SPECIES OF THE BRACHIOPOD ORDER TEREBRATULIDA FROM THE PERMIAN OF EAST AUSTRALIA AND NEW ZEALAND

By J. B. Waterhouse

Earthwise 28

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INTRODUCTION

Permian brachiopods belonging to Order Terebratulida are common throughout most of the marine Permian faunas of east Australia and New Zealand, apart from the basal Permian as represented in Tasmania, where Clarke (1990, 1992) did not record any species. Only one possible specimen is known from the Early Permian at Harper's Hill in New South Wales (Etheridge 1898, pl. 19, fig. 1-3),and the implication may be that this is because those particular faunas accumulated under very cold conditions.

Study of the Permian Terebratulidain Australia enjoys a huge advantage over other brachiopod groups, because they were extensively monographed and illustrated by K.S.W. Campbell (1965) in a study on available collections both in Australia and overseas. The one disadvantage was that many aspects of correlation were not available in those days, particular for the south Sydney Basin and much of Queensland. But that apart, he was able to describe the main genera and many of the species, and expand and qualify attempts by Stehli (1961) to catalogue east Australian terebratulids.The terebratulids are mostly small to medium in size, with subdued if any plicae, and need internal structure to be determined as a rule to identify the genus. They display very light micro-ornament, except for *Grebneffia*, a New Zealand genus with strong angular plicae and striking pattern of commarginal ribs.

REPOSITORIES

Various fossils described throughout this report are housed in the Bulk Storage of the Queens

-land Museum & Science Annex at Hendra, Brisbane, and many are registered individually by number with the prefix U**QF,** inherited from the Department of Geology & Mineralogy, University of Queensland. Other fossil registration prefixes involve **QM**, Queensland Museum and **GSQ**, Geological Survey of Queensland, also stored at the Queensland Museum at Hendra, Brisbane. In New South Wales and Canberra A.C.T., repositories include **AMF** for Australian Museum, Sydney, **ANU**, Australia National University, Canberra, A.C.T., **CPC** – later **AGSO**, former Bureau of Mineral Resources – at Canberra A.C.T. and **SU,** Sydney University. For New Zealand, repositories involve **BR** for brachiopods kept at the Institute of Nuclear and Geological Sciences, Lower Hutt, and **OU**, Department of Geology, University of Otago, Dunedin. Specimens with no published registration numbers and sourced from northwest Nelson in New Zealand are kept at the Department of Geology, Victoria University, Wellington. From further afield, **BM** or B signify Natural **USNM** is short for United States National Museum, Washington D. C., United States.

SYSTEMATIC SUMMARY

Superfamily **DIELASMOIDEA** Schuchert, 1913

In classifying Dielasmatoidea, Campbell (1965) regarded the presence or absence of dental plates as offering a prime guide. Herein more stress is laid of the nature of dorsal plates, which is consistent with the overall stress of the nature of the brachial loop in Terebratulida.

Nomenclature: The terms outer and inner hinge plates are applied by the *Revised Brachiopod Treatise* to particular dorsal plates in the Terebratulida. In comparison with Spiriferida, it may be asked if the term crural plate for the one of the pairs of what are designated as hinge plates would not be more appropriate. But the trouble is, which pair of plates – outer or inner? In many terebratulids, it is the inner hinge plates that bear the crura (Williams Brunton & MacKinnon 1997, Fig. 330.4). But for other genera the crura appear to arise on the outer hinge plates, more in accord with the arrangement in Spiriferida and Athyrida. In yet other genera, the crura arise, or appear to arise, from the socket plates. Evidently, judging from external appraisal, the crura varied with regards to which plates they arose from, though admittedly no thorough examination of shell structure has been undertaken.

Superfamily Dielasmoidea Schuchert, 1913

Family Dielasmidae Schuchert, 1913
Subfamily Dielasminae Schuchert, 1913
Tribe Dielasmini Schuchert, 1913
Tribe Plectelasmini Waterhouse, 2010
Tribe Fletcherithyrini Waterhouse, 2010
Tribe Hoskingini Waterhouse, 2010
Subfamily Centronelloideinae Stehli, 1965
Subfamily Nucleatulinae Muir-Wood, 1965

Family Gillediidae Campbell, 1965
Subfamily Gillediinae Campbell, 1965
Subfamily Hemiptychininae Campbell, 1965
Subfamily Maorielasminae Waterhouse & Piyasin, 1970

Family Heterelasminidae Licharew, 1956

Family Pseudodielasmidae Cooper & Grant, 1976

Family Beecheridae Smirnova, 2004

Table 1. Classification of Dielasmoidea Schuchert. The insertion of "at" or "id" towards the end of the biological genus name as mandated by the International Code of Zoological Nomenclature is regarded as unwarranted and is discarded. Biology is a natural science, not a commemoration of medieval and modern Latin, and years ago Randall & Scott (1969) opposed the granting of syntax to biological nomenclature. Omission of grammatically demanded adjustments was allowed by the ICZN, but this adds to inconsistencies in terminology. it is preferred to add immutable family group endings to the genus name, but out of deference to past practice, the terminal vowel may be omitted.

Family **DIELASMIDAE** Schuchert, 1913

Diagnosis: Genera as a rule small in size, with variably flexed anterior commissure, foramen generally permesothyrid and labiate, collar well-developed, dental plates present as a rule, (except various Nucleatulinae), septalium large, may be sessile or supported on high septum, loop acuminate in juvenile form, deltiform at maturity, may develop anterior vertical blade medianly.

Subfamily **DIELASMINAE** Schuchert, 1913

Diagnosis: Dental plates well-developed, septalium of inner and outer hinge plates, may be divided, sessile or raised on low to high septum, loop deltiform.

Tribe **DIELASMINI** Schuchert, 1913

Diagnosis: Dorsal medium septum low or absent, so that the septalium is sessile or almost so.

Genus ***Amygdalocosta*** Waterhouse, 1967

Diagnosis: Dorsal sulcus and anterior lateral costae. Otherwise like *Dielasma* as far as known, with sessile septalium and no or low median septum.

Type species: *Amygdalocosta rara* Waterhouse, 1967 from Wairaki Breccia of late Changhsingian age in New Zealand, OD.

Discussion: As outlined by Waterhouse (1982, p. 64), this genus is externally a homeomorph of *Dielasmina* Waagen, 1882. Internally, *Dielasmina* displays a high dorsal septum and septalium, as in *Fletcherithyris* Campbell, although one species, described as *Dielasmina extensa* Reed, 1944 from the Chhiddru Formation of the Salt Range in Pakistan could prove to belong to *Amygdalocosta* (Waterhouse 1982, p. 64), but is internally somewhat obscure.

Amygdalacosta rara Waterhouse, 1967

Fig. 1, 2

1967 *Amygdalacosta rara* Waterhouse, p. 103, Fig. 9C, 44, 47.

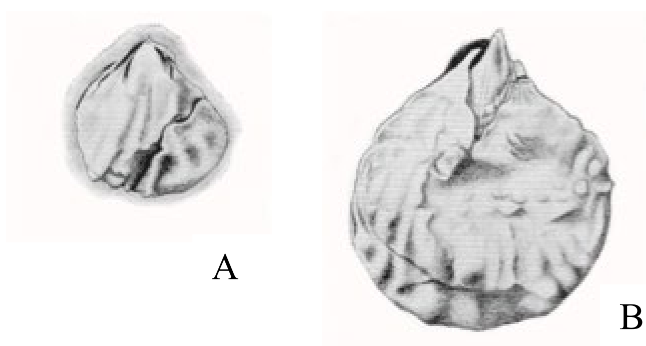


Fig. 1. *Amygdalacosta rara* Waterhouse. A, ventral internal mould BR 1248, x 2.5. B, dorsal internal mould BR 844, holotype, x2. Wairaki Breccia. (Waterhouse 1967).

Diagnosis: Medium-size, almond-shaped shells with long anterior costae, posterior-lateral and umbonal shell smooth.

Holotype: BR 844 from Wairaki Breccia, Wairaki Downs, south New Zealand, figured in Waterhouse (1967, Fig. 47) and herein as Fig. 1B, OD.

Morphology: The ventral valve is faintly arched with low costae arising over the posterior quarter of the shell on each side and two more costae arising medianly just behind mid-length. The dorsal valve is gently and widely sulcate over the anterior half. Two costae lie along the margins of the sulcus and two more within the sulcus, and more anteriorly. Some ten costae are present over the anterior half of a larger dorsal valve. Dental plates are short. The septalium is raised a little above the floor of the valve anteriorly but no septum is present. Crural bases lie close to the dental sockets but the course of the loop is not known.

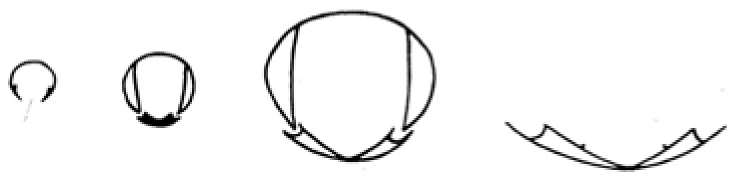


Fig. 2. *Amygdalocosta rara* Waterhouse, reconstructed sections at intervals of 0.5, 1mm, 2mm and 3.5mm intervals from tip of dorsal umbo, based on available material. Wairaki Breccia. (Waterhouse 1967).

Stratigraphy: The species comes from the Wairaki Breccia of very late Permian age in southern New Zealand.

Grebneffia Waterhouse & H. J. Campbell, 2021

Diagnosis: Biconvex, transverse and subpentagonal in outline with maximum width near mid-length, epithyrid foramen, well-defined ventral sulcus bordered each side by narrow-crested plication, dorsal valve of comparable inflation with broad median fold bordered each side by channel, anterior margin parasulcate. Both valves also ribbed by divaricate costae, lying along longitudinal axis within the sulcus and fold, and diverging forward and outward over the lateral shell from along the sulcal and fold margins. Dental plates short, teeth small. Septalium broad and extending forward for at least a quarter of the length of the dorsal valve, lying close to floor of the valve and bearing an upright crural base on each side. The cardinal process is small and non-laminate, with a low median ridge, between a broad oval depression to each side.

Type species: *Grebneffia divaricata* Waterhouse & H. J. Campbell, 2021, from McLean Peaks Formation, Takitimu Group, New Zealand, OD.

Discussion: This genus is distinguished by its distinctive transverse outline, less elongate than most other members of Dielasmidae of east Australia and New Zealand, with ventral sulcus defined by sharply raised ridges diverging anteriorly, the ridges opposed to grooves along the outer edges of the fold in the dorsal valve. The surface of both valves is crossed by divaricate ribs, which diverge from the ridges bordering the ventral sulcus and from the grooves bordering the dorsal fold. No comparable arrangement of sulcus and fold, and divaricate ornament is known amongst other Permian Dielasmidae, although several suggest a general approach. One example is provided by members of the genus *Gilledia* Stehli, 1961, common in Permian faunas of east Australia. *G. homevalensis* Campbell, 1965 from the Early Permian Tiverton Formation of Bowen Basin, Queensland, has ornament of fine furrows, described by K. S. W. Campbell (1965, p. 75) as straight medianly, and outwardly concave laterally (see Campbell 1965, pl. 1, fig. 14, 16, 20). *Gilledia* has different overall shape from *Grebneffia*, and internally, the dorsal and inner margins of the inner hinge plates rest on the floor of the valve, rather than meet centrally. Another externally somewhat similar species from east Australia was described as *Fletcherithyris parkesi* by Campbell (1965, p. 43, pl. 8, fig. 1-23, text-fig. 16). This species has a median ventral fold within a sulcus, and dorsal median sulcus varyingly defined by bordering ridges. There are no ribs, and the interior features a high dorsal median septum as in *Fletcherithyris*.

In summary, *Grebneffia* is distinguished by its external appearance, with the sulcus bordered by plicae, and the fold bordered by channels, and both valves also ornamented by divaricate costae. No other known member of Dielasmidae comes close, though a very few genera have ribs or anterior narrow plicae, such as *Dielasmina* Waagen, 1882 and *Amygdalocosta* Waterhouse, 1967. Internally the structure of the present genus is comparatively normal for the subfamily Dielasminae, with well-formed if small dental plates, and a large sessile septalium. The nature of the brachial loop is not known for the present form. Whatever the nature of the loop, the present form is internally readily distinguished from the Jurassic genera *Tegulithyris* Buckman, 1918 and its ally *Prototegulithyris* Alméras, Elmi & Benshill, 1988, which are externally somewhat comparable, but internally lack dental plates and have a much smaller septalium.

Grebneffia divaricata Waterhouse & H. J. Campbell, 2021

Fig. 3, 4

2021 *Grebneffia divaricata* Waterhouse & H. J. Campbell, p. 69, Fig. 1, 2.

Diagnosis: As for genus. Only one but truly outstanding specimen is so far known for the genus.

Holotype: BR 3454 from McLean Peaks Formation, figured by Waterhouse & H. J. Campbell (2021, Fig. 1, 2) and herein as Fig. 3, 4, OD.

Morphology: Shells small-medium in size, biconvex, pedicle epithyrid with collar. The dorsal valve is slightly higher than the ventral valve near mid-length, and anteriorly the dorsal valve curves to accommodate the ventral sulcus, the anterior margin displaying a modified parasulcate commissure, and the lateral commissure is sinoidal. The sulcus is enclosed by an angle of 13-14^{o}, and bordered each side by a strong plication with narrowly rounded crest. These structures are opposed on the dorsal valve by a broad gently rounded fold commencing at the dorsal umbo, and the fold is bordered each side by a well-formed but shallow and narrow channel, the channels commencing a little in front of the dorsal umbo, and diverging at 25^{o}. As well, the surface of both valves is diversified by firm ribs with well-rounded crests. The posterior sulcus bears only two ribs, compared with eight near the anterior margin, and the ventral ribs originate on the crests of the plicae bordering the sulcus. The lateral ventral valve is ornamented by similar ribbing, which commences at the crest of the pair of ridges bordering the sulcus. The ribs diverge laterally forward, numbering some four in 5mm, and anteriorly, a few ribs increase by intercalation towards the commissure and fine ribs lie over the surface of some of the larger ribs.

Dorsal ornament is similar. Some eight ribs lie anteriorly over the fold, and the number is reduced posteriorly, though the actual number is obscure. The ribs over the fold and over the lateral shell commence within each of the channels that border the fold.

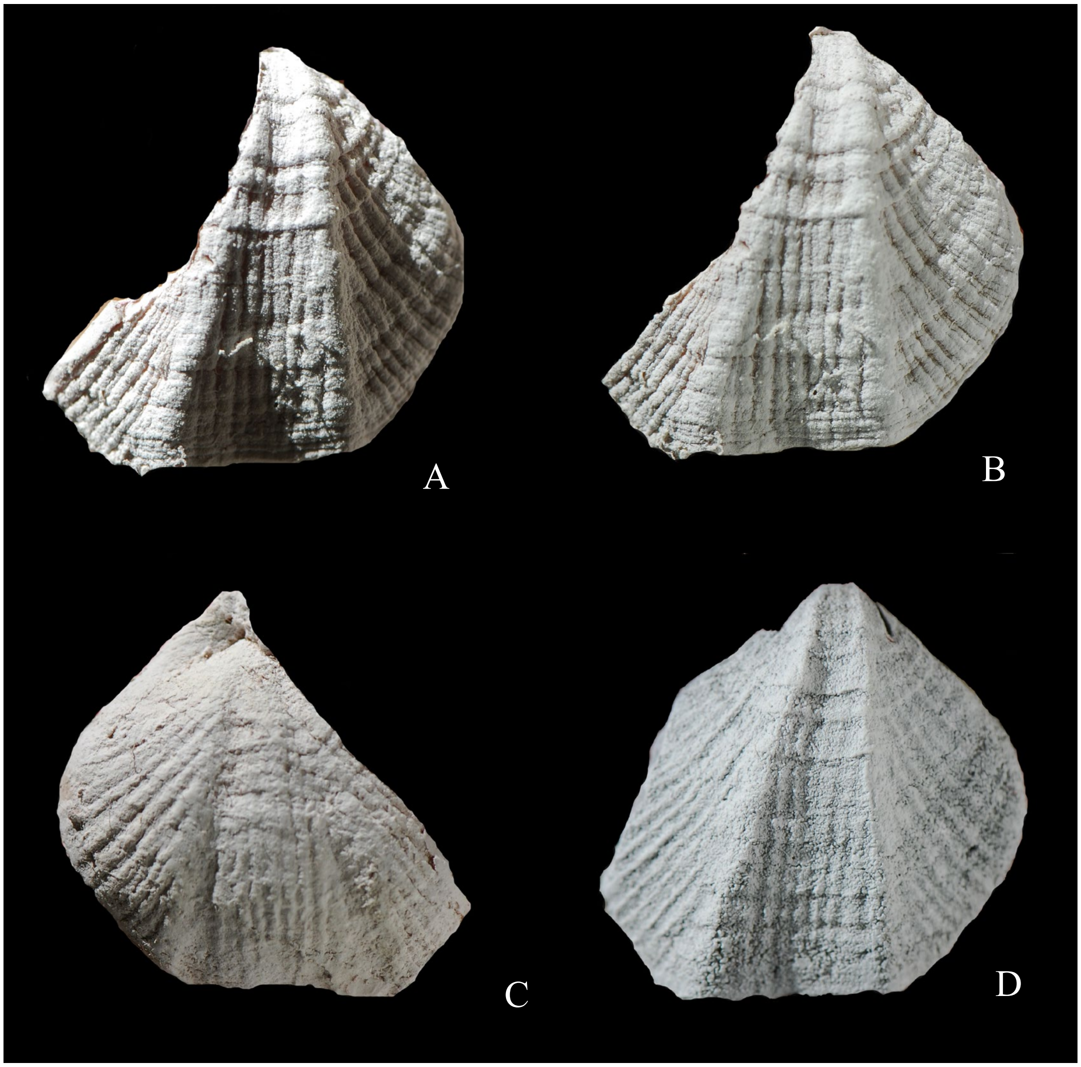


Fig. 3. *Grebneffia divaricata* Waterhouse & Campbell, BR 3454. A, B, ventral aspects of external cast under different lighting. C, dorsal aspect of external cast. D, ventral aspect of internal mould. McLean Peaks Formation, upper Takitimu Group, New Zealand. (Waterhouse & Campbell 2021).

Teeth are short, and dental sockets small. The cardinal process is small, with a low median ridge and subrounded depression each side. There is a large and broad septalium, resting on the floor of the dorsal valve as far as can be seen w: if there was a median septum it must have been very low, and no trace is preserved. Narrow high crural supports lie moderately close to the lateral margins of the septalium, and signify that the loop is likely to be intact. The inner and outer surface of both valves show fine dense punctae, whereas the septalium has a

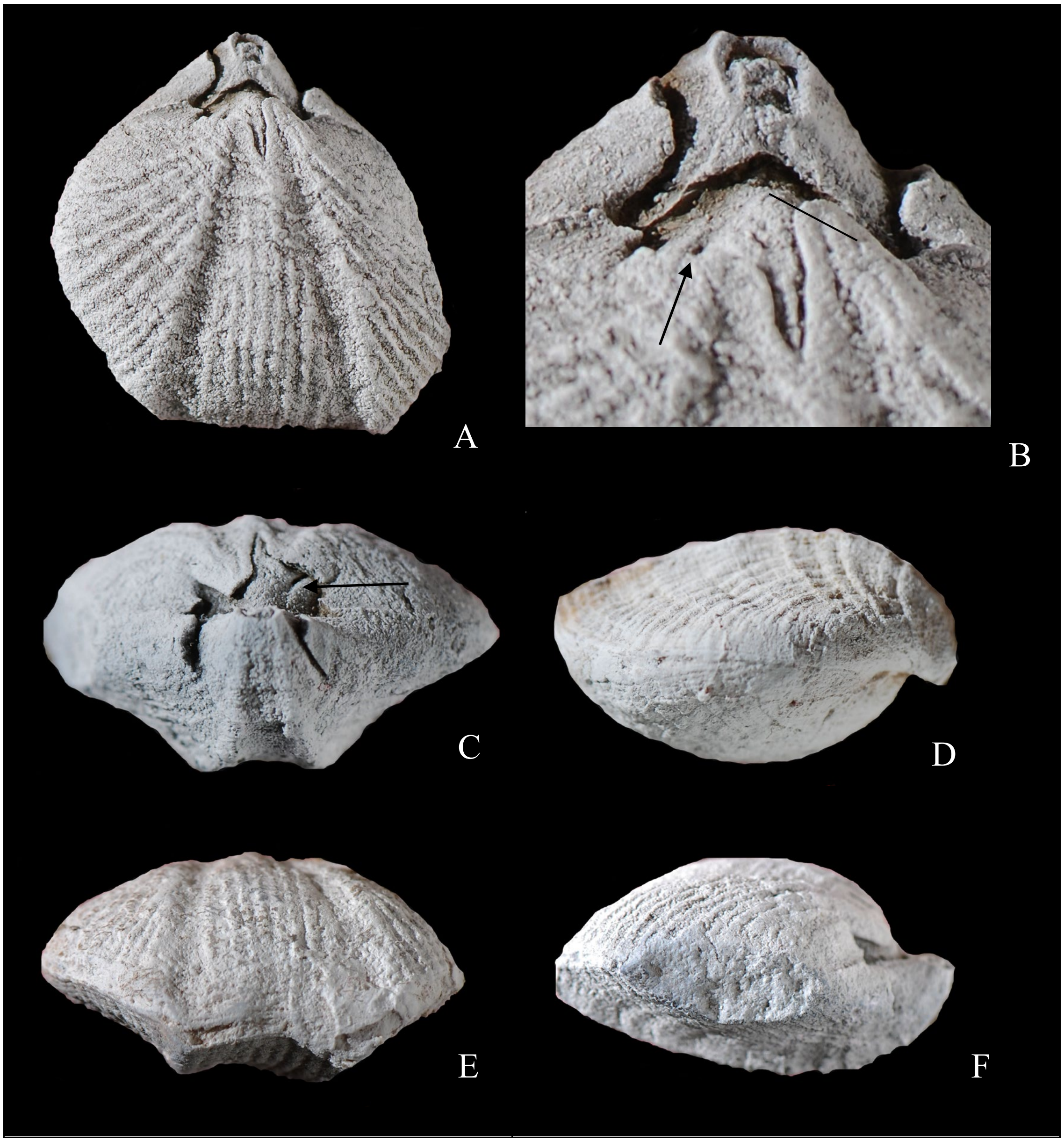


Fig. 4. *Grebneffia divaricata* Waterhouse & Campbell, internal mould of holotype, BR 3454. A, B, dorsal aspect, B showing posterior detail, x2, x4. Arrow points to crural base. Single line indicates mould of cardinal process. C, posterior aspect, dorsal valve on top, x2. Arrow points to crural base. D, F, dorsal valve below in D and on top in F, x2. E, anterior aspect, dorsal valve on top, x2. Upper Takitimu Group. (Waterhouse & Campbell 2021).

smooth surface over where it is exposed, and is not clearly divided into inner and outer hinge plates. Internally, the species is close in structure to that of members of Dielasmini, in having dental plates and a broad well-formed and sessile septalium. Apart from *Amygdalocosta*, no other genus within Dielasminae from the Permian faunas of New Zealand or east Australia is similar, because these genera and species have a high and well-formed medium septum, typical of Fletcherithyrini. The present species and genus is highly distinctive, but the lack of information about the loop means that family relationships needs consolidation.

Tribe **FLETCHERITHYRIN**I Waterhouse, 2010

Diagnosis: Septalium supported on a dorsal septum that is high anteriorly in mature shells. Commissure rectimarginate to sulciplicate.

Name genus: *Fletcherithyris* Campbell, 1965, p. 24 from Gerringong Volcanics (Broughton Formation) of approximately Wordian or lower Capitanian age in the south Sydney Basin.

Discussion: This tribe was discussed by Waterhouse (2010, p. 82). In *Fletcherithyris* the septalium is supported by a high septum, as in *Campbellelasma* Smirnova (2004b) and *Sokelasma* Smirnova, (2004a) and in Late Triassic genera, including *Adygella* Dagys, ?*Coenothyri*s Douvillé, ?*Paradygella* Liao & Sun, *Pirethyris* Sun & Ye and *Tunethyris* Calzada Badia et al. These latter genera may have arisen de novo during Triassic time, but do resemble Permian *Fletcherithyris* in overall shape and other attributes and could to have survived and evolved from *Fletcherithyris*-like shells. Girtyellinae Stehli are a small group of Carboniferous and Permian genera also characterized in part by high dorsal septum, but are cryptonelliform. Some other genera developed a dorsal septum but the loop passed through an acuminate and possibly haploid growth stages, and the genera are referred to Angustothyridae Dagys, for which *Praeangustothyris* Koczyrkevicz is of Middle Permian age, and other genera are Triassic.

The genus *Sokelasma* Smirnova, 2004a, type species *S. guttiformis* Smirnova (2004a) has internal plates, including dental plates, close to those of *Fletcherithyris* (Smirnova 2004a, text-fig. 1). It is not like *Beecheria*, though referred to Beecheriidae by Lee et al. (2007, p. 2801), following the assessment of Smirnova, 2004a. *Beecheria* lacks dental plates and the inner and outer hinge plates form a double-tented structure (Waterhouse 2010), as shown by Fig. 30, p. 35 herein.

Genus ***Fletcherithyris*** Campbell, 1965

Diagnosis: Anterior commissure broadly sinuate or weakly sulciplicate, septalium raised on median septum, which is high anteriorly, crural points high.

Type species: *Fletcherithyris* was proposed as nom. nov. for *Fletcherina* Stehli, 1961 not *Fletcherina* Lang, Smith & Thomas, 1955 according to Campbell (1965), though he did not detail the latter reference, and Jin et al. (2006) also did not provide the reference. The type species was stipulated as *Terebratula amygdala* Dana (1847, p. 142), which is a junior homonym of *T. amygdala* Catullo, 1846 Giorn. Di Fisica 2 (5): 90]. Finlay (1927) proposed replacing Dana's name with a new name *bensoni*, but a substitute name proposed shortly after the Dana publication is *Atrypa biundata* M'Coy (1847, p. 231, pl. 13, fig. 9, 9a) from outcrop at Black Head of the south Sydney Basin in New South Wales [see Waterhouse 1982, p. 62] and Clarke (1987) adopted *biundata* as the species name, whilst noting the proposal by Finlay (1927).

The genus has been reported from Pennsylvanian faunas of Nevada by Perez-Huerta (2004, p. 1507), but his material differs substantially, lacking a median dorsal septum, and displaying a different and more elaborate loop.

Fletcherithyris **sp.**

Fig. 5

2015a *Fletcherithyris* sp. Waterhouse, p. 224, Fig. 178.

Fig. 5. *Fletcherithyris* sp., dorsal aspect of internal mould UQF 81411 x1.5 from basal Tiverton Formation. (Waterhouse 2015a).

A specimen from the *Bookeria pollex* Zone of the basal Tiverton Formation in the northern Bowen Basin of Queensland has valves conjoined with dental plates and septalium raised on a median septum. It is slightly larger and distinctly more transverse and oval in shape than other *Fletcherithyris* from the lower and middle Tiverton Formation.

