

Youngest Permian marine macrofossil fauna from the Bowen and Sydney Basins, eastern Australia

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The marine invertebrate macrofauna from the upper part of the Blenheim Subgroup of the Bowen Basin and the Kulnura Marine Tongue of the Sydney Basin is described. The fauna is assigned to 12 genera, one of which — *Pseudonucula* — is newly recognised, and to 13 species, of which one is new. On the basis of these descriptions and existing published information, three zones are recognised in the Blenheim subgroup, in ascending order, the *Martiniopsis magna*, the *Martiniopsis pelicanensis* and the *Martiniopsis havilensis* zones. An explanation is given of the conclusions of Waterhouse & Jell (1983) about the lower part of the subgroup. From the fauna, particularly the occurrence of *Martiniopsis havilensis*, it is concluded that a hiatus occurs in the Blenheim Subgroup between the Black Alley Shale and the Peawaddy

Formation in the southwestern part of the Bowen Basin, and that the Black Alley Shale is equivalent to the MacMillan Formation in the central part of the basin and the Exmoor Formation in the northeastern part. The upper part of the Blenheim Subgroup (zone of *Martiniopsis havilensis*) seems to be younger than the Mulbring Shale of the Sydney Basin, and the Kulnura Tongue is not likely to be significantly younger than the Blenheim Subgroup. The faunas described appear to be younger than Kungurian, but are not likely to be younger than the Kazanian. They are rather low in diversity relative to older Permian faunas in the two basins, and this probably reflects the rather restricted marine conditions at the end of the open sea in the two basins.

Introduction

Use of the term, and the extent and relationships of the Blenheim Subgroup, remain controversial. The problems have been discussed by Dickins (1983). This paper supports the conclusions in Dickins (1983) with description of the fauna from the upper part of Blenheim Subgroup, and further discussion on the group.

Fauna from the upper part of the Blenheim Subgroup and the Kulnura Tongue.

MacMillan Formation (UDC1 and UDC2) — Pelecypods: *Pseudonucula bradshawensis* nom. nov.; *Paleyoldia* sp.; *Glyptolea flexuosa* Waterhouse, 1965; *Atomodesma* sp.; *Vacunella curvata* (Morris), 1845. Gastropods: *Mourlonia* (*Mourlonia*) *strzeleckiana* (Morris), 1845; *Discotomaria?* sp. Brachiopods: *Martiniopsis havilensis* (Campbell), 1960. Conulariid indet.

Black Alley Shale — Gastropods: *Peruvipira* cf. *modesta* Waterhouse, 1963. Brachiopods: *Martiniopsis havilensis* (Campbell), 1960.

Upper part of the Blenheim Subgroup (Cherwell Range immediately below MacMillan Formation; Tay Glen Crossing): *Martiniopsis havilensis* (Campbell), 1960.

Upper Part Blenheim Subgroup (Blenheim area, MC 803) — Pelecypods: *Pseudonucula bradshawensis* nom. nov.; *Glyptolea flexuosa* Waterhouse, 1965. Gastropods: *Warthia perspecta* Fletcher 1959; *Mourlonia* (*Mourlonia*) *strzeleckiana* (Morris), 1845; *Peruvipira* cf. *modesta* Waterhouse, 1963. Brachiopods: *Terrakea solida* (Etheridge & Dun), 1909; *Echinalosia* cf. *minima* Dear, 1971; *Martiniopsis havilensis* (Campbell), 1960.

Upper part of Blenheim Subgroup — Brachiopods: (Parrot Creek, CB1572) *Martiniopsis havilensis* (Campbell), 1960. Exmoor Formation (MC292) *Martiniopsis havilensis* (Campbell), 1960. Exmoor Formation (MC292) — Brachiopods: *Martiniopsis havilensis* (Campbell), 1960.

Kulnura Marine Tongue — Brachiopods: *Echinalosia* cf. *minima* Dear, 1971; *Echinalosia* cf. *ovalis* (Maxwell), 1954.

Faunal subdivision of the Blenheim Subgroup

During the joint mapping project of the Bowen Basin by the Geological Survey of Queensland and the Bureau of

Mineral Resources, the top part of the Middle Bowen beds (= Back Creek Group) was found to contain a distinctive geological sequence, the Blenheim Subgroup, with a distinctive fauna, Fauna IV (Malone & others 1966, 1969; Mollan & others, 1969; Dickins & Malone, 1968, 1973; Dickins, 1983). At that time, because of the considerable range of many species within the subgroup, a subdivision of Fauna IV was not attempted (see Dickins, 1966, p. 71). The following discussion indicates that such a division still remains difficult.

Dear (1972) described four faunal assemblages within Fauna IV in the northern part of the Basin. The oldest fauna, which he called the Exmoor fauna, contained the diagnostic species *Wyndhamia blakei* Dear, *Ingelarella magna* Campbell, *Ingelarella isbelli* Campbell, *Terrakea elongata exmoorensis* Dear, *Notospirifer duodecimcostatus* (McCoy), and *Notospirifer minutus* Campbell (the taxonomic nomenclature is that of Dear).

The next youngest, called the Scottville fauna, was marked by the abundance of *Wyndhamia clarkei* (Etheridge Snr) and *Terrakea elongata* (Etheridge & Dun), but the ingelarellid species diagnostic of the Exmoor fauna were lacking. The next fauna, the Pelican Creek fauna, contained several species not found in the lower faunas, including *Streptorhynchus pelicanensis* Fletcher, *Ingelarella pelicanensis* Campbell, *Maorielasma globosum* Campbell, a new species of *Gilledia*, and *Gilledia pelicanensis* Campbell. The youngest Havilah fauna was distinguished by the presence of *Ingelarella havilensis* Campbell.

Runnegar & McClung (1975) proposed recognising two zones within the Blenheim Subgroup, the *isbelli* zone in the lower part and the *ovalis* zone in the upper part. The relation of these zones to Dear's scheme has yet to be investigated — the upward range of *I. isbelli* is not clear, nor is the incoming of *E. ovalis*, although I believe that *E. ovalis* can be identified from the base of the Blenheim Subgroup upwards in the sense used by Dickins & Malone (1973) and Dickins (1983).

Waterhouse & Jell (1983) have proposed a faunal subdivision of the Blenheim Subgroup (or Formation). I conclude that the *Notospirifer* (*Glendonina*) *duodecimcostatus*–*Merismop-teria macroptera*–*Etheripecten plicata* Faunal Assemblage is found in the Blenheim Subgroup and represents Fauna IV. This supports my previous conclusions and is not contrary, as claimed by Waterhouse & Jell. The assemblage contains *Martiniopsis magna*, *Megadesmus grandis*, *Myonia carinata*,

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Vacunella curvata, and other species, whose incoming is used to determine Fauna IV. As indicated by Waterhouse & Jell, the lithology is that of the Blenheim Subgroup. At Exmoor and Gebbie Creek, the lower boundary of the Blenheim Subgroup may be shown somewhat too far to the west by Malone & others (1966), and the boundary shown in measured sections may need some revision, which is not surprising, given the map scale and the preliminary state of work at that time. Clarification was given in later publications (Dickins & Malone, 1968, 1973). There is no basis for considering that this assemblage represents Fauna IIIC. Near Homevale, the base of beds with Fauna IV ('*Notospirifer* (*Glendonina*) *duodecimcostatus*-*Merismopteria macroptera*-*Etheripecten plicata* Faunal Assemblage') overlies beds of IIIC with '*Ingelarella*' *undulosa* (see Jensen & others, 1966; Malone & others, 1966).

I do not understand the statement by Waterhouse & Jell (1983, p. 236), 'The Exmoor area was considered to provide the best example of Fauna III of Dickins (1964) and three subdivisions were recognised by Dickins (in Malone & others 1966; Dickins & Malone, 1973)'. The Exmoor section was not one we considered in detail, and Fauna III and its subdivisions were worked out mainly in the Gebbie Creek and Homevale sections (Dickins & others, 1964; Malone & others, 1966).

No justification is given by Waterhouse & Jell (1983) for the use of Moonlight Sandstone at some considerable distance from the type area at Homevale. Apparently the Moonlight Sandstone as used by them (containing the '*Notospirifer* (*Glendonina*) *duodecimcostatus*-*Merismopteria macroptera*-*Etheripecten plicata* Faunal Assemblage') represents the top part of the Moonlight Sandstone at Homevale and, therefore, the basal part of the Blenheim Subgroup (see Dickins, 1983).

Waterhouse recognised three overlying faunas, the *Wyndhamia ingelarensis* Faunal Assemblage, the *Echinalosia ovalis* Faunal Assemblage and the *Wyndhamia clarkei* Faunal Assemblage. *Wyndhamia ingelarensis* Dear had not previously been recognised in the Blenheim Subgroup, and the figures given by Waterhouse (in Waterhouse & Jell, 1983, pl. 1, figs 7,8; pl. 6, fig. 1) are rather inadequate. I have not observed this species in the many hundreds of specimens I have examined, nor apparently has Dear (1971, 1972). The *Wyndhamia ingelarensis* Faunal Assemblage and the following *Echinalosia ovalis* Faunal Assemblage must be treated cautiously, because of the long range indicated by other workers. The *Wyndhamia clarkei* Faunal Assemblage corresponds in part to the Scottville fauna of Dear (1972), but apparently, Waterhouse & Jell (1983, p. 238) consider it extends into younger beds.

I agree with Waterhouse & Jell's conclusion that the Crocker Formation and the Catherine Sandstone cannot be correlated, nor can the Ingelara Shale and Maria Formation (Dickins, 1983).

Waterhouse & Jell (1983) add valuable detail for elaborating the palaeontological and stratigraphical sequence, and give further evidence on the distinctiveness of the Glendoo Fauna (Fauna IIIB) and its distinctiveness from Fauna IV. They substantiate the character of Fauna IV, although, unfortunately, they seem to confuse it with Fauna IIIC.

The base of Fauna IV is marked by the incoming of a considerable number of new forms. Amongst the significant brachiopods are the *Terrakea brachythaerus-elongata-solida*

group¹, the *Echinalosia ovalis* group¹, *Martiniopsis* (= *Ingelarella*) *isbelli*, *Martiniopsis* (= *Ingelarella*) *magna*, *Notospirifer minutus* and several spiriferid species whose names are not yet clear. Amongst the pelecypods, *Astartila cythera* group, *Megadesmus grandis*, *Myonia carinata*, *Vacunella curvata*, and a new species of *Schizodus* are particularly conspicuous. A more exhaustive list was given by Dickins & Malone (1973, table 13).

