SILURO-DEVONIAN FAUNAS OF CENTRAL NEW SOUTH WALES

by

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy 1990

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ABSTRACT

Brachiopods from the Amphitheatre and Winduck Groups (Cobar Supergroup) in The Meadows district of western New South Wales range in age from possible Pridoli to late Lochkovian or early Pragian age. The assemblages occur in sandy sediments deposited by traction currents and thus are likely to have been derived from more than one community. The closest affinities of the fauna are with the Old World Realm brachiopods of Podolia and western Europe. In the Australasian region the most comparable faunas are those from the Mount Ida Formation near Heathcote, Victoria. There are marked resemblances to brachiopods in the Baton Formation of New Zealand. Sixteen brachiopods are described including redescriptions of *Mesodouvillina (Mesodouvillina) convexa* (Dun), *Ancillotoechia duni* (Gürich) and *Howellella jaqueti* (Dun).

Brachiopod faunas are described from the Derriwong, Trundle and Yarra Yarra Creek Groups in central New South Wales. The fauna in the Derriwong Group ranges in age from possible late Ludlow to Lochkovian and has affinities with Late Silurian faunas from the Canberra-Yass district. The faunas in the Trundle and Yarra Yarra Creek Groups are Emsian; dating of all the Groups is based on conodonts. A new species, *Leptostrophia (Mitchella) deckerae*, is described from the Derriwong Group and *Spinella pittmani* (Dun) from the Trundle Group is redescribed. There is trend towards increasing provincialism from Ludlow to Emsian time despite the oldest and
youngest assemblages being limited in the number of genera represented.

Three species of trilobites are described from the Amphitheatre and Winduck Groups (Cobar Supergroup) in The Meadows district west of Cobar, New South Wales. *Encrinurus cf. silverdalensis* occurs in a sandstone member and *Encrinurus cf. mitchelli* in pink mudstone of the Amphitheatre Group. A review of Late Silurian (Pridoli) *Encrinurus* occurrences in central and western New South Wales suggests a correlation of species with lithology. *Craspedarges wilcanniae* Gürich is redescribed, based on material from the Early Devonian (Lochkovian) Winduck Group.

Trilobites in the Trundle district occur at several horizons in the Late Silurian to Early Devonian Derriwong Group but only those in the Cookeys Plains Formation and Milpose Volcanics are well preserved although disarticulated. The fauna is very similar to that from Yass. The cheirurid *Didrepanon* is recorded for the first time from Australasia. The external ornament in *Odontochile cf. loomesi* Mitchell is well preserved and described. *Ceratocephala impedita* is reassigned to *Ceratonurus*.

The Late Silurian to Early Devonian trilobite and brachiopod faunas of central New South Wales are generally poorly preserved but are still sufficiently distinctive to provide a local biostratigraphic scheme. The oldest fauna, *Encrinurus - Molongia elegans capricornae*, can be dated by
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SECTION A

INTRODUCTION
INTRODUCTION

Rocks of Late Silurian to late Early Devonian age are widely distributed over an area of some 80,000 square kilometres between Forbes and Louth in central New South Wales (Fig. 1). The sedimentary rocks represent a variety of environments but, because of the generally deeply weathered terrain, low relief and alluvial cover most outcrops consist of resistant sandstone and conglomerate. Exposures of softer, finer grained sediments are more or less restricted to mines, road cuttings and gravel pits. In areas of apparently no outcrop near Trundle it is possible to expose shale by digging pits less than 40 cm deep. Volcanic rocks, mostly acidic, are widespread in the central part of this region and are especially significant for base and precious metal mineralization (Glen et al., 1985).

Siluro-Devonian fossils have been reported from many localities in this vast region (comprehensive lists of fossil localities are given in Brunker, 1969; Rayner, 1969; Packham, 1969; Baker et al., 1975; Pickett, 1980) but very little work has been published on systematic palaeontology or biostratigraphy. The primary purpose in collecting these fossils was to construct a local biostratigraphy for correlating widely separated outcrops of varied lithology. It is possible to date most formations in this region to the appropriate series or stage using brachiopods but preservation is inadequate for more refined dating except for local
Fig. 1 Distribution of Late Silurian to Early Devonian (Pridolian to Emsian) strata in central New South Wales. Geology after Pogson (1972 and in press), Sherwin (1980, 1981), Krynen et al. (1990) and Henley (1988).
correlation in this region. Accurate dating to part of a stage or series is possible only in the comparatively few localities where there are associated conodont bearing limestones. Most of the fossils described in this thesis were collected as part of the regional mapping program of the Geological Survey in the Cobar (Glen et al., 1985) and Parkes (Krynen et al., 1990) districts, the latter including a review of the fauna identified by Dun (in Andrews, 1910).

Method of study

Almost all of the fossils described are preserved as moulds in clastic, non-calcareous sediments that have been thoroughly leached. The most satisfactory method of study was by the use of latex casts, whitened with magnesium oxide for examination and photography. As noted above, the most common lithologies are fine to medium sandstone, the grainsize being such that fine morphological details are rarely preserved. In larger species it is likely that at worst only details of micro ornament have been lost but in small species the internal structures in the umbonal region are obscured.

In some of the finer grained sandstones, especially in the Trundle district, it is preferable to use weathered rather than freshly split surfaces for examination. Moulds on freshly split bedding planes of these sandstones are coated or even filled with powdery iron oxides that are difficult to remove without damage to the mould. Successive latex casts tend to pluck sand grains from moulds before all the powdery deposits have been removed whereas on weathered surfaces the moulds are free of these powdery oxides. No casts were made of fragile
specimens.

The exposures in shallow gravel pits are generally very blocky because of a combination of close jointing and ready parting along bedding planes. An inevitable consequence of the disrupted bedding is that many moulds are without counterparts.

Significance of fauna

The fossils from the sandy strata in central New South Wales are not as well preserved as the spectacular silicified faunas of comparable age from Taemas (Chatterton, 1971, 1973), Manildra (Savage, 1971) and Wellington (Chatterton et al., 1979; Lenz and Johnson, 1985a, b) but description is justified to avoid any erroneous palaeobiogeographic conclusions because of a bias to studying limestone faunas. The stratigraphy of central New South Wales depends upon these fossils because there is nothing else except for the very few widely scattered limestones with conodont-based dates. Previous work on these faunas is limited and dates back to the late nineteenth century. Most of the species described in the past from this region were based upon poorly preserved material. These have been revised but comparisons with other species are largely restricted to the Australasian region.

ARRANGEMENT OF THESIS

This thesis is divided into sections representing draft papers to facilitate publication of the work. Thus each section has its own abstract, set of references and numbering
of figures. The format adopted for sections B-E is that used in the international palaeontological journal *Alcheringa*. This journal uses figures instead of plates, hence the variation in the size of photographic illustrations in this thesis, all of a size able to be trimmed to fit into a whole or part page of *Alcheringa*. The only changes likely will be in response to any pertinent comments by reviewers and examiners plus inclusion of relevant acknowledgements. The chapter on biostratigraphy is intended for the Quarterly Notes series of the Geological Survey of New South Wales. The order of appearance in this thesis is planned to be that of submission for publication.

**ACKNOWLEDGEMENTS**

This work described in this thesis was done under the supervision of Associate Professor John Talent, assisted by Dr Ruth Mawson. Their careful appraisal of the text and periodic encouragement to persist is gratefully acknowledged although the responsibility for conclusions reached is my own. Both supervisors provided copies of otherwise unobtainable references.

In respect of The Meadows mapping project, especially collecting fossils, I thank fellow Geological Survey staff John Byrnes, John Chapman, Gary Dargan, Harvey Henley, Dave Jones and John Watkins. Gary Dargan also assisted in both field and laboratory with the Trundle faunas. John Pickett was ever ready to discuss and review conodont biostratigraphy in the region. Dennis Pogson and Dick Glen kindly provided draft
copies of coming publications on the geology of Mineral Hill and Cobar region respectively. Michael Leys organised the software to produce the printed copy.

For the loan of specimens and discussions on Devonian fish biostratigraphy I thank Alex Ritchie and Bob Jones at the Australian Museum. Ken Campbell of the Australian National University, Canberra, encouraged the selection of the thesis topic and approved access to the Landrum collection; loan of material from the same institution was arranged by Tim Munsen. Dave Holloway, National Museum of Victoria, approved the loan of type material and provided copies of relevant trilobite publications. Des Strusz, BMR, Canberra, provided numerous photographs of Late Silurian brachiopods and discussed several aspects of Siluro-Devonian trilobite and brachiopod biostratigraphy.

The following are thanked for their part in searching for Gürich's types: Dr. J. Dzik (Zakład Paleobiologii, Warsaw), Mrs J. Poleska (Muzeum Geologiczne, Wrocław University), Dr G.K.B. Alberti and Dr W. Weitschat (both Hamburg University).

Fossil material was forwarded from the Cobar district by Leigh Schmidt and Andy Allen (both BHP North) and from the Trundle district by Gary Jones, Michael Love, Wayne O'Neil, Ian Ingpen and Bill Platts (all Geopeko).

Diana Cornwell and Shirley Sugden assisted with drafting and colouring the diagrams.

Permission to submit this research for a Ph.D. was given by the Assistant Secretary, Department of Mineral Resources (now Minerals and Energy).
REFERENCES


SECTION B

SILURO-DEVONIAN BRACHIOPODS FROM THE AMPHITHEATRE AND WINDUCK GROUPS (COBAR SUPERGROUP), WESTERN NEW SOUTH WALES.
Siluro-Devonian brachiopods from the Amphitheatre and Winduck Groups (Cobar Supergroup), western New South Wales.

LAWRENCE SHERWIN

Sherwin, L., 0000:00:00 Siluro-Devonian brachiopods from the Amphitheatre and Winduck Groups (Cobar Supergroup), western New South Wales. Alcheringa

Brachiopods from the Amphitheatre and Winduck Groups (Cobar Supergroup) in The Meadows district of western New South Wales range in age from possible Pridoli to late Lochkovian or early Pragian age. The assemblages occur in sandy sediments deposited by traction currents and thus are likely to have been derived from more than one community. The closest affinities of the fauna are with the Old World Realm brachiopods of Podolia and western Europe. In the Australasian region the most comparable faunas are those from the Mount Ida Formation near Heathcote, Victoria. There are marked resemblances to brachiopods in the Baton Formation of New Zealand. Sixteen brachiopods are described including redescriptions of Mesodouvillina (Mesodouvillina) convexa (Dun), Ancillotoechia duni (Gürich) and Howellella jaqueti (Dun).

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PUBLISHED WORK on the geology of The Meadows area, some 50 km west of Cobar (fig. 1), is limited to that shown on the Barnato 1:250,000 geological sheet (Rose 1965). Mineral exploration
Fig. 1. Locality diagram showing places mentioned in text.
companies (Lennox 1976, Union Corp. 1977) carried out a limited amount of detailed mapping in the area and recorded some fossil localities; the only account is an unpublished report by Henley (1988).

The area is one of low relief, much of it is covered by Cainozoic alluvium, colluvium and scree. With the exception of some thin Cretaceous and Tertiary outliers and one or two thin sandy beds within the Amphitheatre Group the outcrops consist of Early Devonian Winduck Group quartzose sandstones. Interbedded siltstones are exposed in some of the deeper erosion gullies.

The Winduck Group is overlain paraconformably, locally unconformably, by Middle to Late Devonian sandstones and less commonly quartz pebble conglomerates of the Mulga Downs Group (Glen, 1979). A small area of reddish purple siltstones and thin sandstones belonging to the Amphitheatre Group is exposed in gravel pits just east of The Meadows. The boundary with the Winduck Group is conformable but diachronous with the underlying Amphitheatre Group, both groups being part of the Cobar Supergroup (figs 2, 3).

Fossils are known from many localities within the Cobar Supergroup but because outcrops are isolated the stratigraphic sequence is not known with any precision. Rose (1965) included all pre Mulga Downs strata in The Meadows area within the Amphitheatre Group. This nomenclature was used in later regional compilations by Pogson (1972) and Glen et al., (1985).
Fig. 2. Simplified geological map of The Meadows district modified from Rose (1965), showing the location of the sections in Fig. 4.
Fig. 3. Stratigraphic relationships in The Meadows area, modified from Glen (1987).
The stratigraphy (figs 2 & 3) follows that in the Wrightville area to the east, described by Glen (1987), although the subdivision of the Winduck Group recognised at Wrightville cannot be applied in The Meadows area, probably a reflection of the differing types of deposition in quite different structural zones (Glen 1990). The Amphitheatre Group crops out poorly but the sandier Winduck Group forms a series of strike ridges. The most prominent ridges are formed by thick unfossiliferous cross-bedded sandstone beds.

Some of the more isolated sandstone beds of the Winduck Group, surrounded by areas of no outcrop or at best silty float, are regarded as the distal ends of slump and traction current sands interdigitating with deep water silts of the Amphitheatre Group. Because the Winduck Group is structurally simple in this area the various fossil assemblages in it can be placed in stratigraphic order with some confidence despite the scattered nature of outcrops.

The fauna in the Winduck Group includes several species described from erratic boulders found at White Cliffs, some hundreds of kilometres north west of The Meadows (fig. 1). Similar erratics within Cretaceous sediments have been found in South Australia (Campbell et al., 1977), far from any known Devonian outcrops. The exact source of the erratics is unknown although there are obvious faunal and lithological similarities with the Winduck Group. They may have been derived from several localities and stratigraphic horizons.
The brachiopod and molluscan faunas in the White Cliffs erratics were described by Dun (1898); a brachiopod and trilobite were described by Gürich (1901a, b). Most of Dun's material, formerly held by the Geological Survey, is now stored in the Australian Museum, Sydney. Gürich's material at Breslau (now Wrocław) was moved to Hamburg where it was destroyed by bombing during the Second World War. The brachiopod, mollusc and trilobite faunas of the Cobar district, including some specimens from The Meadows, were the subject of an unpublished PhD thesis by Landrum (1975 ms).

The species described in this paper are based upon original type material where available and later collections made in The Meadows area by Geological Survey staff mapping The Meadows 1:100,000 geological sheet. The lithology of the matrix of the fossils is fine quartzose sandstone varying from clay-rich to orthoquartzite, the latter being typical of the erratic material at White Cliffs. The grainsize of the matrix is such that the finest details cannot be adequately deciphered. For this reason no new species are described although some previously named species have been revised on the basis of neotype material despite the poor preservation. Designating new species on the basis of poorly preserved types does nothing to advance biostratigraphly.

The great majority of fossils described in this paper are from the Winduck Group. The few from the Amphitheatre Group are from thin sandy members except for one or two specimens
from the pinkish-silty mudstone. The fossils are preserved as internal and external moulds, all calcareous matter having been removed. One loose block contained silicified *Atrypa* valves but these could not be cleared of the surrounding rock without damage.

The nearness to shoreline of the Winduck Group faunas in life is uncertain. There is a very small area of outcrop of Ordovician basement, dated by graptolites as Darriwilian (Sherwin 1983), 19 kilometres north west of The Meadows homestead, but the outcrop is too poor to determine the boundary relationship with the Winduck Group.

The fossils are usually disarticulated, whether brachiopod, trilobite or bivalve. Articulated brachiopods are extremely rare except for one bed with whole specimens of *Nanothyris*. Even in the mudstones of the Amphitheatre Group the brachiopods are disarticulated in beds containing complete carapaces of the trilobite *Encrinurus*. Otherwise the valves are usually entire except for fragile structures such as the spiralia and thin spinose ornament. Glen (1987) regarded sandstones of the Winduck Group as indicating a change to shelf sedimentation from the turbidites of the Amphitheatre Group. Some indication of the depositing traction currents is shown by the laminar structure of the fossiliferous sandstone beds and the obvious sorting of many larger brachiopods. *Post mortem* sorting is indicated by the disparate proportions of brachial and pedicle valves of the same species in individual beds, especially where there are marked differences in morphology of
Fig. 4. Measured sections through the Winduck Group showing stratigraphic sequence of localities. Correlation between sections is approximate because the faunas persist through considerable thicknesses of sediment with little obvious change. The apparently unfossiliferous portions of each section are essentially finer grained sediments with poor outcrop. Column A-A' is wholly within the Amphitheatere Group according to existing mapping but there is a change to dominantly Winduck Group lithology at about the position indicated by the dashed line. The amount of section missing between the top of C-C' and D-D' is unknown because of lack of outcrop and structural uncertainties.
the valves, eg. *Iridistrophia*. This disparity is very apparent at one locality (TM 57) where the fossils are preserved in an assemblage that does not represent a former community (*sensu* Boucot 1975). Another example of sorting is at locality TM 151 where whole specimens of *?Nanothyris* are associated with disarticulated, similar sized valves of *Howellella jaqueti* and *Strophochonetes*, the latter as pedicle valves only. These localities are on the measured sections in figure 4 and the assemblages at each locality in figure 5; the section lines are shown in figure 2.

Fossiliferous beds in the Winduck Group fall into two broad categories. In the better laminated sandstone units, undamaged brachiopods on a single bedding plane are separated by an average of one to two centimetres and only two or three species are represented. In other beds the fossils are densely packed with fragmentary remains in discrete bands, separated by several centimetres of unfossiliferous massive sandstone. These densely packed beds also contain a greater variety of species in comparison with the laminite units. In the Amphitheatre Group mudstones there are no clear bedding planes and fossils are widely separated.

Age and correlation of the fauna

There are no fossil groups in the Winduck Group providing better age-resolution than the brachiopods. Tentaculitids are present at some localities (Sherwin and Henley 1988) but the
| Field locality number | H | N | S | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Mesodouvillina       | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| (Mesodouvillina) sp. |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Iridistrophia sp.    | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Salopina sp.         | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Howellella sp.       | x |   | x | x | x | x | x | x | x | x |   |   |   |   |   |   |   |   |   |   |
| Molongia cf. elegans | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| capricornae          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Protocortezorthis sp.| x | x |   |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Molongia sp.         | x | x |   |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Sphaerirhynchia sp.  | x |   | ? | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Mesodouvillina       | x | x |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| convexa              | x | x |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Howellella jaqueti   | x |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Ancillotoechia duni | x |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Levenea sp.          | x |   | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Atrypa cf. reticularis|    |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| nieczlawiensis      |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Strophochonetes sp.  |    |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| ?Nanothyris sp.      |    |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| H. jaqueti multiplicate forms |    |   |   | x | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Amphitheatre Group | Winduck Group
Fig. 5. Fossil localities arranged in approximate stratigraphic order, oldest to youngest from left to right. The post Encrinurus fauna can be divided into three recognisable assemblages based on increasing plication of Howellella. This distribution should be compared with the spiriferid sequence of Gourvennec (1985, fig. 12). In this region Nanothyris is known from only one horizon within the range of Howellella jaqueti. Several localities have not been included because of uncertainty regarding their relative stratigraphic positions. Although locality TM 183c is within an area mapped as Amphitheatre Group it is included in this table within the Winduck Group because of the comparable lithology.
grainsize of the sandstone is too coarse for preservation of ornament essential for identification. Sherrard (1967) recorded tentaculitids from several other localities in the Cobar Supergroup and concluded that the amount of detail preserved in sandy lithologies was insufficient for reliable determinations even at generic level. At two localities, TM 5i and TM 125b (see appendix for locality details), fragmentary fish remains were noted and some brachiopods with overgrowths of *Aulopora* or finely textured algae or sponges. The trilobite *Gravicalymene* is present in the lower part of the Winduck Group but in New South Wales and Victoria this genus is known to occur with little distinctive variation from the Late Silurian to high in the Early Devonian (Sherwin in Pickett 1982; Talent 1963). Another trilobite, (?)*Craspedarges*, is also present in the lower part of the Winduck Group but is not known from anywhere else except the White Cliffs erratics (Gürich 1901b). The underlying pinkish mudstone and siltstone of the Amphitheatre Group, including at least one sandy bed of Winduck Group facies, contains the trilobite *Encrinurus* (Lennox 1976). In New South Wales *Encrinurus* is known to occur above the late Pridoli *M. bouceki* Zone (Sherwin in Pickett 1982) and in Podolia it has been recorded as late as the Lochkovian Mitkov Beds (Modzalevskaya, compiler 1968), although I am unaware of any more confirmatory work on this interesting occurrence. One of the *Encrinurus* species in the Amphitheatre Group belongs to the *mitchelli* group (Strusz 1980) and is closest to the late Ludlovian *E. rothwellae*. The other is atypical of Australasian species in having a distinct terminal spine.
The nearest limestones in the Cobar Supergroup containing a conodont fauna are 70 kilometres to the east (Pickett 1980). Both limestones are near the base of the Cobar Supergroup but their different ages indicate a very diachronous base extending from the woschmidtii to the pesavis zone. With the possible exception of some poorly preserved trilobites, in particular Encrinurus (Baker et al., 1975; Fletcher, 1975; Lennox 1976) there is no evidence for a pre-Devonian age of the basal beds of the Cobar Supergroup anywhere in the vicinity of Cobar.

The brachiopod fauna in the lower part of the Winduck Group has an Early Devonian aspect based on the occurrence of such genera as Iridistrophia and Nanothyris/Podolella. Very small species of the two latter genera were noted by Boucot (1975) as specially indicative of the lower Gedinnian. Johnson (1979) took the appearance of Nanothyris as marking the base of the Lochkovian in the Eastern Americas Realm. The comparison of species from The Meadows with similar species from Belgium, Bohemia and Podolia (fig. 6) shows a strong resemblance to the Belgian (Gedinnian) and Podolian (Borschov) faunas. The indicated age is Lochkovian, although based of necessity upon correlation via the Podolian sequence. Direct correlation with the type Lochkovian hangs very heavily upon a comparison of Iridistrophia from The Meadows and I. umbella from Bohemia. Other than some resemblances to Bohemian rhynchonellids discussed elsewhere in this paper there is nothing in common at species level with the type Lochkovian using the detailed
### AUSTRALASIA
**The Meadows**
- Sphaerirhynchia sp.
- Protocortezorthis sp.
- Howellella sp.
- Howellella jaqueti
- H. jaqueti multiplicate forms
- Molongia sp.
- Mesodouvillina convexa
- Iridistrophia sp.
- Ancillotoechia duni
- Atrypa cf reticularis nieczlawiensis
- Strophochonetes sp.
- Nanothyris sp.

### WESTERN EUROPE
**Gedinnian**
- P. fornicatimcurvata
- H. mercurii subsp.
- H. mercurii s.l.
- ?Homeospira goudmontensis
- Mesodouvillina triculata
- Schuchertella euzona
- Camarotoechia aequicostata

### CENTRAL EUROPE
**Lochkovian**
- Plethorhyncha altera
- Mesodouvillina subinterstrialis
- Iridistrophia praemembracula
- Camarotoechia nucula (partim)
- Atrypa reticularis nieczlawiensis
- Strophochonetes spp.
- Podolella rensselaeroides

### EAST EUROPE
**Borschov / Chortkov**
- Howellella angustiplicata
- Howellella a. zaleszczykiensis
- Mesodouvillina subinterstrialis
- Iridistrophia praemembracula
- Camarotoechia nucula (partim)
- Atrypa reticularis nieczlawiensis
- Strophochonetes spp.
- Podolella rensselaeroides

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**Fig. 6.** Comparison of The Meadows fauna with species from classic European type sections. The basis for these comparisons will be found in the remarks following description of the relevant Australasian species.
faunal lists compiled by Chlupáč (1976). The earlier part (Borschov horizon) of the Lochkovian is indicated using the ranges specified by Nikiforova et al. (1985). In the Rhenish facies the closest faunas are those in the type early Gedinnian Schistes de Mondrepuits (Asselberghs 1930, Boucot 1960) and the H dinghausen Beds (Dahmer 1951). Garratt and Wright (1988, p. 653) regarded the faunas containing Howellella jaqueti as being Lochkovian because of the lack of hysterolitids or Nadiastrophia.

The multiplicate forms of Howellella jaqueti from the highest part of the Winduck Group suggest a late Lochkovian age because of the strong resemblance to H. angustiplicata zaleszczykiensis from the Podolian Chortkov and Ivane horizons.

It might be argued that preservation in a sandy matrix is inadequate for truly reliable comparisons of species, particularly when the type Gedinnian reference faunas are also in a sandy or silty lithology and deformed as well. In such circumstances the Winduck Group can best be regarded as equating with some or all of the Lochkovian or Gedinnian. The assemblage sequence (Fig. 6) based upon the measured sections (Fig. 5) is generally in accord with the provisional sequence used for correlations in central New South Wales (Sherwin, 1980; Glen et al., 1985; Young, 1989). The Nanothyris fauna appears to be comparatively short lived and there is little evidence in The Meadows area for Howellella jaqueti persisting very high into the Pragian as postulated in previous works.
The Early Devonian brachiopod fauna described from the Maradana Shale in the Manildra district (Fig. 1) by Savage (1973, 1974) was also dated as Lochkovian / early Gedinnian but has little in common with The Meadows fauna even at generic level. The differences are doubtless attributable to facies differences.

The similarities between The Meadows fauna and that from the Mount Ida Formation (Talent 1965) in the Heathcote district of Victoria, in particular Mount Ida Unit 3 (Pleurodictyum Beds), have been noted in the descriptions of Mesodouvillina convexa and Molongia. The Mount Ida Formation is a quartz-rich clastic sequence similar to the Winduck Group and on internal evidence Unit 3 has been dated as early Gedinnian (Holloway and Neil 1982). The Heathcote sequence contains graptolites but none has been found any higher than Unit 4 of the Dargile Formation, several hundred metres below the base of the Mount Ida Formation. The single specimen of Monograptus I found in Unit 4 of the Dargile Formation has a poorly preserved proximal end and although the dimensions are consistent with M. transgrediens it cannot be distinguished with any confidence from several other Late Silurian dubius type monograptids, a group believed to have been extinct by Lochkovian time (Koren', 1979, 1983).

In the Craigilee Beds near Rockhampton in Queensland there is an association of Encrinurus and Molongia elegans capricornae (McKellar, 1969) with several genera known from The
Meadows district, but no comparable species.

The lower part of the Baton Formation in New Zealand contains a Gedinnian fauna (Boucot et al., 1963) with several species possibly conspecific with those in the Winduck Group; these are discussed at greater length in the taxonomic section. The basal part of the Lochkovian is indicated by the conodont fauna (Bradshaw, 1988). The fossiliferous members of the Baton Formation consist of moderately calcareous mudstone and thin sandy layers (Willis 1965) suggesting a more distal environment than for the Winduck Group or the sandy beds in the Amphitheatre Group.

Palaeobiogeography

The composition of The Meadows fauna is in accord with the previously recognised Old World Realm character of Australasian Early Devonian brachiopod faunas (Boucot, Johnson and Talent 1969; Talent 1972; Boucot 1975; Johnson 1979). The presence of *INanothyris* is suggestive of the Eastern American realm but the preservation of such small specimens in a coarse lithology is inadequate to rule out the similar *Podolella* from the Old World realm.

The distribution of Old World realm brachiopods is in accord with Early Devonian graptolites (Jaeger 1979), both being associated with inferred Devonian tropical and subtropical palaeolatitudes. The Devonian continental reconstruction and prevailing ocean currents proposed by Heckel and Witzke (1979, text-fig. 5) explains how graptolites from
Europe and North America could have migrated westwards to Australasia on a south equatorial current but it is doubtful if the same means was available for brachiopods, even at the larval stage, because of the distance involved. Heckel and Witzke's hypothetical south equatorial current would have flowed uninterrupted between land masses separated by almost one third the earth's circumference. This distance is more than 13,000 kilometres if the diameter of the Earth is assumed to have remained more or less constant since the Devonian and more than ten times the marine biogeographic barrier of 700-1000 kilometres proposed by Talent (1985; et al., 1986) as likely to lead to differentiation into discrete benthic faunal provinces on continental shelves.

Migration eastwards from Australasia to North America by "creeping" along continental margins would require passage through the comparatively cold water Malvinokaffric realm. Another possibility using the same reconstruction (Heckel and Witzke, 1979) is eastward migration (Africa - Arabia - India - Australasia) along the north coast of Gondwanaland. Access from the west to the east coast of Australasia could have been by the route between the Austalasian and Antarctic plates suggested by Heckel and Witzke. Later work by Witzke & Heckel (1988) did not extend continental reconstructions as far the Australasian plate.

Early to Middle Devonian sandstones, dated by fish faunas, are known from Western and Central Australia (Strusz, 1972;
Long et al., 1988) but the only confirmed marine fossiliferous Early Devonian deposits are the erratics from the north of South Australia (Campbell et al., 1977), of uncertain provenance.

The geographic relationship in Early Devonian time of the areas of deposition for the Cobar Supergroup, Mount Ida Formation and Baton Formation is speculative. Sediment composition suggests that the first two units were deposited nearer to a continental shoreline, although the nature of the basement below the Amphitheatre and Winduck Groups is uncertain. Cooper (1975) proposed a model with deposition of the Baton Formation in a southern offset of the trough or basin where the Mount Ida Formation was deposited. Most of the distance between The Meadows and Heathcote is buried deep below the Cainozoic Murray Basin and the terranes recognised in Victoria cannot be confidently extrapolated to the north (Leitch and Scheibner, 1987; Packham, 1987). The Baton Formation is believed to have been comparatively close to Tasmania and Victoria before New Zealand was separated from the Australasian plate by late Mesozoic rifting (Hayes and Ringis, 1973). Philip (1967) dated the Bell Shale of Tasmania as Gedinnian but the fauna from this formation described by Gill (1950) has nothing recognizable in common with the Cobar Supergroup fauna in The Meadows district, although this can be attributed to different facies. However the relationships of Palaeozoic terranes in southeastern Australasia are far from being established (Schmidt and Embleton, 1987).
SYSTEMATIC DESCRIPTIONS

Unless otherwise mentioned the morphological terms are those defined in the Treatise (Moore, ed., 1965). Catalogue numbers with the preface MMF are from the fossil collection of the New South Wales Geological Survey; the preface AMF refers to the collection of the Australian Museum, Sydney; ANU to the Geology Department, Australian National University, Canberra; NMV to the Museum of Victoria, Melbourne. Dimensions are in millimetres and measured on internal moulds because the rock seldom splits along the commissural plane of contained brachiopods and external moulds are always short of true length in consequence. The height of valves, with the exception of ?Nanothyris, is measured to the nearest millimetre because of the inherent parallax error in measuring a profile. Brachiopods are referred to as small or large rather than young or old because it cannot be shown without doubt that size variations within a single species are purely a function of age unless there is some corroborative evidence such as thickening. Field locality details are given in appendix 1.

Family SCHIZOPHORIIDAE Schuchert & LeVene 1929
Subfamily DRABOVIINAE Havlicek 1950
Genus Salopina Boucot 1960, emended Walmsley 1965
?Salopina sp. (Fig. 7)

Material: MMF 22925(4), 30267(1) and MMF 31394, brachial valves; MMF 22932(1) pedicle valve.
Fig. 7. *Salopina* sp.; A, B, C, D, MMF 31394 brachial valve - A latex cast of internal mould, B internal mould, C counterpart external mould, all x2, D, D1 detail of cardinal area and muscle field x5 approx.; E, G, H, H1 MMF 22925(4) brachial valve - E internal mould x5, G latex cast of external mould x8, H, H1 latex cast of internal mould x5; F MMF 22932(1) internal mould of pedicle valve x3.
Localities: Field localities HF and NB 1, Amphitheatre Group; TM 53 and TM 183c, Winduck Group.

Description: The valves are subcircular in outline and planoconvex in lateral profile, with the pedicle valve being very deep. Maximum width is approximately one third the length from the umbo. The brachial valve has a shallow sulcus; but there is no obvious fold in the pedicle valve. The brachial interarea is orthocline, narrow and uniform in width along the hinge line except near its very rounded cardinal extremities. The pedicle interarea is poorly preserved. The exterior is ornamented by fine costellae; it is difficult to discern the pattern of development described by Walmsley (1965) because the spacing is of the same order as the grainsize of the matrix.

Brachial interior: The sockets are defined by the brachiophores and brachiophore bases. The brachiophore bases are joined to the elevated, boss like cardinal process. The brachiophore bases diverge at approximately the same angle as the brachiophores and continue anteriorly as much lower, subparallel muscle bounding ridges to about mid length of the valve. The muscle field is divided by a low rise marking the internal expression of the sulcus. Fig. 7D shows a thickening at the site of a fulcral plate.

Pedicle interior: The diductor muscle field is subcircular, defined by muscle bounding ridges, continuous with the thicker and higher dental plates. The ridges are much less prominent towards the anterior where they are deflected for a very short distance parallel to the low median adductor ridge dividing the
muscle field. This median adductor ridge extends from the middle of the muscle field to at least the mid length of the valve.

Dimensions:

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<td>MMF 22932(1)</td>
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Remarks: It is uncertain if one or more species is represented here and intraspecific variation is difficult to assess with so few specimens. The material comes from widely separated horizons in the Amphitheatre and Winduck Groups and there is considerable difference in the size of specimens from these two units. The delthyrial cavities in particular are poorly preserved in specimens from the Winduck Group. Pedicle valves of this kind are difficult to separate in a mixed assemblage of similarly sized salopinid and isorthid species, the more so if the pedicle interiors are poorly preserved and tectonically deformed. Some of the pedicle internals of even well preserved *Salopina* illustrated by Walmsley *et al.* (1969) have a marked isorthid aspect.

Strusz (1982) listed all known Australasian species of *Salopina* when describing a new species, *Salopina mediocostata*. Only the specimens from the McIvor Formation in the Heathcote district of Victoria are comparable with The Meadows species, in particular the brachial valve illustrated by Talent (1965, plate 10, figure 9). The McIvor Formation is a sandy unit like
the Winduck Group and believed to be of late Ludlow to Pridoli age (Garrett, 1983). Lenz and Johnson (1985a) described Salopina cf. submurifer from mid to late Lochkovian limestone in the Wellington district. Their material consisted of isolated brachial valves with prominent, very elongate muscle bounding ridges.

Outside of the Australasian region the closest species is Salopina lunata from Ludlovian and Downtonian strata in England (Walmsley, 1965). There is general agreement in the shape of the valves and the muscle fields but S. lunata has much better developed fulcral plates.

Family DALMANELLIDAE Schuchert 1913
Subfamily Isorthinae Schuchert & Cooper 1931 emended Walmsley & Boucot 1975

Genus Isorthis Kozlowski 1929 emended Walmsley & Boucot 1975
Subgenus Protocortezorthis Johnson & Talent 1967

Protocortezorthis sp. (Fig. 8)
?1901a Orthis (Schizophoria?) Gürich p. 502, pl. 18, figs. 9-10

Material: MMF 30580, 30590, 30602, 30627, 31374(1) and (2), 31376, 31378(7), 31379. Both valves are represented on larger slabs.
Locality: TM 5i, TM 20b, TM 42, TM 51b, TM 56b, TM 57, TM 58/1, TM 58/4, TM 58d, TM 59, TM 75, TM 100e, TM 102a, TM 102e, TM 125b, TM 151, TM 183c and TM 192c, all Winduck Group; TM 312, Amphitheatre Group mudstone.
Fig. 8. *Isorthis (Protocortezorthis)* sp.; A, B, C, D MMF 31378(3) - A internal mould, B latex cast of interior, C latex cast of exterior all x1.75, D, D1 latex cast of muscle field x3.5; E, F, G, H, I MMF 31374(2) "gerontic" brachial valve - E latex cast of exterior, G latex cast of interior showing vascular system, H internal mould, I anterior profile, all x1.75, F, F1 cardinal area and muscle field x3.5; J, K MMF 31378(7) internal mould of pedicle valve and latex cast x1.75; L, M MMF 30580 latex cast of external mould of pedicle valve, M anterior profile x1.75.
Description: The profile is ventribiconvex, the brachial valve being distinctly less convex than the pedicle valve. The pedicle valve is deep, the curvature being greatest along the axial plane but does not become carinate. Carinate valves are obviously deformed, the carinae being parallel to the cleavage, not the axis of the valves. The brachial sulcus is broad and shallow with the axis of the sulcus is sharply defined. The outline of least distorted specimens is ovoid, the width being greater than length and greatest at about mid length. The hinge line is approximately one third the total width. The surface is covered by radial costellae of differing widths that increase by bifurcation and intercalation, but most are unbranched and extend from the umbo. The point of bifurcation of individual costellae shows no obvious pattern.

Brachial valve exterior: The umbo is very subdued and the interarea anacline and narrow. On the smallest specimens there is a notothyrium divided by the cardinal process but in even medium sized specimens the notothyrium is closed by an expanded cardinal process. Small valves are more circular than the larger, even after allowing for tectonic distortion. This is reflected by the fanning arrangement of the costellae. The postero-lateral costellae are so curved that at the margin of larger valves they are parallel to the hingeline. The sulcus begins almost at the posterior margin and, although the trough is sharply defined, the sulcus as a whole is very shallow because of its width giving a flattened appearance to the valve. The number of costellae measured at a radius of 10 mm
from the umbo varies from 67 to 74.

Brachial valve interior: The dental sockets in small specimens are defined by the brachiophores and the edge of the interarea. In larger specimens the sockets are sunk in thickened socket pads (Walmsley 1965). The brachiophores in the smallest valves are bladelike but larger valves show progressive development of a robust flange on the inner sides. In smaller specimens the cardinal process is transversely elongate, bilobate, effectively filling the notothyrial cavity, but quite discrete from the brachiophore bases. In the largest specimens the massive cardinal process fills the notothyrial cavity, as well as being in contact with the brachiophore bases. The shaft is indistinguishable from the low ridge marking the interior of the sulcus. Even in the smallest specimens the blade-like brachiophores are supported by short brachiophore supporting plates. In larger specimens these plates fill the space between brachiophores and valve floor and continue anterolaterally to define the posterior adductor muscle field. The crescentic ridges defining the anterior adductor muscle field are comparable in relief. The ovoid to subcircular brachial muscle field extends anteriorly for about half the length of the valve and is divided medially by the low ridge marking the interior expression of the sulcus. The mantle canal system is indistinct in even the largest specimens. One canal extends from the anterior edge of the anterior muscle field to the valve margin. This canal is flanked by two others that diverge anteriorly. The periphery bears impressions of
the external costellae developed continuously almost to the interarea. The internal details of some very large specimens are very indistinct, possibly a result of resorption of shelly matter.

Pedicle valve exterior: The pedicle valve has a slightly overhanging umbo and a gently curved apsacline interarea. The delthyrium is open and equilateral in outline.