Fletcherithyris farleyensis Campbell, 1965

Fig. 6

1965 *Fletcherithyris farleyensis* Campbell, p. 33, pl. 6, fig. 1-10.
2015a *F. farleyensis* – Waterhouse, p. 221.

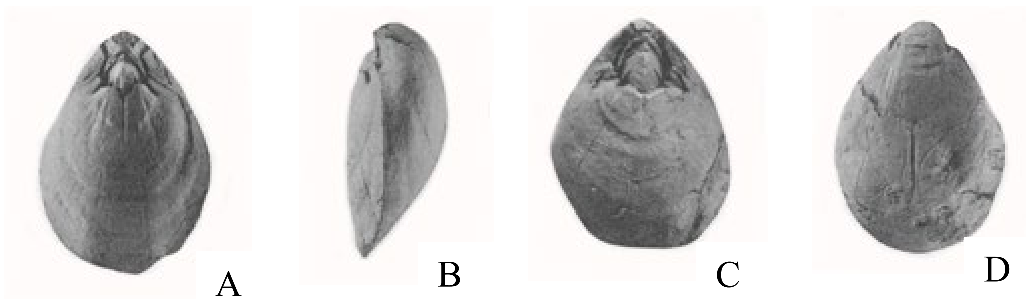


Fig. 6. *Fletcherithyris farleyensis* Campbell. A, B, dorsal and lateral views of holotype, ANU 14092. C, dorsal view AMF 29510. D, ventral view, SU 19463. Specimens x 1, from Farley Formation. (Campbell 1965).

Diagnosis: Almond-shaped, septalium V-shaped in section, strong crural bases.

Holotype: ANU 14092 from Farley Formation, Sydney Basin, figured by Campbell (1965, pl. 6, fig. 7, 8) and herein as Fig. 6A, B, OD.

Morphology: This species was regarded by Campbell (1965) as being very close to *Fletcherithyris amygdala,* renamed *bensoni* Finlay and now replaced by M'Coy's species *biundata*.

Stratigraphy: The species came from the Farley Formation of the north Sydney Basin, and was reported from the Tiverton Formation of the north Bowen Basin by Campbell (1965) and Waterhouse (2015a).

Fletcherithyris farleyensis faba Campbell, 1965

Fig. 7-9, 10B, C

1965 *Fletcherithyris farleyensis faba* Campbell, p. 34, pl. 2, fig. 45-59, text-fig. 11.

2015a *F. farleyensis faba* – Waterhouse, p. 221, Fig. 174, 175B, C, 188B.

Diagnosis: Small shells very close to *farleyensis*, slightly narrower and smaller, sinuate at moderately early growth stage, stronger anterior socket ridges than in *farleyensis*.

Holotype: CPC 5319 from 2km southeast of Lizzie Creek, Tiverton Formation, north Bowen Basin, figured by Campbell (1965, pl. 2, fig. 58, 59) and Fig. 7A, B herein, OD.

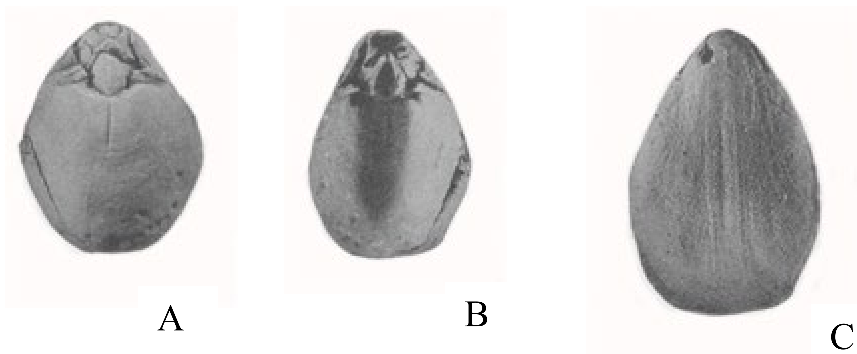


Fig. 7. *Fletcherithyris farleyensis faba* Campbell. A, B, dorsal aspects of external mould and cast, CPC 5319, holotype, x1.5. C, ventral aspect of internal mould, UQF 15710, x2. Tiverton Formation, north Bowen Basin, Queensland. (Campbell 1965).

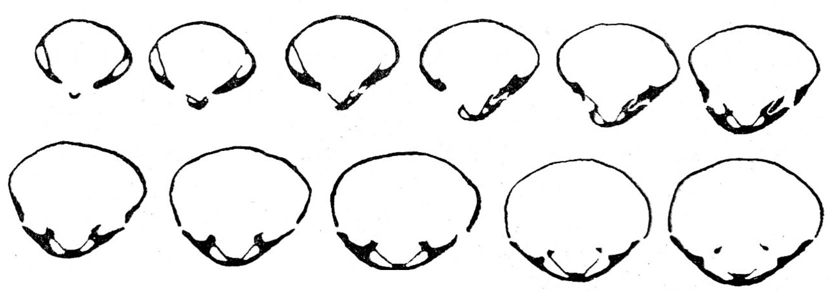


Fig. 8. *Fletcherithyris farleyensis faba* Campbell, serial sections of a small specimen at 0.25mm intervals, x3. Tiverton Formation. (Campbell 1965).

Morphology: Campbell (1965) noted that unlike *farleyensis* the specimens were not only small, but showed a flattening of the ventral valve some 8-12mm from the umbonal tip, especially on Homevale material. Because topotype specimens of *faba* from Tiverton beds 32km north of

Fig. 9. *Fletcherithyris farleyensis faba* Campbell, latex cast of block with numerous specimens, including UQF 81406 and 81407, x2. The cracks developed in the latex, and are not present in the original material. Tiverton Formation. (Waterhouse 2015a).

Homevale varied in the degree of flattening, the variation was deemed by Campbell (1965) to indicate that only a subspecific difference was involved. A number of specimens in the Tiverton

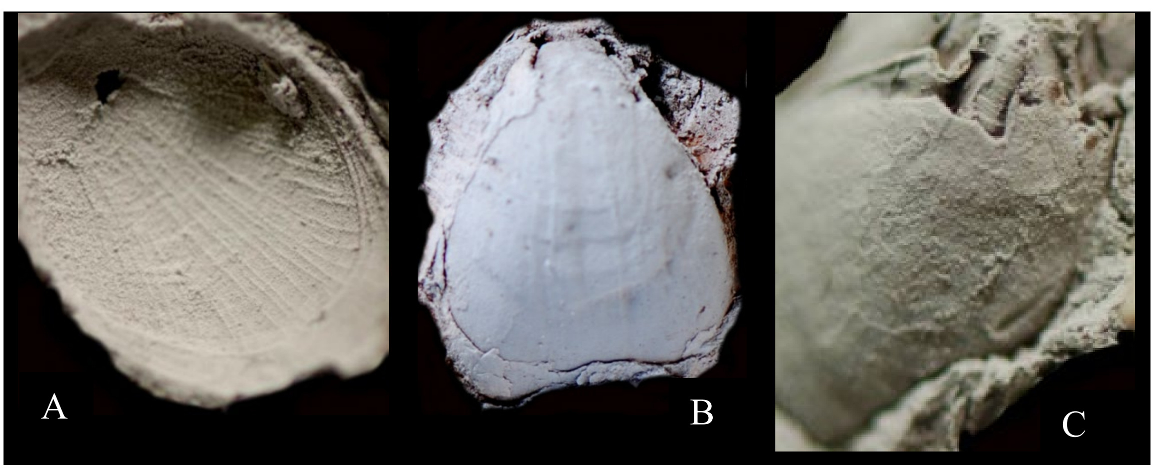


Fig. 10. A, *Fletcherithyris burdenae* n. sp. A, ventral valve external mould UQF 81413, x4. B, C, *Fletcherithyris farleyensis faba* Campbell. B, decorticated ventral valve UQF 81436, x4. C, dorsal view of internal mould UQF 81412, x6. Tiverton Formation. (Waterhouse 2015a).

Formation near Homevale are shaped like *farleyensis* and *faba*, and at least some (Waterhouse 2015a, Fig. 175B) display a median flattening closer to the ventral umbo than developed in *farleyensis*. Campbell (1965, text-fig. 11) illustrated serial sections which show a very low broad median dorsal septum, but figured material in Campbell (1965, pl. 2) imply that other specimens have a high median septum.

Stratigraphy: Specimens come from the *Bookeria geniculata* Zone, now replaced by the *Magniplicatina undulata* Zone as being more widespread, as well as levels of uncertain zonation in the Tiverton Formation, north Bowen Basin.

Fletcherithyris burdenae Waterhouse, 2015a

Fig. 10A, 11, 12

2015a *Fletcherithyris burdenae* Waterhouse, p. 223, Fig. 175A, 176, 177.

Diagnosis: Small elongate shells usually with fine radial threads over the shell surface.

Holotype: UQF 81419 from Tiverton Formation, figured in Waterhouse (2015a, Fig. 176A, B, 177B, C, E), and Fig. 11A, B, 12B, C, E, herein, OD.

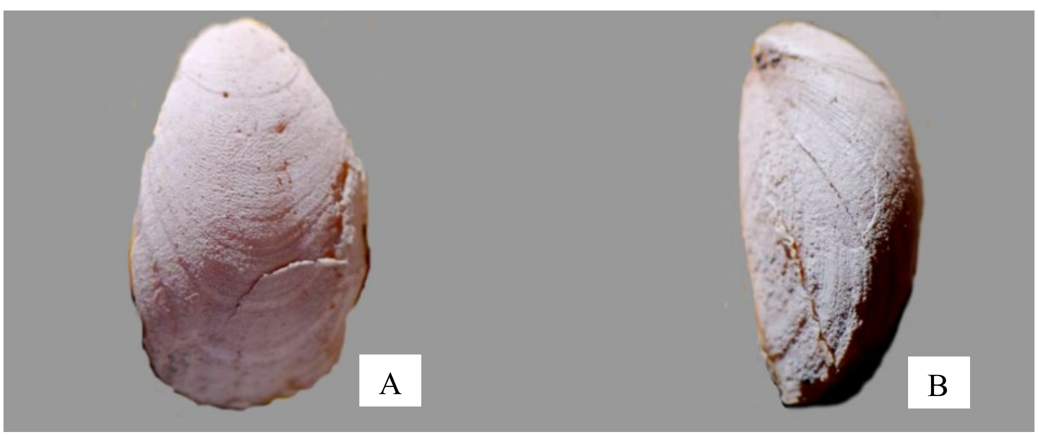


Fig. 11. *Fletcherithyris burdenae* Waterhouse, ventral and lateral aspects of latex cast of UQF 81419, holotype. x3. Tiverton Formation. (Waterhouse 2015a).

Morphology: Shells are small and elongate. The umbonal foramen is large, up to 1.7mm across, and posterior walls diverge at 65-70^{o}, and are almond-shaped, with maximum width placed near

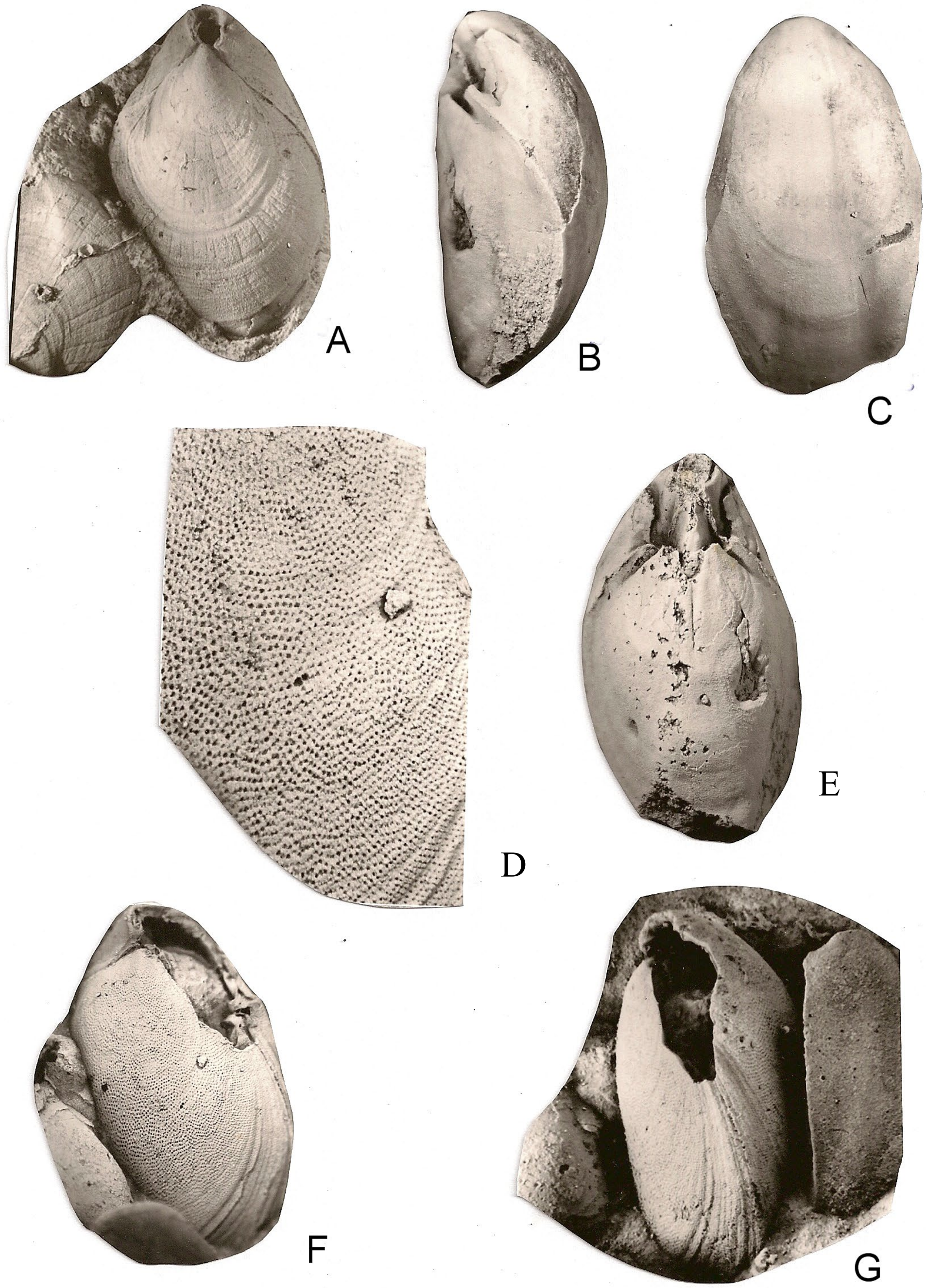


Fig. 12. *Fletcherithyris burdenae* Waterhouse. A, dorsal aspect of latex casts of two specimens UQF 81438 and 81439 (to left), x5. B, C, E, holotype, lateral, ventral and dorsal aspects of internal mould UQF 81419, x3. D, F, G, detail of surface, x10 and dorsal and lateral aspects of latex cast, x2.5, for UQF 81409. Tiverton Formation. (Waterhouse 2015a).

the anterior third of the length. Both valves are ornamented by shallow radial grooves separated by broad ribs 0.6-0.8mm apart, arising near mid-length of both valves, though closer to the hinge on some specimens, and persisting to the anterior margin, or fading anteriorly.

The present species is more widespread than *Fletcherithyris farleyensis faba* Campbell in the Tiverton Formation, and is distinguished by its more elongate shape, with a length/width ratio of 0.55 to 0.66, compared with ratios at of 0.7 to 0.8 as a rule from measurements provided by Campbell (1965) for *faba*. In addition, the present species bears fine radial grooves and ribs over both valves. *Fletcherithyris runnegari* Waterhouse & Balfe in Waterhouse (2015b) from the Late Permian South Curra Limestone of the Gympie district in southeast Queensland is larger, with maximum width placed well forward, and comparatively strong radial markings. Cooper & Grant (1976) recorded radial markings in some of the large number of species of *Dielasma* described from the Glass Mountains Permian faunas in Texas, but the radial markings are colour bands, rather than grooves or ribs.

Stratigraphy: Specimens come from the *Bookeria pollex* Zone, *Bookeria geniculata* Zone, now replaced by a more extensive *Magniplicatina undulata* Zone (Waterhouse 2021, p. 194, 209ff), *Svalbardia armstrongi* Subzone and *Taeniothaerus subquadratus* Zone in the Tiverton Formation of the north Bowen Basin. (Waterhouse 2015a, p. 48).

Fletcherithyris reidi Campbell, 1965

Fig. 13-15

1965 *Fletcherithyris reidi* Campbell, p. 36, pl. 2, fig. 1-13, text-fig. 12, 13.

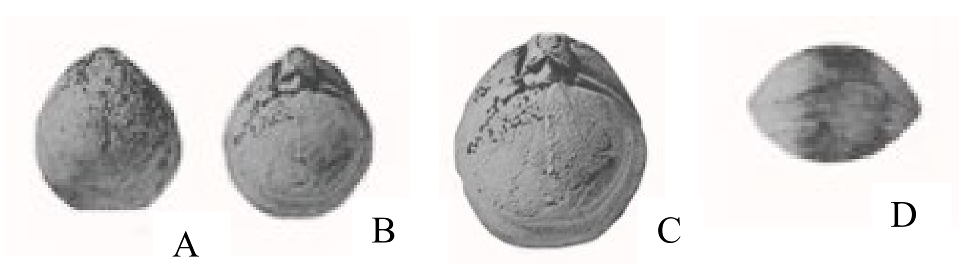


Fig. 13. *Fletcherithyris reidi* Campbell. A-D, ventral, dorsal and anterior views of internal mould, holotype ANU 11981, A, B x1.5, C, D x2. Cattle Creek Formation. (Campbell 1965).

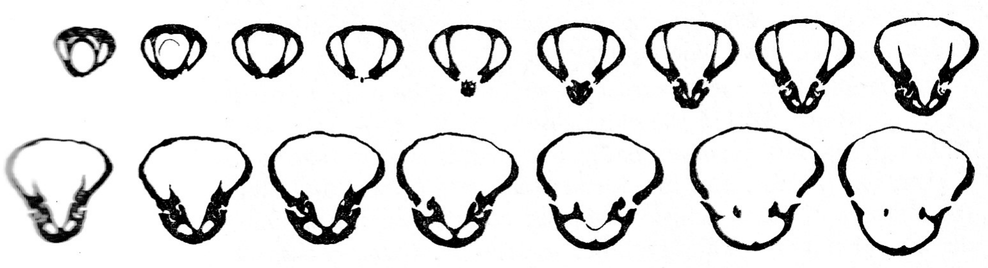


Fig. 14. *Fletcherithyris reidi* Campbell, serial sections at 0.25mm intervals, x2. Cattle Creek Formation. (Campbell 1965).

Diagnosis: Small, dorsal valve somewhat flattened in profile, septalium high above valve floor anteriorly, with concave anterior outline.

Holotype: ANU 11981 from Cattle Creek Shale, figured by Campbell (1965, pl. 2. Fig. 37-40) and Fig. 13A-D herein, OD.

Morphology: Small subrounded and inflated shells.

Stratigraphy: The species was described from the Cattle Creek Shale of the southwest Bowen Basin.

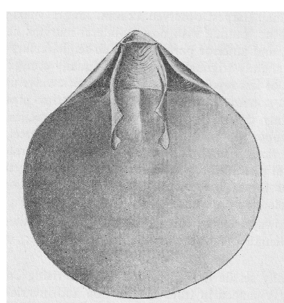


Fig. 15. *Fletcherithyris reidi* Campbell, dorsal interior, x2 approx. Cattle Creek Formation. (Campbell 1965).

Fletcherithyris scotti Campbell, 1965

Fig. 16

1965 *Fletcherithyris scotti* Campbell, p. 38, pl. 2, fig. 26-44.

Diagnosis: Small, ovate, without sulcus or fold in either valve, septalium close to one fourth or fifth of valve length, septum low anteriorly.

Fig. 16. *Fletcherithyris scotti* Campbell. A, B, C, ventral dorsal and anterior aspects of GSQF 5758, holotype, x2. Glendoo Sandstone Member, Queensland. (Campbell 1965).

Holotype: GSQ 5758 from marine band in Glendoo Sandstone Member, north Bowen Basin, figured by Campbell (1965, pl. 2, fig. 37-40) and herein as Fig. 16A-C, OD.

Stratigraphy: The species comes from the Glendoo Sandstone Member, north Bowen Basin.

Fletcherithyris antesulcata Waterhouse *in* Waterhouse & Jell, 1983

Fig. 17

1983 *Fletcherithyris antesulcata* Waterhouse *in* Waterhouse & Jell, p. 247, pl. 3, fig. 7-13.

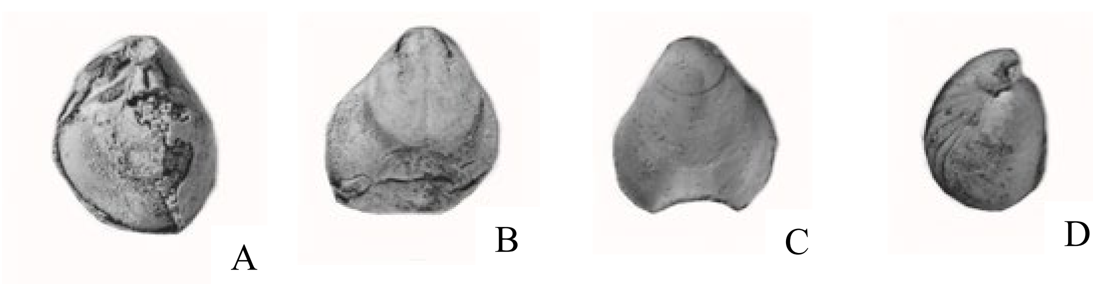


Fig. 17. *Fletcherithyris antesulcata* Waterhouse. A, B, dorsal and ventral aspects of UQF 73224, holotype. C, ventral aspect, latex cast, UQF 72335. D, lateral aspect, latex cast UQF 73226. Specimens x2 from lower Moonlight Sandstone, north Bowen Basin. (Waterhouse & Jell 1983).

Diagnosis: Highly inflated with short and broad anterior ventral sulcus and narrow dorsal fold.

Holotype: UQF 73224 from lower Moonlight Sandstone, north Bowen Basin, figured in Waterhouse & Jell (1983, pl. 3, fig. 7, 8) and herein as Fig. 17A-D, OD.

Morphology: The dorsal septum is high and short, and the septalium short with anterior margin rounded in outline

Stratigraphy: The species comes from above the Glendoo Sandstone in the lower Moonlight Sandstone in the north Bowen Basin of Queensland.

Fletcherithyris braxtonensis Waterhouse, 1982

Fig. 18A-C, E, F, ?D

1982 *Fletcherithyris braxtonensis* Waterhouse, p. 59, pl. 15f, 17e-l, text-fig. 24, 25.

Diagnosis: Small little inflated shells, almond-shaped, with median groove over posterior third of each valve. Densely punctate.

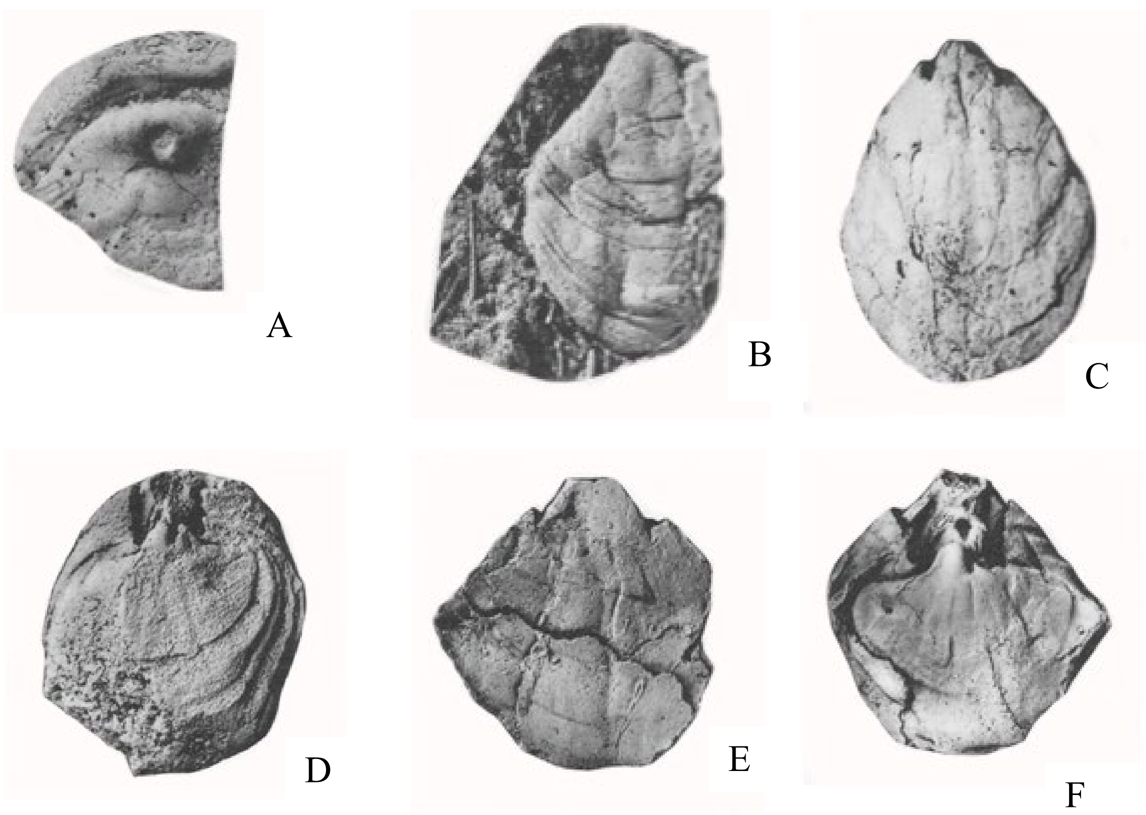


Fig. 18. *Fletcherithyris braxtonensis* Waterhouse. A, umbonal view of PVC cast, ventral valve on top, BR 1693, x2.5. B, cast of ventral exterior, BR 1515, holotype, x3. C, ventral internal mould, BR 847 x3. ?D, dorsal aspect of internal mould, BR 1169, x3. E, F, ventral and dorsal views of internal mould, BR 1515, x3, holotype. A-C, E, F, Letham Burn Member; D, Letham Formation. (Waterhouse 1982).

Holotype: BR 1515 from Letham Burn Member, figured in Waterhouse (1982, pl. 17, fig. j-l) and herein as Fig. 18B, E, F, OD.

Morphology: The dorsal median septum is short and high posteriorly, with low ridge continuing forward. Compared with *Fletcherithyris scotti*, the posterior shell is wider and dental plates lie further apart.

Stratigraphy: The species is known from the Letham Burn Member at Wairaki Downs of southern New Zealand, and a possibly allied specimen comes from the underlying Letham Formation.