Martiniopsis magna appears to be confined to the basal part of the Blenheim Subgroup, the Exmoor fauna of Dear (1972), and the *Etheripecten plicata* and *Wyndhamia ingelarensis* Faunal Assemblages of Waterhouse & Jell (1983); *magna* seems more satisfactory as the nominate species for this zone than *isbelli*, which appears to range higher in the sequence. Unfortunately, neither is known from the southwest or southeast of the basin, but *magna* is known from the western part (Clermont area) as well as the eastern part. In the Clermont area it occurs at the unconformity of the Blenheim Subgroup on pre-Permian beds.

Martiniopsis pelicanensis is known from the middle part of the sequence, and in particular from the Pelican Creek fauna of Dear (1972). It is recorded from its type locality in the northern part of the basin (Campbell, 1960; Dear, 1972), apparently from the southeastern part of the basin in the upper part of the Barfield Formation and the lower part of the Flat Top Formation (Dear, 1972; Dickins, 1972), and from the central part of the basin from the Crocker Formation (Dickins, 1969a). The species therefore seems particularly useful for recognising the middle part of the Blenheim Subgroup and for correlating this part of the sequence. Elsewhere (Dickins, 1969b; 1972), I have considered evidence that the upper part of the Mantuan *Productus* bed, the pelecypod bed of the Clermont area, the lower part of the Crocker Formation, the *Streptorhynchus pelicanensis* bed containing *Martiniopsis pelicanensis* in the northern part of the basin, and the uppermost part of the Barfield Formation and the lower part of the Flat Top Formation are to be correlated.

Martiniopsis havilensis is widespread in the upper part of the Blenheim Subgroup, and its distribution is discussed in this paper and in Dickins (1983). The best faunas are found at localities UDC1 and UDC2 from the MacMillan Formation and from MC 803 in the Blenheim area. Most of the species seem to range through the Blenheim Subgroup, with the exception of *Martiniopsis havilensis*. The occurrence at this level of a *Peruvispira* related to *P. modesta* Waterhouse, 1963 is of interest, since the Stephens Formation, which contains the species, is apparently younger than the Blenheim Subgroup (see Dickins, 1983).

Age and correlation of the Blenheim Subgroup

The correlation and nature of the Blenheim Subgroup were considered by Dickins (1983) and are further considered here. Evidence is given in Dickins (1983) that the Blenheim Subgroup (or any part of it) does not overlap in time the underlying Gebbie Subgroup, and that the upper boundary is more or less coeval in the various parts of the Bowen Basin, which differs from the interpretation of Koppe (1978) and Staines & Koppe (1979). This discussion was apparently unknown to Martini & Johnson (1987). Although their conclusions agree with those in Dickins (1983), their Figure

¹The lack of standardisation in the names for these groups is unfortunate and confusing (Dear, 1971; Waterhouse, 1983; McClung, 1983). The differences between some of the species names used seems rather arbitrary and, in my opinion, a broader grouping would be more practical and useful.

10 shows the Gebbie Subgroup (or Formation) as coeval with part of the Blenheim Subgroup (and apparently all of the Tiverton Subgroup). This is not supported by any field or drilling evidence given by them (for other information see Malone & others, 1966).

Presumably, Martini & Johnson (1987, p. 368) use McClung (1981) in support of their idea, for they state 'McClung...considered the faunas to be facies related, so the time connotation may be invalid'. Dickins & Malone (1973) considered carefully the environmental effects on the ranges and distribution of the fossils, and McClung does not really dispute their data. He claims (1981, p. 28) that few collections 'have been accurately located within measured sections', but clearly this contradicts the published reports on the Bowen Basin (see Dickins & Malone, 1973). In earlier publications, e.g. David & Browne (1950), the entire Back Creek Group (Middle Bowen beds), including its upper part, the Blenheim Subgroup, was considered Lower Permian².

Campbell (1959) suggested that the upper beds of the Middle Bowen (later referred to as Back Creek Group) might be Upper Permian (Kazanian), and Dickins (1961, 1970) concluded that a Kazanian age seemed likely on the basis of the occurrence of *Atomodesma bisulcatum* Dickins, 1961 and species of '*Licharewia*'. Dickins also concluded that the fauna of the Blenheim Subgroup seemed to be intermediate between the faunas of the lower and upper marine parts of the Liveringa Group of the Canning Basin, Western Australia, i.e., between the faunas of the Lightjack and Hardman Formations. The intervening sequence is represented by non-marine beds or a hiatus. This evidence also suggested a Kazanian age.

Waterhouse (1976, p. 137) considered the Exmoor fauna of Dear (1972) to be Ufimian (lowermost Upper Permian), the next two faunas of Dear to be Kazanian, and the Havilah fauna possibly post-Kazanian. Use of Ufimian as the lowest stage of the Upper Permian has presented difficulties because of its poorly developed marine fauna. It has often been ignored or included with the underlying Kungurian or overlying Kazanian. In a recent review of mid-Permian correlation, Dickins, Archbold, Thomas & Campbell (in press) have concluded that a fauna younger than Kungurian and older than Kazanian can be recognised. They consider this fauna Ufimian. On this basis, the basal part of the Blenheim Subgroup is probably Ufimian, as suggested by Waterhouse (1976). Dickins (1983) recorded *Aulosteges* in the Wairaki Breccia of Southland, New Zealand, suggesting a correlation with the Hardman fauna and tending to confirm the intermediate character of Fauna IV (the fauna of the Blenheim Subgroup) between that of the Lightjack and Hardman Formations. Although the evidence for the age of the Blenheim Subgroup is indirect, it seems substantial.

The evidence from the present descriptions does not add a great deal, but the relations with New Zealand help to confirm existing conclusions. *Glyptoleda flexuosa* Waterhouse, 1965a, has been described previously from the Mangarewa Formation, and *Peruvispira modesta* Waterhouse, 1963, from the Stephens Formation. The Stephens Formation has a similar fauna to that of the Wairaki Breccia, and on this basis the fauna of the top of the Blenheim

Subgroup could be only slightly younger than the Kazanian, if at all.

The Hardman Formation has been regarded (Dickins, 1963; Dickins, Archbold & Thomas, in press) as equivalent to the Kalabagh Member of the Wargal Formation (Middle Productus) and the Chhidru Formation (Upper Productus) of the Salt Range, Pakistan. The correlation of the Kalabagh Member and the Chhidru Formation is not altogether clear. Grant (1970) argued strongly that not only are these units pre-Dzhulfian, but that they are Wordian, the lower part of the Guadalupian. If this is correct they can hardly be younger than Kazanian, and it would follow that the upper part of the Blenheim Subgroup is not likely to be younger than Kazanian.

Age and correlation of the Mulbring Formation and the Kulnura Marine Tongue.

Dickins (1970) correlated the Mulbring Formation in a general way with the Blenheim Subgroup (i.e. 'the upper part of the Middle Bowen Beds'), as both contained Fauna IV.

On the basis of the description of the fauna from the upper part of the Blenheim Subgroup (*havlensis* zone), the Mulbring Formation is probably older than the upper part of the Blenheim Subgroup. Most of the species in the *havlensis* zone range through the Blenheim Subgroup and are also found in the Mulbring Formation. *Martiniopsis havlensis*, however, has not been found in the Mulbring Formation, nor has *Peruvispira modesta*, which in New Zealand is apparently found in beds higher in the sequence.

The Kulnura Marine Tongue contains *Echinalosia* cf. *minima* and *Echinalosia* cf. *ovalis*, which are characteristic of Fauna IV and, therefore, the Kulnura Marine Tongue seems unlikely to be significantly younger than the Blenheim Subgroup.

On the basis of palynological examination, McMinn (1985) regarded the top of the Blenheim Subgroup (Black Alley Shale) as younger than the Mulbring Formation. However, he also regarded the top of the Aldebaran Sandstone and the rest of the overlying Gebbie and Blenheim Subgroups as younger than the Mulbring Formation in contradiction to the marine fauna (Dickins, 1970). The correlation of the marine fauna is based on a large number of species and has taken into account differences in ranges apparently caused by water temperature differences (Dickins, 1981). In these circumstances *Dulhuntyispora parvithola*, on which McMinn bases his correlation, apparently appears earlier in the Bowen than the Sydney Basin. This could be an accident of preservation or sampling but a more likely cause is climatic difference. This apparently also affects McMinn's usage of Middle Permian, which, accordingly, would differ in the two basins. He does not, however, define his usage of Middle Permian, and since there are already so many different usages of Middle Permian in different parts of the world, this appears to introduce, accidentally, another one. Use of Middle Permian seems best avoided, at least until its definition has been considered formally by the Subcommittee of Permian Stratigraphy of the International Union of Geological Sciences.

Palaeoecology

The lithology of the samples varies from sandstone to siltstone and at UDC1 and MC803 the fossils occur in nodules. In

²A twofold subdivision of the Permian is used here, corresponding to the usage in the classical area of the Russian Platform-Ural Mountains area. Although some authors use a threefold subdivision, there is no international agreement on the scope of a threefold subdivision, and the different usages at present limit the value of the term.

the sandstone, *Martiniopsis havilensis* occurs in considerable numbers, whereas other fossils are rare. In the nodules a number of species are represented, but even here, the fauna is of low diversity compared with the fauna found at a lower level in the *pelicanensis* and *magna* zones.

The fauna from the nodules is apparently from relatively shallow water below wave base, as the productids would have rested in the substratum anchored only by their spines. *Martiniopsis havilensis* could also have lain in a shallow sublittoral position (Campbell, 1961).

The normal shallow sublittoral fauna, characterised by such forms as *Megadesmus*, *Astartila*, *Stutchburia*, and *Schizodus* (Dickins, 1963), appears to be absent. The low diversity suggests conditions of limited access to the open sea, and may reflect fluctuations in the composition of the water.

Systematic palaeontology

Pelecypods

Superfamily **Nuculacea** Gray 1824
Family **Praenuculidae** McAlister 1969
Genus ***Pseudonucula*** nov. nom.³

Type species. *Pseudonucula bradshawensis* nov. nom. herein.

Diagnosis. Similar in shape to *Nuculopsis*, but apparently lacking a resilifer.

