White: p.293, 300
1961 *Schizoneura* sp.?; White: p.294, 300
1961 *Equisetites;* White: p.300

1961 *Phyllotheca* cf. *P. australis* Brongniart; White: p.298
1966 *Paracalamites australis* Rigby: p.123-125, pl. 32 fig. 19; pl. 33 figs 20, 23
1966 *Paracalamites levis* Rigby: p.125-126, pl. 33 figs 21, 22
1966 *Paracalamites* sp. Rigby: p.140, 147-148
1976 Equisetalean stems White & Yeates: p.3, 7, 9, 14 figs 9, 20

Diagnosis: "Articulate stem, having ribs of pith cast opposite at node; where number of ribs changing at node, occasional ribs alternate; tubercles indicating branches absent; rib vascular bundles dichotomise and recombine with vessels of adjacent ribs at nodes of internal casts, ribs and furrows sometimes finely striated. Node of external cast very weakly marked, ribbing less distinct; except in thick trunks internodes substantially longer than stem diameter. Fructification and foliage unknown" (Rigby, 1966).

Closest species: Any or all of the following genera based on leaves may have contributed stems of *P. australis*: *Phyllotheca, Stellotheca, Raniganjia, Schizoneura.*

Types: Holotype - UWA 22972, specimen as designated in the legend of fig. 19, plate 32, of Rigby (1966); paratypes - UN 716, 717.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; northern **Canning Basin** - Grant Group, Noonkanbah Formation, Lightjack Formation, Condren Sandstone.

Age: Permian.

Value in correlation and dating: None.

Sedimentary environment: Probably grew more commonly along streams and in swampy situations.

?Paracalamites sp.

1923 *?Phyllotheca* sp.; Glauert: p.8
1966 *?Paracalamites* sp.; Rigby: p.140

Distribution and range: **Collie Basin** - Collie Coal Measures.

Abundance: Unknown.

Age: Artinskian.

Order FILICALES *incertae sedis*

Genus **NEOMARIOPTERIS** Maithy 1974

Type species: *Neomariopteris polymorpha* (Feistmantel 1876) Maithy 1974.

Neomariopteris lobifolia (Morris 1845) Maithy 1974
(Plate 83 figs 7b, 9)

1845 *Sphenopteris lobifolia* Morris *in* Strzelecki: p.246, pl. 7

1976 *Sphenopteris lobifolia* Morris; White & Yeates: p.12 figs 3, 3a
1923 **Sphenopteris lobifolia* Morris; Glauert: p.8-9
1931 **Sphenopteris lobifolia* Morris; David & Süssmilch: p.509
1951 *Sphenopteris lobifolia* Morris; Clarke et al.: p.61
1966 *Sphenopteris lobifolia* Morris; Rigby: p.128-129, pl. 33 fig. 35
1974 *Neomariopteris lobifolia* (Morris); Maithy: p.77, pl. 2 figs 12-13
1976 *Sphenopteris lobifolia* Morris; Rigby: p.439-444

Diagnosis: "Frond bipinnate; pinnae, somewhat linear, elongate, alternate; pinnulae membranous, those of the lower pinnae equal, ovate oblong, contracted at the base, approximate, with three nearly equal rounded lobes on each side, and a terminal obtuse one; the veins, proceeding into each lobe, divide near the mid rib, the upper one being furcate; the pinnulae towards the apex of the frond are rather sharply three-lobed and decurrent, the veins becoming furcate in each lobe" (Morris, 1845, p.246).

Closest species: *Neomariopteris polymorpha* (Feistmantel 1876) Maithy 1974.

Holotype: BM(NH) 13530; figured specimen - UWA 53779.

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Condren Sandstone.

Abundance: At least 11 specimens in Western Australia. This species is very irregularly distributed in Gondwana; however, it may be very common locally.

Age: Artinskian, Kazanian in Western Australia.

Value in correlation and dating: Often indicative of Late Permian age, may be used in intracontinental correlation.

Neomariopteris polymorpha
(Feistmantel 1876) Maithy 1974

1976 **Sphenopteris polymorpha* Feistmantel; White & Yeates: p.14

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

?Neomariopteris sp.

1951 **Sphenopteris?* sp. Clarke et al.: p.61

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Family ALETHOPTERIDACEAE Corsin 1961

Genus **ALETHOPTERIS** Sternberg 1825

Type species: *Alethopteris serli* (Brongniart 1828) Goeppert 1836.

Alethopteris lindleyana (Royle 1834) Schimper 1869

1834 *Pecopteris lindleyana* Royle: p.xxix*, pl. 2 fig. 4
1850 *Pecopteris lindleyana* Royle; M'Clelland: p.56, pl. 13 fig. 10
1869 *Alethopteris lindleyana* Royle; Schimper: p.568-569
1901 *Cladophlebis roylei* Arber: p.548
1951 **Cladophlebis roylei* Arber; Clarke et al.: p.61
1976 *Cladophlebis roylei* Arber; White & Yeates: p.11

Diagnosis: Frond tri or more pinnate, pinnae axes arising at 75-80°; pinnae decurrent, subalternate, midrib straight, tertiary veins arising at a low angle, dichotomizing, slightly wavy.

Closest species: None in the Permian of Gondwana.

Holotype: BM(NH) V.4192.

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Condren Sandstone.

Age: Artinskian - Kazanian.

?Rhizome of a fern, probably allied to *Rhizomopteris*

1907 (?)Rhizome of a fern, probably allied to *Rhizomopteris;* Chapman: p.15; pl. 1 fig. 4

Distribution and range: **Collie Basin** - Collie Coal Measures.

Abundance: One specimen.

Age: Artinskian.

Class GYMNOSPERMAE
GLOSSOPTERIDAE *incertae sedis*

Genus **GLOSSOPTERIS** Brongniart 1828

Type species: *Glossopteris browniana* Brongniart 1828.

Glossopteris ampla Dana 1849

1849 *Glossopteris ampla* Dana: p.717, pl. 13 fig. 1
1931 **Glossopteris ampla;* David & Süssmilch: p.509

Discussion: All specimens from Western Australia seen by the compiler that have been attributed to the species *G. ampla* have been reclassified into other species. None bear any close resemblance to the paratype, no. 41296 in the Dana Collection, U.S. National Museum

of Natural History, Washington (figured by Rigby, 1966, pl. 34, fig. 41).

Glossopteris angustifolia Brongniart 1831

1831 *Glossopteris angustifolia* Brongniart: p.224, pl. 63 fig. 1
1896 *Glossopteris angustifolia* Brongniart; Zeiller: p.369-371, pl. 18 figs 1-3
1907 **Glossopteris browniana* var. *angustifolia*; Maitland: p.59
1910 **Glossopteris angustifolia* (Brongniart); Glauert: p.109
1951 **Glossopteris angustifolia* Brongniart; Clarke et al.: p.60-61
1952 **Glossopteris angustifolia* (Brongniart); Lord: p.98
1979 *Glossopteris angustifolia* Brongniart; Chandra & Surange: p.64-66, pl. 3 fig. 6; pl. 13 fig. 5; pl. 18 figs 7, 11; pl. 42 fig. 2

Diagnosis: "Frond small, narrow. Shape linear, length/width ratio 8:1, apex obtuse, base acute-cuneate. Midrib broad, remains about 1/2 the length then tapers towards the apex. Lateral veins arise at an angle of about 45° and travel straight to the margin. Meshes elongated, somewhat broad and of the same size throughout the lamina. Cross-connections present" (Chandra & Surange, 1979, p.65).

Type: MHN 509.

Distribution and range: **Collie Basin** - Collie Coal Measures; northern **Canning Basin** - Poole Sandstone.

Age: Ar'inskian - Tatarian.

Glossopteris sp. cf. **G. angustifolia** Brongniart 1831

1958 *Glossopteris* cf. *angustifolia* Brongniart; Guppy et al.: p.45

Distribution and range: **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Glossopteris browniana Brongniart 1828

1828 *Glossopteris browniana* Brongniart (*part*): p.54
1831 Glossopteris *browniana* var. *australasica* Brongniart: p.233, pl. 62 figs 1, 1a
1869 *Glossopteris browniana* Brongniart; Schimper: p.645-646
1874 *Glossopteris browniana* Brongniart; Schimper: p.38, figs 11, 11b
1894 **Glossopteris browniana*; David: p.256
1898 **Glossopteris browniana* Brongniart; M'Coy: p.5
1907 **Glossopteris browniana*; Maitland: p.59
1910 **Glossopteris browniana* (Brongniart); Glauert: p.109
1923 **Glossopteris browniana* Brongniart; Glauert: p.9
1931 **Glossopteris browniana*; David & Süssmilch: p.509
1937 **Glossopteris* cf. *browniana*; Wade: p.94
1938 **Glossopteris ?browniana* Brongniart; Walkom: p.1340
1951 **Glossopteris browniana* Brongniart; Clarke et al.: p.60-61
1958 **Glossopteris browniana* Brongniart; Guppy et al.: p.45
1976 **Glossopteris browniana* Brongniart; White & Yeates: p.12-14

Discussion: All specimens from Western Australia seen by the compiler that had been attributed to the species *G. browniana* have been reclassified into other species. None bear any close resemblance to the holotype held in the Musée d'Histoire Naturelle, Paris. The holotype has never been figured photographically.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; northern **Canning Basin** - Poole Sandstone, Nura Nura Member of the Poole Sandstone, and Condren Sandstone.

Age: Sakmarian - Kazanian.

Glossopteris communis Feistmantel 1876

1876 **Glossopteris communis* Feistmantel: p.375-376, pl. 21 fig. 5
1907 **Glossopteris browniana* var. *communis*; Maitland: p.59
1907 **Glossopteris indica* Brongniart; Chapman: p.12-13, pl. 1 fig. 2; pl. 2 fig. 2
1910 **Glossopteris communis* (Feistmantel); Glauert: p.109
1952 **Glossopteris indica* (Brongniart); Lord: p.98
1952 **Glossopteris communis* (Feistmantel); Lord: p.98
1961 **Glossopteris communis* Feistmantel; White: p.293, 294, 300, pl. 1 fig. 3(?)
1976 **Glossopteris communis* Feistmantel; White & Yeates: p.3, 10, 12, 14
1979 *Glossopteris communis* Feistmantel; Chandra & Surange: p.28-30, pl. 1 figs 2-3; pl. 13 fig. 7; pl. 15 figs 1, 6; pl. 26 fig. 1

Diagnosis: Leaf medium to large; shape narrow elliptical, length/width ratio 4:1, apex obtuse, base acute-cuneate; midrib wide, distinct, very gradually tapering upwards; lateral veins thin, venation dense; veins arise from the midrib at an angle of less than 45°, arching backwards, pass out to the margin in graceful curves, veins run almost parallel to one another, bifurcating and forming very long and narrow meshes (after Chandra & Surange, 1979, p.29).

Closest species: In eastern Australia this is a very common venation type being found in at least six species; all but one are undescribed. It differs from all in leaf shape. *Glossopteris ganganopteroides* is obovate to oblanceolate. Leaves from Tasmania thought to be *Glossopteris ovata* are very much longer and broader with a more pronounced midrib. Chandra and Surange (1979, p.29) compare it with *Glossopteris major* which is oblanceolate, with *Glossopteris gigas* which is very broad and elliptical, and *Glossopteris raniganjensis* which is a large, narrow elliptical leaf with an acute apex. *Glossopteris stenoneura* is a very small oblanceolate leaf with a thin midrib that dissolves into secondary venation in the apical region.

Holotype: GSI 5022, from the Raniganj Coalfield, Bengal.

Distribution and range: **Collie Basin** - Collie Coal Measures; northern **Canning Basin** - Condren Sandstone.

Age: Artinskian - Kazanian.

Abundance: Several leaves.

Glossopteris condrenensis Rigby, Chandra & Surange 1988
(Plate 84 figs 1, 2, 5; Plate 85 figs 1, 2)

1961 *Glossopteris communis* Feistmantel; White: p.298, pl. 1 fig. 3
1976 *Glossopteris ampla* Dana; White & Yeates: p.3, 10, 11, 13; pl. 4 fig. 11; pl. 5 fig. 15; pl. 7 fig. 22
1976 *Glossopteris longicaulis* Feistmantel; White & Yeates: p.3, 9, 10, 13, 14, pl. 4 fig. 13; pl. 7 fig. 23
1988 *Glossopteris condrenensis* Rigby: p.73-74, figs 1-2

Diagnosis: Medium leaf, 15 cm or larger, width 7 cm or broader, obovate; apex obtuse; base cuneate; midrib pronounced with reticulate ribbing, becoming slender towards apex; secondary venation of *communis* type arching away from the midrib to become essentially straight and parallel over most of the blade, density about 16 per 10 mm, marginal angle 70°, degree of arching <5°, branching and cross connections frequent adjacent to the midrib, thereafter very infrequently between occasional veins, cuticles unknown.

Closest species: *Glossopteris spatulata* Pant & Singh 1971.

Holotype: CPC 26551.

Type locality: North of Condren Pinnacle at approximately 127°40'E, 20°01'S in eastern Canning Basin.

Distribution and range: **Collie Basin** - Ewington Member, Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Condren Sandstone.

Age: Artinskian, Kazanian.

Abundance: Occasional specimens.

Value in correlation and dating: This species has value as it is easily recognizable, and is known from three basins. It is not known outside Western Australia.

Glossopteris sp. cf. **G. decipiens** Feistmantel 1879
(Plate 86 fig. 2)

1951 **Glossopteris decipiens* Feistmantel; Clarke et al.: p.61
1966 *Glossopteris decipiens* Feistmantel; Rigby: p.131, 140, pl. 35 fig. 54

Diagnosis: "Leaf small, narrow. Shape very narrow-elliptic, length/width ratio 5:1, apex acute, base hastate. Midrib thin, evanescent, 2/3 part of the lamina, dissolving into secondary veins in the upper 1/3 part of the lamina. Lateral veins arise at an angle of much less than 45°, at about 10°-15° travel along the midrib for some distance, then arch out to the margin. Veins dense, thin, meshes elongate, narrow" (Chandra & Surange, 1979, p.30).

Figured specimen: UN 731.

Distribution and range: Collie Basin - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures.

Age: Sakmarian - Artinskian.

