PUNCTATE SPIRIFERIMORPH BRACHIOPODA FROM THE PERMIAN OF EAST AUSTRALIA AND NEW ZEALAND

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CONTENTS

INTRODUCTION

This study summarizes the known Permian occurrences of punctate spiriferimorph brachiopods throughout east Australia and New Zealand. Members of Permian Syringothyridei are widespread in east Australia, Etheridge Snr (1872) being the first to describe specimens from the Gympie region in Queensland, and Armstrong (1970a) provided a fine and relatively comprehensive study of Permian species from throughout east Australia. Spiriferinidina are less common. Campbell (1959) authored a detailed analysis of type species of three internationally well-established genera, and Maxwell (1964) recorded a Permian species from the Yarrol Basin in Queensland, later joined by a well-preserved distinct species recognized by Armstrong (1970c).

REPOSITORIES

Many fossils described throughout this report are housed in the Bulk Storage of the Queensland Museum & Science Annex at Hendra, Brisbane, and are registered individually by number with the prefix **UQF**. 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, and **CPC** – now **AGSO**, former Bureau of Mineral Resources – at Canberra A.C.T. 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. From further afield, **TBR** signifies Geological Survey Division, Department of Mineral Resources of Thailand at Bangkok, and **USNM** signifies United States National Museum, Washington D. C., United States.

Order **SPIRIFERIDA** Waagen, 1883

Suborder **SPIRIFERIDINA** Waagen, 1883

Hyporder **SYRINGOTHYRIDEI** Grunt, 2006

[Nom. transl.Waterhouse 2024, p. 10 ex Syringothyridina Grunt, 2006, p. 158].

Diagnosis: Large narrowly plicate spiriferiform shells with well-developed interareas, which are often high in ventral valve, and may display perideltidial areas, micro-ornament of fine short radial striae and elongate pustules or spinules. Dental plates and adminicula well developed, no tabellae, median ventral septum and syrinx rare.

Discussion: In shape, members of Syringothyroidea closely resemble Cyrtospiriferoidea Termier & Termier, 1949, which are mostly transverse shells, with many pairs of plicae, maximum width at hinge, prominent sulcus and fold, and internal plates notably lacking tabellae. Syringothyroidea have a punctate shell, although much less pervasively in one family Licharewiidae. Both superfamilies have a subdelthyrial connector plate, so typical of Spiriferida, but Cyrtospiriferoidea Termier & Termier, 1949, though similar in many respects to shells of Syringothyroidea, have an impunctate shell. Because the two superfamilies are very close in shape and major aspects of ornament, and in some but not all details of inner morphology, it appears that Cyrtospiriferoidea gave rise to the punctate Syringothyroidea.

Members of Syringothyroidea display granulose or minutely spinular micro-ornament, and only some cyrtospiriferoids developed granules, as a rule related to capillae and microfilae. A delthyrial plate, in the form of a cover plate, is widespread. A very few early syringothyrids display a median septum, and some have a syrinx, apparently developed as a modification from a subdelthyrial connector plate. Such is the range of possibilities abounding in the evolution of Brachiopoda, with so much still to be elucidated and options yet to be firmly ruled out. In the meantime, it is proposed to exclude Syringothyridei from Spiriferinida, as a group which developed punctation independently from that order, and the repositioning in Spiriferida, it is preferred to downgrade Suborder Syringothyridina to hyporder, calling the group Syringothyridei (Waterhouse 2024).

Licharewia and allies, classed in Licharewiidae Slusareva, 1958, were treated as a family within Syringothyridoidea by Carter (2006, p. 1906), and were promoted to a superfamily by Grunt (2006), because the shell is largely impunctate, differing from that of syringothyrids (Grigorieva & Solomina 1966, Grigorieva & Kotlyar 1973, Erlanger & Solomina 1989), though it could be considered as a reversion towards the form of shell found in the ancestral cyrtospiriferoid stock. The assignment of *Licharewia* and similar genera to a separate superfamily seems a matter of the significance to be attached to punctation, and therefore a matter to be considered as not finally resolved.

Spiriferinida ranged from Upper Devonian to Lower Jurassic, whereas Syringothyroidea ranged from Upper Devonian to Permian. Unlike Syringothyridei, genera do not as a rule display a connector plate, and many have tabellae. Two suborders are recognized. Suborder Spiriferinidina Ivanova, 1972 involves Pennospiriferinoidea and Spiriferinoidea with genera that as a rule are smaller than those of Syringothyroidea, displaying fewer plicae or no plicae, no perideltidial areas, and with punctae that are more varied in size, and micro-ornament much more diverse in character, including development of strong commarginal lamellation in comparison to Syringtothyridae. Spiriferinid genera have a prominent median ventral septum, and many genera have tabellae, whereas a median ventral septum is restricted to a very few genera in Syringothyroidea, and no genus appears to have tabellae.

Also within the Spiriferinida, Suborder Cyrtinidina Carter & Johnson *in* Carter et al.1994 is of varied appearance, smooth or plicate lateral slopes, subconical or hemipyramidal in early forms, variable in younger, with delthyrium generally covered in early genera, more variable in younger forms, and elevated adductor attachment structures in the ventral interior. The suborder ranged from Lower Devonian to Lower Jurassic, and involved superfamilies Cyrtinoidea, Suessioidea and Spondylospiroidea. In the interrelationships suggested by Carter & Gouvennec (2006, Fig. 1251, p. 1879), Syringothyridoidea was shown as a development from Cyrtinoidea, independently from other spiriferinids.

Superfamily **SYRINGOTHYROIDEA** Fredericks, 1926

Diagnosis: Transverse finely punctate shells with high ventral valve, low dorsal valve, high ventral interarea with perideltidial areas widespread, but rarely present in shells from higher paleolatitudes, fold and sulcus smooth or costate, plicae fine and numerous, adminicula. A connector plate is present.

Discussion: Carter (2006), followed by Gouvennec & Carter (2007, p. 2796), stressed the presence of perideltidial areas as a prime distinction from Licharewiidae Slusareva, but dense punctation is a more amenable criterion. It is not clear that all densely punctate species and genera now associated with Syringothyrididae, and especially within Permasyrinxidae, have perideltidial areas.

Taxonomy: Ivanova (1959, p. 55) promoted Syringothyrinae Fredericks to Family Syringothyridae, which was amended to Syringothyrididae by Pitrat (1965, p. 691). The “id” nowadays seems redundant. The International Commission on Zoological Nomenclature (1999) proposed to allow omission of the id for taxa proposed after 1999, but this will encourage a medley of names, including introduced and omitted “id”. In my view, the simpler and more consistent, the better. It does seem that the arcane if splendid rules of nomenclature, where centred on Latin grammar, are of a past age, no longer enforceable, and no longer desirable.

Family **PERMASYRINXIDAE** Waterhouse, 1986

[Nom. transl. hic ex Permasyrinxinae Waterhouse (1986, p. 31].

Diagnosis: Syrinx absent, no ventral median septum, perideltidial areas variably defined or not developed, particularly amongst species assigned to *Permasyrinx*.

Discussion: This family lacks the syrinx found in Syringothyridae, and lacks the high median septum and syrinx found in the ventral valve of Septosyringothyrinae. The name was proposed as a signal that the genera of the subfamily were related to but different from *Syringothyris*, and could have been better chosen. As all members lack a syrinx and indeed any sign of a ventral median septum, they should be accorded family standing. Most genera of the superfamily have been placed within Perma syrinxinae by Carter (2006), which ranged from Early Carboniferous to Late Permian in age.

Genus	**Connector plate**	**Syrellum**	**Fold channel**
Cundaria	probably		no
Cyrtella	yes	no	yes
Pachycyrtella	yes	?no	yes
Permasyrinx	yes	yes	no
Pseudosyrinx	yes	no	no
Pseudosyringothyris	yes	no	no
Syrella	probably	yes	yes
Pachycyrtella	yes	no	yes
Cundaria	?	no	yes
Kyutepia	?yes	no	no
Verkhotomia	yes	no	no
Subansiria	yes	possible	no
Sulcicosta	yes	no	yes
Primorewia	?no	no	yes
Myodelthyrium	yes	no	no
Asyrinxia	no	no	yes
Woolagia	yes	no	yes?

Table 1. Summary of some features for some genera referred to Permasyrinxidae.

Gourvennec & Carter (2007, p. 2792) asserted that the assignation of genera in their text "remains provisional until the presence of perideltidial areas or syrinx is elucidated", but the absence of a syrinx appears to have been established, and the significance of perideltidial areas appears to have been influenced by paleoclimate. The perideltidial area is well-developed in *Syringothyris* Winchell, 1863, but appears to be lacking from at least many if not all species of *Permasyrinx*. There are further uncertainties, yet to be unravelled. A few species in different genera have a calcite rod or syrellum in the posterior ventral muscle field, and most do not. A syrellum is present not only in most though not all species classed as *Permasyrinx*, but in scattered specimens if not entire species classified within genus *Syrella,* such as *S. confusa* n. sp. (see Fig. 28c, p. 32 herein, as figured in Armstrong 1970a, pl. 2, fig. 23, pl. 3, fig. 1) and in *Sulcicosta ulladullensis* (Armstrong 1970a, pl. 1, fig. 11 (see p. 38). The presence therefore of a syrellum is therefore considered to be likely transgenic, though that depends on assessments of generic boundaries, yet to be conclusively established. A connector plate lies across the delthyrium, extending between the junctions of the adminicula and dental plates in most genera, but is definitely missing from *Asyrinxia* Campbell, 1957 and possibly from *Primorewia* Licharew & Kotlyar, 1978, so these are referred to a new subfamily Asyrinxiinae.

PERMASYRINXINAE Waterhouse, 1986

Diagnosis: Genera with subdelthyrial connector plate. Adminicula, no syrinx or ventral septum, no tabellae. Syrellum present or absent. Shell punctate

Genus ***Permasyrinx*** Waterhouse, 1986

Diagnosis: Large transverse shells with ventral interarea that is high medianly, tapers laterally, delthyrium partly closed by connector plate, sulcus well-defined, smooth, fold high and smooth without median channel, plicae numerous, micro-ornament of shallow linear grooves extending in front of tiny spinules, though some species lack the grooves, shell densely punctate. Dental plates high, adminicula high and short, no syrinx, muscle field short, generally displaying a calcite rod posteriorly, called a syrellum, myosepta may be developed in either or both valves outside the adductor scars. Dorsal ctenophoridium, short subhorizontal socket plates, crural plates, low median ridge, no tabellae.

Type species: *Subansiria procera* Armstrong, 1970a, p. 149 from Fairyland Formation, southeast Bowen Basin, Queensland, OD.

Discussion: There is, in spite of the generic name, no syrinx, but a syrellum or rod of calcite is developed as a cylindrical callus between the posterior adductor scars, as illustrated herein for the type species of *Permasyrinx* (see Fig. 5B, p. 12 herein). As well, myosepta, a term proposed by Waterhouse & Chen (2007, p. 57), may be developed, involving a pair of ridges, one each side of the ventral and/or dorsal muscle field. Archbold (1996) stressed the presence of these features as characterizing his genus *Syrella*, based on type species *Syrella occidenta* Archbold, 1996, p. 32 from the Mingenew Formation of Artinskian age in Western Australia, but there is some variation in the development and preservation of myosepta, and *Syrella* is regarded as a genus to be distinguished from *Permasyrinx* by its channelled dorsal fold, whereas the fold in *Permasyrinx* is rounded in cross-profile. There must remain some reservation about the nature and length of the connector plate between the junction of the dental plates and adminicula in type *Syrella*, because this was not described as such by Archbold. He did record a "delthyrial plate" at the level of the delthyrial grooves. Its nature is not clear, but his illustration in Fig. 8L suggests the likelihood of a connector plate normal for the subfamily. The shell structure of *Permasyrinx* has been described by Armstrong (1968), based on specimens from the Tiverton Formation from the north Bowen Basin. The specific identity was not indicated, nor clarified in Armstrong (1970a).

Permasyrinx is close in many respects to *Pseudosyrinx* Weller, 1914, a genus of Early Carboniferous age with very high ventral interarea. It is also very close in many aspects to the Early Permian genus *Subansiria* Sahni & Srivastava, 1956, also discussed with further references by Singh & Archbold (1993). In erecting *Permasyrinx,* it was noted that *Subansiria* lacked surface pustules or tiny spines that are present in *Permasyrinx* (see Armstrong 1970d), but it may be allowed that preservation of the Himalayan material is not good. Angiolini *in* Angiolini et al. (1997, p. 393, Fig. 11.7-9, 14D) reported elongate pustules in her diagnosis of *Subansiria* in describing a species from Oman, and added that dental plates and adminicula were long, and that a deeply sunken delthyrial plate (ie. a connector plate) and a cylindrical callus which may prove to be a syrellum were present above the floor of the valve. However her figure (Fig. 11.8) suggests a massive umbonal filling rather than connector plate, and apparently is misleading. Singh (1973, 1979) did not observe any pustules in the type or another species from the eastern Himalaya, and did record concentric (=commarginal) growth lines, without pustules or grooves. Singh & Archbold (1993) reported a species from the Himalaya that did not display any micro-ornament, but their figures show a dorsal channel in the fold, unlike that of other *Subansiria*, and a dorsal median septum is displayed, more developed than in any known specimen of *Permasyrinx* (Singh & Archbold (1993, Fig. E-H). Compared with *Permasyrinx*, species ascribed to *Subansiria* in the Himalaya have more numerous and narrower plicae and a highly convex connector plate in the upper delthyrium, and narrow fold and sulcus. They look externally like at least some species ascribed to *Permasyrinx*, and closer scrutiny of further material is required to determine morphological attributes of the taxon. Carter (2006) regarded the genus as being close to *Cyrtella* Fredericks, 1916 apart from having the connector plate, which he called delthyrial plate, close to the inner valve surface. Potentially one additional difference may lie in the nature of the ventral interarea. Amongst well-preserved Syringothyridae, the interarea each side of the delthyrium is subdivided, but this is not always clearly the case for *Permasyrinx*. Sahni & Srivastava (1956), followed by Singh (1979, p. 179), described a ventral interarea for *Subansiria* that "is divided into a median and two lateral portions", possibly like that normal for syringothyrid genera, but there is ambiguity, because they might have been referring only to the delthyrium with interarea each side.

	Connector plate	**syrellum**
Permasyrinx acuta	yes	*?*
P. allandalensis	yes	?
P. procera	*?*	yes
P. subelongata	yes	*?*
P. elongata	yes	yes
P. granulata	yes	yes
P. archboldi	yes	yes
P. transversa	?	?
P. prolonga	?	?
P. mundanus	yes	?

Table 2. Presence or absence of internal features in species assigned to *Permasyrinx***,** starting with the oldest species.

Permasyrinx acuta (Etheridge Snr, 1872)

Fig. 1A - C

1872 *Spirifera bisulcata* Sowerby var. *acuta* Etheridge Snr, p. 329, pl. 16, fig. 1.
1892 *Spirifera trigonalis* Martin var. *acuta* – Etheridge Jnr, p. 230, pl. 10, fig. 12.
1987 *Permasyrinx acuta* (Etheridge) – Waterhouse & Balfe, p. 30, pl. 1, fig. 3.
2015b *P. acuta* – Waterhouse, p. 26, Fig. 7A-C.