Discussion. The specimen taken as the holotype is the external of a left valve and the dentition is beautifully preserved. Not even a reduced resilifer seems to be present. The teeth seem to be slightly larger on the more compressed side of the shell and, according to the criteria of Bradshaw & Bradshaw (1971), the shell has the normal nuculid orientation, i.e., long side towards the front.



Figure 1. *Pseudonucula bradshawensis* gen. et. sp. nom. nov. External view of holotype, a left valve to show dentition, x5.5 approx.

³Nov. nom. is preferred here to gen. nov. and sp. nov. to indicate that, although a taxon is newly recognised, the possibility of its previous existence is not being denied.

Pseudonucula bradshawensis nov. nom.

Pl. 1, figs 1–7

Description. The holotype is an external impression, taken to be a right valve. The dentition and musculature are well shown. The anterior adductor is oval in a dorso-ventral direction. The mark of the posterior adductor is more rounded. The teeth are continuous around the dorsal margin of the shell. The ligament is apparently external, but was not found. Similar characters are shown in the other illustrated specimens. Poorly differentiated pedal scars are associated with the anterior and posterior adductor scars. Externally, the shell is smooth with concentric growth ornament.

Dimensions (mm).

	Length	Height	Width
Holotype (right valve)	12	10	5
Paratype A (bivalved specimen)	13	10.5	10
Paratype B (bivalved specimen)	17	12	11
Paratype C (bivalved specimen)	14	12	10

Occurrence. Holotype, CPC25255, and Paratypes A & B CPC25256, 25257, MC803, Paratype C, CPC25258, UDC1.

Superfamily **Nuculanacea** Adams & Adams 1858

Family **Nuculanidae** Adams & Adams 1858

Genus ***Paleyoldia*** Lintz, 1958 (p. 108)

Type Species (by original designation). *Yoldia glabra* Beede & Rogers (1899, p. 133, pl. 34, figs 4a–b).

Discussion. Although represented by a single incomplete specimen, the evenly rounded anterior part of the shell and the shape behind the umbo indicate the shell is not *Phestia* or a closely related genus, but is related to *Yoldia*. The nature of the distinctive ornament of the anterior part of the shell is not known.

Paleyoldia sp.

Pl. 1., figs 16–18

Description. The details of the external ornament are shown in Plate 1, fig. 16. The gross ornament is concentric. Superimposed on this is a fine irregular ornament, which is approximately concentric. At the front, a number of radiating lines are formed by elongated pustules.

Dimensions (mm).

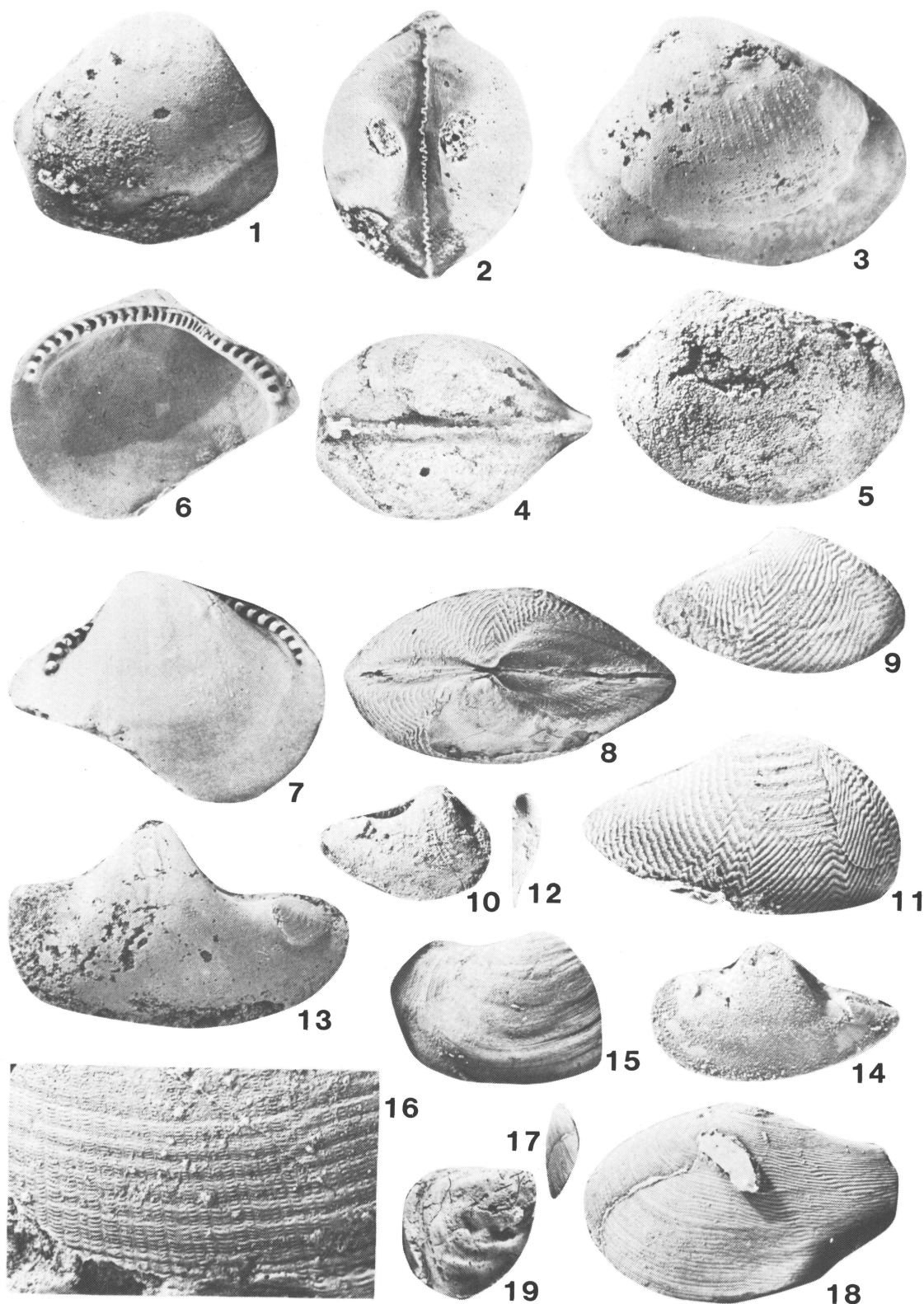
Length	Height	Thickness
—	19	4

Occurrence. CPC25259, UDC1.

Genus ***Glyptoleda*** Fletcher 1945

Type species. *Glyptoleda reidi* Fletcher 1945, p. 299; pl. 19, figs 1–5, by original designation of Fletcher 1945, p. 208.

Discussion. This nuculanid is strikingly distinguished by its V-shaped external ornament. In this respect it can be separated from *Nucundata* Waterhouse (1965a, p. 641), which departs relatively slightly from the concentric ribbing pattern of *Nuculana*. According to Puri (1969, p. N239), the nuculanid *Veteranella* Patte (1926, p. 158) from the Permian–Triassic of Indo-China has a V-shaped ornament, but is oval in outline. Patte's paper is not available to me but, from



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Plate 1.

Pseudonucula bradshawensis gen. et sp. nom. nov. 1-2, CPC25256, paratype A, side and dorsal views of left valve, MC803, x4. 3, CPC25257, paratype B, side view of right valve, MC803, x4. 4-5, CPC25258, paratype C, side and dorsal views of right valve, UDC1, x4. 6-7, CPC25255, holotype, side view of right valve, latex cast of internal and external impressions, MC803, x4. *Glyptoleda flexuosa* Waterhouse, 1965. 8, CPC25264, figured specimen E, latex dorsal view, UDC1, x2. 9, CPC25263, figured specimen D, latex side view, UDC1, x2. 10, CPC25261, figured specimen B, side view, MC803, x1. 11, CPC25260, figured specimen A, side view, MC803, x2. 12-13, CPC25262, figured specimen C, front view x1, side view MC803. 14, CPC25265, figured specimen F, side view, UDC1, x2. *Vacunella curvata* (Morris), 1845. 15, CPC25268, side view, UDC1, x2. *Paleyoldia* sp. 16-18, CPC25259, anterior ornament x16, front view x1 and side view x2, UDC1. *Atomodesma* sp. 19, CPC25267, side view, UDC1, x1.

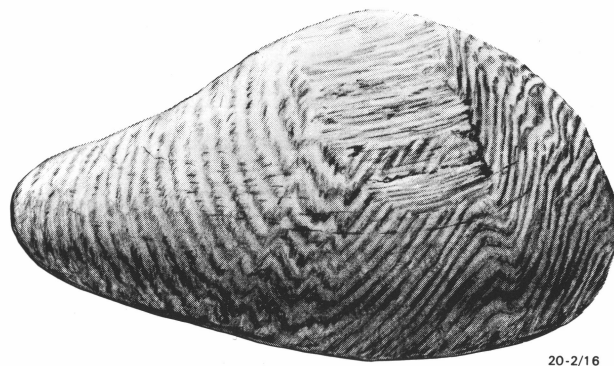


Figure 2. *Glyptoleda flexuosa* Waterhouse, 1965, CPC25260, to show external ornament of a right valve, x5.5 approx.

Puri's description, *Veteranella* seems to differ in shape from *Glyptoleda*.

In 1945 *Glyptoleda* was recorded from the Permian of eastern and western Australia, and in 1965 from the Permian of New Zealand. Now it has been recorded from the Permian of Nova Zemlya (Muromtseva, 1981; 1984). This distribution pattern in beds of broadly similar age within the Permian is thought provoking.

***Glyptoleda flexuosa* Waterhouse**

(1965a, p. 658, pl. 98, figs 6–12)
Pl. 1 figs 8–14

Type specimens. From the Mangarewa Formation, Productus Creek area, Otago, South Island, New Zealand.

Diagnosis (of Queensland specimens). Distinctly tumid in front of the umbo, relatively short at the rear. Shell thickened in the umbonal region, so that the anterior and posterior muscle impressions are distinct; v-shaped ornament complicated.

Description. Figured specimens A, D, and F show the shape and the ornament. There are V-shaped indentations not only in the middle part of the shell as in other species, but also in the anterior and posterior parts of the shell.

Figured specimen E shows the lunule and escutcheon. An inner and outer escutcheon ridge and a posterior umbonal ridge are visible as recognised by Waterhouse (1965a, text-fig. 2).

The internal features are shown by Figured specimens B, C and F. Anterior and posterior pedal scars are visible. The anterior is joined by a ridge to the anterior adductor and the posterior appears to be attached to the top front of the adductor. A large umbonal muscle is associated with an internal ridge running down from the umbo. At least one small umbonal muscle is found at the back tip of the external impression of the umbo.