Fletcherithyris illawarrensis Campbell, 1965

Fig. 19, 20

?1961 *Fletcherina inversa* [not Koninck] – Stehli, p. 453, pl. 61, fig. 13 (part, not fig. 8, 9, 12, 16, 26) = *Paragilledia ulladullensis*).
1961 *Fletcherina inversa* [not Koninck] – Stehli, p. 453, pl. 61, fig. 8, 9, 12, 16, 26 (part, not pl. 61, fig. 13 = *Fletcherithyris illawarrensis*?).
1965 *Fletcherithyris illawarrensis* Campbell, p. 40, pl. 2, fig. 14-25, pl. 15, fig. 1, text-fig. 14, 15. [Not pl. 14 as in the text).
1968 *F. illawarrensis* – Runnegar, p. 21.
1922b *F. illawarrensis* – Waterhouse, p. 110, Fig.11.

Diagnosis: Small to medium size, strongly biconvex, sinuate or uniplicate anterior commissure, long dental sockets, massive teeth, septalium with concave anterior outline.

Holotype: UNE 6052, with figure not cited and apparently not provided, but stated to have come from the Conjola Formation near Wyro, probably the Wandrawandian Formation, south Sydney Basin. University of New England (UNE) types have been transferred to the Australian Museum.

Fig. 19. *Fletcherithyris illawarrensis* Campbell. A-D, ventral, dorsal, lateral and anterior aspects of UNEF 6064B. E, UNE 6053, ventral aspect. From “Conjola Formation” = Wandrawandian Formation, Wyro, x1 approx. (Campbell 1965).

Morphology: Specimens are well inflated and mostly smooth, apart from a few with plicae, and the median septum is high.

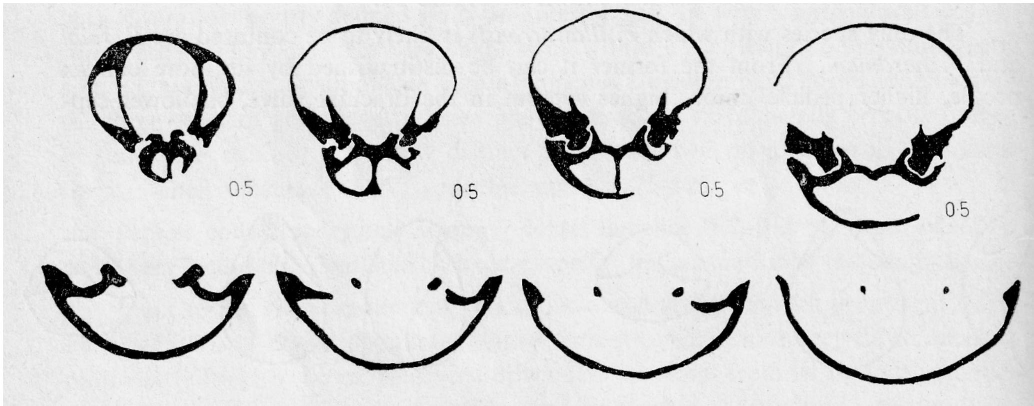


Fig. 20. *Fletcherithyris illawarrensis* Campbell, serial sections at 0.25mm or as indicated in the figure, x3. From Wandrawandian Formation. (Campbell 1965).

Stratigraphy: The stratigraphic range of this species requires clarification. Type material was described from the Conjola Formation, an outdated unit now believed to include several stratigraphic levels, and Wandrawandian Formation appears to have been the original source. Runnegar (1968, p. 21) recorded the same species from what is now called the Scottville Member, somewhat younger than the type locality, and this needs to be confirmed. Campbell (1965) stated that the species occurred some 200ft above or below the "Big Strophalosia Zone" or Scottville Member, and clearly such specimens require further study.

Fletcherithyris parkesi Campbell, 1965

Fig. 21, 22

1898 *Dielasma inversa* [not Koninck] – Etheridge, pl. 1, fig. 4-6, 10,11 (part, not fig. 1-3, *Paragilledia* sp., not fig. 7-9 = *Pseudodielasma campbelli*, not fig. 12, 13 = *Paragilledia ulladullensis*).
1961 *Fletcherina inversa* [not Koninck] – Stehli, p. 453, pl. 61, fig. 13 (part, not fig. 8, 9, 12, 16, 26 = *Paragilledia ulladullensis*).
1965 *Fletcherithyris parkesi* Campbell, p. 43, pl. 8, fig. 1-23, text-fig. 16.
1968 *F. parkesi* – Runnegar, p. 21.
1969 *F. parkesi* – Wass & Gould, pl. 15, fig. 6, 12.
?1982 *F. parkesi*? – Waterhouse, p. 58, pl. 15g.
1987 *F. parkesi* – Clarke, p. 284, Fig. 20A-R.
2022b *F. parkesi* – Waterhouse, p. 111, Fig. 12.

Diagnosis: Moderate in size, mature shell sulciplicate with median ventral fold and dorsal sulcus, dorsal median septum high.

Holotype: UNEF 6048 figured by Campbell (1965, pl. 8, fig. 6-9) from Conjola Formation, now Wandrawandian Formation, Wyro, south Sydney Basin, OD.

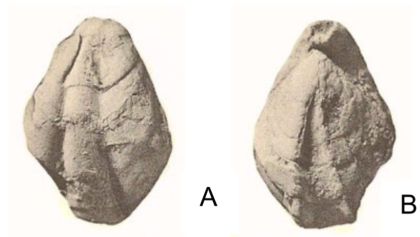


Fig. 21. *Fletcherithyris parkesi* Campbell, ventral and dorsal aspects of AMF 17069 from Gerringong Volcanics, x1 approx. (Campbell 1965).

Morphology: This species is an external homeomorph of *Paragilledia ulladullensis* (Campbel)l, but its interior, shown by Campbell (1965) in specimens that admittedly seem less plicate than the types, is that of *Fletcherithyris*. Such examples include Campbell (1965, pl. 8, fig. 14, 14a, 22. 23) and fig. 16 has only a shallow dorsal sulcus The size is somewhat less than that of mature *ulladullensis.* Campbell (1965, pp. 73, 74) assigned several of the specimens figured as *Dielasma inversa* by Etheridge (1898) to this species.

Stratigraphy: The species was initially described from what appears to be the Wandrawandian Formation in the south Sydney Basin at Wyro, but Campbell also identified the species in the Gerringong Volcanics, as well as 500ft below the “Big Strophalosia Zone” and from above this band and below the *Streptorhynchus pelicanensis* bed in the north Bowen Basin. These occurrences need to be checked, because *Paragilledia* Waterhouse *in* Shi et al. (2020) is also found at some of these levels, externally close to *Fletcherithyris parkesi*, but internally have no septalium or high dorsal median septum. Runnegar (1968) identified this distinctive species from the “Big Strophalosia Zone”, ie. Scottville Member of the north Bowen Basin. A specimen from south Marulan in New South Wales (Wass & Gould 1969) appears close, with deep dorsal sulcus and strong dorsal septum supporting the septalium. Clarke (1987) recorded the species from thoughout his Bernacchian and Lymingtonian Stages of Tasmania, but figured only material from the Malbina E level, which certainly belongs to *Fletcherithyris*. A broad subrounded dorsal internal mould with anterior sulcus from the Letham Burn Member at Wairaki Downs, New Zealand (Waterhouse 1982) could belong to this species or to *Paragilledia*. Its interior is not known.

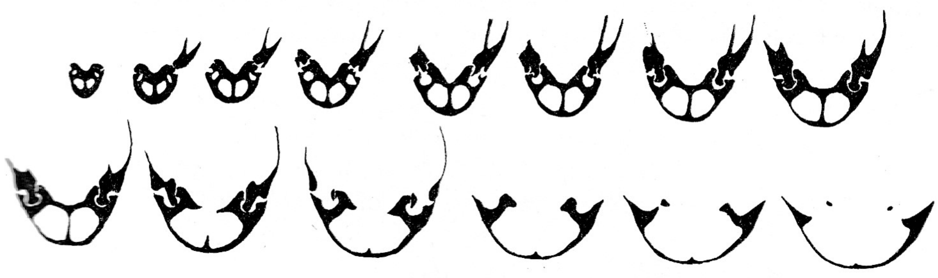


Fig. 22. *Fletcherithyris parkesi* Campbell, serial sections of AMF 21846 at intervals of 0.25mm, x2. From Conjola Group (= Wandrawandian Formation), at Wyro. (Campbell 1965).

Fletcherithyris canni Campbell, 1965

Fig. 23

1965 *Fletcherithyris canni* Campbell, p. 32, pl. 8, fig. 24-31.
1987 *F. biundata* [not M'Coy] – Waterhouse, p. 46, pl. 13, fig. 12-16.
2022a *F. canni* – Waterhouse, p. 14, fig. 5.

Diagnosis: Small inflated elongate shells with maximum width placed usually near mid-length. Posterior walls gently convex and widely divergent in outline, the ventral umbo broad. Septalium elevated high above floor, short with almost straight anterior margin and supported by high median septum.

Holotype: ANU 11988 figured by Campbell (1965, pl. 8, fig. 30, 31) and Fig. 23A, B herein, from probable Nowra Sandstone, south Sydney Basin, OD.

Morphology: The shell is small, highly inflated, with well-formed foramen, commarginal growth increments and growth rugae, and dense punctae. According to Campbell (1965), the septalium tends to be rather short.

Stratigraphy: The source beds were attributed by Campbell (1965) to the Nowra Sandstone, with some hesitation because of the limited nature of the outcrops. Similar-looking specimens come from the Catherine Sandstone of the southwest Bowen Basin and Barfield Formation from the southeast Bowen Basin, and these outcrops seem more like to be correlative with Nowra rather than underlying Wandrawandian beds. However, the internal construct has not been clarified for these specimens.

Fig. 23. *Fletcherithyris canni* Campbell, A, B, dorsal and ventral views of ANU 11988 holotype, x1. Nowra Sandstone, south Sydney Basin. (Campbell 1965). C, E, ventral and dorsal aspects of conjoined specimen UQF 64928, x2. Barfield Formation, southeast Bowen Basin. (Waterhouse 1987). D, F, ventral and dorsal aspects of conjoined specimen UQF 69673 x2 from Catherine Sandstone, southwest Bowen Basin. (Waterhouse 2022a).

Fletcherithyris biundata (M'Coy, 1847)

Fig. 24 - 26

1847 *Terebratula amygdala* [not Catullo 1846 et seq.] – Dana, pp. 54, 152.
1847 *Atrypa biundata* M'Coy, p. 231, pl. 13, fig. 9, 9a.
1849 *T. amygdala* – Dana, p. 682, pl. 1, fig. 2a-c.
1927 *Dielasma sacculum bensoni* Finlay, p. 533.
1961 *Fletcherina amygdala* – Stehli, p. 453, pl. 61, fig. 7, 10, 11, 14, 15, 19-22.
1965 *Fletcherithyris amygdala* – Campbell, p. 26, pl. 3, fig. 1-6, pl. 6, fig. 11-34, text-fig. 7, 8
1969 *F*. cf. *amygdala* – Wass & Gould, pl. 18, fig. 7, 11.
1982 *F. biundata* – Waterhouse, p. 62, pl. 15e, j, pl. 17a, c.
1987 *F. biundata* – Waterhouse, p. 46, pl. 13, fig. 12-16.
1987 *F. biundata* – Clarke, p. 284, Fig. 19A-Z.

Diagnosis: Medium-sized shells with broadly sinuate or sulciplicate anterior commissure, low anterior ventral fold and dorsal sulcus in many specimens. Septalium high and extending for about one fifth of length of valve. Crural points high.

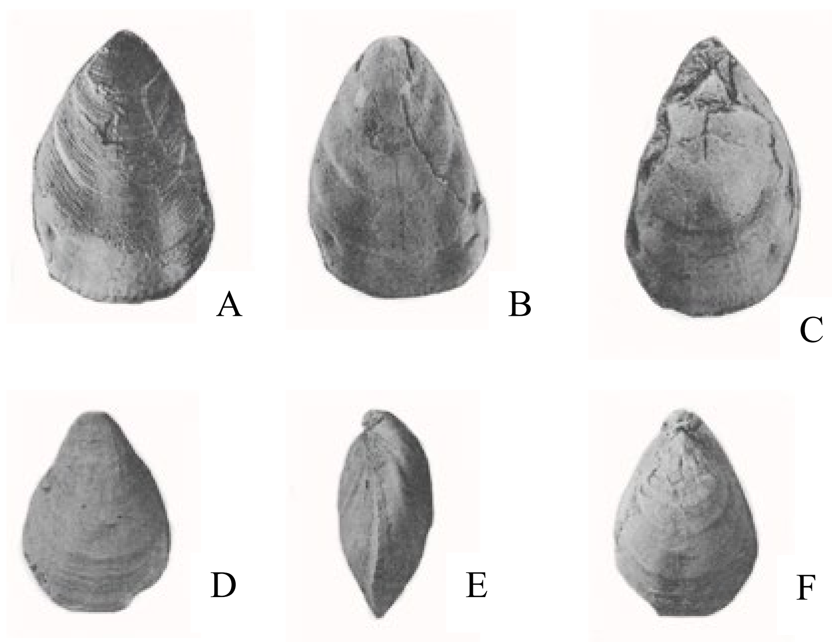


Fig. 24. *Fletcherithyris biundata* (M'Coy) alt. *F. bensoni* (Finlay). A, ventral view ANU 11937 before and B, after leaching in acid. C, dorsal view of same specimen, after leaching. Muree Formation, north Sydney Basin. D-E, lectotype of Dana's *amygdala*, ventral, lateral and dorsal views, USNM 3597, from Gerringong Volcanics, south Sydney Basin. Specimens x1. (Campbell 1965).

Lectotype: SMF 10590 figured by M'Coy (1847, pl. 13, fig. 9, 9a) from Gerringong Volcanics, south Sydney Basin, designated by Waterhouse (1982, p. 63). The lectotype of *Dielasma sacculum bensoni* Finlay is USNMF 35975, figured by Dana (1849, pl. 1, fig. 2a-d) and Campbell (1965, pl. 6, fig. 15-18), designated as the type of *amygdala* Dana [not Catullo] by Campbell (1965, p. 26) from Gerringong Volcanics and shown in Fig. 24D, E herein. In 1982 Waterhouse drew attention to the renaming of *amygdala* as *bensoni* by Finlay (1927), and pointed out that the International Commission of Zoological Nomenclature allowed that a junior synonym as *biundata* M"Coy would be a suitable replacement. The International Code of Zoological Nomenclature, Article 60a states "A subjective synonym retains eligibility as a replacement name (for a homonym, inserted) as long as it is regarded as a synonym of the rejected name". Clarke (1987) preferred to have *biundata* as replacement name, and his lead is followed. The homonymy, replacement name and availability of *biundata* were all overlooked by all Australian workers and by Stehli (1961, 1965) until Waterhouse (1982, 1987) and ignored by Jin et al. (2006, p. 3032).

Morphology: Some of the specimens figured by Campbell (1965) show a number of small radial swellings at the anterior margin.

Stratigraphy: The species is found in the Gerringong Volcanics, and possibly Nowra beds of the south Sydney Basin and Muree Formation in the north Sydney Basin, New South Wales, with further possible occurrences discussed by Campbell (1965, p. 32) and the Flat Top and Barfield Formations of the southeast Bowen Basin, Queensland. As explained by McElroy et al. (1969. p. 365), the Gerringong Volcanics underlie the Illawarra Coal Measures and include several later-

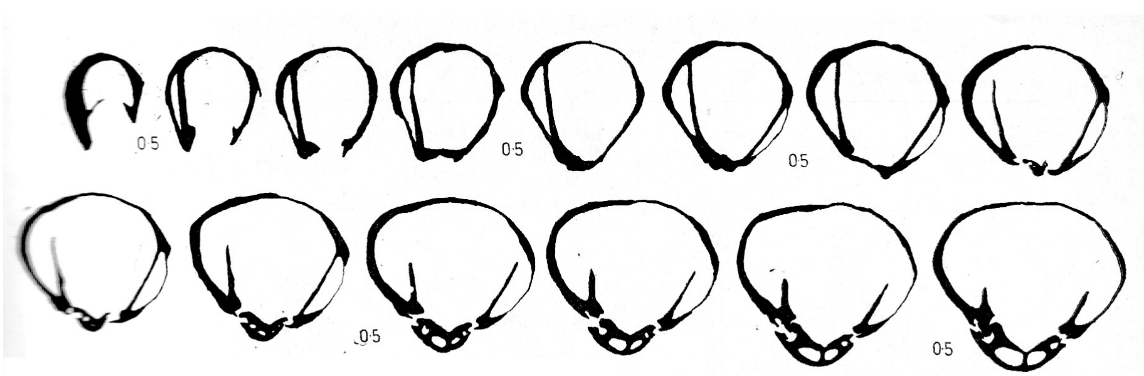


Fig. 25. *Fletcherithyris biundata* (M'Coy). Serial sections mostly at intervals of 0.25mm of AMF 22641, and at 0.5 where indicated. Gerringong Volcanics. (Campbell 1965).

365), the Gerringong Volcanics underlie the Illawarra Coal Measures and include several later-recognized stratigraphic entities, such as the Broughton unit (Raam 1969), which appears to be the likely source of *amygdala* Dana and *biundata* M'Coy.

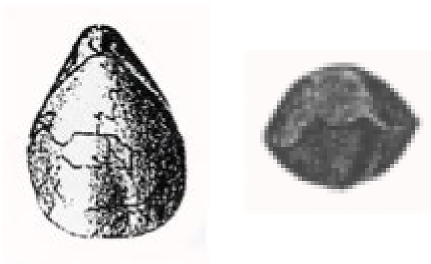


Fig. 26. *Fletcherithyris biundata* (M'Coy), dorsal and anterior aspects of sole figured specimen, holotype, x1 approx. Gerringong Volcanics. (M'Coy 1847).

Fletcherithyris galbina Waterhouse, 1982

Fig. 27, 28

1965 *Fletcherithyris amygdala* [Dana not Catullo] – Waterhouse & Vella, p. 74, pl. 5, fig. 6.
1982 *F. galbina* Waterhouse, p. 60, pl. 14c-f, pl. 15b-d, pl. 16a-k, Text-fig. 24-26.
cf. 1987 *F.* cf. *galbina* – Waterhouse, p. 46, pl. 13, fig. 11.
2022b *F. galbina* – Waterhouse, p. 185, Fig. 44.

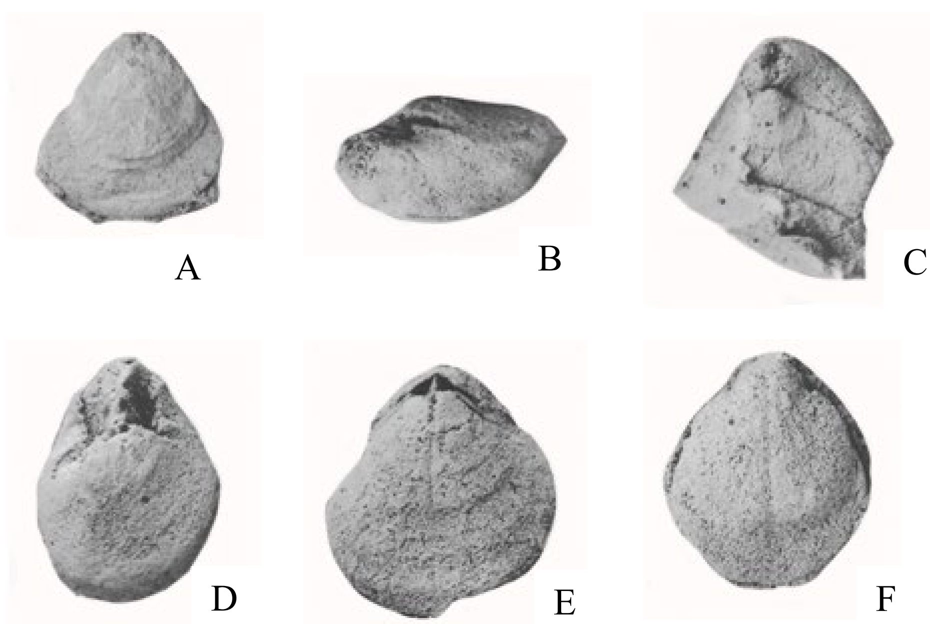


Fig. 27. *Fletcherithyris galbina* Waterhouse. A, ventral valve BR 1130, x3. B, lateral view of specimen with valves conjoined, dorsal valve on top, BR 884, holotype, x3. C, PVC cast of umbonal region, BR 868, x3. D, dorsal aspect of internal mould, BR 884, holotype, x3. E, dorsal view of internal mould, BR 895, x3. F, ventral view of internal mould, BR 1143, x3. Upper Mangarewa Formation. (Waterhouse 1982).

Diagnosis: Small broad and highly inflated subelongate shells with maximum width variably placed between mid-length to well forward. Septalium elevated high above floor, with almost straight anterior margin.

Holotype: BR 854 figured by Waterhouse (1982, pl. 16d-g) and herein as Fig. 27B, D from upper Mangarewa Formation, New Zealand, OD.

Morphology: Shells broad and inflated. The foramen is small with a low pedicle collar and subparallel dental plates, and ventral median ridge in many specimens. The angle of truncation is much higher than for *braxtonensis,* and the shell is thicker and commarginal rugae higher. The septalium extends for a quarter to a third of the length of the valve. Punctate are dense, at 250 per square mm.

Stratigraphy: *Fletcherithyris galbina* is common in the upper Mangarewa Formation of New Zealand. The species has been described from a poorly preserved specimen from the Flat Top Formation of the southeast Bowen Basin as well as better preserved material from the upper Blenheim Formation of the north Bowen Basin in the *Echinalosia* (*Unicusia*) *minima* Zone.

Fig. 28. *Fletcherithyris galbina* Waterhouse. A, latex cast of specimen with valves conjoined, UQF 82706, x4. B, worn ventral internal mould, UQF 82707, x2. From upper Blenheim Formation, *Echinalosia* (*Unicusia*) *minima* Zone. (Waterhouse 2022b).

Fletcherithyris runnegari Waterhouse, 2015b

Fig. 29

1969 *Gilledia homevalensis* [not Campbell] – Runnegar & Ferguson, pl. 2, fig. 21, 22.
1982 *Fletcherithyris* sp. Waterhouse, p. 63, pl. 17b, d.
1987 *Fletcherithyris* n. sp. Waterhouse & Balfe, p. 32, pl. 2, fig. 13-15.
2015b *F. runnegari* Waterhouse, p. 106, Fig. 35.

Diagnosis: Shells with rectimarginate to sulciplicate anterior margin, relatively well-developed radiating riblets over both valves.

Holotype: UQF 45389 from South Curra Limestone (Changhsingian), Gympie, figured by Runnegar & Ferguson (1969, pl. 2, fig. 21, 22), Waterhouse (2015b, Fig. 35A, B), and Fig. 29A, B herein, OD.

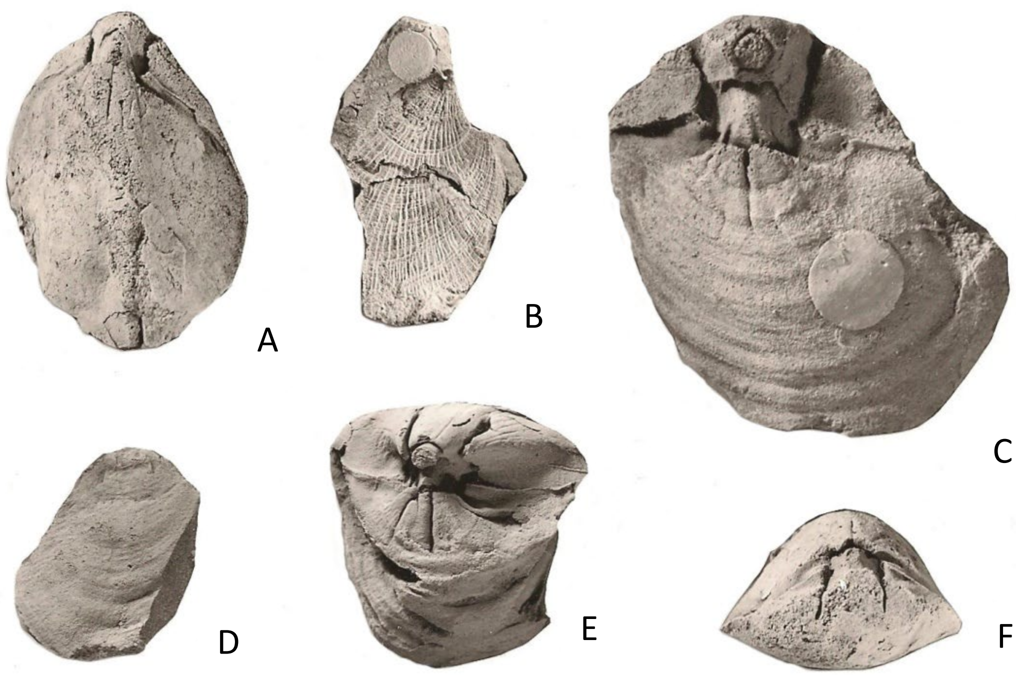


Fig. 29. *Fletcherithyris runnegari* Waterhouse. A, holotype, dorsal aspect of internal mould, UQF 45430, x1. B, external mould of ventral valve, same specimen, x1. C - F, internal mould of specimen UQF 45389, dorsal view, x 1.8, ventral view, x1, posterior ventral view, x 1.5, and posterior view, dorsal valve on top, x1. South Curra Limestone, Gympie. (Waterhouse 2015b).

Morphology: Shell large, holotype measuring approximately 29mm wide, 40mm long and 19mm wide; ventral umbo massive with relatively small foramen 2mm wide, steep but not high posterior walls, anterior margin rectimarginate at first, later develops broad ventral sulcus or flattening, and dorsal valve becoming gently sulciplicate. Surface covered by radiating grooves and broad riblets, six in 5mm posteriorly, increasing by intercalation to ten in 5mm anteriorly, crossing unevenly spaced commarginal grooves that indicate growth pauses and spurts. Well-spaced punctae ca. 60-70 per square mm.

Dental plates sturdy, diverging slightly forward, teeth small, muscle scars not shown, and pedicle collar inconspicuous. Teeth enclosed in socket plates, which are not very thick; dorsal median septum high, supporting septalium of inner and outer hinge plates; base of crura massive.

This species is distinguished by its large size and the strength of its radial ornament. *Fletcherithyris. biundata* M'Coy (see Clarke 1987, Waterhouse 1982, p. 62), is one of the closest species but lacks such well-developed radial ornament and has a broader dorsal septum, and anterior sulcation and plication. *Fletcherithyris burdenae* Waterhouse (2015a, p. 222) has surface ornament of fine riblets, represented in the middle Tiverton Formation of the north Bowen Basin and this species is smaller and more slender than the present species.

This Gympie species was referred to *Gilledia homevalensis* Campbell by Runnegar & Ferguson (1969) in their study of Gympie Permian fossils, but *Gilledia* lacks ventral dental lamellae and high dorsal median septum, and the inner hinge plates are discrete and joined to the posterior floor, rather than uniting medianly as in *Fletcherithyris*.

Stratigraphy: The species comes from the South Curra Limestone, Gympie, and includes rare material from the Kildonan Member of the Bagrie Formation in north Otago, New Zealand.

Tribe **HOSKINGIINI** Waterhouse, 2010, p. 30

Diagnosis: Large shells with dental plates and entire septalium which is sited close to the floor of the valve, and joined to socket plates laterally.