Glossopteris erregullanus Rigby, Chandra & Surange 1988
(Plate 87 fig. 2)

1923 **Glossopteris ampla* Dana; Glauert: p.9-10 (based on description only, not supported by specimens or figures)
1966 *Glossopteris ampla* Dana; Rigby: p.129-130 (*part*) pl. 34 fig. 42
1988 *Glossopteris erregullanus* Rigby et al.: p.74, fig. 3

Diagnosis: Leaf, large, incomplete, broad, base and apex unknown, midrib relatively slender, ribbed with forking and anastomoses between ribs, secondary venation pronounced curving away from the midrib with some forking, more commonly anastomosing producing meshes commonly six or more times longer than broad, averaging between 4 and 6 meshes between midrib and margin, marginal angle 70°, degree of arching 65°, veins tend to be reflexed towards the margin, venation density parallel to midrib at half distance to margin 5 to 7 per 10 mm, and near margin 9 per 10 mm.

Closest species: *Glossopteris ampla* Dana 1849 is also a large, broad leaf, marginal angle = 60°, degree of arching = 45°, with a venation density of 20 per 10 mm.

Holotype: UWA 41425.

Distribution and range: Erregulla Springs Station 2 km east of Mingenew, northern **Perth Basin** - Mingenew Formation; possibly also from the Irwin River area - ?Irwin River Coal Measures.

Abundance: 1 specimen.

Age: Artinskian.

Value in correlation and dating: Too rare to be useful.

Climate: Unknown.

Sedimentary environment: Associated with marine faunas. The leaf is folded suggesting transport in an active environment.

Glossopteris gangamopteroides Feistmantel 1890

1878 *Gangamopteris(?)* sp. Feistmantel: pl. 11 fig. 5
1890 *Glossopteris gangamopteroides* Feistmantel: p.15 pl. 20 fig. 4
1907 **Glossopteris browniana gangamopteroides;* Maitland: p.59
1907 *Glossopteris gangamopteroides* Feistmantel; Chapman: p.13-14. pl. 2 figs 3, 4
1910 **Glossopteris gangamopteroides* (Feistmantel); Glauert: p. 109

Diagnosis: Leaf, small, narrow-elliptical, length/width ratio 3:1, apex unknown, base acute, midrib distinct at base tapering towards apex; veins arched, and densely and evenly spaced throughout maintaining spacing by dichotomous branching; some branches fusing by

gradually merging with adjacent veins, forming very long, pointed areoles; marginal angle 65°, degree of arching 30°.

Holotype: GSN F2930.

Distribution and range: Collie Basin - Collie Coal Measures.

Abundance: Rare.

Age: Artinskian.

Glossopteris gregoryi Rigby, Chandra & Surange 1988
(Plate 88 figs 2, 3; Plate 89 fig. 1c)

1966 *Glossopteris indica* Schimper; Rigby: p.129 (part), pl. 31 fig. 9
1988 *Glossopteris gregoryi* Rigby et al.: p.74-75, fig. 4

Diagnosis: Large leaf <20 cm long, 3.5 cm wide, lorate; apex acute, pointed; base acute tapering; midrib pronounced, continuing almost to apex, finely ribbed; secondary venation fine, with dichotomies and elongate N and X connections, with 2-3 meshes between midrib and margin, density of veins 40-50 per 10 mm, marginal angle 62°, degree of arching 5°; cuticle unknown.

Closest species: No other large leafed species has such dense secondary venation.

Holotype: UWA 45318.

Type locality: North Irwin River, 30 cm below base of bottom coal seam, 360 m upstream from Fossil Cliff, northern Perth Basin.

Distribution and range: Collie Basin - Ewington Member of Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone.

Age: Artinskian, Kazanian.

Abundance: Occasional specimens.

Value in correlation and dating: This species appears to be of value; not known outside Western Australia.

Glossopteris sp. cf. **G. hispida** Pant 1966
(Plate 86 fig 3)

1966 *Glossopteris* cf. *hispida* Pant; Rigby: p.131; pl. 35, fig. 46

Figured specimen: UN 740.

Distribution and range: Collie Basin - Collie Coal Measures (probably Ewington Member).

Age: Artinskian.

Glossopteris indica Schimper 1869

1830 *Glossopteris browniana* var. *indica* Brongniart: p.223, pl. 62 fig. 2
1869 *Glossopteris indica* Schimper: p.645
1907 **Glossopteris browniana* var. *indica* Brongniart; Maitland: p.59
1910 **Glossopteris indica* (Brongniart); Glauert; p.109
1923 **Glossopteris indica* Schimper; Glauert: p.9
1931 **Glossopteris indica;* David & Süssmilch: p.509
1937 **Glossopteris* cf. *indica;* Wade: p.94
1938 **Glossopteris indica* Schimper; Walkom: p.1340
1951 **Glossopteris indica* Schimper; Clarke et al.: p.60
1958 **Glossopteris indica* Brongniart; Guppy et al.: p.45
1961 **Glossopteris indica* Schimper; White: p.293-294, 298-300, pl. 1 fig. 2
1976 **Glossopteris indica* Sch.; White & Yeates: p.3, 7, 11-14

Diagnosis: Frond medium to large, more elongate than broad, narrow elliptical, length/width ratio 3:1, apex acute, base acute, midrib wide and stout, tapers only in the apical region; lateral veins curve away from the midrib then pass more or less straight and parallel to the margin, marginal angle 75°, degree of arching 5°, meshes form short broad areoles along midrib, dichotomize and anastomose to form 2 to 5 long, narrow meshes between broad areoles and margin.

Holotype: MHN 506.

Distribution and range: Collie Basin - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; northern **Canning Basin** - Grant Group, Poole Sandstone, Condren Sandstone.

Age: Sakmarian - Kungurian.

Glossopteris irwinensis Rigby, Chandra & Surange 1988
(Plate 84 fig. 3)

1966 *Glossopteris browniana* Brongniart; Rigby: p.129 (*part*), pl. 35 fig. 48 (only)
1988 *Glossopteris irwinensis* Rigby et al.: p.75-76, fig. 5A

Diagnosis: Leaf small, probably narrowly obovate, apex obtuse slightly emarginate, base unknown, midrib pronounced continuing almost to apex, secondary venation arched and parallel, marginal angle 65°, degree of arching 35°; most veins dichotomize once near the midrib or within the middle half of the leaf, veins anastomose 5-7 times between midrib and margin in the middle part of the leaf; veins spaced about 2 per mm near midrib and about 4 per mm near margin, meshes 8-2.5 mm long; midrib entire, probably unribbed, cuticles and fructification unknown.

Closest species: *Glossopteris bosei* Chandra & Surange has more uniformly wide meshes throughout the leaf whereas the meshes in *G. irwini* are almost twice as wide towards the midrib than along the margin.

Holotype: UWA 52982.

Distribution and range: Perth Basin - Irwin River Coal Measures.

Age: Artinskian.

Value in correlation and dating: It may have significance when further collecting has shown the full distribution of the species.

Glossopteris linearis M'Coy 1847
(Plate 84 fig. 4)

1847 *Glossopteris linearis* (M'Coy): p.151, pl. 9 fig. 5 (only)
1907 *Glossopteris angustifolia* Brongniart; Chapman: p.13, pl. 2 fig. 1
1910 **Glossopteris angustifolia* (Brongniart); Glauert: p.109
1952 **Glossopteris angustifolia* (Brongniart); Lord: p.98
1966 *Gangamopteris obovata* (Carruthers) White; Rigby: p.133-134 (part)

Description: "Leaves very long, narrow, with nearly parallel sides; midrib very large; secondary veins fine, forming an angle of about 50° with the midrib, anastomosing occasionally from the midrib to the margin" (M'Coy, 1847). Veins frequently dichotomize near the midrib, then pass almost unarched to the margin.

Closest species: *Glossopteris angustifolia* has a leaf of similar shape, but the secondary venation is more open, slightly more arched, and at an angle of 30-45° to the midrib.

Types: Holotype - SM L4, Foreign Plant Collection. The paratype, L63, does not belong in this species.

Figured specimen: Chapman (1907) pl. 2 fig. 1 - NMV 10311.

Distribution and range: **Collie Basin** - Cardiff Member of the Collie Coal Measures.

Abundance: Rare.

Age: Tatarian.

Value in correlation and dating: Known also from eastern Australia but its distribution is uncertain.

Glossopteris spathulato-cordata Feistmantel *ex* Walkom 1928

1878 Entwickelungsstadian von *Glossopteris* Feistmantel: p.93, pl. 12 figs 3, 5, 6
1890 *Glossopteris spathulato-cordata* Feistmantel: p.128, pl. 20 figs 5, 7, 8
1928 *Glossopteris spathulato-cordata* Feistmantel *ex* Walkom: p.559, text figs 8a, 8b
1951 **Glossopteris spathulo-cordata* Feistmantel; Clarke et al.: p.61

Diagnosis: Leaf small, spathulate, almost as broad as long, apex deeply emarginate, base attenuate; midrib broad at base, dissolving into secondary venation and finally disappearing near the apex, strongly ribbed; secondary venation curves somewhat irregularly from the midrib to intersect the margin at a high angle dichotomizing once

or twice, and anastomosing towards the margin up to three times forming polygonal meshes 2 to 4 times as long as broad.

Holotype: GSN F2908.

Distribution and range: Perth Basin - Irwin River Coal Measures.

Abundance: Rare.

Age: Artinskian.

Value in correlation and dating: Easily recognizable, and of limited distribution.

Glossopteris waginanus (Rigby 1966) Rigby, Chandra & Surange 1988
(Plate 86 fig. 1; Plate 87 fig. 1b; Plate 88 fig. 4; Plate 89 fig. 1a, 2a; Plate 90 fig. 5b)

1966 *Rhabdotaenia waginae* Rigby: p. 135-136, pl. 34 fig. 43; pl. 35 fig. 56; pl. 36 fig. 57
1988 *Glossopteris waginanus* (Rigby 1966); Rigby et al.: p.76-77, fig 6

Diagnosis: Leaf up to 5 cm wide, length unknown but greater than 20 cm, apex circular to acute, base unknown but blade narrows gradually towards base; midrib broad, coarsely ribbed, dissolving into secondary venation just below apex; secondary venation curves away from midrib then running straight and parallel to the margin; veins generally dichotomizing once, rarely twice; anastomoses rare, marginal angle 65-70°, degree of arching 0°; sometimes secondary venation curves apically near margin.

Closest species: *Glossopteris waginanus* differs from *G. jonesii* by having very few anastomoses in the secondary venation, and from all other species by its very coarse, open, parallel secondary venation.

Types: Holotype - UWA 37594; paratypes - UWA 52980 (more than one specimen).

Distribution and range: Collie Basin - Collie Coal Measures; **Perth Basin** - Wagina Sandstone.

Abundance: Abundant in places in the Wagina Sandstone.

Age: Artinskian (ignoring specimens labelled "Collie Coal Measures").

Value in correlation and dating: Probably excellent.

Sedimentary environment: Fine-grained pink shale with disturbed bedding; lens within the Wagina Sandstone.



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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BULLETIN 136

PALAEONTOLOGY OF THE PERMIAN OF WESTERN AUSTRALIA

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Plants
(continued)

Glossopteris woolaganus Rigb., Chandra & Surange 1988
(Plate 89 fig. 3)

1951 *Glossopteris;* Clarke et al.: p.62 (*in part*)
1966 *Glossopteris browniana* Brongniart; Rigby: p. 129 (part), pl. 34 fig. 38 (only)
1988 *Glossopteris woolaganus* Rigby et al.: p.77, figs 5D,E.

Description: Leaf small, elliptical; base and apex unknown; midrib pronounced, moderately thick; secondary venation parallel arising from the midrib at an angle of about 45°, marginal angle 70°, degree of arching 20°; density of veins about 4 per mm; anastomoses frequent, 4-6 per vein, meshes long and narrow, slightly broader near the midrib; cuticle and fructifications unknown.

Figured specimen: UN 743.

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Abundance: 2 specimens.

Age: Artinskian.

Glossopteris sp. A
(Plate 89 figs 4, 5)

1951 *Glossopteris;* Clarke et al.: p.62 (*in part*)
1966 *Glossopteris* cf. *communis* Feistmantel; Rigby: p.130 - 131, pl. 33 figs 33, 34

Description: Close secondary venation, arched as in *Glossopteris communis*, spaced 2-4 per mm. These fragments are too small and indistinct for any meaningful description to be given, but as they differ from other, better defined species found in Western Australia, they have been separated.

Figured specimens: UWA 52988 (Rigby, 1966; pl. 33, fig. 34). UWA 53784 (Rigby, 1966; pl. 33, fig. 33).

Distribution and range: **Perth Basin** - Irwin River Coal Measures, Mingenew Formation, Wagina Sandstone.

Abundance: 7 specimens.

Age: Artinskian - Kazanian.

Sedimentary environment: These leaves are always fragmentary, so probably indicate a sedimentologically active environment.

Glossopteris sp. B
(Plate 88 fig. 1)

1976 *Gangamopteris angustifolia* M'Coy; White & Yeates: p.10, pl. 5 fig. 14

Description: Leaf of medium length, narrowly obovate, acute apex, contracting gradually towards the base; midrib pronounced, narrow,

extending almost to the apex; secondary venation of *communis* type, very difficult to see, anastomosing and dichotomizing not visible.

Closest species: It is not possible to compare these leaves with either *Glossopteris angustifolia* or *G. linearis* as the preservation is too poor. As they may be one or the other, or possibly some new species, they are designated separately.

Figured specimen: CPC 26552, White & Yeates (1976), pl. 5 fig. 14.

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kungurian.

Abundance: 4 leaves on one slab.

Glossopteris sp. C

1966 *Glossopteris indica* Schimper; Rigby: p.129 (part), pl. 34, fig. 40

Description: Very small leaves having venation similar to *Glossopteris linearis* but differing in size and shape.

Figured specimen: UWA 37569 (Rigby, 1966, pl. 34 fig. 40).

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Abundance: 2 specimens.

Glossopteris sp. D
(Plate 90 fig. 2)

1907 *Glossopteris browniana* Brongniart; Chapman: p.12, pl. 1 fig. 1

Description: Incomplete leaf possibly of large size having smoothly arched venation which dichotomizes and anastomoses occasionally; midrib ribbed; leaf similar to that of *G. communis* but venation more arched and more open.