Dimensions (mm).

	Length	Height	Width
Figured specimen A	30	19 (approx.)	5
Figured specimen B	33 (approx.)	21	6
Figured specimen C	35 (approx.)	24 (approx.)	8
Figured specimen D	23	14	8 (approx.)
Figured specimen E	38	—	16
Figured specimen F	24	14	9
CPC 25266	28	18 (approx.)	(bivalve) 4 (approx.)

Occurrence. Figured specimens A–C, CPC25260–25262, MC803; figured specimens D–F, CPC25263–25265, UDC1, measured specimens, CPC25266, UDC1.

Discussion. The species from the Bowen Basin bears some resemblance to the three species *G. intricata*, *G. flexuosa* and *G. simplicata*, described by Waterhouse (1965a) from the Mangarewa Formation of New Zealand. In the shape and nature of the ornament the Queensland specimens seem closest to *G. flexuosa*. The Queensland and New Zealand specimens are close in age (discussed elsewhere) and younger than other described species of *Glyptoleda* from Western Australia and Queensland, which have less complicated ornament.

Superfamily ?

Family Inoceramidae? Giebel 1852

Subfamily Atomodesminae Waterhouse 1976

Genus Atomodesma Beyrich 1864 (p. 68)

Type species. *Atomodesma exarata* Beyrich 1864, p. 71, pl. 3, figs 4a–b by subsequent designation of Wanner 1922, p. 63.

Discussion. *Atomodesma* and related genera, including their type species, were discussed by Dickins (1963, p. 66). Recently, considerable interest has been caused in the family relationship of *Atomodesma* by the discovery of multiple ligament grooves in what otherwise appear to be ordinary *Atomodesma* (Browne & Newell, 1966). *Atomodesma* can be fairly readily incorporated in the Myalinidae of the superfamily Ambonychiacea, although it seems to be the direct ancestor of the Inoceramidae, and can as readily be included in this family.

Contrary to the then current usage, Waterhouse (1979) proposed restricting the *Atomodesma* to species with one or more radial plicae or grooves⁴, and excluding species that otherwise do not seem to differ significantly. The latter species would then be assigned to a number of genera on doubtful grounds. This proposal is likely to cause only confusion.

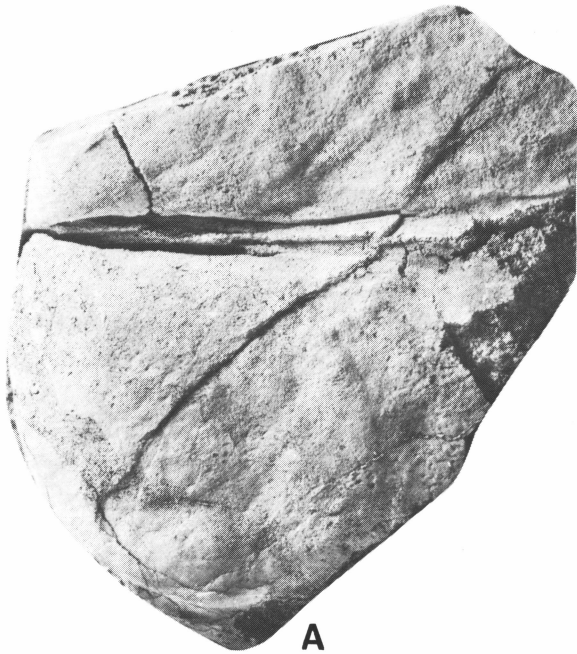
Waterhouse (1979), also proposed two new generic names for New Zealand shells, *Mytilidesmatella* (p. 13) and *Trabeculala* (p. 15). On the basis of the information and figures provided, there seems little basis for separating the type species of these genera from *Atomodesma trechmanni* Marwick 1935, the type Marwick 1935, the type species of *Maitaia* Marwick 1935. I figure here (Fig. 3) a specimen of *A. woodi* Waterhouse 1963, the type species of *Mytilidesmatella*, which is *A. trechmanni* in my opinion. The alleged differences, e.g. in the development of the septum, are not apparent in the figured material.

***Atomodesma* sp.**

Pl. 1, fig. 19

Discussion. The single right valve might be placed either in *Atomodesma* or *Aphanaia* if the latter is regarded as generically separable.

⁴Waterhouse (1979, p. 2) proposed a new name for a specimen which I would refer to *A. exarata* Beyrich 1864 (Dickins, 1963, fig. 5). The specimen was said by Waterhouse and Kauffman & Runnegar (1975) to be from the Noonkanbah Formation. The identification of the formation is apparently a mistake, because this species is known from many localities in the Lightjack Formation of the Liversing Group, but is unknown from the Noonkanbah Formation, as indicated by Dickins (1956, p. 25; 1963, fig. 5).



20/A/114

Figure 3. *Atomodesma trechmanni* (Marwick) 1935, New Zealand Geological Survey No. TM 6846. A, bivalved specimen x1; B, umbonal part of right valve removed to show septum x2.

Dimensions (mm).

Length	Height	Width
24	28	8

Occurrence. CPC 25267 UDC 1.

Superfamily **Pholadomyacea** King 1844

Family **Megadesmidae** Vokes 1967

Subfamily **Vacunellinae** Astafieva-Urbaitis 1973

Genus **Vacunella** Waterhouse 1965

Vacunella curvata (Morris) 1845
Pl. 1, fig. 15

Type species. *Allorisma curvatum* Morris 1845, p. 270, pl. 10, fig. 1, by original designation of Waterhouse 1965b, p. 377.

Description. A single small right valve shows the characteristic shape of this species — the posterior dorsal margin is upturned towards the back; and the umbo, towards the front. From above, the shell is wider towards the front and

evenly curved towards the back; it lacks a distinct umbonal sinus.

Dimensions (mm).

Height	Width
12	3

Occurrence. CPC25268, UDC1.

Discussion. This distinctive species occurs in Queensland, New South Wales, and Tasmania, where it is characteristic of Fauna IV as defined in the Bowen Basin, Queensland.

Gastropods

Superfamily **Pleurotomariacea** Swainson 1940

Family **Pleurotomariidae** Swainson 1940

Genus *Mourlonia* de Koninck 1883 (p. 10)

Type species (by original designation). *Helix carinatus* J. Sowerby (1812, P. 34).

Synonym. *Mourlonopsis* Fletcher 1958.

Discussion. Fletcher (1958, p. 129) proposed the name *Mourlonopsis* (type *Pleurotomaria strzeleckiana* Morris 1845) for *Mourlonia*-like shells with 'a more erect spire'. The height of the spire seems, however, to be a rather variable feature and the higher spire does not seem sufficient for the use of a separate generic name. The relationship between *Neoplatyteichum* Maxwell 1964 (p. 20) proposed for Upper Carboniferous shells from Queensland and *Mourlonia* is not clear. *Neoplatyteichum* does not appear to differ much from *Mourlonia*.

Mourlonia (*Mourlonia*) *strzeleckiana* (Morris 1845, p. 287, pl. XVIII, fig. 5)
Pl. 2., figs 12–19

For synonymy see Fletcher (1958)

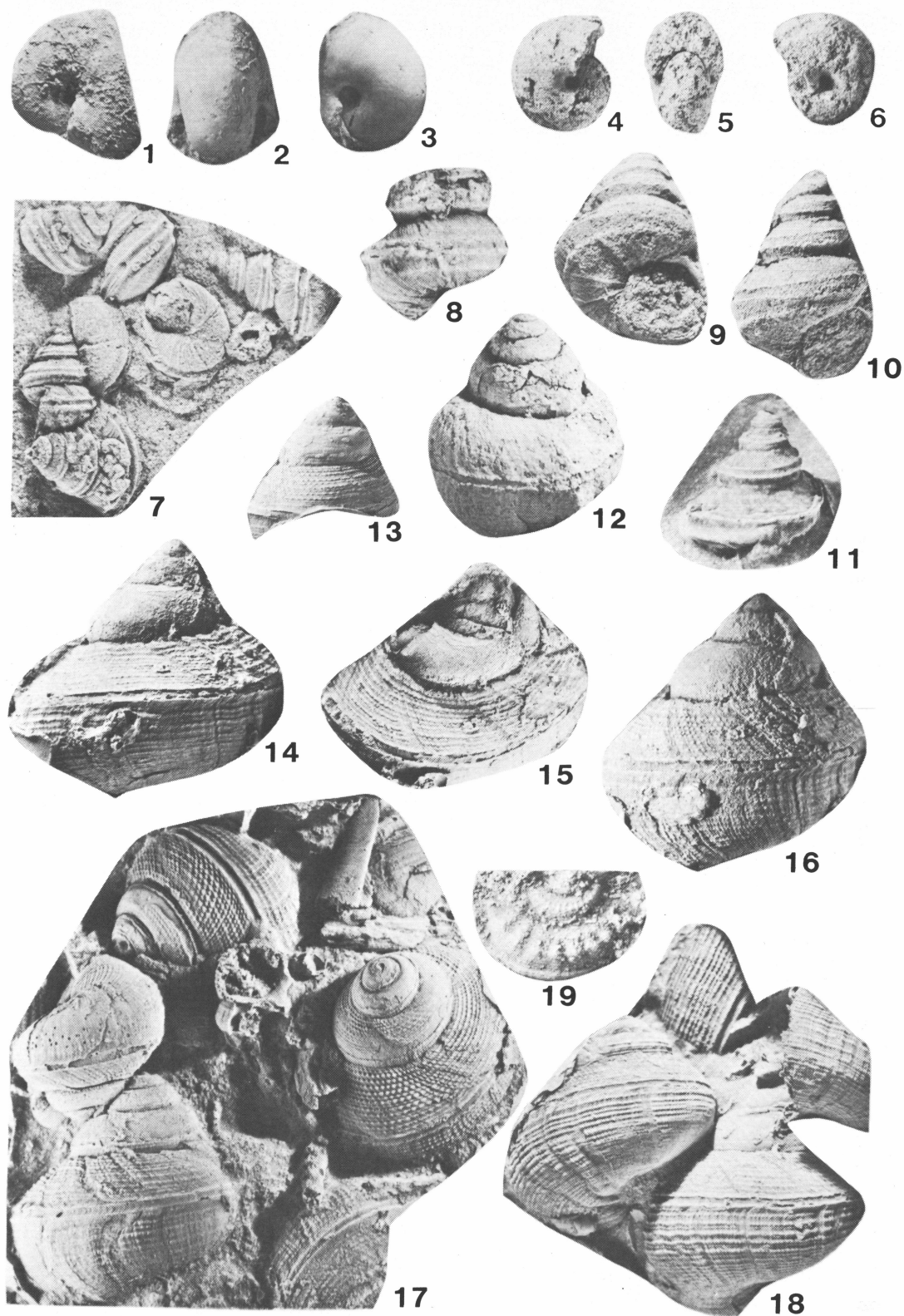
Description. The material includes numerous impressions that show the external ornament beautifully. The conical spire is of moderate height. The sutures are moderately well marked, although the whorls are more or less rounded and not particularly step-shaped. The ornament is made up of numerous fine spiral lirae and growth lines forming pustules where they cross. The selenizone is well marked by a carina on either side, and ornamented only by numerous lunulae. No umbilicus is present. Poor development of the spiral lunae on the smaller whorls of some specimens may be due to abrasion or exfoliation.