Pedicle valve interior: The teeth are robust and triangular in cross section. They are supported on short dental plates continued anteriorly, much reduced in relief, as boundaries of the bilobate diductor muscle field. The sides of the field are approximately parallel, although some specimens show a very slight anterior convergence. The muscle scars, where sufficiently impressed to show at all, are rounded anteriorly and are separated by the adductor muscle field, linear in the delthyrial cavity, but widened anteriorly to about one third the width of the pedicle muscle field. The muscle field as a whole has a length:width ratio of approximately 2:1 and extends for half the length of the valve. The periphery bears the impression of the external costellae especially along the anterior margin.

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<td>MMF 31374(3)</td>
<td>24.0</td>
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</table>
Remarks: The subfamily Isorthinae was reviewed in some detail by Walmsley and Boucot (1975) who reduced several recognised dalmanellid genera to subgeneric status within a redefined Isorthis, following a partial revision by Harper (1973). Using the criteria (Table 1) listed by those authors the "best fit" is I. (Protocortezorthis). The major departure from their diagnosis is the weak transverse ridge dividing the brachial muscle field in even the most "gerontic" specimen from The Meadows. The recognition of posterior and anterior halves in the brachial muscle field of Meadows material depends upon a consistent mid-length break in the muscle bounding ridges. Notwithstanding the comments of Walmsley and Boucot, there is no obvious transverse ridge in many of their illustrations of I. (P.) fornicatimcurvata where the posterior and anterior muscle bounding ridges are likewise disjunct. Havlíček (1977) considered Protocortezorthis and Tyersella to be very closely related genera, differing in the posterior muscle scars and the development of a bilobate and "ponderous" cardinal process in adult or gerontic stages of the latter genus. This kind of cardinal process is present in the larger Meadows specimens but the muscle scars are clearly protocortezorthid. However, Walmsley and Boucot recognise a bilobate or ovoid cardinal process as a characteristic of some I. (Protocortezorthis) species. Melou (1981, fig. 4) illustrated a relatively massive cardinal process in a revision of I. (P.) miloni. This
development of a massive cardinal process in gerontic individuals is a common feature but few taxonomic works describe changes with growth.

The closest species to material from "The Meadows" are \textit{I.}(P.) \textit{festiva} Philip and \textit{I.}(P.) \textit{fornicatimcurvata} (Fuchs). Both have poorly defined transverse muscle ridges in the brachial muscle field and a narrow muscle field in the pedicle valve. Philip's (1962) material included only one pedicle valve of \textit{I.}(P.) \textit{festiva} so that the extent of variation in pedicle muscle patterns is not known. The brachial muscle field extends for almost two thirds rather than half the length of the valve and the myophore of the cardinal process is rounded instead of transversely elongate. These features are true also of the Lochkovian specimens from Manildra assigned to \textit{I. festiva} by Savage (1971). The brachial valve interiors illustrated by Philip show the posterior muscle bounding ridges quite disjunct from the the brachiophore supporting plates, a feature stated by Johnson and Talent (1967) to be characteristic of \textit{Reeftonia}, a late Early Devonian genus, although Talent (1963, fig. 19) shows the brachiophore supporting plates continuous with the muscle bounding ridges in \textit{Reeftonia alpha}. Even in The Meadows material some specimens show a distinct inflection and loss of relief near the mid point in the posterior muscle bounding ridges. The specimen of \textit{R. marwicki} illustrated by Cooper and Bradshaw (1986) shows the protocortezorthid condition of brachiophore supporting plates continued as muscle bounding ridges.
Harper (1973) showed from a study of 2,099 North American specimens that there is considerable variation in *I. (P.) fornicatimcurvata*, especially in the adductor ridge of the pedicle valve, but there is a consistency in the marked anterior taper of the narrow diductor muscle field. The Meadows specimens by contrast have diductor muscle fields with almost parallel sides whatever variation exists in the adductor ridge. The strongly ventribiconvex profile of *I. (P.) fornicatimcurvata* is a point of resemblance. The exterior ornament is impressed more strongly on the internal moulds of *I. (P.) fornicatimcurvata*, especially material from the type locality, than on specimens from "The Meadows".

Melou (1981) revised *I. (P.) miloni* and *I. (P.) trigeri* from Amorican Massif strata comparable in age to the Cobar Supergroup, but both species are almost biconvex in comparison with The Meadows ventribiconvex material. Furthermore, *I. (P.) trigeri* has a brachial muscle field more typical of *I. (Tyersella)*, an observation made before Melou's revision by Walmsley and Boucot (1975) and based upon an examination of specimens collected at several west European localities.

Lenz and Johnson (1985a) described two new species of *I. (Protocortezorthis)* from the Garra Formation in New South Wales, extracted as silicified valves from limestone. *I. (P.) impressiva* is only weakly ventribiconvex and has a more prominent ridge dividing the diductor muscle field in the pedicle valve than material from "The Meadows". *I. (P.) rotunda*
is almost equally biconvex, unlike the ventribiconvex profile of "The Meadows" specimens.

The New Zealand species *I. (P.) allani* (Shirley, 1938) has comparatively robust muscle bounding ridges and differs from "The Meadows" material in having a subequally biconvex profile.

Genus *Levenea* Schuchert & Cooper 1931 emended Walmsley & Boucot 1975

*?Levenea* sp. (Fig. 9)

**Material:** MMF 31375 (1, 3) pedicle valves; MMF 31378 (13, 14, 16) brachial valves, MMF 31378 (15, 17, 18) pedicle valves; MMF 31379 (1) pedicle valve, MMF 31379 (2) brachial valve. All specimens have internal and external counterparts.

**Localities:** TM 42 and TM 57.

**Description:** The valves vary from subcircular to transversely ovoid although it is not always clear how much of this variation resulted from tectonic deformation. The maximum width is approximately one third the length from the umbo. The lateral profile is almost planoconvex, the brachial valve being almost flat. The sulcus in the brachial valve extends from almost the umbo to the anterior margin becoming wider and less distinct anteriorly. A very weak fold on the pedicle valve similarly becomes less distinct anteriorly, although it is emphasised in laterally compressed valves. The orthocline brachial interarea is very narrow and can be distinguished for
Fig. 9. *Levenea* sp.; A, A1, H MMF 31374(1) latex casts of internal and external moulds of small brachial valve possibly referable to this genus – A x3.3, H x2; B-E MMF 31378(19) interior and exterior of brachial valve – B, B1 latex cast of cardinal area and muscle field x4, C internal mould, D latex cast, E latex cast of exterior all x2; F, F1 MMF 31378(14) latex cast of brachial muscle field showing cross section of brachiophore x4; G MMF 31379(1) latex cast of external mould x1.75; I, J MMF 31379(4) latex cast and internal mould of pedicle valve in typical state of preservation x1.75.
only about half the length of the hinge line. The pedicle interarea is low and steeply apsacline. The surface ornament consists of costellae increasing in number by intercalation.

Brachial interior: The sockets are bounded by the brachiophore supporting plates which diverge at approximately 90°. In some larger valves there are low fulcral plates (Fig. 9C). There is no obvious thickening of the valve wall to suggest socket pads. The brachiophores are slightly thicker than the supporting plates and have a blade like free edge. The myophore of the cardinal process is bulbous, more so in larger valves, with a shaft that does not extend anteriorly beyond the brachiophore bases. The adductor muscle field is subcircular and quadripartite, the quadrants being subequal in area. The field is divided by a low, broad ridge marking the interior expression of the sulcus. The posterior muscle bounding ridges are aligned with the brachiophore supporting plates and have a much greater relief than the anterior bounding ridges. In some valves the anterior bounding ridges are barely visible. The gap between the posterior and anterior bounding ridges coincides with deeply impressed mantle canals.

Pedicle interior: The teeth are simple and triangular in cross section. The short dental plates are continuous with low muscle bounding ridges that enclose a slightly longer than wide, subpentagonal diductor muscle field. The adductor muscle trace forms a low ridge that is very broad anteriorly.
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**Remarks:** The genus *Levenea* was reviewed by Walmsley and Boucot (1975). It is clear from their list of species assigned to and removed from *Levenea* that some confusion has existed as to its recognition. Their definition stressed the importance of the shape of the pedicle muscle field and delthyrial cavity in separating *Levenea* from *Isorthis*. In the specimens collected from "The Meadows" this part of the valves is poorly preserved even though there is no obvious wear on the exterior or periphery. Some poorly preserved orthid valves in the Winduck Group could be assigned to *Levenea* or *Salopina*. The attribution of these specimens to *Levenea* has thus been left questionable. Confusion with *I. (Protocortezorthis)* is less likely because the muscle field in that genus is much longer and comparatively narrow, features easily discernable in even poorly preserved interiors. In the Winduck Group (?)*Levenea* is also distinguished from *Protocortezorthis* by a flatter, more rounded brachial valve and a bulbous instead of laterally transverse bilobate myophore in the cardinal process. The marked contrast in relief of the posterior and anterior muscle bounding ridges is a feature of other *Levenea* species, in particular *L. loveni* (Lindstrom) which has also well impressed vascular markings at the break between the posterior and anterior bounding ridges (Walmsley & Boucot, 1975 pl. 9, fig. 33).
Superfamily STROPHEODONTACEA Caster 1939
Family Douvillinidae Harper & Boucot 1978
Subfamily Mesodouvillininae Harper & Boucot 1978
Genus Mesodouvillina Williams 1950

Subgenus Mesodouvillina (Mesodouvillina) Harper & Boucot 1978

Mesodouvillina (Mesodouvillina) cf. convexa (Dun) (Fig. 10)

cf. 1898 Schizophoria convexa Dun p. 162-3; pl. 17, fig. 3.
non 1898 Schizophoria convexa Dun pl. 17, fig. 5.

? 1965 Stropheodonta limbimura Talent p. 28; pl. 5, fig. 11, pl. 14, figs 1-3.


Holotype: Of M. (M.) convexa (Dun) by monotopy, MMF 17, an internal mould of a pedicle valve.

Type locality: Erratic blocks within Cretaceous sediments at White Cliffs.

Other material possibly referable to this species: MMF 19461 an internal mould of a pedicle valve from the White Cliffs erratics; MMF 30618, 30626 and 31377, slabs with several pedicle and brachial valves from The Meadows.

Diagnosis: Profile of pedicle valve convex; pedicle muscle field bounded by parabolic muscle bounding ridges, diverging posteriorly at more than 90° usually open anteriorly.

Description (of material from The Meadows): The profile is gently concavo-convex or plano-convex. Larger specimens,
Fig. 10. *Mesodouvillina convexa* (Dun); A-D MMF 17 holotype pedicle valve from erratic block at White Cliffs - A, B internal mould and latex cast, C lateral profile, D anterior profile, all x1.25; M. (*Mesodouvillina*) cf. *convexa* (Dun); E, F, I, I1 MMF 31377(1) - E, F latex casts of brachial exterior and interior x1.5, I, I1 MMF 31377(1) latex cast of brachial valve x4.5; G, H MMF 31377(3) latex casts of external and internal moulds of pedicle valve x2; J, J1 MMF 31378(5) latex cast of internal mould of small brachial valve showing facets on bilobed cardinal process x4; K MMF 30626 latex cast of laterally compressed pedicle valve showing well impressed adductor scar track x1.5; L, L1 MMF 31377(2) latex cast of pedicle interior showing struts at posterior end of adductor muscle field x4.5; M MMF 31378(2) latex cast of internal mould of small pedicle valve x2.
including the holotype, show an increase in curvature towards the anterolateral margin, though in no sense could it be described as geniculate. The length/width ratio is difficult to estimate as most specimens have suffered some degree of deformation but is approximately 1:1.4 (approximately 1:1 in the holotype of *M.*(*M.*) *convexa*). Maximum width varies from the hinge line to about mid length because the cardinal angles are slightly obtuse to right angled. The ornament is unequally parvicostellate, most clearly seen on the smallest specimens; the spacing of the coarser costellae is variable, being widest near the hinge line. The ornament is much less distinct on the brachial valve. This unlikely to be a result of posthumous abrasion because of the concave surface. The interarea of both valves is very narrow with no obvious pseudodeltidium or chilidium. It is unclear on one small pedicle valve if the break in the hingeline was a delthyrium or damage.

Brachial interior: The hinge line is denticulate for about half its length. The short socket bounding ridges in least distorted valves diverge at about 30° to the hingeline and become thicker anterolaterally. The bilobate cardinal process has a wide base, the lobes being slightly divergent. The facets on each lobe are grooved and face posteriorly. The subcircular adductor muscle field is bounded by low posterolateral ridges continuous with a similarly low and tapered myophragm of variable length. The myophragm is flanked by two ridges of similar relief and variable length though always longer than the myophragm. Some valves show a variably
developed brevisepptom. The surface is finely endospinose surrounding the muscle field and more coarsely endospinose in front of the field in some specimens, especially in line with the ridges flanking the myophragm. The exterior ornament is variably impressed on the interior.

Pedicle interior: The hinge line is denticulate for approximately half its length and widens gradually towards the minute pseudodeltidium. The diductor muscle bounding ridges form an inverted parabolic outline, being open anteriorly in the majority of specimens. In very small valves the ridges are very indistinct. In specimens with anterior muscle field closed the ridges are curved inwards then posteriorly to join the low myophragm present in even small valves. The inwards curvature is almost rhomboidal in some valves. The myophragm is most prominent in the anterior of the muscle field, becoming indistinct posteriorly and in contact with the ventral process in very few specimens. The denticles are raised above and are slightly higher than the hinge line and are supported on short plates parallel to the ends of the muscle bounding ridges. There is a gap in the mid point of the denticulate part of the hinge line in a sufficient number of specimens to suggest a functional pedicle. This gap is more prominent in small specimens. The ventral process is short, low and joined anteriorly by short struts (Harper and Boucot 1978) that are curved parallel to the muscle bounding ridges and mark the posterior end of the pedicle adductor scars. The adductor scars are faint anteriorly although in one specimen there is a
well defined track of adductor scar impressions. The surface is finely endospinose though much less intensely within the muscle field. The external ornament is variably impressed laterally but is less obviously parvicostellate than on the exterior.

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Remarks: Dun (1898) based *Schizophoria convexa* on brachial and pedicle valves in separate slabs. An examination of his types shows that the pedicle valve is attributable to *Mesodouvillina* and the brachial valve is probably *Iridistrophia*. The species name *convexa* has been attached to the pedicle valve because of its better preservation. This species has been assigned to *Mesodouvillina* (*Mesodouvillina*) using the criteria specified by Harper and Boucot (1978). The gentle convexity suggests the subgenus *M.* (*Mesodouviella*) but some of the species included in *M.* (*Mesodouvillina*) by Harper and Boucot, (eg. *M. limbimura*), are less convex than *M. (M.) convexa*. Separating these two subgenera seems to be somewhat subjective. In the absence of a brachial valve any further speculation on the generic identity...
of *M. (M.) convexa* is pointless. For the same reason the material from The Meadows can only be compared with this species and although better preserved than the White Cliffs material is not considered sufficiently well preserved to erect a new species.

*M. (M.) cf. convexa* from The Meadows resembles the Victorian *M. limbimura* (Talent, 1965) in the pedicle valve, less so in the brachial valve, although in terms of size the Victorian species is much closer to the type material from the White Cliffs erratics. The lateral profile of the brachial valve of *M. limbimura* was not mentioned but I have examined the types and noted that the brachial valve is planar, becoming mildly geniculate near the anterior margin of large specimens. The holotype brachial valve of *M. limbimura* is represented by internal and external moulds (NMV P59559 and P59558 respectively) of two distinct individuals. One of the paratype pedicle valves (NMV P59507, figured pl. 5, fig. 11, Talent 1965) differs from *M. convexa* in being planar for most of its length but abruptly geniculate near the anterior margin. However two other pedicle valves on the same slab as this paratype type show less geniculation, one having the same gentle convexity as The Meadows material, so that the geniculation is unlikely to be an artifact of preservation. The very slight convexity of the valves suggests the subgenus *M. (Mesodouviella)* instead of *M. (Mesodouvillina)* as assigned by Harper and Boucot (1978). Savage (1974) compared some very small silicified pedicle valves from Manildra with *M.*
Fig. 11 *Mesodouvillina limbimura* (Talent); A, B, D NMV P39507 paratype pedicle valve – A internal mould, B lateral profile, D latex cast, all x1.25; C, E, E1 NMV P59559 holotype brachial valve – C latex cast x1.25, E, E1 cardinal area x3.
*limbimura*. These are comparable with the smallest Winduck Group specimens of *M. (M.) cf. convexa* but are too fragmentary for useful comparison with the larger valves.

The pedicle valves from the Baton Formation, New Zealand (Willis 1965) identified by Shirley (1938, pl. 40 fig. 13 only) as *Schizophoria provulvaria* (Maurer) and *Brachyprion* sp. (pl. 41 fig 15) may be referable to *M. convexa* but identification is hindered by poor preservation. Harper and Boucot (1978) figured undoubted *Mesodouvillina (Protocymostrophia)* from the same formation but it is difficult to relate their material to that of Shirley for the same reason.

The European species *M. subinterstialis* (Kozlowski 1929) has a comparable brachial interior to *M. (M.) cf. convexa* and, except for a more developed adductor scar, a comparable pedicle interior as well. *M. triculta* (Fuchs) is similar in most respects to "The Meadows" material except for the forms of *M. triculta* with slightly alate cardinal angles. The illustrations of Harper and Boucot (1978) show the external ornament so strongly impressed upon the internal moulds as to suggest that the shelly matter of the valves was very thin.

Smith (1980) described several species of *Mesodouvillina* from Arctic Canada that display considerable intraspecific variation. An unnamed species, *Mesodouvillina* sp. 2, is closest to *M. (M.) cf. convexa* but all the Canadian species have more deeply impressed ventral adductor scars and some forms of *M. musculusvarius* Smith have remarkably divergent diductor...
Several pedicle valves of the Winduck specimens are encrusted with *Aulopora* growths, primarily on the anterior half although at least two valves have the overgrowth concentrated on the left side (viewed from above). It is likely that this overgrowth was present in life otherwise it would be reasonable to expect it on the interior surfaces of brachial valves as well, the interior of a loose brachial valve having much the same geometry as the exterior of a pedicle valve. It is unlikely that *Aulopora* was concerned with settling on either a convex or concave surface because there is one example of an overgrowth on the interior of a pedicle valve of *Protocortezorthis* (MMF 31378c). Consequently the apparent preference for the pedicle valve suggests that the brachial valve was inaccessible, i.e., the pedicle valve was uppermost. This conflicts with suggestions that the brachial valve was uppermost in Early Devonian stropheodontids (Babin & Racheboeuf 1975). Similar conflict between "logical analysis of functional morphology" and overgrowths on geniculate Silurian strophomenids was reported by Spjeldnaes (1984, p. 232) who inferred that the brachiopods lived in a vertical position. Some brachial valves in his material were also encrusted indicating that they were accessible to current-borne larval stages of encrusting organisms. In an environment subject to currents a convex upwards presentation would possibly give the brachiopod more stability. Only a very strong current would have been likely to produce sufficient Venturi effect to move
the valve as well as overcome the suction of a downwardly facing concave valve.

*Mesodouvillina (Mesodouvillina) sp.* (Fig. 12)

**Material:** MMF 22925(2) an incomplete brachial valve; MMF 22925(3) an external mould of a pedicle valve; MMF 22929 and 22930 pedicle valves.

**Locality:** Field localities NB1 and HF, Amphitheatre Group.

**Description:** The valves are concavo-convex in profile, the pedicle valve being quite strongly curved. The greatest width is along the hinge line; the small valves are distinctly alate. Both valves are parvicostellate with the ornament being better developed on the pedicle valve. None of the specimens is sufficiently well preserved to show any detail of the interarea or what proportion of the hingeline is denticulate. The delthyrium is open; all pedicle valves are small.

**Brachial interior:** The socket ridges are bladelike and their posterior ends are in contact with the more prominent muscle bounding ridges diverging from the bilobate cardinal process. The posterior ends of the muscle bounding ridges are arcuate, forming a semi-circle at the posterior end of the muscle field; anteriorly they join low linear divergent ridges that extend over half way to the valve margin. The muscle field is divided by a pair of slightly divergent low ridges or brace plates extending from the cardinal process for about one third the length of the valve. These ridges are distinctly endospinose on their anterior halves.
Fig. 12 *Mesodouvillina (Mesodouvillina)* sp.; A, B, E, E1 MMF 22925(2) latex casts of internal and moulds of brachial valve - A exterior x2, B interior x1.75, E, E1 brachial muscle field x6; C latex cast of brachial exterior x1.75; D, F, F1 pedicle valve MMF 22929 - D, D1 latex cast of pedicle interior, F latex cast of exterior both x5.
Pedicle interior: The diductor muscle field is semi-elliptical in outline, open anteriorly, and defined laterally by well developed muscle bounding ridges. The internal surface bears the imprint of the external costellate ornament.

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Remarks: This description is based upon a very small number of individuals and the pedicle internal details are taken from very small valves. The single large pedicle valve consists of an external mould only. Nonetheless the morphology is consistent with *M. (Mesodouvillina)* assuming that larger pedicle valves do not develop structures that become apparent only with growth. The strong convexity of the pedicle valves in all growth stages distinguishes this species from *M. (Mesodouvillina) convexa* in the Winduck Group.

The endospinose ridges in the brachial valve are suggestive of the braceplates in the Shaleriidae but the widely diverging muscle bounding ridges in the pedicle valves favour the Mesodouvillininae. Moreover, Harper and Boucot (1978) refer to incipient brace plates in some species of *M. (Mesodouvillina)*. McKellar (1969) described the species, *Shaleria armaghensis*, from Siluro-Devonian strata in the Rockhampton district of Queensland. The pedicle valve of this species has features typical of *Shaleria* but the brachial valve
interior is very poorly preserved. The specimens collected near Cobar from the Cobar Supergroup compared with *S. armaghensis* by Baker *et al.* (1975) are very similar regarding the pedicle valve but no brachial valves have been found. However the initial divergence of the muscle bounding ridges in the Cobar *Shaleria* is comparable with that of the small *M.* (*Mesodouvillina*) from the Amphitheatre Group. Pending the discovery of more material the possibility remains that the small *M.* (*Mesodouvillina*) described here is in fact a juvenile *Shaleria*.

Superfamily FARDENIACEA Williams 1965

Family CHILIDIOPSIDAE Boucot 1959

Genus *Iridistrophia* Havlicek 1965

*Iridistrophia* sp. (Fig. 13)

1898 *Schizophoria* sp. ind., Dun, p. 163, pl. 17, fig. 1.

1898 *Schizophoria convexa* Dun, p. 162-3, pl. 17, fig. 5.

non 1898 *Schizophoria convexa* Dun, p. 162-3, pl. 17, fig. 3.

1901a *Orthis* sp.; Gürich p. 501, textfig. 1a, b.

Material: MMF 1116 an internal mould of a brachial valve probably referable to this species but selected by Dun (1898) as a type for *Schizophoria convexa*; MMF 22925(1) a pedicle valve; MMF 22936(3) internal mould of a pedicle valve; MMF 22936(4) external mould of pedicle interarea; MMF 31378 a slab with five reasonably complete pedicle valves and two fragmentary brachial valves; MMF 31390 a slab with two pedicle valves and much fragmentary material; MMF 30625 a slab with
Fig. 13. *Iridistrophia* sp.; A, A1, B, D MMF 31378(4) small brachial valve - A, A1 latex cast of interior, B do. of exterior, D internal all x3.5; C latex cast of incomplete brachial exterior showing faint antero-lateral cancellate ornament x1.5; E MMF 31378(8) internal mould of laterally compressed pedicle valve showing impressed adductor muscle scar x1.25; F MMF 31332 internal mould of pedicle valve showing cordate muscle field x1 (from north of The Meadows, Booroondarra 1:100,000 grid ref 401312); G MMF 31377(4) latex cast of exterior of small pedicle valve x3.5; H, J MMF 31378(9) internal mould and latex cast of pedicle valve x1.5; I, I1 do. showing pseudodeltidium and hinge teeth - irregularities in the hinge line are undulations in the latex x4.
fragmentary external moulds; MMF 31391 an external mould of a brachial valve.

Locality: Erratics from White Cliffs; Field localities NB1, HF, TM 5i, TM 50, TM 57, TM 183c, TM 312.

Description: The valves are ovoid with obtuse cardinal angles and maximum width near midlength of the pedicle valve. The length is approximately equal to the width although it is difficult to be certain because all material has suffered some degree of deformation. Small specimens are gently biconvex but with growth the pedicle valve becomes distinctly concave. The brachial umbo is very low with a short, indistinct sulcus. The interarea is poorly developed. The elongate pedicle umbo is low in relief. The pedicle interarea is orthocl ine and very obtusely triangular in outline. The delthyrium in all specimens is closed by a strongly convex pseudodeltidium with a semicircular to subtriangular gap in the hingeline below the pseudodeltidium to accommodate the very high cardinal process. The exterior of both valves is finely costellate, the interspaces being about equal in width to the costellae, rounded in cross section and increasing by intercalation; because of the slow increase in width of new costellae the exterior appears almost parvicostellate. There are 15 costellae, including the slender ends of intercalated costellae, in 5 mm measured 10 mm from the umbo on the pedicle valve. Some costellae show irregularities such as short undulose sections and discontinuities. Away from the umbonal area there is an indistinct cancellate ornament formed by
costellae/growth line intersections.

Brachial valve interior: The dental sockets are bounded by socket plates, diverging from the hingeline at about 55°. The socket plates are curved vertically presenting a concave surface towards the cardinal angles. The bilobed cardinal process is on an elevated base joining the socket plates and extending a short distance between them. This short extension bears a minute node. An indistinct myophragm extends from the cardinal process base about twice as far forward as the socket plates. The remainder of the interior bears the imprint of the external ornament.

Pedicle valve interior: The hinge teeth are pointed extremities of thin dental plates extending just anterior to the hinge line. The dental plates continue anteriorly much reduced as lateral boundaries of the subtriangular diductor muscle field, although the anterior edge of the diductor muscle field is indistinct in most valves. The adductor muscle field is indicated by a poorly defined scar at the edge of the notothyrial cavity. The external ornament is impressed on the interior but becomes progressively fainter near the muscle field.

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Remarks: These specimens agree quite well with the generic diagnosis of Havlíček (1967) who listed all the European species he regarded as belonging to this genus. *I. eodevonica* Havlíček is the closest to the Winduck Group specimens although the type material does not include any brachial valves with a cardinal process. *I. umbella* (Barrande) and *I. iris* (Barrande) have coarser costellae than The Meadows material; *I. elongata* (Barrande) has a well defined concentric ornament superimposed upon the costellae, a feature not discernable in "The Meadows" specimens. With the exception of *I. umbella*, more detailed comparisons with Barrande's species are impossible for want of suitable types showing internal features. *I. praeumbracula* (Kozlowski) from Podolia has a much broader pseudodeltidium and is more rounded in outline than The Meadows specimens. The comment by Nikiforova et al. (1985) that the pedicle valve becomes "moderately to strongly convex anteriorly in mature individuals" is not supported by the neotype (pl. 6, fig 1c), a pedicle valve with a concave anterior profile. The few specimens from the Amphitheatre Group (MMF 22925, MMF 22936 and MMF 31397) differ from those in the Winduck Group in being slightly scutiform in outline and less resupinate, both features hinting at descent from *Morinorhynchus* as proposed by
Havlíček (1967). However the ornament on these specimens is typical of *Iridostrophia* and quite unlike the fascicostellate pattern of *Morinorhynchus*.

In the Australasian region Lenz and Johnson (1985a) attributed some silicified fragmentary valves from the Wellington district in New South Wales to *Iridistrophia*. The socket plates in this material diverge at a very low angle from the hinge line and one specimen shows a very robust median septum unlike any seen in any other species of this genus. Talent (1965), before the definition of *Iridistrophia* Havlíček (1967), identified some poorly preserved valves from Heathcote in central Victoria as *Schellwienella* sp. and indeterminate schuchertellids. I examined Talent's figured material but the preservation is inadequate to be any more specific than the existing determinations. Allowing for the preservation, this material does not differ markedly from that in the Winduck Group. Savage et al. (1979) referred this material to *Iridistrophia* without qualification. The distorted specimens from the Baton Formation in New Zealand identified by Shirley (1938) as *Hipparionyx minor* Clarke have well developed muscle bounding ridges almost continuous across the anterior of the subtriangular pedicle muscle field. This is comparable with the interiors of large pedicle valves from the Winduck Group.

There is a strong resemblance of "The Meadows" specimens to *Orthotetes euzona* Fuchs from the Gedinnian in Belgium, shown by Boucot (1960) to belong to *Schuchertella*, although a generic reassignment is possible following the amount of work done on
brachiopod systematics since that time. However Smith (1980) has noted that the specimens identified by Dahmer (1951) as O. pecten euzona from the Gedinnian Hüninghausen Beds have a resupinate lateral profile typical of Iridostrophia. Asselberghs (1930) did not illustrate or differentiate Schuchertella pecten and S. euzona but it is clear from his description that at least some of his material from the Gedinnian of the Ardennes likewise has an Iridostrophia type profile.

Smith (1980) described two species from the Canadian Arctic Islands. I. thorsteinssoni differs from "The Meadows" specimens in having much more sharply defined, almost right angled cardinal angles and much less divergence between the socket plates and hingeline; I. johnsoni has dental plates confined to the umbo that do not continue as muscle bounding ridges, quite unlike "The Meadows" specimens. Johnson et al. (1973) compared some silicified valves with I. umbella (Barrande) but their material is too fragmentary for reliable comparison.

The specimen of Iridostrophia sp. from the Altai-Sayan region of central Asia, illustrated by Gratsianova (1975), has socket plates thinner than known in other species of this genus; the shape of the cardinal process is not clear. Strophomena deprati Mansuy (1913) from Tonkin is probably referable to this genus and, allowing for deformation, the pedicle valve is very similar to the Winduck Group specimens;
no brachial valves were recorded.

Superfamily CHONETACEA Bronn 1862
Family CHONETIDAE Bronn 1862
Subfamily STROPHOCHONETINAE Muir-Wood 1962
Genus Strophochonetes Muir-Wood 1962

*Strophochonetes* sp. *sensu lato* (Fig. 14)

Material: MMF 31387 a small block containing several pedicle valves.
Locality: TM 151.
Description: The pedicle valves are small and distinctly convex. The width is greatest about one third the length from the hinge line. The cardinal angles are not clear but tend to be slightly obtuse. The exterior is covered by radiating capillae increasing by intercalation. The median capilla is slightly thicker than the others. The hinge teeth are very small and diverge from the hingeline at an angle of about 35°. The median septum is very thin and low, extending no more than a quarter the length from the umbo. The only other feature visible on the interior is the imprint of the capillae. One specimen has a small boss on the hingeline towards the cardinal angle that is probably a spine base.

Dimensions:  

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Fig. 14. *Strophochonetes* sp. sensu lato; A, B MMF 31387(1) la
casts of external and internal moulds x8.
Remarks: These specimens are assigned to *Strophochonetes* because of the prominence of the median capilla and internal features (hinge teeth and median septum) consistent with that genus. Racheboeuf (1981) defined several subgenera of *Strophochonetes* but the general preservation and lack of brachial valves do not permit any more refined determination. Similar material has been described by Talent (1965) from sandstone of the McIvor Formation at Heathcote in central Victoria.

Superfamily RHYNCHONELLACEA Gray 1848
Family TRIGONIRHYNCHIIDAE McLaren 1965
Genus Ancillotoechia Havlicek 1959

*Ancillotoechia duni* (Gürich 1901) (Fig. 15)

1898 *Rhynchonella pleurodon* Phillips; Dun p. 165-6, pl. 17 fig. 16.
1898 *Rhynchonella* sp. ind.; Dun p. 166, pl. 17 fig. 4.
1901a *Rhynchonella Dunii* Gürich p. 504-5, pl. 18 figs. 11, 12a, b.

Neotype: ANU 30469, a complete steinkern.

Type locality: The material described by Gürich was collected from erratic boulders of uncertain provenance in Cretaceous sediments at White Cliffs. In the interests of sound biostratigraphy the neotype has been chosen from accurately
Fig. 15. Ancillotoechia duni Gürich; A–D ANU 30469 neotype steinkern – A dorsal view, B anterior profile, C lateral profile all x4, D, D1 apical region x6; E, E1 MMF 31378(13) latex cast of interior of brachial valve x7.5; F, G AMF 35678 slab with external moulds from White Cliffs erratics – F latex cast of brachial valve, G latex cast of pedicle valve (Dun 1898 pl. 17, fig. 16) both x4.
located in situ material west of The Meadows (field locality 45 of Landrum 1975).

Other material: Several disarticulated and variably distorted brachial and pedicle valves on slabs AMF 35678 and AMF 50981 (type locality, White Cliffs erratics), MMF 31377 and MMF 31378 (The Meadows).

Nomenclatural note: The "-ii" ending of "Dunii" has been simplified to "-i" in accordance with recommendation 31A of the articles of zoological nomenclature.

Diagnosis: A species considered referable to Ancillotoechia with sulcus developed anteriorly only, normally with three plicae; fold low, less distinct, normally with four plicae; flanks with six to seven plicae; apical angle about 95°.

Description: The posterior margin is triangular, the anterior margin rounded except in the largest specimens where the development of a progressively deeper sulcus forms a concave anterior margin. Small specimens are subequally biconvex, the pedicle valve being slightly deeper. The pedicle beak is incurved; the foramen is not clear on any specimen. The length to width ratio is approximately 1:1.2, increasing slightly with growth; the apical angle is about 95°. The maximum width is between two thirds and three quarters the length from the pedicle umbo, the latter distance being more typical of the larger specimens. The plicae are angular and extend unbranched from the umbo. The average number of plicae on the largest specimens is sixteen varying by one or two more or less. In larger specimens there is a well defined pedicle sulcus with very steep sides and a less distinct brachial fold. The sulcus
has three, exceptionally two, plicae and the fold has correspondingly four or three. Because the fold is comparatively low it appears to have only two plicae except on the largest specimens; on distorted specimens this is difficult to recognise.

Brachial interior: The sockets are more or less parallel to the sides of the valve; their inner edges are defined by short socket ridges or very narrow hinge plates. These are conjunct posteriorly and form a short cover at the posterior end of a small septalium. The septalium extends forward as the anterior ends of the much thicker hinge plates. The thin median septum supporting the septalium continues anteriorly, decreasing in relief, for about one quarter to one third the length of the valve. The crurae are not preserved. The plicae are impressed on the interior except at the umbo.

Pedicle interior: The dental plates are slightly divergent, thin, short, no more than one quarter the length of the valve, close to the sides of the valve and similarly curved. The hinge teeth are not clear but the sockets in the brachial valve suggest that they are small. The delthyrial cavity has a slightly thickened floor, with no imprint of the external plicae, but individual muscle scars cannot be differentiated.

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52
Remarks: Gürich (1901a) designated a pedicle valve as his type for this species and questionably assigned the corresponding brachial valve. The complete steinkern of the neotype confirms his description. The abnormal length/width ratio of AMF 50981 (Dun 1898, pl. 17 fig. 4) is a result of flattening.

The distinction between Ancillotoechia and Cupularostrum is unclear as noted by Bowen (1967); Johnson (1975) considered that there is uncertainty as to how broadly the genus Ancillotoechia can be applied. The differences in shape mentioned in the Treatise, regarded as a distinguishing feature between the two genera, are not supported by the illustrated genotypes. There are some distinctive internal features in Cupularostrum but the persistence of some of these throughout a population has been questioned by Nikiforova et al. (1985). The stout brachial median septum characteristic of Cupularostrum does not occur in The Meadows specimens.

The Bohemian species and genotype A. ancillans (Barrande) differs from A. duni in having far fewer plicae (9-10, approximately half the number in A. duni) and a more triangular outline. The species of Ancillotoechia that most closely resemble A. duni, based upon the external morphology, are A. aptata Johnson, A. gutta Johnson, Boucot & Murphy and A. magnaplica Smith from north America. All these species have a sulcus with three plicae and a fold with four, there being few variations noted within populations of each. This pattern of a
fold and sulcus with four and three plicae respectively is repeated in several apparently unrelated rhynchonellid genera. The illustrations of *A. aptata* Johnson (1970) show that the apical angle is variable though the average value is about the same as *A. duni*. *A. aptata* and *A. gutta* have one to two fewer lateral plicae than *A. duni*. Johnson *et al.* (1973) described *A. gutta* from the lower Gedinnian of Nevada and compared it with some of the specimens of *Camarotoechia nucula* from Podolia in eastern Europe described by Kozlowski (1929). However, Nikiforova *et al.* (1985, p. 36) considered both the generic and specific status of Kozlowski's species as doubtful. Smith (1980) described *A. magniplica*, *A. gutta* and a new subspecies, *A. gutta rotunda*, from the Canadian Arctic Islands, the latter two being from early Lochkovian strata. The lateral plical count is greater than on the Nevadan *A. gutta* and on the subspecies *A. g. rotunda* overlaps that of *A. duni*. *A. g. rotunda* differs from *A. duni* in having a markedly more rounded outline, as has *A. magnaplica*. Lenz (1977) and Perry (1984) also described *A. gutta* from early Lochkovian strata in Canada.

None of these species is synonymised with *A. duni*, even though it is possible that all are synonyms at specific level, because they are much better preserved either as isolated silicified valves or in limestone with shelly matter intact. The majority in fact may be junior synonyms of *A. duni*. Boucot (1960) described "*Camarotoechia* aequicostata" (De Koninck), a possible *Ancillotoechia* with four plicae on the fold and "about" eight plicae on the flanks, from sandstone (Grès de
Gdoument) in western Europe. The median septum is slightly more robust than that in *A. duni* but only the brachial valve was illustrated.

Some of the small rhynchonellids from the Mt Ida Formation in central Victoria probably belong to *A. duni*. They were not illustrated by Talent (1965) because of poor preservation but are on the same bedding planes with other figured species.

Family UNCINULIDAE Rzhonsnitskaya 1956
Subfamily HEBETOECHIINAE Havlíček 1960
Genus *Sphaerirhynchia* Cooper & Muir-Wood 1951

*Sphaerirhynchia* sp. (Fig. 16)

Material: MMF 30618, a large slab with several individuals; MMF 31375(7) a near complete steinkern; MMF 31377 and 31378, slabs with numerous valves at various growth stages.

Localities: TM 102N, TM 42, TM 56B and TM 57.