Figured specimen: NMV P10308, Chapman (1907), pl. 1 fig. 1.

Distribution and range: **Collie Basin** - Collie Coal Measures (undifferentiated).

Abundance: 1 specimen.

Age: Early Permian.

Glossopteris spp. indet.

Listed below are references and identifications of *Glossopteris* in the literature, which can not now be checked as either none were collected, or they have been mislaid subsequently, or are too fragmentary. It is not implied that all or any of these specimens may belong to the same species.

1893 **Glossopteris* or **Noeggerathia*; Etheridge Jnr.: p.241
1907 **Glossopteris*; Maitland: p.58-59
1907 **Glossopteris*; Etheridge Jnr: p.8
1910 **Glossopteris* spp. ind.; Glauert: p.109
1937 **Glossopteris* sp.; Wade: p.93
1942 *Gangamopteris cyclopteroides* Feistmantel; Teichert: p.332-327, pls 14-15
1951 **Glossopteris* sp.; Clarke et al.: p.61
1952 **Glossopteris* sp. indet.; Lord: p.98
1958 **Glossopteris* sp.; Guppy et al.: p.45
1967 **Glossopteris* leaves; Condon: p.114, 118
1969 **Glossopteris*; Condon: p.130, 149
1976 **Glossopteris*; White & Yeates: p.12

Distribution and range: Permian basins of Western Australia - non-marine Permian strata.

Genus **GANGAMOPTERIS** M'Coy 1861

Type species: *Gangamopteris angustifolia* (M'Coy 1847) M'Coy 1861.

Gangamopteris sp. cf. **G. angustifolia** (M'Coy 1847) M'Coy 1861

1847 *Cyclopteris angustifolia* M'Coy: p.148, pl. 9 figs 3, 3a
1861 *Gangamopteris* M'Coy: p.107
1943 **Gangamopteris angustifolia*; Teichert: p.79
1952 **Gangamopteris angustifolia*; Lord: p.98
1976 *Gangamopteris angustifolia* M'Coy; White & Yeates: p.14, pl. 4 fig. 17A

Diagnosis: Leaf, lanceolate or narrowly-oblong, apex acute, acuminate; contracted towards the base, with a well-marked median groove, midrib absent, secondary venation passing towards the margin at a low angle, anastomosing and dichotomizing occasionally to form long, narrow meshes.

Closest species: *Gangamopteris buriadica* is a broader leaf with a square, truncated apex.

Holotype: SM L18, Foreign Plant Collection, (M'Coy, 1847, pl. 9, figs. 3, 3a).

Distribution and range: **Collie Basin** - Collie Coal Measures; **Canning Basin** - Condren Sandstone.

Age: Kazanian, possibly throughout the Permian.

Abundance: Rare.

Gangamopteris clarkeana Feistmantel 1878

1878 *Gangamopteris clarkeana* **Feistmantel**: p.93, pl. 15 fig. 9
1890 *Gangamopteris clarkeana* **Feistmantel**; **Feistmantel**: p.131, pl. 20 fig. 3.
1966 *Gangamopteris obovata* (Carruthers) **White**; **Rigby**: p.133 (in part), pl. 35 fig. 53 (only)

Diagnosis: "Frond spathulately rounded, of medium size, coriaceous, entire, symmetrical, rounded above but greatly attenuated towards the base, whence the somewhat thick and distant veins radiate, forking and forming an oblong network" (Tenison-Woods, 1883, p.127).

Closest species: *Gangamopteris cyclopteroides* has a much larger leaf with less divergent venation.

Holotype: GSN 2942.

Distribution and range: **Collie Basin** - Collieburn Member of the Collie Coal Measures.

Abundance: Very rare.

Age: Kazanian, and possibly younger.

Value in correlation and dating: Possibly of value to indicate Late Permian, but too rare for distribution to be known adequately.

Gangamopteris cyclopteroides Feistmantel 1876
(Plate 87 fig. 3; Plate 90 fig. 4)

1876 *Gangamopteris cyclopteroides* **Feistmantel**: p.78
1879 *Gangamopteris cyclopteroides* **Feistmantel**; **Feistmantel**: p.12-13, pls 7, 8, 9, figs 1-4, 6; pl. 11 figs 2-4; pl. 12 figs 2-3; pl. 13 figs 1, 5; pl. 26 figs 1, 3; pl. 27
1943 **Gangamopteris cyclopteroides* Teichert: p.79-80
1951 **Gangamopteris cyclopteroides* **Feistmantel**; Clarke et al.: p.61
1951 **Gangamopteris*; Clarke et al.: p.62
1952 **Gangamopteris cyclopteroides*; Lord: p.98
1961 *Gangamopteris cyclopteroides* **Feistmantel**; White: p.298-300, pl. 1 fig. 5
1966 *Gangamopteris obovata* (Carruthers) White; Rigby: p.133-134 (*in part*), pl. 34 fig. 37
1976 *Gangamopteris cyclopteroides* **Feistmantel**: White & Yeates: p.2, 7, 8, 14, pl. 1 fig. 5
1976 **Gangamopteris obovata* (Carruthers); White & Yeates: p.3, 10
1976 *Gangamopteris* sp.; White & Yeates: p.10, pl. 3 fig. 10

Diagnosis: "Leaf oblong-ovate, symmetrical possibly sub-oblique, entire; rachis absent, replaced by veins; veins radiating from the base (*Cyclopteris*-like), anastomosing network over length and breadth in mid part of the blade without narrowing towards the margin (*Glossopteris*-like); base attenuate, ..." (from Feistmantel, 1878, p.12).

Closest species: *Gangamopteris obovata* differs by having straight, almost parallel venation rather similar to the venation of *Cordaites* leaves, but having rare anastomoses.

Holotype: Apparently not designated; Geological Survey of India Museum, Calcutta, specimen figured by Feistmantel (1879, pl. 7 fig. 2).

Distribution and range: **Collie Basin** - Collieburn and Cardiff Members of the Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures; **Carnarvon Basin** - Callytharra Formation; northern **Canning Basin** - Condren Sandstone.

Abundance: May be locally common.

Age: Permian

Value in correlation and dating: In many parts of Gondwana this is an index species for the Early Permian.

Gangamopteris spatulata M'Coy 1875
(Plate 87 fig. 1a)

1875 *Gangamopteris spatulata* M'Coy: p.12, pl. 13 figs 1-1a
1966 *Gangamopteris obovata* (Carruthers) White; Rigby: p.133-134 (*part*), pl. 34, fig. 39

Diagnosis: "Spatulate, symmetrical, equal sided, semi-elliptically pointed above, tapering towards base to a slender petiole. Length, 4 1/2 inches; width, about 1 1/2 to 2 inches" (M'Coy, 1875).

Closest species: *Gangamopteris cyclopteroides* has a similar leaf shape and arched venation, and a small number of thick longitudinal veins along the leaf axis lacking in *G. spatulata*.

Holotype: NMV P12204 (M'Coy, 1875, pl. 13 figs 1, 1a).

Distribution and range: **Collie Basin** - Ewington Member of the Collie Coal Measures; **Perth Basin** - Wagina Sandstone.

Abundance: Rare in all known localities.

Age: Artinskian - Kazanian, possibly older in Victoria.

Gangamopteris spp.

1923 **?Gangamopteris* sp.; Glauert: p.10
1931 **Gangamopteris;* David & Süssmilch: p.509
1951 **Gangamopteris;* sp. Clarke et al.: p.61
1958 cf. **Gangamopteris;* sp. Guppy et al.: p.45
1967 **Gangamopteris;* Condon: p.130

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; **Canning Basin** - Poole Sandstone, Condren Sandstone.

Age: Permian.

Genus **PALAEOVITTARIA** Feistmantel 1876b

Type species: *Palaeovittaria kurzii* Feistmantel, p.368, pl. 19 figs 3-4.

Palaeovittaria kurzii Feistmantel 1876

1976 **Palaeovittaria kurzii*; White & Yeates: p.11

Description: The specimen is unfigured. It is a "poorly preserved leaf which may be referable to *Palaeovittaria kurzii*" (White and Yeates, 1976, p.11) so cannot be described here.

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kungurian.

Genus **VERTEBRARIA** Royle 1834

Type species: *Vertebraria indica* Royle 1834.

Vertebraria indica Royle 1834

1834 *Vertebraria indica* Royle: pl. 2 figs 1-3
1847 *Vertebraria australis* M'Coy: p.147, pl. 9 fig. 1
1907 Rhizoma of *Glossopteris (Vertebraria)* Chapman: p.14-15, pl. 1 fig. 3
1910 *Glossopteris (Vertebraria)* sp.; Glauert: p.109
1937 *Vertebraria* sp.; Wade: p.94
1951 *Vertebraria* sp.; Clarke et al.: p.61
1952 *Glossopteris (Vertebraria)* sp.; Lord: p.98
1952 *Rhizomopteris(?)* sp.; Lord: p.98
1959 *Vertebraria*; Playford: p.25
1961 *Vertebraria indica* Royle; White: p.293
1961 *Vertebraria australis* M'Coy; White: p.293, 298
1966 *Vertebraria indica* (Royle); Rigby: p.134
1976 *Vertebraria indica* Royle; White & Yeates: p.2, 7, 9, 11-14
1982 *Vertebraria australis* M'Coy; Schopf: p.38-42, pls 1-5

Diagnosis: Root, irregularly, partially transversely segmented.

Types: Royle's specimen - BM(NH) V.4189; M'Coy's specimen - SM Llab, Foreign Plant Collection.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; northern **Canning Basin** - Grant Group, Nura Nura Member of the Poole Sandstone, Condren Sandstone.

Age: Permian.

Genus **ERETMONIA** du Toit 1932

Type species: *Eretmonia natalensis* du Toit 1932.

Eretmonia balmei (Rigby 1966) Rigby, Chandra & Surange 1988

1966 *Glossopteris balmei* Rigby: p.131-133, pl. 35, figs 47, 49, 52
1988 *Eretmonia balmei* Rigby: p.77-78

Diagnosis: Long, very narrow linear scales, with a small, narrowly angular, obovate expanded terminal lobe, and a long phyllode-like petiole; scale apex rounded, acute; midrib extending almost to the broadest part of terminal lobe, secondary venation at 2° or slightly greater angle to midrib, continuing straight and parallel to the margin, anastomosis and dichotomy rare.

Cell walls straight, hairs absent, cell dimensions indicating petiole fully expanded; upper epidermis without stomata, but with interveinal furrows in petiole; lower epidermis with interveinal stomata having 5-7 subsidiary cells, guard cells not seen, stomatal apparatus slightly elliptical and orientated parallel to the secondary venation.

Closest species: *Eretmonia karanpurensis, E. natalensis.*

Types: Holotype - UN 745; paratypes - UN 747A, UWA 39021.

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Abundance: +50 scales.

Age: Artinskian.

Value in correlation and dating: Known from one locality only.

Scale leaves
(Plate 91 fig. 3)

1961 *Glossopteris* scale leaves; White: p.294, 298, 300
1966 Scale leaves; Rigby: p.134, pl. 33 figs 27, 28

Discussion: These are usually parts of male sporangiate structures. The specimens from Western Australia probably belong to more than one species.

Figured specimens: UWA 37570, 37590.

Distribution and range: **Perth Basin** - Irwin River Coal Measures; northern **Canning Basin** - Condren Sandstone.

Abundance: Uncommon.

Age: Artinskian.

Class GYMNOSPERMAE
GYMNOSPERMAE *incertae sedis*

Genus **CORDAITES** Unger 1850

Type species: *Cordaites borassifolius* (Sternberg 1821) Unger 1850.

Cordaites spatulata (Dana 1849) Rigby,
Maheshwari & Schopf 1980
(Plate 83 fig. 3b; Plate 89 figs 1b, 2b, Plate 90 figs 3, 5a)

1849 *Noeggerathia spatulata* Dana: p.715, pl. 12 fig. 9
1861 *Noeggerathia? (Cyclopteris?) hislopii* Bunbury: p.334, pl. 10 fig. 5
1879 *Noggerathiopsis (Zam. ?) hislopi* (Bunbury); Feistmantel: p.23, pl. 19 figs 1-6; pl. 20 figs 1, 1a
1912 *Cordaites hislopi* (Bunbury) Seward: p.5, pl. 2 figs 5-7
1937 **Noeggerathiopsis hislopi*; Wade: p.94
1938 **Noeggerathiopsis hislopi*; Walkom: p.1340
1958 **Noeggerathiopsis hislopi* (Bunbury); Guppy et al.: p.45
1961 *Noeggerathiopsis hislopi* (Bunbury); White: p.293, 298, 307
1963 *Noeggerathiopsis hislopi* (Bunbury); White: p.55, fig. 12
1966 *Noeggerathiopsis hislopi* (Bunbury) Feistmantel; Rigby: p.136-137, pl. 31 fig. 9; pl. 33 fig. 36
1976 *Noeggerathiopsis hislopi* (Bunbury); White & Yeates: p.7, 8, 13
1982 *Cordaites spatulata* (Dana); Rigby et al.: p.18-21, figs 48-50

Diagnosis: Leaves simple, usually symmetrical, varying greatly in size and shape, lamina broadening gradually upwards from a narrow and truncate base, becoming widest in the region near the apex, broadly linear, oval-spathulate, spathulate, or obovate; apex broad, acute, obtuse, or broadly rounded; midrib absent; veins numerous, strong and coarse, radiating from the base where there are four equally sized veins; veins dichotomize once or several times, but spreading very gradually, appearing parallel over a short distance, and running straight up to the margin without curving or anastomosing; concentration of veins in the broadest region, 5 to 8 per centimetre (from Rigby et al., 1980, p.19).

Lectotype. USNM 41259.

Figured specimens: UWA 32986, UN 723.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; **Canning Basin** - Grant Group, Poole Sandstone, Condren Sandstone.

Abundance: Common.

Age: Permian.

Value in correlation and dating: Limited value because of long range.

Cordaites sp.