Dimensions (mm). UDC1

Height	Width	Apical angle
18	22	69°
16 (approx)	20	71°
22	22	68°
24	22	76°
22	24	74°
25	35	75°
28 (approx.)	32	62°

Occurrence. Figured specimens A–E, CPC25269–25273, UDC1, MC803.

Discussion. The rounded nature of the whorl cross-section above and below the selenizone indicates this form is not a *Platyteichum*. The specimens described by Fletcher (1958)



20/A/110

Plate 2.

Warthia perspecta Fletcher, 1958. 1-3, CPC25277, figured specimen A, side and vertical views, MC803, x1. 4-6, CPC25278, figured specimen B, side and vertical views, MC803, x1. *Peruvispira* cf. *modesta* Waterhouse, 1963. 7, CPC25287, Black Alley Shale, x4. 8, CPC25274, MC803, x2. 9-10, CPC25275, MC803, tilted and normal apertural view, x3. *Peruvispira imbricata* Waterhouse, 1963. 11, Latex of New Zealand Geological Survey No. GS 12641 from Tramway Sandstone, x4. *Mourlonia* (*Mourlonia*) *strzeleckiana* (Morris), 1845. 12, New Zealand Geological Survey TM3877, macrofossil locality GS9477, in loose boulder along road to French Pass, 0.5 miles southwest of roadman's hut and 4.5 miles north of saddle at trig. LXIXA above Croisilles Harbour, latex, x2. 13, CPC25269, figured specimen A, latex, UDC1, x1. 14-15, CPC25270, figured specimen B, latex side and tilted top view, UDC1, x2. 16, CPC25271, figured specimen C, latex side view, UDC1, x2. 17, CPC25272, figured specimen D, latex, UDC1, x2. 18, CPC25273, figured specimen E, latex, UDC1, x2. *Discotomaria?* sp. 19, CPC25279, latex, UDC1, x4.

are internal impressions as, apparently, was the original specimen described by Morris (1845). The internal of the Bowen species, however, seems similar in shape, and Fletcher indicated that the small portions of shell preserved had spiral ribbing above and below the selenizone. The apical angles of Fletcher's shells are similar, but perhaps the spire was slightly higher in the New South Wales specimens, as the Queensland shells seem slightly wider than high, although they vary considerably. The specimens differ considerably from *?Neoplatyteichum numerosum* (Waterhouse, in Waterhouse & Jell, 1983, p. 253, pl. 6, figs 19–21), apparently from the lower part of the Blenheim Group (see earlier discussion on this). *?N. numerosum* apparently has different dimensions and spiral lirae on the selenizone. In Waterhouse's plate caption, the species is said to be from the Glendoo Sandstone, but, from the locality given in the text and Table 7, and by implication from Table 6, this is apparently incorrect. Fletcher recorded *M. (M.) strzeleckiana* from Gerringong, Rylstone, and Glendon, where it is associated with Fauna IV.

Note on *?Mourlonia impressa* Waterhouse 1966

The identification and relation of the species from the Croisilles Volcanics, Eastern Nelson, South Island, New Zealand, are of particular interest because they afford evidence on the age of these volcanics. Waterhouse compared *?M. impressa* to a species from the Callytharra Formation of the Carnarvon Basin, Western Australia, and concluded the Croisilles Volcanics were Lower Permian. He also compared it to much younger specimens from the Clermont area of the Bowen Basin.

A latex cast of Waterhouse's holotype (1966, p. 178, pl. 1, figs 1–3), is figured here (Pl. 2, fig. 11). *?Mourlonia impressa* appears to resemble *M. (M.) strzeleckiana*, with which it may be conspecific, more closely than *M. (M.)* sp. nov. Dickins (1963, pl. 23, figs 18–21). In *M. (M.)* sp. nov., the width of the whorls is considerably less and the selenizone is relatively wider. The whorls also expand in size at a faster rate. The ornament of *?M. impressa* is poorly preserved, but it appears to be similar to that of *M. (M.) strzeleckiana*. I have little doubt of the close relationship of *?M. impressa* with the specimens of *M. (M.) strzeleckiana* described here, and possibly also with the specimen mentioned by Waterhouse from Clermont. On this basis, the Croisilles Volcanics appear to be no older than Late Permian (see also Dickins & others, 1986).

Genus *Peruvispira* Chronic 1949 (p. 146)

Type species (by original designation). *Peruvispira delicata* Chronic (1949, p. 147) in Newell & others (1953, p. 139, pl. 28, figs 9–12).

Synonym. *Pleurocinctosa* Fletcher 1958 (p. 137)

Discussion. The reasons given by Waterhouse (in Waterhouse & Jell, 1983) for the resurrection of the generic name *Pleurocinctosa* are puzzling. *Pleurotomaria trifilata* Dana (1847), the type species of *Pleurocinctosa*, is said to differ from *Peruvispira delicata*, the type species of *Peruvispira*, by having a convex upper whorl cross-section, but Chronic's photographs of *P. delicata* show a convex whorl cross-section. Even if the whorl cross-section did differ as stated, this would not necessarily be a basis for generic differentiation. Waterhouse stated that *P. trifilata* also differs in having (apparently) a carina on the upper whorl. Such a carina is not described by Fletcher, and I have not seen it in

specimens I have examined. This carina is not apparent in Waterhouse's figured specimen (in Waterhouse & Jell, 1983, Pl. 6, fig. 18), which is barely recognisable. On the basis of the evidence considered, there seems no justification for the use of the name *Pleurocinctosa*.

Peruvispira cf. *modesta* Waterhouse 1963 (p. 608, figs 26, 28–30, and table 6) Pl. 2, figs 7–10

Description. The upper whorl cross-section is slightly convex, and there is a moderate angle at the periphery where the selenizone (or slit-band) is situated. The angle in the cross-section is thus more acute than some described species and more rounded than others. Some variation occurs in the upper whorl cross-section, paralleling the specimens figured by Waterhouse from New Zealand. The selenizone is well marked by a carina on either side and, underneath, has a distinct concave area bounded below by a third carina. The parallel growth ornament varies from faint to distinct.

Dimensions (mm).

	Height	Width	Pleural angle
MC 803	12	10	54°
Black Alley Shale	4	3	50°
Black Alley Shale	5	6	48°

Occurrence. CPC25274–25275, MC803, CPC25276, Black Alley Shale.

Discussion. Except perhaps for the pleural angle, the specimens from the Bowen Basin are close to *P. modesta* from the Stephens Formation, near Nelson, north South Island, New Zealand. The difference in pleural angle is small. Waterhouse (1963) records two specimens with an angle of 53° and another with 45°. The variation in parallel ornament may be due to preservation.

Peruvispira imbricata Waterhouse 1963 (p. 513, figs 1, 16–23, 39, and table 3) Pl. 2, fig. 11

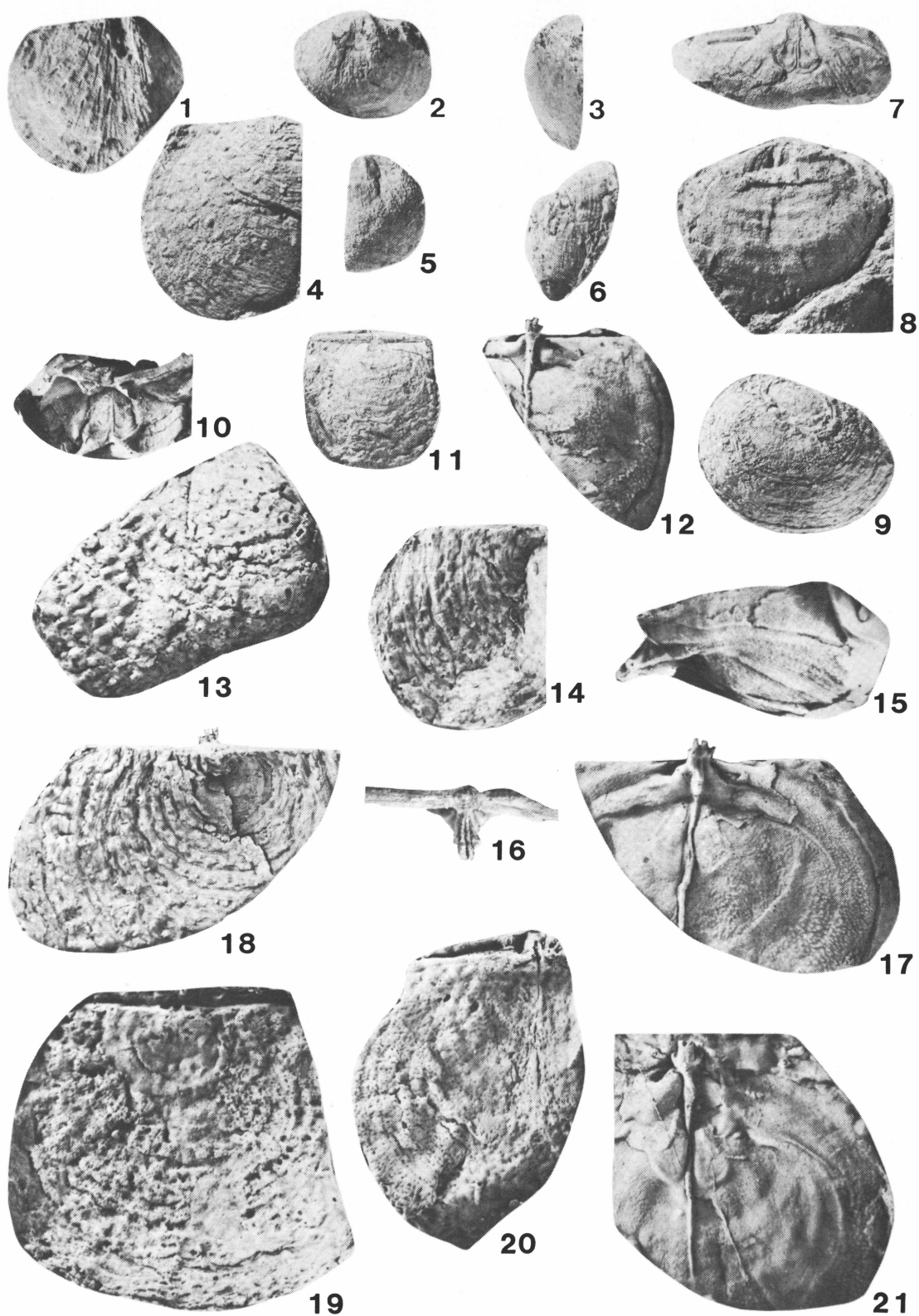
Description. Whorl cross-section very angular with the upper whorl surface concave. The selenizone is well marked and at an angle to the columella. The growth ornament is distinct.