Description: The valves are medium to large in size and at all growth stages the length is greater than the width. Very small specimens are ovoid and gently biconvex. Larger specimens are pentagonal in outline and the largest are almost cuboidal in cross section, the brachial valve being deeper than the pedicle valve. The brachial fold becomes increasingly prominent with very steep to subvertical sides in the anterior half of the largest valves coinciding with the most strongly curved part of the valve. The pedicle sulcus is comparatively feeble and also confined to the anterior two thirds to half of the valve. The floor of the sulcus is continued as a distinct tongue. The
Fig. 16. *Sphaerirhynchia* sp.; A, A1 MMF 3137(8) latex cast of internal mould of small pedicle valve showing dental plates x4; B MMF 31377(6) latex cast of external mould of pedicle valve showing rounded costae x2; C, E, F MMF 31375(7) latex cast of partial internal mould showing - C posterior external view (brachial valve top), E lateral interior showing apertural spines and F interior of umbonal region, brachial valve top x2; D, I, I1, J, J1, K, L, M MMF 30618(1) - latex cast of posterior end of brachial internal mould, D axial view x2, I, I1 vertical view of hinge plates and cruræ x3.5, J, J1 longitudinal view of septalium showing callus filling x3.5; K, L, M vertical, lateral and anterior views of internal mould x1; G, H MMF 30618(2) internal mould and latex cast of pedicle valve showing deeply impressed diductor muscle field and median adductor trace x2.
umbos of both valves are strongly incurved and there is no trace of a delthyrium in larger specimens. The rounded plicae are lacking or indistinct on the posterior ends of the valves and are low even at the anterior margin. The fold bears four plicae and the sulcus three. The plicae on the flanks are narrower and comparatively flattened, there being about eight or nine each side of the fold. In the largest specimens the crests of the antero-lateral plicae have a shallow groove. Growth lines are variably developed.

Brachial interior: The sockets are elongate, parallel to the wall of the valve. In all growth stages there is a thin but otherwise well developed median septum extending anteriorly for one third to half of the valve length. The septum supports a small and narrow septalium, V-shaped in cross-section. Short blade- or rod-like crura extend forward from the join of the septalium and hinge plates. At the join with the septalium the median septum is extended internally as a node. In all but the smallest valves there is callus developed on the posterior half of the median septum and sides of the septalium as well as below the hinge plates. There is less callus lining the inside of the septalium. The rounded plicae are repeated on the interior except at the posterior where there is no trace of the plicae in any growth stage. The umbonal flattening of internal moulds suggests that the valve wall was comparatively thick in the umbonal region of even the smallest specimens.

Pedicle interior: The hinge teeth are short and stumpy. In
the smallest specimens they are supported by thin, subparallel
dental plates extending for about one third the length of the
valve. With growth the plates become incorporated into the
valve walls by callus. The postero-lateral boundary of the
rhomboidal diductor muscle field is very prominent because of
the thick callus almost filling the delthyrium except for the
space next to the diductor attachment in the brachial valve.
In large valves the adductor muscle trace forms a low parallel
sided median ridge dividing the diductor scars. In some valves
with less developed callus there is a distinct myophragm
dividing the muscle field. The impress of the plicae is
obvious only anterior to the lateral corners of the diductor
muscle field because of the thickness of the callus.

Dimensions:

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Remarks: The smooth area on all valves is more or less
restricted to the umbonal region, there being no sharply
defined boundary between the smooth and plicate areas. If the
smooth section marked an early growth stage it should form a
proportionately smaller part of the valve with growth.
Examination of these specimens shows that the proportion of the
valves with a smooth exterior remains more or less constant
with growth indicating that the smooth section also grows.
This expansion of the smooth area is believed to be a result of
abrasion in quartz sands. The naturally low plicae, especially
in the posterior part of the valves, would disappear with comparatively little wear. Loss of calcareous shelly matter, especially in the umbonal region, is common in living fresh water bivalves although in this case solution of shelly matter in acidic waters may be more important than abrasion.

The interior of the brachiopod valves was protected by the thick callus deposits in the umbonal area of both valves. The valves show no evidence for a functional pedicle in most growth stages and the sub-sphaeroidal geometry of the complete brachiopod cannot have been very stable in an environment subject to the currents indicated by the associated sedimentary structures. The thick callus could have had an additional function as ballast (Rudwick, p. H201 in Moore, ed. 1965) so that stable equilibrium was achieved with the beaks downmost as suggested by Babin and Racheboeuf (1975). Bowen (1967) observed from a study of numerous specimens of *Atrypa reticularis* that the valves had variably developed internal deposits, those with the most massive deposits being in sediments indicative of the most turbulent environments. Some valves are lightly covered with *Aulopora* but not to the extent or as common as on valves of *Mesodouvillea*.

It is because of the probable physical, non-genetic origin of the smooth umbos in these uncinulid rhynchonellids that they have been included in *Sphaerirhynchia* although Savage et al. (1979) have suggested that *Sphaerirhynchia* is a form genus in need of more precise definition. The smooth umbo of
Lanceomyonia appears to be a genuine early growth stage in the Bohemian material illustrated by Havlíček (1961) but there is obvious umbonal corrosion in the specimens of *L. borealiformis occidentalis* described by Drot (1964) north Africa. J. Talent (pers. comm.) stated that her material is typically corroded all over from desert weathering. The almost spherical *Estonirhynchia* also has a smooth posterior and heavy callus within the umbos. There is a strong resemblance to *Plethorhyncha*, particularly as regards the elongate ovoid shape, but not even the largest Winduck Group specimens have a cardinal process and there is no sign of the characteristic auriculate projections of *Plethorhyncha*. The largest of the specimens of *Plethorhyncha altera* (Barrande) illustrated by Havlíček (1961, pl. 15, fig. 7) has no obvious auriculate projections and but for the more rounded outline does not differ substantially from the Winduck Group specimens. The interior of *P. altera*, as shown by serial sections (Havlíček 1961, text fig. 50), indicates a deeply impressed diductor muscle scar within thick callus and a deep V-shaped septalium lined with callus but no trace of a cardinal process. The generic assignment of *Plethorhyncha polentinoi* Binnekamp (1965) was largely by default. The interior is much like *Sphaerirhynchia* but the callus is less developed.

The unidentified species of *Sphaerirhynchia* figured by Harper (1973) from the late Llandovery to Ludlow of north America has a remarkably similar brachial interior but a considerably smaller and less impressed pedicle muscle field.
He also described *S. saffordi* (Hall), a possible synonym of the European type species *S. wilsoni* (Sowerby), from Ludlovian strata in the same area. This species has negligible callus and a very indistinct fold. *S. gibbosa* (Nikiforova) occurs in eastern Europe and North America but none of the specimens illustrated by Johnson *et al.* (1973) has a very prominent fold and there is a singular absence of callus in either valve.

Lenz and Johnson (1985b) described a new species, *S. bellensis*, from Wellington in New South Wales with a weaker fold, more plicae on the fold and sulcus and no appreciable callus. The pedicle beak is pierced but this feature is not mentioned in the description and it is not clear from the illustrations if this is a pedicle foramen or just damage. They noted that *Hebetoechia* from this area lacked any callus filling in the septalium. The cuboidal rhynchonellid from the Heathcote district of Victoria illustrated by Talent (1965, pl. 16, fig. 3) has a strongly impressed diductor scar and is possibly a small specimen of the Winduck Group species. *Sphaerirhynchia globularis* Talent (1963) from eastern Victoria has a very weak fold and sulcus as well as a distinctive musculature.

Superfamily ATRYPACEA Gill 1871

Family ATRYPIDAE Gill 1871

Genus *Atrypa* Dalman 1828

*Atrypa* cf. *reticularis nieczlawiensis* Kozlowski 1929 (Fig. 17)
Fig. 17. *Atrypa cf. reticularis nieczlawiensis* Kozlowski; A, D MMF 31388(2) latex casts of exterior and interior of pedicle valve x4; B, B1, C, C1 MMF 31388(2) vertical and inclined views of latex cast of cardinal area of brachial valve x4; E MMF 31389(1) detail of best preserved ornament on pedicle valves in F, x4; F MMF 31389 pedicle valves showing marked differences in surface abrasion x1.3; G MMF 31389(2) brachial valve internal mould, anterior profile x1.
Material: MMF 31388 and MMF 31389, small blocks containing several disarticulated brachial and pedicle valves. 
Localities: TM 5i, TM 125B and TM 151. Description: The valves are small to medium in size and subcircular to ovoid in outline except for the small prominence of the pedicle beak. The cardinal angles are obtuse and well rounded. The length exceeds the width in the larger, least deformed valves, the maximum width occurring about midlength. The profile is biconvex in small specimens but with growth the pedicle valve becomes gently concave anteriorly and the brachial valve very strongly convex, almost hemispherical. A weak pedicle sulcus and slightly more distinct brachial fold are present on the anterior halves of the largest valves and cause the commissure on the largest specimens to be sharply uniplicate. In the absence of any articulated specimens it is uncertain if there was a functional pedicle but the posterior margin of the pedicle valve is such as to suggest that it accommodated only the brachial beak. The exterior is covered by rounded costae changing only slightly in thickness between umbo and anterior margin and increasing by bifurcation. Concentric growth frills that are more or less uniformly spaced, about equivalent to the width of two costae, except near the margin of larger valves where they are more concentrated and less regular in curvature.

Brachial interior: The interarea is very narrow, indistinct and orthocline. The sockets are very wide anteriorly and bounded by disjunct robust hinge plates that are curved vertically. The socket floor has a low median possibly
crenulate ridge parallel to the side of the valve. The inner hinge plates are narrow and bear a shallow median groove for at least the anterior half of their length. A low myophragm, about equal in length to the hinge plates but not reaching the beak, is emphasised by callus and divides two shallow subcircular depressions in the valve floor, probably the site of the adductor attachments. The interior bears the imprint of the external frills and some specimens also show the costae away from the umbo.

Pedicle interior: The interarea is very narrow and almost negligible around the beak. The hinge teeth are very small with a bifid appearance although the inner part of each tooth is elongate and possibly a relict dental plate. The outer part is ovoid in section and scarcely rises above the hinge line. The boundary of the diductor muscle field cannot be distinguished from the imprints of the external frills. A longitudinal depression in the umbalon area, extending about one quarter the length, possibly marks the adductor attachments. The costae are imprinted very weakly and only near the anterior margin.

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Remarks: Of all species represented at "The Meadows" these are

62
the most poorly preserved. In a single bed the condition of preservation varies from loss of external spines to almost loss of all external detail. Both valves occur in about the same proportions despite their contrasting curvature and are found in massive beds.

Furthermore the morphology of an individual species of *Atrypa* has been shown to be much influenced by environment (Bowen 1967). Kozlowski (1929) recognised three varieties of *A. reticularis*, regarded by later workers as species or subspecies of *A. reticularis*. Nikiforova *et al.* (1985) noted that there is some overlap in the variation displayed by populations of each subspecies. The species from The Meadows has been compared with *A. r. nieczlawiensis* because of similarities in ornament, in particular the uniformity of the ribs. The lateral profile is also similar although the uniplicate commissure of The Meadows material is much more like that of *A. r. tajnensis*. Other workers (e.g., Bowen 1967) have refrained from subdividing *A. reticularis* on the basis of variations in valve shape that are more likely to represent responses to variations in environment. The comparatively flattened pedicle valve would assist stability in a turbulent environment especially if there was no pedicle attachment.

There are numerous references to Silurian and Devonian occurrences of *Atrypa* in Australasia, those relating specifically to *A. reticularis* having been itemised by Flood (1974). Strusz (1985) regarded three species recognised by Talent (1963) from Early Devonian (Pragian) strata in eastern
Victoria, A. cf. reticularis, Spinatrypa perflabellata and S. undosa, as synonyms and grouped them as Atrypa perflabellata, although many of the specimens are deformed. This last species he compared with specimens from Wenlockian strata at Canberra, although he considered these to be like A. sp. cf. dzwinogrodenis he described previously from Ludlovian beds also at Canberra (Strusz 1984). He distinguished A. sp. cf. perflabellata from European subspecies of A. reticularis by the thinner shells and more gracile internal features of the Canberra specimens. Differences of this kind, and all intermediate forms, were described by Bowen (1967) in collections of A. reticularis from the Keyser Limestone in north America. The lithology of this formation is variable and suggests palaeoenvironments of varying turbulence, the more gracile valves being associated with the facies suggestive of a calmer environment.

Superfamily ATHYRISINACEA Grabau 1931
Family ATHYRISINIDAE Grabau 1931
Genus Molongia Mitchell 1921

Molongia elegans capricornae McKellar (Fig. 18)

1969 Molongia elegans capricornae McKellar, p. 7-8, pl. 2 figs 8-25.
1984 Molongia elegans capricornae McKellar; Strusz, p. 135-6, fig. 11.

Material: MMF 22928 a deformed pedicle valve; MMF 22936 a slab
with one internal and several external moulds of brachial valves.

Locality: NB 1.

Description: The valves are subcircular to slightly ovoid. In undeformed specimens the greatest width is just anterior to the cardinal angles, between one third and one half the length of the valve. The profile is strongly biconvex, the brachial valve being slightly more convex. The cardinal angles of both valves are well rounded. The fold on the brachial valve is indistinguishable from the flanking plicae near the umbo, but anteriorly is slightly wider and significantly higher, being at least twice the height of the plicae. A shallow median furrow is present on the fold crest in all specimens, beginning where the fold becomes wider than the plicae. On one specimen the furrow is initially clear but very indistinct towards the anterior after crossing a prominent growth line. The pedicle sulcus is broad and bears a low median fold corresponding to the median furrow on the fold. The fold is flanked by five lateral subangular plicae and the sulcus by six, although the sixth plica each side is very indistinct. The only visible surface ornament consists of irregularly spaced prominent growth lines in some valves. Details of the narrow interareas are not clear on any of the specimens available.

Brachial interior: The notothyrial details are poorly preserved in the single internal mould available. A very thin median septum extends anteriorly from the umbo for approximately a quarter the length of the valve, supported on
Fig. 18. *Molongia elegans capricornae* McKellar; A-C MMF 22928 pedicle valve - A latex cast of external mould, B internal mould, C latex cast of interior, all x2; D MMF 22936(2) latex cast of brachial external mould x2; E, E1 MMF 22936(1) latex cast of apical region of brachial interior x6.

Fig. 19. *Molongia* sp.; A MMF 31375(5) latex cast of brachial exterior showing bifurcation of plicae x1.6; B MMF 31375 latex cast of pedicle interior showing pedicle passage and relict dental plates incorporated into valve wall by callus x1.6; C MMF 31375(4) latex cast of pedicle exterior x1.6; D MMF 31375 latex cast of pedicle exterior showing intercalation of extra plica in sulcus x1.6; E, E1 MMF 31378(6) latex cast of brachial interior x4.
the internal expression of the median furrow on the fold. The lateral plicae are impressed on the interior.

Pedicle interior: The teeth are indistinct; the dental plates are short and incorporated into the valve wall for most of their length by callus deposits. In cross section the dental plates are curved with the concave surfaces directed axially, forming a cylindrical delthyrial cavity and implying a functional pedicle. The lateral plicae are repeated on the interior except near the umbo where obscured the callus deposits.

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Remarks: This subspecies was described from Siluro-Devonian strata in the Craigilee Anticline near Rockhampton in Queensland by McKellar (1969). Strusz (1984) revised this subspecies when describing Ludlovian (O. crassa Zone) specimens from Canberra. He noted that the number of lateral plicae on brachial valves varied from four to seven with more than half the specimens having five. Some of Strusz's specimens (Figs 11a-d) are elongately rather than transversely ovoid but the size of the specimens suggests that this is an earlier growth stage. Within the limits imposed by the poorer preservation of The Meadows material there are no significant differences from either the Queensland or Rockhampton material except for the
callus deposits in pedicle valves from The Meadows. Because callus occurs in only the pedicle valve it may represent a more secure attachment for the pedicle in an environment where turbulence could damage valves with pedicles attached to a thin, comparatively weak wall.

The limestones within the Craigilee Anticline were recently dated by conodonts (Jell and Talent, 1989) as Pridoli eosteinhorndis zone. The date of earliest Ludlow given by Strusz (1984) for the Canberra material implies a range for M. elegans capricornae spanning all or most of the Late Silurian (Ludlow-Pridoli). If the callus deposits in all species of Molongia found in The Meadows district are an evolutionary trend and not just a temporary response to local environmental conditions then it is probable that they are late Pridoli or younger in age.

Molongia sp. (Fig. 19)

Material: MMF 30627 an internal mould; MMF 30599 an external mould and counterpart of a brachial valve; MMF 31392 an internal mould of a brachial valve; MMF 31393 a small block with brachial and pedicle valves; MMF 31375 a block containing mostly external moulds of both valves; MMF 31378 a slab with brachial and pedicle valves.
Localities: TM 20b, 42, 82, 102e, 183c.
Description: The valves are medium sized and ovoid or slightly pentagonal in outline but there is some variation because of deformation. Length to width ratios are unreliable although
the width appears to be consistently greater than length, maximum width being about one third the length from the pedicle umbo. Because of the obtusely rounded cardinal angles the extent of the hinge line is unclear, being between one-third and one-half the width. The profile is biconvex but it is difficult to compare convexity of the brachial and pedicle valves because of the lack of any articulated specimens. Small specimens are about equally biconvex but larger brachial valves have a very prominent fold. Near the umbo the fold is no more prominent than the lateral plicae and is divided by a median furrow so as to appear like two plicae. The fold increases in width anteriorly much more than the median furrow and the lateral plicae, as well as being much more prominent. The pedicle sulcus has an anterior width increase commensurate with that of the brachial fold and has a narrow median fold corresponding with the median furrow on the brachial valve. On the brachial valve the interarea is so narrow as to be negligible and even on the pedicle valve it is very small but distinctly apsacline. It is unclear from the available specimens if the foramen on the beak of the pedicle valve is the true pedicle foramen or if it has been enlarged by later damage, the protrusion of the beak rendering it more likely to damage in a turbulent environment. The delthyrium has been partly closed by small deltidial plates. The lateral plicae are subangular in cross section and extend to the beaks. There are five on each flank of brachial valves and six on pedicle valves. One brachial valve shows an asymmetric increase of
plicae by bifurcation at a very prominent mid length growth line. One pedicle valve has an extra plica developed by intercalation, about mid-length in the sulcus, that is not associated with any growth line or other obvious feature. Growth lines are the only external ornament and are irregular in distribution other than a general concentration near the valve margins.

Brachial interior: The deep, well defined sockets are parallel to the valve wall and separated by the hinge plates. The outer hinge plates are narrow, disjunct, and separated by a narrow septalium formed by the inner hinge plates and supported by a thin, low median septum that extends between one-third and one-half the length of the valve. There is a minute node at the posterior end of the septalium that is possibly an incipient cardinal process. The adductor scars are striate and subcircular, one either side of the median septum just forward of the septalium. The interior bears the imprint of the plicae and growth lines. In larger specimens the external details are indistinct because of secondary deposits over all the interior.

Pedicle interior: The hinge teeth are very short, rounded and supported by short and thin dental plates in small specimens but in larger valves are incorporated into the valve wall by callus deposits. The whole of the pedicle interior has been thickened by callus except for the pedicle passageway. This space widens anteriorly at the site of the diductor muscle scar. As in the interior of the brachial valve, the imprint of
the plicae is obscured by pervasive callus.

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**Remarks:** Strusz (1984) revised the genus *Molongia*, demonstrating that the Chinese genus *Protathyrisina* Chu is a probable junior synonym, and reviewed all known species from Australasia and east Asia. The external morphology of this species from The Meadows, in particular the very expanded anterior of the fold and sulcus, is a homoeomorph of the rhynchonellids *Stegorhynchella* Rzhonsnitskaya (regarded by Jones (1981) as a synonym of *Stegerhynchus*) and *Stegocornu* Dürkoop and also *Machaeraria obesa* Smith. This feature is atypical of Australasian species except for some specimens of *M. elegans capricornae* McKellar from Siluro-Devonian siltstone at Armagh station near Rockhampton in Queensland, but even these have a comparatively narrow fold. All of the specimens of *M. elegans capricornae* from the underlying Amphitheatre Group and the Ludlovian Yarralumla Formation at Canberra have comparatively narrow folds and sulci. The genotype, *M. elegans elegans*, has comparatively subdued plicae.

The poor preservation of the material from The Meadows is not considered suitable to describe a new species or subspecies. Some of the specimens of *Molongia aff. elegans* described by Talent (1965) from the Mount Ida Formation in
central Victoria have a prominent elevated brachial fold but in none is the fold expanded laterally. However the small brachial valve illustrated in his plate 16 figure 2 has a fold that increases in width at a much greater rate than the plicae.

The callus deposits in these valves are thicker than in the underlying *M. elegans capricornae* and unusual for *Molongia*, having no obvious function in a brachiopod with a functional pedicle, in contrast to an unattached species such as the associated *Sphaerirhynchia* where the callus may have functioned as ballast.

Strusz (1984) noted that of four Chinese species of *Molongia* three are very like *M. elegans*. *M. puta* (Rong and Yang 1980) is more like the species from The Meadows in having a more distinct pentagonal outline. Fu (1984) described four new species from the Silurian of China. All have comparatively subdued folds with very shallow median furrows.

The specimens of *Homeospira [sic] gdwoumontensis* (Asselberghs) described by Boucot (1960) from the Grès de Gdoumont of Belgium have a brachial fold with a furrow that divides into three narrow furrows anteriorly and a pedicle sulcus with at least one plica. The apparent lack of dental plates may be a result of incorporation with delthyrial callus but the preservation is inadequate to be sure of this detail. The outline is circular but otherwise there is some resemblance to those valves from The Meadows with more than one plica in the sulcus and dental plates wholly obscured by callus.
The definition of *Howellella* was shown by Johnson (1970) to be sufficiently embracing to include several other spiriferid genera. The generic diagnosis was refined by Gourvenne (1985), who listed all those species he considered should be assigned to the genus, whatever their present generic status. Carls (1985) defined a new subgenus *H. (Hysterohowellella)* without a corresponding diagnosis for *H. (Howellella)*. The characteristic fimbriate micro-ornament of the Delthyridae is indefinite in even the best preserved material from the Winduck Group although Gourvenne (1987) has shown that the significance of the micro-ornament has been misapplied in systematics.

*Howellella* sp. (Fig. 20)

**Material:** MMF31372-2 internal and external counterparts of a pedicle valve.  
MMF31372-4 internal and external counterparts of a brachial valve.  
**Locality:** Locality TM42.  
**Description:** The species is small to medium for the genus. The valves are biconvex in lateral profile, the biconvexity becoming more marked with size. The width is slightly greater than the length, the maximum width being between one third and one half of the length from the posterior. The hinge line is
Fig. 20. *Howellella* sp.; A–D, K MMF 31372(4) brachial valve – A latex cast of exterior x3.5, B, C internal mould showing crural bases x3.5, D, D1 cardinal process x20, K, K1 anterior view of cardinal area x5; E–H MMF 31372(2) pedicle valve – E, E1 latex cast of interior showing thin dental plates, F, G vertical and posterior profiles, all x3, H lateral profile x5; I, I1, J MMF 31383 anterior and lateral profile of conjoined valves x5.
about two thirds the greatest width. The commissure, apart from the zigzag pattern of the plicae, fold and sulcus, is essentially in a single plane. The cardinal angles are very obtuse and not well differentiated from the lateral margin. The fold and sulcus are well defined with a wide U-shaped cross section. The plicae are rounded in cross section but variable in amplitude such as to be very indistinct on the lateral extremities of some specimens. The largest valves have as many as four plicae either side of the fold or sulcus. The surface ornament is indistinct because of the generally small size of the specimens and the grain size of the host lithology, although there are some faint growth lines.

Brachial valve exterior: The fold is about equal in width to the adjoining plica near the low beak, but increases in width anteriorly so that on the largest valves it is as wide as two plicae at the anterior margin. There is a corresponding increase in the relief of the fold in lateral profile. The anacline interarea is very narrow and almost negligible away from the umbo.

Brachial valve interior: The crural plates are short and attached to the inner surface of the interspaces flanking the fold. The larger hinge plates are inflected sharply towards the floor of the valve along the weak socket ridges. The dental sockets are well defined. The cardinal process is triangular, with the base of the triangle elevated, and it was probably striate although this is uncertain because of the sandy
lithology.

Pedicle valve exterior: The sulcus widens anteriorly more than the plicae. The plicae become weak laterally, the lateral extremities being almost bald. The interarea is markedly apsacline. The open delthyrium is triangular.

Pedicle valve interior: The dental plates are thin and extend about one-third the length of the valves along the inner surface of the interspaces flanking the sulcus. The hinge teeth are small but finer details are obscured by poor preservation. In some specimens there is a fine myophragm that extends anteriorly a short distance beyond the dental plates.

Dimensions:

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Remarks: This species falls in the subgenus *H. (Howellella)* because of its comparatively pauciplicate flanks and maximum width near midlength, two features that distinguish it from the mostly younger *H. (Hysterohowellella) jaqueti* also from the Winduck Group. In small or incomplete specimens, especially when examined without any magnification, these differences are less distinctive and it is very likely that many published references to *H. jaqueti* are in fact this species.

The mid to late Silurian species *H. elegans* (Muir-Wood) and *H. nucula* (Barrande), described from southern New South Wales by Strusz (1982, 1984), are comparable in convexity but
much smaller in size and less plicate than "The Meadows" material. Savage (1969) described a new subspecies, *H. nucula australis*, from the Early Devonian Mandagery Park Formation near Manildra in the central west region of New South Wales. This species has dental lamellae that extend as much as one-third of the valve length, rather more than appears to be the case in *H. nucula* judging by the serial sections provided by Havlicek (1959, figs. 41, 42). Some of the larger specimens approach "The Meadows" material in the number of lateral plicae but most are considerably smaller and more strongly biconvex.

*H. latisulcata*, described by Talent (1956) from the Early Devonian of Victoria, has a comparable plical count but is distinguished by an unusually broad sulcus. An associate of *latisulcata, H. lirata* Talent, has more plicae. Lenz and Johnson (1985b) compared specimens from Early Devonian limestone near Wellington in New South Wales with *latisulcata*, noting that their specimens were variable in the width of the sulcus. The specimens they compared with *H. medioplicata* Kul'kov are very indistinctly plicate. *H. scabra* Philip (1962), from the Early Devonian of Victoria, has slightly fewer plicae that are also much lower in relief. Another Early Devonian species from Victoria, *H. textilis*, has comparable plicae in shape and number but the type material illustrated by Talent (1963) is generally deformed so that the true outline of the valves is uncertain. The cardinal angles in particular vary from obtuse to almost mucronate and the well developed myophragm in both pedicle and brachial valves is quite atypical.
of The Meadows Howellella. The Wellington material compared with *H. textilis* by Lenz and Johnson (1985b) is quite variable but in general the plicae are more angular than any seen in the Amphitheatre or Winduck Groups. The very well preserved specimens of *H. aff. textilis* from the Murrumbidgee Group in southern New South Wales illustrated by Chatterton (1973) are comparable in the number of rounded lateral plicae but the dental plates are significantly shorter in length.

McKellar (1969) described a new species, *H. pyramidalis*, from Siluro-Devonian strata near Rockhampton in Queensland. This species is distinguished from all other Australasian species by a combination of very small size, almost bald flanks and a cyrtinid lateral profile.

Comparison with more distant species of *Howellella* is handicapped by differences between species being sometimes less significant than intraspecific variation, a factor noted already for many north American species by Bowen (1967). Outside of the Australasian region there are numerous species with similar external morphologies but widely differing ages. *H. sarytchumyshensis* Zintchenko from the late Llandovery of Salair illustrated by Ivanovskiy and Kul'kov (1974) is very like Winduck *Howellella* externally but has shorter dental plates. Several north American species of Late Silurian - Early Devonian age likewise have similar exteriors, in particular *H. vanuxemi* (Hall), but comparatively short dental plates. Elongate dental plates are a feature of some Early Devonian *Howellella* species and not just confined to the
subgenus Hysterohowellella. The Nevadan specimens described by Johnson et al. (1973) as Undispirifer cf laeviplicatus are notably more plicate than the types of laeviplicata illustrated by Kozlowski (1929), being very like The Meadows specimens but differ in being larger and an apparent lack of crural plates. The specimens of Undispirifer? ovatus (Wang) illustrated by Xu and Yao (1986) from Lingshan in China are like The Meadows Howellella in the number of plicae and long dental plates but the serial sections suggest that the plicae are very subdued in relief.

The west European species H. mercurii (Gosselet) is larger, broader and more plicate but an unnamed subspecies described by Carls (1985) from lowest Early Devonian strata in northern Spain has a similar plical count and mid-length maximum width.

Subgenus Hysterohowellella Carls 1985

Carls (1985) established Howellella (Hysterohowellella) for species with hysterolitiform features such as multiplicate flanks and elongation along the hingeline.

Howellella (Hysterohowellella) jaqueti (Dun) (Fig 21)

1898 Spirifera Jaqueti Dun, p. 166-7, pl. 17, figs. 2, 12, 13, 14, 17.
1901a Spirifer Jaqueti Dun; Gürich, pl. 18, figs. 13, 14.
Fig. 21. *Howellella (Hysterohowellella) jaqueti* (Dun); A, A1 AMF 35677 latex cast of brachial interior (fig 2, Dun 1898) x5; B AMF 35676 latex cast of brachial interior (fig 13, Dun 1898) x5; C AMF 35676 latex cast of pedicle exterior showing ornament x4; D MMF 31380 brachial internal mould from near top of Winduck Group x2.5; E, E1 AMF 35678 lectotype latex cast of pedicle interior (fig 14, Dun 1898) x3.5; F AMF 35678 latex cast of small brachial valve x6; G, G1 MMF 31377 latex cast of brachial exterior from lower part of Winduck Group x3.5; H AMF 35678 latex cast of brachial interior x4.
Lectotype: AMF35678, an internal mould of a pedicle valve (Dun figure 14). This number refers to a slab with moulds of several brachial and pedicle valves, including those shown in Dun's figure 17. This particular slab is chosen because there is no doubt about the association of the valves from a single locality and horizon.

Paralectotypes: AMF35676 and 35677, internal moulds of brachial valves (figures 2 and 13 respectively of Dun). The specimen shown by Dun as figure 12 could not be located.

Other material: F31377, F31378, F31381 and F31380, all being slabs from The Meadows with numerous moulds of disarticulated brachial and pedicle valves.

Type locality: Erratic boulders at White Cliffs, western New South Wales.

Other localities: Field localities TM 56B, 57, 504 and 508.

Diagnosis: Species medium to large for genus; maximum width between one quarter and one third of length from pedicle beak; cardinal angles well rounded; flanks of larger specimens with six to seven distinct lateral plicae having a rounded cross section; some larger (?gerontic) specimens have a shallow groove on the brachial fold with a corresponding myophragm; dental plates thin and straight; a weak myophragm is common in the pedicle valve extending anteriorly for almost half the length of the valve.

Description: The valves are markedly biconvex in profile, the convexity increasing with growth, and have well rounded cardinal extremities. The maximum width is between one quarter
and one third the length measured from the pedicle beak. The fold, sulcus and lateral plicae are very distinct except near the hingeline so that the number of distinct plicae on each flank varies in different specimens from five to seven, depending upon the size of the specimen. In some specimens there is a wider smooth space corresponding to the sixth plicae in other specimens. The external ornament is unclear because of the sandy lithology and some secondary silicification although closely spaced growth lines are visible on some specimens.

Brachial valve exterior: The well developed fold and lateral plicae are rounded in cross section with narrow interspaces. Larger specimens are slightly flattened on the crest of the fold with a slight median groove. The interarea is very narrow and anacline to orthocline.

Brachial valve interior: The crural plates are short and where in contact with the floor of the valve are on the inner surface of the interspace bounding the fold. The dental sockets are not complete on any specimen but are clearly defined adaxially. The cardinal process is not obvious, possibly obscure because of the comparative coarseness of the sandy lithology. Specimens with a shallow groove on the fold have a corresponding myophragm-like line on the interior.

Pedicle valve exterior: The broad well developed sulcus is flanked by six to seven lateral plicae including those defining the edges of the sulcus. On some specimens these flanking
Plicae have a fine median groove comparable to that on the fold of some brachial valves. The plicae are rounded in cross section with narrow interspaces. The interea on sufficiently clear specimens is high and slightly apsacline. The well defined delthyrium is higher than wide. In some specimens there is an indistinct myophragm extending from the umbo for one third the length of the valve.

Pedicle valve interior: The dental plates are thin, except near the contact with the floor of the valve where they rise from the internal surface of the interspaces flanking the sulcus and extend only about one quarter the length of the valve. In very small specimens the dental plates are not always visible. This is possibly a result of fragility or alternatively they are incompletely calcified in younger specimens.

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Remarks: Gourvennec (1985) omitted any reference to *Howellella jaqueti* in his list of recognised species of *Howellella*. This species is included within the subgenus *H.(Hysterohowellella)* because of the high lateral plical count and the characteristic thin dental plates. Some of the White Cliffs material is notably larger than the lectotype or any of the specimens found at "The Meadows" and possibly represents another (?younger)
horizon. Specimens from horizons high in the Winduck Group show an increase in the number of lateral plicae without any marked increase in size, partly compensated by a comparative narrowing of the fold. The stratigraphically youngest specimens show a superficial external resemblance to small specimens of the late Early Devonian Spinella. There is some resemblance to specimens of Howellella from the Mt Ida Formation in Victoria figured by Talent (1965, pl. 17, figs. 6, 7, 9, 11) as regards outline and flattening of the brachial fold. The upper Winduck specimens have a shape and plical count comparable with Spirifer (Hysterolites) cf. subspeciosus (de Verneuil) described by Shirley (1938) from the Baton River Beds (now Baton Formation) of New Zealand but the latter are as big as the largest specimens from the White Cliffs erratics as well as deformed.

H.(H.) jaqueti resembles H.(H.) knetschi Carls in many respects. The only significant feature where there is no real overlap is that the fold in jaqueti, although flattened in some larger specimens, has nothing like the median depression in the fold of knetschi. The other species assigned to this subgenus by Carls, H. cortazari Carls and H. lunae Gourvennec, are readily distinguished by their more multiplicate flanks and more angular cardinal extremities. It is notable that all of these species are from non- or poorly calcareous sediments. H. jaqueti resembles some forms of the European species H. mercurii and H. angustiplicata, both showing considerable external variation judging from illustrations by Carls (1985),
Gourvennec (1985) and Nikiforova et al., (1985). Boucot (1960) suggested that these species are synonyms but Carls (1985, p.306) stated that they can be differentiated in a single assemblage from the Ebbe Anticlinorium. *H. jaqueti* is most like the neotype material of *H. angustiplicata angustiplicata* (Kozlowski) from Podolia (Nikiforova et al., 1985), but lacks the thick dental plates of that species. Carls (1985) revised *H. mercurii* and included moderately thickened dental plates as one of the diagnostic features. Illustrations of well preserved internal moulds show that the dental plates of *H. mercurii* are distinctly curved, in contrast with the straight dental plates of *H. jaqueti*. The forms of *H. jaqueti* in the highest part of the Winduck Group with the greatest number of lateral plicae are very like *H. angustiplicata zaleszczykiensis* (Kozlowski 1929).

*H. (H.) jaqueti* appears higher in the Winduck Group than *Howellella* sp., but there is some overlap in stratigraphic range, both occurring on the same bedding plane at locality TM 57. The greater than usual variety of species at this locality and their close packing and sorting is suggestive of mixing environmental assemblages. The order of appearance suggests that *H. (H.) jaqueti* is a possible descendant of *Howellella* sp., but sedimentological evidence suggests also that it occupied a different, most likely shallower environment. The comparative increase in the length of the hingeline of *H. (Hysterohowellella)* also suggests a response to a different substrate along the lines described by Bassett (1984) for
Fig. 22. *Nanothyris* sp.; A, E MMF 31387 latex cast of external moulds of a pedicle valve (top) and a brachial valve showing variation in shape and ornament, E conjoined valves showing marked discontinuity in ornament, both x4; B, C MMF 21471 (Cobar 1:250,000 grid ref 370055) - B internal mould showing incipient trace of cardinal plate, C another showing (?)crural plates, both x4; D ANU 29885(B) (locality 55 of Landrum) internal mould of brachial valve showing (?)crural plates and low median ridge x4.
Silurian spiriferids.

Superfamily STRINGOCEPHALACEA King 1850

Family CENTRONELLIDAE Waagen 1882

Subfamily Rensselaeriinae Raymond 1923

Genus Nanothyris Cloud 1942

?Nanothyris sp. (Fig. 22)

Material: MMF 31387, a small block containing numerous closely packed articulated individuals.

Locality: TM 151.

Other material: MMF 21472 a small block containing several articulated specimens from the Cobar district (Cobar 1:250,000 grid ref. 370055); ANU 29885b a small slab with an internal mould of a brachial valve, Landrum locality 55.

Description: The valves are very small and vary in outline from ovoid to almost circular, although tectonic deformation is at least partly responsible. The lateral profile is subequally biconvex and varies from lenticular in very small specimens to almost obese in larger specimens. The curvature of internal moulds is disrupted by thickened growth lines that may also accentuate the umbo of both valves. On the most complete specimens the beak is suberect. The delthyrium is triangular in outline without any obvious deltidial plates. There is no obvious ornament on the smallest specimens. Larger specimens have costate antero-lateral margins, the costae beginning abruptly at heavy growth lines, and a rectimarginate commissure that is anteriorly finely crenulate.
Brachial valve interior: The cardinal plate is perforate, more or less planar, and roofs a thin notothyrial cavity that breaks away readily on internal moulds. For this reason it is difficult to discern any distinct crural plates in the majority of specimens. In some larger complete specimens there are very short and thin traces, much thinner than the cardinal plate, that are clearly crural plates and continued anteriorly beyond the cardinal plate. The form of the loop is unclear but it extends anteriorly for at least half the length of the valve. In a few larger specimens there is an indistinct myophragm extending from near the umbo for about half the length of the valve.

Pedicle valve interior: Most valves have thin but well defined dental plates that do not extend forward beyond about the umbo.

Dimensions: All of the following measurements are taken from complete specimens.

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<td>MMF 31387(4)</td>
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Remarks: It is difficult to separate small terebratulid genera such as *Nanothyris* and *Podolella* when poorly preserved, as is the case with these specimens from The Meadows. There is a trace of crural plates in some larger specimens but this is hardly enough to separate the two genera. Very small or
delicate structures are unlikely to be preserved in a sandstone that is coarse grained compared with the diminutive size of whole shells. The dental and crural plates are very thin compared with those on internal moulds of the type species, *Nanothyris mutabilis* (Hall) from eastern north America, illustrated by Cloud (1942, pl. 3 figs. 10, 11). However, Bowen (1967) described the crural plates in *N. mutabilis* as being variable in development from very short to strong and thickened by secondary material.