Diagnosis: Subelongate shells with only moderately inflated ventral valve and well-rounded comparatively low dorsal fold, up to twelve pairs of plicae on ventral valve. The presence of a syrellum is uncertain.

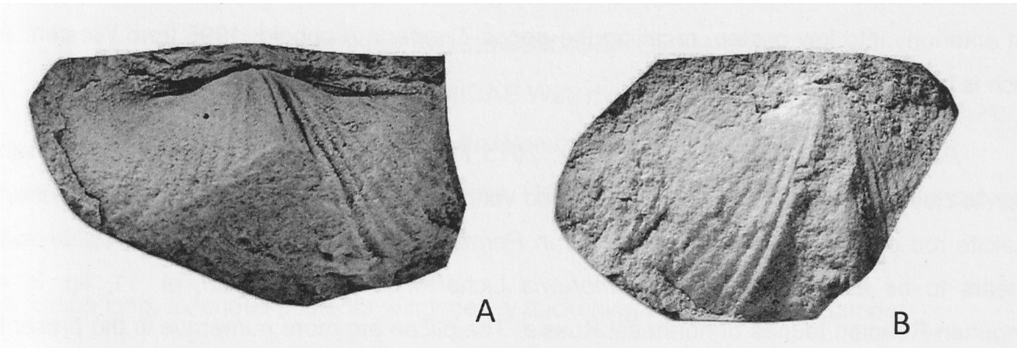

Fig. 1. *Permasyrinx*? *acuta* (Etheridge). A, holotype, dorsal internal mould QMF 5639. B, ventral valve GSQF 13178.. Specimens x1 from lower middle Rammutt Formation, Gympie. (Waterhouse 2015b).

Holotype: Sole specimen QMF 5639, by monotypy, from Rammutt Formation, Gympie, figured by Etheridge Snr (1872, pl. 16, fig. 1), Etheridge Jnr (1892, pl. 10, fig. 12), Waterhouse & Balfe (1987, pl. 1, fig. 3), and herein as Fig. 1A.

Morphology: The ventral valve QMF 14404 is transverse, with only moderately high interarea, smooth sulcus, and some twelve pairs of plicae. The delthyrium is occupied by a concave plate with swelling below umbo. The dorsal fold is moderately high, with apparently rounded crest (allowing for the effect of the septum on the profile of the internal mould); higher in the holotype than other specimens, well-defined in some specimens, or gradually sloping into lateral shell. Ten pairs of plicae are present in the holotype, and one or two more pair to each side, only nine pairs in small specimen, and twelve pairs occur in the best-preserved external mould, curving outwards in a small shell, straight in other more mature specimens. Micro-ornament consists of slender surface grooves, each passing forward from a minute spinule, and commarginal growth lines, two per mm. Shell punctate, punctae numbering four to five in 1mm, and up to thirteen to twenty in one square mm, radiating forward and inward over plicae. The ventral valve has short high narrowly diverging adminicula, supporting widely diverging dental plates (QMF 14404). The junction between the plates is joined by a connector plate marked by commarginal growth lines.

Stratigraphy: The species occurs in the green fossiliferous sandstone in the lower middle Rammutt Formation of the Gympie district, well below the upper Rammutt beds with the upper Asselian linoproductoid *Bandoproductus* (Waterhouse 2015b, p. 51ff).

Permasyrinx allandalensis (Armstrong, 1970a)

Fig. 2, 3

1969 *Pseudosyrinx* sp. nov. Runnegar, p. 292, pl. 20, fig. 13, 14.
1970a *Pseudosyrinx allandalensis* Armstrong, p. 140, pl. 1, fig. 1-3, 5, 6 (part, not fig. 4, 7 = aff. *Cyrtella erecta*).
1970a *Subansiria* sp. cf. *procera* [not Armstrong] – Armstrong, pl. 2, fig. 17 (part, not pl. 2, fig. 12-15 = *procera*, not fig. 16 = ?*elongata* [cf. p. 12]. not fig. 18 = *papula*).
1990 *Ps. allandalensis* – Clarke, p. 72, Fig. 14A-H.
1992 *Ps. allandalensis* – Clarke, p. 25, Fig. 14A-H.
2014 *Pseudosyrinx* sp. Cisterna & Shi, Fig. 8.18-20.
?2015b *Permasyrinx allandalensis* – Waterhouse, p. 25, Fig. 7E.

Diagnosis: Fold low with rounded crest, up to twelve pairs of round-crested plicae.

Holotype: ANUF 17766 from Allandale Formation (Asselian), Sydney Basin, figured by Armstrong (1970a, pl. 1, fig. 1, 2) and Fig. 2A herein, OD.

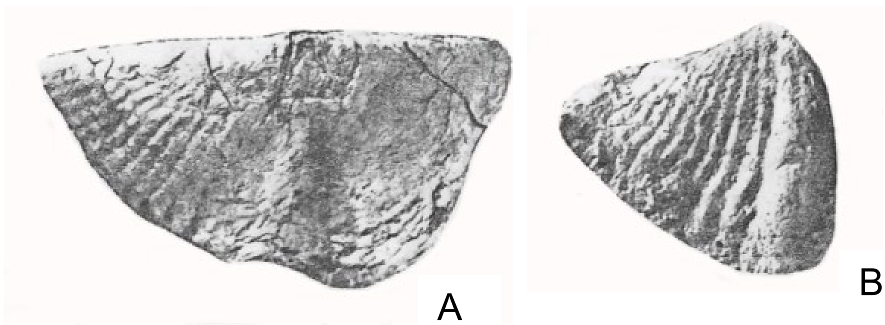

Fig. 2. *Permasyrinx allandalensis* (Armstrong). A, ventral valve ANUF 17766, holotype. B, dorsal valve ANUF 17767. Specimens x1 from Allandale Formation. (Armstrong 1970).,

Morphology: What is now termed a connector plate was reported by Armstrong (1970a), but specimens do not show if a syrellum is present or not. The species is distinctive in the relatively high number of plicae. Although Armstrong stated that punctae occurred at a density of 600-800 per square centimetre, compared with an estimated 1200-2000 punctae in *acuta,* Prof. K. S. W. Campbell, Australian National University, kindly re-examined type material of *allandalensis* that is kept at the Department of Geology, Australian National University, to report that ventral valve ANUF 17766 has twelve to eighteen punctae per square mm depending on where the count is made, and pointed out that this indicates a density at twice the figure indicated by Armstrong.

The species is close to *Permasyrinx acuta* (Etheridge), but appears to have a more conspicuous dorsal fold and less sharply defined ventral sulcus. Further study may well reveal that this is an inconsistent feature of the species, and it is thus not established that *allandalensis* can be validly separated from *acuta*.

Clarke (1990, 1992) described the species as occurring throughout most of the local Tamarian Stage in Tasmania, though never abundantly, and Cisterna & Shi (2014) reported *Pseudosyrinx* Weller, 1914 from the lower Wasp Head Formation of the south Sydney Basin. It seems likely that the specimens belong to *Permasyrinx*, a genus not considered by those authors. Weller's genus is of Early Carboniferous age (Carter 2006, p. 1900) and has a very high ventral interarea. The figured dorsal valve of the Australian specimen from Wasp Head is externally like that of *P. allandalensis*, and the ventral fragments show a wide anterior sulcus close to that of *allandalensis*.

Fig. 3. *Permasyrinx allandalensis* (Armstrong), dorsal valve GSQ F 13148. Specimen x1. Monkland beds, Rammutt Formation, Gympie. (Waterhouse 2015b).

Stratigraphy: *Permasyrinx allandalensis* (Armstrong) was initially described from the Allandale Formation of the Hunter Valley, New South Wales, and is also present in the upper Wasp Head beds now discriminated for part of an initial Conjola unit, in the south Sydney Basin of New South Wales, and also the Lizzie Creek Volcanic Group of the Bowen Basin in Queensland. A dorsal valve was reported from the Early Permian Monkland beds of Gympie, placed above the green fossiliferous sandstone in the Rammutt Formation according to Waterhouse (2015b, Table 1).

Permasyrinx procera (Armstrong, 1970a)

Fig. 4 - 6

1970a *Subansiria procera* Armstrong, p. 149, pl. 2, fig. 12-15, aff. sp. cf. *procera* pl. 3, fig. 14 (part, not pl. 2, fig. 16 = *elongata*?, fig. 17 = *allandalensis*, fig. 18 = *papula*).
1987 *Permasyrinx procera* – Waterhouse, p. 7, pl. 1, fig. 10-12, 19.
2015a *P. procera* – Waterhouse, p. 208, Fig. 159.
? 2015a *P. elongata* [not Armstrong?] – Waterhouse, Fig. 160A (part, not Fig. 160B, 161-163 = *elongata*).

Diagnosis: Smooth well-formed sulcus and fold, six to eight pair of narrow plicae, high gently curved ventral interarea.

Holotype: UQF 12607 figured by Armstrong (1970a, pl. 2, fig. 12-15) from Fairyland Formation, southeast Bowen Basin, OD.

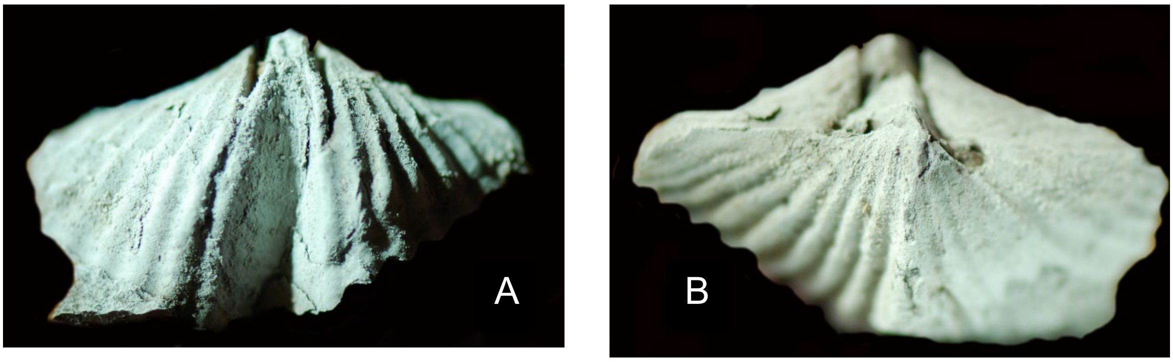

Fig. 4. *Permasyrinx procera* (Armstrong), ventral and dorsal aspects for internal mould of specimen with valves conjoined, UQF 81384, x1.5. Lower Tiverton Formation. (Waterhouse 2015a).

Morphology: Shell transverse with narrow cardinal extremities and high gently concave ventral interarea divided by triangular delthyrium. Sulcus deep and narrowly concave, fold high and narrow-crested. Plicae narrow with slightly subangular crests and interspaces, numbering six well-formed pairs and two faint pairs laterally, micro-ornament of fine numerous spines in single rows between distinct growth laminae. Dental plates high and resting on high adminicula, subdelthyrial connector plate at junction; muscle scars weakly impressed, and a syrellum is present. Ctenophoridium with short vertical laminae, vertical small crural plates and small horizontal dental socket plates. Unlike type Fairyland material, the single known example from the lower Tiverton Formation has two additional but very fine ribs are visible laterally, whereas the corresponding shell in type *procera* is smooth – as far as it is preserved. The plicae are much narrower and more sharply crested than in *P. elongata* (Armstrong, 1970a), which also has six or seven pair of plicae, and its plicae are close to those of *P. granulata* (Armstrong), a transverse species like *procera* but with wider ventral muscle field.

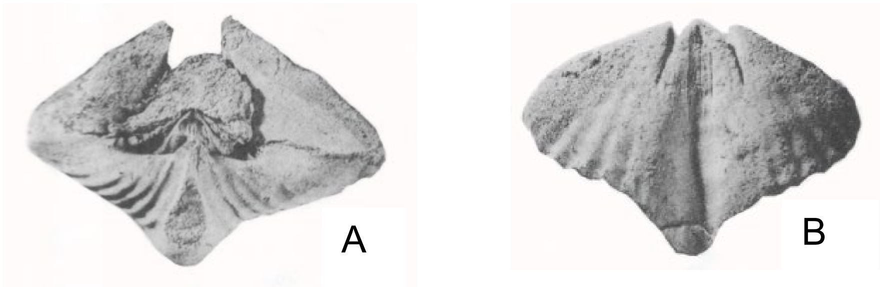

Fig. 5. *Permasyrinx procera* (Armstrong), dorsal posterior view of conjoined internal mould, UQF 74121. ventral aspect of internal mould UQF 74148. Fairyland Formation. (Waterhouse 1987).

Fig. 6. *Permasyrinx procera* (Armstrong), external dorsal valve UQF 74129 showing micro-ornament. Fairyland Formation. (Waterhouse 1987).

Stratigraphy: The species is found in the Fairyland and lower Tiverton Formations of the Bowen Basin in Queensland. Individual specimens figured as cf. *procera* from the Ravensfield Sandstone of the north Sydney Basin (Armstrong 1970a, pl. 3, fig. 14) is close.

Permasyrinx subelongata Waterhouse, 1987

Fig. 7

1987 *Permasyrinx subelongata* Waterhouse, p. 8, pl. 1, fig. 13-18, 20?,

Diagnosis: Subelongate shells with moderately defined sulcus and fold, apsacline ventral interarea and eight pairs of plicae.

Holotype: UQF 74123 from Dresden Limestone, figured in Waterhouse (1987, pl. 1, fig. 13) and herein as Fig. 7B herein, OD.

Morphology: This species displays two more pairs of plicae than found in *Permasyrinx elongata* and adminicula are closer-set and diverge less. A connector plate is well-developed but material does not show if a syrellum was present. The species is similar to *procera* but has a higher interarea.

Stratigraphy: The species is limited to the Dresden Formation of the southeast Bowen Basin.

Fig. 7. *Permasyrinx subelongata* Waterhouse. A, ventral valve UQF 74126. B, dorsal aspect of specimen with valves conjoined, UQF 74123, holotype. C, ventral interior, partly plugged with limestone, UQF 74125. Specimens x1 from Dresden Limestone, southeast Bowen Basin. (Waterhouse 1987).

Permasyrinx elongata (Armstrong, 1970a)

Fig. 8 - 11

1964 *Spirifer* cf*. tasmaniensis* [not Morris] – Maxwell, pl. 8, fig. 13.
1964 *Pseudosyrinx* sp. Hill & Woods, pl. P7, fig. 14, 15.
1970a *Subansiria elongata* Armstrong, p. 151, pl. 2, fig. 1-5, text-fig. 4.
1970a *Su. procera* [not Armstrong] – Armstrong, p. 149, pl. 2, fig. 16 (part, not pl. 2, fig. 12-15 = *procera*, pl. 2, fig. 17 = *allandalensis*, pl. 2, fig. 18 = *papula*).
1970a *Subansiria* sp. cf. *procera* – Armstrong*,* pl. 3, fig. 14.
1972 *Su. procera* – Hill, Playford & Woods, pl. P7, fig. 14, 15.
1987 *Permasyrinx elongata* – Waterhouse, p. 9, pl. 2, fig. 1-4.
2015a *P. elongata* – Waterhouse, p. 209, Fig. 160B-163A-E (part, not Fig. 160A = *procera*.

Diagnosis: Somewhat elongate shells with apsacline ventral interarea, six to seven pair of narrow plicae, adminicula short and subparallel.