Dimensions (mm).

Height	Width	Pleural angle
11 (approx)	9	40°

Occurrence. Latex cast made from GS 12641; loose slab at first ford across United Creek on track to smelter from Roding River; Tramway Sandstone.

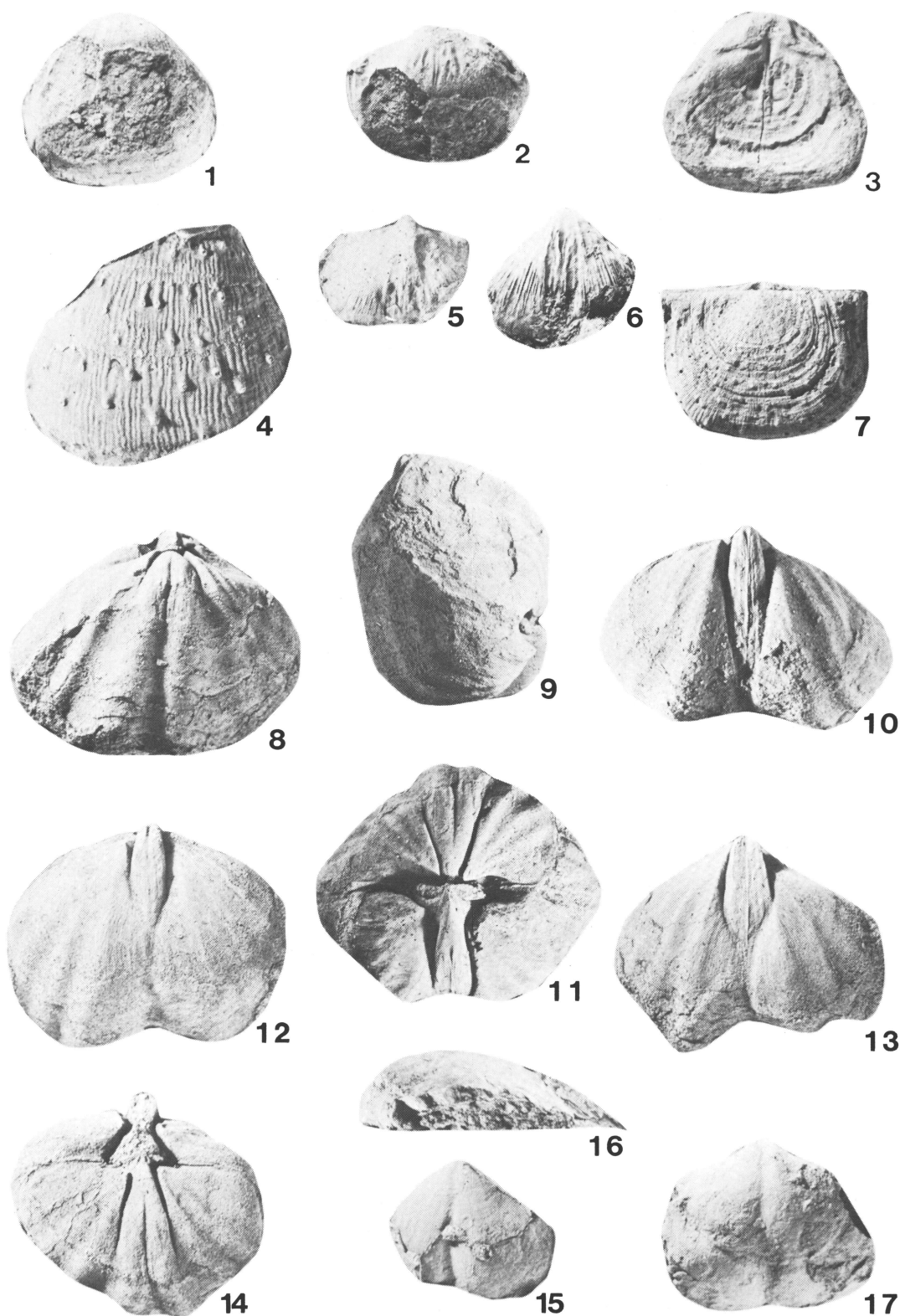
Discussion. The specimen can be referred with little doubt to *P. imbricata*, which so far has been described from the Letham and Mangarewa Formations. The occurrence of the species in the Tramway Sandstone is, therefore, of considerable interest in correlation between the northern and southern parts of South Island, New Zealand. Specimens belonging to, or closely related to, *P. imbricata* also occur in the Peawaddy Formation of the Bowen Basin. Thus, in both New Zealand and the Bowen Basin there is a parallel occurrence of specimens related to *P. imbricata*, lower in the sequence (in the Letham, Mangarewa and Tramway Formations) and in the lower part of the Blenheim Subgroup, i.e. the lower part of the sequence with Fauna IV and the occurrence of *P. modesta* forms higher in the Blenheim Subgroup and higher in the sequence in New Zealand (Stephens Formation).



20/A/111

Plate 3.

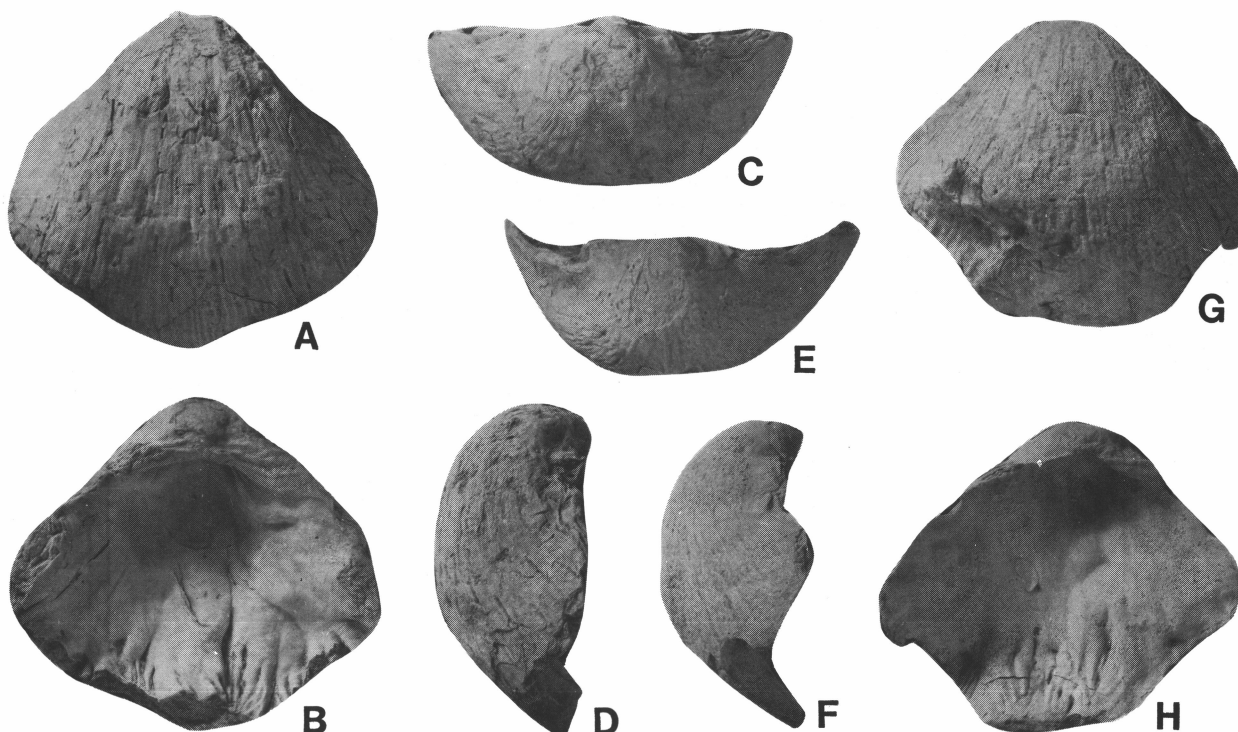
Echinalosia cf. minima Dear, 1971. 1, CPC25285, figured specimen A, pedicle valve, MC803, x2. 2-3, CPC25286, figured specimen B, internal of pedicle valve, ventral and side views, MC803, x1. 4, CPC25287, figured specimen C, latex of pedicle valve, MC803, x2. 5, CPC25288, figured specimen D, pedicle valve, MC803, x1. 6, CPC25289, figured specimen E, pedicle valve, MC803, x1. 10, Figured specimen F, latex of pedicle valve, muscle platform, NSW Geological Survey Bore DDH3, x2. 11, CPC25290, figured specimen G, internal impression of brachial valve, MC803, x1. 12, Figured specimen H, latex of inside of brachial valve, NSW Geological Survey Bore DDH3, x2. 13, Figured specimen I, latex of pedicle valve, NSW Geological Survey Bore DDH3, x2. 14, Figured specimen J, latex of outside of brachial valve, NSW Geological Survey Bore DDH3, x2. 15-18, Figured specimen K, latex of brachial valve, side, posterior, inside and outside views, NSW Geological Survey Bore DDH3, x2. 19, Figured specimen L, latex of outside of brachial valve, NSW Bore DDH3, x2. 20, Figured specimen M, latex of outside of brachial valve, NSW Geological Survey Bore DDH3, x2. 21, Figured specimen N, latex of inside of brachial valve, NSW Geological Survey Bore DDH3, x2. *Echinalosia cf. ovalis* (Maxwell), 1954. 7, Figured specimen B, internal of pedicle valve, NSW Geological Survey F15009, Bore DM Camden 75, x1. 8, Figured specimen C, internal of pedicle valve, NSW Geological Survey F15010, Bore DM Camden 75, x1. 9, Figured specimen A, internal of brachial valve, NSW Geological Survey F15006, Bore DM Camden 75, x1.