Kozlowski's serial sections (1929, fig. 90) of *Podolella rensselaeroides* from Podolia show that the cardinal plate is not only comparatively thick where closest to the posterior margin but is supported by thick plates (fig. 90E). These plates are interpreted as the underside of the dental sockets where the latter are closest to the valve wall. Otherwise there is little to separate these crural plates (see fig. 23) from the crural plates in *N. subglobosa* (Weller) (Cloud, 1942, pl. 42 fig. 23) or in *N. boucoti* revealed in serial sections by Bowen (1967, fig. 6). The minor plate supporting the cardinal plate in *N. boucoti* appears in only one of the sections and is unlikely to be preserved in a sandstone typical of the Winduck Group. The costae on the Winduck Group material are more like those on *Nanothyris* in commencing sharply at growth lines. The neotype of *Podolella rensselaeroides* shows prominent costae demarked by a growth line but there are indistinct traces extending from the umbo (Nikiforova et al., 1985). The specimens from the Winduck Group could be assigned to either
Nanothyris or Podolella.

Binnekamp (1965) described variations in the shape of Podolella renssealeroides from Spain very much like those in the Winduck material.

The Winduck Nanothyris differs from the north American species N. mutabilis (Hall), N. subglobosa (Weller), N. porteri Cloud, N. reesidei Cloud and N. boucoti Bowen by its much smaller size and thinner dental plates, although there is some size overlap with the smallest specimens of N. mutabilis. N. excavatus from central Asia (Gratsianova 1967) is comparable in size but has a distinct fold and sulcus.

These specimens are unusual for the Winduck Group in that almost all of them are still articulated whereas the associated Strophochonetes valves have been disarticulated and sorted to the extent that only pedicle valves remain. The cause is believed to be the different hydrodynamic response of the Nanothyris shells. Menard and Boucot (1951) have demonstrated experimentally that terebratulid brachiopods can be moved by currents without being disarticulated.

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Prototethys: Fact or phantom? Palaeobiogeography in relation to the crustal mosaic for the Asia-Australia hemisphere in Devonian-Early Carboniferous times. 

*International Symposium on Shallow Tethys 2 - Wagga Wagga, 87-111.*


Appendix - Fossil localities

The most suitable means of describing localities in this rather featureless region is to use the grid reference (GR) from "The Meadows" 1:100,000 topographic map. Some localities were sampled using the Barnato 1:250,000 and in these cases the original grid reference is shown in brackets. Unless otherwise stated the fossils are found in sandstone beds which protrude above the surrounding scree of finer more thinly bedded sediments or soil.

**NB 1 GR 559123** (Barnato 1:250,000 GR 34601015): off white fine quartzose sandstone. This locality was sampled by Lennox (1976) who gave a grid reference (Barnato 1:250,000) of 348102 and in a later exploration report (Union Corp., 1977) renumbered the locality to F1.

**HF GR 55151035** (Barnato 1:250,000 GR 347099): greyish brown silty sandstone. This locality was renumbered F2 (Union Corp., 1977).

**10 S&H GR 50201175** (Barnato 1:250,000 GR 340100): fine to very...
fine white to off white quartzose sandstone.

TM 5i GR 33650985: flaggy fine quartz sandstone with mica rich bands.

TM 20b GR 208926: clay rich fine quartz sandstone.

TM 42 GR 439005: clay rich fine quartz sandstone.

TM 51b GR 47750390: fine quartz sandstone.

TM 56b GR 459008: fine micaceous quartz sandstone.

TM 57 GR 46000155: fine to medium quartz sandstone.

TM 58/1 GR 42309830: fine clay rich sandstone.

TM 58/4 GR 42259835: fine quartz sandstone.

TM 58d GR 41709905: laminate orthoquartzite.

TM 59 GR 405008: fine quartz sandstone.

TM 65 GR 46300095: fine orthoquartzite.

TM 75 GR 379951: laminate fine sandstone.

TM 82 GR 37308845: fine quartz sandstone near shearing shed.

TM 100e GR 40950345: quartz sandstone.

TM 102a GR 40150105: massive orthoquartzite.

TM 102b GR 40150070: thick bedded (30-50 cm) massive sandstone interbedded with less common laminate and cross bedded sandstone.

TM 102e GR 40950185: fine laminate quartz sandstone.

TM 125b GR 246040: very fine quartz sandstone.

TM 151 GR 455995: fine quartz sandstone.

TM 169 GR 436081: clay rich white quartzose sandstone with claystone pellets.

TM 183c GR 51150805: fine silty sandstone.

TM 192c GR 579049: fine quartz lithic sandstone.

TM 219 GR 35259275: fine quartz sandstone.
TM 312 GR 505130: pale reddish purple massive or thickly bedded siltstone exposed in gravel scrapes.

TM 504 GR 533214: clay rich quartz sandstone.

TM 508 GR 490768: clay rich quartz sandstone.

Field locality 45 (Landrum 1975) GR 265084 Barnato 1:250,000 geological map: "in creek 100 metres southwest of northeast corner of southeast paddock; 9.4 km 066°T from Bulla house."

Field locality 55 (Landrum 1975) GR 327108 Barnato 1:250,000 geological map: "on east side of hill 1.9 km. 076°T from Tambua Trig. Station."
SECTION C

SILURO-DEVONIAN BRACHIOPODS FROM THE TRUNdle DISTRICT, CENTRAL NEW SOUTH WALES.
Siluro-Devonian brachiopods from the Trundle district, central New South Wales.

Lawrence Sherwin

Sherwin, L., 0000:00:00. Siluro-Devonian brachiopods from the Trundle district, central New South Wales. Alcheringa.

Brachiopod faunas are described from the Derriwong, Trundle and Yarra Yarra Creek Groups in central New South Wales. The fauna in the Derriwong Group ranges in age from possible late Ludlow to Lochkovian and has affinities with Late Silurian faunas from the Canberra-Yass district. The faunas in the Trundle and Yarra Yarra Creek Groups are Emsian; dating of all the Groups is based on conodonts. A new species, Leptostrophia (Mitchella) deckerae, is described from the Derriwong Group and Spinella pittmani (Dun) from the Trundle Group is redescribed. There is a trend towards increasing provincialism from Ludlow to Emsian time despite the oldest and youngest assemblages being limited in the number of genera represented.

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IN THE AREA between Mineral Hill and Ootha (figs 1, 2) Late Silurian to Early Devonian sediments and volcanics rest upon a metamorphic basement of Ordovician or older age (Pogson 1988 and in prep.). Further east near Bogan Gate they have an erosional contact with Late Ordovician shoshonitic volcanics and at Forbes there is a slight angular unconformity between
Fig. 1. Locality diagram showing places mentioned in text. The "village" of Yarrabandai is half way between Oothe and Bogan Gate. Taemas is near Yass.
the Siluro-Devonian strata and the Wenlock to early Ludlow Forbes Group (Krynen et al., 1990). The outcrops of pre-Quaternary strata throughout this area are very scattered and poor except for the coarser clastic sediments and less altered volcanics. Limestone is present as isolated lenses and indicated at several other localities by heavy calcrete float. Very fine grained softer sediments are known only from cuttings and excavations.

Poorly preserved fossils are locally very abundant; very few have been described. The brachiopods described herein are from the Late Silurian (Pridoli) to Early Devonian (Lochkovian) Derriwong Group and the Early Devonian (?Pragian-Emsian) Trundle and Yarra Yarra Creek Groups.

Although the sediments of the Murda Syncline can be equated with either the Yarra Yarra Creek Group or the Trundle Group on the basis of age and known lithology, they have been included with the Yarra Yarra Creek Group herein because of their greater proximity to the Yarra Yarra Creek Group (the area north of Mineral Hill mapped as Early Devonian in fig. 2) and a thick basal conglomerate always present or well developed at the base of the Yarra Yarra Creek Group.

STRATIGRAPHY

The geology and stratigraphy of the area between Mineral Hill and Trundle were described by Raggatt (1937) but published without any geological map. A concise summary of the geology
Fig. 2. Distribution of Devonian and Siluro-Devonian rocks in the Mineral Hill - Forbes region showing fossil localities mentioned in text. The stratigraphy at Mineral Hill, Ootha and either side of the Tullamore Syncline is shown in fig 3. Modified from Goldberry et al. (1977) and Brunker et al. (1970).
between Forbes and Trundle was compiled by Packham (ed., 1969), though this also was without any detailed maps. A smaller area in the immediate vicinity of Mineral Hill was mapped in detail by McClatchie (1971) with some minor revision of the stratigraphy. Pogson and Felton (1978) discussed the various facies represented at Mineral Hill and produced a correlation chart for the region between Mineral Hill and Cobar.

Conolly (1965) described the stratigraphy and sedimentology of the more topographically prominent sandstones and conglomerates that delineate the major structures in this region, the Murda and Tullamore synclines (fig. 2), correlating them with the Late Devonian Hervey Group between Forbes and Wellington. The sandstones at Mineral Hill and in the Murda Syncline were later found to be of Early Devonian age (Pogson and Felton, 1978; Sherwin, 1980) and quite unrelated to the Hervey Group. In this region only the youngest sandstones in the Tullamore syncline have been retained in the Hervey Group, correlation with the established Late Devonian age of the type Hervey Group (Hills, 1932; 1936) having been demonstrated by Ritchie (1975) and Campbell & Bell (1977). Brunker (1972a, b) used Conolly's work in compiling the Forbes and Narromine geological maps at 1:250,000 scale and incorporated unpublished work by Foldvary (1969) for the area north of Bogan Gate. These maps cover all but the western limit of the area in fig. 2 and were revised in preparing geological bases for the Forbes (Bowman, 1977) and Narromine (Bowman et al., 1982) 1:250,000 metallogenic maps; a revision including unpublished work by
Fig. 3. Siluro-Devonian stratigraphy of Mineral Hill, Ootha, Trundle-Yarrabandai and Bogan Gate-Forbes. The geological periods and stages are shown approximately in proportion to their absolute duration.
Nazer (1972) on the area between Bogan Gate and Trundle. The base maps used to prepare fig. 2 (Brunker et al., 1970; Goldbery et al., 1977) are essentially compilations of previous mapping. The stratigraphy in the vicinity of Ootha has been difficult to interpret because as well as the poor outcrop the sediments are strongly cleaved and the boundaries of the Ootha beds are uncertain (Sherwin, 1981; Pickett, 1982). The stratigraphy on the eastern side of the Tullamore syncline was revised extensively by Krynen et al., (1990).

The Derriwong Group (fig. 3), widely distributed on both sides of the Tullamore Syncline, has a well marked base, the Edols Conglomerate west of the syncline and the Calarie Sandstone to the east. North of Yarrabandai the Derriwong Group has a thickness of approximately 2,500 metres (Sherwin, 1980). Neither of the basal formations is particularly fossiliferous, the high energy environment of deposition, inferred from mass flow conglomerates and coarse cross bedding, having been unfavourable for preservation. The Edols Conglomerate consists of massive conglomerate units several metres in thickness interbedded with thinner massive sandstones and minor flaggy fine-grained sandstone. The Calarie Sandstone is a thinner but more widespread formation with comparatively little conglomerate, consisting mostly of coarse cross-bedded sandstone and thinner flaggy sandstone beds, and a more abundant fauna, poorly preserved except for the molluscs. The fossiliferous beds of both formations are in the comparatively
Fig. 4. Simplified geological map of areas either side of the Tullamore Syncline between Trundle and Forbes. Only the larger limestone outcrops are shown and the Yarrabandai Formation has been included with the Cookeys Plains Formation because it is too thin to be shown separately at this scale. Blank areas are covered by Cainozoic deposits. Modified from Brunker (1972a, b).
softer, flaggy sandstones that are well-exposed only in coteans. Both these formations are overlain by the Cookeys Plains Formation consisting of limestone, siltstone and well bedded minor sandstone, although outcrops of this formation are very poor except for the sandstone and limestone members. East of the Tullamore Syncline some of the fine grained beds occur in outcrops where they are interbedded with the resistant Milpose Volcanics. West of the Tullamore Syncline there are a few thin beds of sediment within the more massive Byong Volcanics; these are not particularly fossiliferous. The Milpose and Byong Volcanics are similar in composition as well as age (Clarke, 1990). The abundant algae in the limestone members suggests a shallow environment of deposition (Krynen et al., 1990).

The Ootha beds has been placed in the Derriwong Group because field relations (Brook & Rose, 1977; Sherwin, 1981) indicate that the unit overlie the Edols Conglomerate (fig. 3) and the fauna is comparable in age to that in the Cookeys Plains Formation. The mid to late Silurian age of the Ootha beds in Pickett (1982) was based upon earlier work that was much delayed in press and written before Sherwin (1981). Differences between the Ootha beds and Cookeys Plains Formation may be over emphasized because outcrops of the latter are mostly the sandstone beds and limestone lenses, not the dominant siltstone and shale. However, turbidite sequences observed in exposures of the Ootha beds at Ootha garbage tip have not been seen anywhere in the Cookeys Plains Formation.
The Yarrabandai Formation (Sherwin, 1980 after Foldvary, 1969 unpubl.) is a distinctive unit because of the fine uniform sandy lithology and ready fissility, a property resulting in generally poor outcrop except at Bogan Hill, 8 kilometres north-west of Bogan Gate, where this formation is buttressed and possibly indurated by a rhyolitic intrusion. Some bedding planes show ripple marks and meandering trails. The outcrops on the edge of Yarrabandai village, formerly believed to be part of the Yarrabandai Formation, are now known to be within the Cookeys Plains Formation. However the validity of the Yarrabandai Formation is unaffected because the good outcrops at Bogan Hill have been quoted as a reference section (Sherwin, 1980) and the fossils were recorded from outcrops by Yarrabandai Road, south of Bogan Gate (Sherwin, 1973, p. 75).

The lower part of the Wallingalair beds is equivalent to the Derriwong Group (fig. 3) but the upper part (ie., above the Yarrabandai Formation) has only one datable horizon. This is a thin unnamed limestone south east of Bogan Gate (localities BG/I/25 and BG/I/26), separated from the underlying Yarrabandai Formation by crossbedded sandstone and fine quartz pebble conglomerate, that contains a late Lochkovian conodont fauna, probably referable to the *delta* Zone (Pickett, 1983). This date is much older than the Emsian *dehiscens* to *perbonus* Zone assemblages reported from the Yarra Yarra Creek or Trundle Groups (Pickett, 1989), although these younger faunas are near the top of these groups. It is tempting to consider the upper
part of the Wallingalair beds equivalent to the Yarra Yarra Creek/Trundle Group but sufficient fossil evidence is wanting.

A formal subdivision of the Trundle Group has yet to be devised. In the Trundle district outcrops are widely scattered and the lithologies varied. Float is abundant but in most paddocks it has been piled in mounds so that it is difficult to establish the correct sequence of lithologies. North of Trundle, the base of the Trundle Group is marked by fine siltstone and mudstone where it rests, probably unconformably, on the Kadungle Volcanics. In the south near Yarrabandai the base, whether on Byong Volcanics or the Yarrabandai Formation, is marked by a thin bed of coarse sandstone to fine conglomerate. Limestone lenses are common higher in the Trundle Group.

At Mineral Hill the Yarra Yarra Creek Group has been divided into six formations (fig. 5) by MacRae (1982) but only two, the Gwando Siltstone and Gleninga Formation, are known to be fossiliferous (Pogson, in prep.). The Gwando Siltstone consists of heavily ironstained off-white to greenish thinly interbedded fine quartz sandstone and siltstone. The Gleninga Formation consists of fine quartz sandstone and discontinuous well bedded fossiliferous limestone. Several formations were recognised in the Murda Syncline by Conolly (1965) but these will need to be reassessed now that they are known to be time equivalent to the Yarra Yarra Creek and Trundle Groups and not the Hervey Group. Conolly did recognise that the Spinella-bearing limestone (locality BM/III/1) of the Condobolin
Fig. 5. Distribution of species by locality and formation in the Mineral Hill - Ootha district. Locality BM/III/1 is from the Murda Syncline (see fig. 2).
Formation in the Murda Syncline was older than Late Devonian, the age of the Hervey Group, but still regarded the conformably overlying sandstones as typical of the Hervey Group.

PREVIOUS PALAEONTOLOGICAL WORK

Fossils in the Siluro-Devonian sediments of this region have been reported since the late nineteenth century (Wilkinson, 1879; Carne and Jones, 1919) but works on systematic palaeontology of this region are few. Dun (1904) described *Spirifera pittmani* (redescribed herein as *Spinella pittmani*), from sediments now included in the Trundle Group and Etheridge (1921) described stromatoporoid, *Clathrodictyon conophoroides*, from limestone low in the Derriwong Group. Chapman (1920) noted the Siluro-Devonian character of several ostracodes from a limestone "10 miles E.S.E of Fifield". This indicates a locality just north west of Trundle but these details could apply to any one of three distinct limestone occurrences in the area. Sherrard (1967) examined some tentaculitids from a locality probably within the Yarrabandai Formation (Derriwong Group) concluding that the preservation in a sandy matrix was inadequate for reliable identification. Foldvary (1971) described the trilobite, *Cheirurus (Crotalocephalus) regius*, from float associated with limestone in the Milpose Volcanics. Conodonts and corals from these limestones indicate an age near the Ludlow-Pridoli boundary (Pickett, 1978; Pickett & Ingpen, 1990). Landrum and Sherwin (1975) described the trilobite, *Warburgella (Anambon) jelli*, from the Derriwong Group; they expressed doubts as to the exact
Fig. 6. Distribution of species by locality and formation in the Trundle-Forbes region. The localities within any particular formation are more or less from the same horizon except in the Cookeys Plains Formation where locality TU/III/39 is probably younger than other localities in this unit, being much closer to the base of the overlying Yarrabandai Formation. The other localities in the Cookeys Plains Formation are more or less coeval with those in the Milpose Volcanics.
localities as some of the material was collected early in the twentieth century and precise details were not available. Trace fossils have been recorded from some horizons of the Derriwong and Yarra Yarra Creek Groups (Sherwin, 1976) but have not been studied in any detail.

The stratigraphic worth of the older descriptions and fossil lists is questionable. Early collections from this region were located by the distance to the nearest town or by parish and portion number, no other means of recording locality information being then available. Many portions even now have boundaries several kilometres in length so it can be very difficult to identify a locality unless the particular portion contains few outcrops. In times past, specimens were forwarded to the Geological Survey by the Regional Inspector of Mines often without any identification of the actual collector and with only very generalised locality information. In attempting to resample localities the details provided by Andrews (1910) proved to be the most reliable and concise.

AGE OF THE FAUNA

There are several distinct brachiopod faunal assemblages in this region (figs 5, 6), although some of the differences are a reflection of the different environments of deposition indicated by the varied lithologies. In particular, the Notanapia fauna of the Ooola beds is probably a deep water contemporary of that in the Cookeys Plains Formation. In the Manildra district Savage (1974) recognised a Notanapia
community as the deepest of three distinct brachiopod communities. These assemblages, even if not perfectly preserved, are sufficiently well differentiated to allow confident recognition and correlation in the region between Mineral Hill, Forbes and West Wyalong.

Many of the brachiopod genera, but not species, from the Trundle district are represented in the type Siluro-Devonian boundary beds of the Barrandian. Genera not represented in the Barrandian, such as *Baturria* sp. and *Podolella* sp., are known from similarly dated reference strata in western (Carls, 1974) and eastern Europe (Nikiforova et al., 1985). The oldest fauna described in this paper, that from the Calarie Sandstone (fig. 6), is clearly late Silurian in age despite the poor preservation. *Atrypoidea* has a world wide Ludlow-Pridoli range (Copper, 1977) but the Calarie Sandstone at Forbes rests with a low angle unconformity on mudstone of the Mumbidgle Formation, Forbes Group, that contains a late Wenlock graptolite fauna (Sherwin, 1975), in particular *Monograptus sherrardae* Sherwin. Thus it is unlikely that the Calarie Sandstone is any older than late Ludlow. An upper age limit is imposed by *crispa* subzone (Ludlow-Pridoli boundary) conodonts in the overlying Cookeys Plains Formation (Pickett, 1978; Pickett & Ingpen 1990). The limestone nearest the Calarie Sandstone, sampled for the first of these conodont age determinations, occurs as heavy float associated with the Milpose Volcanics 20 kilometres northeast of Bogan Gate. The base of the Derriwong Group, i.e., the Calarie Sandstone, is not exposed at this locality.
but it is only necessary to extrapolate the base for a kilometre to the nearest outcrop of Calarie Sandstone. The distribution of limestone float in this vicinity indicates that it is low in the Milpose Volcanics/Cookeys Plains Formation.

The brachiopods in the Cookeys Plains Formation occur above the limestones with *crispa* subzone conodonts and, with the possible exception of the *Notanoplia* cf. *pherista* locality (TU/III/39), are overlain by a limestone with an assemblage indicating *woschmidtii* Zone (Pickett, 1975). The most widely distributed brachiopod in the Cookeys Plains Formation is *Molongia elegans capricornae* McKellar. The type locality of this species in the Craigilee beds west of Rockhampton in Queensland contains *eosteinhornensis* Zone conodonts (Jell & Talent, 1989) and the Canberra occurrences in the Yarralumla Formation have been dated as Ludlow (Strusz, 1984). The specimens of the trilobite *Warburgella (Anambon) jelli* Landrum and Sherwin associated with *M. elegans capricornae* (Landrum & Sherwin, 1975, pl. 1, fig. 13) were assigned by Yolkin (1983) to the species *W. tcherkesovae* Maximova and *W. waigatschensis* (Tschernyschev & Yakovlev) from the Pridoli of Eurasia. A Pridoli age for the brachiopod fauna in the lower part of the Cookeys Plains Formation is thus well attested. The age of the upper part, containing *Notanoplia* cf. *pherista* (Gill), is much less certain. In Victoria, Garratt & Wright (1988) used the incoming of *N. pherista* to define the base of their *Boucotia australis* Assemblage Zone of late Lochkovian age, based upon an
association with *sulcatus* Zone conodonts. This would require the upper part of the Cookeys Plains Formation to be two conodont zones younger than a limestone overlying the Yarrabandai Formation, an unlikely prospect even allowing that the mapping north of Trundle is far from perfect. The doubt as to the specific identification of the single specimen of *Notanoplia cf. pherista* must be stressed.

The presence of *Notanoplia cf. panifica* Garratt suggests a late Ludlovian to latest Pridolian age for the Ootha beds, using the range proposed by Garratt & Wright (1988). This agrees well with the inferred correlation of the Ootha beds and Cookeys Plains Formation.

The fauna in the Yarrabandai Formation consists of small species preserved in a sandy matrix so that preservation is poorer than in the Cookeys Plains Formation. "Ancillotoechia" *cf. duni* (Gürich) is typical of several species of small rhynchonellids that appear early in the Devonian (Sherwin, Section B herein) and *Podolella?*, irrespective of doubts concerning its generic status, is typical of the very small terebratulids regarded by Boucot (1975) as characteristic of the lower Gedinnian (= earlier Lochkovian). This internal age accords with that imposed by the conodont dates mentioned above, the *woschmidtii* Zone below the Yarrabandai Formation and *delta* Zone above it.

In the Yarra Yarra Creek Group there are two distinct faunal assemblages (fig. 5) separated by three unfossiliferous
formations. This separation probably represents a sufficiently long time break to result in faunal changes although differences in lithology of the fossiliferous formations, siltstone as opposed to limestone, suggest that the changes may also reflect different environments. A silicified mudstone in the Trundle Group (fig. 6) contains an aggregation of both faunas in the Yarra Yarra Creek Group, the only species not found also in the Trundle Group being Salopina cf. hitchcocki Walmsley, Boucot & Harper. The Spinella in this mudstone is smaller than typical Spinella pittmani (Dun) and very small specimens are reminiscent of multiplicate forms of Howellella (Hysterohowellella) jaqueti (Dun). Normal sized specimens of S. pittmani occur in limestone near the top of the Trundle Group as is the case in the Yarra Yarra Creek Group. Full size S. pittmani is known from sandstones that are probable lateral equivalents of the limestones but in these cases the valves are usually broken. None of these species is known from the type Siluro-Devonian sections so that these faunas also depend upon associated conodonts for dating. Conodonts recovered from the S. pittmani limestone indicate early Emsian dehiscens or perbonus zones (Pickett, 1989).

FAUNAL AFFINITIES

The fauna in the Calarie Sandstone and Cookeys Plains Formation has its closest counterpart in the Late Silurian faunas of the Canberra-Yass district (Strusz, 1984) and the Armagh district near Rockhampton in Queensland (McKellar, 1969). The differences between the Trundle and Canberra-Yass
species are described in detail in the taxonomic section of this paper but are no more than is to be expected from the slightly younger age of the Trundle assemblage. The close comparison of the Trundle (Cookeys Plains Formation) and Armagh faunas has been noted previously (Nazer, 1972; Landrum & Sherwin, 1975; Sherwin, 1980), although some of the strophomenid species from Armagh are poorly preserved and their identifications doubtful. The fauna in the Cookeys Plains and Yarrabandai Formations fauna resembles that in the Amphitheatre and Winduck Groups respectively where the latter units have been sampled west of Cobar (Sherwin, Section B herein), although the Amphitheatre Group is comparatively poor in the variety of species present.

The brachiopod faunas from all formations in the Trundle district belong to the Old World Realm in common with Siluro-Devonian brachiopod faunas recorded elsewhere in Australasia (Boucot, Johnson & Talent, 1969; Talent, 1972; Boucot, 1975; Johnson, 1979) although the genera in the Yarra Yarra Creek and Trundle Groups are less widespread than those represented in the Derriwong Group. However the comparative provinciality of successive assemblages is difficult to assess because of the widely differing number of genera represented in each. The fauna in the Calarie Sandstone has a very cosmopolitan aspect because of the recorded wide distribution of *Atrypoidea* (Copper, 1977); this is one of only two genera represented in this formation, the other genus being an unidentifiable uncinulid. Of the ten genera identified in the Cookeys Plains
Formation the locally widespread *Molongia* is known outside of Australasia only in the Late Silurian of China (Strusz, 1984) and the subgenus *Leptostrophia (Mitchella)* is known only from New South Wales although *Leptostrophia (sensu lato)* is distributed throughout the Old World Realm (Harper & Boucot, 1978a). The Notanopliidae are known from north Africa, North America, central Europe, far east Asia and China as well as Australasia but *Notanoplia* is more restricted being unknown in Africa and North America except for the Arctic region (Garratt, 1980). The low diversity fauna in the Yarrabandai Formation is broadly Old World but the preservation precludes a more detailed assessment of its affinities.

The fauna in the Yarra Yarra Creek and Trundle Groups is also low in diversity with only five genera represented. Three of the genera, *Salopina, Sphaerirhynchia* and *Howellella* are widespread throughout the Old World Realm. *Reeftonia* is known from New Zealand, New South Wales and Victoria and several species have been listed from regions surrounding the Siberian Block in east Asia (Talent *et al.*, 1987). Reports of *Reeftonia* in North America were discounted by Savage *et al.* (1979). *Spinella* is widely distributed in Emsian sediments throughout New South Wales and Victoria (Garratt & Wright, 1988).

These brachiopod assemblages show a distinct trend towards greater provinciality from Pridoli to Emsian but the significance of the trend is tempered by being based upon a very limited number of genera in all but the Cookeys Plains Formation.
The disarticulated condition and imbalance of pedicle and brachial valves at most localities indicates general posthumous reworking with consequent masking of living community associations. The *Strophochonetes* sp. in the Yarrabandai Formation may be representative of the living community because some valves are conjoined and many of the disarticulated valves have intact slender hinge spines. Babin and Racheboeuf (1975) described a purely chonetid community with only two genera from Middle Devonian sandstone (Grès à *Chonetes*) in western Europe. They regarded this community or association as one of several in a region subject to instability, involving restriction of marine conditions. As noted above in the section on stratigraphy the Yarrabandai Formation is overlain by sediments (upper Wallingalair beds) with features (cross bedding in coarse sandstone) possibly indicative of marginal marine conditions. In the Oothy beds many of the valves of *Notanoplia cf. panifica* Garratt are articulated though fully gaping. The large spiriferid *Spinella pittmani* (Dun) is known only in disarticulated condition but where most abundant in limestone is not associated with any other brachiopod genera. In general, the closer any of the assemblages from the Trundle district approaches an original community the fewer the number of genera represented in that assemblage.

**SYSTEMATIC DESCRIPTIONS**

Unless otherwise mentioned the morphological terms are
Fig. 8. *Baturria* sp.; a–c MMF 22971, latex cast of external mould, b internal mould, c, c' stereo pair latex cast of interior, all x3.6.
those defined in the Treatise (Moore, ed., 1965). Catalogue numbers with the preface MMF are from the fossil collection of the New South Wales Geological Survey.

The majority of the species described are internal moulds in leached marl, siltstone or fine sandstone. Latex casts were used extensively in examining material and all specimens, whether originals or latex casts, were whitened with magnesium oxide for photography. Original specimens were painted with black watercolour before application of magnesium oxide. Some of the valves of Spinella preserved in limestone were etched with acid to reveal details of the cardinal process, there being too few brachial valves for destructive (serial sectioning) processes, and photographed while wet.

Family RHIPIDOMELLIDAE Schuchert 1913
Subfamily PROSCHIZOPHORIINAE Boucot, Gauri & Johnson 1966
Genus Baturria Carls 1974

*Baturria* sp. (Fig. 8)

**Material:** MMF 22971 a single brachial valve.

**Locality:** Yarrabandai, field locality BG/IV/3, Cookeys Plains Formation.

**Description:** The valve is slightly transversely elliptical and convex in profile, the curvature being strongest near the umbo. The posterior half of the valve crest is slightly flattened suggesting an indistinct sulcus. The cardinal angles are very obtuse and do not interrupt the curvature of the valve margin. The hingeline is slightly greater than half the width and the
orthocline interarea is obtusely triangular in shape. The surface is covered with costellae increasing in number by intercalation. Because the new costellae do not appear in the middle of the interspace but rather next to the costella nearer the median there is a superficial appearance of bifurcation.

Interior: The notothyrium is partly closed by the medially thickened blade of the cardinal process protruding slightly above the interarea. The sockets are defined by well developed brachiophore supports that diverge at about 60° and much thinner, lower fulcral plates. It is unclear in the available specimen if the brachiophores are indistinguishable from the plate-like supports or if they have broken away. The anterior edge of the supports is vertical without any obvious damage. The indistinctly quadripartite muscle field extends for about half the valve length and is bounded postero-laterally by very low ridges continuous with the brachiophore supports. The anterior part of the muscle field is much less distinct and marked by a scar which obliterates the impression of the external ornament. The muscle field is divided throughout its length by a wide median ridge with a sharp crest. This ridge is formed by thickening of the valve wall, there being very little indication of the ridge on the exterior. Outside of the muscle field the interior bears the impression of the external costellae, especially near the antero-lateral margin.

Dimensions: length 11.5 width 13.0 height 3

Remarks: The assignment of this specimen to *Baturria* is based
on the brachial valve only. Some of the specimens of *B. pini*, described by Carls (1974) from the lower Gedinnian of western Europe, have very similar brachial interiors, especially the paratype in his plate 3 figure 16. The Trundle specimen differs in having a less distinct median ridge and in being more convex in profile. The internal brachial morphology is consistent with the generic diagnosis of *Schizophoria* as revised by Pocock (1966), although none of the species she described from the Devonian of western Europe has a comparable interior. *Hirnantia* is another possibility and it is interesting to note the Pridolian age of this specimen coincides with the time postulated by Walmsley et al. (1969) when *Hirnantia* gave rise to *Schizophoria*. Lenz and Johnson (1985a) described a new species, *S. fecunda*, from Early Devonian (Pragian) limestone at Wellington (Wilson, 1990) with a very indistinct anterior margin to the brachial muscle field but with much longer and more distinct lateral bounding ridges.

Subfamily DRABOVIINAE Havlicek 1950

Genus *Salopina* Boucot 1960

*Salopina* sp. A (Fig. 9)

**Material:** MMF 31455 and 31457(3) brachial valves, MMF 31456, 31457(1) and 31460(1) pedicle valves.

**Locality:** Field localities BG/I/44 (MMF 31455) and BG/I/45 (MMF 31456-7), both within the Milpose Volcanics.

**Description:** The valves are variably ovoid in shape and ventribiconvex, almost planoconvex in profile. The cardinal
Fig. 9. *Salopina* sp.; a MMF 31456, latex cast of exterior, x8.4; b, c MMF 31460(1) internal mould and latex cast of pedicle valve, x5.6; d, e MMF 31457(3) brachial valve, d, d' stereo pair latex cast of internal mould, e latex cast of external counterpart, both x3.6.
angles are well rounded. In anterior profile the curvature of the pedicle valve is strongest at the crest, though not to the extent of developing a fold. The brachial valve has a shallow sulcus that is narrow near the umbo but broadens anteriorly becoming indistinct near the margin. The pedicle interarea is high, apsacline and with only very slight curvature. The only brachial interarea preserved is planar and distinctly anacline. The extent of the hingeline is clear on only one of the brachial valves, being less than half the maximum width. The exterior has an ornament of costellae, some increasing by intercalation, others by asymmetric bifurcation or trifurcation. The new costellae are very thin and emplaced alongside existing costellae, rather than in the middle of troughs separating costellae, so that they appear to increase by bifurcation.

Brachial interior: The brachiophores are very short and supported by thick plates that diverge at 45°. The sockets are bounded by the interarea, socket plates and low fulcral plates. The cardinal process is not preserved in either brachial valve although a narrow ridge superimposed on a much broader median ridge is possibly the shaft leading to a myophragm. The brachial muscle field is elongate, extending for almost half the length of the valve, and bounded for all but the anterior tip by well developed bounding ridges. These ridges are continuous with the brachiophore supporting plates and have a mid length medially directed inflection, giving the muscle field a quadripartite appearance. The muscle field is divided
throughout by a low, broad median ridge. Beyond the muscle field this ridge is indistinguishable from the impressed external ornament.

Pedicle interior: The teeth are short, stout and triangular in cross section. The dental plates are continued forward as muscle bounding ridges and form small cavities with the interarea and valve walls. The diductor muscle field extends for about one third the length of the valve, the anterior end being impressed rather than bounded by ridges. In one valve there is no apparent division of the muscle field. In the other there is a distinct adductor track represented by a low broad ridge which extends from the delthyrial cavity almost to the anterior edge of the diductor scars.

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Remarks: The definition of this genus was revised in detail by Walmsley et al. (1969), who also described several species.

The pedicle muscle field in these specimens is variable as is the case for *S. mediocostata* described by Strusz (1982, 1984) from Wenlockian strata at Canberra and Ludlovian at Yass. It differs from *S. mediocostata* in having a flatter brachial valve and lacking the diagnostic median costella in the sulcus. The unidentified Siluro-Devonian species of *Salopina* from the Heathcote district of central Victoria (Talent, 1965) and The
Meadows area in western New South Wales (Section B-herein) have much weaker muscle bounding ridges in the brachial valve and a comparatively subdued ornament. *S. kemezysi* from Emsian limestones in the Yass district of New South Wales (Chatterton, 1973) is another species with a comparable pedicle interior but differs in having remarkably linear muscle bounding ridges in the brachial valve and comparatively coarser ornament. Lenz and Johnson (1985a) described *S. cf. submurifer* and *S. cf. kemezysi* from Pragian limestone at Wellington but all their material likewise has very linear muscle bounding ridges.

Outside of the Australasian region the closest species to the Trundle material are *S. crassiformis* from Podolia and *S. submurifer* from North America. The former from the Tajna Beds at the base of the Podolian Devonian was described by Kozlowski (1929) with only one brachial interior illustrated so that it is unclear what variation exists in this species, especially regarding the brachial median ridge. Only the exterior of the neotype was illustrated by Nikiforova *et al.* (1975) and this is notably biconvex. *S. submurifer* described by Johnson *et al.* (1973) was based on 2,634 specimens ranging in age from late Pridolian to early Gedinnian. The main difference from the few Trundle specimens is the more distinct median ridge in the brachial valve which extends beyond the muscle field to the valve margin.

Some of the Whitcliffian specimens of *S. lunata* illustrated by Walmsley (1965, plate 64, figs 24-27) and
Walmsley et. al. (1969, plate 73, fig. 3) resemble the Trundle specimens especially as regards the distinct median ridge in the brachial muscle field and the wide adductor trace in the pedicle muscle field, but differ in having a finer ornament.

*Salopina cf. hitchcocki* Walmsley, Boucot & Harper (Fig. 10)


Material: MMF 20849(2) an incomplete internal mould of a brachial valve; MMF 20849(4) an internal mould of a pedicle valve; MMF 20851 a brachial valve.

Locality: Field locality BOB/II/1, Gwando Siltstone, Yarra Yarra Creek Group.

Description: The valves are transversely ovate, maximum width being about mid length, and almost planoconvex in profile. The cardinal angles are obtuse, rounded and more obvious in the brachial valve. The curvature in the pedicle valve is strongest at the crest. The shallow sulcus in the brachial valve commences near the umbo and becomes progressively wider so that at the anterior margin of the valve it is almost one third the maximum width of the valve. The interarea in both valves is orthocline, very narrow and very obtusely triangular. The exterior is covered by costellae increasing in number by intercalation and unequal bifurcation.

Brachial interior: The sockets are bounded by the hingeline and thin socket plates that diverge at 35°. The cardinal
Fig. 10. *Salopina cf. hitchcocki* Walmsley, Boucot & Harper; a-c MMF 20851 brachial valve, a internal mould, b, b' stereo pair latex cast of interior, c latex cast of exterior, all x3.6; d, d' MMF 20849(2) stereo pair latex cast of brachial interior showing overlap of brachial supporting plates and muscle bounding ridges, x3.6; e, f MMF 20849(4) pedicle valve, e internal mould, f, f' stereo pair latex cast, x3.6.
process consists of an elongate lobate myophore and a very low indistinct shaft. The muscle field is bounded by subparallel ridges that enclose and slightly overlap the brachiophore supports. In larger valves the muscle bounding ridges are continuous with the brachiophore supports, the join marked by a sharp flexure in the composite ridge. The anterior end of the muscle field is not marked by ridges or obvious scars but the lateral bounding ridges indicate that the field is about half the length of the valve. The interior is impressed with the external ornament, even in the muscle field.