Holotype: UQF 52857 from Tiverton Formation, figured by Armstrong (1970a, pl. 2, fig. 2), OD.

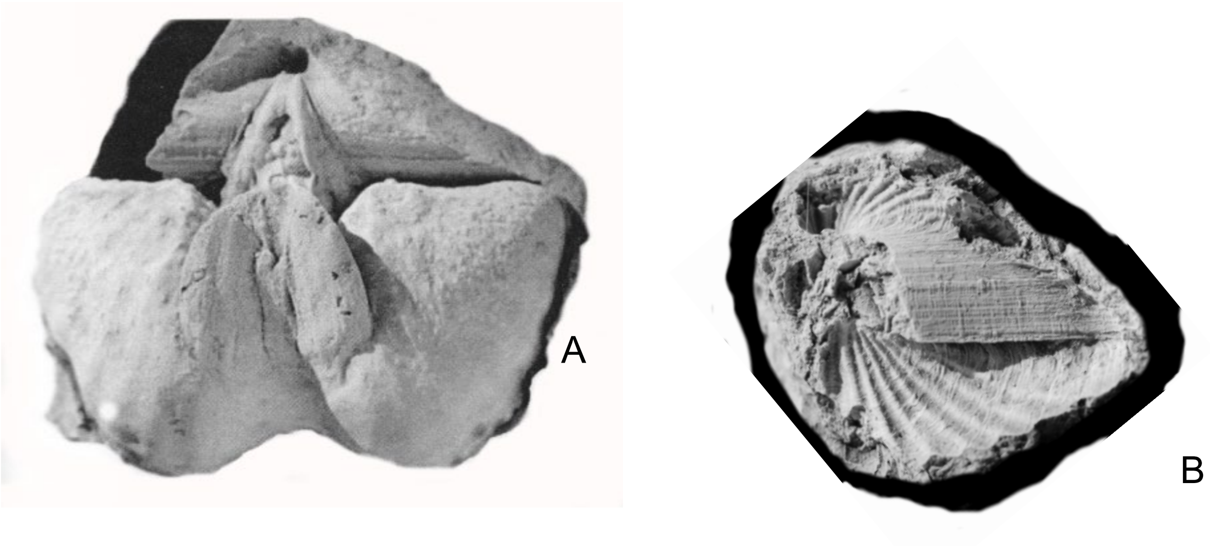

Fig. 8. *Permasyrinx elongata* (Armstrong). A, ventral internal mould, UQF 81388, x2. B, dorsal aspect of broken external mould, showing high ventral interarea with lower interarea area marked by vertical striae, UQF 81393, x1. From Tiverton Formation. (Waterhouse 2015a).

Fig. 9. *Permasyrinx elongata* (Armstrong) latex cast of dorsal interior, UQF 81390, x5, showing ctenophoridium, and base of the crura resting within crural plates. Middle Tiverton Formation. (Waterhouse 2015a).

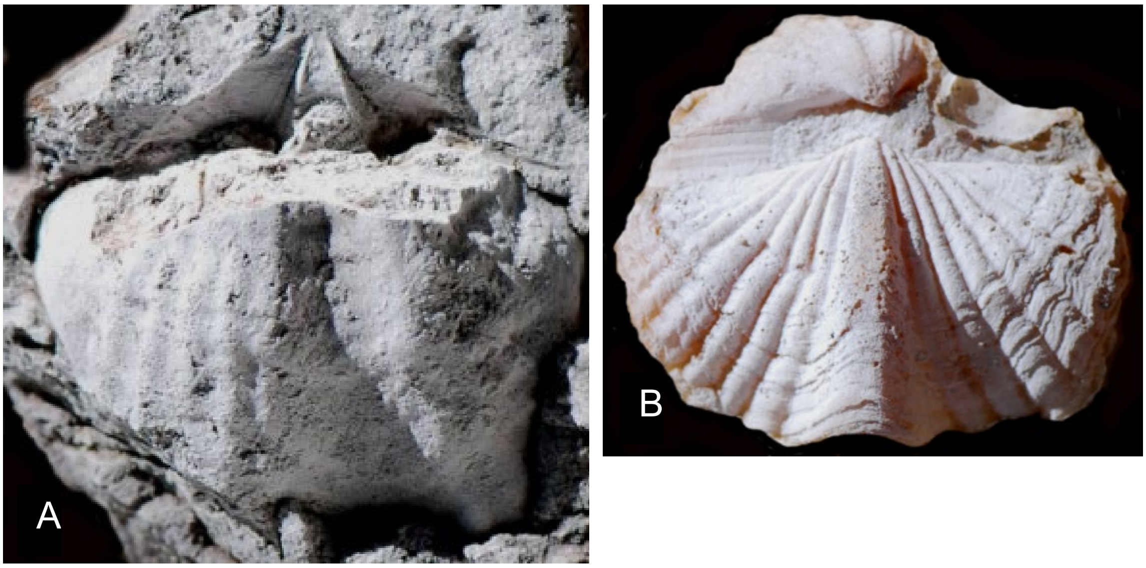

Fig. 10. *Permasyrinx elongata* (Armstrong). A, ventral internal mould showing subdelthyrial plate, UQF 81380, x2. B, dorsal aspect of latex cast UQF 81810, x1.3. Tiverton Formation. (Waterhouse 2015a).

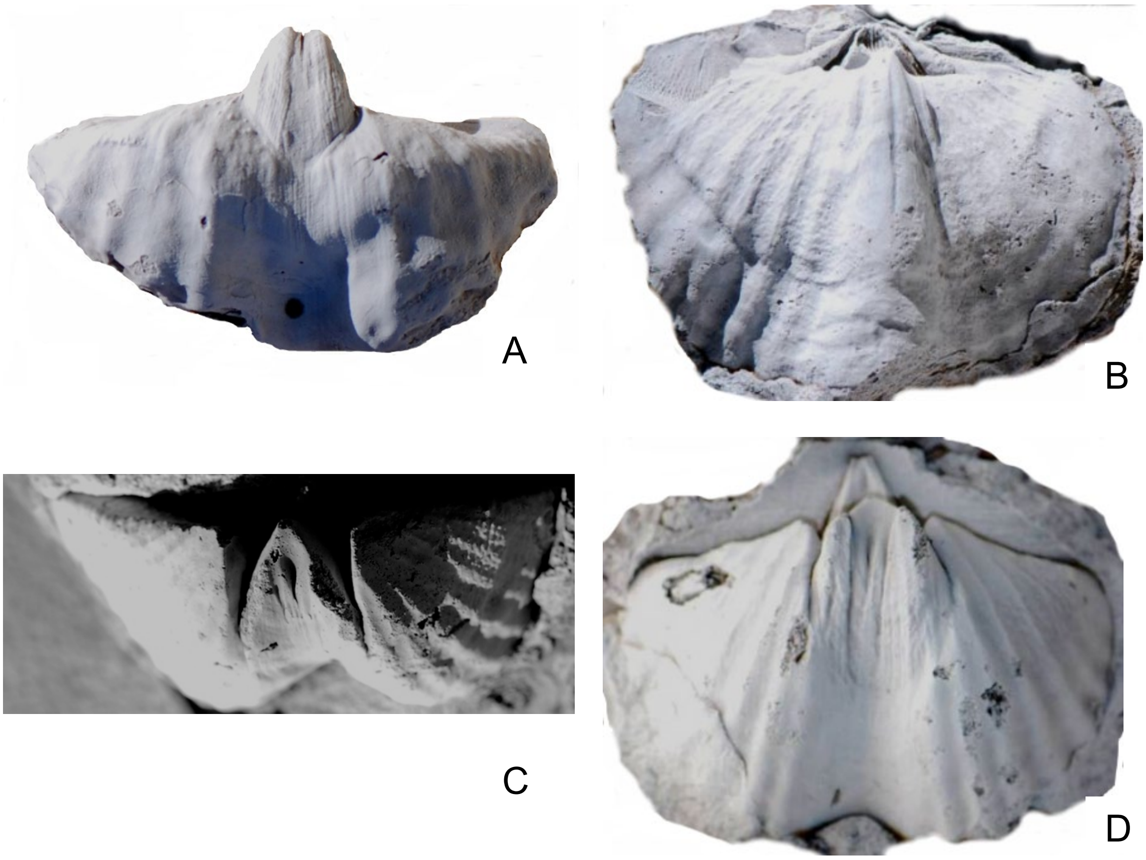

Fig. 11. *Permasyrinx elongata* (Armstrong). A, ventral aspect of internal mould UQF 81389, x2. B, dorsal internal mould UQF 81390, x1, showing dorsal myosepta. C, posterior aspect of ventral interior, UQF 81833, x1.1, showing syrellum at posterior end of adductor scars. D, ventral internal mould UQF 81392, x1. Tiverton Formation. (Waterhouse 2015a).

Morphology: This distinctive species is less transverse with lower ventral interarea and fewer plicae than in *Permasyrinx procera* (Armstrong). A connector plate and syrellum are present. *P. subelongata* Waterhouse (1987, p. 8, pl. 1, fig. 13-18, 20?) from the Dresden Formation of the same area is very close in number of plicae and other detail, but has more concave less widely diverging posterior walls, imparting a different outline, and the sulcus is shallower and the ventral interarea more curved. *P. transversa* (Armstrong, 1970a, pl. 4, fig. 2-4) from the Roses Pride Formation of the southeast Bowen Basin is more transverse with low ventral area.

Stratigraphy: This species occurs in the middle Tiverton Formation of the north Bowen Basin and allied material comes from the Yarrol Formation of the Yarrol Basin, Queensland.

Permasyrinx granulata (Armstrong, 1970a)

Fig. 12 - 16

1964 *Spirifer* sp. Hill & Woods, pl. P8, fig. 1.
1970a *Subansiria granulata* Armstrong, p. 153, pl. 3, fig. 1-4, 6-12, pl. 4, fig. 1, pl. 5, fig. 11-12, pl. 6, fig. 3, 5, 6, text-fig. 5 (part, not pl. 3, fig. 13 = aff. *procera*, pl. 5, fig. 13, 14 = *Cyrtella furcata*).
1970a *Subansiria* sp. cf. *granulata* Armstrong, pl. 3, fig. 5.
?1970a *Subansiria* sp. aff. *granulata* Armstrong, pl. 3, fig. 13.
1970b *Subansiria* sp. Armstrong, p. 205, pl. 14, fig. 1-3.
1972 *Su. granulata* – Hill, Playford & Woods, pl. P8, fig. 1.
2015a *Permasyrinx granulata* – Waterhouse, p. 212, Fig. 163F, 164-169.

Diagnosis: Transverse shells with wide hinge and subtriangular outline, some nine to eleven pair of plicae.

Holotype: UQF 52862 from Tiverton Formation, figured by Armstrong (1970a, pl. 3, fig. 1, 2), OD.

Morphology: This species is not as common in the Tiverton Formation as *Permasyrinx elongata*, and is distinguished by its transverse outline and more pairs of plicae, usually nine and up to eleven pairs. The species may be found in the same band as *elongata*, and rarely, on the same block. Several specimens of *granulata* show spinules, three to four per mm in commarginal rows, and a connector

Fig. 12. *Permasyrinx granulata* (Armstrong), latex cast of ventral valve aspect, UQF 81387 x1.5. Arrow points to small apparent split in the plication. From Tiverton Formation. (Waterhouse 2015b).

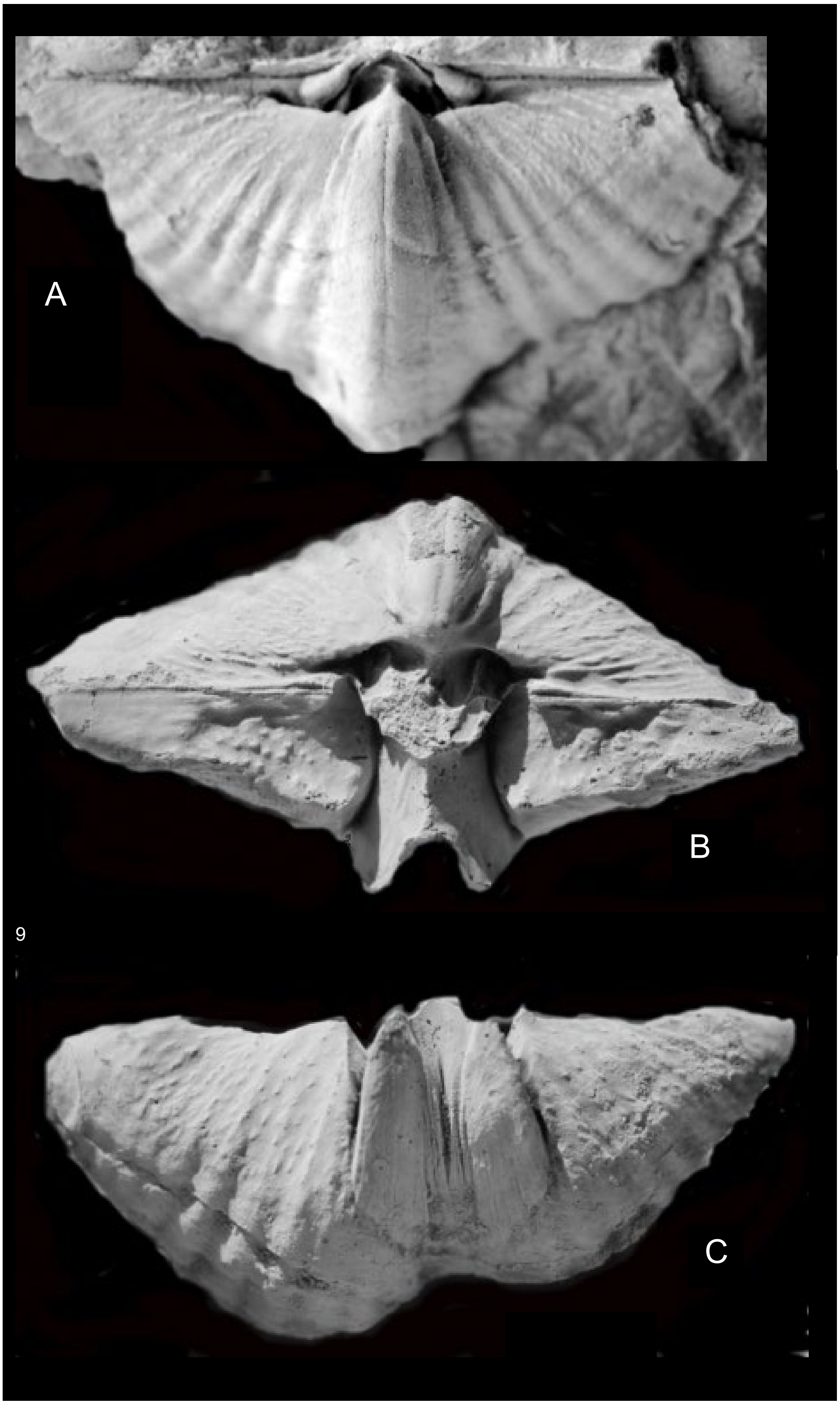

Fig. 13. *Permasyrinx granulata* (Armstrong) x2. A, internal mould of dorsal valve UQF 81447. B, C, UQF 81839, internal mould of specimen with valves conjoined, and no syrellum. B, posterior aspect, dorsal valve on top. C, ventral aspect. Tiverton Formation. (Waterhouse 2015a).