1923 *?*Noeggerathiopsis* sp; Glauert: p.10-11
1931 **Noeggerathiopsis* sp; David & Süssmilch: p.509
1951 **Noeggerathiopsis* sp; Clarke et al.: p.61-62
1952 **Noeggerathia*(?) sp.; Lord: p.98

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone; northern **Canning Basin** - Condren Sandstone.

Age: Artinskian, Kazanian.

Genus **ARTISIA** Sternberg 1838

Type species: *Artisia transversa* (Artis 1825) Sternberg 1838.

Artisia alternans Lignier 1895

1961 **Artisia alternans* Lignier?; White: p.294, 300

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

Genus **CORDAIANTHUS** Grand'Eury 1877

Type species: *Cordaianthus gemmifer* Grand'Eury 1877.

?Cordaianthus sp.

1963 *?Cordaianthus* sp.; White: p.55, fig. 14

Discussion: This doubtful record is the only mention of this genus from the Permian of Gondwana, so is disregarded until better evidence of its presence is available.

Distribution and range: **Canning Basin** - Grant Group.

Age: Early Permian.

Genus **BOTRYCHIOPSIS** Kurtz 1895

Type species: *Botrychiopsis weissiana* Kurtz 1895.

Botrychiopsis valida (Feistmantel 1876) Archangeslsky & Arrondo 1971

1876 *Neuropteridium validum* Feistmantel: p.75
1879 *Neuropteris valida* Feistm.; Feistmantel: p.10-11, pls 2-6
1927 *Gondwanidium (Neuropteridium) validum* Gothan: p.342
1964 *Gondwanidium validum* (Feistmantel); Balme: p.82
1971 *Botrychiopsis valida* (Feistmantel); Archangelsky & Arrondo: p.213-214

Diagnosis: Bipinnate frond, subcircular basal pinnae, non imbricate; all pinnules confluent, pinnae subrhombic with sinuous margins.

Closest species: *Botrychiopsis weissiana* has ovate-spathulate pinnules that are separated in the mid-part of the frond; *B. plantiana* has pinnules with rounded margins.

Holotype: GSI 4994 (Feistmantel, 1879, pl. 6 fig. 5).

Distribution and range: **Perth Basin** - Wagina Sandstone.

Abundance: 4 specimens.

Age: Kazanian.

Value in correlation and dating: This is an index species for the Early Permian of India.

Genus **SENIA** Khan 1969

Type species: *Senia reticulata* Khan 1969.

Senia? sp.
(Plate 91 fig. 4)

1966 *?Pseudoctenis* sp. Rigby: p.138, pl. 33 fig. 29

Figured specimen: UWA 23679.

Distribution and range: **Perth Basin** - Irwin River Coal Measures, Wagina Sandstone.

Abundance: Two specimens, not necessarily conspecific.

Age: Artinskian, Kazanian.

Genus **GONDWANOPHYTON** Maithy 1974

Type species: *Gondwanophyton indicum* Maithy 1974.

Gondwanophyton daymondii Rigby sp. nov.
(Plate 91 fig. 5)

Diagnosis: Leaf elliptical, of unknown affinities, apparently peltate but having very pronounced auriculate base, attachment typically ^-notched, stem-clasping. Venation in upper part of the leaf, radial, dichotomizing forking generally three times; venation in lower part of leaf arising from a vein along the inner margin, the vein is no thicker than other veins. Veins thin slightly towards the margin.

Holotype: WAM P86.58.

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Abundance: Two leaves of the holotype.

Value in correlation and dating: The only other species occurs in the Early Permian Barakar Coal Measures of India. The genus may be restricted to the Early Permian. Specimens are easily identifiable, hence the species may prove to be of biostratigraphic value.

Genus **LIKNOPETALON** Smithies *ex* Anderson & Anderson 1985

Type species: *Liknopetalon enigmata* Smithies *ex* Anderson & Anderson 1985.

Liknopetalon enigmata Smithies *ex* Anderson & Anderson 1985
(Plate 91, fig. 1)

1985 *Liknopetalon enigmata* Smithies, *in* Anderson and Anderson: p.105, pl. 52, figs 1-7.

Diagnosis: Fertile foliage shoot-axis of shoot relatively board (2-3 mm diam.), foliage arrangement and attachment uncertain; fertile leaves non-petiolate, small (15 x 18 mm), gracile, fan-shaped, occasionally cleft, slides concave, distal margin convex; veins spreading from base, fork repeatedly; sporangia small (1 x 0.5 mm), narrowly obovate, sessile along veins, in a single row along distal margin of lamina (Anderson & Anderson, 1985, p.105).

Holotype: BPIP BP/2/7414.

Distribution and range: **Perth Basin** - Irwin River Coal Measures. Middle Ecca Series of South Africa.

Age: Artinskian in Western Australia, Early Permian of South Africa.

Abundance: Rare.

Value in correlation and dating: May be significant in the older part of the Lower Gondwana sequence.

Discussion: Anderson and Anderson (1985, p.105) suggest this species may belong to a fern-like plant. I have placed it next to *Gondwanophyton* because there is a similarity between the leaf morphology of both, but do not imply any relationship. Both occur at the same horizon in Western Australia, although *Gondwanophyton* is unrecorded in South Africa.

Class PENTOXYLALES
Family PENTOXYLACEAE

Genus **TAENIOPTERIS** Brongniart 1828

Type species: *Taeniopteris vittata* Brongniart 1828.

cf. **Taeniopteris spatulata** McClelland 1850

1958 cf. *Taeniopteris spatulata* McClelland; Guppy et al.: p.46

Discussion: Rigby (1966, p.147) considered this to be a misidentification. It is probably a *Glossopteris* of a type similar to *G. waginae*.

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Class CYCADACEAE

Cycad pith casts

1961 *Cycad pith casts; White: p.294

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

Class CONIFERACEAE

Genus **BRACHYPHYLLUM** Brongniart 1828

Type species: *Brachypyllum mammilare* Brongniart 1828.

?**Brachyphyllum** sp.

1958 **?Brachyphyllum* sp.; Guppy et al.: p.45

Discussion: This is a Mesozoic genus.

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Genus **CORDAICLADUS** Grand'Eury 1877

Type species: *Cordaicladus subschnorrianus* Grand'Eury 1877.

Cordaicladus sp.

1966 *Cordaicladus* sp.; Rigby: p.137, pl. 30 figs 4, 6, 7

Figured specimen: UWA 39021.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Irwin River Coal Measures.

Abundance: +8 specimens.

Age: Sakmarian - Artinskian.

Genus **GINKGOPHYLLUM** Saporta 1875

Type species: *Ginkgophyllum grasseti* Saporta 1875.

Ginkgophyllum diazii Archangelsky & Arrondo 1975
(Plate 91, fig. 6)

1966 lycopod leaves, probably of *Cyclodendron leslii*, *in* Rigby: p.116 (*in part*), pl. 30 figs 1, 3
1975 *Ginkgophyllum diazii* Archangelsky & Arrondo: p.358-360, figs 2-8
1980 *Ginkgophyllum diazii* Archangelsky & Arrondo 1975; Archangelsky & Leguizamon: p.212 - 216, pls 1 - 3

Diagnosis: Forking ginkgophyte leaves having one or two very acute dichotomies, apex pointed, acicular, leaves appear to be thick and rigid; stem having circular leaf cushions, apparently spirally arranged giving the appearance of a *Ginkgo* short shoot.

Holotype: LPMA PB 8616.

Distribution and range: Collie Basin - Ewington Member of the Collie Coal Measures. Uppermost Carboniferous strata of the Paganzo Basin, Argentina (Archangelsky & Arrondo, 1975; Archangelsky & Leguizamon, 1980).

Age: Artinskian in Western Australia, latest Carboniferous in Argentina.

Abundance: Rare.

Value in correlation and dating: Significant in the older part of the Lower Gondwana sequence.

?Gymnosperm stems

1907 A stem-like fragment of doubtful affinity; Chapman: p.15, pl. 2 fig. 5
1966 ?Gymnosperm stems; Rigby: p.138, 139, pl. 35 fig. 55

Figured specimen: UN 718.

Distribution and range: Collie Basin - Collie Coal Measures.

Abundance: 1 specimen only.

Age: Sakmarian - Artinskian.

Genus **ARAUCARITES** Presl 1838

Type species: *Araucarites goeppertii* Presl, in Sternberg 1838.

Araucarites cutchensis Feistmantel 1876

1876 *Araucarites cutchensis* Feistmantel: p.62, 80; pl. 7 fig. 7; pl. 8 figs. 2-6; pl. 9 figs 1-3; pl. 12 fig. 10
1961 *Araucarites cutchensis* Feistmantel; White: p.300, pl. 2 fig. 4

Discussion: This is not a Palaeozoic species, and as White's (1961) identification appears to be correct, the source rock was probably not the Condren Sandstone.

Conifer cone

1966 ?Conifer cone; Rigby: p.138, pl. 33 fig. 26

Figured specimen: UWA 53329, 53330 (part and counterpart).

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

Value in correlation and dating: Will be of value if additional specimens are found.

Silicified wood

1937 *Dadoxylon* type; Wade: p.94, 95
1967 Silicified wood *?Araucaria;* Condon: p.130

Distribution and range: Northern **Canning Basin** - Grant Group, Poole Sandstone.

Wood

1967 Wood; Condon: p.114, 188, 152

Distribution and range: **Carnarvon Basin** - "One Gum Formation", Keogh Formation, Mallens Sandstone.

GYMNOSPERMOUS SEEDS

Genus **CARDIOCARPUS** Brongniart 1881

Type species: *Cardiocarpus drupaceus* Brongniart 1881.

Cardiocarpus sp.

1937 **Cardiocarpus* sp.; Wade: p.94
1938 **?Cardiocarpus* sp.; Walkom: p.1340

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Genus **CARPOLITHES** Sternberg 1820

Type species: None designated.

Carpolithes sp.

1961 *Carpolithus* sp.; White: p.293, 298

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazanian.

Genus **CORDAICARPON** Geinitz 1862

Type species: *Cordaicarpon cordai* Geinitz 1862.

Cordaicarpon emarginatum Walkom 1935

1935 *Cordaicarpus emarginatus* Walkom: p.462, pl. 19 fig. 11
1958 **Cordaicarpus emaginata* Walkom; Guppy et al.: p.45

Diagnosis: "Seeds ovate, platyspermic, measuring 6-8 mm by 4-5 mm, with slight emargination at apex" (Walkom, 1935, p.462).

Holotype: SUGD 2039.

Distribution and range: Northern **Canning Basin** - Poole Sandstone.

Age: Artinskian.

Genus **SAMAROPSIS** Goeppert 1864

Type species: *Samaropsis ulmiformis* Goeppert 1864.

Samaropsis milleri (Feistmantel 1879) Seward 1917

1937 **Samaropsis milleri* Wade: p.94
1952 **Samaropsis milleri* (Feistmantel); Edwards: p.162, pl. 1 fig. 5
1958 **Samaropsis milleri* Guppy et al.: p.46
1961 *Samaropsis milleri* Feistmantel; White: p.294, 299
1966 *Samaropsis milleri* (Feistmantel); Rigby: p.147-148

Diagnosis: Sarcotesta broad, narrower at the sides and broadening out at the base and apex; sclerotesta 27 mm by 21 mm, base slightly cordate, apex acute, a single axial longitudinal groove.

Paratype: GSI 5464.

Distribution and range: Northern **Canning Basin** - Poole Sandstone, Condren Sandstone.

Age: Artinskian - Kungurian.

Samaropsis sp. cf. **S. milleri** (Feistmantel 1879) Seward 1917
(Plate 90 fig. 1)

1938 **Samaropsis* cf. *milleri* Feistmantel; Walkom: p.1340
1952 *Samaropsis milleri* (Feistmantel); Edwards: p.162, pl. 1 fig. 5

Description: Large n.at-shaped seed, 27 mm by 21 mm, with wing 4 mm wide at base, narrowing to 2 mm at 20 mm below apex; discontinuous shallow axial groove towards apex and towards hilum.

Figured specimen: BM(NH) V.25721.

Distribution and range: Northern **Canning Basin** - Nura Nura Member of the Poole Sandstone.

Age: Sakmarian.

Abundance: 1 specimen.

Samaropsis moravica (Helmhacher) Zeiller 1892

1961 **Samaropsis moravica* (Helmhacher); White: p.294, 29?

Distribution and range: Northern **Canning Basin** - Condren Sandstone.

Age: Kazarian.

Samaropsis sp.

1961 *Samaropsis* sp.; White: p.293, 294, 298
1963 *Samaropsis* sp.; White: p.55 fig. 12
1964 *Samaropsis;* Balme: p.82
1966 *Samaropsis* sp.; Rigby: p.138-139, pl. 33 fig. 24
1966 "winged seed"; Rigby: p.139

These specimens may not be conspecific.

Figured specimen: UN 721.

Distribution and range: **Collie Basin** - Collie Coal Measures; **Perth Basin** - Wagina Sandstone; northern **Canning Basin** - Grant Group, Condren Sandstone.

Age: Sakmarian - Kungurian.

Seed

1966 seed; Rigby: p.139, pl. 33 fig. 25

Figured specimen: UWA 39022.

Distribution and range: **Perth Basin** - Irwin River Coal Measures.

Age: Artinskian.