Pedicle interior: The shape of the teeth is unclear; they are small, projecting only slightly above the commissural plane. The short, curved dental plates are continuous with much lower muscle bounding ridges that enclose a muscle field about one third the length of the valve. The field is about as wide as long and divided by a broad but weak adductor trace.

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Remarks: The specimens of *S. hitchcocki* from the Siegenian of North America illustrated by Walmsley *et al.* (1969) show considerable variation especially in the development of muscle bounding ridges in both valves and to a lesser extent the presence or otherwise of a median ridge in the brachial valve. There is less variation in the comparatively fewer specimens...
from the Gwando Siltstone and these resemble most closely the holotype of *S. hitchcocki*. Another point of resemblance is the minimal curvature of the costellae, especially the posterior pairs that are subparallel to the hingeline. The weak sulcus and low divergence of the muscle bounding ridges in the brachial valve are comparable to those in *Salopina* sp. from Lochkovian strata in The Meadows district (Section B herein) but the older species is more circular in shape and has weaker ornament.

Chatterton (1973) described *S. kemezysi* from Emsian limestones at Taemas, west of Canberra, a species with similar muscle bounding ridges in the brachial valve to those of *S. hitchcocki*. The pedicle muscle field shows some variation in different specimens from Taemas, some being similar to the specimens in the Gwando Siltstone. However *S. kemezysi* is much smaller and has comparatively coarse ornament.

Family SKENIDIIDAE Kozlowski 1929
Genus *Skenidioides* Schuchert & Cooper 1931

*Skenidioides* sp. (Fig. 11)

**Material:** MMF 29266, a small slab with two brachial valves; MMF 31460(2), a small block with several fragmentary brachial valves.

**Locality:** BG/I/41, a lens of sediment within the Milpose Volcanics.

**Description:** The valves are transversely pentagonal, being widest at midlength, with a hinge line two thirds the maximum
Fig. 11. *Skenidioides* sp.; a, d, e MMF 31460(2) brachial valve, a latex cast of exterior, d internal mould, e, e' stereo pair latex cast of interior; b, c MMF 29266 brachial valve, all x8.4.
width. The lateral and anterior profile is slightly convex, the curvature decreasing towards the anterior margin because of the increasing depth of the sulcus that commences near the umbo. The cardinal angles are well defined, obtuse and show a slight tendency to be mucronate. The anacline interarea is planar and obtusely triangular. The notothyrium is open with an almost equilateral triangle outline. The ornament consists of rounded costellae that increase by bifurcation and possibly intercalation. It is noteworthy that the points of bifurcation are not arranged symmetrically on the valve. Distinctive costellae in the sulcus do not appear until almost midlength.

Brachial interior: The sockets are bounded by the brachiophores, hinge line and small fulcral plates. The cardinal process appears as a very slight thickening and elevation at the proximal end of a long median septum. The brachiophore supporting plates are strongly curved and form a U shaped cruralium. The brachiophores are thick and rod-like, forming a distinct ridge on the inner surface of the supporting plates. The narrow median septum extends almost to the anterior margin of the valve; it is highest where it intersects the anterior of the cruralium and thickest in the anterior two thirds of the septum. The external ornament is impressed over the antero-lateral internal surface.

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Remarks: No pedicle valves of this species were found, suggesting perhaps that the pedicle valve differed markedly in convexity. Savage (1974) reported similar problems in finding only pedicle valves of this genus in collections from Manildra. Comparison of the Manildra and Trundle material is therefore not possible.

Boucot et al. (1966) described *Skenidioides* from very Early Devonian strata in Victoria and Tasmania but the preservation is too poor for confident comparisons. Strusz (1982) described a new species, *S. thrinax*, from much better preserved material in Wenlock strata at Canberra. This species differs from the Trundle material in being more transverse and in having the maximum width much closer to the hingeline.

**Family DALMANELLIDAE Schuchert 1913**

**Subfamily ISORTHINAE Schuchert & Cooper 1931, emended Walmsley & Boucot 1975**

**Genus Isorthis Kozlowski 1929**

**Subgenus Isorthis (Arcualla) Walmsley & Boucot 1975**

*Isorthis (Arcualla)* sp. (Fig. 12)

**Material:** MMF 29270 a brachial valve; MMF 31452, 31453 and 31457(2), pedicle valves; MMF 31461, conjoined but crushed valves.

**Locality:** BG/I/41, BG/I/44 and BG/I/45, all within the Milpose Volcanics.

**Description:** The valves are transversely ovoid to subquadrate and biconvex in profile, the pedicle valve being deeper than the brachial. The transverse curvature of the pedicle valve is
Fig. 12. *Isorthis* (Arcualla) sp.; a-c MMF 29270 brachial valve, a, a' stereo pair latex cast of interior, b latex cast of exterior, x3.6; c, d MMF 31452 pedicle valve, c latex cast of exterior, d internal mould, x1.6; e, e' MMF 31457(2) stereo pair latex cast of delthyrial cavity x5.6.
greatest at the crest but not to the extent of developing a carina. The brachial sulcus is narrow and V shaped in section near the umbo but becomes broader and U shaped anteriorly being somewhat indistinct at the anterior margin. The cardinal angles are obtuse and well rounded such that they barely interrupt the curved outline of the valve, particularly in the brachial valve. The hinge line is approximately half the maximum width. The brachial interarea is orthocline, obtusely triangular and very narrow. In the only brachial valve the notothyrium is closed by a protruding cardinal process. The pedicle interarea is anacline and gently curved parallel to the hinge line. The delthyrium is almost equilateral in outline and in two valves the apex is covered by a convex apical plate. The ornament consists of costellae that increase by bifurcation, the divergence between costellae being so acute that it is difficult to be certain how the increase took place. Widely spaced growth lines are present on some valves.

Brachial interior: The deep dental sockets are bounded by the interarea and brachiophores and supported by incipient fulcral plates or socket pads. The cardinal process consists of a thick blade like myophore which protrudes from the notothyrium and a thin, short shaft that does not extend anteriorly beyond the brachiophore bases. The brachiophores are indicated by thickening in the plate like brachiophore supports and diverge at about 75°. The brachial muscle field is elongately ovoid, indistinctly quadripartite, slightly wider anteriorly and slightly less than half the length of the valve. The posterior
muscle bounding ridges are aligned and possibly continuous with the much higher brachiophore supports. The anterior bounding ridges are comparable in relief to the posterior pair and are strongly curved anteriorly to meet a low but wide median ridge dividing the muscle field. Where the posterior and anterior muscle bounding ridges meet there is a slight narrowing of the muscle field. The external ornament is impressed on the internal margin.

Pedicle interior: The strong hinge teeth are triangular in cross section and supported on thick but short plates continuous or slightly overlapping with much lower ridges bounding the parallel sided, elongately bilobed diductor muscle field. As a whole the muscle field is one third the length of the valve. The adductor trace forms a median ridge which extends from the anterior edge of the delthyrial cavity and widens anteriorly to between one third and two thirds the width of the muscle field. The highest point of the median ridge is level with the muscle bounding ridges and the anterior end of the ridge forms a gently concave triangular slope.

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Remarks: These specimens agree very closely with the generic diagnosis of *Isorthis (Arcualla)* by Walmsley and Boucot (1975). The only significant variation is that the single brachial valve with the cardinal process intact has a non lobate myophore, probably an artifact of age. Similar growth variations in several species were illustrated by Walmsley and Boucot and also by Havlíček (1977).

The specimens from the Milpose Volcanics most closely resemble the north American species *I. (Arcualla) arcuaria* (Hall and Clarke) and *I. (Arcualla) rockhousensis* (Dunbar), the former of Ludlovian age, the latter Early Gedinnian. *I. (A.) arcuaria* differs principally in lacking a sulcus and *I. (A.) rockhousensis* has a much longer pedicle muscle field and a more constricted posterior muscle field in the brachial valve than the Trundle material. The long ranging (Llandovery - Ludlow) *I. (A.) sulcata* Walmsley and Boucot is also similar to the species described herein but the brachial muscle field is narrower.

This material is distinct from all known species of *I. (Arcualla)* but a new species is not proposed because with so few specimens it is impossible to assess the intraspecific variation. Resemblance to the above group of species suggests a possible local variant of a described species, perhaps *I. (A.) arcuaria*.

Subfamily CORTEZORTHINAE Johnson & Talent 1967
Genus *Reeftonia* Allan 1947

*Reeftonia* sp. (Fig. 13)

**Material:** MMF 20845, 20846, 20849, 20850 and 20853, small slabs with numerous disarticulated valves.

**Locality:** BOB/II/1, Gwando Siltstone, Yarra Yarra Creek Group. Some external moulds from TU/III/40, Trundle Group, are probably referable to this species.

**Description:** The valves are transversely ovoid and ventribiconvex, almost planoconvex, although the exact ratio of valve depths cannot be determined in the absence of complete specimens. A comparison of similarly sized valves indicates that the pedicle is deeper than the brachial valve by a factor of about 3:1. The brachial valve is very slightly convex, a wide sulcus with a V shaped trough imparting a flattened profile. The pedicle valve is most strongly curved across the crest, some valves being distinctly carinate. The anterior commissure is markedly sulcate. The cardinal angles are obtuse, rounded and poorly defined. Details of the interarea and hinge line are not clear on any of the valves. The pedicle interarea is anacrine, inclined at less than 20° to the commissural plane, and largely occupied by the delthyrium. None of the comparatively few brachial valves has the interarea intact. The exterior of both valves is covered by costellae that increase by intercalation or unequal bifurcation, fine details being obscured by poor preservation.

**Brachial interior:** The myophore, where preserved, is slightly

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Fig. 13. *Reeftonia* sp.; a, a' MMF 20849(1) stereo pair latex cast of brachial interior x3.6; b MMF 20846(1) latex cast of brachial exterior x1.8; c, d MMF 20849(1) brachial valve, c, c' stereo pair latex cast axial view of cardinal area x3.6, d internal mould x2; e MMF 20849(3) pedicle valve internal mould x2; f MMF 20849(5) pedicle valve internal mould x2. Note the asymmetric muscle fields of the last two specimens.
longer than wide and supported by a shaft. The only socket preserved contains a low socket pad. The robust brachiophores diverge at approximately 90° and overlap considerably the shorter and much lower ridges bounding the posterior half of the subcircular, indistinctly quadripartite muscle field. The anterior half of the muscle field is impressed comparatively weakly on the valve floor. Because of this the extent of the muscle field is not clear but it extends at least half the length of the valve. A low median ridge, corresponding with the sulcus, extends the full length of the valve with width and height variable in different specimens; it is consistently widest where it divides the muscle field. The external ornament is impressed on most of the interior, including the muscle field in some valves.

Pedicle interior: The teeth are short, triangular in cross section, and supported on short dental plates continuous with the lower muscle bounding ridges. The diductor muscle field extending for at least half the length of the valve, and one third the width, is bounded laterally by ridges but is impressed anteriorly. The outline of the muscle field varies from cordate to anteriorly tapered. The left and right halves of the diductor field can differ even within a single valve. In one specimen the outline of the muscle field is convex one side, almost concave the other. Another valve has one side of the muscle field with a scalloped margin. There is no obvious distortion in the valves to suggest that the asymmetry is a result of the preservation. The muscle field is divided in all
specimens by a ridge that is consistently higher and narrower in the anterior half of the field. The lower, broader posterior half of the ridge is the probable site of the adductor muscle attachment. The external ornament is impressed on the interior though less prominently in the muscle field.

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**Remarks:** Allan (1947) placed *Reeftonia* in the family Rhipidomellidae, a classification followed in the Treatise. Johnson and Talent (1967) included this genus in a new subfamily, the Cortezorthinae, based upon several points of resemblance to *Protocortezorthis*. They noted the rhipidomellid outline of the pedicle muscle field in *Reeftonia* but from an examination of several specimens were unable to find any evidence for the flabellate outline mentioned by Allen and emphasised the non rhipidomellid character of the brachial interior of *Reeftonia*. Walmsley and Boucot (1975) reduced *Protocortezorthis* to subgeneric status within the Isorthinae and left *Reeftonia* in a taxonomic limbo other than referring to the salopinid aspect of the pedicle muscle field. Alekseeva et al. (1981) considered that *Reeftonia* is sufficiently close to *Isorthis* to be included with the Isorthinae.
The specimens from Mineral Hill (Yarra Yarra Creek Group) are not sufficiently well preserved to provide a basis for determining the familial placement of *Reeftonia*. Brachial valves are rare in comparison with the numbers of pedicle valves and none is complete in the umbonal area. The transversely elongate shape of the valves is more typical of the Isorthinae than the Rhipidomellidae. However the pedicle muscle fields in some valves show incipient, if asymmetric, flabellate or wavy margins (Fig. 13f) and are much wider in proportion to the width of the valve than is usual for the Isorthinae.

The (?)adjustor muscle scars in the postero-lateral part of the the pedicle muscle field are comparable to those in some species of *Cortezorthis* (eg. Johnson and Talent, 1967, pl. 20, fig. 21) and *Cariniferella* (do. pl. 22, figs 20, 21). The considerable overlap of the brachiophore supporting plates and posterior muscle bounding ridges is a feature common to *Cortezorthis*, including *C. windmillensis*, transferred from *Protocortezorthis* by Johnson (1975), *Reeftonia* and possibly *Cariniferella*. In the Isorthinae the brachiophore supporting plates either abut against the posterior muscle bounding ridges or are continuous with them but in no isorthid do they overlap. The median ridge in *Reeftonia* does not approach the relief of that in some species of *Cortezorthis* but is similar in extent and cross section. For these reasons I have retained *Reeftonia* in the Cortezorthinae rather than transferring it to the Isorthinae as was done with *Protocortezorthis* .

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Comparisons with other species of *Reeftonia* are hindered by the incomplete brachial valves collected from the Yarra Creek Group. *R. marwicki* Allen, the genotype from the Bolitho Mudstone, Reefton Group (Bradshaw, 1983) in New Zealand, has much thicker dental plates, a less distinct ridge dividing the pedicle muscle field and more distinct adductor scars in the pedicle valve. The muscle bounding ridges in the brachial valve are more distinct in specimens illustrated by Johnson and Talent (1967) and Cooper and Bradshaw (1986). *R. alpha* (Gill) from the Kilgower Member of the Tabbberabbera Formation in eastern Victoria displays quite remarkable variations in morphology to judge from the abundant illustrations of Talent (1963), although Walmsley and Boucot (1975) expressed reservations as to whether the specimens were conspecific or even congeneric. The pedicle valve illustrated in pl. 27, fig. 15 of Talent is closest to the Yarra Creek material but in general the Kilgower specimens have consistently narrower pedicle muscle fields and more distinct muscle bounding ridges in the brachial valves. Alekseeva et al. (1981) refigured *R. taeniolata* (Khalfin) and *R. borealis* Hamada from Mongolia. Both species have variably divergent bilobate pedicle muscle fields, moreso than anything seen in *R. marwicki*, and a brachial muscle field bounded and divided by a series of ridges with no counterpart in Australasian species of *Reeftonia*.

Superfamily STROPHEODONTACEA Harper & Boucot 1978
Family LEPTOSTROPHIIDAE Caster 1939

Genus Leptostrophia Hall & Clarke 1892

Subgenus Leptostrophia (Mitchella) Strusz 1984

Leptostrophia (Mitchella) deckerae sp. nov. (Fig. 14)

Origin of name: After Forbes Shire councillor Dianne Decker in recognition of her work in preserving geological sites within the Shire of Forbes.

Holotype: MMF 20528 a pedicle valve.
Paratypes: MMF 20530 a brachial valve, MMF 20496 a small pedicle valve.

Other Material: MMF 20492, 20524 and 20526(1) all brachial valves; MMF 20497, 20500, 20525, 20526(2), 20527, 20529, 20531, 20534, 20855, 31462 all pedicle valves.

Type Locality: BG/IV/1, Cookeys Plains Formation, Derriwong Group.
Other localities: BG/IV/3 (MMF 31462 only), also Cookeys Plains Formation.

Diagnosis: A species of Leptostrophia (Mitchella) with semi-elliptical to circular outline, distinct widely spaced ornament and pedicle muscle field impressed in valve floor rather than bounded by ridges.

Description: The valves are semi-elliptical, the eccentricity increasing with growth, very small specimens being almost subcircular. At all growth stages the valves are very gently concavo-convex to nearly plano-convex although the degree of curvature decreases distally, the antero-lateral part of the pedicle valve being nearly planar if not actually sulcate. The
Fig. 14. *Leptostrophia (Mitchella) deckerae* sp. nov.; a-c MMF 20530 paratype brachial valve, a, a' stereo pair of latex cast of cardinal area x8.4, b, c internal mould and latex cast x1.3; d MMF 31462 latex cast of pedicle exterior x1.3; e-g MMF 20528 holotype pedicle valve, e, e' latex cast of delthyrial area x8.4, f, g internal mould and latex cast x1.3.
hinge line is denticulate for about three quarters of its length and in some pedicle valves is most pronounced. The cardinal angles are orthogonal to slightly obtuse in all growth stages. The pedicle interarea is apsacline and divided by a partially open delthyrium with an indistinct pseudodeltidium suggested by the truncated top of the delthyrium. The brachial interarea is very narrow. A small protrusion on the hingeline posterior to the cardinal process is possibly a very small very convex chilidium. The surface ornament is apparently uniformly costellate but the wide spaces between costellae, as much as three times as wide as a costella, suggest an unequally parvicostellate ornament.

Brachial interior: The socket ridges are vestigial and almost parallel to the hingeline for most of their length; only near the base of the cardinal process is there some indication that they diverge at an acute angle from the hingeline. The minute bilobed cardinal process is supported on a notothyrial platform. The adductor muscle field is very small, about three times the length of the cardinal process. The field is bounded at the posterior end by short, very low rounded ridges and divided by a short, low tapered myophragm that extends about one quarter the length of the valve. Outside of the muscle field and away from the hingeline the surface bears the imprint of the external ornament with the external intercostellar furrows represented as endospinose costellae.

Pedicle interior: The denticulate edge of the interareas is
narrow and extends on either side of the delthyrium for approximately twice the width of the delthyrium. The muscle field is triangular, open anteriorly, and impressed into the floor of the valve. In only one specimen was there any trace of distinct muscle bounding ridges. The length of the field is indicated by a very low and thin myophragm that extends from the bilobate ventral process for about one third the length of the valve. The ventral process is V-shaped, the lobes diverging anteriorly, and flanked by small process pits. A short strut, more or less parallel to the hinge line, joins the anterior end of each lobe and marks the posterior edge of each adductor scar. In juvenile specimens the ventral process consists of little more than a low ridge. The adductor scars are approximately half the length of the diductor muscle field. Except for the muscle field the interior is endospinose, the endospines being arranged on costellae corresponding to the external furrows.

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Remarks: Strusz (1984) based this subgenus upon L. (M.) quadrata (Mitchell) from Bowning, north west of Canberra, and discussed its relationships, particularly with reference to the Early Devonian L. (Rhytistrophia), a genus with similar muscle bounding ridges. Mitchell (1923) gave a very approximate
locality for his types but Strusz found comparable material, all moulds preserved in mudstones, at what is probably the same locality in the early Ludlovian Silverdale Formation (Link 1970, Link and Druce 1972, Pickett 1982). Strusz noted also that this species occurs in the similarly aged Yarralumla Formation at Canberra. *L. (M.) deckerae* is a younger species, of late Ludlovian to Pridolian in age.

The muscle bounding ridges in *L. (M.) quadrata* are weak though still more obvious than in any of the specimens of *L. (M.) deckerae*. This weakness or complete lack of muscle bounding ridges was listed by Harper and Boucot (1978a) as more typical of Llandoverian Mesoleptostrophiinae, the earlier members of the Leptostrophiidae. The trend to stronger muscle bounding ridges is reversed in the two species of *L. (Mitchella)*, the younger species having the weaker, insignificant muscle bounding ridges. *L. (M.) deckerae* differs also in having a more rounded outline in all growth stages and pedicle valves that all are very flattened antero-medially but not actually sulcate. Strusz (1984) noted that only about one third of his specimens are sulcate so that this feature is not absolutely diagnostic.

The interior of *L. (M.) deckerae*, with respect to the negligible muscle bounding ridges in the pedicle valve and the vestigial socket plates almost parallel to the hingeline in the brachial valve, is diagnostic of *Pholidostrophia* (*Mesopholidostrophia*) (Harper & Boucot, 1978b). Williams (1953) described this genus as having a smooth exterior but
subsequently Harper and Boucot (1978c) noted that some species have a faint radial ornament. However it is unlikely that either the Yass or Trundle species, both of late Silurian age, is ancestral to P. *Mesopholidostrophia* known from strata as old as late Llandovery (Harper and Boucot 1978c) unless the latter genus is polyphyletic. McKellar (1969) placed some valves from latest Silurian strata in Queensland in the subfamily Pholidostrophiinae, the poor and fragmentary preservation precluding a more definitive identification. However some of the pedicle interiors he illustrated resemble *L. (M.) deckerae*.

Some of the pedicle valves have an *Aulopora* epifauna but there is no obvious pattern to the density or distribution of the encrustation on the three valves examined, all parts of the exterior from umbo to anterior margin having been colonised. This implies that the pedicle valve was either uppermost, as noted in similarly encrusted *Mesodouvillea* from The Meadows district (Section B-herein) or else the whole valve was balanced on the hingeline as suggested by Spjeldnaes (1984, p.232) for some European strophomenids covered with *Aulopora* on both valves. No brachial valve exteriors of *L. (M.) deckerae* have been found so either of these life positions is credible from the available evidence.

Family SHALERIIDAE Williams 1965
Genus Shaleria Caster 1939

*Shaleria* sp. (Fig. 15)
Fig. 15. *Shaleria* sp.; a, a' MMF 20495 stereo pair of latex cast of pedicle interior x3.65.
Material: MMF 20495 and 22518(2), internal moulds of pedicle valves.

Locality: BG/IV/1, Cookeys Plains Formation.

Description: The pedicle valves are subquadrate to semicircular and strongly convex, with maximum width at the hingeline. In one valve the cardinal angles are slightly mucronate. At least half the hingeline is denticulate, the true extent being unclear because of poor preservation. The interarea is planar and obtusely triangular. The apex of the delthyrium is covered by a convex pseudodeltidium that is joined to the ventral process. The elongately bilobed muscle field extends two thirds the length of the valve, being about twice as long as wide. The short posterior sections of the muscle bounding ridges diverge from the ventral process parallel to the edges of the delthyrium. Just anterior to the denticles there is a marked inflection in the ridges so that they are almost parallel for most of their length. The point of inflection is also the point of greatest relief of the ridges. The muscle field is divided by a prominent ridge extending from the ventral process and increasing in width and height to about mid length. The anterior half of the ridge decreases in relief and the anterior third is bifurcate, the branches diverging towards the tips of the muscle bounding ridges. Each lobe of the muscle field is divided by an indistinct median longitudinal ridge. The deeply impressed subcircular area occupying most of the interior probably marks the extent of the visceral area.
The exterior of the valves is unknown, nor is there any ornament impressed upon the interior.

**Dimensions:**

| MMF 20495 | pedicle | >10 | 12.5 |
| MMF 22518(2) | pedicle | 7.0 | 10.0 |

**Remarks:** The distinctive parallel-sided muscle field suggests attribution to *Shaleria* despite the lack of brachial valves and any external impressions. The only other genus assigned to the family Shaleriidae by Harper and Boucot (1978b), *Shaleriella*, is distinguished from *Shaleria* and these specimens by a geniculate profile.

*Shaleria armaghensis* was described from latest Silurian strata in Queensland (McKellar 1969) and recorded from the Siluro-Devonian Cobar Supergroup in western New South Wales (Baker *et al.* 1975). The muscle bounding ridges in this species are notably less parallel than in the Trundle specimens.

Family CHILIDIOPSIDAE Boucot 1959

Genus *Iridistrophia* Havlicek 1965

*Iridistrophia* sp. (Fig. 16)

**Material:** MMF 20493, 20503, 20518, 20520, 20522 and 20853 brachial valves; MMF 20521, 22518 and 31459 pedicle valves. MMF 22518 is a slab with several small brachial and pedicle valves.

**Locality:** BG/IV/1 and BG/IV/3, thinly bedded sandstones,
Fig. 16. *Iridistrophia* sp.; a, b, e, f MMF 20520 brachial valve, a internal mould x1.5, b latex cast of external mould showing overgrowth of *Aulopora* x1.5, e, e' latex cast of cardinalia x5.6, f, f' latex cast showing chilidium x3.65; c MMF 20854 internal mould of brachial valve x1.25; d MMF 31459(1) latex cast of brachial exterior x1.25; g, g' MMF 22518(3) stereo pair of latex cast of small brachial interior x3.65; h MMF 31459(2) latex cast of pedicle interior x1.25; i-k MMF 22518(1) pedicle valve, i, i' latex cast of interarea showing pseudodeltidium x3.65, j latex cast of exterior x1.5, k latex cast of interior x1.5.
Cookeys Plains Formation.

Description: Small valves are subcircular, becoming transversely elliptical to subquadrate with growth, with the width of mature valves being almost twice the length. Very small specimens are slightly biconvex becoming increasingly convexo-concave with growth, the largest pedicle valves being almost geniculate. The brachial valve is deeper in all but the smallest specimens. The broad and shallow V shaped sulcus in the brachial valve persists for no more than two thirds the length in the largest specimens. In the best preserved specimens the cardinal angles are slightly obtuse, the size of the angle increasing slightly with growth. Distortion has caused elongation of some specimens. The brachial interarea is very narrow and of uncertain extent, although it is at least half the length of the hinge line. The prominent chilidium is very obtusely triangular, the width being about four times the height, and is almost the full height of the interarea in the best preserved specimen. The pedicle interarea is steeply apsacine and extends almost the full length of the hinge line. The delthyrium is almost wholly closed by a strongly convex equilateral pseudodeltidium. The ornament is parvicostellate to unequally parvicostellate with increase by intercalation except in some larger pedicle valves where the internal imprint near the margin shows increase by quite abrupt branching, although no such branching is obvious on the corresponding part of the exterior.

Brachial interior: The cardinal process is bilobed with a
posteriorly directed facet or groove on each lobe. The sockets are bounded by robust socket ridges and the hinge line. In very small specimens the socket ridges are narrow and diverge from the hingeline at 35° but in the largest specimen they are comparatively thick, less distinctive and diverge from the hinge line at approximately 15°. In all growth stages the socket ridges are in contact with the base of the cardinal process. At the base of the cardinal process is a low median ridge, corresponding the sulcus on the exterior, that divides an indistinct adductor muscle field. The anterior of the muscle field is indistinct, approximately one fifth the length of the valve. Except in the cardinal area the interior is marked by the impression of the external ornament.

Pedicle interior: The triangular hinge teeth are robust and supported on thick plates that diverge from the hingeline at approximately 25° defining the posterior margin of the diductor muscle field. The anterior of the muscle field is less well defined but the most deeply impressed scars indicate the anterior margin is semicircular; the field overall is about one third the length of the valve. The field is divided by a low, at times medially grooved ridge, that joins a very small subcircular ridge defining the adductor muscle field. A low strut, parallel to the hingeline, extends from each side of the adductor muscle field to approximately midlength of the dental plates. The external ornament is impressed on the interior except for the marginal variations noted above.
Dimensions:

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Remarks: This species does not fit easily into any of the genera recognised by either Havlíček (1967) or Strusz (1985a) as belonging to the Chilidiopsidae. The closest genus is *Iridistrophia* of Late Silurian to Early Devonian age. The Trundle species differs in having an entire chilidium instead of the reduced, discrete or missing chilidial plates mentioned by Havlíček, although it is questionable if too much reliance should be placed on chilidial structures in a genus with such a reduced brachial interarea. It is also possible that in genera with very reduced or linear brachial interareas the chilidium may be present but unrecognised. Wright (1971) observed in the related triplesiacean genera *Meekella* and *Triplesia* that the development of a chilidium was variable even within a single species, depending in part upon the amount of available interarea. The Trundle specimens lack the medial minute node on the base of the cardinal process in *Iridistrophia*. More significant is the planar morphology of the socket plates in all growth stages of the Trundle species, unlike the strongly concave socket plates of *Iridistrophia*. Havlíček regarded straight socket plates as characteristic of primitive Chilidiopsidae and all of the species he listed are younger than that from Trundle.

This species differs from *Iridistrophia* sp. in the Early
Devonian Winduck Group (Section B—herein) near Cobar in being wider than long and in having planar instead of curved socket plates. The same differences separate it from other species elsewhere in the world. Small, gently biconvex specimens of the Trundle species resemble some of the smaller valves of *Morinorhynchus oepiki* from late Ludlovian strata at Yass (Strusz 1982, 1985a), approximately the same age as the Cookeys Plains Formation. The Trundle specimens could be derived from *Morinorhynchus* by the pedicle valve becoming depressed and distally concave.

Overgrowths of the tabulate coral *Aulopora* are usual on the exterior of the deeper brachial valves, especially larger specimens, but have not been seen on pedicle valves of any size. This pattern of overgrowth suggests that *Iridistrophia*, in common with other similarly shaped strophomenids, rested with the convex valve uppermost, even if in this instance the brachial valve is the convex valve.

Superfamily CHONETACEA Bronn 1862

Family CHONETIDAE Bronn 1862

Subfamily STROPHOCHONETINAE Muir-Wood 1962

Genus *Strophochonetes* Muir-Wood 1962

*Strophochonetes* sp. sensu lato (Fig. 17)

**Material:** MMF 31463 and 31464, small slabs with numerous disarticulated valves.

**Locality:** BG/I/39, well bedded flaggy fine grained quartzose sandstone, Yarrabandai Formation.
Fig. 17. *Strophochonetes* sp.; a, b MMF 31463(1) latex cast of brachial valve, a, a' stereo pair of exterior, b, b' do of interior, all x8.4; c, c' MMF 31464 stereo pair of latex cast of brachial interior x8.4; d, d' MMF 31463(2) stereo pair of latex cast of pedicle interior x8.4; e MMF 31463(3) latex cast of pedicle exterior showing elongate hinge spines x3.
Description: The valves are very small, distinctly concavo-convex and approximately twice as wide as long. In some pedicle valves there is an indistinct sulcus in the more strongly curved posterior part of the valve. The cardinal angles are orthogonal, the straight hinge line coinciding with the greatest width. The interareas of both valves are very narrow; other details, including the presence or otherwise of a pseudodeltidium and chilidium, are obscured by the comparatively coarse matrix. The pedicle valve has at least one hinge spine at a variable distance from the umbo in different specimens. Where only one hinge spine is present there is no obvious preference for either side of the umbo. On the best preserved pedicle valve there are four hinge spines or spine bases arranged symmetrically about the umbo. The hinge spines diverge from the hingeline at angles between 80° and 90° tapering distally. The hinge spines nearest the umbo are very elongate, several times the length of the valve, and generally straight. The pair nearest the cardinal angles are much shorter and comparatively strongly curved, the extremities pointing towards the umbo. The longest spine is at least two and a half times as long as the length of the valve. The surface of each valve is covered by capillae, those on pedicle valves being slightly more prominent, most extending to the umbo. The median capilla on some pedicle valves is slightly thickened.

Brachial interior: The bilobate cardinal process is joined to short socket ridges that are subparallel to the hingeline. The
distinct alveolus is approximately equal in width to the
cardinal process. The anderidia are less prominent, being
thinner and lower than the socket ridges, and diverge at 40°.
They are distinct for less than one fifth the length of the
valve, being aligned with pustulose ridges marking the internal
imprint of the inter-capillar furrows. The development of
these ridges is variable other than being concentrated medially
and even within a single valve the distribution may be
asymmetric.

Pedicle interior: The hinge teeth are transversely elongate
and raised only slightly above the hinge line. The median
septum is very thin and extends from the hinge line for less
than on quarter the length of the valve. The interior bears
the imprint of the external capillae.

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Remarks: The fine details in these specimens are obscure
because of the comparatively coarse grain size of the enclosing
sediment. Using the criteria established by Racheboeuf (1976,
text fig. 44) for differentiating genera and subgenera of the
Strophochonetinae the best fit is Strophochonetes
(strophochonetes), the only significant difference being the
smaller angle (40° instead of 60°) between the anderidia in the
Trundle material. These specimens are also unusual in the length of hinge spine preserved, several times the length of the valves. If broken off at the hinge line it could be difficult to determine if the hinge spines were perpendicular to the hinge line or at an acute angle, with corresponding difficulties as to generic assignment.

The *Strophochonetes* species from the Cobar district (Sherwin, in prep.) in the north west of New South Wales is probably the same species as that from Trundle but the preservation of the former is too poor for confident comparison. Chapman (1903) described three new species from the late Silurian of Victoria, *Chonetes melbournensis*, *C. robusta* and *C. cresswelli*, all having perpendicular hinge spines and transversely elongate valves. The latter two species are much larger than the Trundle species. *C. melbournensis* is similar in size to the Trundle species but differs in having a distinct median ridge in the brachial valve and an external ornament noted by Strusz (1984) as uncharacteristic of the chonetids. Savage (1974) described a small chonetid from the Early Devonian Maradana Shale near Manildra in central New South Wales as *Chonetes cresswelli*. In size and internal details there is little to separate his material from the Trundle specimens. The Manildra specimens are more variable in shape, some distinctly transverse, others with length almost equal to width. The hinge spines nearest the umbo are at an acute angle to the hinge line but are initially curved so that for most of their length they are
essentially perpendicular to the hinge line. Unlike the Trundle specimens the shorter, more strongly curved hinge spines further from the umbo are situated on the cardinal angles. The (?) *Devonochochetes* and *Asymmetrochochetes* species described by Lenz and Johnson (1985a) from the Early Devonian Garra Formation near Wellington have similar hinge spines but differ in having a distinct myophragm in the brachial valve.

The European species *Strophochonetes* (*S.*) *cingulatus* (Lindstrom), *S.* (*S.*) *mediocostalis* (Kozlowski) and *S.* (*S.*) *jouannensis* Garcia-Alcalde & Racheboeuf (the first Late Silurian the others Early Devonian) have distinct median ridges in the brachial valves and are less transverse. Alekseeva (1967) described four new species from the far east USSR but provided insufficient illustrations for reliable comparisons. Some of the specimens of *Asymmetrochochetes spinalonga* Smith from the early-late Lochkovian of Arctic Canada have interiors very similar to the Trundle specimens, especially with respect to the weak or imperceptible median ridge in the brachial valve.

Superfamily RHYNCHONELLACEA Gray 1848

Family TRIGONIRHYNCHIIDAE McLaren 1965

*Ancillotoechia* Havlicek 1959

"Ancillotoechia" cf. *duni* (Gürich 1901) (Fig. 18)

**Material:** MMF 31465 a slab with numerous disarticulated valves. **Locality:** BG/II/16, thinly bedded flaggy fine quartzose sandstone of the Yarrabandai Formation.
Fig. 18. "Ancillotoechia" cf. duni (Gürich); a MMF 31465(3) latex cast of brachial exterior x3.65; b, b' MMF 31465(1) stereo pair, latex cast of brachial interior x3.65; c MMF 31465(4) latex cast of pedicle exterior x3.65; d MMF 31465(2) latex cast of pedicle interior x3.65.
Description: The valves are small, pentagonal and biconvex, the biconvexity being much more pronounced in larger specimens because of the almost geniculate profile of the pedicle valve. The low brachial fold and shallow pedicle sulcus are developed in only the anterior half of the largest specimens. The fold has four subangular plicae, the sulcus three. The flanks of the brachial valve have 6-7 plicae either side of the fold and 7-8 flanking the sulcus. All plicae commence at the umbos.

Brachial interior: The details of the sockets are unclear because of the preservation. The small septalium is buttressed by a low median septum that extends for almost half the length of the valve. The plicae are impressed upon the interior except for a small area that extends from the septalium for less than one quarter the length of the valve.

Pedicle interior: The hinge teeth are either not preserved or inconspicuous on the specimens available. The dental plates are very small, extending less than one quarter the length of the valve, and almost totally incorporated into the valve wall. The plicae are impressed upon the interior except in the delthyrial cavity.

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Remarks: These specimens are consistent with "Ancillotoechia"
duni Gürich described from the Cobar district (Section B-
herein). The same paper should be consulted for a discussion
of the age and relationships of this species. In the Trundle
district "A." cf. duni is known with certainty only in the
Yarrabandai Formation. Very small poorly preserved specimens
could be confused with similarly sized poorly preserved
Molongia elegans capricornae McKellar, known from the
underlying Cookeys Plains Formation.

Family UNCINULIDAE Rzhonsnitskaya 1956
Subfamily UNCINULINAE Rzhonsnitskaya 1956

Uncinulid indet. (Fig. 19)


Material: MMF 9421(1) pedicle internal mould; MMF 9421(2),
27867 brachial internal moulds. Fragmentary external moulds
are known from all localities.

Locality: BG/I/27, BG/II/21, BG/II/22 Calarie Sandstone, base
of Derriwong Group.

Description: Small specimens are biconvex, becoming
subglobular with growth because of increased curvature, almost
geniculate in the brachial valve. Complete specimens were
probably higher than wide. There is a weak sulcus, containing
five plicae, on the anterior half of the largest pedicle
valves. The brachial fold commences at the point of greatest
curvature of the valve and incorporates four plicae. The
external details are unclear because the external moulds are
very fragmentary. The umbonal region is smooth, the rounded
plicae beginning between one quarter and one half the length

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Fig. 19. Uncinulid indet.; a, b MMF 9421(2) brachial valve, a internal mould x1.5, b, b' latex cast of cardinal area stereo pair x3.65; c, d MMF 9421(1) pedicle valve, c internal mould x1.5, d, d' latex cast of delthyrial area stereo pair x3.65.
from the umbo. There are 3-4 plicae to either side of the fold and 4-5 either side of the sulcus.

Brachial interior: The hinge plates are conjunct, forming a platform supported by a thin, low median septum that extends for nearly half the length of the valve floor. The slight thickening of the median septum next to the hinge plates is possibly a very narrow callus-filled septalium, but details are obscure because of the poor preservation. The cardinal process is also obscure. The plicae are impressed on the anterior half of the interior.

Pedicle interior: The teeth are very small and supported on short dental plates that are almost incorporated into the wall by callus. The muscle field is divided by a low and narrow flat topped ridge that extends from the delthyrial cavity for approximately half the length of the valve. The posterior end of the diductor field is bounded by low ridges continuous with the dental plates. The plicae are impressed on the interior except in the umbo and muscle field.