Discussion: Despite the caution expressed by Campbell (1965, p. 54) in expressing reservations over his proposal of the genus *Hoskingia*, with the possibility that it might prove to be *Beecheria* Hall & Clarke, 1893, Waterhouse (2010, pp. 80, 81, text-fig. 34) showed that the dorsal interior of the two genera differed significantly. The ICZN stricture that taxa proposed tentatively were not valid has for *Hoskingia* been widely ignored, including by the *Revised Brachiopod Treatise*, and

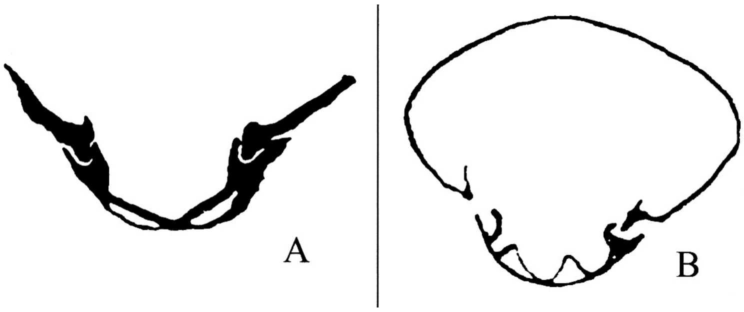


Fig. 30. A, *Hoskingia trigonopsis* (Hosking), cross-section showing sessile septalium extending inwards from socket plates. B, *Beecheria davidsoni* (Hall), showing double-tented structure. Specimens x1, redrawn by Waterhouse (2010, Fig. 34) from Campbell (1965, fig. 21 and 19).

rightly so: the role of scientific caution should not be set aside. In *Beecheria*, the inner and outer sides of both the inner and outer hinge plates arise from the floor of the valve (Fig. 30B). In *Hoskingia*, the outer hinge plate makes contact with the socket plates on the outer side (Fig. 30A) and with the inner hinge plate on the inner side (Campbell 1965, pl. 12, fig. 14, pl. 13, fig. 6, 8, text-fig. 21). Waterhouse (2010, p. 30) showed that Campbell had in part misinterpreted the dorsal interior of *Hoskingia*, and it was concluded that *Hoskingia* marked a distinctive tribe within Dielasmidae. Stehli (1965) referred *Beecheria* to Heterelasminidae, whereas Jin et al. (2006, p. 2039) recognized Beecheridae, following Smirnova (2004a). But these authorities referred *Hoskingia* to that family, surely an error.

Genus ***Hoskingia*** Campbell, 1965

Diagnosis: Comparatively large, dental plates and pedicle collar present, inner hinge plates sessile or almost so.

Type species: *Dielasma trigonopsis* Hosking, 1933, p. 44 from Madeline Formation (Artinskian), Western Australia, OD.

Discussion: *Hoskingia* has been reinterpreted by Waterhouse (2010, p. 80) and shown to be close to Dielasmidae in the development of the septalium and dental plates, whereas Campbell (1965) and Jin et al. (2006, p. 2040) regarded the form as close to *Beecheria* Hall & Clarke, 1893. The dorsal septa in *Beecheria* form a double-tented structure, completely unlike the arrangement in *Hoskingia,* underlining the difference in family relationships (Fig. 30).

Hoskingia glabra Waterhouse, 2015b

Fig. 31A-C

2015b *Hoskingia glabra* Waterhouse, p. 62, Fig. 20.

Diagnosis: Large shells with small pedicle collar, moderately coarse punctae and smooth shell without strong plicae or deep ventral sulcus, no conspicuous radial ornament.

Holotype: QMF 57786 from upper Rammutt Formation (upper Asselian), figured in Waterhouse (2015b, Fig. 20A, C) and herein as Fig. 31A, C, OD.

Description: Shell moderately large, elongate, ventral umbo prominent with small pedicle collar and posterior walls diverging at nearly 50°, persisting beyond mid-length, ventral valve medianly less convex, but without sulcus, bearing slender median groove over at least middle third of length; dorsal valve a little less inflated, posterior walls diverging at 70°, shell raised medianly over mid-length, slightly flatter at anterior margin. Punctae number 13-18 per mm, close to 150 per square mm. Both valves unevenly ornamented by commarginal wrinkles, numbering three in 5mm, more closely spaced in dorsal valve. Faint longitudinal lineations suggested in Fig. 31A, C might be a metamorphic effect.

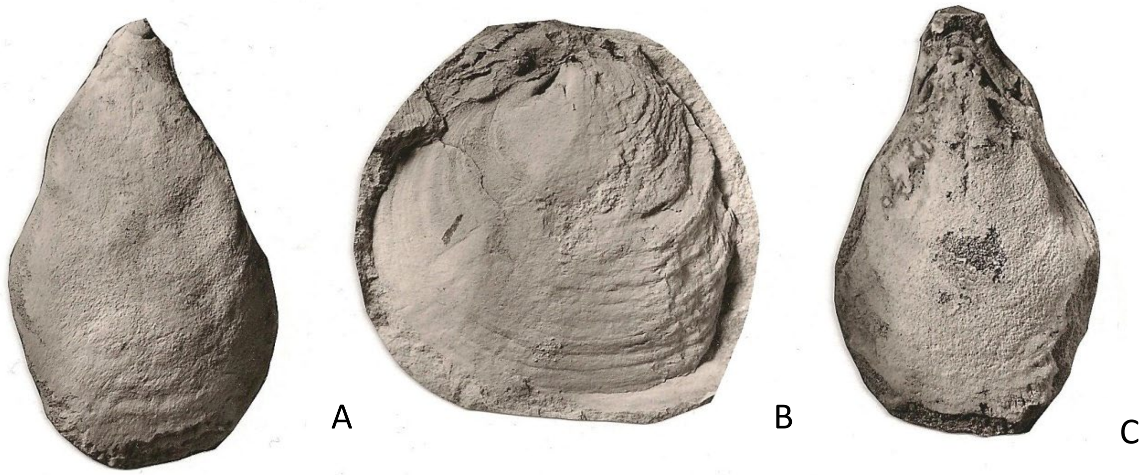


Fig. 31. *Hoskingia glabra* Waterhouse. A, C, ventral and dorsal aspects of holotype, QMF 57786, x1. B, dorsal view of QMF 57787. Specimens x1 from Rammutt Formation, near Gympie, southeast Queensland. (Waterhouse 2015b).

Dental plates slender and close to lateral walls. Muscle scars not clearly impressed. Dorsal sockets long and shallow, cardinal process masked, median ridge extends forward beyond posterior third of shell length, inner hinge plates close to floor of valve, extending for less than a quarter of dorsal valve length as far as can be seen, bearing low crural bases which lie a little closer to the mid-line than to the lateral edges.

he species is distinguished by its lack of ventral sulcus and strong radial ornament, and comes closest to *Hoskingia kennediensis* Campbell (1965, p. 65, pl. 12, fig. 1-3, text-fig.26) from the Bulgadoo Formation (Kungurian) in the north end of the Kennedy Range in Western Australia. The crural bases are based further apart in *kennediensis*, and its hinge is comparatively broader.

Stratigraphy: *Hoskingia glabra* comes from the upper Rammutt Formation near Gympie, southeast Queensland.

Hoskingia sp.

Fig. 32

1987 *Hoskingia* sp. Waterhouse, p. 47, pl. 13, fig. 25.

Ventral valves from the Brae Formation have long posterior walls and flat disc as in *Hoskingia*.

Fig. 32. *Hoskingia* sp. UQF 70290 from Brae Formation, southeast Bowen Basin, Queensland. (Waterhouse 1987).

Family **GILLEDIIDAE** Campbell, 1965

Diagnosis: Shells large, no dental plates, crura arising from crural plates sited on floor of valve or uniting to form sessile septalium.

Subfamily **MAORIELASMINAE** Waterhouse & Piyasin, 1970

Diagnosis: Large shells without dental lamellae, large and well formed septalium.

Name genus: *Maorielasma* Waterhouse, 1964, p. 95 from the upper Mangarewa Formation of southern New Zealand, OD.

Discussion: *Maorielasma* Waterhouse, 1964 is widespread in eastern Australia (Campbell

1965), and is based on *M. imperatum* Waterhouse from the upper Mangarewa Formation of upper Capitanian age in New Zealand. It differs from *Hoskingia* Campbell in lacking dental plates, and is placed in Maorielasminae Waterhouse & Piyasin, 1970, p. 95. Because of the absence of dental plates and commissural plication, the genus was treated as a member of Gillediidae by Campbell (1965) and Jin et al. (2006), even though the nature of the cardinalia strongly suggests a position within Dielasmidae. *Hoskingia* Campbell is a large dielasmatid with large septalium adpressed against the floor, and with dental plates, and *Maorielasma* therefore approaches that genus. The Early Carboniferous genus *Balanoconcha* Campbell, 1957 is also large without dental plates, and has a large septalium, attached laterally to socket plates, and said to be sessile anteriorly, although not all detail is clear. Jin et al. (2006, p. 2041) attached less significance to the nature and development of the septalium, and therefore included *Balanoconcha* and *Maorielasma* in an undivided Gillediiidae, a position that seems challengeable, with *Balaniconcha* indicating that Maorielasminae began well before *Gilledia*. That suggests *Gilledia* developed from Maorielasminae under the strong influence of a very cold climate.

Genus ***Maorielasma*** Waterhouse, 1964

Diagnosis: Shell large, teeth not supported by dental plates, foramen present. Dorsal valve with slender socket plates and well-developed septalium formed chiefly by inner hinge plates which bear crura, sessile as a rule. No radial plicae or riblets.

Type species: *Maorielasma imperatum* Waterhouse, 1964, p. 175 from upper Mangarewa Formation (late Capitanian) of New Zealand, OD.

Maorielasma balfei Waterhouse, 2015a

Fig. 33

2015a *Maorielasma balfei* Waterhouse, p. 228, Fig. 183.

Diagnosis: Medium size for genus, ventral posterior walls long, weakly concave or concavo-convex in outline, maximum width placed well forward, ventral valve with sulcus that is narrow posteriorly and broadens anteriorly and may bear median swelling.

Holotype: UQF 81414 from Tiverton Formation, figured in Waterhouse (2015a, Fig. 183A) and Fig. 33A herein, OD.

Morphology: Shell elongate, maximum width just in front of mid-length, ventral valve with slender median channel and broad and shallow anterior sulcus, large permesothyrid foramen with well-formed labrum, no radial ornament, no dental plates. The dorsal valve has septalium, dental sockets that are broad, and sturdy but low median septum.

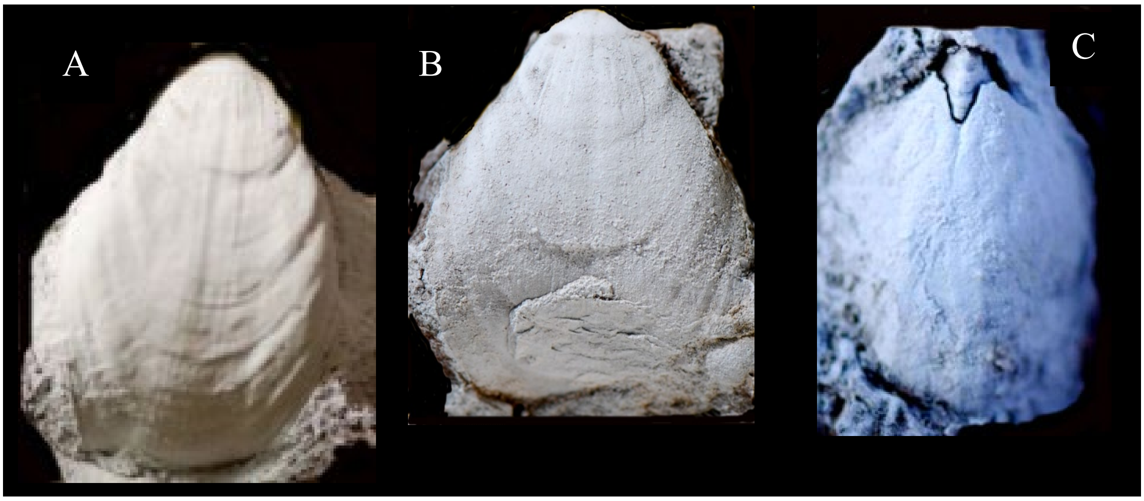


Fig. 33. *Maorielasma balfei* Waterhouse. A, holotype, ventral valve UQF 81414, x2. B, ventral valve UQF 81435, x2. C, dorsal internal mould UQF 81613, x1.5. Tiverton Formation. (Waterhouse 2015a).

No species so far described from east Australia or New Zealand comes close in shape. The species *Maorielasma inflata* Waterhouse (1987, pl. 13, fig. 17-19) from the Roses Pride Formation, southeast Bowen Basin, is closest in age, but valves are much more swollen. Two further species from the Middle Permian of east Australia, *M. callosum* Campbell (1965) from the Ingelara Shale, Barfield Formation and Flat Top Formation in the Bowen Basin, and *M. globosum* Campbell (1965) from the Mantuan shell bed in the Peawaddy Formation of the southwest Bowen Basin are larger with posterior ventral walls more rounded in outline, and no ventral groove or anterior sulcus.

Stratigraphy: The species comes from the *Magniplicata undulata* Zone, and a possible dorsal valve comes from the *Taeniothaerus subquadratus* Zone in the Tiverton Formation.

Maorielasma sp.

Fig. 34

1982 *Maorielasma* sp. Waterhouse, p. 64, pl. 18c, 19n.

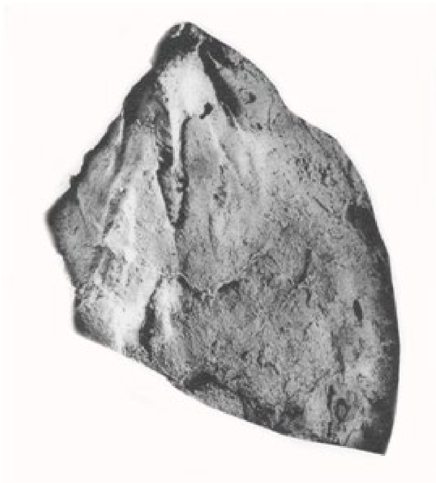


Fig. 34. *Maorielasma* sp., dorsal interior BR 893 x1.5 from *Notostrophia zealandicus* Zone of Brunel Formation, New Zealand. (Waterhouse 1982).

The dorsal internal mould of a large specimen from the Brunel Formation of southern New Zealand was assigned to *Maorielasma* by Waterhouse (1982) and the septalium is complete. The shell is less inflated than in *M. inflata* from the slightly younger beds of Roses Pride Formation, but not enough material is available for adequate comparison with M. *balfei* from the slightly older Tiverton Formation of Queensland.

Maorielasma inflata Waterhouse, 1987

Fig. 35

1987 *Maorielasma inflata* Waterhouse, p. 47, pl. 13, fig. 17-19.

Diagnosis: Broad relatively well-inflated shells with large foramen and fine punctae, brachidium large.

Holotype: UQF 74258 from Roses Pride Formation, figured by Waterhouse (1987, pl. 13, fig. 17-19 and herein as Fig. 35A, C, OD.

Morphology: Shells over 40mm in length at maturity, small specimens relatively less inflated. The brachidium is sessile.

Stratigraphy: The species is known from the Roses Pride Formation of the southeast Bowen Basin in Queensland. The dorsal valve from the *Notostrophia zealandicus* Zone in the Brunel Formation of the Takitimu Group in New Zealand as shown in Fig. 34 appears to be less inflated and more elongate, and so closer to *Maorielasma balfei*.

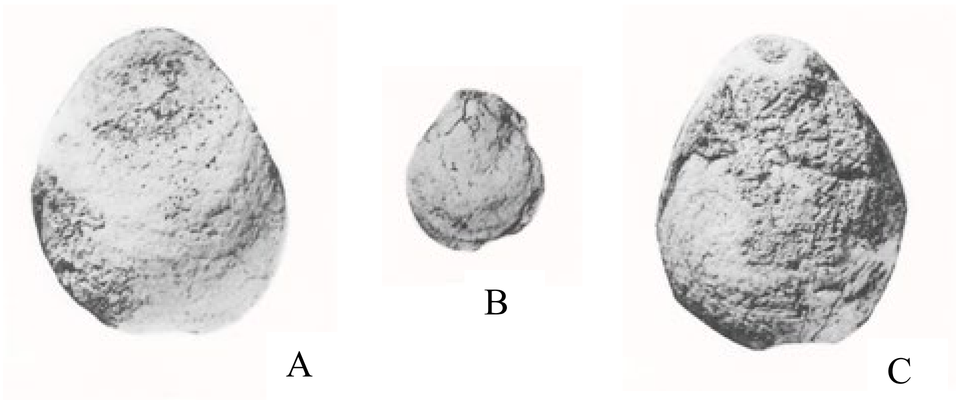


Fig. 35. *Maorielasma inflata* Waterhouse. A, C, ventral and dorsal aspects of holotype, UQF 74258. B, dorsal view, UQF 74259. Specimens x1, from Roses Pride Formation, southeast Bowen Basin. (Waterhouse 1987).

Maorielasma callosum Campbell, 1965

7Fig. 36

1953 *Maorielasma callosum* Campbell, p. 96, pl. 4, fig. 20-25, pl. 14, fig. 1-8.
1983 *M. callosum* – McClung, p. 69, Fig. 11.1, 3, 4.
1987 *M. callosum* – Waterhouse, p. 48. pl. 13, fig. 23.
1988 *M. callosum* – Parfrey, p. 20, pl. 5, fig. 1-3, 6, 7.

Diagnosis: Large globose shells with relatively small foramen, septalium that is V-shaped in most specimens and short, extending for 0.24 to 0.32 the length of the dorsal valve.

Holotype: CPC 5941 from Ingelara Formation, figured by Campbell (1953, pl. 14, fig. 6), OD.

Morphology: The labrum is short and teeth are supported by callus in most specimens according to the original description. *Maorielasma callosum* Campbell is less elongate than the preceeding three species in this text, with a relatively short septalium.

Stratigraphy: The species was recorded from the Ingelara, Barfield and Flat Top Formations by Campbell (1965), from Ingelara to Mantuan beds by Parfrey (1988), and the Flat Top Formation by Waterhouse (1987), as well as small specimens from interval E in the GSQ Eddystone 1 bore (McClung 1983). Reports of the species near Gympie by Waterhouse (1982) and in the *Plekonella multicostata* Zone of the Kildonan Member in New Zealand are discounted, and these specimens are reallocated to *Fletcherithyris runnegari*. As well,

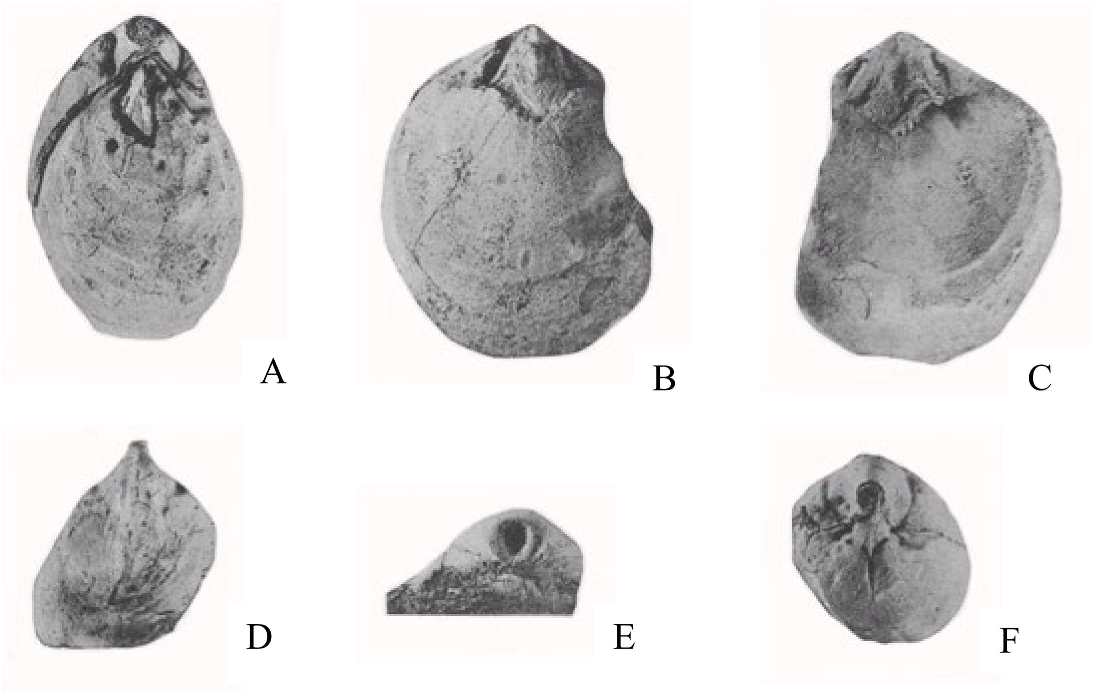


Fig. 36. *Maorielasma callosum* Campbell. A, dorsal view of internal mould CPC 5945, B, C, dorsal internal mould and latex cast, GSQ 5955. D, ventral internal mould, CPC 5942. E, ventral umbo, CPC 5945. F, postero-dorsal aspect of internal cast, showing pseudo-dental lamellae, CPC 5942. A, D-F from Ingelara Formation (or lower Peawaddy Formation), B, C from Barfield Formation, specimens x1. (Campbell 1965).

ascription of the dorsal valve BR 1247 from the Kildonan Member of the Bagrie Formation in New Zealand to ?*callosum* by Waterhouse (1982, pl. 18e) is set aside. The specimen is rounded and of similar size to7 *callosum* but has dental plates, suggesting identification with *Fletcherithyris runnegari*.

Maorielasma globosum globosum Campbell, 1965

Fig. 37, 38

1964 "*Dielasma*" sp. Hill & Woods, pl. P7, fig. 5, 6.
1965 *Maorielasma globosum* Campbell, p. 97, pl. 4, fig. 1-28, pl. 14, fig. 9-12, 16, pl. 14, fig. 9-12, 16 (part, not pl. 14, fig. 13-15 = cf. *imperatum*).
1972 *M. globosum* – Hill et al., pl. P7, fig. 5, 6.
?1982 *M. globosum* – Waterhouse, p. 65, pl. 18, fig. f, g.
1987 *M. imperatum* [not Waterhouse] – Waterhouse, p. 48, pl. 13, fig. 22, 24.

Diagnosis: Shells with more rounded outline than *imperatum* and strongly biconvex. Large foramen, lateral and anterior commissures weakly sinuate, septalium averages 0.35 length of dorsal valve, supported in a few specimens by a low septum.

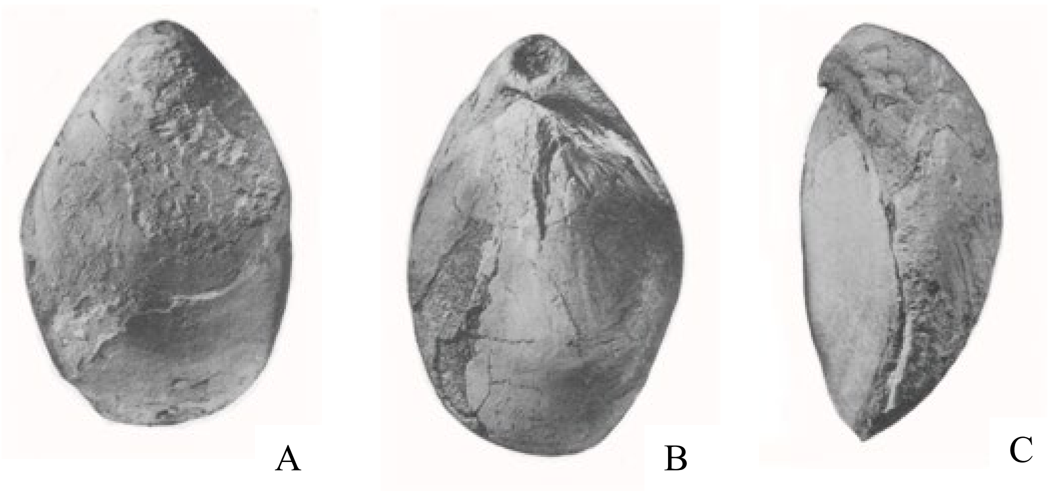


Fig. 37. *Maorielasma globosum* Campbell. A-C, ventral dorsal and lateral aspects of holotype, GSQ 2253 x1, from Mantuan Member, southwest Bowen Basin. (Campbell 1965).

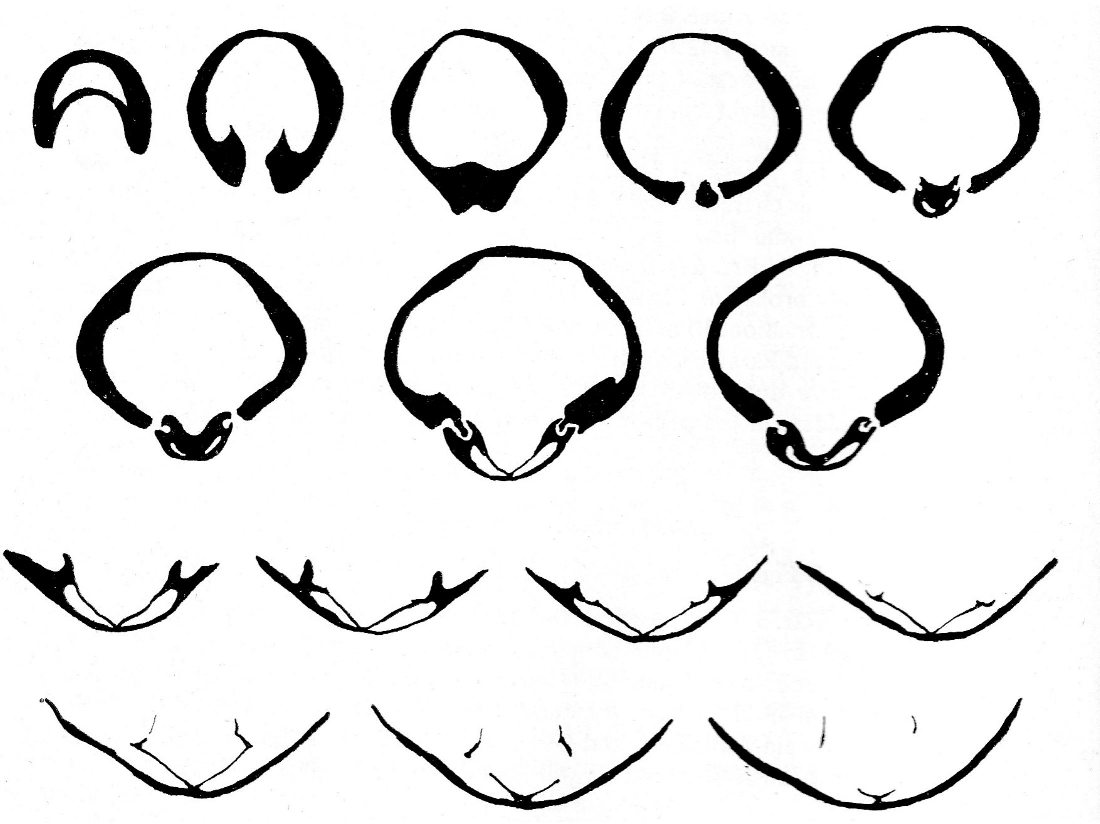


Fig. 38. *Maorielasma globosum* Campbell, serial sections compiled from two individuals at intervals of about 1mm. Mantuan Member, southwest Bowen Basin. (Campbell 1965).