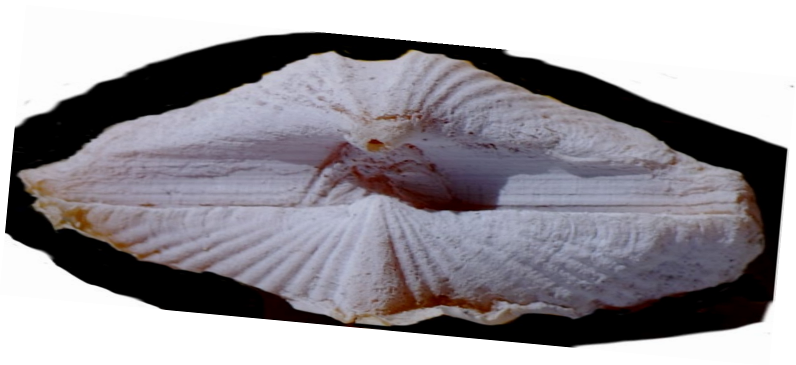

Fig. 14. *Permasyrinx granulata* (Armstrong), dorsal aspect of latex cast, UQF 81387, x2 from Tiverton Formation. (Waterhouse 2015a).

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Fig. 15. *Permasyrinx granulata* (Armstrong), internal mould of ventral valve UQF 81386, x2. From Tiverton Formation. Note small scars (a). (Waterhouse 2015a).

Fig. 16. *Permasyrinx granulata* (Armstrong), latex cast of posterior internal shell, ventral valve on top, UQF 81839 x2 from Tiverton Formation. The cracks are in the latex mould, not the original. (Waterhouse 2015a).

plate and syrellum are exposed. Armstrong (1970a) recorded and figured material from the Berriedale Limestone of Tasmania. He also incorporated specimens from the Sirius Shale of the Cattle Creek Formation from the southeast Bowen Basin, but the dorsal fold of these specimens has a well-defined channel. Although Armstrong stated that the fold in *granulata* was “with or without a gentle median furrow”, no specimens in the suites of either *elongata* or *granulata* amongst present collections shows a dorsal fold channel, and no channel is found in type *procera*. A specimen from the younger Tiverton Formation also looks like *granulata* (Waterhouse 2015a, Fig. 160A). The specimen that was figured and compared to *granulata* from Wallaby rocks in the fault blocks south of Warwick by Armstrong (1970a, pl. 3, fig. 13) is close but appears to have ten plicae pairs more closely spaced than in the Tiverton specimens, and its dorsal fold possibly displays a median channel. The material is elongate like *procera* from the Fairyland Formation of the southeast Bowen Basin, and could be this species .

One ventral valve of the present suite (Fig. 12) shows a split in the plication outside the one bordering the sulcus, as arrowed. A specimen figured from the same locality as the holotype (Armstrong 1970a, pl. 3, fig. 8, 12) shows a number of plical splits on each valve. This would appear to be an intrasubspecific variation.

Stratigraphy: The species is reliably found in the middle Tiverton Formation and possibly in the Wallaby rocks at the Queensland southern border.

Permasyrinx archboldi Waterhouse, 2015a

Fig. 17

1987 *Cyrtella erecta* [not Waterhouse] – Waterhouse, p. 12, pl. 2, fig. 15, 17 (part, not fig. 14, 21 = *Cyrtella erecta*).
2015a *Permasyrinx archboldi* Waterhouse, p. 215, Fig. 170.

Diagnosis: High ventral interarea, pointed ventral umbo, well-defined ventral sulcus and eight to thirteen pairs of narrow plicae.

Holotype: UQF 81396 from UQL 4519, Tiverton Formation, figured in Waterhouse (2015a, Fig. 170A) and herein as Fig. 17A, OD.

Morphology: Shells subpentagonal in outline, well-formed sulcus with angle of 25°, less triangular shape and coarser ribs than in *Sulcicosta pelicanensis.* The interarea is high and not strongly incurved, the delthyrium narrow with angle of 35°, closed by plate with arched growth-lines. Nine plicae pairs are found in two of the specimens and thirteen pairs in another, low and close-set, with interspaces as wide as plicae. Micro-ornament is poorly preserved, with vestiges of small pustules and pores. Adminicula are high, diverge forwards at angle of 45°, diverge slightly to floor of valve, supporting dental plates which diverge at low angle to teeth. One specimen shows a small convex plate under umbo, in addition to the connector plate, and has a syrellum or rod of shell over the posterior muscle field. Adductor scars are narrow, bordered each side by low myoseptum, and divided by low ridge extending almost to half length; diductors are wide, marked by growth-lines parallel to curved anterior margin.

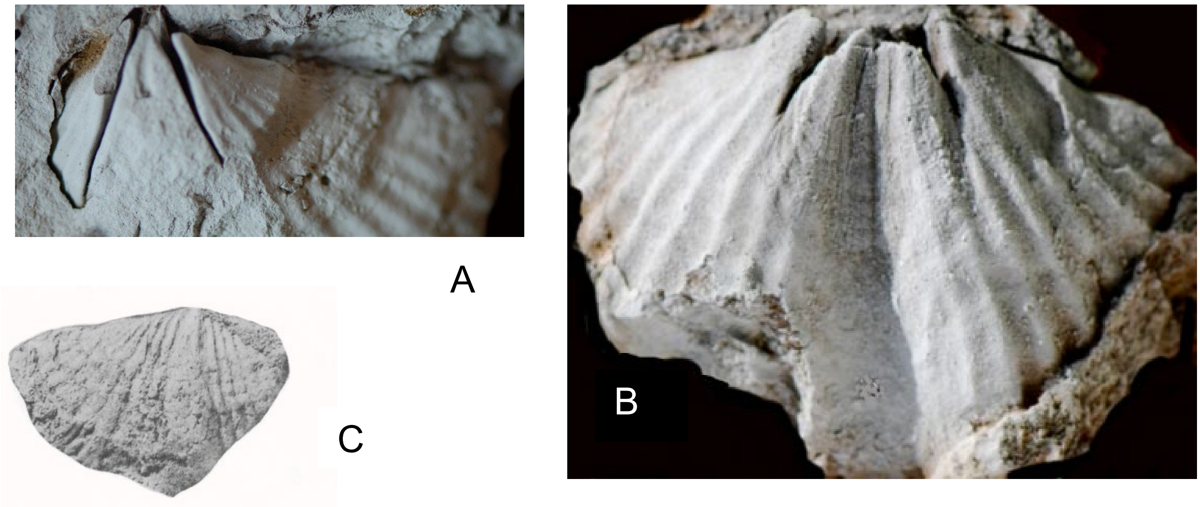


Fig. 17. *Permasyrinx archboldi* Waterhouse. A, holotype, ventral internal mould UQF 81396, showing syrellum. B, ventral internal mould UQF 81612, x2. Tiverton Formation. C, dorsal valve UQF 74143 x1 from Roses Pride Formation (C, Waterhouse 1987, A, B, 2015a).

Similar material was illustrated from the Roses Pride Formation in the *Echinalosia preovalis* - *Ingelarella plana* Zone of the southeast Bowen Basin, and the dorsal valve (Waterhouse (1987, pl. 2, fig. 17) has a rounded crest without a median channel, although there is a faint suggestion of a discontinuous median slit, due to wear of shell above median septum.

The present species is characterized by its high number of narrow plicae, and its extended and pointed ventral umbo. In that regard it comes close to *Syrella erecta* (Waterhouse, 1987), which has a dorsal fold channel, and lacks a syrellum. The species comes from the Early Permian volcanics at Collaroy in Queensland. Ventral valves approaching present material figured by Armstrong (1970a, pl. 1, fig. 4, 7) as *Pseudosyrinx allandalensis* (part, not pl. 1, fig. 1-3, 5, 6 = *allandalensis*). from the

Tiverton Formation, though the exact stratigraphic level was not provided. But provisionally these are assigned to *Cyrtella erecta*.

Stratigraphy: *Permasyrinx archboldi* comes from the upper middle Tiverton Formation of the north Bowen Basin, accompanied by *Taeniothaerus subquadratus*, and similar material comes from the slightly younger Roses Pride Formation of the southeast Bowen Basin.

Permasyrinx transversa (Armstrong, 1970a)

Fig. 18

1970a *Subansiria transversa* Armstrong, p. 155, pl. 4, fig. 2-4.
1987 *Permasyrinx transversa* – Waterhouse, p. 9.

Diagnosis: Transverse and weakly biconvex, five to seven plicae pairs, sulcus narrow and shallow, fold low.

Holotype: UQF 52878, apparently from Roses Pride Formation, figured by Armstrong (1970a, pl. 4, fig. 2-4) and herein as Fig. 18A-C, OD.

Morphology: Only three specimens are known, and one was sectioned by Armstrong, but no information provided on the delthyrial construct.

Stratigraphy: The specimen comes from beds believed to belong to the Roses Pride Formation.

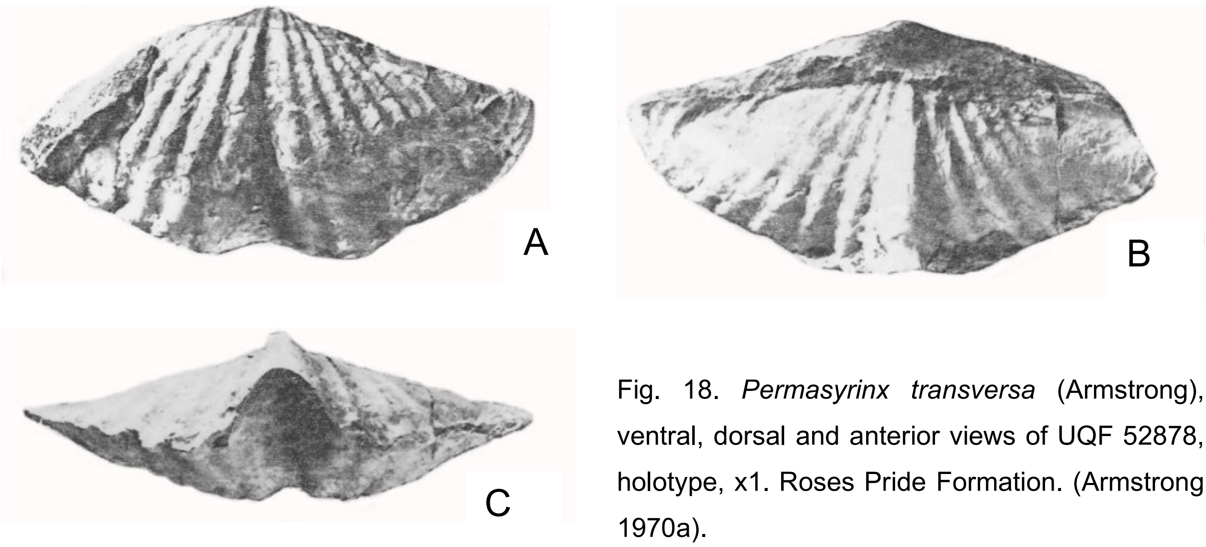


Fig. 18. *Permasyrinx transversa* (Armstrong), ventral, dorsal and anterior views of UQF 52878, holotype, x1. Roses Pride Formation. (Armstrong 1970a).

Permasyrinx*? *prolonga Waterhouse, 1987

Fig. 19

1987 *Permasyrinx prolonga* Waterhouse, p. 9, pl. 2, fig. 13, 16, pl. 11, fig. 5-8.

Diagnosis: Small narrow shells with poorly developed interarea and wide sulcus.

Holootype: UQF 70211 from Brae Formation, southeast Bowen Basin, figured in Waterhouse (1987, pl. 11, fig. 5, 6), OD.

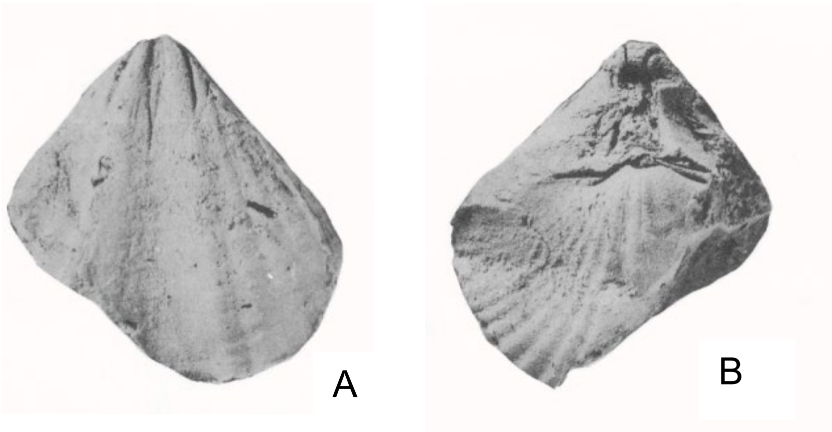


Fig. 19. *Permasyrinx*? *prolonga* Waterhouse. A, B, ventral and dorsal views of internal mould UQF 70141 x2 from Brae Formation, southeast Bowen Basin. (Waterhouse 1987).

Morphology: This species is readily distinguished by its elongate shape with few narrow plicae and poorly defined ventral interarea. The dorsal fold is well-rounded without median channel. Adminicula are long in the ventral valve figured in Waterhouse (1987, pl. 11, fig. 5) and lie outside the sulcal boundaries. Pustules are well-defined. The presence or absence of a subdelthyrial connector plate is not clear, and there does not appear to be a syrellum, which might signify that the species, with its narrow outline, marks a different taxon, in accord with its unusual shape.

Stratigraphy: The species is limited to the Brae Formation.

Permasyrinx nobilis (Armstrong, 1970a)

Fig. 20

1970a *Subansiria nobilis* Armstrong, p. 155, pl. 5, fig. 1-3, pl. 6, fig., 7-9 (part, not pl. 5, fig. 6-8, 10, pl. 6, fig. 1, 2 = *Syrella confusa*, not pl. 5, fig. 4, 9 called sp. cf. *nobilis* = *Cyrtella* or *Syrella* sp. indet.
1970d *Subansiria* sp. B Armstrong, p. 296, Fig. 5.

Diagnosis: Transverse shells with twelve to fifteen pairs of plicae and moderately well-defined sulcus. Ventral interarea low. Crest of fold rounded.

Holotype: UQF 52872 from lower Peawaddy Formation, figured by Armstrong (1970a, pl. 5, fig. 1, 2) and herein as Fig. 20A-C, OD.

Morphology: A median rib lies in the sulcus of the type specimen. The dorsal fold on the type specimen was described by Armstrong (1970a) as having a flattened crest, but is shown to be gently arched without any median channel in his figure. The species *nobilis* is provisionally assigned to *Permasyrinx* on the basis of the round-crested dorsal fold, but it must be pointed out that various other specimens assigned to the same species by Armstrong (1970a, pl. 5, fig. 6, 7, 10 and fig. 4, 9 as cf. *nobilis*) have a channelled dorsal fold. Only that of fig. 10 comes from the type Peawaddy Formation. The others come from the Flat Top Formation (fig. 6), Scottville Member (fig. 7), and Grange Mudstone ((fig. 9). This raises the likelihood that at least two taxa are involved, or that the fold profile is variable, with little weight to be attached to what may have been a variable fold profile. On the other hand, Armstrong's designated holotype for *nobilis* might prove to have been exceptional, but this option is not favoured.