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Fish

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Class CHONDRICHTHYES
Subclass ?ELASMOBRANCHII

Order ?EUGENEODONTIDA (Zangerl 1981)

Family HELICOPRIONIDAE Karpinsky 1911

Genus **Helicoprion** Karpinsky 1899

Helicoprion davisi (H. Woodward 1886)
(Plate 92 Figs 1-5)

1886 *Edestus davisii* Woodward (H.): p.7, pl. 1
1891 *Edestus davisi* Woodward (A.S.): p.153
1899a *Edestus (Helicoprion) davisii* H. Woodward; Karpinsky: p.191, 236-237, fig. 79
1899b *Helicoprion davisii* (H. Woodward); Karpinsky: p.440-443
1900 *Helicoprion (Edestus) davisi* (H. Woodward); A.S. Woodward: p.34
1902 *Campyloprion (Edestus) davisii* (H. Woodward); Eastman: p.148, 152
1910 *Toxoprion davisii* (H. Woodward); Hay: p.56-57
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1922 *Helicoprion (Edestus) davisii* (H. Woodward); Karpinsky: p.313
1928 *Edestus davisii* (H. Woodward); David: p.1845, 1847
1928 *Helicoprion* Schuchert: p.864
1930 *Edestus davisii* (H. Woodward); Karpinsky: p.341
1931 *Helicoprior or Toxoprion* David & Süssmilch: p.511-513
1939 *Helicoprion (Edestus) davisi* (H. Woodward); Wheeler: p.104
1937 *Helicoprion(?)* Raggatt & Fletcher: p.181
1940 *Helicoprion davisi* (H. Woodward); Teichert: p.145-147 pl. 22 figs 1-4; pl. 23 figs 1-4
1958 *Helicoprion davisi* (H. Woodward); Hills: p.92-93
1964 *Helicoprion* Obruchev: p.254.
1966 *Helicoprion davisii* Bendix-Almgreen: p.34-35, 43
1967 *Helicoprion* Condon: p.142, 173
1981 *Helicoprion* Karpinsky; Archbold: p.23
1982 *Helicoprion* Long: p.68
1984 *Helicoprion davisi* Long & Turner: p.238

Diagnosis: Large triangular teeth with forward-directed (labiad) elongate bases which are arranged in a symphysially place tooth whorl to form a spiral. The first formed (juvenile) teeth are located in the centre of the spiral which is formed of four or more volutions. There are at least 120 denticles. The older, non-functional portions of the spiral were housed in a groove in the symphysial fused Meckel's cartilages.

Closest species: Teichert (1940) concluded that *Helicoprion davisi* was closest to the genotype, *Helicoprion bessonowi* Karpinsky 1899a, also is very similar to *H. ferrieri* (Hay). More study is required to show whether all three species are synonymous. Other very similar, if not identical, specimens include those from Japan (Arakio, 1980),

Texas (Chorn, 1978) and Canada (e.g. Logan & McGugan, 1968; Nassichuk, 1971).

Types: Holotype, WAM 9080; other specimens, WAM G8523, UWA 19921a,b.

Type locality: Clay-ironstone nodule not *in situ*, "Arthur River" valley, now Cream Creek and affluent of the Gascoyne River from the north, above the confluence of the Lyons and Gascoyne Rivers, Carnarvon Basin.

Distribution and range: Gascoyne and Minilya River districts, **Carnarvon Basin** - Bulgadoo Shale, Wandagee Formation, Nalbia Sandstone.

Age: Artinskian (Baigendzhinian) - Kungarian.

Abundance: 6 specimens reported.

Value in correlation and dating: The presence of *Helicoprion* will verify a Permian age for rocks. *Helicoprion* has a world-wide distribution in the Permian -- recorded from Western Australia, the USSR, Japan, Laos, Mexico, western USA, Canada, Spitsbergen, Greenland, and Iran?.

Sub class HOLOCEPHALI

Order CHIMAERIDA (*sensu* Moy-Thomas & Miles 1971)

Family COCHLIODONTIDAE Owen 1867

Genus **CRASSIDONTA** Branson 1916

Crassidonta is a Permian holocephalian. Obruchev (1967) and Romer (1966) refer the genus to the Suborder Cochliodontei, Family Cochliodontidae Owen 1867, whereas Teichert (1943) found them most similar to *Psammodus* of the Suborder Psammodontidei.

Crassidonta? subcrenulata Teichert 1943
(Plate 93 figs 1-7, 9-10)

1943 *Crassidonta subcrenulata* Teichert: p.546-551, pl. 1 figs 1-14; pl. 2 figs 17-18; pl. 3 figs 19-20
1958 *Crassidonta subcrenulata* Teichert; Hills: p.93
1958 *Crassidonta* Berg: p.78
1964 *Crassidonta* Obruchev: p.246
1966 *Crassidonta* Romer: p.351
1967 *Crassidonta* Obruchev: p.365
1981 *Crassidonta* Archbold: p.23
1984 *Crassidonta subcrenulata* Long & Turner: p.237

Diagnosis: Teeth with elongate, obliquely rectangular crowns which are composed of tubular dentine. Strongly rounded central symmetrical ridge, almost semicircular in cross-section in large teeth, somewhat flattened in smaller teeth; steep sides to the ridge sloping steeply towards both ends of the teeth. The central ridge flanked on both sides by flattened extensions which thin towards the

edges. Lower side of the crown is concave, less so than the upper surface. The lower surface is crenulated transversely, with wrinkles 2.5 to 3.5 mm apart. Medullary vascular canals of dentine closely spaced, about 0.5 mm apart, fairly straight and freely anastomosing; numerous fine dentine canals with short ramifying branches penetrate the dentinous tissue at right angles to the main vascular canals. Sets of dentine tubules from each vascular canal do not impinge and leave a narrow area of clear tissue between each denteon.

Closest species: There is only one other known species, *Crassidonta stuckenbergi* Branson 1916, from the Phosphoria Formation of Wyoming, USA, and the Lower Permian Arta Beds of Samarskaya Luka (Samara Bend), Urals, USSR, (Obruchev, 1964, 1967). Teichert regarded the Russian specimens as closest to the American ones, but he did point out deficiencies in Branson's original diagnosis. The status of the genus and the Australian species must await restudy of the type and other material. Teeth of *Crassidonta* appear to be very similar to those of the genus *Deltodus*.

Holotype: UWA 21401a-i.

Type locality: 645 m N 150° E from the isolated white gum in northern half of Nalbia Paddock, Wandagee Station (3036 m N 63° E from Trig. Station on Wandagee Hill), Gascoyne and Minilya Rivers region.

Distribution and range: Type locality only, **Carnarvon Basin** - Wandagee Formation (upper part of *Calceolispongia* zone of Teichert).

Age: Late Artinskian (Baigendzhinian).

Abundance: Type material only, 9 teeth plus thin sections.

Value in correlation and dating: The known specimens of the genus *Crassidonta* all come from the Lower Permian. Teichert assessed Stuckenberg's specimens from the Samara Bend of the Volga to be of Late Carboniferous age. However, the Russian specimens, which are figured by Obruchev (1967, p.365, fig. 7), are now regarded as Early Permian in age.

Family HELODONTIDAE Patterson 1965

Genus **HELODUS** Agassiz 1838

Helodus? sp. Teichert 1943
(Plate 93 fig. 8)

1943 *Helodus* sp. ind. Teichert: p.546, pl. 1 figs 15-16
1958 *Helodus* sp. Hills: p.93
1966 *Helodus* Romer: p.351
1967 *Helodus* Obruchev: p.363
1981 *Helodus* Archbold: p.23
1982 *Helodus* Long: p.68

Diagnosis: Medium-sized tooth at least three times as long as wide (labio-lingual distance); strongly convex crown flattened towards the perimeters. Tubular dentine crown, narrow constricted neck;

sinusoidal twist to the crown in dorsal view; base as deep as the crown, and concave below.

Holotype: UWA 21400.

Type locality: 274 m east of mouth of southeastern gully of Wandagee Hill, Carnarvon Basin.

Distribution and range: Type locality only, **Carnarvon Basin** - Wandagee Formation (uppermost zone of *Pseudogastrioceras goochi* of the *Linoproductus* zone of Teichert).

Age: Late Artinskian (Baigendzhinian).

Abundance: 1 specimen.

Value in correlation and dating: The range of genus is from Late Devonian to Permian. It is found in the Lower Permian of USA, Urals, and Australia. Hitherto, no attempt has been made to use helodont teeth in correlation.

Family HELODONTIDAE?

Genus **POECILODUS** M'Coy 1855

"Poecilodus jonesi" M'Coy 1855

1884 *Poecilodus jonesi* M'Coy; Hardman: p.10
1940 *"Poecilodus jonesi"* Teichert: p.543
1958 *"Poecilodus jonesi"* Hills: p.93
1982 *?Poecilodus* Long: p.68
1984 *Poecilodus jonesi* Long & Turner: p.237

Type: No specimen; record presumed to be based on a tooth.

Locality: Plains near Mount Percy, northern Canning Basin. Hardman's collection was dispersed, some of it going to the British Museum (Natural History). The specimen referred to as *P. jonesi* is presumed lost. However, Teichert (1940) pointed out that the Mount Percy area contains mainly Devonian - Carboniferous rocks. As many bradyodont teeth are rather similar, it is possible, therefore, that this record is based on a Devonian form. Turner is currently studying a suite of Lower Carboniferous bradyodont teeth from the Mount Percy district.

Elasmobranchii undet.

1967 a shark's tooth Condon: p.85

Locality and horizon: Locality M40, 24.5 km north north-east of Middalya Homestead, **Carnarvon Basin** - basal Moogooloo Sandstone. The specimen may have been derived from the Callytharra Formation.

Age: Late Artinskian (Baigendzhinian); ?Sakmarian.

1975 shark teeth Yeates et al.: p.24

Locality and horizon: Coquinas near Balgo Mission, Stansmore Range, northern **Canning Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

These two records remain to be verified and the specimens (held in the BMR collections) are yet to be studied.

Class OSTEICHTHYES
Sub class ACTINOPTERYGII

Order PALAEONISCOIDEA
= Palaeonisciformes *(sensu* Gardiner, 1967)

Family CRYPHIOLEPIDIDAE Moy-Thomas and Miles, 1971

Cryphiolepidid? gen. et sp. indet. (Archbold 1981)
(Plate 94 figs 1-9)

1981 Pisces *Incertae sedis* Archbold: p.25, fig. 1A-I
1984 Acrolepid indet? Long & Turner: p.242

Diagnosis: Small asymmetrical elliptical cycloid scales, length range 10 - 17 mm, thickness up to 0.5 mm. Posterior external portion of the scale formed of a series of narrow anastomosing dentine ridges, aligned anteroposteriorly, which cover approximately one-quarter scales length; overlap area of dorsal surface composed of numerous subconcentric growth lines with a superimposed ornament of fine striae; inner surface of scale smooth.

Closest species: Archbold (1981) found only one fish which he thought bore similar scales to those described above, namely *Acrolepis molyneuxi* Woodward from the Sengwe Coalfield of Rhodesia (now Zimbabwe), whose scales appear to be similar in general form of the digitate hind margin and in apparent cycloid shape. However, other fish groups, notably the Actinistia, have similar cycloid scales. It is possible that the Western Australian scales might belong to a coelacanth such as that found at Blackwater in Queensland (Duy Phuoc, 1981; Leu, pers. comm., 1984). Nevertheless, I provisionally refer the Western Australian scales to *Cryphiolepis*, a genus of palaeoniscoid fishes, which bears very similar cycloid scales that were originally referred to a coelacanth. Scales similar to those of *C. striata* Traquair from the Early Carboniferous of Scotland (Woodward 1891) have been found in the Carboniferous of Queensland (Geological Survey of Queensland specimens, personal observation). Woodward (1891) regarded Early Permian Bohemian *Sphaerolepis kounoviensis* as closely related to *Cryphiolepis* (see Gardiner, 1967).

Figured specimens: GSWA 445553, F11006-F11012.

Type locality: Lat. 25°49'28"S, Long. 115°38'33"E, about 300 m south of Wooramel River, north-east of Darcy Hill, Carnarvon Basin.

Distribution and range: Type locality only - near top of Coyrie Formation.

Age: Late Artinskian (Baigendzinian).

Abundance: Over 100 scales in one block of possible coprolitic origin.

Value in correlation and dating: Potentially valuable for core dating because of small size.

Actinopterygian? undet.

1975a fish teeth and bones Yeates et al.: p.24

Locality and horizon: Coquinas near Balgo Mission, **Carnarvon Basin** - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Remarks: These remains may prove useful in correlation with east Australian sites when more is known about them.

Annelids

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Class POLYCHAETIA Grube 1850
Order SEDENTARIDA Lamarck 1818

Family SERPULIDAE Burmeister 1837

Genus **SERPULITES** Blumenbach 1803

Type species: *Serpulites coacervatus* Blumenbach 1803.

Serpulites indicus Waagen

1952 *Serpulites indicus* Waagen; Teichert: p.125

Remarks: The specimen was found in the Late Artinskian (Baigendzhinian) Bulgadoo Shale in the Barrabiddy Dam area, Carnarvon Basin. The repository of the specimen is not known.

Serpulites spp.

1958 *Serpulites* Guppy et al.: p.48

The report by Guppy et al. (1958) is of an unknown number of specimens in the Noonkanbah Formation and the base of the Liveringa Group, northern Canning Basin, of Late Artinskian (Baigendzhinian) to Chhidruan in age.

1967 *Serpulites* sp. Condon: p.186

Condon's specimens were found in the Chhidruan Mungadan Sandstone on Wandagee Hill, Wandagee Station, Carnarvon Basin.

1976 Serpulids Playford et al.: p.94

These specimens are from the Early Sakmarian (Tastubian) Woolaga Limestone Member of the Holmwood Shale, in the Irwin River area, Perth Basin.

Genus **SPIRORBIS** Daudin 1800

Type species: *Serpula spirorbis* Linne 1758.

Spirorbis ambiguus Fleming 1825

1825 *Spirorbis ambiguus* Fleming: p.246, pl. 9 fig. 3
1903 *Spirorbis ambiguus* Fleming; Etheridge Jnr: p.10, pl. 3 fig. 2

Distribution and range: Fossil Hill near Wyndham River, **Carnarvon Basin** - Callytharra Formation.

Age: Late Sakmarian (Sterlitamakian).

Abundance: 1 specimen.

Family AMPHICTENIDAE Malmgren 1867

Genus **AMPHICTENE** Saviguy 1820

Type species: *Amphitrite auricoma* Muller 1788.

Amphictene permiana Parr 1942
(Plate 95 fig. 7)

1942 *Amphictene permiana* Parr: p.109-110, pl. 2 fig. 5

Diagnosis: Tube thin, circular in section, tapering slightly, formed of fragments of siliceous sponge spicules arranged concentrically in a single layer.

Closest species: *?Amphictene auricoma* (Muller), a present day form.

Holotype: UWA 20672.

Type locality: South side of Minilya River near Coolkilya Pool, Wandagee Station, Carnarvon Basin.

Distribution and range: Type locality only - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: A single specimen.

INCERTAE SEDIS

Genus **CONCHOTREMA** Teichert 1945

Type species: *Conchotrema tubulosa* Teichert 1945.