Holotype: GSQ 2253 from Mantuan Member, figured by Campbell (1965, pl. 4, fig. 13-16) and herein as Fig. 37A-C, OD.

Morphology: Campbell (1965, p. 99) noted that the pedicle collar was thick and long, and claimed that *Maorielasma imperatum* differed because of its smaller size, smaller septalium and less thickened umbonal shoulders. To me size and shell thickening reflect in this instance ecological differences, and the statement about relative septalial length is incorrect.

Stratigraphy: The species comes from the Mantuan Member of the Peawaddy Formation and the Flat Top Formation in the southwest and southeast Bowen Basin. Possibly the species is present in the lower Mangarewa Formation of Wairaki Downs in New Zealand.

Maorielasma globosum deflatum Waterhouse, 2022a

Fig. 39

2022a *Maorielasma deflatum* Waterhouse, p. 88, Fig. 18.

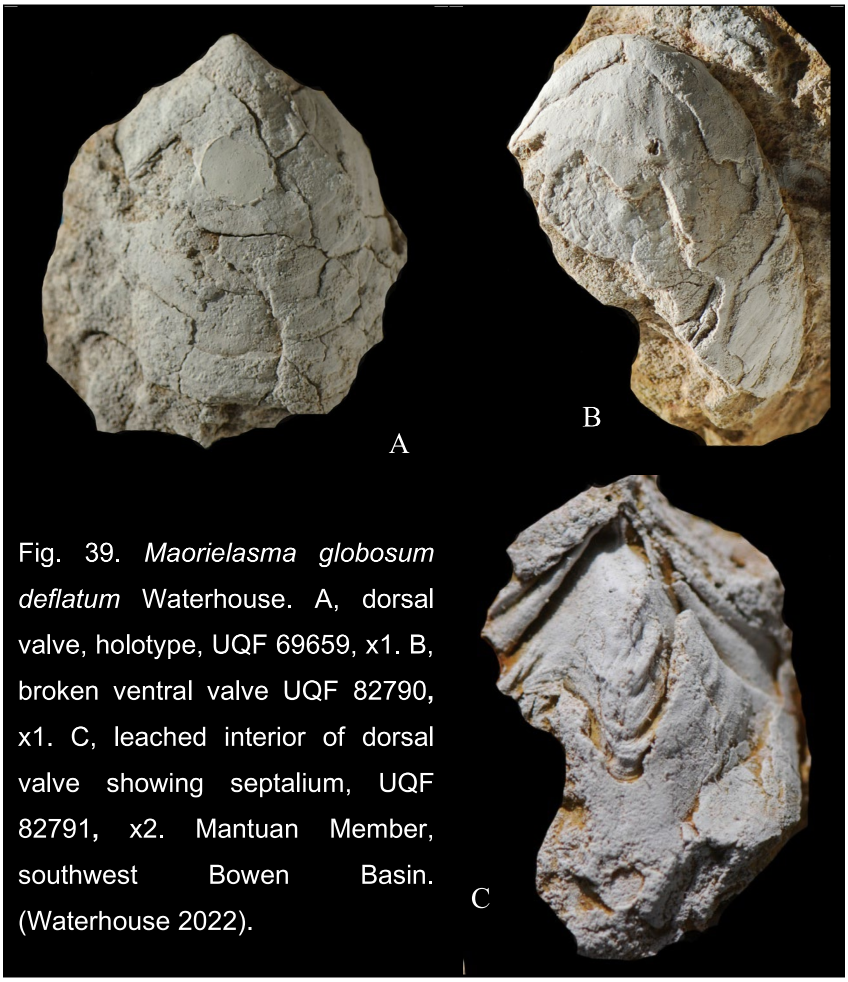


Fig. 39. *Maorielasma globosum deflatum* Waterhouse. A, dorsal valve, holotype, UQF 69659, x1. B, broken ventral valve UQF 82790, x1. C, leached interior of dorsal valve showing septalium, UQF 82791, x2. Mantuan Member, southwest Bowen Basin. (Waterhouse 2022).

Diagnosis: Medium large but little inflated shells with full posterior shoulders, moderately long septalium with anterior margin arching well forward.

Holotype: UQF 69659 from Mantuan Member, southwest Bowen Basin, figured in Waterhouse (2022a, Fig. 18A) and herein as Fig. 39A, OD.

Morphology: Valve are large, wide and not very inflated, and close in shape to other species, especially *globosum*. The septalium is large and almost sessile, with anterior margin arching forward, showing anterior growth lines over the anterior median section. Crural bases are widely spaced, lying close to the lateral margin. A very low broad ridge lies in front, with no visible median septum. The taxon is interpreted as a subspecies of *globosum*.

Stratigraphy: The subspecies is found in the Mantuan Member of the southwest Bowen Basin. But possibly the Mantuan Member has more than one faunal level, a matter yet to be clarified.

Maorielasma imperatum Waterhouse, 1964

Fig. 40, 41

1964 *Maorielasma imperatum* Waterhouse, p. 175, pl. 34, fig. 3-5.
cf. 1965 *M. globosum* [not Campbell] – Campbell, pl. 14, fig. 13-15 (part, not pl. 4, fig. 1-28, pl. 14, fig. 9-12, 16 from Mantuan Member = *globosum globosum*).
1982 *M. imperatum* – Waterhouse p. 65, pl. 18a.
2022b *M. imperatum* – Waterhouse, p. 112, Fig. 13.

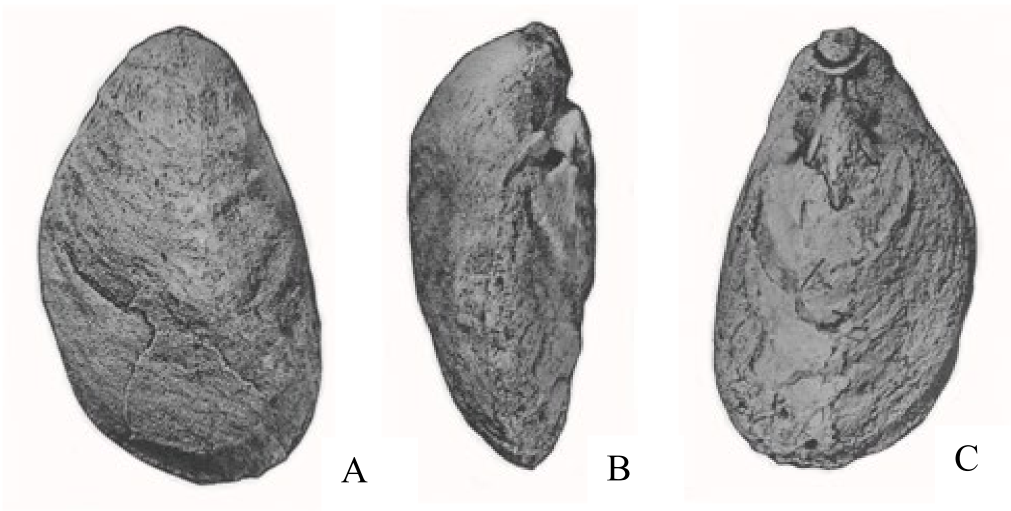


Fig. 40. *Maorielasma imperatum* Waterhouse. A, B, C, ventral, lateral and dorsal aspects of internal mould, BR 869, holotype, x1.5. From upper Mangarewa Formation, New Zealand. (Waterhouse 1964).

Diagnosis: Elongate shells with highly arched dorsal valve, long septalium and wide crural plates steeply inclined from the socket plates.

Holotype: BR 896 figured by Waterhouse (1964, pl. 34, fig. 3-5) and herein as Fig. 40A-C from *Ingelarella costata* Zone, upper Mangarewa Formation, New Zealand, OD.

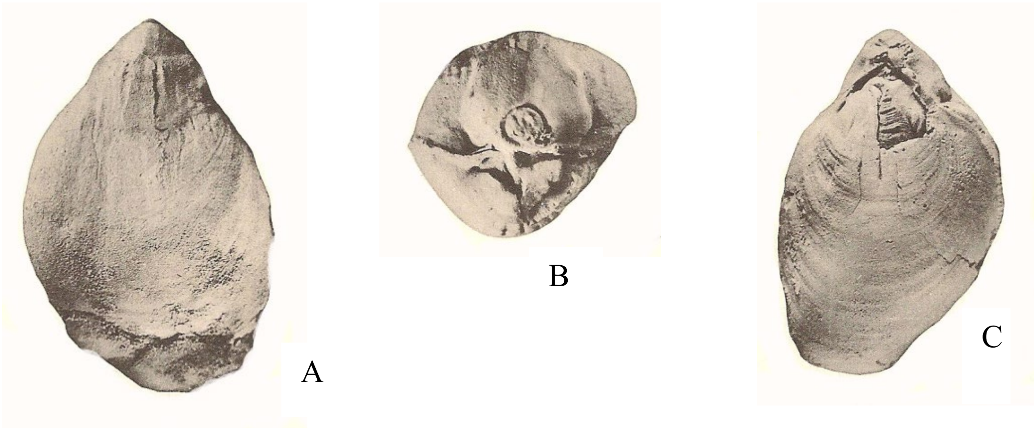


Fig. 41. *Maorielasma* cf. *imperatum* Waterhouse, A-C, ventral, posterior (ventral valve on top in Fig. 13B), and dorsal aspects of specimen GSQF 5956 from Scottville Member, north Bowen Basin, x1. (Campbell 1965).

Morphology: *Maorielasma imperatum* Waterhouse is close to *M. globosum* Campbell, 1965. Campbell (1965) assumed that the septalium in the New Zealand type for *imperatum* was shorter than in the Queensland specimens assigned to *globosum* but the relative length of the septalium is much the same in both suites, with a length close to 3.5 in the type of *imperatum*, essentially the same as in *globosum*. The large umbonal foramen is found in both suites. The difference in size means little, the New Zealand specimens having a more compact ontogeny, consistent with other species found in the New Zealand Permian faunas. The shape of the New Zealand type is obviously affected by distortion on one side, to slightly compress the width, and some Australian specimens are narrower than others (Campbell 1965, pl. 14, fig. 13-15; Waterhouse, 1987, pl. 13, fig. 22). The types of *globosum* came from the Mantuan Member (Campbell 1965, pl. 4, fig. 13-16), whereas a slightly narrower specimen figured by Campbell (1965, pl. 14, fig. 13-15) came from the younger Scottville Member, and is closer in width to *imperatum*, which came from the *Ingelarella costata* Zone in New Zealand. The Scottville material seems to show a cardinal process like that of *imperatum* and the present material. The species *globosum* is distinguished by its globose ventral valve more rounded in outline, compared with the more elongate *imperatum,* which has an extended and relatively narrower umbonal portion.

Stratigraphy: The species is found in the upper Mangarewa Formation at Wairaki Downs, New Zealand and is close to material from the Scottville Member (Fig. 41) of the north Bowen Basin, Queensland.

Subfamily **GILLEDINAE** Campbell, 1965

Diagnosis: Shells smooth or simply plicate, shoulders of ventral valve with thick callus deposits. No dental plates, inner hinge plates rarely united, usually sessile and may be difficult to discern, or lost, and arise separately from the floor of the valvecrura arise close to junction of inner and outer hinge plates, no median septum.

Name genus: *Gilledia* Stehli, 1961 from New South Wales.

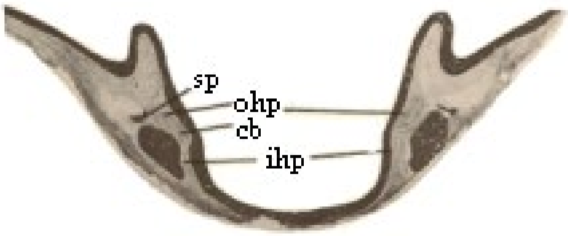


Fig. 42**.** *Gilledia culburrensis* Campbell, section of dorsal valve showing dental sockets and inner and outer hinge plates, from Campbell (1965, pl. 17, fig. 4), x8 approx. cb = crural base; ihp = inner hinge plate; ohp = outer hinge plate; sp = end of tooth from ventral valve. (Campbell 1965).

Discussion: The genus was classed in Gillediinae Campbell, with Hemiptychininae Campbell as a sister subfamily, both placed in Family Gillediidae Campbell, by Campbell (1965), as followed by Jin et al. (2006), whereas Stehli (1965) classed the genus in Heterelasminidae Likharev, 1956, which it somewhat approaches internally to the extent that the septalium is not fully formed, though differences are substantial. Waterhouse & Piyasin (1970) placed *Gilledia* in Gillediinae Campbell, Family Heterelasminidae Likharev. The type species of *Heterelasmina* Licharew, 1939, *Hemiptychina dieneri* Gemmellaro, 1899 from Sicily, lacks dental plates, like *Gilledia*, and unlike Gillediidae has crura arising each from a slender subvertical plate from the floor of the valve, between the dental sockets, to form a clavis, as opposed to a septalium.

The general diagnosis for Gillediidae provided by Jin et al. (2006) stated that outer hinge plates were attached to socket ridges, or directly to the floor of the valve, and that inner hinge plates were absent or small and joined to the floor of the valve along their inner edges, or broad and uniting to form a sessile septalium. Waterhouse (2010) demonstrated that for *Gilledia* Stehli, type species *Terebratula cymbaeformis* Morris, 1845, the outer hinge plates were attached to the socket plates, and joined by low inner hinge plates resting on the floor of the valve, and bearing the crural bases. The relationship is especially well-illustrated for *G. culburrensis* by Campbell (1965, pl. 17, fig. 3-5) as reproduced in Fig. 42. The dorsal interior approaches that of Tribe Plectelasmini Waterhouse, 2010, p. 80, based on Permian genera in west Texas, and *Gilledia* is distinguished from that tribe by the lack of dental plates from the ventral valve, and also by the larger size. Other genera that appear to show essentially similar interior include *Pyandzhelasma* Smirnova & Grunt, and *Tacinia* Glushenko. *Aneuthelasma* Cooper & Grant (1976, pl. 762, fig. 26-61), although included in Gillediidae by its authors as accepted uncritically by Jin et al. (2006, p. 2041), lacks dental plates and outer hinge plates, as affirmed by Cooper & Grant (1976). They described inner hinge plates as short and low, and nearly erect, suggesting a position within Heterelasminidae. *Camerelasma* Cooper & Grant (1976, pl. 745, fig. 57, pl. 763, fig. 36-51, pl. 764, fig. 1-20) may be similar: figures are obscure and the text not clear, but it seems possible that the genus is close to *Aneuthelasma*.

The fact that outer hinge plates are developed, and that inner hinge are frequently present, though generally incomplete and may be somewhat obscured by their mergence with the floor of the valve suggests that the dorsal valve strongly approaches that of Dielasmidae, and conceivably had evolved from that family. Given that few genera are referred to the group, it could be regarded as a largely Australian-based modification from within Dielasmidae, probably Maorielasminae, and might be well regarded as a subfamily within Dielasmidae. Alternatively, and closer to the view expressed by Campbell (1965), Gillediiidae could constitute a separate family, closely allied to Dielasmidae, and distinguished by its loss of dental plates and larger size, and so incorporating Maorielasminae as an ally.

Genus ***Gilledia*** Stehli, 1961

Diagnosis: Small to large shells with short terebratuliform loop, transverse band often incomplete.

Type species: *Terebratula cymbaeformis* Morris, 1845, p. 278 from Raymond Terrace, possibly upper Elderslie Formation or more likely Muree Formation (Roadian), north Sydney Basin, New South Wales, OD. Campbell did not identify the stratigraphic unit involved.

Discussion: This genus was discussed in Waterhouse (2010, pp. 83, 84), in showing that the outer hinge plates were normally if not always attached to the socket plates, and did not connect with the floor of the valve to form a tented structure, unlike the arrangement in *Beecheria* Hall & Clarke. Whether the inner hinge plates are absent from *Gilledia*, or small or joined directly to the floor of the valve along the inner edges or broad and united in sessile septalium as stated in Jin et al. (2006, p. 2041) appears contentious: they relied partly on Campbell (1965), who included *Marinurnula* in the family, an error because *Marinurnula* belongs to a different family with different plates. Some of the species of *Gilledia*, including the type, have a broadly flattened median ventral valve, whereas others are more swollen medianly.

Gilledia fairylandensis Waterhouse, 1987

Fig. 43A-D

1987 *Gilledia fairylandensis* Waterhouse, p. 49, pl. 1, fig. 2, pl. 13, fig. 1, 2, 27, 28.

Diagnosis: Shells small at maturity, with narrow and shallow sulcus and moderately arched dorsal valve.

Holotype: UQF 74264 from Fairyland Formation, figured in Waterhouse (1987, pl. 13, fig. 1, 2) and herein as Fig. 43A, B, OD.

Morphology: The species is distinguished by its shallow narrow ventral sulcus, and is smaller than other known species.

Stratigraphy: The species comes from the Fairyland Formation of the southeast Bowen Basin.

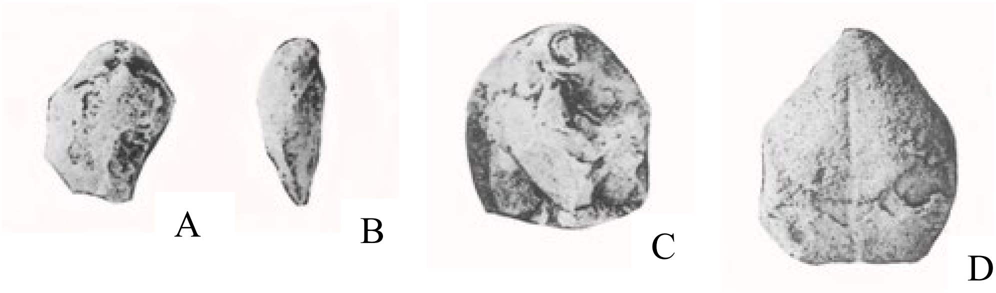


Fig. 43. *Gilledia fairylandensis* Waterhouse. A, B, dorsal and ventral views of holotype UQF 72464, x1. C, dorsal aspect of UQF 80002, x2. D, ventral valve UQF 73000 x2. Fairyland Formation. (Waterhouse 1987).

Gilledia homevalensis Campbell, 1965

Fig. 44 - 49

1964 *Gilledia* sp. Hill & Woods, pl. P7, fig. 1-4.
1965 *Gilledia homevalensis* Campbell, p. 74, pl. 1, fig. 1-27, text-fig. 27-29 (part, not pl. 9, fig. 33-41 = *Gilledia* n. sp. from Western Australia)
1972 *G. homevalensis* – Hill, Playford & Woods, pl. P7, fig. 1-4.
2006 *G. homevalensis* – Jin et al., p. 2041 (part), Fig. 1349. 1e.
2015a *G. homevalensis* – Waterhouse, p. 226, Fig. 180-182.

Diagnosis: Moderately large shells with broad anterior flattening of sulcus ventrally, dorsal valve well inflated, surface marked by divaricating very low ribs, foramen strongly labiate, inner and outer hinge plates very narrow, dorsal pedicle adjustor scars short. Holotype: UQF 20825 from unstated level in Tiverton Formation, Homevale, figured by Campbell (1965, pl. 1, fig. 15-19) and herein as Fig. 45A-C, OD.

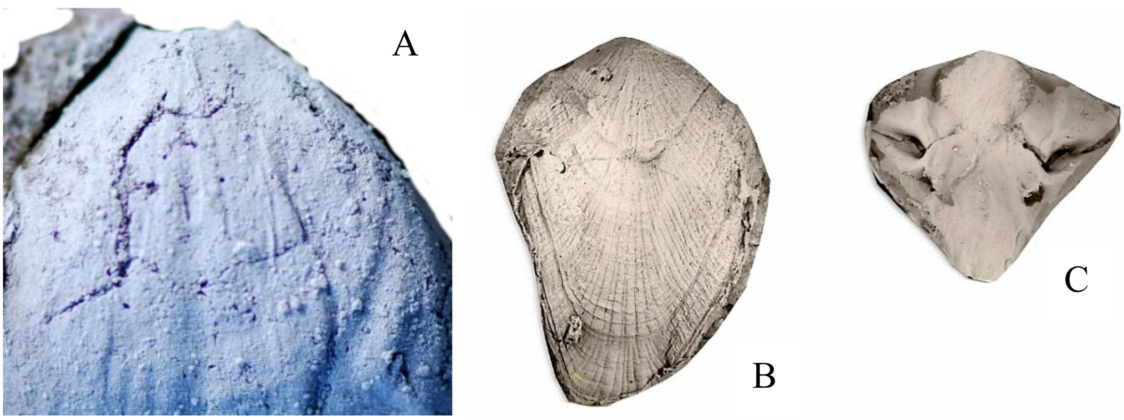


Fig. 44. *Gilledia homevalensis* Campbell. A, posterior ventral internal mould showing floor markings, UQF 81439, x2. B, latex cast of ventral valve UQF 81415, x1. C, latex cast of cardinalia, ventral valve on top, UQF 81416, x1.5. Tiverton Formation. (Waterhouse 2015a).

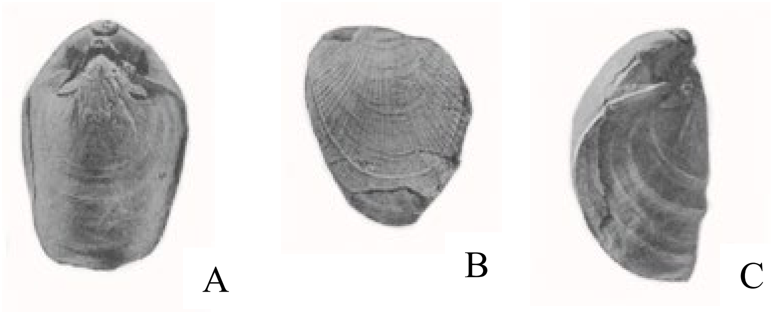


Fig. 45. *Gilledia homevalensis* Campbell. A, B, C, UQF 20825, holotype, x1, dorsal view of internal mould, B, ventral exterior, and C, lateral view of internal mould. Tiverton Formation. (Campbell 1965).

Morphology: Surface grooves radiate from the middle of the shell, aligned longitudinally along the centre and curve to each side towards the anterior lateral margin. No dental plates are developed, and muscle impressions lie over the posterior ventral valve. The hinge plates arise from the floor of the valve, and extend laterally to join the socket plates. There is no median septum. Crura arise from close to the junction of the inner and outer hinge plates. Specimens figured as *homevalensis* by Campbell (1965, p. 79, fig. 33-41) from Western Australia are markedly younger than *homevalensis* and seem unlikely to be conspecific.

Stratigraphy: This species is found in the *Magniplicatina undulata* Zone, and rarely in *Taeniothaerus subquadratus* Zone in the Tiverton Formation. It was described by Campbell (1965) from the Tiverton Formation at Homevale, as well as from the Dilly beds (now River-

Fig. 46. *Gilledia homevalensis* Campbell, dorsal aspect of internal mould UQF 81418, x 3. Tiverton Formation. (Waterhouse 2015a).

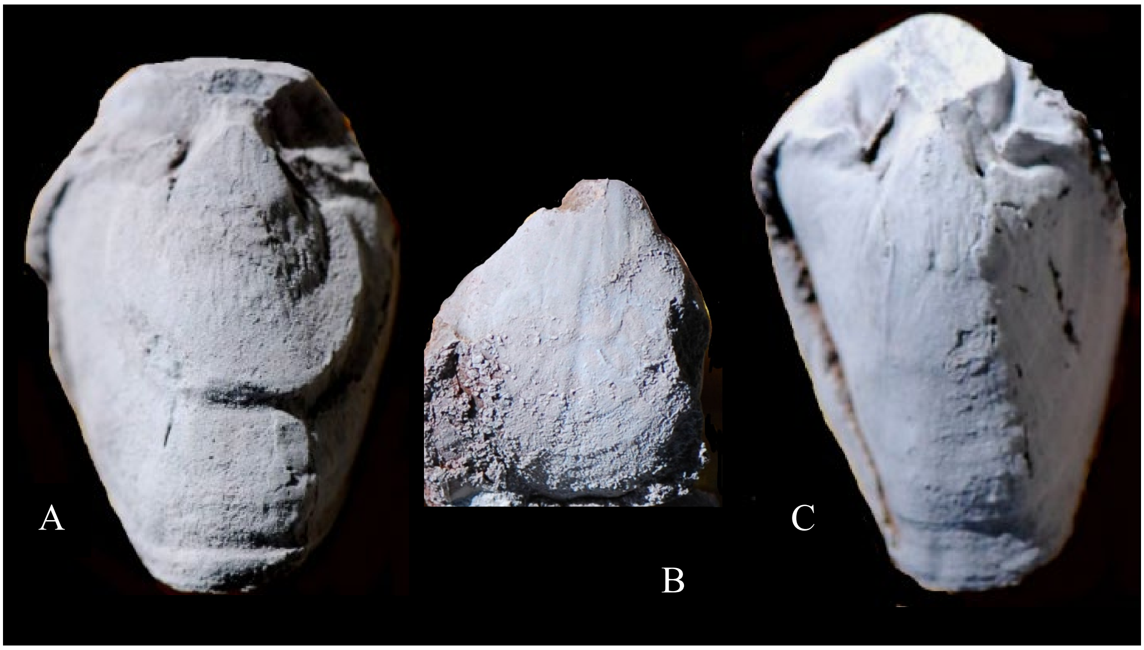


Fig. 47. *Gilledia homevalensis* Campbell. A, dorsal aspect, internal mould of specimens with valves conjoined, UQF 81416, x2. B, ventral aspect of specimen with valves conjoined, UQF 81418, x2. C, dorsal aspect of internal mould UQF 81417, x2. Tiverton Formation. (Waterhouse 2015a).

stone Sandstone Member) of the southeast Bowen Basin, and from the Farley Formation of the north Sydney Basin in New South Wales. The material identified as *Gilledia homevalensis* by Runnegar & Ferguson (1969, pl. 2, fig. 21, 22) from the lower South Curra Limestone of Gympie has somewhat similar ornament of low radial ribs. But the interior is that of *Fletcherithyris* Campbell, with high dorsal median septum supporting a septalium, as shown by Waterhouse & Balfe (1987, pl. 2, fig. 13-15). The radial threads are strong and separated by narrow grooves, much as in *Gilledia*, and not like the radials of *Fletcherithyris.*

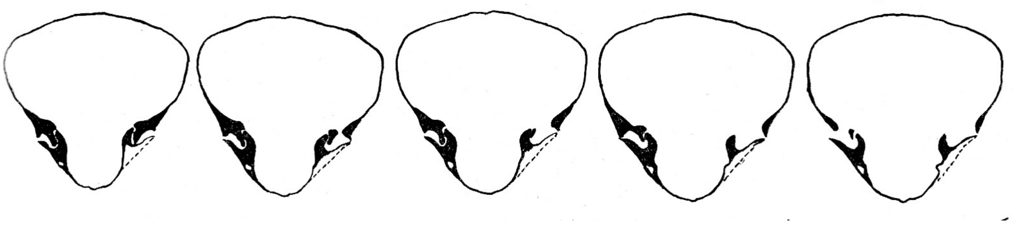


Fig. 48. *Gilledia homevalensis* Campbell, serial sections at 0.25mm intervals. Tiverton Formation. (Campbell 1965).