Stratigraphy: Reliable accounts of this species appear to limited to the Peawaddy Formation in the Bowen Basin of Queensland (Armstrong (1970a).

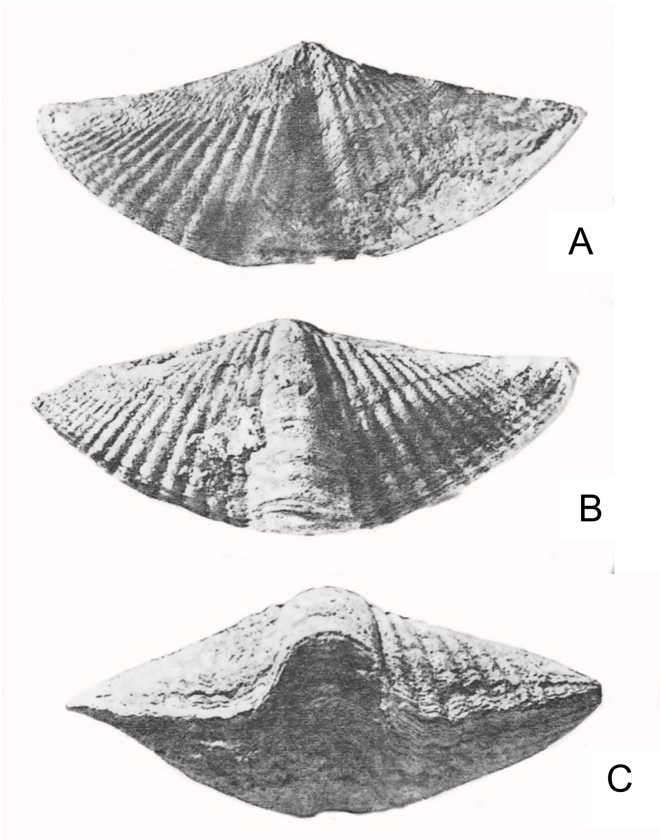


Fig. 20. *Permasyrinx nobilis* (Armstrong). A-C, UQF 52872 holotype, x1, from ventral, dorsal and anterior aspects. Peawaddy Formation, southwest Bowen Basin. (Armstrong 1970a).

Permasyrinx mundanus Waterhouse, 2022

Fig. 21A-E, 22.

2022 *Permasyrinx mundanus* Waterhouse, p. 179, Fig. 38A-E, 39.

Diagnosis: Transverse shells with well-formed sulcus and fold with rounded crest, up to nearly twenty pairs of plicae in large specimens, outer plicae very fine. Sulcus narrow and without median costa.

Holotype: UQF 82650 from the upper Blenheim Formation, illustrated in Waterhouse (2022, Fig. 39) and herein as Fig. 22A-C, OD.

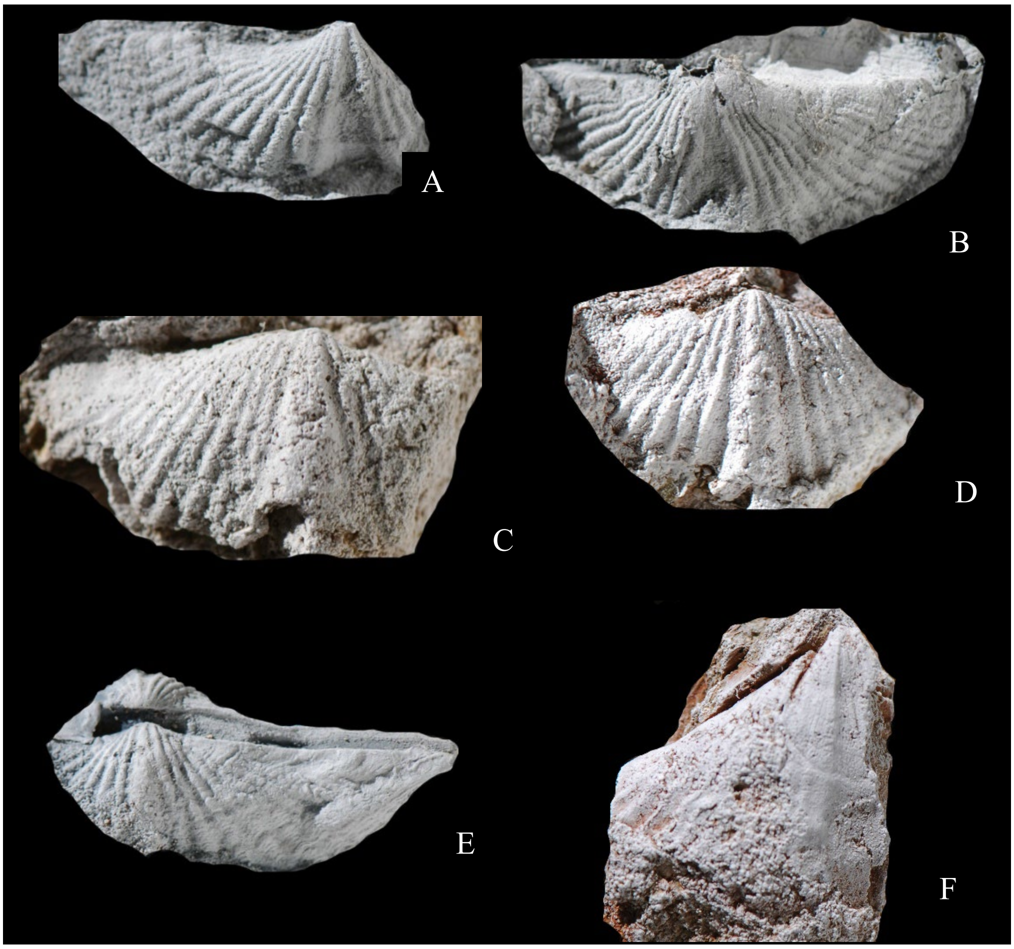


Fig. 21A-E, *Permasyrinx mundanus* Waterhouse. A, ventral valve, latex cast UQF 82626, x1.5. B, ventral valve, latex cast, UQF 82627, x1.5. C, dorsal internal mould UQF 82646, x1.5. D, dorsal internal mould UQF 82651, x2. E, dorsal aspect of specimen with valves conjoined, UQF 82645, x1.5. F, *Sulcicosta pelicanensis* (Armstrong), ventral internal mould UQF 82647, x2. Upper Blenheim Formation. (Waterhouse 2022).

Morphology: Specimens have a wide hinge, alate cardinal extremities, low broad ventral umbo with angle of 110°, and sulcus with angle close to 18°. The dorsal umbo is broad, and the fold upstanding. The ventral interarea is high with strong horizontal striae and a narrow delthyrium with angle of only 25°. Plicae are narrow with rounded crests and interspaces of similar width on

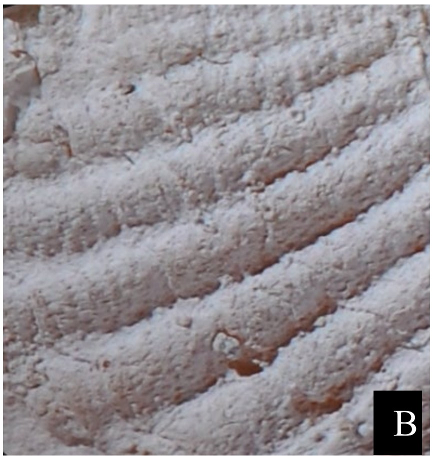


Fig. 22. *Permasyrinx mundanus* n. sp. A, ventral valve, latex cast x4. B, detail of micro-ornament on cast, x8, and C, part of external mould, x10. UQF 82650, holotype. Upper Blenheim Formation. (Waterhouse 2022).

both valves, numbering sixteen to eighteen pairs in most specimens, the outer ones slender. Micro-ornament is composed of dense small slightly elongated pustules, but grooves are not clearly defined. An outwardly convex triangular subdelthyrial connector plate is developed. The dental plates are supported by high adminicula diverging at 70°, but it is not certain whether a syrellum is present or not.

Permasyrinx nobilis Armstrong (1970a, p. 155, pl. 5, fig. 1-3, pl. 6, fig. 7-9 (part, not pl. 5, fig. 6-8,10, pl. 6, fig. 1, 2 = *Syrella confusa*) from the Peawaddy Formation is very close in shape and in number of plicae, apart from the slightly different and wider sulcus which is apparently traversed by a very low median rib (Fig. 20A herein), at least in the holotype. *P. granulata* (Armstrong, 1970a; Waterhouse 2015a, p. 212) from the Tiverton Formation has fewer plicae and is longer, whereas *P? transversa* (Armstrong, 1970a; Waterhouse 1987, p. 9) is transverse, but also with fewer plicae. It is known only from the Roses Pride Formation. *P. elongata* (Armstrong, 1970a) from the Tiverton Formation (see Waterhouse 2015a, p. 209) and from the Elvinia Formation (Waterhouse 1987) is more elongate.

Stratigraphy: The species is found in the upper Blenheim Formation of the north Bowen Basin.

Genus ***Cyrtella*** Fredericks, 1924

Diagnosis: Large, transverse as a rule with triangular interarea, high medianly, tapering laterally, plain sulcus and channelled fold. a number of plicae, micro-ornament of crowded small spinules, ventral muscle field broad in type but not in all species, no syrellum. Dental and adminicular plates widely divergent, no ventral median septum. dorsal septum inconspicuous, crural plates but no tabellae.

Type species: *Cyrtia kulikiana* Fredericks, 1916, p. 43 from Russia. OD.

Discussion: Carter (2006, p. 1900) stated that *Asyrinx* Hudson & Sudbury, 1959, p. 46) and *Punctocyrtella* Plodowski 1968, 252 and possibly *Kungaella* Solomina, 1988 were synonyms. Angiolini *in* Angiolini et al. (1996) confirmed that the holotype of *Asyrinx* was probably *Cyrtella*. She transferred the paratype ventral valve to *Subansiria* (p. 391), so that *Asyrinx* was based simply on one ventral valve, with no known dorsal valve, hardly an ideal for establishing a new genus. Angiolini (*in* Angiolini et al. 1996, p. 394, Fig. 15.1-3) granted validity to *Punctocyrtella*, which surely has to be endorsed because its dorsal fold lacks any sign of a median channel, and because the hinge is very wide and the interarea high even near the cardinal extremities. Why did Carter ignore her interpretations? Perhaps he overlooked them, or regarded them as unworthy of consideration. But there is another aspect: Carter had completed his assessments before 1996, and the tardy publication in 2006 was not his fault, the delay engendered by a long-delayed contribution from at least one other major contributor. In *Kungaella* Solomina, the dental supports converge under the umbo, and her sections show no sign of a connector plate, suggesting that perhaps it was very short. The fold lacks a dorsal channel, indicating the genus was not the same as *Cyrtella*.

	Connector plate	**syrellum**
Cyrtella subparallela	yes	no?
C?. furcata	?	?
C. erecta	yes	no
C?. campbelli	?	?
C. papula	?	no
Syrella confusa	yes	yes

Table 3. Presence or absence of internal features in east Australian species with channelled dorsal fold, assigned to *Cyrtella* and *Syrella*.

The type species of *Cyrtella, Cyrtia kulikiana* Fredericks, 1916, p. 312 from the Bolshezemelskaya Tundra of northern Russia, was well described and illustrated by Fredericks (1916), and clearly shows that a syrellum, or calcite rod, is not developed, and that a channel, sometimes shallow, is developed along the crest of the dorsal fold (see for example Fredericks 1916, pl. 2, fig. 1b, 3b, 4b). Carter (2006, p. 1900) stated that a delthyrial plate was absent from *Cyrtella*, which is true if he meant a delthyrial cover plate, but he added that it was simulated by thick callus. However, a connector plate is illustrated by Fredericks (1916, pl. 2, fig. 2b, 4b) and confirmed by Grigorieva & Kotlyar (1966, p. 49). *Cyrtella* has a very wide ventral muscle field, between widely diverging adminicula which extend laterally forward past the crest of the sulcal boundaries, and the micro-ornament involves dense moderately well-formed pustules (Fredericks 1916, pl. 2, fig. 4b). The presence of perideltidial areas in not clear to judge from the figures in Fredericks (1916) and Carter offered no specific clarification.

Cyrtella subparallela Waterhouse, 1987

Fig. 23

1987 *Cyrtella subparallela* Waterhouse, p. 11, pl. 2, fig. 5-12.

Diagnosis: Transverse shells with moderately high ventral interarea, ten to twelve pairs of plicae, shallow dorsal fold channel, heavy posterior thickening, long adminicula and tabellae.

Holotype: UQF 74136 figured in Waterhouse (1987, pl. 2, fig. 7) and herein as Fig. 23E, OD.

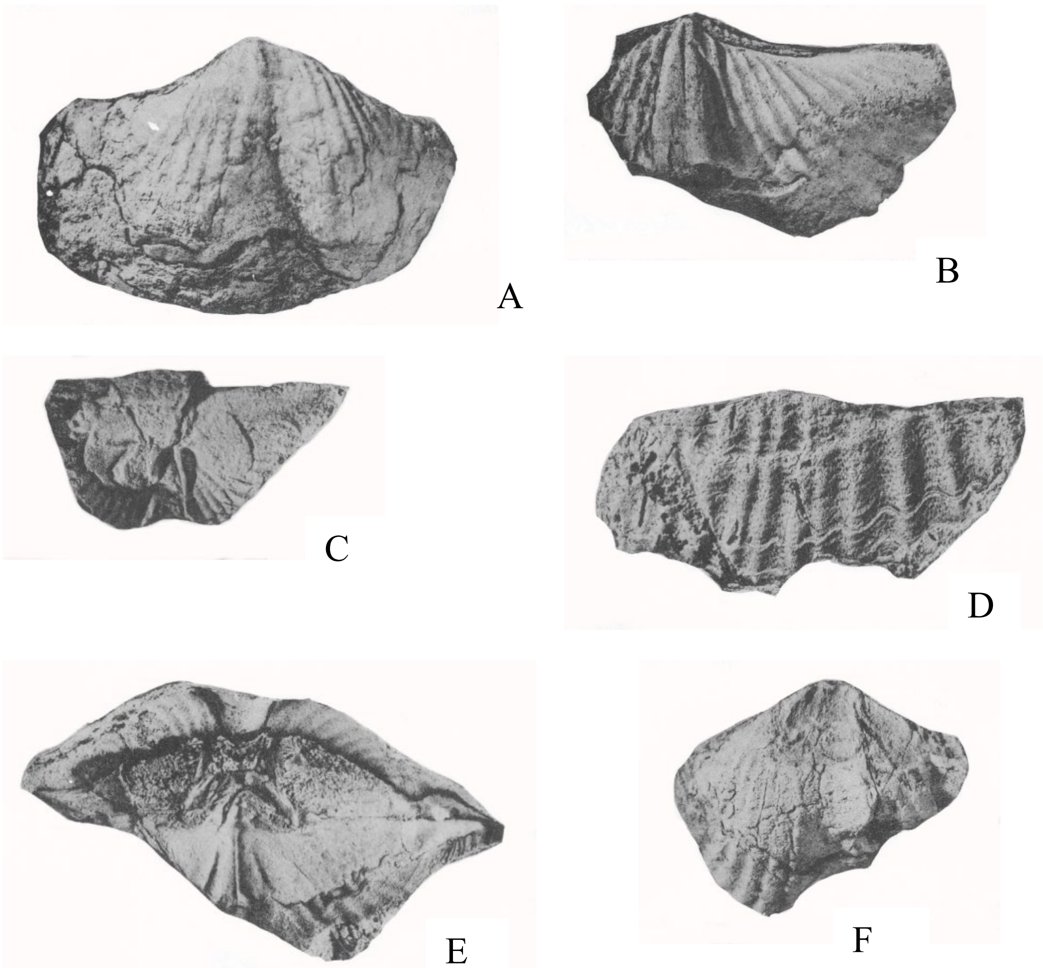


Fig. 23. *Cyrtella subparallela* Waterhouse. A, ventral valve UQF 74135. B, dorsal internal mould UQF 74139. C, ventral interior of UQF 74140, D, micro-ornament on UQF 74138. E, posterior view of UQF 74136, holotype. F, ventral aspect of internal mould UQF 74141. Specimens x1 from Elvinia Formation, southeast Bowen Basin. (Waterhouse 1987).