Häntzschel (1975) discusses *Conchotrema* under Trace Fossils and notes that it is probably a worm boring.

Conchotrema tenuis Teichert 1945
(Plate 95 fig. 11)

1945 *Conchotrema tenuis* Teichert: p.206-207, pl. 2 fig. 3

Diagnosis: Tubes enter brachiopod dorsal valve from outside, entrances 0.2 - 0.3 mm apart; tubes less than 0.1 mm thick, branching freely, seldom straight but mostly curved or sinuous; tubular network very fine.

Closest species: *Conchotrema tubulosa* Teichert, which has a coarser network and thicker tubes.

Holotype: UWA 21321.

Type locality: Syncline west of Coolkilya Pool on Minilya River, Carnarvon Basin.

Distribution and range: Type locality only - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Two infected shells known.

Conchotrema tubulosa Teichert 1945
(Plate 95 figs 8-10, 12)

1945 *Conchotrema tubulosa* Teichert: p.193-195, pl. 1 figs 1, 2; pl. 2 figs 1, 2

Closest species: *Conchotrema tenuis* Teichert, which has much finer and closer network of tubes.

Types: Holotype - UWA 21319; other figured specimens - UWA 8483, 21270, 21441.

Type locality: 3.2 km east of Christmas Creek Homestead, northern Canning Basin.

Distribution and range: Coolkilya Pool area, Station R20 area on Wooramel River, **Carnarvon Basin** - Byro Group, Wandagee Formation; type locality - Noonkanbah Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Several infected shells known.

Genus **PARAMELONELLA** Howell 1956

Type species: *Paramelonella etheridgei* Howell 1956.

Paramelonella etheridgei Howell 1956
(Plate 95 figs 1-6)

?1918 *Anthracosycon* sp. Etheridge Jnr: p.251, fig. 1
?1926 *Anthracosycon* sp. Glauert: p.45
1956 *Paramelonella etheridgei* Howell: p.30-31, pl. 2 figs 1, 2
1956 *Paramelonella lata* Howell: p.31-32, pl. 2 figs 3, 4
?1956 *Stylopegma singularis* Howell: p.32-33, pl. 2 figs 8-10
?1956 *Stylopegma incerta* Howell: p.33, pl. 2 figs 5-7
?1956 *Laubenfelsia australiensis* Howell: p.33-34, pl. 3 figs 1, 2
1983 *Paramelonella etheridgei* Howell; Pickett: p.110

Discussion: Pickett (1983, p.110-111) during a recent review of the Australian fossil sponges concluded that Howell's material and all of his, then new, sponge genera and species (apart from the inorganic *Paramorphospongia*) are traces made by burrowing worms. It is not clear whether Pickett regarded all Howell's species as belonging to the same worm species.

Types: Holotype - UWA 36395; paratype - PU 76205; other figured specimens - UWA 36396, 36399, 36400.

Type locality: East limb of syncline, north of Minilya River, west of Coolkilya Pool, Carnarvon Basin.

Distribution and range: Syncline west of Coolkilya Pool, north and south banks of Minilya River, and east of Bogadi Outcamp on Wooramel River, **Carnarvon Basin** - Byro Group, Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Gen. et sp. indet.

1945 Gen. et sp. indet. Teichert: p.207, pl. 3 fig. 1

Diagnosis: Tubes few and relatively large (0.8 - 1.1 mm), almost straight, capable of sudden change of direction.

Illustrated specimen: UWA 21130.

Distribution and range: West of Coolkilya Pool on Minilya River, **Carnarvon Basin** - Wandagee Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: One affected specimen known.

"Vermes"

1967 *Vermes* Condon: p.131

The specimen is from the Late Artinskian (Baigendzhinian) Coyrie Formation in the Carnarvon Basin.

Trace fossils and problematica

TRACE FOSSIL AND PROBLEMATICA GENERA AND SPECIES

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TRACES OF INFAUNAL FARMING (Agrichnia)

Genus **PALEODICTYON** Meneghini *in* Murchison 1850

Type species: *Paleodictyon strozzii* Meneghini *in* Murchison 1850; M.

Paleodictyon? sp.
(Plate 96 figs 1a, 3, 5a)

Description: Meshes pentagonal or hexagonal, not numerous, somewhat irregular, up to 20 mm across but averaging 15 - 17 mm in diameter, with tube fillings up to more than 4 mm thick.

Figured specimens: GSWA F46903a, F46902, F46904a.

Distribution and range: Nearest hill due west of Twin (triple) Bore, Middalya Station, and Wandagee Hill on Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone, Mundagan Sandstone.

Age: Kungurian.

Abundance: 5 specimens.

Value in correlation and dating: Low, not many found, but locally promising because of lateral distribution.

Sedimentary environment: *Paleodictyon* is generally indicative of bathyal environment.

Discussion: Net-shaped trace fossils of this general type and size are a typical element of flysch ichnocoenoses. Like other graphoglyptids, they originally formed an open tunnel system that systematically covered a given area within the sediment, but equally systematically left enclosed spaces untouched. It has consequently been hypothesized that their inhabitants were not deposit feeders in the true sense, but farmed bacteria or other micro-organisms that could drain nutrients from the surrounding sediment.

There is some doubt, however, that the figured meshworks represent *Paleodictyon* s. str. Firstly, they appear to have originated from dendroid patterns rather than being "knitted" along a spiral path, and secondly, they do not appear to be exhumed and cast by a turbidity current as is always the case in typical forms. Care should therefore be exercised in drawing palaeobathymetric conclusions.

Subgenus **SQUAMODICTYON** Vyalov & Golev 1960

Type species: *Squamodictyon squamosum* Vyalov & Golev 1960.

Paleodictyon? (Squamodictyon?) sp.
(Plate 96 figs 1b, 2, 5b)

Description: Meshes pentagonal, irregular, large, up to at least 50 mm across, with tube fillings up to 8 mm thick, curved.

Figured specimens: GSWA F46903b, F46905, F46904b.

Distribution and range: Nearest hill due west of and north-facing scarp south of track west of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Coolkilya Sandstone, Mungadan Sandstone.

Age: Kungurian.

Abundance: 2 specimens.

Value in correlation and dating: None apparent at present.

Sedimentary environment: *Paleodictyon* is generally indicative of bathyal environment.

BURROWS OF INFAUNAL BULLDOZERS

Genus **SCOLICIA** de Quatrefages 1849

Discussion: *Scolicia* are produced by an animal which bulldozed through the sediment in the mode of modern heart urchins, continuously backfilling the burrow behind the body. The direction of movement is indicated by the angularity of the backfill lamellae (backward convergence) and by the asymmetry of meander lobes (backwardly lopsided, Pl. 97 fig. 3). The trace profile changes depending on the level at which the animal bulldozed relative to the sand - mud interface (Plate 102 fig. 1). This is because in an interface situation sand tends to be deposited in the lower parts of the backfill lamellae relative to the more muddy material (geopetal effect). As the two sandy backfill bodies get smaller, a median ridge becomes visible between them at the mucus-lined floor (Pl. 97 fig. 3). In very shallow impressions of the present material (Pl. 97 fig. 1) this ridge is zigzagged, possibly due to an alternation between the two sides of the body in the backfilling activity.

Regular meandering, as seen in these specimens, is generally a deep water phenomenon (*Nereites* facies). *Scolicia* meanders in Silurian to Permian shallow-marine sandstones, however, are a notable exception to this rule. Since the animal in Plate 97 figure 3 meandered along a trough between oscillation ripples, the present occurrence appears to fall into this category.

Scolicia sp. 1
(Plate 96 fig. 8)

Description: Trail at least 50 cm long, and 20 - 25 mm wide of irregular direction; median groove clearly defined; outer longitudinal zones missing; herringbone-shaped ridges prominent, at high angle to median furrow, forming open V-shaped or almost continuously gently flexed arch across the furrow.

Figured specimen: GSWA F46919.

Distribution and range: Gascoyne River, about 1 km downstream from Gascoyne Junction, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Common at locality of occurrence.

Value in correlation and dating: Not observed outside the type locality.

Sedimentary environment: Occurs in sedimentary rocks that were laid down in bathyal environment.

Scolicia sp. 1?
(Plate 97 fig. 2)

Description: Trail at least 110 mm long, about 20 mm wide; with flat, rather than rounded, upper surface; prominent longitudinal median groove along middle, and with both flanks with chevron-shaped grooves, two or three millimetres apart, inclined at about 60 degrees to the length of trail.

Figured specimen: GSWA F45918.

Distribution and range: Shore Range, nearest hill west of road south of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Abundance: Single specimen.

Value in correlation and dating: None at present.

Scolicia sp. 2
(Plate 96 fig. 9; Plate 100 fig. 3)

Description: Burrow about 15 mm wide and 6 mm deep, closely and fairly evenly flexed, with "dorsal" surface evenly convex and smooth (except for on one surface two fine parallel lateral longitudinal grooves) and "ventral" surface with pronounced central longitudinal groove and numerous fine longitudinal striations.

Figured specimens: GSWA F46931a,b.

Distribution and range: Mesa east of road, about 4 km north of Swordfish Bore, Crossland 1:250 000 sheet area, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: 2 specimens.

Value in correlation and dating: Known from only one locality.

Scolicia sp. 3
(Plate 97 fig. 1)

Description: Trace 8 to 13 mm wide, capable of close coiling, with upper surface convex and separated into two longitudinal somewhat depressed tubes obliquely striated with a pronounced longitudinal groove; impression of ventral surface longitudinally striated with fine striae, and with prominent, though narrow, zigzag ridge along median line.

Figured specimen: GSWA F46924.

Distribution and range: Shore Range, nearest hill west of road south of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Abundance: Moderately common.

Value in correlation and dating: Known from only one locality.

Scolicia sp. 3?
(Plate 97 fig. 3)

Description: Trace about 15 mm wide, up to at least 70 cm long; tightly or more closely winding, with pronounced epirelief, uninterrupted median ridge along deep central longitudinal groove which separates very convex and apparently smooth longitudinal lateral ridges.

Figured specimen: GSWA F46922.

Distribution and range: Gascoyne River 1 km downstream from main crossing at Gascoyne Junction, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: 2 specimens.

Value in correlation and dating: Known from only one locality.

Scolicia sp. 4
(Plate 97 fig. 7)

Description: Trace smooth open furrow up to 12 mm wide, tightly or gently flexed, broadly U-shaped in cross-section, with median longitudinal smooth ridge parallel to side of trace, continuous or periodically interrupted by spheroidal or slightly elongated nodes.

Figured specimen: GSWA F46929.

Distribution and range: Nearest hill west of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Mundagan Sandstone.

Age: Kungurian.

Abundance: Apparently common.

Value in correlation and dating: Yet to be established; probably limited.

Scolicia sp. 5
(Plate 101 fig. 1)

Description: Specimens robust, about 20 mm across, of high relief, with narrow longitudinal furrow and apparently smooth and flattened dorso-lateral walls.

Figured specimen: GSWA F48500.

Distribution and range: Scrivener Hills, Crossland 1:250 000 sheet area, northern **Canning Basin** - Kirkby Range Member of the Hardman Formation.

Age: Chhidruan.

Genus **CURVOLITHUS** Fritsch 1908

Type species: *Curvolithus multiplex* Fritsch 1908.

Curvolithus sp.
(Plate 97 figs 4, 5)

Description: Trail 15 - 18 mm wide, at least 130 mm long, with flattened cross-section, tightly convex lateral walls, two parallel longitudinal grooves close to lateral margins, and broadly convex surface between grooves; opposite surface also with parallel longitudinal grooves, but at distances somewhat greater from lateral walls, and consequently narrower inner strip.

Figured specimens: GSWA F46940, F46921.

Distribution and range: Nearest hill due west of Twin (triple) Bore, Middalya Station, and Wandagee Hill on Wandagee Station, **Carnarvon Basin** - Mundagan Sandstone.

Age: Kungurian.

Abundance: Four specimens, three of which are from the type locality.

Value in correlation and dating: Yet to be determined.

Discussion: This ribbon-shaped trace, known from shallow marine sandstones of Ordovician to Tertiary age, is characterized by a flattened cross-section and a narrow lobe along each of the two borders. There may also be a pair of delicate grooves (Pl. 97 fig. 5) or a shallow depression along the top of the infill (Pl. 97

fig. 4). Although backfill lamellae can never be distinguished on the smooth surface, a similar origin as in *Scolicia*, is indicated by the preservation of the trace where it crosses a sand - mud interface. Coming from mud, the animal started to transport sand from in front along the body into the backfill from the moment the head touched the interface (Pl. 102 fig. 2). Therefore, the length and shape of the tongue in Plate 97 figure 5 provides a backfill phantom that corresponds to the animal's body suggesting a flatworm. This worm probably had an undulating edge on either side that produced the lateral backfill lobe before the rest of the cross-section became stuffed by the pointed tail end. Still enigmatic is the origin of the double groove along the crest. Possibly it reflects similar grooves on the dorsal side of the animal. The cleft between the backfill body (top part of Pl. 97 fig. 4) and the bedding plane (with an earlier trail) suggests that the wall was mucus-lined and that the animal cut across the sediment without deforming its surroundings.

Genus **MARGARITICHNUS** Bandel 1973

Type species: *Cylindrichnus reptilis* Bandel 1967.

Margaritichnus sp. 1
(Plate 96 figs 4, 10)

1980a *Scalarituba* Moore et al.: p.53
1980b *Scalarituba* Moore et al.: p.69, Fig. 6G

Description: Track robust, up to 15 mm wide, with ridges numbering 5.5 to 7.0 in 10 cm, asymmetrical, overlapping and sloping forward.

Figured specimens: GSWA F46911, F46910.

Distribution and range: Wandagee Hill, Wandagee Station, and elsewhere, **Carnarvon Basin** - Nalbia Sandstone, Coolkilya Sandstone, Mundagan Sandstone, and Binthalya Formation; Bucknall Pinnacle west of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Very common at one locality, and common at others.

Value in correlation and dating: As yet not determined, but promising because of considerable geographic distribution.

Sedimentary environment: Deeper water, offshore environment.