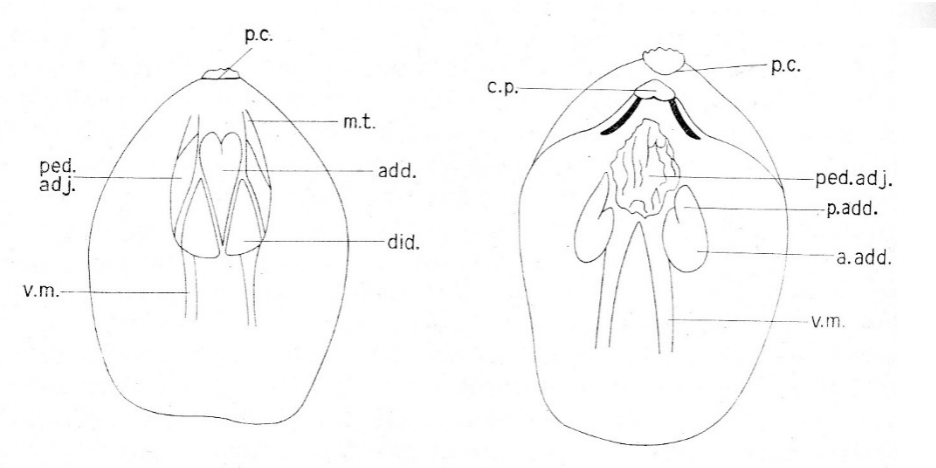


Fig. 49. *Gilledia homevalensis* Campbell. Muscle scars in ventral and dorsal valves, ANU 11934 and UQF 20825. add. = adductor scars, c.p.= cardinal process, m. t. = muscle tracks, p. add.= anterior and posterior pedicle adjustor scars, p. c. = pedicle collar, ped. adj. = pedicle adjustor scars, v.m. = vascular media,. Tiverton Formation. (Campbell 1965).

Gilledia oakiensis Campbell, 1965

Fig. 50 – 52

1965 *Gilledia oakiensis* Campbell, p. 79, pl. 8, fig. 32-41, text-fig. 30-32.

Diagnosis: Surface smooth without furrows or ribs, foramen large and pedicle collar weak, inner and outer hinge plates large.

Holotype: UQF 21269 from Oakey Creek, figured by Campbell (1965, pl. 8, fig. 40) and herein as Fig. 50A, OD.

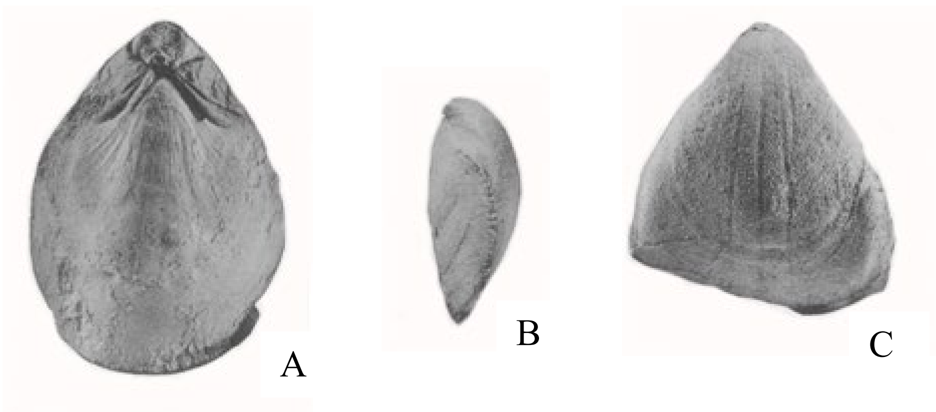


Fig. 50. *Gilledia oakiensis* Campbell. A, dorsal view of internal mould UQF 21269, holotype. B, lateral aspect, ANUF 11914. C, ventral aspect of internal mould, ANUF 11919. Specimens x1 from Oaky Creek, north Bowen Basin. (Campbell 1965).

Stratigraphy: The types come from Oakey Creek, with correlation poorly known to Campbell (1965) and to me. He also identified specimens from the Stanleigh Shale of the southeast Bowen Basin, to suggest an age somewhat older than the Exmoor beds or lowest Blenheim Formation in the north Bowen Basin, but whether the species is present in the Stanleigh beds and is of the same age as the type *oakiensis* requires confirmation.

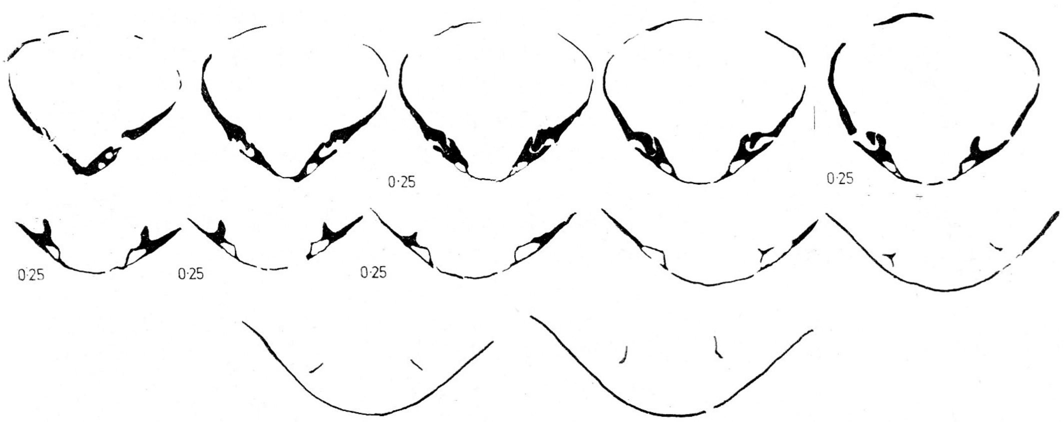


Fig. 51. *Gilledia oakiensis* Campbell, serial sections at 0.5mm intervals except where indicated, x3. From Oaky Creek, north Bowen Basin. (Campbell 1965).

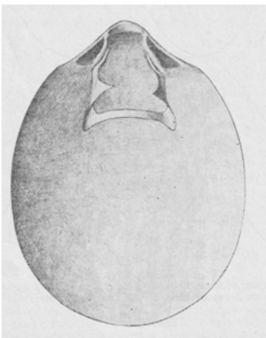


Fig. 52. *Gilledia oakiensis* Campbell, reconstruction of dorsal interior, x1 approx. From Oaky Creek, north Bowen Basin. (Campbell 1965).

***Gilledia*? sp.**

Fig. 53. ?54

1982 *Gilledia* sp. Waterhouse, p. 67, pl. 18b, d, h

Fig. 53. *Gilledia*? sp., ventral internal mould BR 1507 from middle Letham Formation, New Zealand, x1. (Waterhouse 1982).

Two incomplete specimens from the Letham Formation of New Zealand appear to belong to this species. There are no dental plates, and the venter is gently convex, but the generic position is yet to be confirmed by the dorsal interior.

The specimen could prove to be close to specimens as figured in Shi & Weldon (2002, pl. 9, fig. 8). from the Wandrawandian Siltstone of the south Sydney Basin, which appears to share various species with the upper Letham Formation, The dorsal view of a specimen they identified as *Gilledia* is well preserved (see Fig. 54 herein), and indeed strongly approaches *G. cymbaeformis* (Morris), as outlined below.

Fig. 54. *Gilledia* sp. from Wandrawandian Siltstone, Warden Head, south Sydney Basin, NMV P1456840, x1. (Shi & Weldon, 2002).

Gilledia cymbaeformis (Morris, 1845)

Fig. 55

1845 *Terebratula cymbaeformis* Morris, p. 278, pl. 17, fig. 4, 5.
1965 *Gilledia cymbaeformis* – Campbell, p. 72, pl. 5, fig. 1-4. With record of mistaken references to the species by other authors.
cf. 2002 *Gilledia* sp. Shi & Weldon, pl. 9, fig. 8.

Diagnosis: Moderately large, ventral valve only moderately convex, with anterior sulcation, well-defined commarginal rugae, massive ventral shoulders.

Holotype: Sole specimen BM 96872 figured by Morris and Campbell as in synonymy, and herein as Fig. 55A-D, possibly from Muree Formation, north Sydney Basin, by monotypy.

Morphology: As made clear by Campbell (1965), only the one specimen was known to Campbell, so that features may not have been consistently the same in other specimens. Campbell (1965) asserted that the outer hinge plates not joined to inner socket ridges, but that was his interpretation of an internal mould, and would appear to require confirmation.

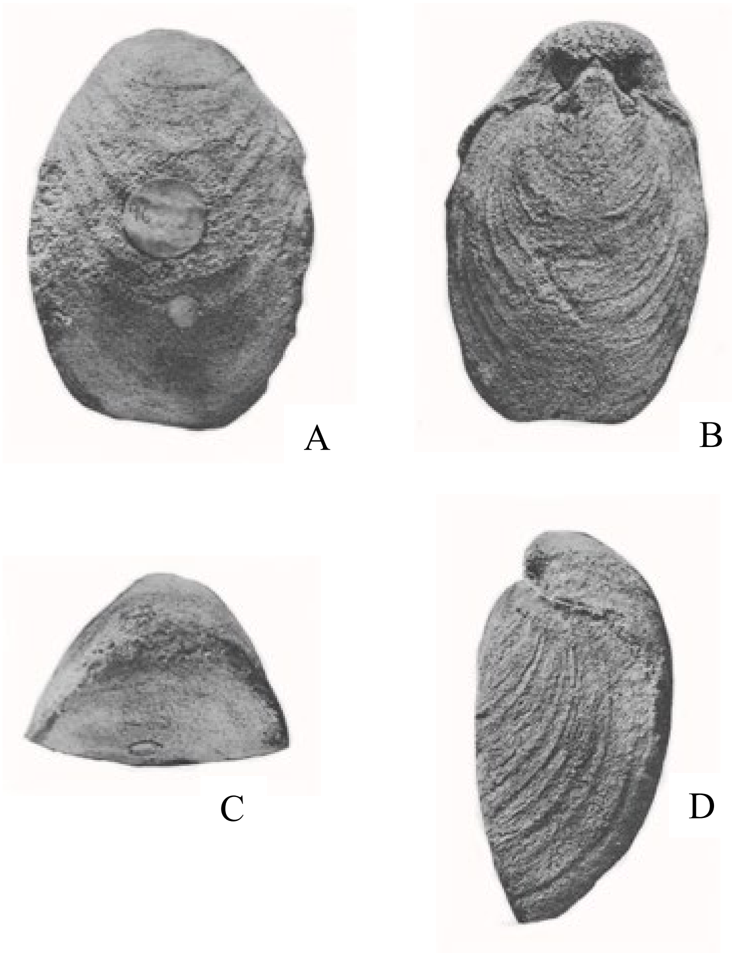


Fig. 55. *Gilledia cymbaeformis* (Morris). A-D, ventral, dorsal anterior (ventral valve on top) and lateral aspects of B 96872, holotype, considered to be from Raymond Terrace, north Sydney Basin. (Campbell 1965).

Stratigraphy: The specimen is said to have come from Raymond Terrace in the north Sydney Basin, perhaps from the Muree Formation, but Campbell (1965) could find no comparable material either in the field or in other collections. The type specimen is moderately close to an internal mould figured from the underlying Wandrawandian Siltstone (Fig. 54), admittedly with finer matrix, and the range of the species requires more study. Stehli (1961) and Jin et al. (2006) figured material from the Wandrawandian beds, but Campbell (1965) rejected their identification. Jin et al. relied heavily on Stehli, and set aside other studies that expressed views differing from those of Stehli.

Gilledia jervisensis (Etheridge 1919)

Fig. 56

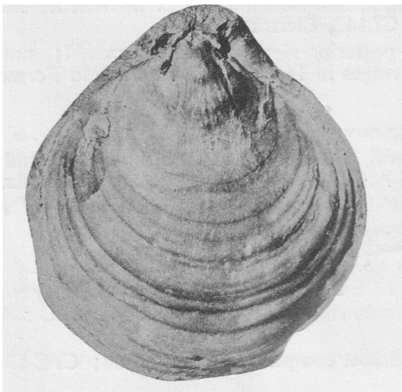
1919 *Dielasma jervisensis* Etheridge, p. 183, pl. 28, fig. 4.
1965 *Gilledia jervisensis* – Campbell, p. 87, pl. 15, fig. 12.

Diagnosis: Broad little inflated shell and almost circular in outline. Outer hinge plates wide, growth halts strong.

Holotype: AMF 268, figured as in synonymy and herein as Fig. 56, from either Nowra Sandstone or upper Wandrawandian Formation, south Sydney Basin, OD.

Morphology: Only one specimen is known. In shape it somewhat approaches *Maorielasma callosum*, but has the dorsal interior of *Gilledia.*

Fig. 56. *Gilledia jervisensis* (Etheridge) dorsal aspect of AMF 268, holotype, x1. Nowra Sandstone or upper Wandrawandian beds. (Campbell 1965).



Stratigraphy: Campbell (1965) considered that the specimen came from either the Nowra Sandstone or upper Wandrawandian Formation, south Sydney Basin. There has to be some uncertainty as to whether the taxon named is a broad variant of *culburrensis*, named well after *jervisensis*.

Gilledia culburrensis Campbell, 1965

Fig. 57 - 59

1961 *Gilledia cymbaeformis* [not Morris] – Stehli, p. 451, pl. 61, fig. 1, 2, 5, 6. Fig. 3, 4 uncertain.
1965 *Gilledia culburrensis* Campbell, p. 89, pl. 3, fig. 7-21, pl. 17, fig. 3-5, text-fig. 35-39.
2006 *G. cymbaeformis* [not Morris] – Jin et al., p. 2041, Fig. 1349.1a-d**.**

Diagnosis: Large shells without anterior ventral sulcus, highly convex posteriorly, fine furrows over shell surface, lateral commissure weakly sinuate. Ventral umbonal shell thickened in many specimens. Inner and outer hinge plates relatively broad.

Fig. 57. *Gilledia culburrensis* Campbell. A, B, C, ventral, lateral and dorsal aspects of holotype, CPC 5337 from ?Nowra Sandstone, south Sydney Basin, x1. (Campbell 1965).

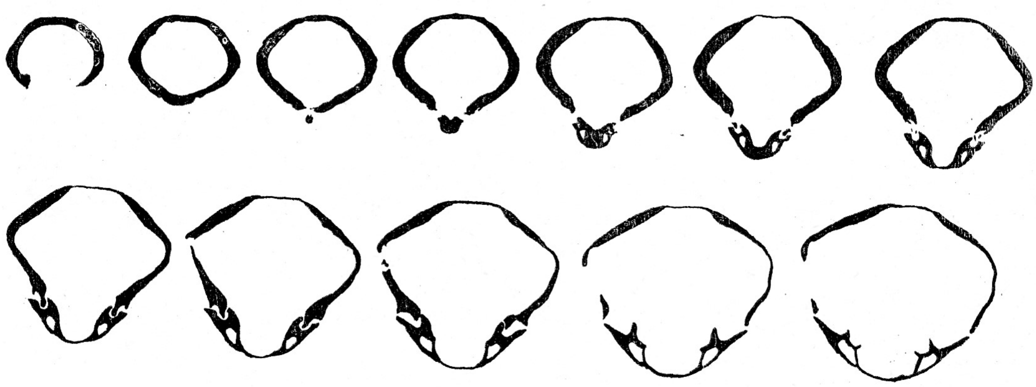


Fig. 58. *Gilledia culburrensis* Campbell, serial sections at intervals of 0.25m, young topotype, x2. ?Nowra Sandstone. (Campbell 1965).

Holotype: CPC 5337 from ?Nowra Sandstone, south Sydney Basin, figured by Campbell (1965, pl. 3, fig. 16-19) and herein as Fig. 57A-C, OD.

Morphology: The figured specimens allocated to *cymbaeformis* in Stehli (1961, pl. 61, fig. 3, 4) were left unidentified by Campbell (1965), though they do look close to *culburrensis*. They apparently came from the Woodbridge glacial formation of Tasmania.

Stratigraphy: Campbell (1965, p. 94) stated that the types came from the Nowra Sandstone,

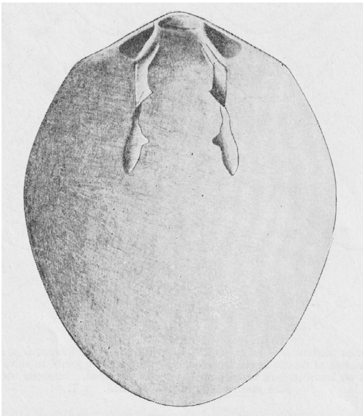


Fig. 59. *Gilledia culburrensis* Campbell, reconstruction of dorsal interior from serial sections in Campbell (1965, text-fig. 38), x1. ?Nowra Sandstone. (Campbell 1965).

or just below, at Culburra Head, and considered that the species was also common at Wardens Head in what Fletcher (1958) had called Ulladulla Mudstone. The Woodbridge glacial formation of Tasmania involved the Cascades Group and Malbina Formation according to Banks (1962) and yielded large specimens figured by Stehli (1961), but not identified by Campbell (1965).

Gilledia pelicanensis Campbell, 1965

Fig. 60, 61?

1892 *Dielasma cymbaeformis* [not Morris] – Etheridge p. 225, pl. 9, fig. 10, 11.
1964 *Gilledia* sp. Hill & Woods, pl. P7, fig. 7, 8.
1965 *Gilledia pelicanensis* Campbell, p. 87, pl. 5, fig. 5-9, pl. 15, fig. 5-7.
?1969 *G. pelicanensis* – Waterhouse, p. 723.
1972 *G. pelicanensis* – Hill et al., pl. P7, fig. 7, 8.
? 1982 *G. pelicanensis* – Waterhouse, p. 68, pl. 18l.
? 1987 *Marinurnula mantuanensis* [not Campbell?] – Waterhouse, p. 49, pl. 13, fig. 26, 29-31.

Fig. 60. *Gilledia pelicanensis* Campbell. A-C, ventral, lateral and oblique dorsal views of GSQ 1485, holotype, x1. Upper Blenheim Formation, north Bowen Basin. (Campbell 1965).

Diagnosis: Shells large for genus, ventral valve strongly convex posteriorly, flattened or slightly plicate anteriorly, ventral umbo long and narrow, anterior commissure weakly sinuate. Inner and outer hinge plates narrow, dorsal pedicle adjustor scars long.

Holotype: GSQF 1485 from *Isbellina pelicanensis* band, north Bowen Basin, figured by Campbell (1965, pl. 5, fig. 5-8), Hill & Woods (1964, pl. P7, fig. 7, 8) and Hill et al. (1972, pl. P7, fig. 7, 8) and herein as Fig. 60A-C, OD.

Morphology: Specimens figured by Waterhouse (1987) as *Marinurnula* from the Flat Top Formation of the southeast Bowen Basin appear to have a dorsal interior like that of *Gilledia* rather than *Marinurnula*. Of course this needs to be checked.

Stratigraphy: The species is found typically in the upper Blenheim Formation of the north Bowen Basin, and a specimen was reported from the Mangarewa Formation of New Zealand, though this shows a weak sulcal swelling (Fig. 61). Campbell (1965, p. 89) suggested that specimens from the Nowra Sandstone in the south Sydney Basin were comparable, but noted substantial differences in episulcation between the two species.

Fig. 61. ?*Gilledia pelicanensis* Campbell, ventral valve BR 1168, x 2 from Mangarewa Formation, New Zealand. (Waterhouse 1982).

Genus ***Paragilledia*** Waterhouse *in* Shi et al. 2020, p. 424

Diagnosis: Foramen mesothyrid to permesothyrid, no dental plates, pedicle collar weak to strong. Ventral sulcus bordered and may be divided by median plication, dorsal valve with wide deep sulcus bordered by plicae. Outer hinge plates joined to socket plates, septalium incomplete with inner edges of inner hinge plates fused separately to the floor of the valve. Loop well-developed and terebratuliform, transverse band may be incomplete.

Type species: *Gilledia ulladullensis* Campbell, 1965 from Wandrawandian Siltstone, south Sydney Basin, OD.

Paragilledia sp. A

Fig. 62

1898 *Dielasma inversa* [not Koninck] – Etheridge, p. 175, pl. 19, fig. 1-3 (part, not fig. 4-6, 10, 11 = *Fletcherithyris parkesi*. not fig. 7-9 = *Pseudodielasma campbelli*, not fig. fig. 12, 13 = *Paragilledia ulladullensis*).
1965 not *Dielasma inversa* [=various genera and species discussed] Campbell, p. 73

A specimen from Harper's Hill, north Sydney Basin, strongly suggests from shape and size that it belongs to *Paragilledia*, and no dental plates are present. Dorsal internal plates are no exposed. The location implies Allandale Formation, so it would be the oldest known of example of *Gilledia*, and possibly of any Permian terebratulid in east Australia.

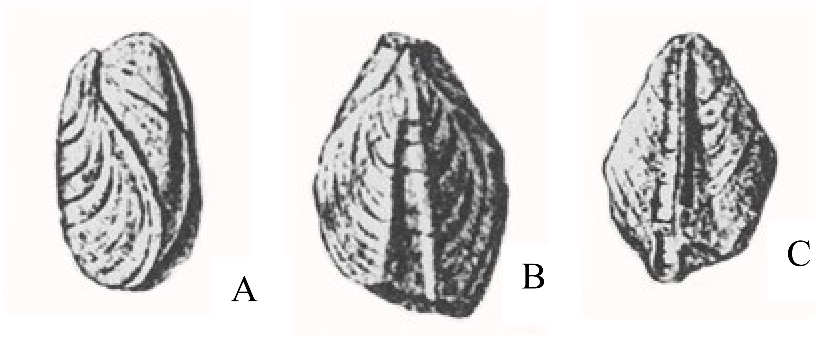


Fig. 62. *Paragilledia* sp. AMF 35797 x2, A, lateral aspect, dorsal valve to left. B, dorsal aspect. C, ventral aspect. From Allandale Formation, north Sydney Basin. (Etheridge 1898).

Paragilledia kioloaensis Waterhouse, 2020

Fig. 63, 64

1983 *Gilledia ulladullensis* [not Campbell] – Waterhouse & Jell, p. 247, pl. 3, fig. 14-18.
2020 *Paragilledia kioloaensis* Waterhouse *in* Shi et al., p. 424, Fig. 8-10.

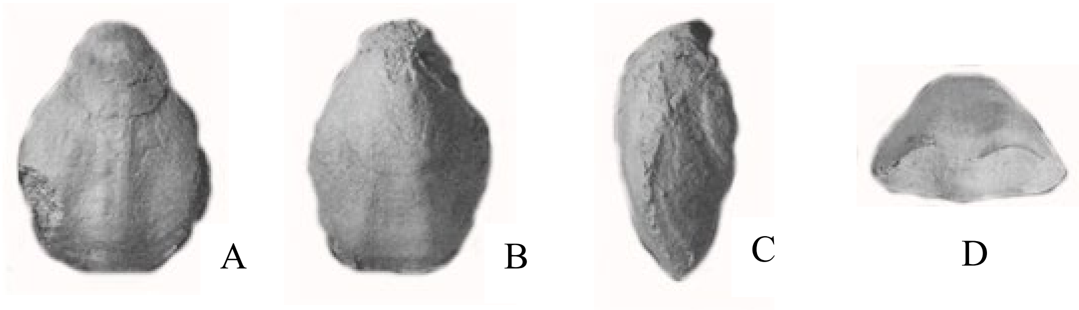


Fig. 63. *Paragilledia kioloaensis* Waterhouse, AMF 146273, holotype, A, ventral, B, dorsal, C, lateral and D, anterior (dorsal valve on top) aspects, x 1 approx. Pebbley Beach Formation, south Sydney Basin. (Shi et al. 2020)

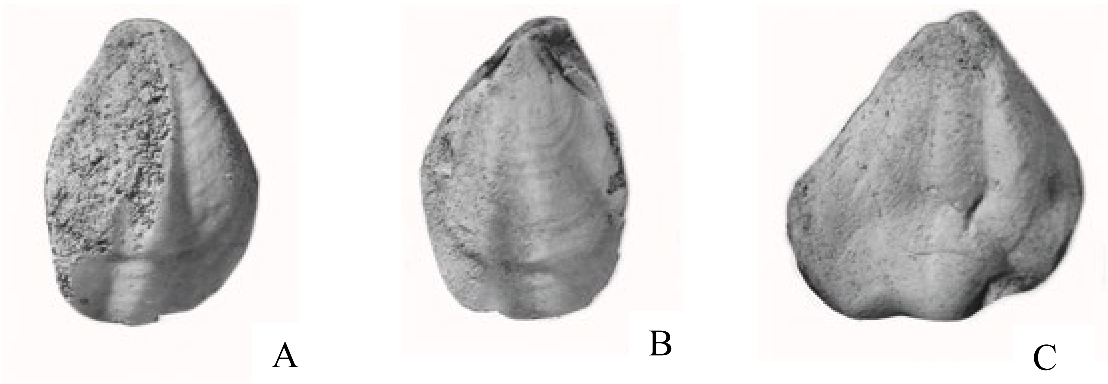


Fig. 64. *Paragilledia kioloaensis* Waterhouse. A, B, ventral and dorsal views of UQF 73231. C, latex cast of ventral valve UQF 73232. Specimens x2 from lower Moonlight Sandstone, north Bowen Basin. (Waterhouse & Jell 1983).

Diagnosis: Ventral median fold, which in many specimens bears a median channel, dorsal broad anterior sulcus, plicae more subdued than other species.

Holotype: AMF 146263 from Pebbley Beach Formation, figured in Shi et al. (2020, Fig. 10X-AB), and herein as Fig. 63A-D, OD.

Stratigraphy: The species is described from the Pebbley Beach Formation of the south Sydney Basin. Specimens figured from the upper Moonlight Sandstone by Waterhouse & Jell (1983) are close in shape and strength of plicae, though none of the figured specimens shows a channel in the ventral median fold (Fig. 64).

Paragilledia ulladullensis (Campbell, 1965)

Fig. 65, aff. 66, 67, 68

?1877 *Terebratula inversa* Koninck, p. 171, pl. 11, fig. 11, a, b.
1898 *Dielasma inversa* [not Koninck] – Etheridge, pl. 1, fig. 12, 13 (part, not fig. 4-6, 10,11 = *Fletcherithyris parkesi*, not fig. 1-3 = *Paragilledia* sp. A, not fig. 7-9 = *Pseudodielasma campbelli*).
1961 *Fletcherina inversa* [not Koninck] – Stehli, p. 453, pl. 61, fig. 8, 9, 12, 16, 26 (part, not pl. 61, fig. 13 = *Fletcherithyris illawarrensis*?).
1965 *Gilledia ulladullensis* Campbell, p. 83, pl. 7, fig. 1-23, pl. 15, fig. 8-11, text-fig. 33, 34.
1969 *G. ulladullensis* – Wass & Gould, pl. 15, fig. 8, 9, 10, 13.
1987 *G. ulladullensis* – Clarke, p. 286, Fig. 21A-D.