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**Remarks:** These specimens have been assigned to the Uncinulinae because of the conjunct hinge plates. There is some resemblance to the Late Silurian-Early Devonian *Lanceomyonia* (subfamily Hebetoechiinae) in that the plicae do not extend to
the umbo but *Lanceomyonia* differs in having an uncovered septalium. Their major value in the Forbes district has been corroborative evidence in identifying scattered outcrops of the Calarie Sandstone. This formation consists of mostly unfossiliferous cross bedded quartzose sandstone, the fossils being restricted to softer laminated sandstone interbeds.

None of the specimens has the pedicle beak preserved so that it is uncertain if this species had a functional pedicle, although there are no callus deposits in the delthyrial cavity blocking the pedicle passageway.

Subfamily *HEBETOECHIINAE* Havlicek 1960

*Sphaerirhynchia* Cooper & Muir-Wood 1951

*Sphaerirhynchia* sp. (Fig. 20)

Material: MMF 20512 a small block of leached marl containing several moulds of disarticulated specimens of pedicle and brachial valves.

Locality: TU/III/40, Trundle Group. Some fragmentary valves from locality BOB/II/1, Yarra Yarra Creek Group, are possibly referable to this species.

Description: Both valves are very strongly curved, the brachial more than the pedicle, and slightly wider than long, the overall shape being transversely globular. The pedicle valve has a broad, very weak sulcus with seven costae in the anterior half of the valve near the start of the tongue but there is no obvious fold in the brachial valve. Both valves have low, well rounded costae that originate at or near the
Fig. 20. *Sphaerirhynchia* sp.; a–d MMF 20512(2) brachial valve, a internal mould, b anterior profile, c lateral profile, all x1.2, d, d' stereo pair of umbonal region x3.65; e MMF 20512(1) latex cast of pedicle exterior x1.2; f, g MMF 20512(3) pedicle valve, f internal mould, g lateral profile both x1.2.
umbo and are longitudinally grooved near the commissure.

Brachial interior: The hinge plates are separated by a deep, narrow septalium that is notably constricted near its join with the supporting median septum. The median septum extends for approximately half the length of the valve and is much thickened posteriorly by callus deposits. The internal surface near the septalium is weakly pitted but the remainder of the interior bears the imprint of the costae.

Pedicle interior: The teeth and dental plates are indistinct, almost wholly incorporated into the wall by callus. The muscle field is indistinct but is divided anteriorly by a low and narrow ridge. The internal surface, except where thickened by callus, bears the imprint of the costae.

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Remarks: The internal and external morphology of these specimens is consistent with *Sphaerirhynchia* but it is difficult to make comparisons with many *Sphaerirhynchia* species because they were described from serial sections. The applicability of the genus has also been questioned (Savage et al. 1979). Comparisons have been restricted to species described from moulds or silicified valves extracted from limestone.
The species described from The Meadows district (Section B-herein), has much coarser costae as well as being distinctly longer than wide. Talent (1963) described *S. globularis* from moulds in Early Devonian clastics in the Lilydale district of Victoria. It is distinguished readily from the Trundle species by a shorter brachial median septum that ends anteriorly in a circular (?muscle bounding) ridge system. Lenz and Johnson (1985b) described *S. bellensis* using silicified material in limestone from the Pragian Garra Formation at Wellington (Wilson, 1989). Internal comparisons are difficult because of the different type of preservation but the Wellington species is distinctly pentagonal in shape unlike the transversely rounded Trundle species. The Wellington species has also a more truncate anterior profile, deeper sulcus and a distinct fold.

Superfamily ATRYPACEA Gill 1871
Family ATRYPIDAE Gill 1871

*Atrypa* Dalman 1828
*Atrypa* sp. (Fig. 21)

Material: MMF 20502, 20503 external moulds of pedicle valves; MMF 31466 fragmentary external moulds.
Locality: BG/I/46 and BG/IV/1, Cookeys Plains Formation, Derriwong Group.
Description: The pedicle valves are scutiform with length and width about equal, maximum width being at or just anterior to the rounded cardinal angles. The fold is well developed
medially and almost carinate in the posterior half of the valve. The costae are rounded in cross section and separated by slightly wider interspaces. Increase is symmetric and mostly by bifurcation at alternate intersections with the prominent growth lamellae. Costae that appear by intercalation are few, a very narrow one on the crest of the fold and one in the middle of each flank. None of the intercalated costae shows any sign of by bifurcation.

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Remarks: This material is inadequate for anything other than very generalised comparisons and recording the occurrence of Atrypa in the Cookeys Plains Formation. The thin median costa separates this species from Atrypa cf reticularis nieczlawiensis Kozlowski described from the Winduck Group in The Meadows district (Section B-herein). However, Strusz (1985b, p. 114) noted the presence of a thin median costa in a minority of specimens of Atrypa sp. cf. perflabellata (Talent) from the Wenlock Canberra Formation at Canberra. A median costa of this type is present also in the specimens of Atrypa reticularis cf. inversa Savage illustrated by Lenz and Johnson (1985b) from limestone of Pragian age (Wilson, 1989) in the Garra Formation near Wellington. The presence of this thin median costa on the pedicle valve thus appears to have little or no stratigraphic significance.
Fig. 21. *Atrypa* sp.; MMF 20502 latex cast of pedicle exterior x3.65.

Fig. 22. *Atrypoidea*? sp.; MMF 9420 pedicle valve, a internal mould, b latex cast do., x1.5.
Family LISSATRYPIDAE Twenhofel 1914

Atrypoidea Mitchell & Dun 1920

Atrypoidea? sp. (Fig. 22)

Material: MMF 9420 a small slab containing several incomplete internal and external moulds of pedicle valves.

Locality: BG/II/22, Calarie Sandstone (Basal Derriwong Group).

Description: The pedicle valve is subcircular, strongly convex, with an incurved beak and negligible interarea. Maximum width is close to midlength. The exterior surface is smooth. The shell is thickest at the umbo. The teeth are attached directly to the wall, inclined adaxially and elongate parallel to the wall. The muscle field is approximately one quarter the length of the valve and impressed deeply into the valve floor at its posterior end. It is bounded laterally by very faint vascula myaria or vascula media impressions and anteriorly by a thin, indistinct chevron shaped scar (Fig. 23a) with the apex forward. All other details are obscure because of the poor preservation.

Dimensions: length width height

MMF 9420 pedicle 27.0 c. 24.0 8.5

Remarks: Copper (1977) revised this genus including all known species in Australasia, North America, Europe and Central Asia. To this list may be added later East Asian discoveries of Atrypoidea in China (Rong and Yang, 1980) and Mongolia (Rong et al., 1983; Su et al., 1983).

The poor preservation of these specimens from Forbes as
well as the lack of any recognisable brachial valves means that the generic identification remains uncertain. The type for the genus, *Meristina (?) australis* Dun, was collected from limestone (Dun 1904), as was the additional material used to establish the genus *Atrypoidea* by Mitchell and Dun (1920) and Copper's (1977) revision. There is thus the added difficulty in reconciling these moulds with serial sections. More complete and better preserved moulds of *A. australis* have been figured by Strusz (1984) from siltstone in the Ludlovian Yarralumla Formation at Canberra and possible *Atrypoidea* by McKellar (1969) from siltstones in the Craigilee Beds near Rockhampton in Queensland, dated subsequently (Jell & Talent, 1989) as Pridoli in age.

**Family NOTANOPLIIDAE Gill 1969**

The relationships of the Notanopliidae have been a matter for some speculation as noted by Garratt (1980). Johnson (1973) gave a reasoned case for including the Notanopliidae within the Atrypacea and this classification is used here. The mode of preservation of some notanopliids, articulated but with both valves fully supine (e.g., Boucot & Johnson, 1972, pl. 1, figs 15, 16; Gill, 1969, pl. 144, figs 22, 23) is very reminiscent of some similarly sized sowerbyellids (Talent, 1965, pl. 6, figs 1, 3, 7).

**Notanoplia Gill 1950**

*Notanoplia cf. pherista* Gill (Fig. 23)
Fig. 23. *Notanoplia* cf. *pherista* Gill; a, b MMF 23596(1) brachial valve, a internal mould, b, b' stereo pair latex cast; c-e MMF 23596(2) pedicle valve, c internal mould, d, d' stereo pair latex cast, e latex cast of external mould. All x5.6.

Material: MMF 23596(1) brachial valve internal mould; MMF 23596(2) internal and external mould of a pedicle valve.
Description: The valves are plano- to concavo-convex and the more complete pedicle valve is subcircular, greatest width being near to mid length. The cardinal angles are rounded and slightly obtuse. Most of the apsacline pedicle interarea is occupied by an equilateral delthyrium equal in width to half the length of the hinge line. There is no obvious ornament on the poorly preserved pedicle exterior.

Brachial interior: The prominent socket ridges are almost parallel to the hingeline and joined medially to an indistinct bilobed cardinal process. A prominent median septum extends almost the full length of the valve and is joined proximally by two widely divergent curved lateral septa, all three septa being of comparable relief.

Pedicle interior: The teeth are circular in section with a very narrow longitudinal groove on their posterior surface and are attached to the hingeline at the corners of the delthyrium. The diductor muscle field is divided by a low ridge with a longitudinal groove closed over posteriorly to form a tube that ends blindly in the delthyrial cavity. This ridge bifurcates at one quarter the valve length, the branches diverging before fading at mid-length. At approximately mid-length there is
another low median ridge or septum that extends almost to the anterior margin. The postero-lateral margins of the diductor muscle scars are very deeply impressed, the edges developing into low ridges antero-laterally.

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**Remarks:** For a detailed synonymy see Garratt (1980).

The original illustrations of *Notanoplia pherista* by Gill (1950, pl. 1, figs 29-32) are too small for reliable comparison but he refined this earlier work with better preserved and much better illustrated topotype material (Gill, 1969). Garratt (1980) refigured Gill's types with additional material to show the intraspecific variation. The lateral septa in the brachial valve are variable in relief but not as curved as in the Trundle specimen. In all the Tasmanian and Victorian specimens the median septum in the pedicle valve is continuous although Garratt noted two specimens with incipient development of accessory septa in the anterior part of the valve. The specimens described by Savage (1974) from Manildra have very distinct accessory septa developed mid way along the continuous pedicle median septum and also straight lateral septa in the brachial valve. The specimen from Trundle represents a development of the pedicle accessory septa but with only one specimen it is unclear if this a general feature or just a gerontic valve. Creation of a new species is unwarranted with
only one specimen. All known occurrences of *N. pherista* are of probable Lochkovian age and at no locality is the species very abundant.

Garratt (1980) described two new species from Victoria, *N. panifica* and *N. philipi*, both differing from the Trundle specimen in having a distinct costellate or costate ornament. *N. mitchelli* Wright from near Yass in southern New South Wales is another costate species.

*Notanoplia ganinensis* Gratsianova (1967) from the Early Devonian of Siberia has very alate cardinal angles and much shorter septa in the brachial valve compared with the Trundle specimen.

At this locality (TU/III/39) there are no other brachiopods present, the associated fauna being dominated by tentaculitids.

**Notanoplia cf. panifica** Garratt 1980 (Fig. 24)


Material: MMF 23557, a small block with numerous individuals, many conjoined but with both valves supine.

Locality: BM/II/7, Ootha beds. Strongly deformed specimens are very abundant at CD/I/6 and similarly preserved though much rarer at CD/I/1 and CD/II/1, all within the Ootha beds.

Description: The valves are scutiform to subcircular, the exact shape being uncertain because of the deformation. The pedicle valve is clearly convex whatever its orientation with respect to the cleavage but the profile of the brachial valve
Fig. 24. *Notanopia cf. panifica* Garratt; a, b MMF 23557(1) fully gaping joined valves, brachial valve to top, a', a stereo pair latex cast of internal mould, b, b' do external mould; c MMF 23557(2) stereo pair of latex cast of internal mould, brachial valve at top. All x5.6.
is less certain. Where the axis of the brachial valve is parallel to cleavage the profile is convex, flattened slightly by a deep sulcus. Where the axis is perpendicular to cleavage the profile is nearly planar. The hinge line is straight and close to the maximum width of the valves. The cardinal angles are orthogonal to slightly obtuse. Details of the interareas are unclear, though that on the brachial valve is very narrow. The pedicle interarea is slightly apsacline and judging by the separation of the hinge teeth is largely occupied by the delthyrium. The surface of both valves is ornamented with costellae, some at least originating at the umbo but the type of any increase is unclear.

Brachial interior: The inner socket ridges are very distinct and inclined at less than 30° to the hingeline in even the most laterally compressed valves. They are joined medially to form a scroll like but otherwise undifferentiated cardinal process. The outer socket plates are much smaller, mounted on the hinge line and arranged en echelon with the inner socket plates. A prominent median septum extends almost the full length of the valve, from just short of the cardinal process to the anterior margin. At its posterior end the septum bisects a deeply impressed semi circular adductor muscle field. The serrated crest of the septum is reminiscent of the crestsepta in Boucotia but is possibly an artifact of preservation, although the median septum in the pedicle valves is definitely aseptate. There are no distinct accessory septa other than raised areas, corresponding to depressions on the exterior, either side of
the muscle field in the postero-lateral part of the valve. The external ornament is imprinted upon the antero-median part of the interior.

Pedicle interior: The teeth are transversely elongate and attached to the hinge line. Because of the deformation it is unclear if they are parallel or slightly inclined to the hingeline. The median septum is low, extending from the anterior of the delthyrial cavity to near the anterior margin. The accessory septa are indistinct and mark the anterior margins of raised areas flanking the delthyrial cavity. Indistinct muscle scars flank the posterior end of the median septum but do not reach the accessory septa. The external ornament is impressed upon the antero-median part of the interior.

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Remarks: These specimens, after making allowances for deformation, are consistent with Garratt's (1980) description of *N. panifica*. The only discrepancy is the serrated crest of the brachial median septum in the specimens from the Ootha beds. Garratt stated (1980, p. 27) that "no pits are present on the septa" although his illustrations were confined to moulds. However there is sufficient doubt about the origin of the serrations, possibly caused by cleavage, that they have
been discounted in making comparisons. It would be unusual if they were crestsepta. The related genus Boucotia was redefined by Garratt as having crested septa in both valves or in the pedicle valve only. Whatever the cause of the serrated crest of the brachial median septum in the Ootha specimens there is no doubt that the pedicle median septum is quite smooth, a reversal of the condition in Boucotia. Notanoplia philipi Garratt differs from both N. panifica Garratt and the Ootha specimens in having a distinctly coarser ornament. N. mitchelli Wright from the Lochkovian Elmside Formation at Yass (Wright, 1981) has a slightly coarser ornament than the Ootha specimens but the numerous marginal radial septa in the pedicle valve that set it apart from all the other species of Notanoplia.

The occurrences of Notanoplia in the Ootha district (identified tentatively as family Foliomenidae in Pickett, 1982) were used as evidence of an Early Devonian age for the Ootha Group (Sherwin, 1981). However, a slightly older, latest Silurian age is possible as suggested by Garratt and Wright (1988), based upon the "?Late Ludlovian or Pridolian" age quoted by Garratt (1980, p. 26) for N. panifica. The Ootha beds (beds being the preferred usage to group pending resolution of the stratigraphic boundaries) are believed to overlie the western extension of the Edols Conglomerate (basal Derriwong Group). Nearer to Trundle the Edols Conglomerate dips below limestone lenses containing an eosteinhornensis conodont fauna (Pickett & Ingpen, 1990), supporting a Pridoli age for the Ootha beds.
The preservation of so many articulated, if gaping, specimens of *Notanoplia* in the Ootha beds suggests minimal posthumous sorting and movement, unlike the obviously resorted faunas in all other similarly aged formations in this region. Hence this *Notanoplia* fauna is probably one of the few that can be said to represent a community, even if a very exclusive one because there is very little associated with it. The only other brachiopods reported are possible *Plectodonta* (Sherwin, 1981), but these are doubtful because cleavage can produce a pseudo denticulate hinge line in deformed material. Nautiloids and lamellibranchs are very rare associates. In the Goulburn district of southern New South Wales *Notanoplia* occurs without any associated fauna (Sherwin, in Pickett, 1982). The exposures in Ootha garbage tip (locality CD/I/1) include rhythmically interbedded fine and coarse sediments as well as graded bedding, suggesting deep water conditions.

Superfamily ATHYRISINACEA Grabau 1931

Family ATHYRISINIDAE Grabau 1931

*Molongia* Mitchell 1921

*Molongia elegans capricornae* McKellar (Fig. 25)


1984 *Molongia elegans capricornae* McKellar; Strusz, p. 135-6, fig. 11.

**Material:** MMF 20503, 23575 brachial valves; MMF 22973, 23573
Fig. 25. *Molongia elegans capricornae* McKellar; a-c MMF 20503 brachial valve, a latex cast of exterior, b latex cast of interior both x4, c, c' stereo pair of cardinal area showing narrow socket plates x8.4; d, e MMF 23573 pedicle valve, d latex cast of exterior x4, e, e' stereo pair of latex cast of interior showing small thin dental plates and an ovoid hinge tooth x4. Both specimens have been deformed, the brachial valve shortened lengthwise and the pedicle valve compressed laterally. The intersection of cleavage planes and growth lines has produced a pseudo fimbriate ornament.
pedicle valves; MMF 31466 a small slab with several external moulds of both valves.


Description: The valves are subpentagonal to ovoid, the specimens being slightly distorted. The brachial valve has a well developed fold with a shallow crestal furrow, flanked each side by five to six strong well rounded plicae, separated by similarly rounded furrows, all originating at the umbo. Towards the anterior margin the fold increases in width more than the plicae. The pedicle sulcus is obvious only in the anterior half of the valve and bears a median plica comparable in relief posteriorly with the lateral plicae but is significantly weaker anteriorly. The sulcus is flanked either side by from four to seven plicae, with the outermost pairs being very weak. The exterior is otherwise without ornament except for some irregularly spaced heavier growth lines. The fimbriate appearance of some growth lines is believed to be an artifact of preservation, being most obvious where the growth lines are more or less perpendicular to an incipient cleavage. Neither interarea is clear on any of the specimens.

Brachial interior: The sockets are supported on very small discrete hinge plates and bounded posteriorly by even shorter outer socket ridges that are little more than elevated thickenings of the wall. The inner socket ridges are thicker anteriorly. The structure of the cardinal process is unclear because of the preservation. It appears as a boss like
protrusion between the hinge plates. A low and very thin median ridge extends from the notothyrial cavity for less than one quarter the length. The plicae are repeated on the interior, including the notothyrial cavity.

Pedicle interior: The dental plates are very thin and close to the wall so that the small longitudinally elongate teeth are attached to the wall. The plicae are repeated on the interior, including the delthyrial cavity.

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Remarks: These specimens from the Trundle district closely resemble McKellar's (1969) types from the Rockhampton district in Queensland as well the material from the Ludlovian Yarralumla Formation at Canberra (Strusz, 1984). The number of ribs or plicae either side of the fold suggests closer relationship with the Canberra specimens, six plicae either side of the fold being noted for the Trundle and Canberra material but no more than five for the Rockhampton specimens. M. elegans capricornae from The Meadows district west of Cobar (Section B–herein) has thick callus deposits in the pedicle valve, sufficient to obscure the dental plates. No such deposits were seen in the few pedicle internal moulds from Trundle. Strusz suggested that Molongia aff. elegans described from Victoria by Talent (1965) is probably referable to this
subspecies and made comparisons with species described from China.

Superfamily SPIRIFERACEA King 1846
Family DETHYRIDAE Waagen 1883
Subfamily ACROSPIRIFERINAE Termier & Termier 1949
Howellella Kozłowski 1946

Howellella cf. pyramidalis McKellar (Fig. 26)

cf. 1969 Howellella pyramidalis McKellar, p. 8-9, pl. 2, figs 27-36.

Material: MMF 20495 brachial valve; MMF 22517 a small block with several moulds of both valves; MMF 31455 external mould of a pedicle valve; MMF 31467 a small slab with numerous moulds of both valves.

Locality: BG/I/44 Milpose Volcanics; BG/IV/1, BG/IV/3 Cookeys Plains Formation, all within the Derriwong Group.

Description: The valves are small, transversely ovoid, maximum width being near mid length, and strongly biconvex, the pedicle valve being much more convex than the brachial. The cardinal angles are well rounded and obtuse, the hinge line being approximately two thirds the maximum width. The brachial fold is low and rounded in cross section and no wider than the adjoining plicae for most of its length. The pedicle sulcus is narrow and with a U shaped cross section. The fold is flanked by three low but distinct rounded plicae that commence at the umbo. The sulcus is flanked by three to four plicae, the outer
Fig. 26. Howellella cf. pyramidalis McKellar; a, a' MMF 31467(3) stereo pair of latex cast of brachial exterior; b, b' MMF 31467(1) stereo pair of latex cast of brachial interior; c, c' MMF 31467(2) stereo pair of latex cast of pedicle exterior; d, d' MMF 31467(4) stereo pair of latex cast of pedicle interior; e MMF 31455 latex cast of larger pedicle valve believed to be same species showing very fine fimbriate ornament. All x5.6.
pair being weak and obvious only on larger, well preserved specimens. No specimen of either valve is sufficiently well preserved to show details of the interarea, although the brachial interarea is unlikely to be very wide. The external ornament is visible only in specimens preserved in very fine lithologies and consists of close spaced growth lines with fimbriate edges.

Brachial interior: The narrow crural plates are disjunct. The fold is visible on the interior from the notothyrial cavity but the plicae are clear only away from the umbo. The cardinal process was not seen.

Pedicle interior: The teeth are very small and supported on thin straight dental plates, approximately one quarter the length of the valve, that follow the imprint of the furrows flanking the sulcus. There is a low narrow median ridge at the anterior end of the delthyrial cavity. The plicae are imprinted on the interior.

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Remarks: There is some variation in the size of specimens from different localities but otherwise there is general
morphological consistency in form within the limits imposed by preservation. In appearance and size these specimens resemble *Howellella pyramidalis* McKellar (1969) from near Rockhampton although none is sufficiently well preserved to show the characteristic high interarea of that species. McKellar's types are not well preserved and some at least have been deformed. The few and low plicae of these specimens is closer to types resembling Silurian *Howellella elegans* (Muir-Wood) than the Early Devonian *Howellella angustiplicata* (Kozlowski) with comparatively more and stronger plicae. Savage (1969) described a new subspecies, *Howellella nucula australis*, from the Early Devonian Mandagery Park Formation near Manildra that is similar in size and development of plicae to the Cookeys Plains Formation material but differs in having a distinctly wider sulcus. *Delthyris (Howellella) scabra* Philip (1962) from the 'late' [sic] Lochkovian (Garratt and Wright, 1988) Boola Beds in eastern Victoria, is similar to *H. pyramidalis* and the Trundle species in most respects except that it has much less distinct plicae. More detailed comparisons with other species of *Howellella* is not possible of poor preservation.

*?Howellella* sp. (Fig. 27)

**Material:** MMF 20504 and 31465, small slabs with numerous moulds of brachial and pedicle valves.

**Locality:** BG/I/9 and BG/II/16 Yarrabandai Formation, Derriwong Group.

**Description:** The valves are very small, subcircular and
Fig. 27. *Howellella* sp.; a, a' MMF 31465(6) stereo pair of latex cast of brachial interior x5.6; b, b' MMF 20504 stereo pair of latex cast of pedicle exterior x5.6; c, c' MMF 31465(5) stereo pair of latex cast of more developed pedicle exterior x8.4.
biconvex, the pedicle valve being much deeper than the brachial with the length of the hinge line approximately half the maximum width. The cardinal angles are well rounded and scarcely disrupt the rounded shape of the valves. Details of the interarea in either valve are not preserved. The rounded plicae are very weak and only two can be distinguished either side of the brachial fold. Pedicle valves have two plicae either side of the sulcus, possibly three in larger valves. The sulcus is very shallow but has a sharply defined trough.

Brachial interior: The sockets are bounded by narrow, very divergent and disjunct short crural plates and slightly longer crural bases. The cardinal process was not seen. The plicae are repeated on the interior and the external lirate micro-ornament is impressed on one specimen (MMF 31465(8)).

Pedicle interior: The pedicle interiors are poorly preserved and few details are visible. The dental plates are very short and thin, less than one eighth the length of the valve. The angular trough in the sulcus is represented internally by a low ridge, very sharply defined in the posterior third of the valve.

Dimensions:  

<table>
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<tr>
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<td>brachial</td>
<td>3.0</td>
<td>4.0</td>
<td>&lt;1.0</td>
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</table>

Remarks: The weak pauciplicate valves and very small dental
plates separate this species from all others in the region so that it has some value in local correlations. It is very like the juvenile forms of *Howellella aff. Howellella textilis* Talent described from Emsian limestones at Taemas by Chatterton (1973, pl. 27, figs 6, 7), the significant difference being the much smaller size of the comparably plicate Taemas valves.

The pauciplicate character resembles the lesser plicate forms of *Howellella nucula* (Barrande) illustrated by Havlíček (1959, pl. 18, fig. 9) but comparisons with other species are speculative because of the poor preservation.

*Howellella (Hysterohowellella) jaqueti* (Dun) (Fig. 28)

1898 *Spirifera Jaqueti* Dun, p. 166-7, pl. 17, figs 2, 12, 13, 14, 17.

**Material:** MMF 20845 a small slab with numerous moulds of both valves; MMF 20849(6, 7) internal moulds of brachial valves; MMF 20849(8) pedicle internal mould.

**Locality:** BOB/II/1, Gwando Siltstone, Yarra Yarra Creek Group.

**Remarks:** For description of specimens from the Gwando Siltstone see description of the types from erratics at White Cliffs and *in situ* material from The Meadows district near Cobar (Section B-herein). There are five to six plicae either side of the fold and six to seven either side of the sulcus, indicative of the more multiplicate and possibly younger varieties of *H. (H.) jaqueti*. The preservation is poor because the matrix has been secondarily ferruginised.
Fig. 28. *Howellella (Hysterohowellella) jaqueti* (Dun); a, a' MMF 20845(1) stereo pair of latex cast of pedicle interior x5.6; b MMF 20853 internal moulds showing variation in development of lateral plicae x2.
Spinella Talent 1956

Spinella pittmani (Dun) (Fig. 29)

1904 Spirifera Pittmani Dun, p. 320-1, pl. 61, figs 4, 4a, b.

Neotype: The fossil catalogue of the Geological Survey of New South Wales lists MMF 4006 (Dun, figs 4a, b) and MMF 4009 (do., fig. 4) as the types of this species. There are three specimens numbered MMF 4009 in the collections but none is readily identifiable with those illustrated by Dun. (Identical species from a single locality were commonly assigned the same catalogue number at the start of the century.) The published type catalogue of the Australian Museum does not mention this species but an annotated copy held by the Museum includes a handwritten note stating that the types had been transferred to the Australian Museum. The note is undated but R. Jones, Curator of Palaeontology at the Museum, considers it was written during the nineteen seventies (pers. comm.). However none of the types could be located in 1990. The three specimens numbered MMF 4009 still in the collections of the Geological Survey have freshly broken surfaces and it is possible that all were broken from a single large block that included the types. Dun did not specify any particular specimen as the type. The neotype is MMF 4009(1), a nearly complete pedicle valve. Paratype is MMF 4009(2), an incomplete brachial valve.

Locality of type specimens: Dun (1904, p. 321) described the type locality as "limestone, The Troffs, one mile east of
Fig. 29. *Spinella pittmani* (Dun); a–c MMF 4009(1) neotype ("The Troffs"), a partly exfoliated pedicle valve, b lateral view, c posterior view showing thick dental plates x1.25; d MMF 4009(3) broken surface exposing cross section of small pedicle valve showing high and thin dental supports x3.65; e MMF 4009(4) pedicle valve showing spine bases of micro ornament x5.6; f, g MMF 4009(2) paratype, f an incomplete partly exfoliated brachial valve showing low internal median ridge x1.25, g etched section through umbo showing striate cardinal process x8.4; h–i MMF 20514 (TU/III/40) posterior of pedicle valve, h, h' stereo pair of latex cast of internal mould showing short dental plates and very long ventral adnecula x1.5, i internal mould x1.5; k MMF 20515(1) (TU/III/40) latex cast of sulcus showing micro ornament x8.4; l MMF 23061 (BG/IV/4) latex cast of pedicle interior showing unobstructed delthyrium x1.5; m MMF 23540 (TU/III/9) latex cast of pedicle exterior x1.5.
Portion 13, Parish Gillenbine, County Cunningham; on boundary between Parishes Gobondery and Gillenbine. "The Troffs" is believed to refer to the property in its original extent because the present "Troffs" homestead is many kilometres south of Portion 13. Nor is it likely that The Troffs railway siding is meant because that section of the Bogan Gate to Tottenham branch line did not open until 15-12-1908, four years after publication of Dun's description. Portion 13 has a north-south length of just over four kilometres so that any locality "one mile" to the east could still be difficult to locate, although any locality answering this description would be in an area of very little outcrop and none of it limestone. The reference to the boundary between the Parishes is unclear because this is also the eastern boundary of Portion 13. A locality "one mile east of Portion 13" cannot possibly be on the boundary between the parishes. The remaining type material is friable and has a calcined appearance, suggesting that it has been discarded from lime burning. This is quite feasible because Spinella bearing limestones are known further east and it is believed that the type material is from one of those formations, probably near TU/III/40.

Other material: MMF 20999 an incomplete brachial valve; MMF 20514, 20515, 23061 and 23540, all pedicle valves.

Other localities: TU/III/9, TU/III/34, TU/III/40 and BG/IV/4, Trundle Group; BM/III/1 unnamed limestone member in the Belvedere Formation, Yarra Yarra Creek Group; GI/I/4 Gleninga Formation, Yarra Yarra Creek Group.

Diagnosis: A large species of Spinella with length
approximately equal to width, up to eleven plicae either side of the fold and twelve either side of the V shaped sulcus, pedicle muscle field with weak longitudinal striations.

Description: The valves are large, slightly wider than long, and strongly biconvex, but in the absence of any complete brachial valves it is unclear if the valves are equally convex or not. The maximum width is along the hinge line in larger specimens, the cardinal angles becoming sub-mucronate. In small specimens the maximum width is nearer mid length. The brachial interarea is not preserved. The pedicle interarea is apscaline and incurved with a large open delthyrium as high as the interarea, with height approximately twice the width. The brachial valve has rounded fold that becomes more elevated anteriorly and is flanked by as many as eleven strong plicae commencing at or near the umbo. Medially the plicae are subangular in cross section, becoming more rounded and lower laterally. The pedicle valve has a well developed sulcus, the cross section U-shaped near the umbo but becoming progressively more V-shaped anteriorly, and is flanked by as many as twelve rounded plicae. The micro-ornament consists of very fine spines arranged in radial linear patterns on growthlines.

Brachial interior: Only one brachial valve has any internal details preserved and even that is incomplete. The umbonal shelly material is comparatively thick and the cardinal process multi striate. A low median ridge extends anteriorly for at least half the length of the valve. Crural bases present. The plicae are repeated on the internal surface.
Pedicle interior: The shape of the teeth is unclear but they are small in comparison with the rest of the valve and are supported on short dental plates supported in turn by very long ventral admincula, thin in small specimens, very thick in large specimens, that extend anteriorly for approximately half the length of the valve. They diverge slightly and enclose a longitudinally striate muscle field. The cavities flanking the delthryial cavity have a weakly pitted surface. The imprint of the plicae on the interior is quite variable, from a close repeat to almost no imprint at all. This feature is unrelated to locality because even the topotype pedicle valves show such a variation.

Dimensions: length width height
MMF 4009(1) pedicle 30.0 >32.5 15.0

Remarks: The exterior and pedicle interior of this species supports its assignment to Spinella. There is a marked discrepancy in the proportion of brachial to pedicle valves, irrespective of valve size. In the topotype sample (limestone) there are recognisable fragments of at least six pedicle valves but only two brachial valves and of these only one shows any internal detail. In sandstone localities no brachial valves have been found. Thus the brachial interior of S. pittmani is poorly known. Most of the specimens in sandstone are broken along the sulcus. Small specimens of S. pittmani with fewer plicae and thin dental plates and ventral admincula are not
readily distinguishable from multiplicate Howellella (H.) jaqueti (Dun). Dental plates in the latter species are shorter and lower.

No articulated specimens of *S. pittmani* have been found so that comparisons with other species based on serial sections are not possible. Statistical size analysis of the kind used on subspecies of *Spinella yassensis* (de Koninck) from the Taemas district near Yass by Strusz et al. (1970) is not practical for the available specimens of *S. pittmani* because even the best preserved material in limestone is still too fragmentary for detailed measurements.

*S. pittmani* is similar in size to *Spinella buchanensis* Talent from the Buchan Caves Limestone in eastern Victoria (Talent, 1956), but the latter is distinctly more transverse and has a more rounded sulcus in cross section. *Spinella maga* Talent, also from the Buchan Caves Limestone, is easily distinguished from *S. pittmani* because it has eighteen or twenty lateral plicae compared with the eleven or twelve of *S. pittmani*. Specimens of *Spinella? sp. cf. S. buchanensis* from the Roaring Mag Member, Tabberabbera Formation, also from eastern Victoria, have similar though slightly deeper pitting either side of the delthyrial cavity (Talent, 1963, pl. 53, fig. 9). Similar but less distinct pitting is visible in some valves of *S. yassensis* subspecies illustrated by Strusz et al. (1970, pl. 8, figs 5, 6). *S. pittmani* has a strong resemblance to the less transversely elongate subspecies, *Spinella yassensis yassensis* (de Koninck), but the latter is much smaller and some specimens have a radial rather than
longitudinally striate muscle field in the pedicle valve. All specimens of *S. pittmani* found to date are poorly preserved in comparison with other Australasian species and there is little to be gained by comparing scrappy material with well preserved species from elsewhere in the world.

All of these species are similar in age (early Emsian) based upon conodont data. The *S. pittmani* locality (GI/I/4) in the Gleninga Formation, Yarra Yarra Creek Group, contains a conodont assemblage indicating an age within the *dehiscens* or *perbonus* zones (Pickett, 1989). For a discussion of the age and geographic distribution of *Spinella* faunas see Garratt and Wright (1988).

Superfamily STRINGOCEPHALACEA King 1850

Family CENTRONELLIDAE Waagen 1882

Subfamily RENSSELAERIINAE Raymond 1923

*Podolella* Kozlowski 1929

*?Podolella* sp. (Fig. 30)

**Material:** MMF 20504, 31465 slabs with numerous, mostly disarticulated valves.

**Locality:** BG/I/9 and BG/II/16, Yarrabandai Formation, Derriwong Group.

**Description:** The valves are very small, subcircular in small specimens becoming terebratuliform with growth, and biconvex, the brachial valve being deeper in the best articulated specimen. However this may not be consistent because there is
Fig. 30. *Podolella* sp.; a, a' MMF 31465(14) stereo pair of latex cast of brachial interior x8.4; b MMF 31465(13) latex cast of exterior of pedicle valve x5.6; c, c' MMF 31465(11) stereo pair of latex cast of pedicle interior x5.6; d MMF 31465(9) latex cast of conjoined valves x8.4. All specimens from BG/II/16.
variation in the convexity of disarticulated valves. Maximum width is near to mid length. The brachial interarea is negligible. The pedicle beak is suberect but other details of the pedicle interarea including the delthyrium are unclear. The costellate ornament is developed variably in the anterior half of the valve, although any very fine costellate ornament nearer the umbo is unlikely to have been preserved in the sandy lithology.

Brachial interior: The hinge plate is small with a comparatively large perforation indicated by the irregular break in the anterior margin of the plate. The narrow sockets are parallel to the valve margin. In some valves (Fig. 30a) there are very thin crural plates continued anteriorly as low ridges and converging on a low median ridge that extends from the notothyrial cavity for as much as two thirds the length of the valve floor. The presence or absence of these ridges is probably due as much to preservation as gerontic thickening. The external ornament and less commonly heavy growth lines are impressed upon the interior.

Pedicle interior: The teeth are indistinct because of the preservation but thin dental plates extend anteriorly for between one fifth and one third the valve length. The external ornament is variably imprinted upon the interior.

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<td>Pedicle</td>
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Remarks: Within the limits imposed by preservation of small brachiopods in a comparatively coarse matrix these specimens of *Podolella* do not differ significantly from those described from The Meadows district west of Cobar (Section B–herein). At both localities they are restricted to a comparatively thin band, only a few metres thick, within a sequence of several thousand metres of sediment.

The better preserved specimens show definite if very thin crural plates but none of the very few specimens with conjoined valves is sufficiently well preserved to show any details of the loop. The reasons for placing *Podolella* within the Centronellidae have been discussed elsewhere (Section B–herein).

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Part I: Leptostrophiidae, Eostropheodontidae and

Part II: Douvillinidae, Talaeoshaleriidae, Amphistrophiidae and

Part III: Stropheodontidae (*sensu strictu*) [sic],
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**APPENDIX - Locality details**

The localities are pinpointed by grid references from the relevant 1:100,000 topographic sheet, or 1:250,000 sheet for some of the localities sampled before the availability of more detailed topo maps, supplemented by any distinctive locality details. The relevant topographic sheet is indicated by the initial letters of each locality number, viz.,

- **BOB** Bobadah
- **BG** Bogan Gate
- **BM** Boona Mount
- **CD** Condobolin
- **GI** Gindoono
- **TU** Tullamore
- **BOB/II/1** GR 946049, outcrops of ferruginous Gwando Siltstone exposed in bed of small creek on south slope of ridge.
- **BG/I/9** Forbes 1:250,000 GR 580914, Yarrabandai Fm, outcrop by road on crest of hill.
- **BG/I/10** Forbes 1:250,000 GR 59689160, Cookeys Plains Formation/Milpose Volcanics, rock pile in middle of field.
- **BG/I/27** GR 828335, Calarie Sandstone, shallow costeans near top of slope on west side of hill.
BG/I/39 GR 805399, Yarrabandai Fm, low rubbly outcrops near gate.

BG/I/41 GR 837425, Milpose Volcanics, low outcrop of thinly bedded sediments within volcanics.

BG/I/44 GR 829423, Milpose Volcanics, low rubbly outcrop of thinly bedded sediments near top of rise.

BG/I/45 GR 830416, Milpose Volcanics, low rubbly outcrop of thinly bedded sediments near track.

BG/I/46 GR 827418, Milpose Volcanics, low outcrops of thinly bedded sediments east of dam.