Discussion: This type of endichnial bulldozer trail is characterized by its striking top/bottom asymmetry. The base of the finger-thick backfill body is smooth and hard to distinguish from any planolitid or teichichnoid burrow. The top side, however, shows a series of round pads in the shape of an upside-down elephant's foot. These pads may be crowded to become seleniform in outline (Pl. 96 fig. 7). In side view (Pl. 96 fig. 10) the segments merge obliquely into the basal trunk (Pl. 102 fig. 5). This suggests that the animal moved rhythmically and backfilled the sediment posterodorsally with its stump-like rear end. Burrows of this type are known from shallow marine sandstones of Carboniferous to Permian age in the USA and

Egypt, but also in a more massive, non-turbidite part of a Lower Carboniferous flysch sequence in Morocco.

Margaritichnus sp. 1?

(Plate 96 fig. 6)

Description: Dorsal ridges closely spaced and horizontally compressed, about 8.5 in 10 cm, in many cases oblique to length of track.

Figured specimen: GSWA F46909.

Distribution and range: In Gascoyne River, downstream from the Gascoyne Junction crossing, **Carnarvon Basin** - Cundlego Formation; Bucknall Pinnacle, northern **Canning Basin** - Lightjack Formation.

Age: Artinskian (Baigendzhinian) - ?Kungurian.

Abundance: Abundant at the type locality.

Value in correlation and dating: Yet to be determined; potentially good because of apparent abundance and lateral distribution.

Margaritichnus sp.
(Plate 96 fig. 7)

Description: Subcylindrical in cross section, less than 40 mm long and up to 15 mm wide; consists of five "segments" concavo-convex or almost crescent-shaped in outline.

Figured specimen: GSWA F46908.

Distribution and range: Between Donnellys Well and Moogooree Homestead in the east, **Carnarvon Basin** - Billidee Formation.

Age: Artinskian.

Value in correlation and dating: None at present.

Genus **MACARONICHNUS** Clifton & Thomson 1978

Type species: *Macaronichnus segregatis.*

Macaronichnus sp. 1
(Plate 98 fig. 5a)

Description: Trail up to 14 mm wide, moderately deep, and with a wall up to 2 mm thick, proceeding in irregular but fairly straight direction but with some curves and flexures; trace generally smooth but invariably with periodic moderately closely, but not very regularly, spaced rings or grooves, when shallowly incised usually more flexed and with scratch marks.

Figured specimen: GSWA F46944a.

Distribution and range: Bottom of west side of Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Mundagan Sandstone; Shore Range, hill west side of road south of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Abundance: Not known.

Value in correlation and dating: Shows some promise as a potential key fossil for beds of Kungurian age in the Canning and Carnarvon Basins.

Discussion: While there is no doubt that this is the actively backfilled burrow of a worm-like infaunal animal, the detailed origin of this trace fossil remains enigmatic. Initially the animal lined its burrow with a thin cortical sand layer, the imbricated backfill structure of which can be recognized in the southeastern part of the slab. If the widely spaced rings on the smooth inside reflect the peristaltic movement of the body, the cortical layer was made by the expandable head region (proboscis). In analogy to *Nereites* one would expect the core to have been actively backfilled with mud, but true branchings are incompatible with this assumption.

On the figured slab the traces cut across a rectangular graticule whose origin is problematic.

Helicoidal backfill burrow
(Plate 100 fig. 5)

Description: Structure up to at least 25 cm long and 8 cm (but usually not more than 6 cm) across at its greatest diameter, tapering gradually and evenly in one direction but with sudden increase in diameter at one end; circular in cross-section, with frequent evenly spaced linear constrictions along entire length.

Figured specimen: GSWA F46961.

Distribution and range: Minilya River crossing at Cundlego Well, Wandagee Station, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Discussion: This unique trace fossil differs from other cork-screw burrows (*Gyrolithes; Xenohelix*) by tight coiling and by being backfilled with meniscoid lamellae. The only comparable form comes from terrestrial Oligocene deposits (Pl. 102 fig. 4). It is tentatively interpreted as the work of a large sediment-feeding insect larva that produced a protective burrow structure around the chamber for its pupa stage. Whether a similar origin is possible also in the Permian case depends on facies relationships and the original orientation of the trace in the rock.

Genus **LOPHOCTENIUM** Richter 1850

Type species: *Lophoctenium comosum* Richter 1851.

An unknown worm-like deposit feeder deposited the handled sediment not behind the body, but obliquely at one side of the head end. Advancing bite by bite, it produced a cylindrical branch consisting of oblique backfill lamellae, until it collided with an earlier mining front. At this point the head end was withdrawn to the origin and a new branch, or strip, advanced along the previous one. After having continued to strip-mine in this fashion to the critical distance from the origin, the animal gave up the guidance of the old front and added new strips in the same manner, but now in a backward sequence. Nevertheless, the free strip ends did not project beyond the contour, but formed a continuous front suitable as a guidance for the next strip-mining cycle. By endless repetition of these activity cycles, large areas could be processed without any gaps and overlaps. The regularity of the burrowing process (which is all the more surprising as it was executed inside the sediment) allows to distinguish ichnospecies by modifications of the basic behavioral program in more complete systems.

Lophoctenium is known from Ordovician to Permian flysch sedimentary rocks. Its reported occurrence in the Eocene flysch appears to be a convergence. Its occurrence in shallow marine Permian sandstones in Western Australia would thus be exceptional.

Lophoctenium sp. 1
(Plate 99 fig. 1)

1980 *Lophoctenium* Moore et al.: p.55, 56, 64, Fig. 4B

Description: Individual "branches" gently flexed and subparallel to each other with sublinear "levels" on both sides of each branch, on convex side possibly at higher angle to stem than on concave side.

Figured specimen: UWA 113240.

Distribution and range: Minilya River, and Wandagee Station, **Carnarvon Basin** - Bulgadoo Shale (upper part, at the type locality).

Age: Late Artinskian (Baigendzhinian).

Sedimentary environment: Lower and upper offshore zone; *Nereites* ichnofacies.

Abundance: Two hand specimens.

"Lophoctenium" sp. 2
(Plate 99 fig. 4)

Description: Broadly discernible fan-shaped, but irregular in detail, masses of lumps of sediment distributed and rearranged by feeding activity.

Figured specimen: GSWA F46971.

Distribution and range: East side of Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Coolkilya Sandstone and Mundagan Sandstones.

Age: Kungurian.

"Lophoctenium" sp. 3
(Plate 99 fig. 5a)

Description: Basket-like burrow complexes in horizontal plane; each elongate-curved, or rounded, or twisted pear-shaped, less than 5 cm in any direction, made up of curved elongate, usually discontinuous, twists of sediment; convex in direction of increasing width.

Figured specimen: GSWA F46950a-c.

Distribution and range: Nearest hill due east of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Mundagan Sandstone.

Age: Kungurian.

Abundance: Common at type locality.

Value in correlation and dating: Yet to be determined.

Genus **PHYCOSIPHON** von Fischer-Ooster 1858

Type species: *Phycosiphon incertum;* M.

Phycosiphon incertum von Fischer-Ooster 1858
(Plate 99 fig. 5b)

Along with *Lophoctenium*, the figured slab contains a few hairpin lobes of the minute trace fossil *Phycosiphon*. Although it has a slight resemblance to the much larger trace fossil *Rhizocorallium*, the origin of *Phycosiphon* was more like that of *Lophoctenium*, because sediment was obliquely backfilled in a dead-end tube.

Phycosiphon is known from the Ordovician through to the Tertiary and occurs in deep-sea, as well as shallow-marine, silts and sands.

Genus **ZOOPHYCOS** Massalongo 1855

Type species: *Zonarites caputmedusae* Massalongo 1855.

Zoophycos sp.
(Plate 99 fig. 6)

1980a *Zoophycos* Moore et al.: p.56, 63. 64, Fig. 4C
1980b *Zoophycos* Moore et al.: p.66

Description: Simple low cone-shaped structures some 30 cm across, gregarious and closely spaced, and merging into each other;

striations close to centre of each cone almost straight, distally curving in one direction.

Figured specimen: GSWA F46946.

Distribution and range: Throughout northern Kennedy Range, and elsewhere, **Carnarvon Basin** - Nalbia Sandstone, Coolkilya Sandstone.

Age: Late Artinskian (Baigendzhinian) - Kungurian.

Abundance: Abundant locally.

Value in correlation and dating: Yet to be determined.

Sedimentary environment: *Zoophycos* is regarded as indicative of intermediate and bathyal environment, but in Kennedy Range it is found in the lower transition zone or outer shelf facies.

Discussion: The figure shows two cone-shaped systems of this large spreite burrow. They originated by the protrusive displacement of a narrow U-shaped burrow around one of its openings. *Zoophycos* occurs from the Ordovician through to the Mesozoic at various depths, but always in impure sands and muddy silts below storm wave base, where sediment feeders had a chance to thoroughly churn the sediment. Since the Tertiary, *Zoophycos* appears to have been restricted to deep-sea environments. Although the trace is commonly found in modern deep-sea cores, its presumably worm-like maker is still unknown.

RESTING TRACES (Cubichnia)

Genus **CRUZIANA** d'Orbigny 1842

Type species: *Cruziana rugosa*; SD Bassler 1915.

Discussion: The bilobed burrows of trilobites (Pl. 102 fig. 6) are useful guide fossils in shallow marine sandstones of the Early Paleozoic, but rare in later times. Therefore the two specimens described below as *Cruziana*? sp. 1 and *Cruziana*? sp. 2 are of general interest, as they could represent the youngest known trace fossil record of trilobites. If corroborated by additional specimens, the regular longitudinal scratch pattern on the lobes of Plate 98 fig. 4 could serve as distinctive and stratigraphically useful feature, comparable only to the Lower Silurian *Cruziana acacensis*. The oblique sculpture of Plate 99 figure 3 is less distinctive at the species level, but even more indicative of a trilobite-made rusophyciform resting trace.

Bilobed hypichnial casts of smaller size (Pl. 97 fig. 6; Pl. 98 figs 1, 3) are more ambiguous, because they may also have been made by crustaceans (e.g. phyllopods), that ploughed the sediment in a similar fashion.

Cruziana? sp. 1
(Plate 98 fig. 4a)

Description: Track up to 11 mm across, made up of up to 12 parallel grooves separated by gently convex or flat interspaces. Width of track possibly depends on type (hardness?) of substratum or undertrack level.

Figured specimen: GSWA F46935a.

Distribution and range: Rim of plateau, east side of road about 4 km north of Swordfish Bore, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Common at the one locality where it was found.

Value in correlation and dating: Not determined, but apparently limited.

Cruziana? sp. 2
(Plate 99 fig. 3)

Description: Cast of pair of asymmetric bilobed impressions inclined to each other with consequently widening furrow between them; striated with fine irregular scratch marks.

Distribution and range: Float in Gascoyne River downstream from the main crossing at Gascoyne Junction, **Carnarvon Basin** - stratigraphic unit and range not known.

Figured specimen: GSWA F46936.

Genus **PELECYPODICHNUS (= Lockeia)** Seilacher 1953

Type species: *Pelecypodichnus amygdaloides* Seilacher 1953.

Pelecypodichnus sp.
(Plate 100 fig. 1)

Description: Numerous elongate, up to 5 cm long, almond-shaped or oblong, or more irregularly shaped structures of strong relief below bedding plane and orientated at various angles to it.

Figured specimen: GSWA F46959.

Distribution and range: About 3 km east of Kennedy Bore, **Carnarvon Basin** - Nalbia Sandstone.

Age: Late Artinskian (Baigendzhinian) - Early Kungurian.

Abundance: Abundant on the single slab found.

Value in correlation and dating: Value not yet apparent.

Remarks: This trace fossil is made by infaunal bivalves, other than protobranchia, when they burrow in sand and their wedge-shaped foot

penetrates a muddy layer underneath. Because similar impressions may originate in other ways, determination should be based on multiple occurrences within the same bedding plane.

Genus **IMBRICHNUS** Hallam 1970

Type species: *Imbrichnus wattonensis* Hallam 1970.

Imbrichnus sp.
(Plate 101 fig. 5)

Description: Thick (about 13 mm), round in cross-section, irregularly orientated, closely spaced burrows some with lineations.

Figured specimen: GSWA F46958.

Distribution and range: East side of Wandagee Hill, Wandagee Station, **Carnarvon Basin** - Coolkilya and Mungadan Sandstones.

Age: Kungurian.

Remarks: The chevron markings on the cast in the northeast corner of the specimen suggest that it was made by a protobranch bivalve with a flapping, rather than a wedging, foot.

DWELLING BURROWS (Domichnia)

Genus **DIPLOCRATERION** Torell 1870

Type species: *Diplocraterion parallelum* Torell 1879; SD Richter 1926.

Diplocraterion sp.
(Plate 100 figs 4, 6)

1984 *Diplocraterion* Bhatia et al.: p.302

Description: Burrows gregarious, regularly U-shaped with parallel sides, up to 10 cm deep, 55 mm across, and from 6 to 14 mm thick; irregularly striated with scratch marks.

Figured specimen: UWA 21307.

Distribution and range: Northern slope of Madbie Hills, Madbie Paddock, Wandagee Station, **Carnarvon Basin** - unit not known; subsurface **Bonaparte Basin** - Tern Member of the Hyland Bay Formation.

Age: Permian; Chhidruan.

Abundance: Clusters of specimens.

Value in correlation and dating: Insufficient numbers available for evaluation.

Discussion: Like *Zoophycos* and *Rhizocorallium*, this is a typical spreite burrow produced by the gradual displacement of a U-tube

within the plane of the U. In this case, however, the U was perpendicular and as indicated by laminae in the side view (Pl. 100 fig. 6), it was not protrusively deepened (which is the more common mode) but migrated upward to produce a retrusive spreite -- possibly in response to sedimentation. This suggests that the burrowing animal got its food from outside and used the burrow only for protection. The scratches on the exposed surface also suggest that the animal was a crustacean.

Burrows of this type are typical of the very shallow littoral zone (*Skolithos* Ichnofacies). The scratches also tell us that the mud had become compacted enough to be a firm ground (*Glossifungites* Subfacies) and that it was already covered by sand when the burrows were made.

ADDITIONAL TRACE FOSSIL TAXA AND PROBLEMATICA

Genus **ASTEROSOMA** von Otto 1854

Type species: *Asterosoma radiciforme* von Otto 1854.

Asterosoma sp.