Diagnosis: Moderate size, episulcate at maturity, fold in anterior commissure high, fan-like radial furrows over median plications. Outer hinge plates strong, attached to inner socket ridges. Cardinal process with median boss.

Holotype: AMF 20779 from Wandrawandian Siltstone, figured by Campbell (1965, pl. 15, fig. 8-11) and herein as Fig. 65A-C, OD.

Fig. 65. *Paragilledia ulladullensis* (Campbell). A-C, dorsal, anterior (dorsal valve on top) and ventral aspects of AMF 20779, holotype, x1. Wandrawandian Siltstone, north Sydney Basin. (Campbell 1965).

Morphology: Campbell (1965) proposed that the name *inversa* Koninck, 1877 be suppressed, because Koninck's material had been destroyed by fire, and no further material was known from the source in the Muree Formation at Raymond Terrace. Specimens externally similar to *inversa* from the Conjola Formation at Wyro, now Wandrawandian Formation, and with internal structures as in *Gilledia* were referred to a new species *Gilledia ulladullensis* by Campbell (1965).

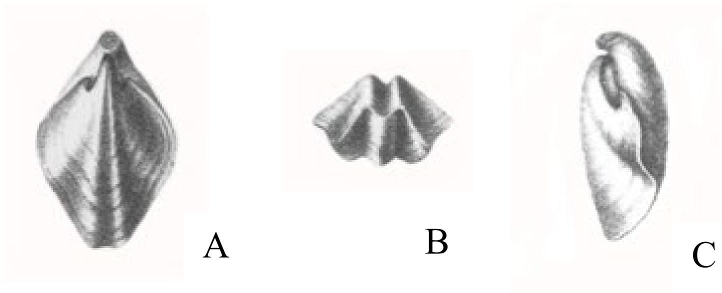


Fig. 66. *Rhynchonella inversa* Koninck = *Paragilledia*. A, dorsal aspect. B, anterior aspect, dorsal valve on top, C, lateral aspect. From Muree Quarry, in Muree Sandstone? (Koninck 1877). The broad pair of notches in Fig. 66A may reflect partial wear of the shell, or imperfect drafting. Campbell considered that Koninck's figure as reproduced as Fig. 66C shows dental lamellae, but this seems challengeable: the lengthy plates in 66C are dental sockets.

Stratigraphy: Campbell (1965) reported specimens from near or just above the top of the Collinsville Coal Measures in Queensland (which might be *kialoaensis*), and another from 160m below the Scottville Member in the north Bowen Basin. Clarke (1987) stated that the species was to be found throughout the late Bernacchian and Lymingtonian stages of Tasmania and figured material from the Malbina E fauna.

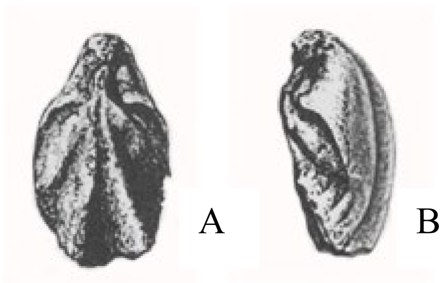


Fig. 67. *Paragilledia ulladullensis* (Campbell) from west Maitland, figured as *Dielasma inversa* but now missing. A, dorsal aspect. B, lateral aspect, x1. (Etheridge 1898).

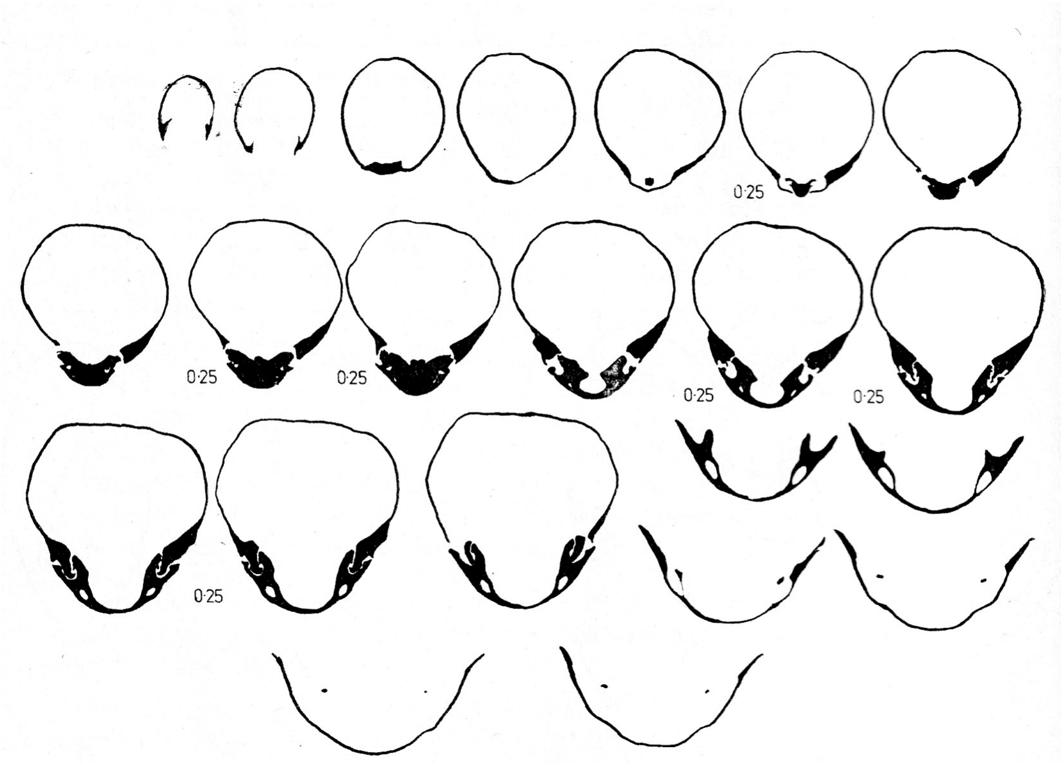


Fig. 68. *Paragilledia ulladullensis* (Campbell). Serial sections of specimen at early maturity AMF 24269 at intervals of 0.5mm unless otherwise indicated, x2. Capertree Group. (Campbell 1965).

Paragilledia ulladullensis alta (Campbell, 1965)

Fig. 69

1919 *Dielasma inversa* [not Koninck] – Etheridge, p. 183, pl. 29, fig. 3, 4.
1965 *Gilledia ulladullensis alta* Campbell, p. 85, pl. 7, fig. 24-32, text-fig. 33.

Diagnosis: Valves less convex than in *ulladullensis*, with less marked episulcation, larger foramen with more massive labrum, greater overall size.

Holotype: AMF 49647 from Capertree Group, figured by Campbell (1965, pl. 7, fig. 30-32) and here as Fig. 69A, B, D, OD.

Stratigraphy: The type locality is at Rhylstone, and Campbell (1965, p. 87) considered that the material had come from the Megalong Conglomerate at the base of the Capertree Group. He also assigned specimens figured by Etheridge (1919) from the Gerringong Volcanics to *alta*.

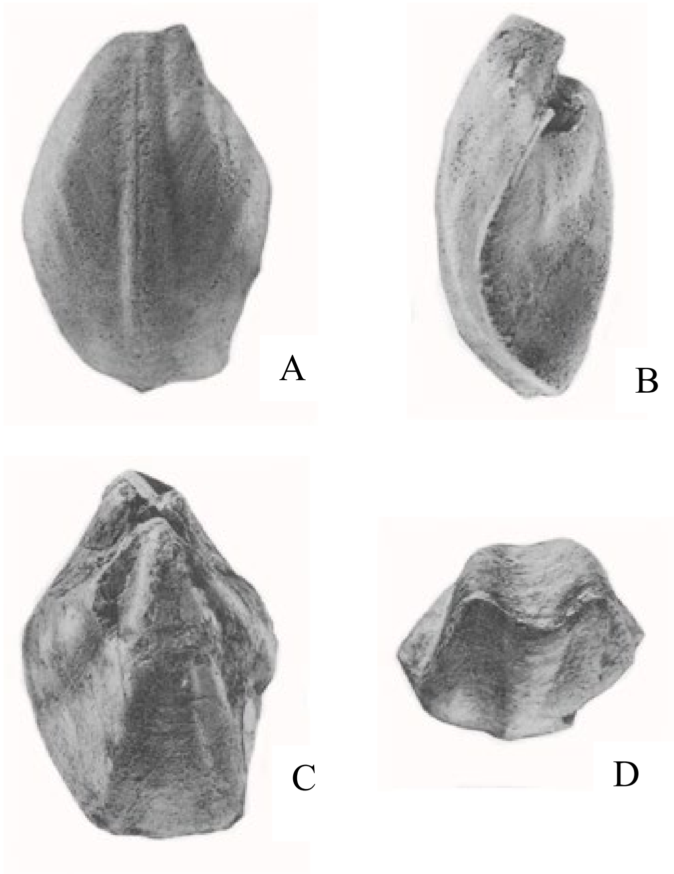


Fig. 67. *Paragilledia ulladullensis alta* (Campbell). A, B, D, ventral, lateral and anterior aspects of internal mould AMF 49647, x1, holotype. C, dorsal view of internal mould AMF 43035, x1. Capertree Group. (Campbell 1965).

***Paragilledia* sp. B**

Fig. 70

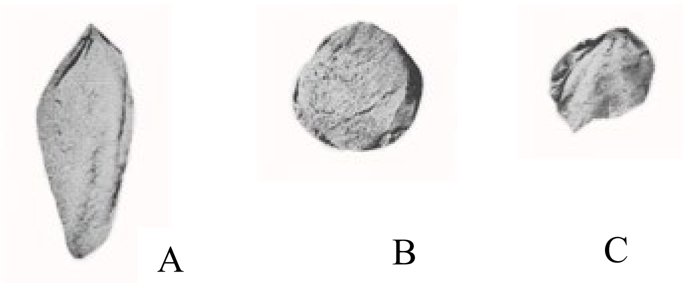


Fig. 70. *Paragilledia* sp. B, described as *Gilledia inversa* (Koninck) by Waterhouse & Vella (1965) from Flowers Formation, northwest Nelson, but needing re-examination. A. dorsal internal mould. B, ventral external mould. C, dorsal external mould. No registration numbers were published. Specimens x1.5. (Waterhouse & Vella 1965).

1965 *Gilledia inversa* – Waterhouse & Vella, p. 73, pl. 5, fig. 3-5.

Waterhouse & Vella (1965) described small specimens as *inversa* (Koninck) from northwest Nelson in New Zealand, and the figured specimens do not full agree with that form or *ulladullensis*, having a ventral fold that commences further from the umbo (Fig. 70B), suggesting the need for reappraisal.

Paragilledia sp. ***C***

Fig. 71

1967 *Maorielasma* sp. Waterhouse, p. 114, Fig. 45.

Several ventral valves and a conjoined specimen from the Late Permian Pig Valley Limestone of Nelson suggest *Maorielasma*, because dental plates are lacking. But the presence of a median sulcus suggests the likelihood that the specimen belongs to *Paragilledia*.

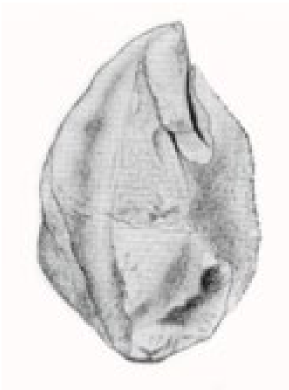


Fig. 71. *Paragilledia* sp. oblique view of ventral internal mould BR 1280, x1.5 from Pig Valley Limestone, Nelson, New Zealand. (Waterhouse 1967).

Family **HETERELASMINIDAE** Licharew, 1956

The morphology of *Heterelasmina* Licharew, 1939, name genus for Heterelasminidae contains uncertain aspects. The genus was proposed with type species *Hemiptychina dieneri* Gemmellaro, 1899 from Sicily. Stehli (1962) attempted to clarify the internal morphology, examining the interior not of the nominated type species, but that of an associated species *genuflexa*, also from Sicily and represented by many specimens figured by Gemmellaro. He concluded that *Heterelasmina* Licharew was a junior synonym of *Jisuina* Grabau, 1931 from Mongolia, and clarified the interior for *genuflexa* which was more abundant than *dieneri* in the Sicilian faunas, as shown in Fig. 72. The striking feature in the interior centres on the present of a subvertical pair of plates, forming what I call a clavis (as distinct from a septalium) in the posterior part of the dorsal interior, and bearing the crura. They are independent of the socket plates. In the first edition of the *Brachiopod Treatise*, Stehli (1965) featured *Jisuina* as the

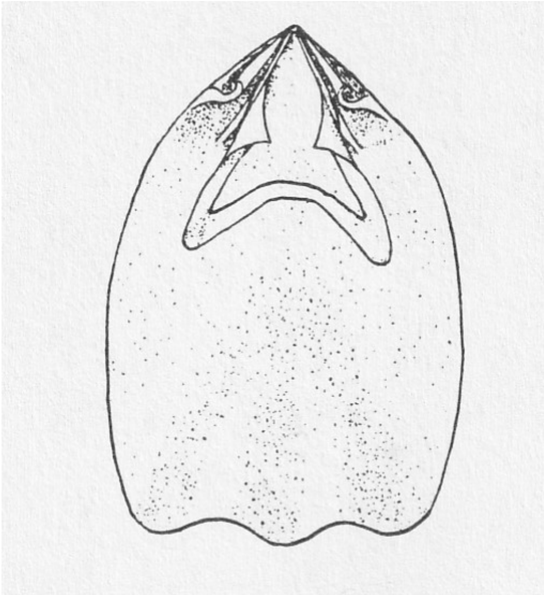


Fig. 72. Dorsal interior for *Jisuina* {now *Heterelasmina*] *elegantula* Grabau, showing crura arising from slender vertical plates forming what I call a clavis, inside the dental sockets. (Stehli 1965)

prime constituent of Heterelasminidae, and omitted *Heterelasmina* as a constituent genus, because he regarded it as a junior synonym of *Jisuina*. The *Revised Brachiopod Treatise* (Jin et al. 2006) restored *Heterelasmina*, and left out *Jisuina*, which they placed as a junior synonym of *Hemiptychinina* Waagen, 1882, p. 335. Certainly the external appearance of *Jisuina*, with its numerous short anterior plicae, is close to that of *Terebratula himalayensis* Davidson, 1862 and *Hemiptychina sparsiplicata* Waagen, 1882, the original nominated type of Hemiptychininae. All are now placed in Hemiptychininae Campbell, 1965, with outer hinge plates bearing crural bases, and in contact with the fucral plates or socket plates.

Campbell (1965, p. 105) questioned whether the species *genuflexa* could be relied on to clarify the interior of another species, *dieneri*, but the two species do externally appear rather similar, so whilst uncertainty remains, Jin et al. (2006) appear to have provided on present evidence the best solution so far for the content and limitations of the two family groups involved.

Genus ***Marinurnula*** Waterhouse, 1964

Diagnosis: Medium size, elongate, non-plicate, anterior commissure uniplicate, no dental plates, small teeth and reduced dental sockets, crural-bearing plates upright, joined to floor of valve well away from mid-line to form a clavis, no septalium, crural points long. Striate cardinal process.

Type species: *Marinurnula rugulata* Waterhouse (1964, p. 477) from Kildonan Member (Changhsingian), Bagrie Formation, Arthurton Group, New Zealand, OD.

Discussion: Jin & Lee (2006, p. 2045) classed *Marinurnula* in Pseudodielasmatidae Cooper & Grant, 1976 with a query. This seems to be markedly inappropriate. Jin et al. ignored the placement of *Marinurnula* in Heteralasminidae by Waterhouse (1987, p. 49; 2001, p. 105) and to place the genus in Pseudodielasmidae is in defiance of the dorsal morphology. Crura are attached to the socket plates in *Pseudodielasma* (see Cooper & Grant 1976, pl. 760) whereas in *Marinurnula*, the crura are attached to subvertical vertical plates diverging forward and forming a “clavis”, independent of the socket plates. The course of the loops for *Marinurnula* in east Australia and New Zealand remains unresolved, leaving the classification uncertain. It would seem possible that the loop is not as complex as that of Heteralasminidae and Pseudodielasmatidae. But there is scope for further evaluation of these and other families assigned to Dielasmoidea, with uncertainty remaining over whether the loop could have varied in a more complex or even less consistent manner within families than allowed in present understanding.

Marinurnula prima Waterhouse, 1987

Fig. 73

1987 *Marinurnula prima* Waterhouse, p. 49, pl. 13, fig. 20, 21.

Diagnosis: Small shells with moderately well-spaced pores, maximum width near anterior third of shell length, teeth leaving low dental ridges.

Holotype: UQF 74260 from Fairyland Formation, figured in Waterhouse (1987, pl. 13, fig. 20, 21) and herein as Fig. 73A, B, OD.

Morphology: The pores number some 120 per square mm. Specimens are close to *Marinurnula rugulata* in shape and transverse profile, but more inflated with reduced com-

Fig. 73. *Marinurnula prima* Waterhouse. A, B, ventral and dorsal aspects of UQF 74260, holotype, x2. Fairyland Formation. (Waterhouse 1987).

marginal growth rugae and maximum width placed further forward. The figure of the dorsal interior (Fig, 73B) appears to suggest a large septalium, which is not indicative of *Marinurnula*, but the figure must be misleading, because the textual description indicates *Marinurnula*, and first-hand examination is more reliable than interpretation from figures.

Stratigraphy: The species comes from the Fairyland Formation of southeast Bowen Basin.

Marinurnula ovata Waterhouse, 2001

Fig. 74

2001 *Marinurnula ovata* Waterhouse, p. 105, pl. 8, fig. 4-8.

Diagnosis: Shell of oval outline, distinguished by having maximum width close to mid-length.

Holotype: BR 2346 from upper Letham Formation, Wairaki Downs, figured in Waterhouse (2001, pl. 8, fig. 4, 7) and herein as Fig. 74A, B, OD.

Morphology: A number of specimens are available from several localities. Some dorsal valves show an anterior median channel.

Stratigraphy: The species comes principally from the *Echinalosia discinia* Zone in the upper Letham Formation of New Zealand, and a single rather similar specimen is found in the overlying beds of the lower Mangarewa Formation (Fig. 74D) herein.

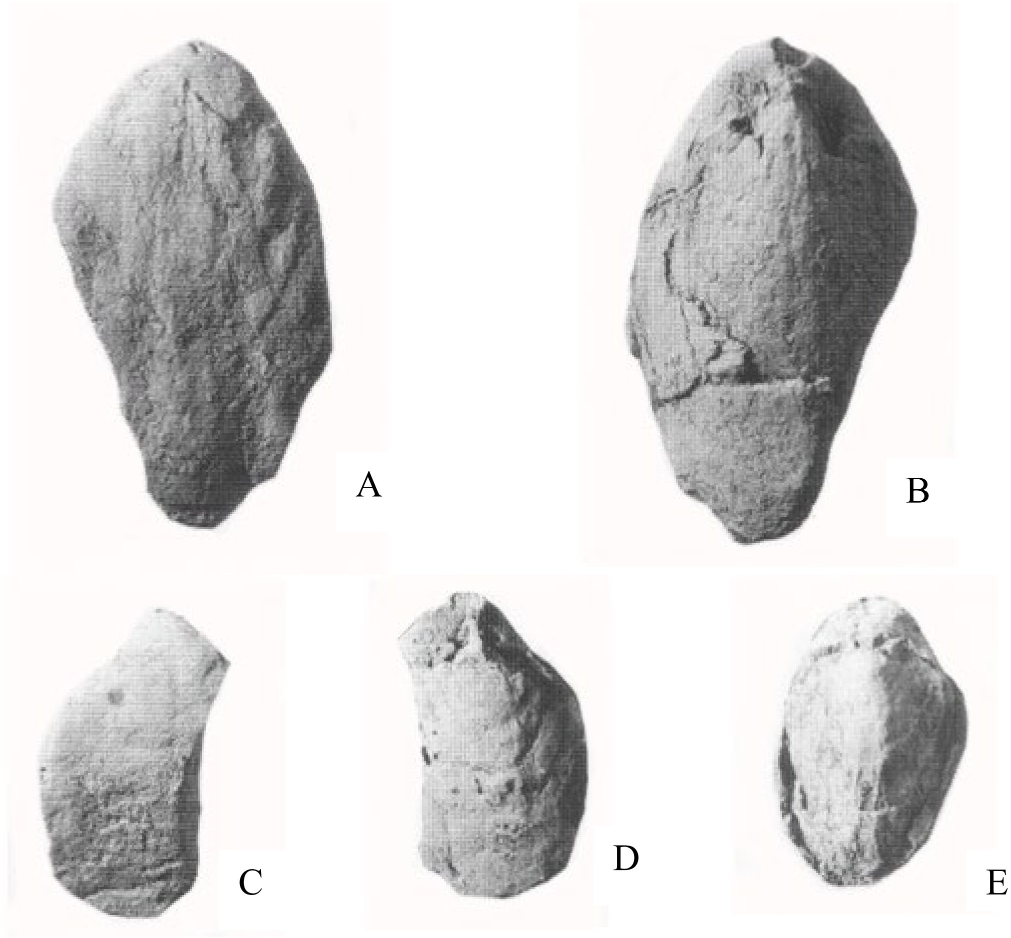


Fig. 74. *Marinurnula ovata* Waterhouse, x2. A, B, ventral and dorsal aspects of BR 2348, internal mould, holotype. C, D, ventral and dorsal aspects of OU 18771. E, dorsal aspect of internal mould BR 2347. A-C, E, *Echinalosia discinia* Zone, upper Letham Formation, D, lower Mangarewa Formation, New Zealand. (Waterhouse 2001).

Marinurnula mantuanensis Campbell, 1965

Fig. 75, 76, cf. 77

1965 *Marinurnula mantuanensis* Campbell, p. 102, pl. 5, fig. 10-14, pl. 16, fig. 20, 21 [not pl. 14 as stated in the text], text-fig. 41.
cf. 1965 ?*Pseudodielasma* sp. Campbell, p. 106, pl. 16, fig. 10-12 (part, not fig. 13, 14 = *Pseudodielasma* sp. A).
?1982 *M*. cf. *mantuanensis* – Waterhouse, p. 66, pl. 18i.
1983 *M. mantuanensis* – Waterhouse & Jell, p. 247, pl. 3, fig. 19.

Diagnosis: Large with dorsal valve more inflated and rugae less prominent than in *Marinurnula rugulata.*

Holotype: UQF 25686 from Mantuan Member, figured by Campbell (1965, pl. 5, fig. 10-12) and herein as Fig. 75A, B, OD.

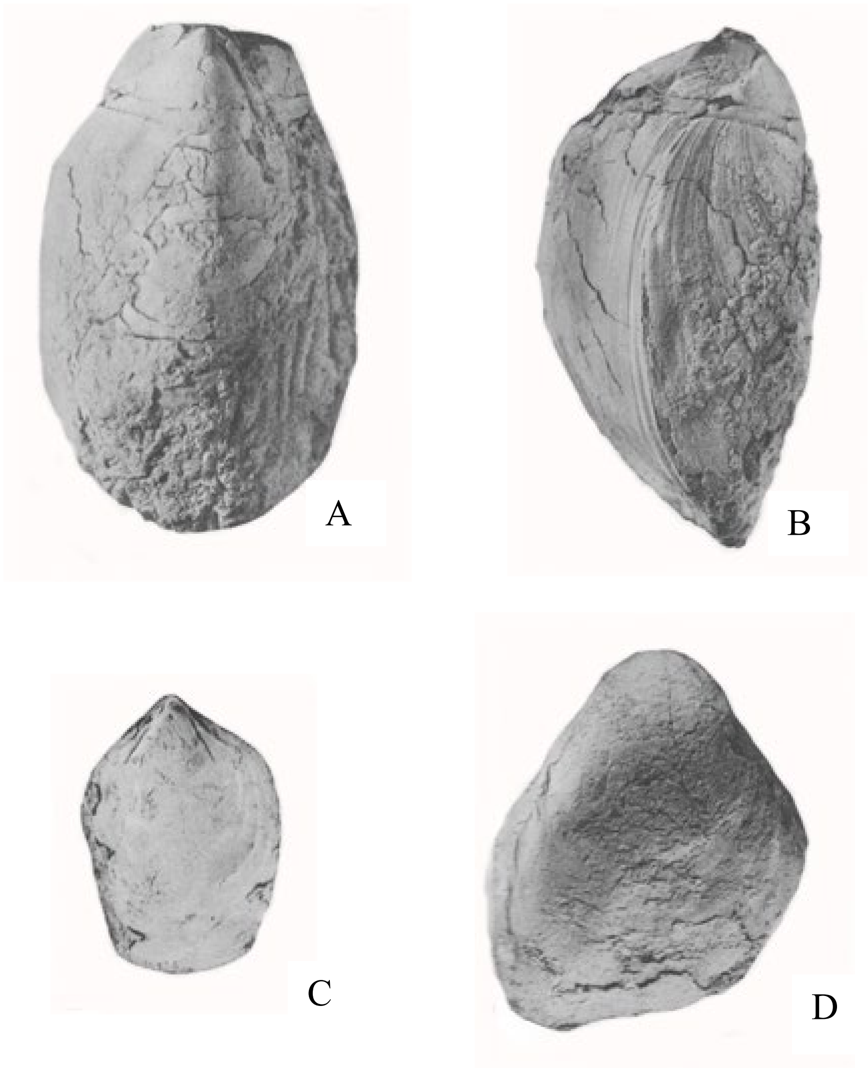


Fig. 75. *Marinurnula mantuanensis* Campbell. A, B, dorsal and lateral views of UQF 25686, holotype, x1. C, dorsal internal mould CPC 5948. D, ventral valve GSQF 2255. A, B, D from Mantuan Member, C from lower Peawaddy Formation. (Campbell 1965).

Stratigraphy: The types come from the Mantuan Member of the Peawaddy Formation in the southwest Bowen Basin, and Campbell (1965, p. 103) reported occurrences from the Catherine Sandstone and what is probably the lower Peawaddy Formation, as also tabulated by Parfrey (1988, Fig. 10). Occurrences were also reported by Parfrey from the southeast

Bowen Basin in the upper Oxtrack Formation, upper Barfield Formation and Flat Top Formation, though Waterhouse (1987) had not found any occurrences in the Flat Top Formation, presumably because Parfrey had examined additional localities. A possible occurrence was reported in the lower Mangarewa Formation of New Zealand by Waterhouse (1982), and Waterhouse & Jell (1983) recorded the species as occurring with *Maxwellosia ovalis* in the lower Blenheim Formation below the Scottville Member of the north Bowen Basin.