BG/II/16 Forbes 1:250,000 GR 58758845, Yarrabandai Fm, thin beds of sandstone at north end of low ridge.

BG/II/21 GR 920066, Calarie Sandstone, broken outcrop in scraped area on east slope of rise about half way between rubbish tip and graveyard.

BG/II/22 Portion 145, Parish Bocobidgle, County Ashburnham, ridge formed by Calarie Sandstone. Locality collected by E.C. Andrews.

BG/IV/1 Forbes 1:250,000 GR 56759170, Cookeys Plains Fm, shallow scrapes in fine sandstone on western side of road, about 100 metres west of fence.

BG/IV/3 Forbes 1:250,000 GR 56159050, Cookeys Plains Fm, shallow scrapes on low rise about 500 metres to north east of town of Yarrabandai.

BG/IV/4 Forbes 1:250,000 GR 570907, Trundle Group, sandstone on west slope of low rise.

BM/II/7 Narromine 1:250,000 GR 535922, Ootha beds, outcrop of strongly cleaved shale in gutter on north side of road.

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BM/III/1 Narromine 1:250,000 GR 52679467, Belvedere Formation, very low limestone outcrops.

CD/I/1 Forbes 1:250,000 GR 54809055, Ootha beds, exposures of interbedded siltstone and fine sandstone near the south eastern corner of Ootha garbage tip.

CD/I/6 Forbes 1:250,000 GR 543897, quarry in olive to brown strongly cleaved shales, Ootha beds. The fossils were found south of the access road near the gate.

CD/II/1 Forbes 1:250,000 GR 530874, Ootha beds, strongly cleaved shale on south side of road in drainage cuts on east flank of hill.

GI/I/4 Nymagee 1:250,000 GR 499978, Gleninga Fm, limestone outcrops on east side of low ridge either side of track to west from shearing shed.

TU/III/10 Narromine 1:250,000 GR 577945, Trundle Group, float on northern slope near top of low rise.

TU/III/13 Narromine 1:250,000 GR 564947, ?Cookeys Plains Fm, low outcrops on crest of hill, east side of road.

TU/III/34 Narromine 1:250,000 GR 57726 94603, Trundle Group, fine calcareous sandstone.

TU/III/39 Narromine 1:250,000 GR 564943, ?Cookeys Plains Fm, scattered float.

TU/III/40 Narromine 1:250,000 GR 570950, Trundle Group, rock pile in channel leading to dam.
SECTION D

SILURO-DEVONIAN TRILOBITES FROM THE MEADOWS DISTRICT,
WESTERN NEW SOUTH WALES
SILURO-DEVONIAN TRILOBITES FROM THE MEADOWS DISTRICT, WESTERN NEW SOUTH WALES.

Lawrence Sherwin

Sherwin, L., 0000:00:00. Siluro-Devonian trilobites from The Meadows district, western New South Wales.

Three species of trilobites are described from the Amphitheatre and Winduck Groups (Cobar Supergroup) in The Meadows district west of Cobar, New South Wales. *Encrinurus cf. silverdalensis* occurs in a sandstone member and *Encrinurus cf. mitchelli* in pink mudstone of the Amphitheatre Group. A review of Late Silurian (Pridoli) *Encrinurus* occurrences in central and western New South Wales suggests a correlation of species with lithology. *Craspedarges wilcanniae* Gürich is redescribed, based on material from the Early Devonian (Lochkovian) Winduck Group.

L. Sherwin, Geological Survey of New South Wales, P.O. Box 53, Orange, New South Wales 2800.

IN "THE MEADOWS" district south-west of Cobar (Figs. 1,2,3) trilobites of Siluro-Devonian (Pridoli to Lochkovian) age occur in the Amphitheatre and Winduck Groups of the Cobar Supergroup. The stratigraphy and brachiopod faunas of this area have been described elsewhere (Section B - herein) and on a broader scale the structural setting has been described by Glen (1990). Trilobites have not been reported previously from this area, the nearest occurrences recorded in the Cobar Supergroup being
Fig. 1. Locality diagram showing places mentioned in text.
in the vicinity of Cobar, (Baker et al., 1975; Fletcher, 1975) 60 kilometres east of "The Meadows". Fletcher also described several other species of trilobites from the vicinity of Cobar and several localities north east of Nymagee where Webby (1972) had noted an *Encrinurus* occurrence. From that same area, Landrum & Sherwin (1976) described a new proetid, *Warburgella* (*Anambon*) *jelli*, regarded by Yolkin (1983) as a junior synonym of the Eurasian species *W. tcherkesovae* Maximova and *W. waigatschensis* (Tschernyschew & Yakovlev). Strusz (1980) reviewed the species of *Encrinurus* described by Fletcher and regarded the specific attributions as doubtful because of the poor preservation. The associated stratigraphy of these Nymagee localities has been described by Felton (1981). The lichid trilobite *Craspedarges wilcanniae* Gürich, found at several localities within the Winduck Group, was described from erratics, believed derived from the Cobar Supergroup, in Cretaceous sediments at White Cliffs (Gürich, 1901) about 230 kilometres north west of "The Meadows" (fig. 1).

Several genera of trilobites are represented in "The Meadows" district but only the lichid and encrinurid species are described here. The calymenids are too poorly preserved to warrant description and proetids are represented by a nondescript pygidium. Many of the *Encrinurus* specimens in the pinkish mudstones of the Amphitheatre Group are more or less complete even if fine details are not well preserved. Trilobites in sandy beds, whether in the Amphitheatre or Winduck Groups, are completely disarticulated.
Fig. 2. Geological sketch map of "The Meadows" district, modified from Rose (1965), showing trilobite localities.
Fig. 3. Stratigraphic relationships in "The Meadows" district, modified from Glen (1987), showing approximate position of trilobite localities.
AGE OF THE FAUNA

The problems in dating the faunas from "The Meadows" district have been mentioned elsewhere (Section B—herein). Both species of *Encrinurus* are of probable latest Silurian (Pridoli) age. The brachiopods associated with *Craspedarges wilcanniae* indicate an Early Devonian (Lochkovian) age. The only other recorded species of *Craspedarges*, *C. superbus*, was described from the "Gedinnian to Emsian or early Eifelian" Fukuji series in Japan by Kobayashi & Hamada (1977a, b); the generic identification was queried by Thomas & Holloway (1988). Lichid trilobites have been described from Early Devonian limestones (Pragian–Emsian) in New South Wales (Chatterton et al., 1979) and quartzose clastics in Victoria (Gill, 1939; Holloway & Neil, 1982) but all belong to the genus *Acanthopyge* except for one doubtful reference to *Terranovia* from New South Wales (Chatterton & Wright, 1986).

SYSTEMATIC PALAEONTOLOGY

Morphological terms, unless otherwise specified, are as defined in the Treatise on Invertebrate Paleontology (Moore, ed. 1959). For encrinurids the morphological terms are as used by Strusz (1980), a refinement of earlier work by Tripp (1957, 1962); lichid morphology follows Thomas & Holloway (1988) except that I do not regard the occipital ring as part of the glabella. All specimens are stored in the collections of the Geological Survey of New South Wales. External moulds were studied using latex casts and all specimens, whether casts or originals, were whitened with MgO for photography. Original
specimens were blackened with water colour before application of MgO. None of the material, in particular the encrinurids, is sufficiently well preserved or abundant for applying the numerical taxonomic methods described by Temple & Tripp (1979).

Family ENCRINURIDAE Angelin 1854
Subfamily ENCRINURINAE Angelin 1854

Encrinurus Emmrich 1844

Encrinurus (Pacificurus) Ramsköld 1986b

Ramsköld (1986a, b) concluded from a study of Encrinurus that the Australasian species form a sufficiently discrete group to justify classification in a separate subgenus. He included in the diagnostic characters the non-spinose genal angles and pygidia. However, both of these features are present to a variable extent in the specimens of Encrinurus cf. mitchelli described herein. Ramsköld quoted a range of upper Llandovery to Ludlow for E. (Pacificurus) but the E. mitchelli species group, basis of the sub-genus, occurs also in the conodont-dated Pridoli of New South Wales (Section E-herein) and Queensland (Jell & Talent, 1989).
Encrinurus (Pacificurus) cf. silverdalensis Etheridge & Mitchell 1916 (Fig. 4)

cf. 1916 Encrinurus silverdalensis Etheridge & Mitchell, p. 665-667, pl. 54, fig. 11; pl. 55 figs 4, 9; pl. 56, figs 4-6, 14; pl. 57, figs 3, 10.

1975 Encrinurus cf. silverdalensis Etheridge & Mitchell; Fletcher, p. 71-72, figs 3c-e.

cf. 1980 Encrinurus silverdalensis Etheridge & Mitchell; Strusz, p. 35-37, pl. 5, figs 8-16. (cum syn.)

Material: MMF 22932(2) and 22936(5) external moulds of incomplete cranidia; MMF 22937(1) external mould of a free cheek; MMF 22937 internal mould of a pygidium.

Locality: NB 1, unnamed sandstone member, Amphitheatre Group.

Description: Because of the poor preservation, especially as regards completeness of material, it is not possible to determine the shape of the cephalon or glabella, let alone the shape of a complete carapace. Neither cranidium has the anterior intact, the more complete cranidium having a short length of the preglabellar furrow. The postero-lateral border is widest at the rounded genal angles, tapering gently to the deep, well defined rachial furrows. Near the genal angles there are very indistinct widely spaced tubercles. The antero-lateral part of the border by contrast is very coarsely tuberculate, the tubercles being irregular in shape and almost the full width of the border. The outer margin of the border consists of a narrow ridge formed by coalesced small tubercles. The anterior ends of the rachial furrows bifurcate, the shorter
Fig. 4. *Encrinurus cf. silverdalensis* Etheridge & Mitchell; A MMF 22932 (2) latex cast of incomplete cranidium x4; B MMF 22936(5) latex cast of incomplete cranidium x3; C MMF 22937(1) latex cast of right free cheek x4; D MMF 22937(2) internal mould of pygidium x3.
branches trending adaxially and merging with the spaces between the border tubercles. The other branches are continuous with the well defined narrow border furrow. The postero-lateral section of the border furrow is narrow, steep sided, and more or less uniform in width. The occipital rings on both specimens are nearly obliterated suggesting that the relief is appreciably greater than the basal glabellar lobes. The anterior margin of the wide (sag.) occipital ring is very convex and the narrow occipital furrow is strongly curved in consequence. The anterior margin of the glabella is rounded, the maximum width being at the antero-lateral corners. Only the lateral extremity of the preglabellar furrow is preserved, where it is narrow and deep at the join with the rachial furrow but is much shallower adaxially. 1L is narrow, bent more or less parallel to the arcuate occipital furrow, and has lobate extremities. The width is slightly less than the occipital ring. 2L and 3L are essentially large tubercles. All glabellar furrows are laterally as deep as the rachial furrows but fade axially. Each of the 1S furrows extends approximately one third the width of the glabella but 2S and 3S extend no further than the adjacent lobes. The glabellar tubercles, except for the comparatively large rounded ones defining 2L and 3L, are low, crowded and somewhat irregular in shape. The preservation is not regarded as suitable for determining tubercle arrays. The eyes or palpebral lobes are transversely elongate and level with 2S. The librigenal field is small and covered with coarse irregular tubercles.
No hypostomes or thoracic segments have been identified at this locality.

The only pygidium is a distorted internal mould. The anterior margin is curved, the sides straight. The rachis is very long, uniformly tapered and with at least 23 rachial rings. The total number exceeds this figure but the preservation is inadequate for an exact count. There are at least 9 pleurae, the posterior pair(s) being more or less fused to the rachis. The sagittal tubercles are prominent on rings 5, 8, 12 and 16.

Dimensions: Because of the fragmentary condition of the specimens the width of the cranidia has been estimated by doubling the measurable half width.

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<tr>
<td>MMF 22936(5)</td>
<td>&quot;</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>MMF 22937(2)</td>
<td>pygidium</td>
<td>15.5</td>
<td>17</td>
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Remarks: This species was revised in considerable detail by Strusz (1980) with a detailed synonymy. The specimens from the Amphitheatre Group have oblique elliptical 1L stated by Strusz to be typical of the species although this feature is not included in his diagnosis. Other points in common include eyes set opposite 2S, heavily tuberculate lateral borders, prominent occipital ring and prominent rachial tuberculation. The Amphitheatre Group specimens differ from *E. silverdalensis* in having a much greater size variation in glabellar tubercles and
differently arranged tubercles on the pygidial rachis, although Strusz's illustrations show this last feature to be quite variable.

The specimens of *E. cf. silverdalensis* described by Fletcher (1975) are not as well preserved as the Amphitheatre Group specimens but are probably the same species because they show the same pattern of tuberculation along the border and on the pygidial rachis.

Determining the glabellar tubercle arrays as described by Tripp (1957, 1962) was not attempted partly because of the preservation as noted above and partly because of the marked variation in the size of tubercles in comparison with most of the European species, making it difficult to determine the appropriate array for many tubercles. Ramsköld (1986a) considered that the taxonomic value of these glabellar arrays is of limited value, based upon the differences in European at almost every locality sampled.

Although *Encrinurus* occurs in more than one lithology in the Amphitheatre Group *E. cf. silverdalensis* has been found only in the sandy beds and always disarticulated as are all the associated brachiopods and lamellibranchs. Fletcher's (1975) material is similarly disarticulated and preserved in fine sandstone. Etheridge & Mitchell (1916) did not give precise details as to where their type material was collected in the Yass district but Strusz (1980) suggested on the basis of the calcareous mudstone lithology "a level low in the Black Bog Shale". The top of the Black Bog Shale contains a late Ludlovian graptolite fauna (Jaeger, 1967; Sherwin, 1979). The
grey calcareous mudstone contrasts with the fine sandy lithology hosting the Cobar Supergroup specimens of probable latest Silurian age (Section B-herein).

*Encrinurus* (*Pacificurus*) *cf. mitchelli* Foerste 1888 (fig. 5)

cf. 1888 *Encrinurus mitchelli* Foerste, p. 124-126, pl. XIII, fig. 2.


**Material:** MMF 31469 a complete specimen but with a poorly preserved cephalon, MMF 31395 an internal mould of an incomplete cephalon and thorax, MMF 30851 an external mould of a free cheek, MMF 31396 a pygidium.

**Locality:** TM 312, Amphitheatre Group.

**Description:** The shape of the cephalon is uncertain because it is incomplete or poorly preserved in all specimens. The border furrow on the free cheek is narrow and deep sided, becoming shallow and fading on the stout genal spine. Elsewhere in the available material it is visible only along the posterior of a poorly preserved cranidium as a narrow depression about equal in width to the border. The deep, well defined rachial furrows join the posterior border and are curved outwards meeting the preglabellar furrow and border furrows. The anterior of the glabella is approximately twice the width of the base. L1 is very weak in comparison with L2, L3 and the frontal lobe. All glabellar furrows are deep, connected to the rachial furrows and short in length, S2 and S3 being approximately double the
Fig. 5. *Encrinurus* cf. *mitchelli* Foerste; A MMF 31395 incomplete internal mould x2; B, C MMF 31396 pygidium, B latex cast of external mould, C internal mould x2; D MMF 30851 latex cast of external mould of left free cheek x3.65.
length of S1. Except for the large tubercles forming the glabellar lobes the glabella is covered by numerous fine tubercles but the available is unsuitable for determining arrays. The anterior portion of the free cheek between the border and suture bears similar tubercles, although they are notably weaker posterior to the eye and are absent from the posterior. The antero-lateral border and genal spine are either smooth or bear an ornament too fine to be preserved in the silty lithology. Most of the occipital ring is obliterated but it is clearly wider than the base of the glabella and was probably higher than the glabella overall. The remaining portion of the ring suggests that it was slightly arched forward but still narrow (sag.).

The sides of the thorax are subparallel to posteriorly tapered, the most complete thorax containing eleven segments. The rachis is similarly tapered, bounded by very distinct rachial furrows and distinctly higher in relief than the pleural segments. The median part of each rachial ring between the apodemes is curved anteriorly, the curvature being more marked posteriorly. The outer half of each pleural segment is flexed posteriorly and bears a well developed articulating facet on the anterior edge.

The pygidium has a curved anterior margin but is otherwise triangular in shape with straight to slightly sigmoidally curved sides. The tip is extended into a short spine that was probably solid in the original carapace, there being no indication on the internal mould that it was ever filled with sediment. The narrow doublure shows only a very slight
decrease in width posteriorly. The rachial furrows are well
developed in the anterior half of the pygidium but barely
distinguishable in the posterior half. The rachis contains as
many as thirty rings and is gently tapered, the tapering being
more marked over the three anterior rings. There are
eleven pairs of pleurae, the first strongly flexed, almost
geniculate, postero-laterally but the flexure, as well as the
inclination to the rachis, decreases posteriorly and the last
few pleurae are almost straight as well as subparallel to the
rachis. In the best preserved pygidium the outer ends of the
last two pleurae are fused and incorporated into the terminal
spine. The interpleural furrows are otherwise distinct
throughout the pygidium. The sagittal tubercles are very
subdued and too indistinct for a reliable count. There is no
obvious ornament but anything very fine would not be preserved
in the silty lithology.

Dimensions: Because of the incomplete material some values for
the width have been estimated by doubling the measurable half
width.

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<td>c. 11</td>
<td>c. 24</td>
</tr>
<tr>
<td>MMF 31396</td>
<td>pygidium</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>MMF 31469</td>
<td>complete carapace</td>
<td>38</td>
<td>21</td>
</tr>
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</table>

Remarks: This species was revised by Strusz (1980),
supplemented by material collected from several localities
additional to what remained of Foerste's (1888) types and of Etheridge & Mitchell's figured specimens (1916). Strusz demonstrated considerable intraspecific variation, to some extent overlapping with other Australasian species, and regarded all of them as belonging to an *Encrinurus mitchelli* species-group.

The incomplete specimens from the Amphitheatre Group are consistent with *E. mitchelli* Foerste, in particular the numerous small glabellar tubercles, short deep 2S and 3S and the marked taper of the first few rachial rings of the pygidium, but differ in having a robust genal spine in some cephalons and a terminal spine on the pygidium. This last feature is otherwise unknown in Australasian encrinurids (Strusz 1990, pers. comm.) but is common in the European *Encrinurus punctatus* (Wahlenberg) species-group (Tripp, 1962). The terminal spine or mucro is variably developed even within a single species but Tripp did not attach any special significance to this variation. Ramsköld (1986a, text-fig. 5) likewise illustrated several pygidia of *Encrinurus macrourus* Schmidt that display a much greater variation in the development of a terminal spine than exists in "The Meadows" material. Because the terminal spine in the Amphitheatre Group specimens is solid there is no indication of it on internal moulds. The pink silty mudstone containing these specimens breaks irregularly, though favouring weaknesses caused by hollow moulds of fossils, but the fracture surface is rarely in the same plane as the narrow terminal spine so that it is easily overlooked on external moulds.
Field relations indicate that both species of *Encrinurus* in the Amphitheatre Group are comparable in age but lived in different environments. *E. cf. silverdalensis* is always found completely disarticulated, with similarly preserved brachiopods, in well bedded fine quartz sandstones. *E. cf. mitchelli* occurs as complete as well as variably disarticulated carapaces in massive pink silty mudstones with mostly disarticulated but some rare conjunct orthid brachiopods. These different modes of occurrence suggest that *E. cf. silverdalensis* lived in a shallower, more turbulent environment than *E. cf. mitchelli*. The specimens identified by Fletcher (1975) as *E. mitchelli* are preserved in sandstone but are too poorly preserved for specific identification (Strusz, 1990, pers. comm.). The lectotype of *E. mitchelli* is in mudstone and the specimens described by Etheridge & Mitchell (1916) are in silty sediments (Strusz, 1980). Other occurrences near Canberra listed by Strusz are also in shales or fine grained sediments. At Cheesemans Creek west of Orange *E. mitchelli* occurs as complete exuviae in shales deposited in a calm, deep environment (Sherwin, 1971). Circumstantial evidence thus suggests that *E. mitchelli* lived in a calmer, possibly deeper environment than *E. silverdalensis*. It may be that the differences between these species, both recognised by Strusz as belonging to the *E. mitchelli* group, are environmentally induced variations within a single species.

Family LICHIDAE Hawle & Corda 1847
Subfamily TROCHURINAE Phleger 1936

218
**Craspedarges Gürich 1901**

**Type species:** *Craspedarges wilcanniae* Gürich 1901

**Diagnosis (revised):** Trochurine with very globose cranidium; anterior border wide and gently convex in section (sag.), becoming flatter near suture; longitudinal furrows shallow posteriorly, much deeper anteriorly including in front of S1 and subparallel for most of length from posterior edge of cranidium, diverging anteriorly to join border furrow; S1 deep behind bullar lobes, weak between longitudinal furrows; portion of L1 between longitudinal furrows much lower than occipital ring and median lobe but approximately the same width (trans.) as the occipital ring; pygidium approximately as wide as long with narrow well developed raised border; rachis approximately one third the maximum width of the pygidium; first pair of pleurae backwardly flexed, second less flexed but more inclined to rachis, third subparallel to rachis; abaxial ends of pleurae continued beyond border as tapered spines with circular cross sections; rachis parallel sided for approximately one third length of pygidium, remainder tapered and continued beyond border as terminal spine flanked by a pair of border spines.

**Remarks:** The types of this genus are believed to have been destroyed with the remainder of Gürich's collection when Hamburg was bombed during World War II. The search described by Thomas & Holloway (1988) was repeated as well as being extended to the Geological Survey collections without any success. This redescription is based upon material found *in situ* in sandstones of the Winduck Group. The types came from
erratic boulders at White Cliffs (Gürich, 1901) but the source of the erratics is unknown, there being very little pre-Quaternary outcrop over much of the 230 km between White Cliffs and "The Meadows". However the erratics are comparable in terms of lithology and faunal content with the Winduck Group. Because of doubts about the source of the erratics it is necessary to establish that the lichids from the Winduck Group are definitely *Craspedarges*. Gürich's material comprised an internal mould of an incomplete cranidium and three fragmentary moulds of ventral surfaces of the pygidium. The cranidium, except for some flattening indicated by a line drawing of the profile, matches the Winduck Group material. Matching the pygidia is difficult because the one pygidium known from the Winduck Group has more or less uniformly slender marginal spines preserved whereas two (pl. 18, figs 6 and 8) of Gürich's specimens have comparatively short very wide spines. These two particular specimens are very fragmentary and it is not at all certain that they belong the same species. The remaining fragment illustrated by Gürich (pl. 18, fig. 7) is of the posterior margin and is reconcilable to a greater extent with the Winduck Group specimen. Gürich's specimens are illustrated by drawings only so that there is the possibility that the figures are not necessarily an accurate representation of the originals, especially his diagrammatic sketch of the cranidium (pl. 20, fig. 20). The illustration in the Treatise (fig. 396-6a) is a line drawing that does not correspond with either of Gürich's sketches but seems to be based upon a composite of the
Fig. 6. _Craspedarges wilcanniae_ Gürich; A, A' MMF 31377(5) neotype (locality TM 56B), stereo pair of latex cast of exterior of incomplete cranidium x3.65; B MMF 31399 (locality TM 65) latex cast of exterior of flattened incomplete cranidium showing affect upon anterior border x3.65; C, C' MMF 31334 (locality TM 56B) stereo pair of latex cast of exterior of posterior part of cranidium x3.65; D MMF 31377(11) (locality TM 56B) latex cast of interior of hypostome x3.65; E–F MMF 31377(10) (locality TM 56B) latex casts of interior and exterior of hypostome, E interior, F, F' stereo pair of incomplete exterior x3.65; G MMF 31398 (locality TM 56B) latex cast of exterior of incomplete pygidium x4.
two. The profile in the Treatise (fig. 396-6b) is clearly copied from Gürich (fig. 1a) but the anterior border has been changed from planar to slightly concave and the figure generally flattened. In this paper (fig. 6, A and B) a slightly flattened cranidium has been placed alongside the relatively undeformed neotype to show how the anterior border has been emphasised to look like the Treatise illustration. The shading in Gürich's illustration (pl. 18, fig. 1) suggests that some convexity remains in the left side of the anterior border.

*Craspedarges* is closely related to *Richterarges*, as noted previously by Thomas & Holloway (1988), the major differences being the more prominent anterior border and much deeper anterior part of the longitudinal furrows. A slight midlength expansion in the median lobe of *Richterarges* has no counterpart in the corresponding part of *Craspedarges* where the sides of the median lobe are quite straight. The pygidium of *Richterarges* has only two distinct pleurae compared with three in *Craspedarges*. Thomas & Holloway also postulated that *Craspedarges* was derived from *Richterarges* in about Late Silurian - Early Devonian time. However the pygidial segmentation in *Craspedarges* is less effaced than *Richterarges* suggesting it departed earlier from the ancestral hemiargid stock.

*Craspedarges wilcanniae* Gürich 1901 (Fig. 6)

1901 *Craspedarges wilcanniae* Gürich, p. 532-538, pl. 18, figs 1, 6-8; pl. 20, fig. 20.
Neotype: MMF 31377(5) a cranidium lacking the postero-lateral extremities.


Other material: MMF 31333 anterior of cranidium, MMF 31334 posterior half of cranidium, MMF 31399 and 31400 poorly preserved cranidia, MMF 31377(10) and (11) hypostomes, MMF 31398 incomplete pygidium.

Other localities: TM 65, Winduck Group (MMF 31399 only).

Diagnosis: Craspedarges with 1L undivided between longitudinal furrows.

Description: The cranidium is very strongly convex, almost globose. The border is very distinct and anteriorly convex in section (sag.), being broadest near the anterior and posterior ends of the suture. The border furrow is narrow, except at the genal angles, and well defined. The rachial furrows are indistinct on the posterior border and effaced on the postero-lateral cranidial lobe between the palpebral lobe and posterior border furrow. The occipital ring is poorly defined laterally because of the weak posterior rachial furrows, but is clearly differentiated from 1L by the occipital furrow. The longitudinal furrows are weak between the posterior margin and S1 but deep anteriorly and sub-parallel along the inner sides of the bullar lobes. The median part of 1L is well marked by the longitudinal furrows and comparative depression among otherwise inflated lobes but the lateral ends are lost in the undifferentiated postero-lateral cranidial lobes. The bullar lobes are clearly defined by the circumscribing furrows. The
median lobe is the most inflated part of the cranidium and very wide anteriorly though the antero-lateral extremities do not overlap the bullar lobes. The surface is covered with small pointed tubercles that are finer on the border. The perforations on some tubercles are believed to be bubbles in the latex cast and are irregular in distribution. The free cheeks are unknown.

The hypostome is wider than long although the posterior border is incomplete on both specimens. The posterior lobe is narrow (sag.) and crescentic in shape compared with the larger subquadrate anterior lobe. The surface of at least the median body is ornamented with tubercles finer but otherwise similar to those on the cranidium.

No thoracic segments of this species are known.

The only pygidium is incomplete at its anterior edge and the rings are not preserved on the prominent rachis. The posterior edges of the three pleurae form well defined ribs in the pleural fields, the ribs on the second and third pleurae being continued beyond the well-defined raised border as robust spines. The very poorly preserved internal mould, counterpart to the exterior in fig. 6G, shows that the first pleura is also continued beyond the border as a marginal spine of uncertain length. The internal mould also shows a short, comparatively broader spine corresponding to the anterior edge of the second pleura, making a total of five pairs of marginal spines. The pair of spines flanking the terminal spine are in the position that would correspond to a fourth pair of pleurae. The surface
is covered with irregularly distributed and widely spaced granules. The doublure is unclear in extent but is approximately as wide as the border.

Dimensions: Because of the fragmentary preservation some of the dimensions have been estimated by doubling measurable half widths.

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<td>12.5</td>
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<tr>
<td>MMF 31398</td>
<td>pygidium (ex spines)</td>
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<td>≈10.0</td>
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</table>

Remarks: The reasons for assuming that these specimens are truly conspecific with Gürich's originals are discussed under the generic remarks. The only other species assigned to this genus, Craspedarges superbus Kobayashi & Hamada from Japan, was questionably assigned to Richterarges by Thomas & Holloway (1988) although this decision was influenced by the poorly known morphology of Craspedarges. The extra pair of pleural segments and five pairs of marginal spines on the pygidium quoted by Kobayashi & Hamada (1977a) is in agreement with C. wilcanniae, the principal distinction being that S1 in C. superbus is not discrete but instead merges medially with the occipital furrow. The age of C. superbus is imprecise, Kobayashi & Hamada (1977b) giving a range of Gedinnian to Emsian or early Eifelian.

REFERENCES CITED


basins in the western part of the Lachlan Fold Belt, Australia, with emphasis on the Cobar Basin. *Journal of Structural Geology* 12. (in press)


Strusz, D.L., 1980. The Encrinuridae and related trilobite families, with a description of Silurian species from


Appendix - Fossil localities

Grid reference (GR) are from "The Meadows" 1:100,000 topographic map. Other localities were sampled using the Barnato 1:250,000 grid; the original grid reference, shown in
brackets, has been retained. Unless otherwise stated the fossils are found in sandstone beds protruding above the surrounding scree of finer more thinly bedded sediments or soil. All localities are within the Cobar Supergroup.

NB 1 GR 559123 (Barnato 1:250,000 GR 34601015): off white fine quartzose sandstone. This locality was sampled by Lennox (1976) who gave a grid reference (Barnato 1:250,000) of 348102.

Unnamed sandstone member, Amphitheatre Group.

TM 56b GR 459008: fine micaceous quartz sandstone. Winduck Group.

TM 65 GR 46300095: fine orthoquartzite. Winduck Group.

TM 312 GR 505130: pale reddish purple massive or thickly bedded siltstone exposed in gravel scrapes. Amphitheatre Group.
SECTION E

SILURO-DEVONIAN TRILOBITES FROM THE TRUNDLE DISTRICT,
CENTRAL NEW SOUTH WALES.
SILURO-DEVONIAN TRILOBITES FROM THE TRUNDLE DISTRICT, CENTRAL NEW SOUTH WALES.

LAWRENCE SHERWIN

Sherwin, L., 0000:00:00. Siluro-Devonian trilobites from the Trundle district, central New South Wales. *Alcheringa*

Trilobites in the Trundle district occur at several horizons in the Late Silurian to Early Devonian Derriwong Group but only those in the Cookeys Plains Formation and Milpose Volcanics are well preserved although disarticulated. The fauna is very similar to that from Yass. The cheirurid *Didrepanon* is recorded for the first time from Australasia. The external ornament in *Odontochile* *cf.* *loomesi* Mitchell is well preserved and described. *Ceratocephala impedita* is reassigned to *Ceratonurus*.

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SILURO-DEVONIAN trilobites are present at several localities in the area between Forbes and Trundle in central New South Wales (Fig. 1). All are within the Derriwong Group/Wallingalair beds (Figs 2, 4) but only those within the Cookeys Plains Formation, including lateral extensions interbedded with the Milpose Volcanics at "North Gunning" (Fig. 3), are sufficiently well preserved to warrant description. With the exception of a very small phacopid, two cephal a of *Odontochile* (species with functional sutures) with free cheeks attached and some
Fig. 1. Locality diagram showing places mentioned in text.
Fig. 2. Geological sketch map of the Trundle district, modified from Brunker (1972a, b), showing trilobite localities. The localities within the Milpose Volcanics at "North Gunning" are within the small outlined area north east of Bogan Gate and are shown in more detail in fig. 3.
Fig. 3. Enlargement of area outlined in fig. 2 showing outcrops of limestone and sediments (light stipple) in the Milpose Volcanics. The upper Walingalair beds/(?)Trundle Group in the north west corner is shown by heavy stipple. "North Gunning" is a property name and not to be confused with the town of Gunning in southern New South Wales.
contiguous thoracic segments of *Odontochile* all the trilobites are disarticulated. *Odontochile* is by far the most abundant of the trilobites, fragments littering bedding planes at most localities where it occurs, although its large size possibly exaggerates its abundance in comparison with the common but minute *Warburgella jelli* Landrum & Sherwin. *Encrinurus* and *Warburgella* are also common in the sandier beds as well as being more widespread in occurrence. Other genera are represented by not much more than one to three specimens.

The environment represented by all the localities within the Milpose Volcanics is limy mud, locally approaching a limestone, much of it leached to a porous siltstone. The more convex species show signs of burial compression. Conjoined isorthid brachiopods in the same beds have fracture patterns consistent with deformation in a brittle regime. There are proetid fragments in the Calarie Sandstone and the Yarrabandai Formation but all available material from these formations is too poorly preserved for even familial determination and is not described in this paper.

The earliest record of Siluro-Devonian trilobites in this area is a reference by Dun (1899) to "a pygidium of one of the Phacopidae, possibly *Coronura*" on the Bogan Gate to Trundle Road. The specimen is in the collection of the New South Wales Geological Survey and is a poorly preserved pygidium of *Encrinurus*. Other occurrences of Siluro-Devonian trilobites in the Derriwong Group/Wallingalair beds were recorded by Raggatt (1937), Sherwin (1980) and Krynen *et al.* (1990) but only two
Fig. 4. Stratigraphic relationships in the Trundle district showing approximate position of trilobite localities.
taxonomic studies have been published. Foldvary (1971) described a new species, *Cheirurus (Crotalocephalus) regius*, collected from float associated with the Milpose Volcanics north east of Bogan Gate. Landrum & Sherwin (1976) described a new proetid, *Warburgella (Anambon) jelli*, from a locality north east of Trundle, supplemented with material collected from the Nymagee district. Yolkin (1983) considered that these types are a mixture of the Eurasian species *Warburgella*, *W. tcherkesovae* Maximova and *W. waigatschensis* (Tschernyschev & Yakovlev), although the Trundle specimens he so reattributed would require both Eurasian species to be present at the one locality in the Derriwong Group. I think it possible that *W. (A.) jelli* is a junior synonym of one or other of these similar species but the preservation is inadequate for any more precise comparisons.

**AGE AND AFFINITIES**

The stratigraphy and associated brachiopod fauna of the Forbes-Trundle district is described elsewhere (Section C-herein). The trilobite faunas are well dated by a *crassa* or earliest *eosteinhornensis* zone conodont fauna at or near the base of the Milpose Volcanics about 10 km north east of "North Gunning" (Pickett 1978). The localities in the Cookeys Plains west of Bogan Gate are below a limestone with a *woschmidtii* zone assemblage fauna (Pickett, 1975). A Pridoli age for this trilobite fauna is thus probable. There is a close resemblance to the late Ludlow to Pridoli trilobite faunas of Yass (Sherwin, in Pickett, 1982) in southern New South Wales,
although there are problems in assigning precise ages to many of the Yass species because of poor or confusing locality details (Sherwin, 1971; Strusz, 1980). Many of the species described herein have been compared with previously described taxa but have been more accurately located. The fauna from the Mt Ida Formation near Heathcote in central Victoria, with an age near the Siluro-Devonian boundary (Holloway & Neil, 1982), is also similar although close specific comparisons are difficult because of the sandy lithology of the Mt Ida Formation. The presence of Homalonotus in the Victorian fauna is not typical of any assemblage in New South Wales.

The genera in the Derriwong Group are typical of "Old World" faunas in Australasia, North Africa, Europe, Asia and North America. At the species level I am unaware of any represented in other continents with the possible exception of the proetid Warburgella (Anambon) jelli Landrum & Sherwin.

SYSTEMATIC PALAEONTOLOGY

Morphological terms, unless otherwise specified, are as defined in the Treatise (Moore, ed. 1959). For encrinurids the morphological terms are as used by Strusz (1980), a refinement of earlier work by Tripp (1957, 1962), and lichid morphology follows Thomas & Holloway (1988). All specimens are stored in the collections of the Geological Survey of New South Wales. External moulds were studied using latex casts and all specimens, whether casts or originals, were whitened with MgO sublimate for photography. Original specimens were blackened with water colour before application of MgO. None of the
material, in particular the encrinurids, is sufficiently well preserved or abundant for applying the numerical taxonomic methods described by Temple & Tripp (1979).

Family ENCRINURIDAE Angelin 1854
Subfamily ENCRINURINAE Angelin 1854

*Encrinurus* Emmrich 1844

*Encrinurus* cf. *civicae* Strusz (Fig. 5)

cf. 1980 *Encrinurus* *civicae* Strusz, p. 31-33, pl. 4, figs 1-16.

Material: MMF 20497 an external mould of an incomplete cranidium; MMF 9564 and 9571 internal moulds of pygidia; MMF 22516 external mould of pygidium. Locality: BG/I/3, BG/IV/1, Cookeys Plains Formation.

Description: The anterior of the cranidium is not preserved and the shape uncertain although the anterior margin of the glabella is well rounded. The eyes are approximately level with 2S/3L. The short section of posterior border preserved is more or less uniform in width (exsag.), about two thirds that of the prominent occipital ring. The occipital and posterior border furrows are deep and narrow. The rachial furrows are straight between the posterior and anterior border furrows and are also connected to the comparatively weak preglabellar furrow. The glabella is slightly longer than wide. The glabellar furrows are shallow except where in contact with the rachial furrows. 1S is almost transglabellar and each part of 2S extends almost one third the width of the glabella. 1L
Fig. 5. *Enocrinurus cf. civicae* Strusz; A MMF 20497 latex cast of external mould of incomplete cranidium x4; B MMF 22516 latex cast of external mould of pygidium x4.
consists of a row of comparatively uniform tubercles but the remaining glabellar lobes are indicated abaxially by large tubercles. Opposing the glabellar lobes across the rachial furrows is a row of four coarse tubercles on the fixed cheeks. The tubercles over the median part of the glabella are variable in size and shape though all are much smaller than those forming the lobes. The posterior arrays are 1L - 1, 2, 3; 1S - 0; 1S - 0; 2L - 1, 2, 3; 2S - 0, 1. On the anterior half of the glabella the tubercles are very numerous and cannot be arranged into discrete arrays. The tubercles on the fixed cheeks are also variable in size, the coarsest being next to the rachial furrows and palpebral lobes. The tubercles on the occipital ring are small, low and widely scattered. Superimposed over the tubercles is a fine indistinct granulation.

No hypostomes or well preserved thoracic segments have been identified at this locality.

The posterior part of the pygidium is triangular in shape with straight sides. The pleurae are flexed near midlength, becoming straighter and subparallel to the rachis posteriorly. The two most complete pygidia have nine pairs of pleurae. The rachis is uniformly tapered and flanked throughout by well defined rachial furrows. There are at least 28 rachial rings in the best preserved specimen, the eleventh bifurcating on the right side of the axial line. The tubercles are very weak, even on internal moulds, the most obvious being on rings 4, 5,
9 and 13. There is also a very weak sagittal furrow between rings 4 and 16.