Morphology: *Cyrtella campbelli* (Armstrong) from the Ingelara Formation has a similar number of plicae but is much narrower in outline. Preservation is such that the presence or absence of a syrellum cannot be definitely established, but seems to be absent, and a delthyrial connector plate was reported.

Stratigraphy: The species is known from the Elvinia Formation of the southeast Bowen Basin.

Cyrtella*? *furcata (Waterhouse, 1987)

Fig. 24

1970a *Subansiria granulata* Armstrong, p. 153, pl. 5, fig. 13, 14 (part, not pl. 3, fig. 1-4, 6-12, pl. 4, fig. 1, pl. 5, fig. 11, 12, pl. 6, fig. 3, 5, 6 = *granulata*).
Not 1970a *Subansiria* sp. cf./aff. *granulata* Armstrong, pl. 3, fig. 5, ?13 = ?*granulata*. See p. 17.
1987 *Cyrtella furcata* Waterhouse, p. 13.

Diagnosis: Transverse, ventral interarea moderately high, eight to nine pairs of plicae, well-formed dorsal fold channel.

Holotype: UQF 13932 figured by Armstrong (1970a, pl. 5, fig. 13) and herein as Fig. 24A, OD.

Morphology: The fold of *furcata* is deeply grooved, unlike the round-crested fold of *Permasyrinx granulata*, and the adminicula diverge less in *granulata*. The species is close to *Syrella subparallela* but has few plicae pairs, lower ventral interarea and more transverse outline. Preservation is such that the presence or absence of a connector plate or syrellum cannot be established, so that *Syrella* might prove a more appropriate genus.

Stratigraphy: The form is found in the Sirius Shale of the lower Cattle Creek Formation of the southwest Bowen Basin.

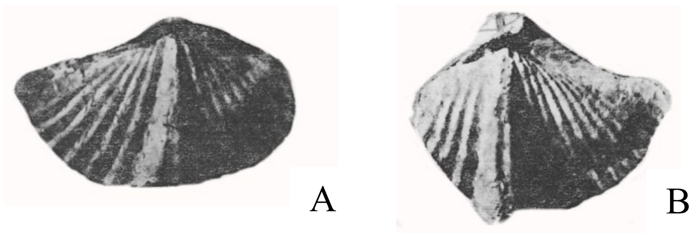


Fig. 24. *Cyrtella*? *furcata* (Waterhouse). A, dorsal aspect of complete shell, holotype, UQF 13932. B, dorsal view of complete shell, UQF 52856. Specimens x1 from Sirius Shale, southwest Bowen Basin. (Armstrong 1970a).

Cyrtella erecta Waterhouse, 1987

Fig. 25

?1970a *Pseudosyrinx allandalensis* [not Armstrong] – Armstrong pl. 1, fig. 4, 7 (part, not p. 1, fig. 1-3, 5, 6 = *allandalensis*). Possibly close to *Permasyrinx archboldi* (see p. 21).
1987 *Cyrtella erecta* Waterhouse, p. 12, pl. 2, fig. 14, 21 (part, not fig. 15, 17 = *archboldi*).

Diagnosis: Plicae in ten to twelve pairs, sulcus well defined, ventral interarea high.

Holotype: UQF 52894 figured in Waterhouse (1987, pl. 2, fig. 14, 21) and Fig. 23B, D herein from possible Roses Pride Formation, southeast Bowen Basin, OD.

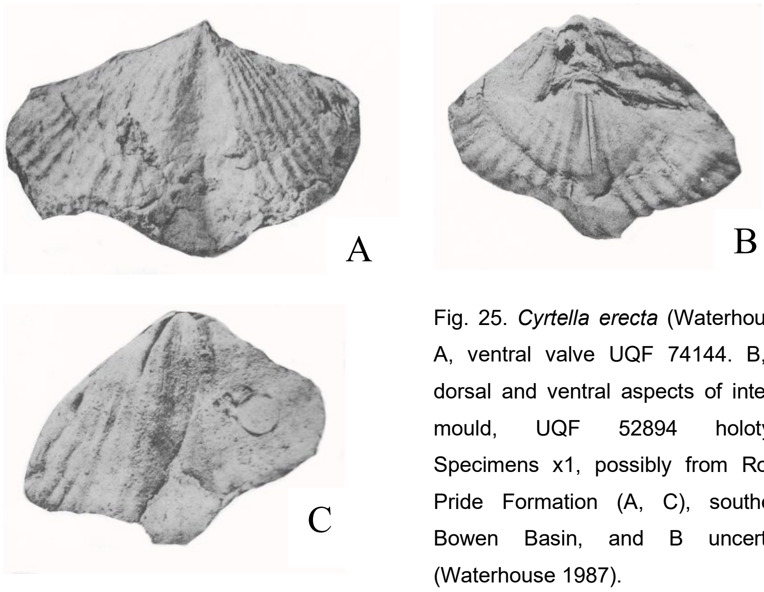


Fig. 25. *Cyrtella erecta* (Waterhouse). A, ventral valve UQF 74144. B, C, dorsal and ventral aspects of internal mould, UQF 52894 holotype. Specimens x1, possibly from Roses Pride Formation (A, C), southeast Bowen Basin, and B uncertain. (Waterhouse 1987).

Morphology: Adminicula in the figured ventral internal mould (Fig. 25C) lie in the second or third interplical furrows from the mid-line, pointing to a wide ventral muscle field. The specimens have a channelled fold and lack a syrellum.

Stratigraphy: The species comes from the Roses Pride Formation, with material also from rocks of uncertain age, possibly Roses Pride beds, southeast Bowen Basin, Queensland. Specimens from an uncertain part of the Tiverton Formation in the north Bowen Basin may prove to be identical.

Cyrtella*? *campbelli (Armstrong, 1970a)

Fig. 26

1953 *Pseudosyrinx* sp. nov. Campbell, p. 13, pl. 2, fig. 12-14.
1970a *Subansiria campbelli* Armstrong, p. 152, pl. 4, fig. 8, 9 (part, not fig. 7 called "sp. cf. *campbelli*" from *clarkei* bed, possibly = aff. *Syrella confusa*, fig. 10 = "sp. cf. *campbelli*" = aff. *Sulcicosta pelicanensis* and other taxa).
1987 C*yrtella campbelli* – Waterhouse, p. 13.

Diagnosis: Shell transverse and well inflated, sulcus and fold broad, fold with median channel, twelve pairs of coarse plicae with possibly subsidiary ribs laterally, adminicula short.

Holotype: UQF 14236 from lower Peawaddy Formation, southwest Bowen Basin, figured by Campbell (1953, pl. 2, fig. 12-14), Armstrong (1970a, pl. 4, fig. 8, 9) and Fig. 26A, B herein, OD.

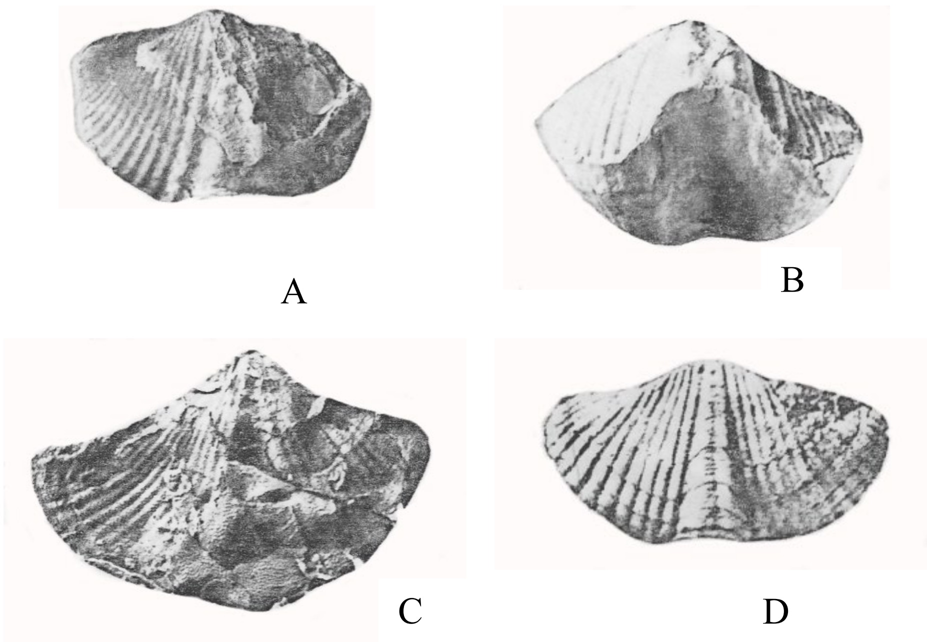


Fig. 26. A, B, *Cyrtella*? *campbelli* (Armstrong). A, B, dorsal and anterior views (dorsal valve on top of holotype, UQF 14236 from Peawaddy Formation, southwest Bowen Basin, x1. C, shell described as S*ubansiria* sp. cf. c*ampbelli* from Oxtrack Formation by Armstrong (1970a, pl. 4, fig. 10), a specimen suggestive of *Sulcicosta pelicanensis* Armstrong from the upper Blenheim Formation. D, shell described as *Subansiria* sp. cf. *campbelli* from *clarkei* beds, ie. Scottville Member, by Armstrong (1970a, pl. 4, fig. 7), possibly suggestive of *Sulcicosta pelicanensis* Armstrong and *S. lata* Waterhouse, and close in some respects to *Syrella confusa* from the Flat Top Formation, as well as approaching a dorsal valve figured by Armstrong (1970a) [see Fig. 28D herein] from the Grange Mudstone of Tasmania. (Armstrong 1970a).

Holotype: UQF 14236 from lower Peawaddy Formation, southwest Bowen Basin, figured by Campbell (1953, pl. 2, fig. 12-14), Armstrong (1970a, pl. 4, fig. 8, 9) and Fig. 26A, B herein, OD.

Morphology: Preservation is such that the presence or absence of a connector plate and syrellum cannot be established, so that *Syrella* remains possible for the genus.

Stratigraphy: The species is found in the lower Peawaddy Formation of Queensland. Armstrong reported possible specimens from the Scottville Member in the north Bowen Basin. *Permasyrinx mundamus* Waterhouse (2022) comes from the Scottville fauna, but the specimens are not

Cyrtella or *Syrella*. Armstrong also compared specimens to *campbelli* from the Flat Top Formation, and the Oxtrack Formation.

Cyrtella papula Waterhouse, 2015b

Fig. 27

1969 *Subansiria* sp. nov. Runnegar & Ferguson, pl. 3, fig. 6-7.
1970a *Subansiria procera* [not Armstrong] – Armstrong, pl. 2, fig. 18 (part, not pl. 2, fig. 12-15 = *procera,* not fig. 16 = ?*elongata*, not fig. 17 = *allandalensis*). See p. 12 herein.
2015b *Cyrtella papula* Waterhouse, p. 104, Fig. 34.

Diagnosis: Shell of small to moderate size, width generally twice the length. Some ten pairs of lateral plicae; sulcus low, smooth; fold well-defined, weakly furrowed. Interarea high, delthyrium arched, narrow. Adminicula very long, straight, placed relatively close together, diverging by 10-15°. Ventral muscle area elongate, adductor scars slender and raised, no syrellum.

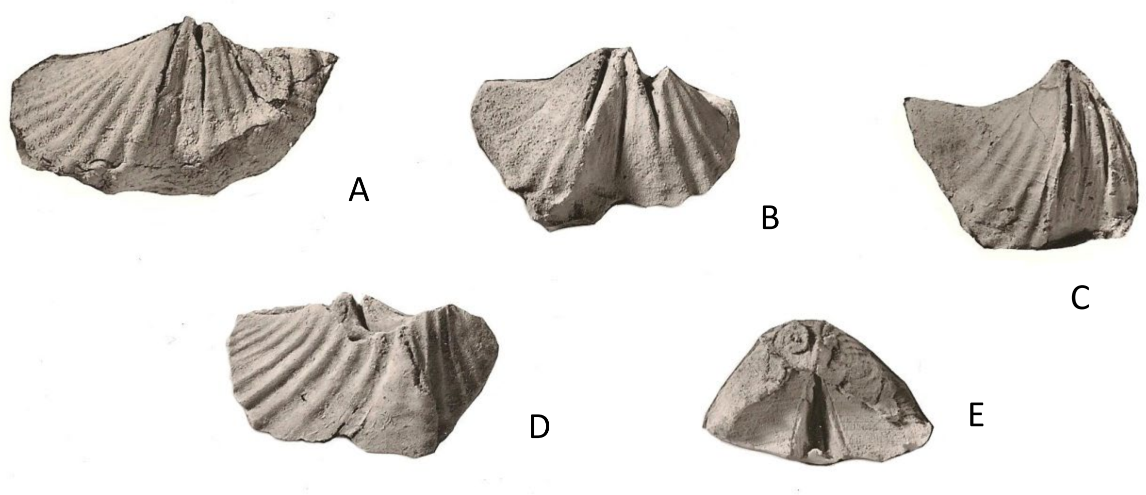


Fig. 27. *Cyrtella papula* Waterhouse. A, ventral internal mould, holotype, UQF 69188, lacking a syrellum. B, ventral internal mould, UQF 45384a. C, ventral internal mould, UQF 69189. D, dorsal aspect of internal mould, UQF 61989. E, latex cast of ventral valve, posterior dorsal view, UQF 45456. Specimens x1 from South Curra Limestone, Gympie. (Waterhouse 2015b).

Holotype: UQF 69188 from South Curra Limestone, Gympie, figured in Waterhouse (2015b, Fig. 34A) and Fig. 27A herein, OD.

Morphology: Armstrong identified a Gympie specimen with *Subansiria procera* Armstrong, now *Permasyrinx* Waterhouse, 1983, and the interarea is high as in this species, but is more curved, Unlike *procera*, the dorsal fold displays a shallow median channel, and adminicula are long. A connector plate was not reported though it should be visible if present, but perhaps it was overlooked. No syrellum is present in this species. With no syrellum and no perideltidial interareas, and narrow adductor scars on a raised ridge, and closely spaced adminicular, this species is outstanding amongst other species assigned to *Cyrtella*, and could prove to be a candidate for a separate generic entity.

A solitary ventral valve assigned to *Pseudosyrinx* sp. by Clarke (1987, p. 283, fig. 18) from the Malbina E and Abels Bay Formations of mid-Permian age in Tasmania shows a degree of similarity in its narrow plicae and slender raised ventral adductor bases. Adminicula are long, but more laterally placed than in *papula*, lying between the second and third pair of plicae from the sulcus. Most species allocated to *Cyrtella*, including the type species, are more transverse and larger, with more plicae and more widely spaced adminicula, but share the absence of a syrellum.