20/A/112

Plate 4.

Terrakea solida (Etheridge Jnr & Dun), 1909. 1-3, CPC25280, figured specimen A, pedicle valve, pedicle valve tilted and brachial valve, MC803, x1. 4, CPC25281, figured specimen B, ornament of pedicle valve, MC803, x2. 5, CPC25282, figured specimen C, internal of pedicle valve, MC803, x1. 6, CPC25284, figured specimen E, internal of pedicle valve, MC803, x1. 7, CPC25283, figured specimen D, internal impression of brachial valve, MC803, x1. *Martiniopsis havilensis* (Campbell), 1968. 8-11, CPC25291, figured specimen A, dorsal side, ventral and posterior views, Tay Glen Crossing, x1. 12, CPC25292, figured specimen C, pedicle valve, Tay Glen Crossing, x1. 13, CPC25293, figured specimen C, pedicle valve, Tay Glen Crossing, x1. 14, CPC25294, figured specimen D, brachial valve, Tay Glen Crossing x1. 15, CPC25295, figured specimen E, Black Alley Shale type section, pedicle valve, x1. 16-17, CPC25296, figured specimen F, pedicle valve, side and tilted ventral view of pedicle valve, UDC2, x1.



20/A/115

Figure 4. *Terrakea solida* (Etheridge Jnr & Dun) 1909. A-D, Lectotype, Australian Museum No. F.35782, dorsal, ventral, posterior and side views x2; E-H, Australian Museum No. F.35478, posterior, side, dorsal and ventral views x2. Both specimens from Darr (?Don) River.

Superfamily **Bellerophontacea** McCoy 1851

Discussion. The present material throws no light on whether the bellerophontids (in the broad sense) are gastropods or monoplacophorans (see Yochelson, 1967). However, their structure leads me to include them in this paper in the gastropods.

Family **Sinuitidae** Dall 1913

Genus *Warthia* Waagen 1880 (p. 13)

Type species (by subsequent designation of de Koninck, 1882, p. 81): *Warthia brevisinuata* Waagen (1880, p. 161, pl. 15, figs 6a-g).

Warthia perspecta Fletcher 1958

p. 149, pl. 15, figs 3-10)

Pl. 2, figs 1-6

Type. Specimen figured by Dana (1849, pl. X, figs 6, 6a); plaster replica figured by Fletcher (1958, pl. 15, figs 9, 10) from Gerringong Volcanics of the Illawarra District, South Coast, Sydney Basin, New South Wales.

Description. The material is made up mainly of internal impressions, in which the umbilicus is rather narrow. The outer whorl surface is evenly rounded. The shell is moderately wide, and increase in size is gradual.

Dimensions (mm).

	Lengthwise diameter	Cross diameter	Width of aperture	Height of aperture	Axial width
Figured specimen A	28	26	22	—	19
Figured specimen B	23	20	15	8	16

Occurrence. CPC25277 and CPC25278, MC803

Discussion. Species differentiation of *Warthia* is mainly based on the dimensions, a characteristic rather limited in scope. There seems no basis for separating our specimens from *W. perspecta*, which occurs in rocks of similar age in New South Wales.

Family **Phymatopleuridae** Batten 1956

Genus *Discotomaria* Batten 1956

Type species (by original designation). *Discotomaria basisulcata* Batten (1956, p. 43).

Discotomaria? sp.

Pl. 2, fig. 19

Description. A single rather incomplete specimen shows a low spine with a distinct keel. The upper whorl surface has a distinct carina which has prominent nodes associated with it. Faint spiral ornament can be seen.

Discussion. Unfortunately, this interesting shell is too incomplete to be sure of its affinities. Probably a selenizone is associated with the peripheral keel.

Brachiopods

Superfamily **Productacea** Gray 1840

Family **Linoproductidae** Stehli 1954

Genus *Terrakea* Booker 1930 (p. 66)

Type species (by original designation). *Productus brachythaerus* Morris 1845 (p. 284, pl. 14, fig. 40).

Terrakea solida (Etheridge Jnr & Dun) 1909
(pp. 303–304, pl. 43, figs 1–4).
Pl. 4, figs 1–7

Lectotype F35478 Australian Museum, Sydney, the specimen figured by Etheridge Jnr & Dunn (1909, pl. 43, figs 1 & 2) designated by Dear (1971, p. 20). The lectotype designated by Dear is figured here (Australian Museum No. F.35782) with an accompanying specimen from the same locality, Darr River, (Australian Museum No. F35478). I have no reason to disagree with Dear's conclusion that the specimens came from the Mantuan *Productus* bed, although they could equally well have come from the east side of the basin, for example from the Oxtrack Formation. I am also not sure that the lectotype can be readily distinguished from other species from the Bowen Basin, such as *Terrakea elongata* Booker of Dear (1971, p. 16).

Description. Shell of moderate size and only moderately geniculate, not particularly elongate. Spines fairly sparse and of moderate size, smaller in younger parts of shell. Ornament consists of spines, radial capillae and growth lines. The interior of the pedicle valve had heavily thickened posterior walls.

Dimensions (mm).

	Width	Length	Height
Figured specimen A:		28	20 (approx.)
brachial valve	36		
pedicle valve	36	38	20 (approx.)
Figured specimen C:			11
pedicle valve	29		
Figured specimen D:		29	13
brachial valve	40		

Occurrence. Figured specimens A–E, CPC25280–25284, MC803.

Discussion. In shape, ornament and nature of spines, these specimens seem to conform to *Terrakea solida*.

Superfamily **Strophalosiaceae** Schuchert 1913
Family **Strophalosiidae** Schuchert 1913
Genus ***Echinalosia*** Waterhouse 1967 (p. 167).

The type species and generic relationships are discussed in Dickens (1981, p. 30).

Echinalosia* cf. *minima Dear 1971 (p. 17, pl. 3, figs 11–16)
Pl. 3, figs 1–6, 10–21

Description. A number of incomplete specimens. Pedicle valve rather convex and not particularly wide. Apparently originally with numerous spines, the brachial valve is concave and has a number of spines apparently arranged rather irregularly. Adductor muscles lacking a distinct platform.

Dimensions (mm).

	Width	Length
Brachial valve (DDH3)	36	29
Figured specimen L	36	28
Brachial valve (DDH3)		

Occurrence. Figured specimens A–G, CPC25285–25290, MC803 and DDN3.

Discussion. Separating species of strophalosiids in the Blenheim Subgroup presents considerable difficulties (Dickens, 1969b, p. 89). In examining large numbers of

specimens, I commented on the difficulty of separating the species *clarkei*, *clarkei* var. *minima* (later separated by Dear, 1971, as a species of *Echinalosia*), *ovalis*, and *brittoni* var. *gattoni* (later transferred by Dear, 1971, to *Wyndhamia clarkei gattoni* subsp. nov.). Waterhouse (in Waterhouse & Jell, 1983) complicated the picture by assigning *Wyndhamia blakei* to the synonymy of *W. ingelarensis* Dear 1971 and claiming that *Echinalosia ovalis* Maxwell 1954 is confined to a single limited horizon in the Blenheim Subgroup. The holotype of *W. blakei* is narrow, especially at the umbonal (posterior) end, which is characteristic of many specimens from the basal part of the Blenheim Subgroup. The specimens of this type have been referred by Dear (1971) to *Wyndhamia blakei* and *Echinalosia minima gattoni* subsp. nov. The type of *W. ingelarensis* is quite different, having a relatively wider, less convex pedicle valve. The consistency of these differences is confirmed by the specimens I have examined. I consider *E. ovalis* is quite long ranging, from the base of the Blenheim Subgroup and possibly through Fauna IV, as concluded by Maxwell (1954), Dear (1971) and McClung (1978).

The specimens assigned to *E. cf. minima* are those from MC 803 and from bore DDH3 Stockton 3 (413.80) in the Sydney Basin. The specimens from MC 803 are similar in shape to *E. ovalis*, but lack the muscle platform. Those from the Sydney Basin are somewhat broader, but also lack the distinct muscle platform of *E. ovalis*.

Echinalosia* cf. *ovalis (Maxwell) 1954 (p. 548, pl. 57, figs 4–14)
Pl. 3, figs 7–9

Description. 3 specimens in which the valves are moderately wide, with numerous spines on the pedicle valve and scattered spines on the brachial valve. The adductor muscles are lodged on a distinct platform and differ considerably in length in the two pedicle valves.

Dimensions (mm).