**Dimensions:** Because of the fragmentary condition of the specimens the width of both cranidium and pygidium has been estimated by doubling the measurable half width.

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**Remarks:** This species is clearly a member of the *Encrinurus mitchelli* Foerste group (*sensu* Strusz, 1980) but assigning it to any particular species in the group is difficult because of the intraspecific variation displayed by this group. Most of the species described by Etheridge & Mitchell (1916) were reviewed in considerable detail by Strusz but because the majority of types are internal moulds without external counterparts it is difficult to make comparisons with external moulds. The coarser tubercles flanking the rachial furrows on the glabella and the generally uninterrupted rachial rings is a characteristic of *E. robustus* (Mitchell), but that species has fewer rachial rings. *E. silverdalensis* has a comparable number of rachial rings but differs from the Trundle material in having very distinct rachial tuberculation in the pygidium. The best fit, having regard to the glabellar tuberculation and number of rachial rings, is with the more coarsely tuberculate forms of *Encrinurus civicae* Strusz.

These specimens occur in fine to medium sandstone, the
pygidia mentioned by Dun (1899) being in a reddish medium sandstone associated with marl and limestone containing a variety of corals and stromatoporoids (Pickett & Ingpen, 1990). This environment is possibly somewhat shallower than those associated with the localities where all previous collections of Encrinurus mitchelli group species were made and is possibly a reason that the Trundle specimens do not fit into existing taxa.

Family CHEIRURIDAE Hawle & Corda 1847
Subfamily CHEIRURINAE Hawle & Corda 1847
Cheirurus Beyrich 1845
Cheirurus (Crotalocephalus) Salter 1853

Cheirurus (Crotalocephalus) regius Foldvary 1971 (Fig. 6)

1971 Cheirurus (Crotalocephalus) regius Foldvary, p. 85-6, pl. 1.

Material: MMF 31460, an incomplete cranidium with some silicified test adhering.

Locality: BG/I/41 Milpose Volcanics. A poorly preserved cranidium, probably referable to this species, has been noted at TU/III/14 in the Cookeys Plains Formation.

Description: The specimen consists of little more than the glabella. The occipital ring is very wide (sag.) because of the anteriorly directed median section of the occipital furrow. The rachial furrows are narrow and diverge anteriorly as far as 3L, the widest part of the glabella, but cannot be traced.
beyond the frontal lobe because of the preservation. The frontal gabellar lobe is well rounded anteriorly. The 1S furrows are deepest where joined to the rachial furrows and most shallow medially where the adaxial ends are flexed posteriorly to meet the anterior flexure of the occipital furrow. The 2S and 3S furrows are continuous across the glabella without any appreciable variation in depth between the rachial furrows and have a depressed chevron shape, 2S being more the more depressed and almost straight. The 1L lobes are circumscribed by furrows and tapered adaxially, each extending (trans) slightly more than one third the width of the glabella. All lobes are rounded at their abaxial ends. Only a very small part of the fixed cheek remains and that is much lower in relief than the glabella. The surface of the glabella is covered with coarse tubercles that do not have any obvious pattern of distribution. The fixed cheek is coarsely pitted, the size, relief and spacing of the pits being comparable with the glabellar tubercles. Tubercles on the fixed cheek are more widely scattered than on the glabella and tend to be smaller in size. It is obvious from the remaining pieces of test that the tubercles are repeated on the interior.

No thoracic segments or pygidia of this species have been found.

Dimensions: Length of specimen (approximately length of the glabella) 31 mm. Width of glabella 22.5 mm.

Remarks: Foldvary (1971) based this species on a single large
cranidium. This specimen differs from the type in having the median part of the glabellar furrows less deflected posteriorly and lacking the narrow tubercle-free zone along the sagittal line of the glabella. With so little material available to assess the variation in this species these differences are not considered sufficient to warrant a new species or even subspecies. Comparable intraspecific variations in glabellar furrows is evident in the well preserved material described by Ramsköld (1983). This specimen and the type, the latter found approximately 9 kilometres along strike to the north east (at or near TU/II/1), are in a poorly bedded porous siltstone, probably a leached marl.

The status of the subgenus *Cheirurus* (*Crotalocephalus*), in particular its relationship to *C.* (*Crotalocephalina*), has been discussed at length by Lane (1971), Holloway & Neil (1982) and Chatterton & Wright (1986). Holloway & Neil showed that the two subgenera intergrade morphologically and the more significant diagnostic features are related to the pygidium. In the absence of anything other than cranidia I consider it preferable to leave the subgeneric status of this species unchanged. Lane (1971) regarded *Crotalocephalus* as a discrete genus, and certainly it differs from *Cheirurus sensu stricto* just as much as other genera in the Cheirurinae.

Foldvary (1971) regarded the large size of *C.* (*Crotalocephalus*) *regius* as a principal diagnostic character, but the tuberculation is also unusually coarse and concentrated
Fig. 6. *Cheirurus (Crotalocephalus) regius* Foldvary; MMF 31460 external mould of incomplete cranidium with some relict test, latex cast x2.5.

Fig. 7. *Didrepanon* sp.; MMF 31478(1) external mould of incomplete cranidium, latex cast x2.5.
in comparison with most other species of this genus. The largest cranidium of *C. (Crotalocephalus) silverdalensis* Etheridge & Mitchell (1917, pl. 25, fig 2), a similarly aged species from the Yass district, has only very indistinct and widely scattered tubercles. Holloway & Neil (1982) noted the strong resemblance of *C. (C.) regius* to their new species *C. (Crotalocephalina) oxina* but among other minor differences noted the more prominent tubercles of *C. (C.) regius*. A large cheirurid from the Nymagee district, identified by Fletcher (1975) as *C. (C.) silverdalensis*, has similar 2S and 3S but is too poorly preserved to discern if tubercles are present or not. Maximova (1968) illustrated an unidentified cranidium of *Cheirurus* from the late Ludlow of Kazakhstan with transglabellar 2S and 3S and distinct tubercular ornament, differing from *C. (C.) regius* in having the greatest width of the glabella across the frontal lobe instead of across 3L. The significance of the tuberculation is difficult to assess with so few specimens. The well preserved Moroccan cheirurids illustrated by Alberti (1969), including the very large *C. (Crotalocephalina?) africanus* Alberti, show considerable intraspecific variation as regards ornament.

*Didrepanon* Lane 1971

*Didrepanon* sp. (Fig. 7)

Material: MMF 31474 cranidium, internal mould; MMF 31478(1) cranidium, external mould; MMF 31473 fragment of a thoracic segment.
Locality: BG/I/42, Milpose Volcanics.

Description: The width of the cephalon is greater than the length by a factor of almost 2:1, the available material being too fragmentary for more precise estimates. The anterior and lateral borders are not preserved in either cranidium. The posterior border is well defined by a slightly wider deep border furrow and extends into a short genal spine. The occipital ring is the highest part of the cranidium to judge from the damage it has suffered in comparison to the glabella. The occipital ring is also very wide (sag.) and clearly separated from the glabella by an occipital furrow that is shallow medially. The rachial furrows are deep with steep sides. The width of the glabella across 1L is approximately one third the width of the cephalon. The sides of the glabella diverge slightly as far as 3S where there is an abrupt widening at the base of the frontal lobe, the widest part of the glabella. All glabellar furrows join the rachial furrows. The adaxial ends of 1S are strongly flexed posteriorly to meet the forward flexure of the occipital ring, creating a large gap between the 1L lobes. 2S and 3S are curved and each pair is connected medially by a very shallow transverse depression. There is no obvious ornament on the glabella other than a few very indistinct tubercles on the anterior extension of the occipital ring and the postero-median part of 2L. The fixed cheeks are lower than the glabella and covered with small distinct pits arranged, at least in the middle of the cheeks, in rows that diverge anteriorly at approximately 45° to the
A fragment of a thoracic segment shows the normal lanceolate extremity.

No cheirurid pygidia have been found at this locality.

**Dimensions:**

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**Remarks:** The shallow transverse depressions connecting the adaxial ends of the 2S and 3S furrows indicate the genus *Didrepanon* even in the absence of any pygidia. The linear arrangement of pits on the fixed cheek seems not to have been recorded before in cheirurids, other species having a generally random pattern of pitting. Some of the specimens of *Didrepanon* illustrated by Ramsköld (1983, pl. 20, figs 5, 8) show linear arrangements of pits on the adaxial parts of the fixed cheek but these tend to be part of a radial pattern about the eye.

**Family CALYMENIDAE Milne Edwards 1840**

**Subfamily FLEXICALYMENINAE Siveter 1976**

*Sthenarocalymene* Siveter 1976

*Sthenarocalymene? sp. (Fig. 8)*

**Material:** MMF 31475 an incomplete cranidium, MMF 31476 an incomplete crushed cephalon, both external moulds.

**Locality:** BG/I/42, Milpose Volcanics.

**Remarks:** These specimens are too poorly preserved to warrant
Fig. 8. *Sthenarocalymene* sp.; MMF 31475, latex cast of exterior of cephalon, x2.5.

Fig. 9. *Ananaspis?* sp.; A MMF 31470, latex cast of doublure showing vincular furrow and granular ornament x4; B MMF 31471 latex cast of exterior x4.
describing in detail. However the profile, glabellar lobation and ornament are consistent with Siluro-Devonian species from Yass (Etheridge & Mitchell, 1917) and the Heathcote district of Victoria (Holloway & Neil, 1982). Etheridge & Mitchell based most of their descriptions upon internal moulds and ornament was mentioned only if coarse enough to be imprinted on the interior or if some of the carapace remained. I examined Mitchell's collection of Yass-Bowning material and found the external counterpart of one of the syntypes of *Sthenarocalymene australis* (Etheridge & Mitchell, 1917, pl. 24, fig. 1). This was poorly preserved but sufficient of the ornament remained to show that it is very like the scattered low granules of the "North Gunning" material.

**Family PHACOPIDAE Hawle & Corda 1847**

**Subfamily PHACOPINAE Hawle & Corda 1847**

*Ananaspis* Campbell 1967

*Ananaspis? sp.* (Fig. 9)

**Material:** MMF 31470 external mould of the cephalic doublure, MMF 31471 very small almost complete specimen.

**Locality:** BG/I/43, Milpose Volcanics.

**Remarks:** This species has been assigned to *Ananaspis* on the basis of the vincular furrow and the ornament on the small portion preserved of the glabella anterior. The small specimen, although much more complete, is poorly preserved in fine details. This material is just sufficient to note the occurrence of this genus.

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In the *Treatise of Invertebrate Paleontology* (Moore, 1959) *Odontochile* is separated from *Dalmanites* by an anterior facial suture clearly distant from the anterior of the frontal glabellar lobe, a denticulate posterior margin to the hypostome, twelve to fifteen pairs of ribs in the pygidium as opposed to six or seven, sixteen to twenty two rachial rings in the pygidium instead of eleven to sixteen and a broad instead of narrow doublure in the pygidium. With this number of differences these two genera should be easily separated, although there is a notional overlap in the number of rachial rings in the pygidium. However, some species of *Odontochile* and *Dalmanites* have been described on pygidia only and there is a certain amount of subjectivity in deciding whether the doublure in the pygidium is broad or narrow. Whittington & Campbell (1967) considered that the number of rachial rings in the pygidium was of doubtful taxonomic value and the classification of Siluro-Devonian dalmanitids in need of clarification. Thus they, as well as Campbell (1967), included species in *Dalmanites* that have typical *Odontochile* type anterior facial sutures. Chlupac (in Horny & Bastl, 1970) designated and refigured one of Barrande's (1852, pl. 24, fig. 1) specimens of *Odontochile hausmanni* as lectotype of the species and thus type for the genus. This specimen has badly
damaged eyes but the position of the anterior suture is clear. Pribyl & Vanek (1970) separated Devonian species with a pointed extension of the anterior border into a new subgenus Odontochile (Zlichovaspis). Kobayashi & Hamada (1971) added a new genus, Prodontochile, to the Dalmanitinae in a review of the subfamily but retained the separation of Odontochile and Dalmanites, stressing again differences in the facial sutures, more pleural segments in the former and a less developed caudal spine in Odontochile. Prodontochile is readily separated from Odontochile by a Dalmanites type anterior facial suture and a non-mucronate pygidium. The generic distinctions between Odontochile and Dalmanites have been applied consistently by various authors where the completeness of the material permitted and so the use of Odontochile for the "North Gunning" specimens has been retained.

Odontochile cf. loomesi (Mitchell) (Figs 10, 11)

cf. 1919 Dalmanites (Hausmannia) loomesi Mitchell, p. 441-446, pl. 15, figs 1, 2; pl. 16, figs 3, 4, 5.

Material: MMF 29543 incomplete internal mould of a cephalon, MMF 31480, 31481 & 31482 external moulds of incomplete cranidia; MMF 31479 external mould of hypostome; MMF 31752 external mould of thoracic segments; MMF 31751 external mould of pygidium; MMF 31747 internal mould of pygidium; MMF 31472, 31750 incomplete pygidia. Fragmentary material, especially of pygidia, is common in both localities.
Fig. 10. *Odontochile* cf. *loomesi* (Mitchell); A MMF 31480 cranidium, latex cast of exterior x1.5; B, E MMF 29543 incomplete cephalon, B internal mould x1.5, E doublure on genal spine, latex cast x3.65; C MMF 31481 cranidium of small specimen, latex cast of exterior showing ornament on palpebral lobe x3.65; D, H MMF 31479 hypostome, latex cast of external mould, D x1.5, H showing dense fine granular ornament x3.65; F, G MMF 31482 incomplete cranidium, F 3L and frontal lobe showing ornament, G base of glabella showing ornament, both x3.65. All from locality BG/I/42.
Locality: BG/I/42 & 43, Milpose Volcanics.

Description: The overall shape is unknown because of the disarticulated material. The antero-lateral outline of the cephalon is paraboloid with well developed genal spines of uncertain length though probably at least as long as the glabella. The posterior and antero-lateral border is well defined by the continuous border furrow but the anterior border is not well preserved in any of the available material although it is clearly much narrower. The palpebral lobes are clearly defined by shallow palpebral furrows connected anteriorly to the rachial furrows. The anterior branch of the suture follows the abaxial side of the rachial furrow, the central part separates the eye from the semicircular palpebral lobe and the posterior branch for half its length is almost concentric with the visual surface, at its posterior extremity being mid way between eye and posterior border furrow. The outer part of the posterior branch is smoothly curved forward level with 2L before intersecting the margin of the cephalon approximately level with 1L. The occipital ring is slightly wider medially (sag.) and well defined by the rachial furrows and an occipital furrow that is medially shallow. The glabella has a maximum to minimum width ratio of 1.8:1 and is approximately as wide as long. The 1S and 2S furrows are very shallow next to the rachial furrows, being deepest adaxially and extending more than one third the width of the glabella. The 1S furrows are slightly curved, and both pairs have a slight abaxial posterior inclination. The 3S furrows are strongly inclined to the axis, much wider and almost meet axially, there being a slight

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transverse median depression. The frontal lobe of the glabella is almost detached from the posterior lobes because of the depth of the 3S furrows and is ovoid in shape, almost pointed at the lateral extremities. The 3L lobes have a distinct convex abaxial margin. The ornament of very fine granules is concentrated on the postero-median part of the occipital ring, the median part of the glabella between 2S and 3S, the frontal lobe and the palpebral lobes. The eyes are too poorly preserved for a lens row count. The only part of the cephalic doublure preserved is on the genal spine where the marginal part is ornamented with densely packed granules. Many of the granules appear to be flattened but this flattening is also most apparent along the lowest part of the genal spine, presumably the part in most contact with the seafloor in life and so most likely to be abraded.

The hypostome has a gently convex anterior margin/suture, very narrow border, three short terminal spines and two very short lateral spines spaced uniformly on each side. The crescentic posterior lobe is separated by a continuous furrow and the rear of the anterior lobe has a pair of irregular elongate hollows but nothing recognisable as maculae. The entire surface is covered by fine closely spaced granules.

The thoracic segments are very fragmentary. The rachial furrows are shallow but well defined. The pleural furrows meet the shallow but well defined rachial furrows at the anterior edge of each segment but abaxially are parallel to the edges of the pleurae. The articulating half ring is well defined by a
Fig. 11. *Odontochile* cf. *loomesi* (Mitchell); A MMF 31751 pygidium, latex cast of exterior x1.5; B MMF 31752 thoracic segments, latex cast of exterior x3.65; C, G MMF 31750 incomplete pygidium, latex cast of exterior, C ornament on rachis, G do. on margin, both x3.65; D, E MMF 31747 pygidium, latex cast of ventral surface, D showing extent of doublure x1.5, E ornament on doublure x3.65; F MMF 31472 teratological fragment of pygidium, latex cast of exterior showing ornament, x3.65. F is from locality BG/I/43, all others are from BG/I/42.
distinct furrow and is approximately half the width (trans.) of the rachial ring. The fine granular ornament is most obvious on the posterior, higher part of the rachial ring and thinly distributed on the anterior ridge of the pleurae.

The pygidium is almost one and a half times wide as long. The lateral margins are gently curved and the border is defined by slight flattening and fading of the prominent pleural grooves and comparatively indistinct interpleural furrows. There are twelve to thirteen distinct pygidial ribs. The rachis is long and uniformly tapered with at least sixteen distinct rachial rings and a terminal piece. The ring furrows are narrow and deep abaxially. The posterior end is continued as a short mucro rather than a distinct spine. The fine granulose ornament is concentrated on the border and higher parts of the rachis and ribs. The doublure is wide, approximately one quarter the maximum width of the pygidium, and is only slightly narrower next to the rachis. The ornament is uniformly fine close-spaced granules.

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</table>

Some of these measurements are necessarily estimates obtained by doubling half a measurable width. The length of the cephalon / cranidium is measured from posterior to anterior margin.
Remarks: These specimens agree with the recognised diagnosis of *Odontochile*, although the number of rachial rings in the pygidium is at the lower limit of the recorded range. The Victorian dalmanitids have been reviewed by Holloway & Neil (1982) and Jell & Holloway (1983), including comparisons with those from the Yass district of New South Wales. Etheridge & Mitchell (1896) described *Hausmannia meridianus* with syntypes consisting almost wholly of internal moulds and Mitchell (1919) described *Dalmanites loomesi* from an internal mould, both species subsequently recognised as *Odontochile* by Gill (1948). Some external moulds of pygidia of *Odontochile meridianus* in the collections of the Geological Survey of New South Wales show an ornament comparable to that of the "North Gunning" material but otherwise the two species differ, *O. meridianus* having a more triangular-shaped pygidium and a narrower, more *Dalmanites*-like doublure. The closest comparison is with *O. loomesi* although this species is without any known external moulds (Jell & Holloway, 1983) and its type locality in the Yass-Bowning district must be regarded as doubtful given problems encountered with all of Mitchell's material (Sherwin, 1971; Strusz, 1980).

As a group, the Australasian species of *Odontochile* differ from most others, in particular those from Bohemia (Přibyl & Vaněk, 1970), by having smaller eyes and a correspondingly large gap between eye and posterior border furrow. Comparison with central Asian species is difficult because many of the species described by Maximova (1968) are based on pygidia only.
Fig. 12. Indet. lichid; MMF 29271 latex cast of exterior of incomplete pygidium x4.

Fig. 13. *Leonaspis* cf. *rattei* (Etheridge & Mitchell); MMF 31477 cranidium, stereo pair of latex cast of exterior x3.65.
and the few cephalas are internal moulds.

**Family LICHIDAE Hawle & Corda 1847**

**Subfamily TROCHURINAE Phleger 1936**

gen. indet. (Fig. 12)

**Material:** MMF 29271, an incomplete pygidium.

**Locality:** BG/I/41

**Remarks:** The shape of the rachis indicates the familial affiliations of this fragment but the generic identification is less clear. The anterior end of the rachis is damaged but the first two or three rachial rings are more distinct and enough of the pleural field is preserved to show that the rachis is at most only one quarter the width of the pygidium, both features being diagnostic of *Richterarges*. The presence of a distinct third pair of pleural segments is a feature of *Craspedarges* (Section D-herein) but the rachis in that genus is approximately one third the width of the pygidium, although Thomas & Holloway (1988) regard the two genera as closely related. There is a very indistinct third pair of pleural segments in *Richterarges ptonurus* (Hall & Clarke) from the upper Pridoli Cobleskill Limestone of North America.

**Family ODONTOPOLEURIDAE Burmeister 1843**

**Subfamily ODONTOPOLEURINAE Burmeister 1843**

*Leonaspis* Richter & Richter 1917

*Leonaspis cf. rattei* (Etheridge & Mitchell) (Fig. 13)
cf. 1896 *Odontopleura rattei* Etheridge & Mitchell, p. 699-703, pl. 50, fig. 7; pl. 51, figs 8-9; pl. 52, figs 1-4; pl. 53, figs 1-3.

cf. 1971 *Leonaspis rattei* (Etheridge & Mitchell); Chatterton, p. 90-92, pl. 22, figs 8-14; pl. 23, fig. 14.

**Material:** MMF 31477 an incomplete cranidium.

**Locality:** BG/I/42, Milpose Volcanics.

**Remarks:** This cranidium has the deep longitudinal glabellar furrows and denticulate anterior border diagnostic of *L. rattei*, but has a less tuberculate palpebral lobe. The original description by Etheridge & Mitchell (1896), illustrated by drawings, was revised by Chatterton (1971) using what remained of their types with a warning note on the uncertainties associated with the type localities.

Subfamily MIRASPIDINAE Richter & Richter

*Ceratonurus* Prantl & Přibyl 1949

*Ceratonurus?* cf. *impedita* Etheridge & Mitchell (Fig. 14)


**Material:** MMF 31478(2) internal mould of cranidium; MMF 37153 external mould of pygidium, possibly referable to this species.

**Locality:** BG/I/42 (cranidium), BG/I/40 (pygidium).

**Description:** The cranidium is almost hexagonal in shape. The
Fig. 14. *Ceratonykus*? cf. *impedita* (Etheridge & Mitchell); A MMF 31478(2) internal mould of cranidium, locality BG/I/42, x4; B MMF 31753 pygidium, latex cast of exterior, locality BG/I/40, x4.
anterior margin is quite straight but the posterior border is unclear. The antero-lateral margins of the cranidium, formed by the anterior branch of the suture, are gently curved. The occipital ring is elongate (sag.) and bears two posteriorly directed spines of unknown length. It is not clear if there is a posterior band to the occipital ring. The weak rachial furrows extend from the posterior to the anterior border furrow. The sides of the glabella are gently convex and the base separated from the occipital ring by a poorly defined shallow occipital furrow. The 1S furrows are very weak, 1L and 2L almost forming a composite lobe bounded abaxially by a longitudinal furrow that is much deeper and better defined than the rachial furrows, very deep near 1S and extends from the occipital furrow to the 2S furrows. The 2S furrows are deepest adaxially and connect the longitudinal and rachial furrows. The frontal lobe is abruptly transverse and has a straight (trans.) anterior margin. The fixed cheeks are tapered anteriorly, the anterior tip being level with the frontal lobe of the glabella. The narrow eye ridges are bounded by the anterior branches of the suture and palpebral furrows almost as deep as the rachial furrows. The eye lobes are long, narrow, almost level with 1S and directed almost perpendicular to the axis. It is uncertain if the complete lobe is represented. The surface is covered with widely and asymmetrically distributed, variably sized tubercles and granules. It is assumed that these reflect the surface ornament of the exterior.
The free cheeks, hypostome and thorax are unknown.

The pygidium is very broad, the width being almost four times the length measured without the marginal spines. The rachis is short, slightly more than one quarter the width of the pygidium, strongly convex and contains three rachial rings, the first two separated by a distinct furrow. A possible fourth ring is suggested by a prominent pair of tubercles at the tip of the rachis. Pleurae cannot be recognised with any confidence. The pleural ribs extending from the second rachial ring are sharply flexed backwards abaxially and continued beyond the margin of the pygidium as a pair of robust sabre-like spines. These spines bear a median groove believed to be an original feature and not an artifact of burial pressure because no other spines are so affected. There are ten straight marginal spines approximately equal in length between the main pair and four pairs outside. The outer two of these pairs are much shorter. Distinct ornament consists of a few small symmetrically arranged tubercles and an indistinct more widely distributed granulation continued onto the spines.

Dimensions:

MMF 31478 width measured to bases of eye lobes 15 mm
length measured from anterior margin to base of occipital spines 11 mm

MMF 31753 length (exclusive of spines) 5 mm
width 19 mm

Remarks: This cranidium and pygidium are assumed to be part of a single species but this is not absolutely certain because
they come from different horizons. The lectotype cranidium of *C. impedita* Etheridge & Mitchell selected by Chatterton (1971, pl. 23, fig. 11) has straight rather than curved antero-lateral margins and is missing any eye lobes, although it appears to have suffered some deformation like much of the material found northwest of Yass near Bowning. No pygidia of this species are known from Yass-Bowning. The material used by Prantl & Příbyl (1949) to establish the genus *Ceratonurus* was very scrappy and did not include any complete specimens. The pygidia in particular are all isolated specimens and their diagnosis amounted to a cephalon of ceratocephalid type with a pygidium of miraspid type. However in their remarks on relationships of the new genus they remarked that *Ceratocephala* lacked functional facial sutures, an observation reinforced by later studies on silicified cephala of several species of *Ceratocephala* (Chatterton & Perry, 1983). My assignment of *C. impedita* to *Ceratonurus* is thus not reliant upon a miraspid pygidium in the same area. The pygidia of *Ceratonurus* illustrated by Prantl & Příbyl had secondary spines only between the major pair. The distribution of marginal spines in the pygidium from "North Gunning" is more typical of *Miraspis* except that the spines are without any secondary spines.

The holotype of *Ceratonurus selcanus* (Roemer), refigured by Ormiston (1968), and the subspecies *C. selcanus dilatus* Ormiston have antero-lateral margins like the "North Gunning" material but much shallower longitudinal furrows. The former is from Europe, the latter from North America, both of Early
Devonian age in common with the species described by Prantl & Přibyl (1949).

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APPENDIX - Locality details

The localities are pinpointed by grid references from the relevant 1:100,000 topographic sheet, or 1:250,000 sheet for some of the localities sampled before the availability of more detailed topographic maps, supplemented by any distinctive locality details. Unless the grid reference is from a specified 1:250,000 sheet, the relevant 1:100,000 topographic sheet is indicated by the initial letters of each locality number, viz.,

BG  Bogan Gate
TU  Tullamore
BG/I/3 Forbes 1:250,000 GR 582918, reddish sandstone interbedded with unnamed limestone near base of Cookeys Plains Formation. This locality has been disrupted by road works since the trilobite material was collected.

BG/I/40 GR 836423, Milpose Volcanics, outcrop at top of low rise.
BG/I/41 GR 837425, Milpose Volcanics, low outcrop of thinly bedded sediments within volcanics.
BG/I/42 GR 835426, Milpose Volcanics, low outcrop of sediments interbedded with volcanics.
BG/I/43 GR 826422, Milpose Volcanics, low outcrops of sediments near old fence.
BG/IV/1 Forbes 1:250,000 GR 56759170, Cookeys Plains Fm, shallow scraps in fine sandstone on western side of road, about 100 metres west of fence.
TU/III/14 Narromine 1:250,000 GR 566949, Cookeys Plains Formation, gravel pit about 200m north west of Kadungle railway siding, on west side of road, in light coloured siltstone.
SECTION F

SILURO-DEVONIAN BIOSTRATIGRAPHY OF CENTRAL NEW SOUTH WALES
SILURO-DEVONIAN BIOSTRATIGRAPHY OF CENTRAL NEW SOUTH WALES

By Lawrence Sherwin

ABSTRACT

The Late Silurian to Early Devonian trilobite and brachiopod faunas of central New South Wales are generally poorly preserved but are still sufficiently distinctive to provide a local biostratigraphic scheme. The oldest fauna, *Encrinurus - Molongia elegans capricornae*, can be dated by conodonts as spanning most of the Pridoli. The *Podolella* or *Nanothyris* fauna is widespread but of probable short duration, being overlain by late Lochkovian conodonts. The faunas with *Howellella jaqueti* are reputedly very widespread but this is a reflection of the difficulty in differentiating poorly preserved very similar species. The *Reeftonia* and *Spinella* faunas are restricted to the eastern part of the region and of possible late Pragian to Emsian age.

Most of the Siluro-Devonian outcrops in central New South Wales, the area north west from Forbes to Louth on the Darling River (Fig. 1), are sandstones and acid volcanics, the latter sometimes associated with interbeds of fine grained sediments. Consequently the biostratigraphy of this region depends upon fossils preserved in sandy facies, with uncertainties caused by the loss of fine details in sandy lithologies and the generally disarticulated condition of the brachiopods and trilobites. Few species had been described from this area and much of the
Fig. 1  Distribution of Late Silurian to Early Devonian (Pridolian to Emsian) strata in central New South Wales. Geology after Pogson (1972 and in press), Sherwin (1980, 1981), Krynen et al. (1990) and Henley (1988).
taxonomic work was in need of revision (Section A-herein).

The biostratigraphic scheme (Fig. 2) constructed to assist correlations in the area was based partly on these old taxonomic works and numerous unpublished reports by the Geological Survey. It evolved from a need to produce a scheme for local correlation with the added hope that it might prove useful for correlating with internationally recognised stages. Local correlation was particularly important for mineral exploration whereas the standard geological age might be irrelevant. Poorly preserved material, if distinct in morphology, could be useful as marker fossils but was of rather less use when an accurate geological age was required. Dating to standard intervals using this scheme depended very much on the few localities where associated limestones contained useful conodont assemblages (Pickett, 1978; 1980). Describing the faunal assemblages in terms of components was difficult because so little of the fauna had been described.

Although this scheme was devised for local mapping and mineral exploration in the limited, though still extensive area of New South Wales where it was applied, it has gained some recognition as a zonation scheme for Australasian clastic sequences (Young, 1989), though with obvious application to New South Wales. The alternative is a zonation developed in Victoria by Garratt & Wright (1988) and based on notanopliid brachiopods. This group is known from several localities in New South Wales (Savage, 1974; Sherwin, 1981; Wright, 1981; Section C-herein) but with few exceptions is not associated
<table>
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<tr>
<th>period</th>
<th>faunal assemblage</th>
<th>typical components of fauna</th>
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<td>brachiopods</td>
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<td>H. jaqueti, Ancillothecia duni,</td>
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Fig. 2. Biostratigraphic scheme previously used for correlation in central New South Wales (Glen et al., 1985). The Cheirurus-Howellella assemblage is now included within the Encrinurus-Molongia elegans capricornae assemblage and the Nanothysis is probably Podolella. All assemblages have been dated approximately half a stage older on the basis of associated conodonts.
with any other stratigraphically useful fauna, or indeed any other fauna at all in central New South Wales. The occurrences of *Notanoplia* in central New South Wales suggest that it occupied a deeper environment than the other species found in this area and the fine grained lithologies typical of these environments are those least likely to form outcrops in the deeply weathered and alluvium covered western plains.

The revised biostratigraphic scheme for this region is shown in Fig. 3. The trilobite and brachiopod faunas are described herein (Sections B-E). Mixed trilobite and brachiopod faunal assemblages have been used, this having proved more reliable than zonation based on changes in a single taxon. The molluscan fauna is generally too nondescript to be of use in biostratigraphy, the exception being the distinctive bivalve *Kochia? rayneri* Fletcher. The generic status of this bivalve is questionable because Fletcher (1975) did find any specimens of the diagnostic operculate right valve, and it is possibly an unusually incurved *Actinopteria*. However, the valves have been identified at several localities between Nymagee and Forbes (Krynen *et al.*, 1990) and, although associated with laminated sandstones interbedded with cross bedded units, are known only from the oldest (essentially basal) of several such units in the region.

**ASSEMBLAGE DESCRIPTIONS**

*Kochia? rayneri* assemblage

This assemblage occurs in basal sequences and is difficult to recognise in the absence of the nominate species because the
Fig. 3. Revised biostratigraphy of central New South Wales based upon taxonomy in sections B–E herein. Conodont occurrences providing tie points to the internationally recognised conodont zones are indicated in the columns by *. Hiatuses are indicated by cross hatching.
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associated brachiopods are poorly preserved in the usual coarse sandy lithology. This fauna occurs at or just below limestone with a crassa zone conodont fauna in the Bogan Gate area.

Fauna: brachiopods

Atrypoidea? sp.

uncinulid indet.

lamellibranchs

Kochia? rayneri

Encrinurus-Molongia elegans capricornae assemblage.

This is now known to include the former Cheirurus - Howellella assemblage (fig. 2), both assemblages being interbedded in the Milpose Volcanics north-east of Bogan Gate. The differences are believed facies related, Molongia elegans capricornae favouring sandier environments. This assemblage is also the most widespread, occurring west of Rockhampton in Queensland (McKellar, 1969), central and southern New South Wales and central Victoria (Section B—herein). There is some resemblance to the Eldon Group faunas described by Gill (1948, 1950) from western Tasmania but comparisons are difficult because these faunas were illustrated with minimal enlargement. I have examined the specimens of Encrinurus described from Tasmania by Etheridge (1896) and noted the specimens of Molongia elegans capricornae on the same slab. However there are doubts as to the provenance of this Tasmanian material (P. Baillie, pers. comm.) and it has been suggested that this
material is in fact from Trundle in New South Wales (J. Pickett, pers. comm.). Conodonts associated with this fauna in the Trundle district indicate that it spans most or all of the Pridoli (Pickett, 1975) and a similar date is indicated by conodonts at the Rockhampton locality (Jell & Talent, 1989). An important associate in the Trundle and Nymagee districts, and possibly Rockhampton, is the proetid trilobite *Warburgella (Anambon) jelli* Landrum & Sherwin (1976). This species is less facies influenced than most other trilobites contemporary with this assemblage and thus assists local correlation. This assemblage overlies the *Kochia? rayneri* occurrences near Bogan Gate.

The occurrences of *Notanoplia* in central New South Wales are difficult to relate to this or other assemblages because they are unaccompanied by any other age diagnostic faunas and for the most part are geographically isolated as well. Stratigraphic considerations suggest that the *Notanoplia cf. pherista* locality occurs at or near the boundary between the *Encrinurus-Molongia elegans capricornae* and "Podolella" assemblages.

Fauna: trilobites

*?Ananaspis sp.*

*?Ceratonurus cf. impedita* (Etheridge & Mitchell)

*Cheirurus (Crotalocephalus) regius* Foldvary

*Didrepanon* sp.

*Encrinurus cf. civicae* Strusz

*E. cf. mitchelli* Foerste

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E. cf. *silverdalensis* Etheridge & Mitchell

*Leonaspis* cf. *rattei* (Etheridge & Mitchell)

*Odontochile* cf. *loomesi* (Mitchell)

*Sthenarocalymene* sp.

*Warburgella* (*Anambon*) *jelli* Landrum & Sherwin

brachiopods

*Atrypa* sp.

*Baturria* sp.

*Howellella* cf. *pyramidalis* McKellar

*Iridistrophia* sp.

*Isorthis* (*Arcualla*) sp.

*Leptostrophia* (*Mitchella*) deckerae Sherwin

*Molongia elegans* capricornae McKellar

*Salopina* sp.

*Shaleria* sp.

*Skenidioides* sp.

The coral, stromatoporoid and conodont faunas from the Trundle district that are more or less coeval with this assemblage have been itemised by Pickett and Ingpen (1990).

"*Podolella*" assemblage

This assemblage is present in both the Cobar/Meadows area and Trundle but occupies only a very part of the stratigraphic columns wherever it occurs (Sections B & C - herein). The usual preservation is too poor to be sure if *Podolella* or the similar *Nanothyris* is represented. In the Trundle district the
underlying interval between this and the Encrinurus – Molongia assemblage, where there is any exposure or fauna, is dominated by nondescript, pauciplicate forms of Howellella. Near Bogan Gate this fauna underlies a delta zone conodont assemblage (Pickett, 1983). In The Meadows district west of Cobar this assemblage forms a narow band within the Howellella jaqueti assemblage.

Fauna: brachiopods

Podolella sp. / Nanothyris sp.
Ancillotoechia duni (Gürich)
Howellella spp.
Iridistrophia sp.
?Mesodouvillina sp.
Strophochonetes sp.

indet. tentaculitids
beyrichiid ostracodes

Howellella jaqueti assemblage

The widespread geographic distribution and apparent long time duration of this assemblage suggest that the normal preservation of H. jaqueti is inadequate to differentiate several species. As a "rule of thumb" the more multiplicate forms of Howellella are also in the younger horizons of the Cobar Supergroup. In The Meadows district the H. jaqueti assemblage is separated from the Encrinurus-Molongia elegans capricornae assemblage by nondescript pauciplicate species of Howellella.
Fauna: trilobites

Craspedarges wilcanniae Gülich

?Sthenarocalymene sp.

brachiopods

Howellella jaqueti (Dun)

Howellella sp.

Ancillotoechia duni (Gürich)

Atrypa cf. reticularis nieczlawiensis Kozlowski

Iridistrophia sp.

Levenea sp.

Mesodouvillina convexa (Dun)

Protocortezorthis sp.

Salopina spp.

Sphaerirhynchia sp.

Reeftonia and Howellella jaqueti assemblage

This assemblage is restricted to the Yarra Yarra Creek and Trundle Groups and occurs only in the south-east of the area in Fig. 1. Both of these groups rest unconformably upon strata containing either an Encrinurus-Molongia elegans capricornae or "Podolella" assemblage. The presence of Reeftonia is a more reliable indicator of this assemblage and hence age than H. jaqueti. In both the Mineral Hill and Trundle districts this assemblage is overlain by limestones with early Emsian conodont faunas (Pickett, 1989) and the Spinella pittmani assemblage.

Fauna: brachiopods

Howellella jaqueti (Dun)
Reeftonia sp.

Salopina cf. hitchcocki Walmsley, Boucot & Harper

?Sphaerirhynchia sp.

Spinella pittmani assemblage

In siliceous sediments Spinella pittmani is associated with poorly preserved rhynchonellids but has no known brachiopod associates in limestone. This is the most accurately dated assemblage because of the early Emsian conodonts (dehiscens or perbonus zones) in the same beds (Pickett, 1989).

Fauna: brachiopods

Spinella pittmani (Dun)

?Sphaerirhynchia sp.

REFERENCES