Stratigraphy: The species comes from the South Curra Limestone of southeast Queensland.

Genus ***Syrella*** Archbold, 1996

Diagnosis: Transverse as a rule with wide cardinal extremities and numerous narrow plicae, fold with median channel, syrellum present in type species. Spinules small and crowded, without posterior ridge. No perideltidial areas as far as known, ventral muscle field extends laterally beyond borders of sulcus.

Type species: *Syrella occidenta* Archbold, 1996, p. 32 from Mingenew Formation, Perth Basin, Western Australia, OD.

Discussion: *Syrella* has been described by Archbold (1996) from Western Australia, and is close in several vital respects to east Australian species which share a channelled dorsal fold, finely spinulose micro-ornament without posterior ridges or grooves and apparently no perideltidial area. But uncertainty remains over aspects of the genus, namely over the extent to which the lack of a perideltidial area and presence of syrellum or calcite rod at the posterior end of the ventral muscle field characterize the genus. It appears that the perideltidial area features mostly if not entirely in species from lower paleolatitudes. And a syrellum typifies the type species, and is present in one east Australian species, but is definitely absent from several of the other east Australian species, yet is present in some but not all members of *Permasyrinx* and *Sulcicosta*.

Are then these features not so much generic characters, but reflective of environment, or even infrasubspecific variants – assuming of course that the present distinctions for genera, arguably for *Syrella*, are valid?.

In summary, the obvious differences between *Cyrtella* Fredericks, 1924 and *Syrella* Archbold, 1996 involve the lack of a syrellum, and, uncertainly, presence of a perideltidial area. But the presence of a syrellum as an infallible criterion seems challengeable, judged from species in east Australia, and the validity of *Syrella* is at present open to question. The genus is retained in this study, as indicating an alliance with a west Australian taxon, but at present must be regarded as provisional.

Syrella confusa n. sp.

Fig. 26D, 28, 29

1970a *Subansiria* sp. cf. *campbelli* [not Armstrong] – Armstrong, pl. 4, fig. 7.
1970a *Subansiria nobilis* [not Armstrong] – Armstrong, p. 155, pl. 5, fig. 6-8, 10, pl. 6, fig. 1, 2 (part, not pl. 5, fig. 1-3, pl. 6, fig. 7-9 = *Permasyrinx nobilis*; pl. 5, fig. 4, 9 called sp. cf. *nobilis* = *Cyrtella* or *Syrella* sp. indet.).
aff. 1983 *Punctocyrtella nobilis* [not Armstrong] – Waterhouse & Jell, p. 243, pl. 6, fig. 2, 3.
1987 *Cyrtella nobilis* [not Armstrong] – Waterhouse, p. 13, pl. 2, fig. 20, 22, 23, pl. 3, fig. 1, 2 (part, not pl. 2, fig. 24 = indet,).

Derivation: confusa, a mixing or blending – Lat.

Diagnosis: Transverse shells with twelve to fifteen pairs of plicae, becoming fine laterally, and moderately well-defined sulcus. Ventral interarea low. Crest of fold furrowed. No syrellum as far as can be seen.

Holotype: UQF 74147 from Flat Top Formation, figured by Waterhouse (1987, pl. 2, fig. 20) and herein as Fig. 27A, here designated.

Morphology: In this species the ventral muscle scars extend laterally well beyond the sulcal borders, and are fringed by adminicula, much as in type *Cyrtella*. *Permasyrinx nobilis* Armstrong (1970a, p. 155, pl. 5, fig. 1-3, pl. 6, fig. 7-9) from the Peawaddy Formation is very close in shape and in number of plicae, apart from the slightly different and wider sulcus which is apparently traversed by a very low median rib (Fig. 28A). For this species, the dorsal fold on the type specimen was described by Armstrong (1970a) as having a flattened crest, though it would seem to be gently arched in his figure, whereas the fold in *confusa* carries a distinct median channel, raising the possibility that either two taxa are involved, or that the fold profile is variable, with little weight to be attached to what may have been a variable fold profile. Given the consistency over this feature displayed widely within the family, it has been decided to distinguish the two populations, but it must be stressed than in external appearance the populations are otherwise similar, and the two types come from correlative stratigraphic levels. Indeed one specimen from the Peawaddy Formation has a channelled fold (Armstrong 1970a, pl. 5, fig. 10).

Armstrong (1970a, pl. 5, fig. 9) assigned specimens from a range of localities to his species *nobilis*. A well-preserved dorsal valve from the Grange Mudstone is comparable in shape and plication (Fig. 28D herein), but further material is needed to reveal the nature of the ventral valve. The dorsal aspect of a specimen from the Branxton Formation (Armstrong 1970a, pl. 5, fig. 4) shows a somewhat allied but more elongate specimen. A Peawaddy specimen from the same locality as type *nobilis* has a distinct fold-channel (Armstrong 1970a, pl. 5, fig. 10). Does that mean that the holotype of *nobilis* was not typical but exceptional in the nature of its dorsal fold? The ventral and dorsal views of material called *nobilis* by Waterhouse & Jell (1983)

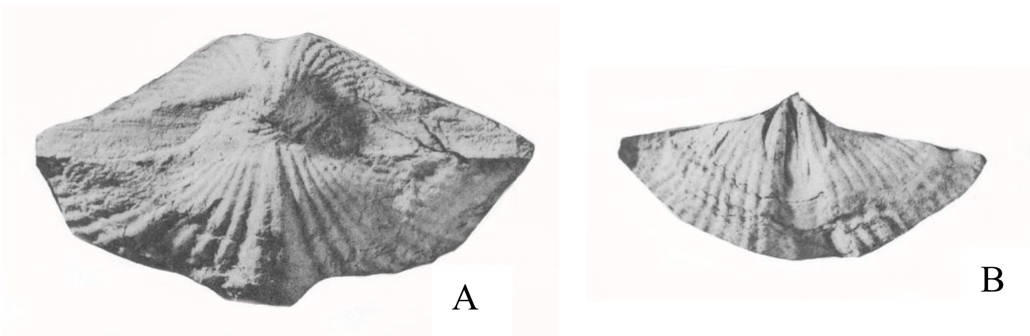


Fig. 28. S*yrella confusa* n. sp. A, UQF 74147, holotype. B, ventral internal mould, UQF 74142. C, ventral internal mould, UQF 74151, indicating syrellum. Specimens from Flat Top Formation, x1. (Waterhouse 1987).

from the lower Moonlight Sandstone of the northern Bowen Basin in Queensland suggest individuals with slightly fewer and broader plicae, and broader channelled fold.

The ventral valve of Waterhouse (1987, pl. 2, fig. 24) from the Oxtrack Formation has numerous plicae finer than those of *confusa* and approaching those of *Sulcicosta pelicanensis* from the younger upper Blenheim Formation in the north Bowen Basin, but the sulcus in the Oxtrack Formation appears to lack sulcal costae, though this needs to checked, and wear remains a possibility.

Stratigraphy: The species *nobilis* was supposed by Armstrong (1970a) to have had a relatively long range, but some of those specimens are reassigned to *Syrella confusa,* with a channelled fold. They were reported from beds as old as the Moonlight Member in the north Bowen Basin, the Grange Mudstone of Tasmania and into higher beds of the Mantuan Member of the Peawaddy Formation and Flat Top Formation in the Bowen Basin of Queensland (Armstrong (1970a). But preservation of specimens is imperfect, and S*yrella confusa*, named for the specimens with channelled fold, is reliably found only in the Flat Top Formation, and reportedly from the Peawaddy Formation, with apparent allies in the Grange Mudstone of Tasmania and Branxton Formation of the north Sydney Basin, regarded as belonging to *Cyrtella* or *Syrella* sp. indet., with ventral valve not known.

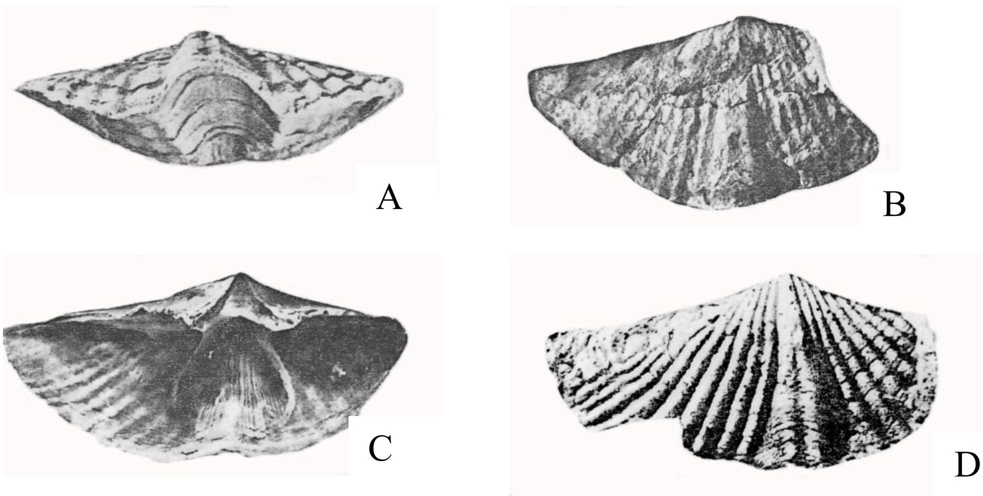


Fig. 29. A-C. *Syrella confusa* n. sp*.* A, anterior aspect of specimen with valves conjoined, UQF 52873 x1. B, dorsal valve GSQF 10605. Ventral interior, UQF 52877. C, ventral interior with prominent connector plate and myosepta, UQF 52877, referred to *Subansiria* cf. *nobilis* by Armstrong (1970a), and with dorsal valve not known. Specimens x1 from Flat Top Formation, southeast Bowen Basin. D, *Cyrtella* (or *Syrella*)? sp. indet., latex cast of dorsal valve UQF 49362, from Grange Mudstone, Tasmania. (Armstrong 1970a).

Genus ***Sulcicosta*** Waterhouse, 1983

Diagnosis: Medium in size, transverse to subelongate, distinguished by the presence of several costae over the fold and sulcus. Lateral plicae numerous, subdelthyrial connector plate, no syrellum as a rule, but present in some material, short to medium-length adminicula, dental plates, crural plates. Shell punctate.

Type species: *Pseudosyrinx plicata* Armstrong, 1970a, p. 142 from the Capertree Group of western Sydney Basin, New South Wales, OD.

Discussion: *Sulcicosta* Waterhouse, 1983, type species *Subansiria plicata* Armstrong, 1970a, pl. 2, fig. 6-11, is distinguished by the presence of costae over the sulcus and fold. A connector plate is present, but there is no syrellum nor myosepta in the ventral valve, as far as can be determined in two of the four species amongst those allocated to the genus. Several species are found in east Australia, and *Subansiria ananti* Singh & Archbold (1993) from the Early Permian of the Himalaya is congeneric. A number of species described from east Australia do not show internal features adequately and are identified solely from external morphology.

	Connector plate	**syrellum**
Sulcicosta sp.	?	?
S. costata	?	?
S. dolosus	?	?
S. ulladullensis	yes	yes
S. plicatus	yes	no
S. brevis	?	no?
S. pelicanensis	?	?
S. lata	yes	no

Table 4. Presence or absence of internal features in east Australian species assigned to *Sulcicosta.* Species arranged according to age.

A species described originally as *Brachythyrina thailandica* Hamada, 1960 from Early Permian pebbly mudstones of the Phuket Group in southern Thailand shows a strong resemblance to this genus (Fig. 28). It was reassigned to *Sulciplica* by Waterhouse (1982, p. 347), although it was noted that the species showed finer sulcal and fold ribs than in *Sulcicosta*.

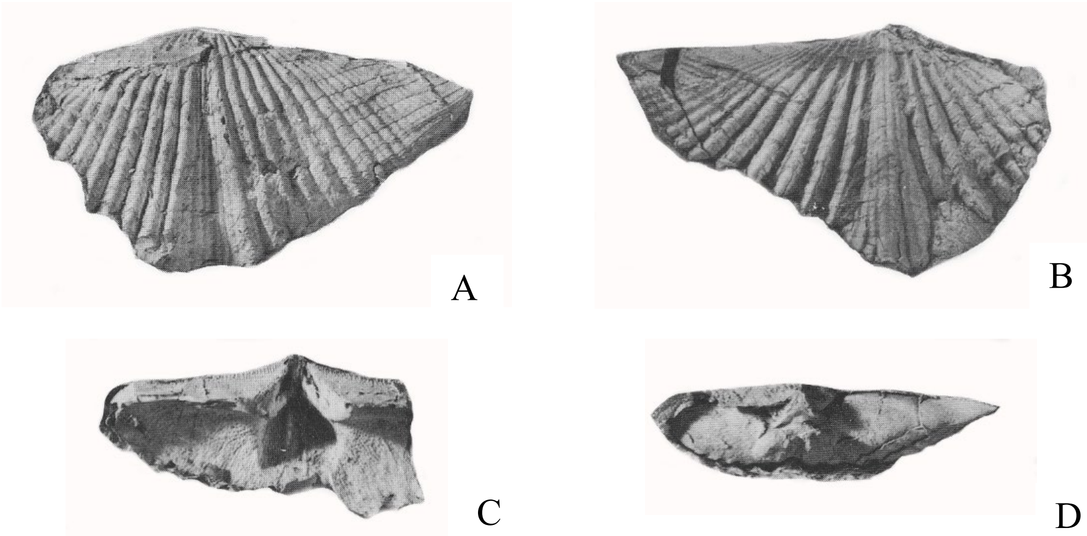


Fig. 30. "*Brachythyrina" thailandica* Hamada. A, latex cast of ventral valve, TBR 516. B, dorsal exterior, TBR 518. C, latex cast of ventral interior, TBR 514. D, posterior view of ventral internal mould, showing subdelthyrial connector plate. Specimens x1, from upper Phuket Group, Ko Muk, Thailand. (Waterhouse 1982).

The species is closer to *Sulcicosta* except for one apparent and vital difference: the Thai shell does not appear to be densely punctate and so is closer to *Sulciplica*. Externally, the species is very close to *Brachythyrina* Fredericks, but this genus as interpreted in Waterhouse (2016, p. 243) lacks adminicula and subdelthyrial connector plate, whereas these are present in the Thai species. Perhaps *Sulciplica* is the most appropriate position, though the sulcal and fold ribs are unusually fine and numerous for this genus.

Sulcicosta sp.

Fig. 31

1987 *Sulcicosta* sp. Waterhouse & Balfe, p. 30, pl. 1, fig. 4.
2015a *Sulcicosta* sp. Waterhouse, p. 28, Fig. 7D.

A single poorly preserved dorsal valve GSQF 13150 shows some ten pairs of fine plicae, and has a low fold apparently carrying some five or six costae. The type species of the genus, *Sulcicosta plicata* (Armstrong), is more elongate and has a higher dorsal fold though it has a similar number of plicae. *Sulcicosta costata* Waterhouse, 1987 from the Dresden Formation of the southeast Bowen Basin has eight or nine pairs of plicae.

Stratigraphy: The specimen comes from the lower Rammutt Formation of the Gympie district.