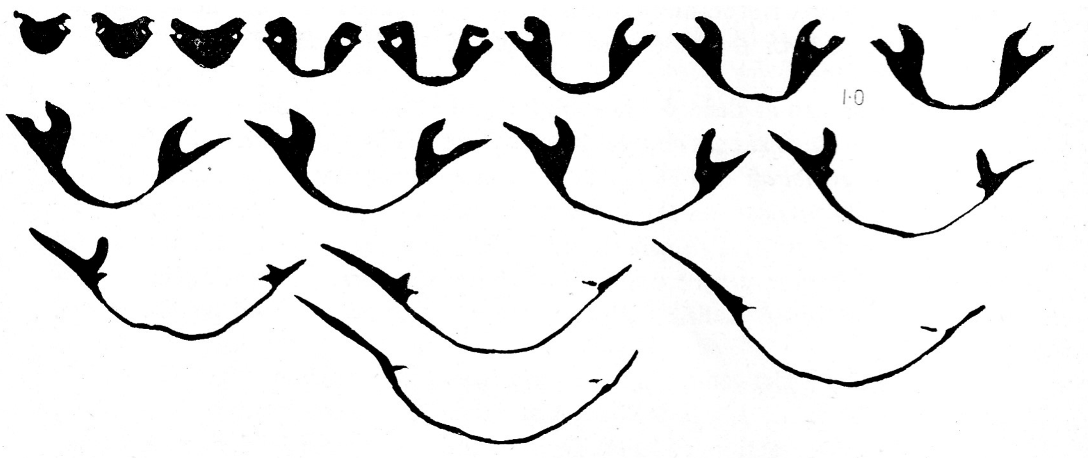


Fig. 76. *Marinurnula mantuanensis* Campbell, serial sections of GSQF 2256 at intervals of 0.5mm. x 1.5. From Mantuan Member. (Campbell 1965).

Fig. 77. *Marinurnula* cf. *mantuanensis* Campbell. A-C, ventral, dorsal and lateral views of internal mould CPC 5300a x1 from "*clarkei* or cephalopod bed", Scottville Member, north Bowen Basin. (Campbell 1965).

Specimens recorded from the "*clarkei* or cephalopod bed" possibly in the Scottville

Member, north Bowen Basin, (Campbell 1965, pl. 16, fig. 10-12) are similarly inflated and might prove to be lingering components of this species. They were described as ?*Pseudodielasma* by Campbell but appear to have distinct if slender erect plates, which bear the crura and form a clavis as in *Marinurnula*.

Marinurnula sp.

Fig. 78

2022b *Marinurnula* sp. Waterhouse, p. 188, Fig. 45.

Part of a dorsal internal mould exposes the dental sockets and base of the crus on one side. A very low ridge lies along the posterior mid-line, and dense punctation is displayed.

Fig. 78. *Marinurnula* sp., dorsal internal mould UQF 82708, x2. Upper Blenheim Formation. (Waterhouse 2022b).

Stratigraphy: The specimen comes from the *Echinalosia* (*Unicusia*) *minima* Zone in the upper Blenheim Formation of the north Bowen Basin, Queensland. It might prove to belong to the following species, but the dorsal valve seems to be more inflated and lacks commarginal rugae typical of *rugulata*.

Marinurnula rugulata Waterhouse, 1964

Fig. 79, 80

1964 *Marinurnula rugulata* Waterhouse, p. 177, pl. 34, fig. 6-8, text-fig. 81.
1982 *M. rugulata* – Waterhouse, p. 67.
2001 *M. rugulata* – Waterhouse, p. 106, pl. 8, fig. 10.
2015b *M. rugulata* Waterhouse, p. 147, Fig. 65.

Diagnosis: Moderately large for genus, extended posterior walls, low even or irregular commarginal rugae.

Holotype: BR 900 figured by Waterhouse (1964, pl. 34, fig. 6-8, text-fig. 81) and Fig. 79 herein from Kildonan Member, Bagrie Formation, Arthurton Group, New Zealand, OD.

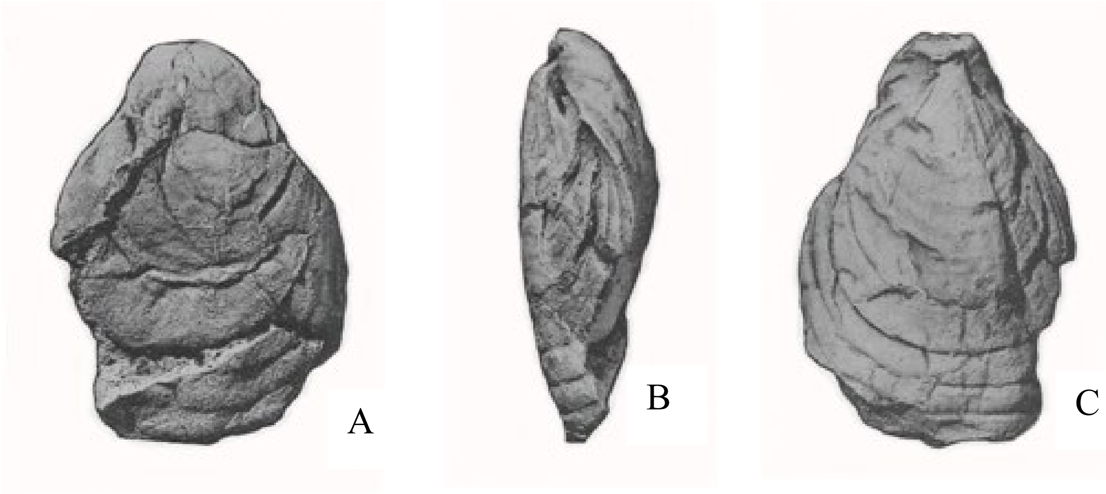


Fig. 79. *Marinurnula rugulata* Waterhouse. A-C, ventral, lateral and dorsal aspects of internal mould BR 900, x1.5, holotype. From Kildonan Member, Bagrie Formation, New Zealand. (Waterhouse 1964).

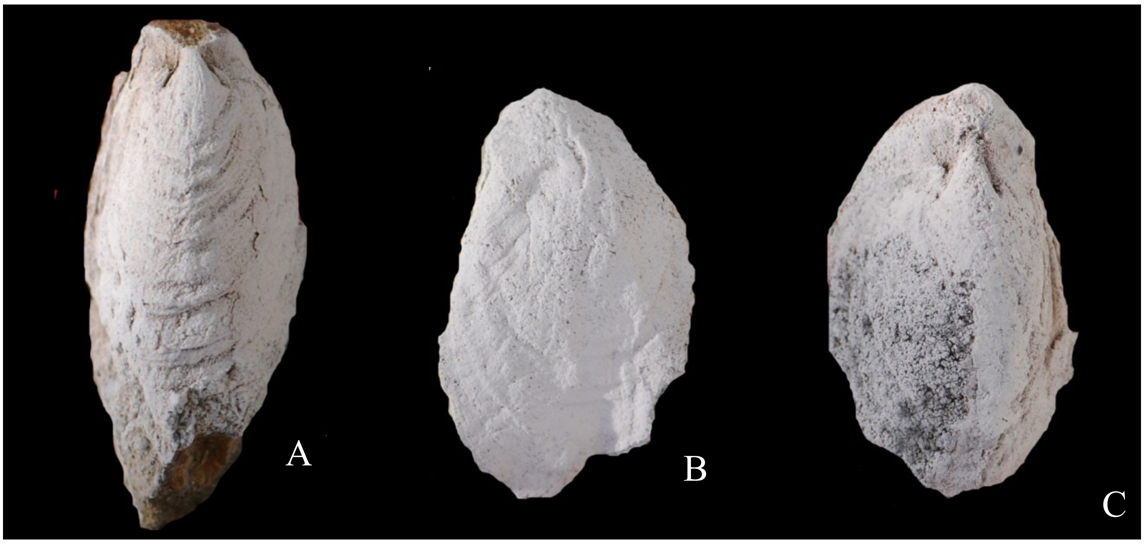


Fig. 80. *Marinurnula rugulata* Waterhouse. A, dorsal aspect of internal mould UQF 46632, laterally crushed. B, C, ventral and dorsal aspects of internal mould UQF 46631. Specimens x1. Gundiah Bridge Greywacke. (Waterhouse 2015b).

Morphology: The specimens from southeast Queensland near Gympie agree in size, shape and ornament with *Marinurnula rugulata* from the Kildonan Member, though the laminated cardinal area in the New Zealand material is smaller. Campbell (1965, p. 103) claimed that the type material was “much deformed”, but that is not correct. Perhaps that is why he misinterpreted the dorsal interior of *Marinurnula.*

Stratigraphy: The species was initially described from the Kildonan Member of the Bagrie Formation in south Otago and later illustrated from the lower clastics of the Glendale Formation at Wairaki Downs, south New Zealand, and the Gundiah Bridge Greywacke of Brown (1964), near Gympie in southeast Queensland.

Family **PSEUDODIELASMIDAE** Cooper & Grant, 1976

Genus ***Pseudodielasma*** Brill, 1940

Diagnosis: Small biconvex shells with teeth but no dental lamellae, no separate hinge plates, and crura arise from socket plates.

Type species: *Pseudodielasma perplexa* Brill, 1940 from Whitehorse Sandstone in United States, declared to be of Wordian age by Jin Yugan et al. in the *Revised Brachiopod Treatise* (2006, p. 2045), though this assigned age is surely too great (Newell et al. 1940, Waterhouse 1976, p. 166).

Discussion: It was declared that the crura arise from the socket plates in *Pseudodielasma* by Jin et al. (2006), and this is amply supported through the description and figures provided for a number of species provided by Cooper & Grant (1976, p. 2910). Inner hinge plates were stated to be absent in the *Revised Brachiopod Treatise* but Campbell (1965, p. 106) argued that they were simply reduced in size, writing of very narrow outer hinge plates attached directly to the inner socket ridges. Yet this is not obvious and requires substantiation from detailed shell studies.

Pseudodielasma campbelli n. sp.

Fig. 81, 82

1898 *Dielasma inversa* [not Koninck] – Etheridge, p. 175, pl. 1, fig. 7-9 (part, not fig. 1-3 = *Paragilledia* sp. A, not fig. 4-6, 10, 11 = *Fletcherithyris parkesi*, not fig. 12, 13 = *Paragilledia ulladullensis*).

1965 *Jisuina* sp. Campbell, p. 105, pl. 15, fig. 13-15, text-fig. 42.

Derivation: Named for K. S. W. Campbell.

Diagnosis: Broad shell with wide hinge and massive posterior shoulders, wide sulcus with median rib, and shorter dorsal median sulcus. Dorsal interior as reconstructed by Campbell (1965, text-fig. 42), shown herein as Fig. 82.

Holotype: AMF 35682 figured by Campbell (1965, pl. 15, fig. 13-15, text-fig. 42) and herein as Fig. 81A-C, here designated.

Morphology: The species is distinguished by its massive posterior shoulders and by the broad ventral sulcus, bearing a rib, and a narrower more anteriorly placed dorsal sulcus, aspects of shape that distinguish the species from other more oval or rounded and less sulcate species so far assigned to *Pseudodielasma,* and probably indicating that a distinct genus is involved, allied to type *Pseudodielasma* by its internal features.

Fig. 81. *Pseudodielasma campbelli* n. sp. A-C, lateral, ventral, lateral and dorsal views of AMF 35682, holotype, from ?Muree Formation, north Sydney Basin. (Campbell 1965).

Only one specimen is known, but it is highly distinctive in shape, and for reasons of paleobiogeographical reasons is named to facilitate understanding of faunal links.

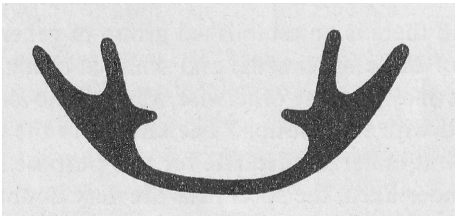


Fig. 82. *Pseudodielasma campbelli* n. sp. Transverse section of dorsal valve AMF 35682 from ?Muree Formation. (Campbell 1965),

Pseudodielasma sp. A

Fig. 83

1965 ?*Pseudodielasma* sp. Campbell, p. 106, pl. 16, fig. 13, 14 (part, not fig. 10-12 = *Marinurnula* cf. *mantuanensis*).

Diagnosis: Small subelongate shells with prominent ventral umbo and peduncular gap, shallow ventral sulcus. Dorsal valve swollen and convex, with crura diverging from the socket plates.

Morphology: Only one specimen is known, and further study is required to consolidate the morphology and taxonomic position. Campbell (1965) wrote of slender outer hinge plates, but none can be discerned from his figures of the particular specimens.

Stratigraphy: The species comes from the Flat Top Formation [though reported as Barfield Formation in Campbell's plate caption] of the southeast Bowen Basin and from the Scottville Member of the north Bowen Basin of Queensland.

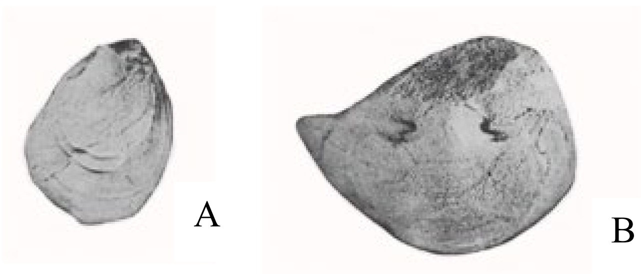


Fig. 83. *Pseudodielasma* sp. A, B, dorsal and posterior views x1, x2, of dorsal internal mould, CPC 5301, Flat Top Formation, southeast Bowen Basin. (Campbell 1965).

Pseudodielasma? sp. B

Fig. 84, 85

1967 *Pseudodielasma* sp. Waterhouse, p. 104, Fig. 9B, 43, 46.
1982 *Labaia* sp. Waterhouse, p. 69, Fig. 17O.

Diagnosis: Small subrounded shells with moderately wide hinge and strong dorsal septum. Each crus arises from the dorsal socket plate each side of the shell.

Fig. 84. *Pseudodielasma*? sp. B, latex cast of dorsal interior. B, dorsal internal mould, BR 1260, x2.5. Wairaki Breccia, New Zealand. (Waterhouse 1967).

Morphology, Stratigraphy: A dorsal valve with rounded outline and slightly produced anterior comes from the Wairaki Breccia of southern New Zealand. This was reallocated to *Labaia* Licharew 1956 in Waterhouse, 1982 on the grounds that *Pseudodielasma* Brill, 1940, based on *Pseudodielasma perplexa* Brill had much more reduced cardinalia than displayed by the New Zealand and likely allied material from Australia recorded by Campbell (1965), but this view is now set aside.

Fig. 85. *Pseudodielasma*? sp. B, dorsal valve holotype at 0.1, 0.5 and 1mm intervals from tip of dorsal umbo, reconstructed from BR 1260, x5 approx. Wairaki Breccia, New Zealand. (Waterhouse 1967).

Superfamily **CRYPTONELLOIDEA** Thomson, 1926

Family **CRANAENIDAE** Cloud, 1942

Subfamily **GIRTYELLINAE** Stehli, 1965

Genus ***Eremithyris*** Bruegge, 1973

Diagnosis: Small to small medium broadly subpentagonal shells, widest near mid-length, with rectimarginate or uniplicate anterior margin, dental plates, imperforate hinge plate supported by median septum, loop deltiform.

Type species: *Eremithyris muhlbergensis* Bruegge, 1973, p. 199 from Zechstein (Wuchiapingian), Germany, OD.

Discussion: The Permian Terebratulida of eastern and Western Australia are dominated by Dielasmoidea in a few widespread genera represented by a number of species, as shown by Campbell (1965) in his extensive study of the group. An exceptional and rare genus, represented by a few specimens, was found by Campbell (1965) in the Middle Permian of the Bowen Basin, and was identified as ?*Glossothyropsis* Girty, and another rare genus is represented by a few well preserved specimens in the upper middle Tiverton Group, and is assigned to *Eremithyris* Bruegge.

Eremithyris? _longiquincus_ Waterhouse, 2015a

Fig. 84 - 86

2015a *Eremithyris*? *longiquincus* Waterhouse, p. 229, Fig. 49B, 184-186.

Diagnosis: Small and relatively transverse in shape, rectimarginate or weakly uniplicate, permesothyrid foramen, dental plates well formed and divergent, hinge plate entire without foramen, deeply concave in section, supported posteriorly by short thick septum.

Fig. 84. *Eremithyris? longiquincus* Waterhouse. Specimens including UQF 81422 and UQF 81423 scattered over small slab with dorsal valve of *Costatumulus tumida* UQF 81424, *Orbiculipecten* and *Ambikella* (lower right), x2 approximately. Tiverton Formation. (Waterhouse 2015a).

Holotype: UQF 81420 from *Taeniothaerus subquadratus* Zone of Tiverton Formation, figured in Waterhouse (2015a, Fig. 185A) and herein as Fig. 85A, OD.

Morphology: Specimens small, ventral valve elongately ovoid, foramen large, permesothyrid, posterior walls, maximum width placed near anterior third of the shell length, shallow short groove in front of foramen, anterior commissure rectimarginate or transverse. Dental plates divergent and short, posterior floor of ventral valve marked by light radial striae, and median pair of light adductor impressions, within small pair of posterior-lateral closely striated pedicle adjustor impressions. Dorsal valve with widely divergent well-formed non-crenulate sockets, joined by inner hinge plates that form V-shaped shelf in apical region, not perforated, and less than 1.5mm long, supported by very short high septum 1.5mm long, and extended to mid-length as a very low slender ridge in the holotype. Muscle impressions in two pair, a tiny elongately oval posterior pair, and anterior larger ovally elongate pair, floor in front marked by shallow radial grooves. Fine punctae, 80-100 per square millimetre.

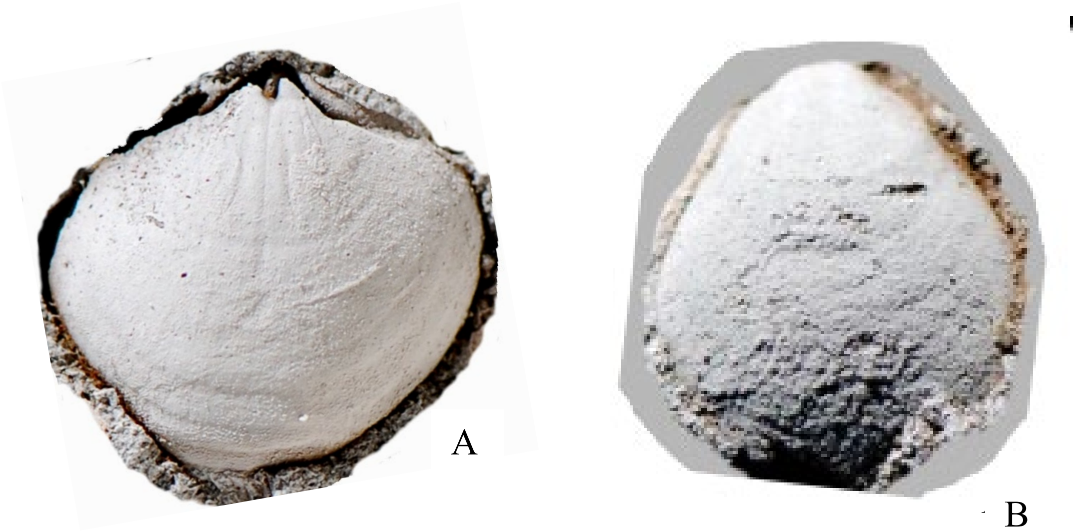


Fig. 85. *Eremithyris*? *longiquincus* Waterhouse. A, holotype dorsal internal mould UQF 81420, x7. B, ventral valve UQF 81421, x 6. Tiverton Formation. (Waterhouse 2015a).

The family alliances of these specimens are somewhat obscure, because of the lack of knowledge about the loop. The overall shape and dorsal morphology are consistent with Cryptonelloidea, and the inner hinge plate forms a concave septalium, that is entire, whereas in many cryptonellids the hinge plate is perforated.

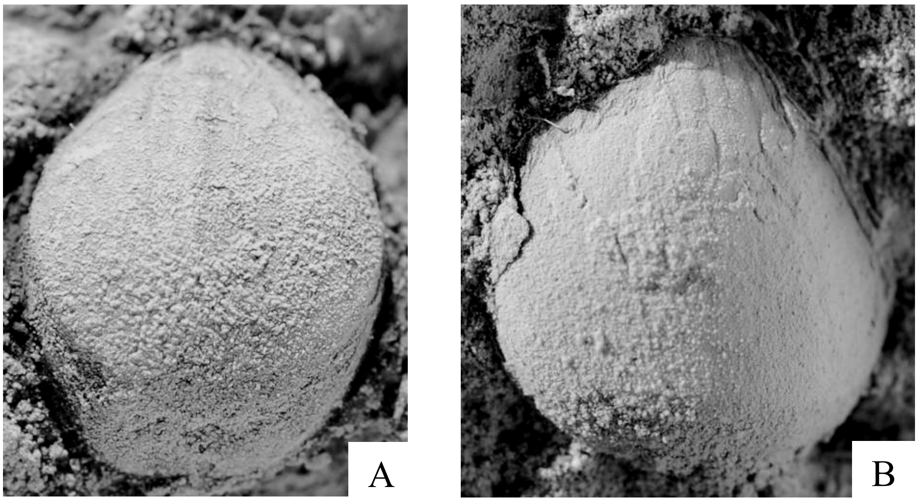


Fig. 86. *Eremithyris*? *longiquincus* Waterhouse. A, ventral internal mould UQF 81440, x5. B, ventral internal mould UQF 81602, x6. Tiverton Formation. (Waterhouse 2015a).

The rectimarginate to uniplicate anterior commisssure, and lack of dorsal or ventral median sulcus are not common features in the family or superfamily, although typical of several genera. There is some approach in shape to *Eremithyris*, especially in shape. Some aspects also suggest the Mississippian genus *Girtyella* Weller, 1911, but this genus is more elongate with maximum width anteriorly placed. The Tiverton species must await the discovery of further material for clarification of generic and family relationships.

Stratigraphy: Specimens come from the *Taeniothaerus subquadratus* Zone of the upper middle Tiverton Formation.

Family **CRYPTONELLIDAE** Thomson, 1926

Subfamily **CRYPACANTHIINAE** Stehli, 1965

Genus ***Glossothyropsis*** Girty, 1934.

Diagnosis: Small to medium in size, planoconvex or slightly concavo-convex. Unisulcate anterior commissure, telate beak ridges, distinct interarea. Wide outer hinge plate, inner hinge plates separate at first, then form undivided inner hinge plate at maturity, supported by strong septum. Loop long, ascending lamellae and transverse band from a broad-ribboned ring.

Type species: *Cryptacanthia*? *robusta* Girty, 1934, p. 251 from Capitanian of Delaware Basin, United States.

Glossothyropsis australis n. sp.

Fig. 87 -89

1953 small dielasmid Campbell, pl. 6, fig. 7, 8.
1965 ?*Glossothyropsis* sp. Campbell, p. 107, text-fig. 43, 44.

Derivation: australis – southern, Lat.

Diagnosis: Small suboval shells with swollen ventral valve dorsal sulcus. Short dental lamellae. Short septalium supported by median septum and robust crural bases, connected to floor of the valve by outer hinge plates. The descending lamellae twist to form an open W-shape in transverse section, and their further course is recorded in detail by Campbell (1965).

Holotype: ANU 14454 from Ingelara Shale (now lower Peawaddy Formation), figured by Campbell (1965, Fig. 43, 44) and herein as Fig. 87, 88, here designated.

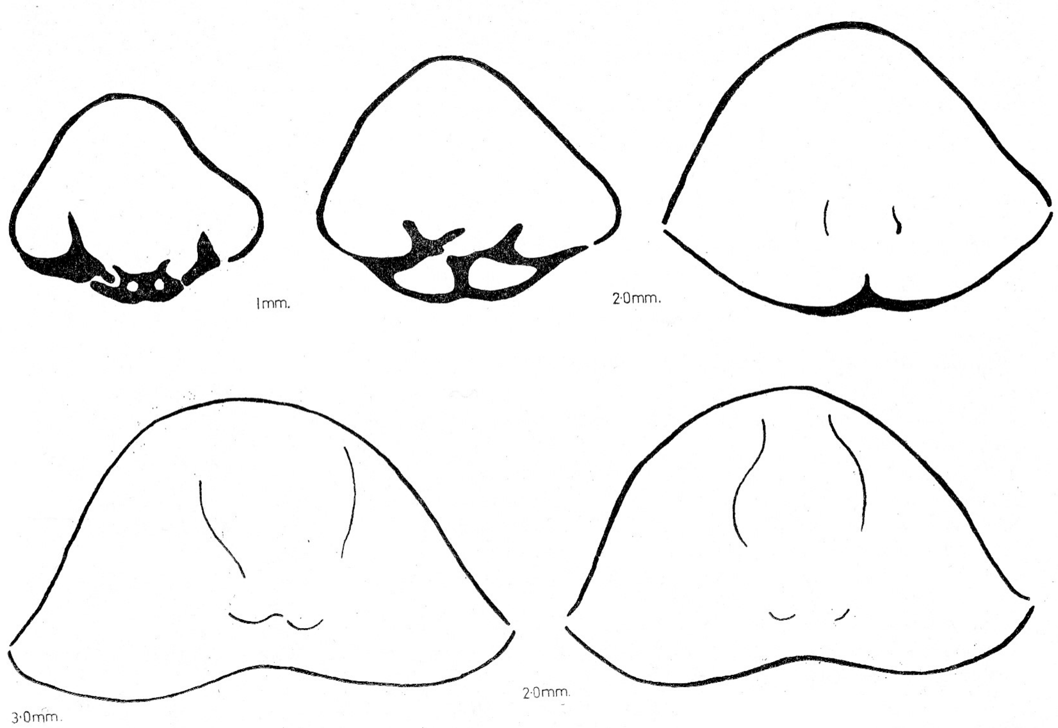


Fig. 87. *Glossothyropsis australis* n. sp. serial sections reconstructed for holotype ANU 14454, at intervals shown in the figure, x5. (Campbell 1965).

Stratigraphy: Campbell (1953, 1965) recorded his material as coming from the Ingelara Shale, which has been subsequently interpreted as lower Peawaddy Formation. Jin & Lee (2006, p. 2027) questioned if the age was really Permian, but they gave no reason for questioning the studies by K. S. W. Campbell.

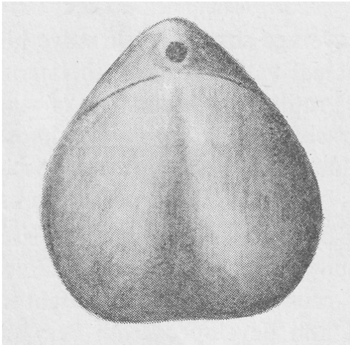


Fig. 88. *Glossothyropsis australis* n. sp. Holotype, ANU 14454? ?Lower Peawaddy Formation (Campbell 1965).

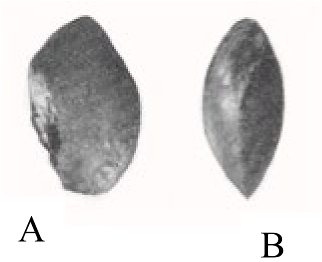


Fig. 89. *Glossothyropsis australis* n. sp. ventral and lateral aspects of UQF 14275 x3, regarded as immature representative of the species. Basal Peawaddy Formation (?). (Campbell 1953).

ACKNOWLEDGEMENTS

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