	Width	Length	Height
Figured specimen A:	38	30	8
brachial valve (F15006)			
Figured specimen B:	40	40	—
pedicle valve (F15009)			
Figured specimen C:	34	38	—
pedicle valve (F15010)			

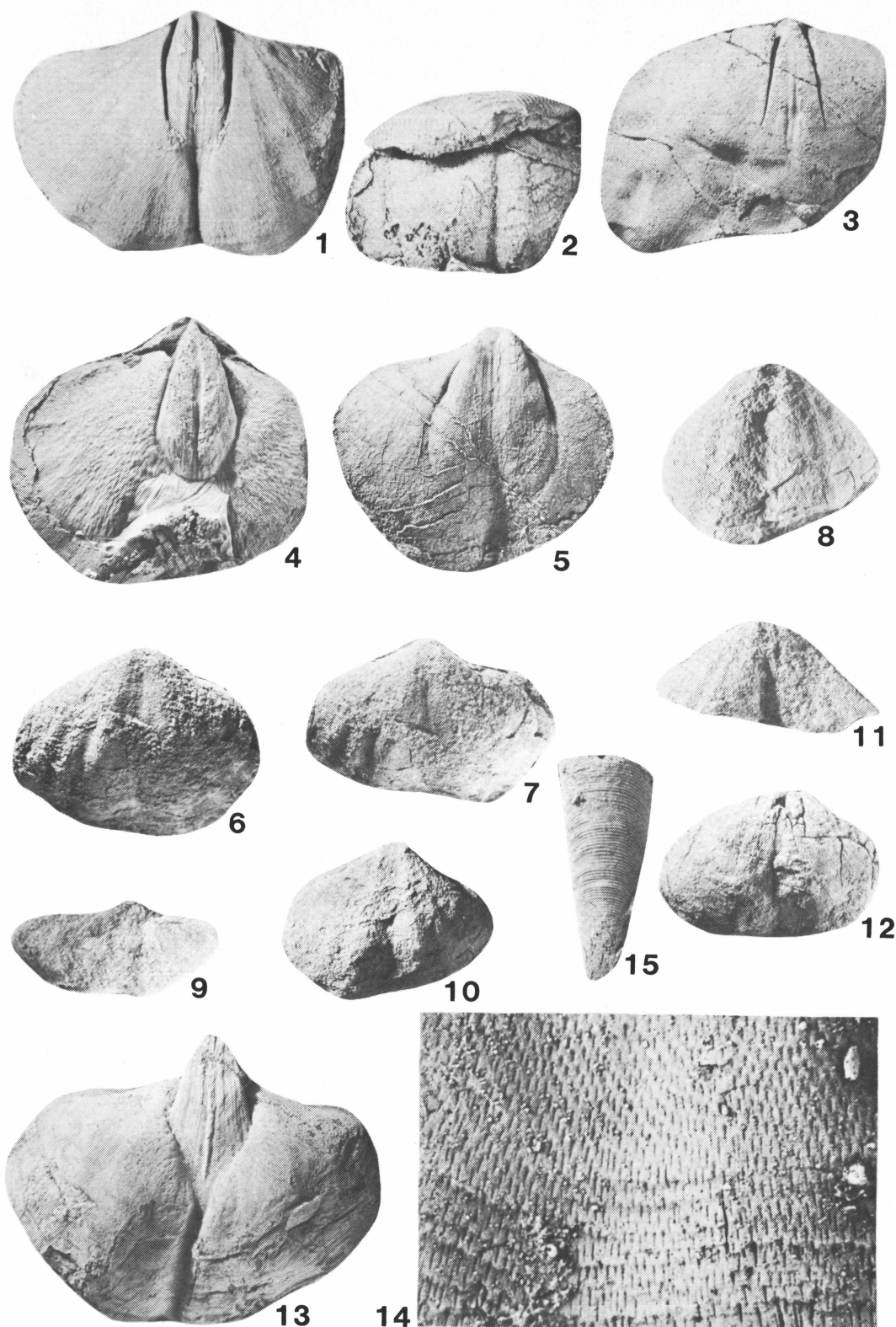
Occurrence. Bore DM Camden 75, 2880–2890 ft.

Discussion. The specimens are compared with *E. ovalis* because of the dimensions, the nature of the ornament, and the distinct adductor muscle platform.

Superfamily **Reticularinaceae** Waagen 1883
Family **Martiniidae** Waagen 1883
Genus ***Martiniopsis*** Waagen 1883

Type species (by subsequent designation of Hall & Clarke, 1894 — fide Brown, 1953, p. 103). *Martiniopsis inflata* Waagen (1883, p. 525, pl. 41, figs 7, 8), from the Upper Productus Limestone (Chhidru Formation) of Chhidru, Salt Range, Pakistan.

Discussion. The difficulties of generic names for this group of forms have been outlined in Dickens (1981, p. 30). N.W. Archbold (personal communication) favours the retention of *Ingelarella* for forms with low C-shaped protuberances at the posterior end of elongate, narrow, shallow grooves



20/A/113

Plate 5.

Martiniopsis havilensis (Campbell), 1960. 1, CPC25298, figured specimen I, pedicle valve, MC803, x1. 2, CPC25300, figured specimen K, latex of pedicle valve, MC803, x1.5. 3, CPC25297, figured specimen H, internal of brachial valve, UDC2, x1. 4, CPC25296, figured specimen G, internal of pedicle valve, UDC2, x1. 5, CPC25299, figured specimen J, internal of pedicle valve, MC803, x1. 6-7, CPC25302, figured specimen M, pedicle valve and tilted pedicle valve, MC292, x1. 8-10, CPC25303, figured specimen N, pedicle valve, posterior view and tilted pedicle valve, MC292, x1. 11, CPC25301, figured specimen L, pedicle valve, MC292, x1. 12, CPC25305, figured specimen P, pedicle valve, B1572, x2. 13, CPC25304, figured specimen O, internal of pedicle valve, B1572, x2. 14, CPC25306, figured specimen Q, latex showing external ornament of brachial valve, MC803, x12. *Conulariid* indet. 15, CPC25307, latex, x4.

arranged in quincunx. The micro-ornament of *M. inflata* is still not known in detail. In many specimens the micro-ornament is not preserved, and a classification based on it may present more difficulty than a broader scheme. The specimens described below are placed in *Martiniopsis* because they lack a well-developed fold and sulcus. Shallow grooves arranged in quincunx are present, but no C-shaped protuberances.

Martiniopsis havilensis (Campbell), 1960
(p. 1120, pl. 139, figs 3–6)
Pl. 4, figs 8–7; Pl. 5, figs 1–14

Description. The shells assigned to this species are distinguished by a relatively wide shallow sulcus containing a narrow groove, although this is variably developed in specimens from the same locality. The fold is also relatively broad and has a corresponding groove in the fold. Young shells are wider than long, but older shells vary from being almost smooth to having distinctly marked plicae. The original specimens were described as smooth, but the specimens figured here from the type locality (Pl. 5, figs 12, 13) show low but distinct plicae. Older specimens are thickened at the umbo, and the adminicula vary considerably in length and shape. In the brachial valve they are rounded, divergent, and reasonably long. The micro-ornament comprises elongated shallow grooves arranged in quincunx, slightly wider towards the umbonal end. No C-shaped protuberances are visible (Pl. 5, fig. 14).

Dimensions (mm).

		Length	Height	Width
Figured specimen A (Tay Glen Crossing)	Brachial valve	40	52	28
Figured specimen B (Tay Glen Crossing)	Pedicle valve	49	53	24
Figured specimen C (Tay Glen Crossing)	Pedicle valve	40	52	17
Figured specimen D (Tay Glen Crossing)	Pedicle valve	35	50	20
Figured specimen E (Tay Glen Crossing)	Brachial valve	33	47	22
Figured specimen F (UDC2)	Pedicle valve	40	45 (approx.)	19
Figured specimen G (UDC2)	Pedicle valve	50 (approx.)	60 (approx.)	20
Figured specimen H (MC 803)	Pedicle valve	50	63	20
Figured specimen I (MC 803)	Pedicle valve	48	51	12
Figured specimen J (MC 292)	Pedicle valve	41	50	12
Figured specimen K (MC 292)	Pedicle valve	34	41	12
Figured specimen L (B 1572)	Brachial valve	50	68	19
Figured specimen M (B 1572)	Pedicle valve	55	68	22
Figured specimen N (B 1572)	Pedicle valve	35	42	16

Occurrence. Figured specimens A–P (as above), CPC25291–25305, Figured specimen Q, CPC25306, MC803, Tay Glen, UDC 2, MC 803, MC292, B1572 and base of Black Alley Shale.

Discussion. *Martiniopsis havilensis* is widespread in the upper part of the Blenheim Subgroup. Its occurrence in the Black Alley Shale (type section) and at MC 292 is particularly significant. The occurrence in the Black Alley Shale indicates an important hiatus between the Peawaddy Formation and the Black Alley Shale. The evidence of *M. havilensis* is corroborated by the occurrence of *Peruvipira* cf. *modesta* at the same locality. The occurrence at MC 292 is important because this locality is in the Exmoor Formation and, therefore, suggests correlation with the MacMillan Formation and the Black Alley Shale.

At some localities the species is represented by numerous specimens, as at Tay Glen Crossing (CL 21/5) and MC 292 where other faunal elements are poorly represented.

Some ventral valves with a relatively poorly developed sulcus resemble *Martiniopsis woodi* Waterhouse (1964, p. 148, pl. 30, figs 3–5, 8, pl. 37, figs 2, 3 and figs 71, 72, A,B) from the Arthurs Group of the Southland syncline, New Zealand.

Conulariid Indet. Pl. 5, fig. 15

Description. Two faces and the furrow between are shown by a single specimen. The transverse ribs are evenly arcuate and lack a mid-longitudinal bar. The transverse grooves are closely spaced. The relations of the ribs in the furrow are obscure.

Discussion. The characters of the specimen appear to be somewhat unusual. At first it was considered likely to be *Calloconularia* Sinclair (1952, p. 140), but it is possible that the specimen is not referable to any described genus.

Occurrence. CPC25307, UDC 1.

Localities from the Bowen Basin

B 1572 — Bowen 1:250 000 Sheet area; 20°47'15"S, 147°44'45"E; upper part of Blenheim Subgroup.
CL 21/5 — Clermont 1:250 000 Sheet area (BMR Report No. 66); crossing of Phillips Creek immediately north of Tay Glen Homestead. Also specimens without number referred to as Tay Glen Crossing; upper part of Blenheim Subgroup.
MC 292 — Mount Coolon 1:250 000 Sheet area; Collinsville Road crossing of Blenheim Creek; Exmoor Formation.
MC 803 — Mount Coolon 1:250 000 Sheet area; 4 km north-northwest of Blenheim Homestead; upper part of Blenheim Subgroup.
UDC (Utah Development Co.) 1 — Duaringa 1:250 000 Sheet area (BMR Report No. 121); on fence about 4 km northeast of Lyra Park Homestead; MacMillan Formation.
UDC 2 — Duaringa 1:250 000 Sheet area (BMR Report No. 121); Cattle Creek, 8 km northwest of Mount Stuart Homestead; MacMillan Formation.
Black Alley Shale — Springsure 1:250 000 Sheet area; about 2 m above base of type section, in the main west branch of Dry Creek, about 3 km southeast of Black Alley Peak.

Localities of New South Wales Bore Holes DDH3 Stockton 3

Newcastle 1:250 000, ISG Metric

371614.7 E

136476.3 N

9232 II

Newcastle 50 000

DM Camden 75

Wollongong 1:250 000

ISG Metric

298629.2 E

1226333.1 N

Wollongong 50 000

9029 I

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helped put together the report. Photography was by R.W. Brown and H.M. Doyle, and the drawings of fossils, by J. Mifsud. Typing and secretarial work were done by Beryl Marshall and Pushpa Nambiar.

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