1984 *Asterosoma* Bhatia et al.: p.302

Distribution and range: Subsurface **Bonaparte Basin** - Tern Member of the Hyland Bay Formation.

Age: Chhidruan.

Sedimentary environment: *Cruziana* Association typical of shoreface and foreshore regions.

Remarks: *Asterosoma* is a burrow system in which waste sand has been deposited at the wall of a defined tunnel section and then radially pressed out. Repetition of such disposal led to spindle-shaped backfill bodies that bear characteristic longitudinal patterns of extensional micro-faults on the outside and have an internal onionskin structure. Several bodies may be arranged in star-shaped, dendroid, or other fashions. Representatives are known from shelf deposits of Devonian through to Cretaceous age.

Genus **CHONDRITES** von Sternberg 1833

Type species: *Fucoides lycopodioides* Brongniart 1928.

Chondrites sp.

1980a *Chondrites* sp. Moore et al.: p.55

Distribution and range: **Carnarvon Basin** - Baker Formation.

Age: Kungurian

Sedimentary environment: Upper offshore.

Remarks: Like the comparable root systems of land plants, the branches of *Chondrites* systematically fill a given space in the sediment without overlap and always keeping a certain distance to neighbouring branches. Therefore it is likely that the worm-like maker was not a sediment feeder but extracted hydrogen sulphide or methane as a fuel for endosymbiotic bacteria. This model agrees with the occurrernce of this trace fossil in shallow to deep marine facies, but mainly in beds that show signs of oxygen deficiency.

Genus **COSMORHAPHE** Fuchs 1895

Type species: *Helminthopsis sinuosa* Azpeitia 1933; SD Hantzschel 1975.

Cosmorhaphe sp.

1980a *Cosmorphaphe* (*sic*) Moore et al.: p.56
1980b *Cosmorphaie* (*sic*) Moore et al.: p.69, Fig. 6I

Distribution and range: Watermelon Creek, Kennedy Range, and elsewhere, **Carnarvon Basin** - Nalbia Sandstone, Murgadan Sandstone, Binthalya Formation.

Age: Kungurian - Kazanian.

Sedimentary environment: Transition zone to middle shore facies.

Remarks: *Cosmorhaphe*, like *Paleodictyon*, is a graphoglyptid burrow system typically found in flysh turbidites of Late Cretaceous and younger ages. Its occurrence in other situations should be viewed with some scepticism unless the combination of two orders of meandering is very clear.

Genus **CYLINDRICHNUS** Toots *in* Howard 1966

Type species: *Cylindrichnus concentricus* Toots *in* Howard 1966; M.

Cylindrichnus sp.

1984 *Cyclindrichnus* Bhatia et al.: p.302

Distribution and range: Subsurface **Bonaparte Basin** - Tern Member of the Hyland Bay Formation.

Age: Chhidruan.

Sedimentary environment: *Cruziana* Association typical of shoreface and foreshore regions.

Genus **CYLINDRICUM** Linck 1949

Type species: *Tubifex antiquus* Plieninger 1845; OD.

Cylindricum? sp.
(Plate 98 fig. 4b; Plate 99 fig. 2)

Diagnosis: Round or rounded stumps 6 - 8 mm across and of unknown depth, not very closely spaced from each other, vertically oriented to bedding plane, and of unknown length.

Figured specimens: GSWA F6935b, F46970.

Distribution and range: 3 km east of Kennedy Bore, Kennedy Range, **Carnarvon Basin** - Nalbia Sandstone; 4 km north of Swordfish Bore, northern **Canning Basin** - Hardman Formation.

Age: Kungurian to Chhidruan.

Abundance: Common locally.

Value in correlation and dating: Some potential yet to be determined.

Remarks: The ichnogenus was erected for millimetric stumps on sole faces of Triassic fluvial sandstones that are only 2 - 3 times as deep as they are wide. Otherwise distinction from the marine *Skolithos* may be problematic.

Genus **DIDYMAULICHNUS** Young 1972

Type species: *Fraena lyelli* Roualt 1850; OD.

Didymaulichnus? sp. 1
(Plate 97 fig. 6)

Description: Trace about 8 mm wide, more or less straight or broadly flexed, bilobate, with rather narrow and shallow longitudinal groove separating two symmetrical convex smooth-walled longitudinal lobes.

Figured specimen: GSWA F46932.

Distribution and range: Cundlego Crossing on Minilya River, Wandagee Station, **Carnarvon Basin** - Cundlego Formation.

Age: Late Artinskian (Baigendzhinian).

Abundance: Numerous traces on single slab in the collection.

Value in correlation and dating: Not determined; probably limited.

Remarks: *Didymaulichnus* are small scoliciid trails that are not always clearly distinguishable from other bilobed ribbons, such as *Asopodichnus* that are mere hyporeliefs without backfill structure. Ichnogenera within the scoliciids are not well defined (see Pl. 102 fig. 1).

Didymaulichnus? sp. 2
(Plate 98 fig. 1)

Description: Burrows small, less than 3 mm across, of irregular direction; two longitudinal lobes separated by narrow, but conspicuous, longitudinal furrow.

Figured specimen: GSWA F46937c.

Distribution and range: 4 km north of Swordfish Bore, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Common at type locality.

Value in correlation and dating: None at present.

Gen. and sp. 1
(Plate 99 fig. 7)

Description: Smooth, straight or slightly curved elongate subcylindrical structures about 13 mm long and 3 mm thick, with rounded and abruptly or more gradually tapering ends.

Figured specimens: GSWA F46964.

Distribution and range: Rim of plateau, east side of road about 4 km north of Swordfish Bore, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Abundance: Common locally.

Value in correlation and range: Not determined.

Gen. and sp. 2
(Plate 100 fig. 2)

Description: Tubular structures at least 14 cm long, 4 cm by 2 cm at the wide end, gradually tapering to a 2 cm width at other end; surface apparently devoid of structures.

Figured specimen: GSWA F46960.

Distribution and range: North-facing scarp south of track west of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Mungadan Sandstone.

Age: Kungurian.

Gen. and sp. 3

1975 Worm trails? Skwarko: p.24, pl. 1 fig. 10

Description: Short and stubby sub-cylindrical structures up to 2 cm across.

Distribution and range: Gibson Desert, **Officer Basin** - Permian?.

Gen. and sp. 4

1975 Problematicum Skwarko: p.24, pl. 4 fig. 12

Description: "Unusual looking 'worm casts' which in some cases have a spongelike appearance... they are composed of sandstone much coarser than the surrounding rock." (Skwarko, 1975).

Distribution and range: Gibson Desert, **Officer Basin** - Permian?.

Gen. and sp. 5
(Plate 101 fig. 2)

Description: Straight or broadly flexed burrows of irregular width and direction, joining together or crossing each other, flat but of irregular breadth, usually limited to bedding plane.

Figured specimen: GSWA F46978.

Distribution and range: Twin Bore area, Middalya Station, **Carnarvon Basin** - Coolkilya and Mundagan Sandstones.

Age: Kungurian.

Gen. and sp. 6
(Plate 101 fig. 4)

Description: Worm burrows, mostly straight, of variable and irregular shape and up to 8 mm thick, haphazardly orientated to each other.

Figured specimen: GSWA F46967.

Distribution and range: North-facing scarp south of track west of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Coolkilya and Mundagan Sandstones.

Age: Kungurian.

Gen. and sp. 7
(Plate 101 fig. 6)

Description: Solid mass of worm burrows, flattened, uniformly about 1 cm across, haphazardly orientated, devoid of any wall lineations or structures.

Figured specimen: GSWA F46972.

Distribution and range: Wandagee Hill, **Carnarvon Basin** - Coolkilya Sandstone.

Age: Kungurian.

Value in correlation and dating: Known geographic distribution limited.

Genus **GYROCHORTE** Heer 1865

Type species: *Gyrochorte comosa* Heer 1865; SD Häntzschel 1962.

Gyrochorte? sp.
(Plate 98 fig. 3)

Description: Specimen small, preserved part being 25 mm long and 3 mm across at widest end; divided into two symmetrical elongate lobes by longitudinal central groove, and each lobe into numerous segments by constrictions oblique to longitudinal groove.

Figured specimen: GSWA F46944c.

Distribution and range: Shore Range, nearest hill west of road south of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Value in correlation and dating: Known geographic distribution too limited.

Remarks: While sharing its bilobedness with other ichnogenera, *Gyrochorte* is very distinctive by its upside-down preservation (epichnial ridges or hypichnial grooves) that results from a unique mode of locomotion through the sediment. It is generally a shall / marine form that ranges all through the Phanerozoic, but minaturized representatives occur in deep-sea flysch deposits of Eocene age.

Genus **OPHIOMORPHA** Lundgren 1891

Type species: *Ophiomorpha nodosa*.

Ophiomorpha? sp.

1984 *Ophiomorphia(?)* (*sic*) Bhatia et al.: p.302

Distribution and range: Subsurface **Bonaparte Basin** - Tern Member of the Hyland Formation.

Age: Chhidruan.

Sedimentary environment: *Cruziana* Association typical of shoreface and foreshore regions.

Genus **PLANOLITES** Nicholson 1873

Type species: *Planolites vulgaris* Nicholson & Hinde 1875.

Planolites sp.

1980a *Planolites* Moore et al.: p.55

Distribution and range: Southeastern **Carnarvon Basin** - Baker Formation.

Age: Kungurian.

Sedimentary environment: Upper offshore.

Genus **RHIZOCORALLIUM** Zenker 1836

Type species: *Rhizocorallium jenense* Zenker 1836.

Rhizocorallium sp.

1980a *Rhizocorallum (sic)* Moore et al.: p.56
1980b *Rhizocorallium* Moore et al.: p.69, Fig. 6H
1984 *Rhizocorallium* Yeates et al.: p.38, Fig. 34

Distribution and range: Southeastern and eastern **Carnarvon Basin** - Nalbia Sandstone, Mungadan Sandstone, Binthalya Formation; northern **Canning Basin** - Godfrey Beds.

Age: Kungurian - Kazanian, Chhidruan.

Abundance: Abundant in Godfrey Beds.

Sedimentary environment: Transitional zone, and lower and middle shoreface.

Value in correlation and dating: Has some potential because of geographic distribution.

Remarks: *Rhizocorallium*, known from shallow-marine facies all through the Phanerozoic, is a protrusive spreite burrow. It differs from *Zoophycos* by the hairpin-shape of the marginal tube and a larger tunnel diameter relative to the width of the "U". In contrast to *Diplocraterion* the burrow is vertical only in its initial part and then becomes oblique or parallel to the bedding plane. Burrows of this type were probably made by shrimp-like crustaceans and may have served as permanent homes for suspension-feeding species (short firmground version: *Glossifungites)* or as feeding burrows whose length exceeds that required to accomodate growth of the inhabitant.

Genus **SKOLITHOS** Haldemann 1840

Type species: *Fucoides? linearis* Haldemann 1840.

Skolithos sp.

1980a *?Skolithos* Moore et al.: p.58
1980b *Skolithos* Moore et al.: p.69
1984 *Skolithos* Bhatia et al.: p.302

Distribution and range: Southeastern **Carnarvon Basin** - mainly Mallens Sandstone, but also in Nalbia Sandstone and Coyrie and Cundlego Formations; subsurface **Bonaparte Basin** - Tern Member of the Hyland Bay Formation.

Age: Late Artinskian (Baigendzhinian) - Chhidruan.

Sedimentary environment: At least in part *Cruziana* Association typical of transitional zone and lower and middle shoreface facies.

Value in correlation and dating: Has some potential because of geographic distribution.

Genus **TEICHICHNUS** Seilacher 1955

Type species: *Teichichnus rectus* Seilacher 1955.

Teichichnus sp.

1984 *Teichichnus* Bhatia et al.: p.302

Distribution and range: Subsurface **Bonaparte Basin** - Tern Member of the Hyland Bay Formation.

Age: Chhidruan.

Sedimentary environment: *Cruziana* Association typical of shoreface and foreshore regions.

Value in correlation and dating: Not known.

PROBLEMATICA

Problematicum 1
(Plate 98 fig. 2)

Description: A shield-like structure 28 mm across, of slightly inflated relief, with convex "dorsal" margin more so on the right side than on the left and with invagination in the middle, which is occupied by an irregular-shaped structure about 5 mm across. The main body divided into three visible segments on right flank, and probably same number on the left. The "ventral" part of the problematicum is missing.

Figured specimen: GSWA F46945b.

Distribution and range: Nearest hill due west of Twin (triple) Bore, Middalya Station, **Carnarvon Basin** - Mundagan Sandstone.

Age: Kungurian.

Abundance: One specimen.

Value in correlation and dating: Limited known geographic distribution.

Problematicum 2
(Plate 98 fig. 5b)

Description: Straight rectangular to square "incision" graticule, usually about 10 - 14 cm long, apparently vertical -- or at least at high angle -- to the bedding plane, occurring in sets of three or more parallel (rarely obliquely oriented) cuts, usually about 2 cm

apart from each other, each set either discrete or criss-crossing each other at right angles; incisions commonly infilled with a central ridge for at least part of length -- a ridge which may obscure the original cut. Problematicum directly associated with *Macaronichnus* sp. 1.

Figured specimen: GSWA F46939.

Distribution and range: Shore Range, nearest hill west of road south of Cherrabun Homestead, northern **Canning Basin** - Lightjack Formation.

Age: Kungurian.

Abundance: Seems common at the single locality known.

Discussion: The variable orientation of the graticule excludes its tectonic origin. One possible explanation is the impression of a hexactinellid sponge (*Protospongia*), whose opal spicules would have already been dissolved by the time of trace formation.

Problematicum 3
(Plate 101 fig. 3)

Description: Concentric grooves up to 3 cm across, circular to ovate in horizontal plane, dipping apparently concentrically into and across bedding in a concretion-like fashion.

Figured specimen: GSWA F46965.

Distribution and range: Rim of plateau east side of road about 4 km north of Swordfish Bore, northern **Canning Basin** - Hardman Formation.

Age: Chhidruan.

Value in correlation and range: None at present.

Remarks: In spite of their striking regularity, the circular patterns on this slab appear to be of non-biogenic origin. They probably resulted from conchoidal weathering in the shale layer that originally adhered to this sandstone surface.

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