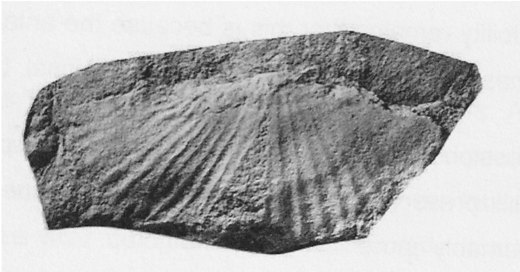


Fig. 31. *Sulcicosta* sp., dorsal valve GSQF 13150 x1 from lower Rammutt Formation, Gympie. (Waterhouse 2015b).

Sulcicosta costata Waterhouse, 1987

Fig. 32

1987 *Sulcicosta costata* Waterhouse, p. 14, pl. 1, fig. 1, pl. 3, fig. 5.

Diagnosis: Transverse shells with eight to ten plicae pairs, weakly defined sulcus.

Holotype: UQF 74154 from Dresden Formation, figured in Waterhouse (1987, pl. 1, fig. 1, pl. 3, fig. 5) and herein as Fig. 32, OD.

Morphology: *Sulcicosta plicata* (Armstrong) is less transverse with higher ventral interarea and some eleven pairs of plicae and sulcate dorsal fold. Internal detail is poorly known.

Stratigraphy: The species comes from the Dresden Formation of the southeast Bowen Basin in Queensland.

Fig. 32. *Sulcicosta costata* Waterhouse, ventral aspect of the holotype, UQF 74154 x1 from the Dresden Limestone, Queensland. (Waterhouse 1987).

Sulcicosta dolosus Waterhouse, 1987

Fig. 33

1970a *Pseudosyrinx* sp. cf. *plicata* Armstrong, p. 142, pl. 2, fig. 6, 7.
1987 *Sulcicosta dolosus* Waterhouse, p. 15.

Diagnosis: Elongate shells with well-defined dorsal fold and close-set plicae.

Holotype: CPC 9348 from Barfield-Ingelara beds at Duaringa, Bowen Basin, figured by Armstrong (1970a, pl. 2, fig. 7) and herein as Fig. 33B, OD.

Morphology: Plicae number some ten to twelve pairs. Low costae are developed on the anterior fold. Armstrong (1970a) had referred the specimens to *Pseudosyrinx* in the text and to *Subansiria* in the plate caption. Internal detail is poorly known.

Stratigraphy: The species comes from equivalents of Ingelara or Barfield beds of the Bowen Basin in Queensland.

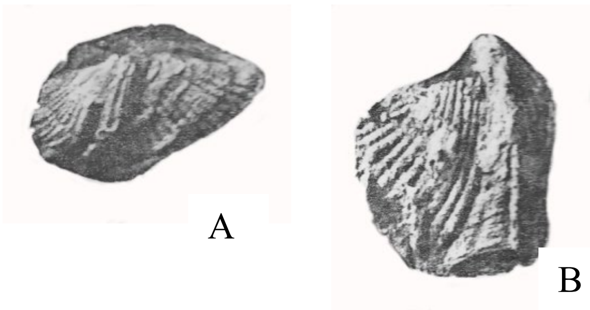


Fig. 33. *Sulcicosta dolosus* Waterhouse. A, ventral valve CPC 9347. B, dorsal aspect, specimen with valves conjoined, CPC 9348, holotype. Specimens x1 from beds equivalent to the Barfield or Ingelara Formation near Duaringa. (Armstrong 1970a).

Sulcicosta ulladullensis (Armstrong 1970a)

Fig. 34, 35

1970a *Subansiria ulladullensis* Armstrong, p. 150, pl. 1, fig. 8-14.
1987 *Cyrtella ulladullensis* – Waterhouse, p. 12, pl. 2, fig. 18, 19.
1988 *C. ulladullensis* – Parfrey, p. 15, pl. 3, fig. 15-19, 22.

Diagnosis: Transverse shells with eight to nine pairs of plicae, dorsal fold with variably defined and often shallow median channel, ventral interarea of only moderate height. Ribs subdued over the sulcus and fold. A syrellum is developed.

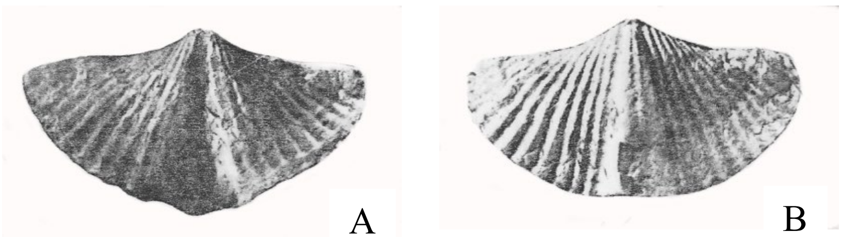


Fig. 34. *Sulcicosta ulladullensis* Armstrong. A, ventral aspect of holotype, AMF 39495. B, dorsal aspect of AMF 20755. Specimens x1 from Ulladulla Mudstone, south Sydney Basin. (Armstrong 1970a).

Holotype: AMF 39495 from Ulladulla Formation, south Sydney Basin, figured by Armstrong (1970a, pl. 1, fig. 8, 10) and herein as Fig. 35C, OD.

Morphology: Possibly the vestiges of a syrellum is visible in UQF 52853 (see Fig. 35A herein). The flanks of a subdelthyrial plate are suggested in cross-section by Armstrong (1970a, Fig. 4).

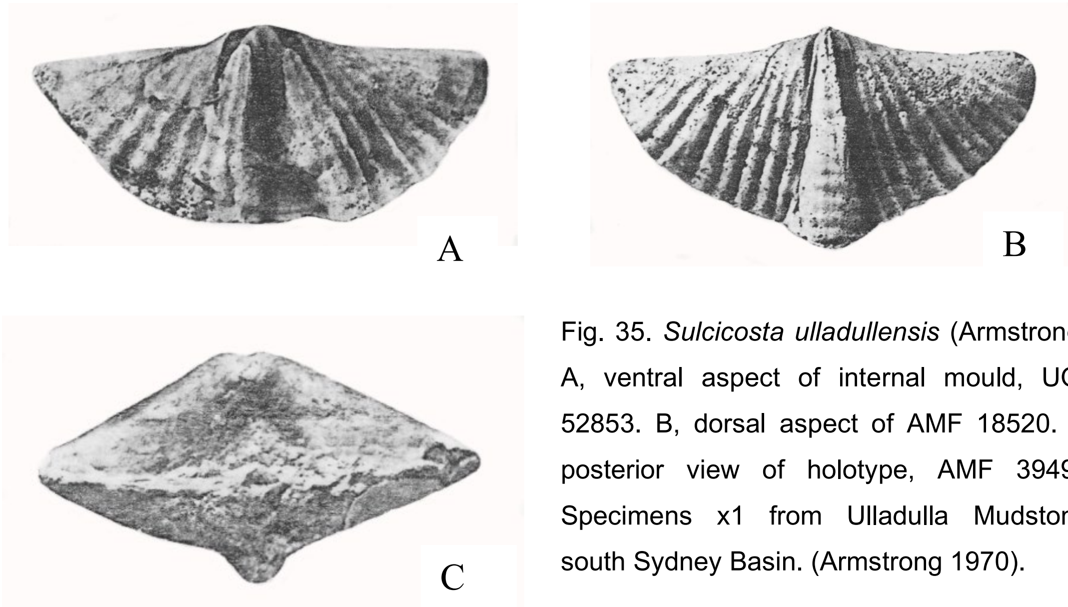


Fig. 35. *Sulcicosta ulladullensis* (Armstrong). A, ventral aspect of internal mould, UQF 52853. B, dorsal aspect of AMF 18520. C, posterior view of holotype, AMF 39495. Specimens x1 from Ulladulla Mudstone, south Sydney Basin. (Armstrong 1970).

Stratigraphy: The species was described from the Ulladulla Formation, with somewhat similar specimens recorded by Armstrong (1970a) from the Fenestella Shale, and allied material added from the Barfield Formation in Parfrey (1988) and Waterhouse (1987).

Sulcicosta plicata (Armstrong, 1970a)

Fig. 36

1970a *Pseudosyrinx plicata* Armstrong, p. 142, pl. 2, fig. 6-11.
1983 *Sulcicosta plicatus* – Waterhouse, p. 156.
2006 *S. plicata* – Carter, p. 1900, Fig. 167.2a-d.

Diagnosis: Sulcus broad and shallow with three ribs, fold high with three furrows. Some ten pairs of plicae. Adminicula thin and diverge forward. Connector plate, no syrellum or posterior thickening of shell.

Holotype: AMF 45488 from Capertree Group, New South Wales, figured by Armstrong (1970b, pl. 2, fig. 8-11), and herein as Fig. 36A-D, OD.

Morphology: Part of a connector plate is suggested by Armstrong (1970, pl. 2, fig. 10), but the presence or absence of a syrellum is not clear.

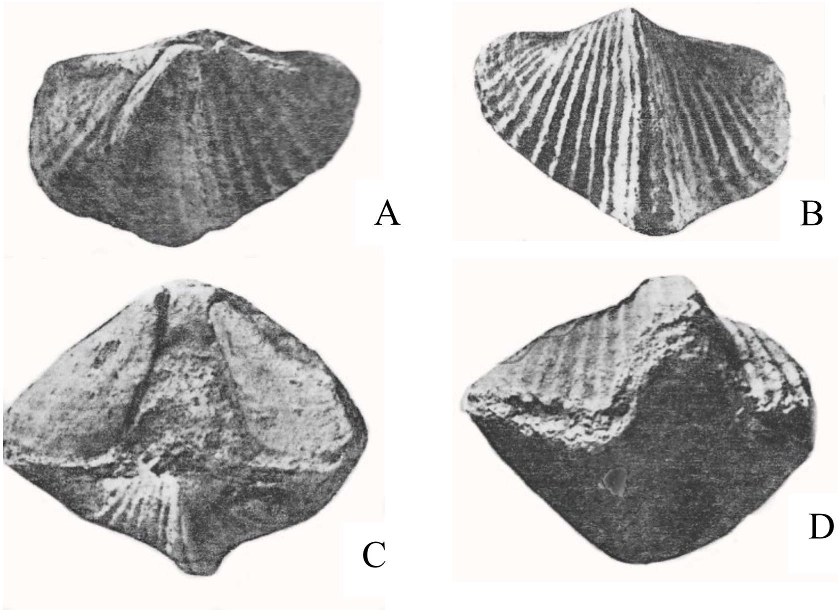


Fig. 36. *Sulcicosta plicatus* (Armstrong), A-D, ventral, dorsal posterior and anterior aspects of AMF 45488, holotype, x1. From Capertree Group at Rhyslone, New South Wales. (Armstrong 1970a).

Stratigraphy: The species is found in marine beds of early Middle Permian age belonging to the Capertree Group in the southwestern coalfield of New South Wales.

Sulcicosta sp.

2001 *Sulcicosta* sp. Waterhouse, p. 105, text-fig. 7h.

The fragment of a ventral valve BR 2363 from the lower middle Mangarewa Formation, Wairaki Downs, New Zealand, has narrow plicae and four costae in the sulcus. The shell is finely punctate.

Sulcicosta brevis (Armstrong, 1970a)

Fig. 37

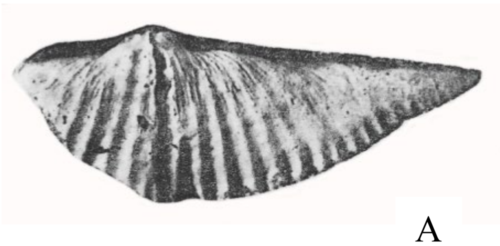
1970a *Subansiria brevis* Armstrong, p. 157, pl. 1, fig. 15, 16.

Diagnosis: Shell highly transverse, distinguished by Armstrong (1970a) from *nobilis* by median channel along costate dorsal fold, which is low and narrow. Very short adminicula, wide ventral muscle field, possibly bearing a syrellum.

Holotype: CPC 9350 from the *Pseudostrophalosia clarkei* band (= Scottville Member) of north Bowen Basin, figured by Armstrong (1970a, pl. 1, fig. 15), and herein as Fig. 37B, OD.

Morphology: A syrellum is suggested, though not clearly developed, and the presence or absence of a connector plate not known, but should be visible on the holotype, which needs to be rechecked.

Stratigraphy: The species is found in the Scottville Member in the upper Blenheim Formation of the north Bowen Basin.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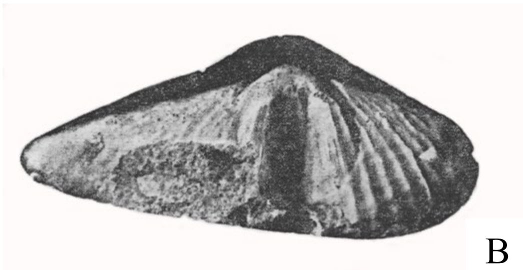
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Fig. 37. *Sulcicosta brevis* (Armstrong, 1970a). A, dorsal internal mould, CPC 9351, x1. B, ventral internal mould CPC 3950 holotype, x1. Scottville Member, north Bowen Basin. (Armstrong 1970a).

Sulcicosta pelicanensis (Armstrong, 1970a)

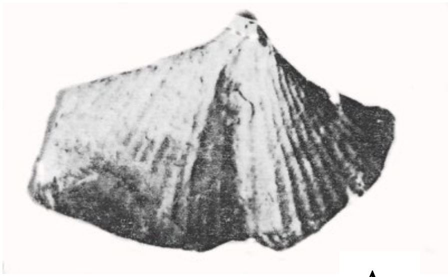
Fig. 21F, 38A-C

1970a *Subansiria pelicanensis* Armstrong, p. 152, pl. 4, fig. 11, 12, pl. 6, fig. 4.
?1970a *Subansiria* sp. cf. *campbelli* [not Armstrong] – Armstrong, pl. 4, fig. 7. [see Fig. 26D herein].
aff. 1970a *Subansiria* sp. ?*campbelli* [not Armstrong] – Armstrong, pl. 4, fig. 10. [See Fig. 26C herein].
1970d *Subansiria* sp. A Armstrong, p. 295, Fig. 6 (part).
aff. 1987 *Cyrtella nobilis* [not Armstrong] – Waterhouse, pl. 2, fig.24.
2022 *S. pelicanensis* – Waterhouse, p. 185, Fig. 38F.

Diagnosis: Shells with at least twelve slender plicae pairs, sulcus wide and shallow, bearing well-defined costae, fold costate. Internal features not known.

Holotype: GSQF 10606 from *Isbellina pelicanensis* band (see Waterhouse 2022, p. 127; 2023, p. 14), figured by Armstrong (1970a, pl. 4, fig. 12) and herein as Fig. 38B, OD.

Morphology: Internal detail is poorly known. This species has weak sulcal costae and in shape and ventral ornament comes close to *Verkhotomia* Sokolskaya, 1963. The type species *Verkhotomia plenoides* Sokolskaya, 1963 from the Visean of the Kuznets Basin of Russia was named for medium-sized to large shells with ventral interarea of moderate height, numerous simple plicae, sulcus with few fine ribs on sides and smooth or very weakly ribbed dorsal fold. Fold ribs are stronger in the Australian species. The adminicula, delthyrial plate and median septum are all long. *Verkhotomia* is close to *Sulcicosta* Waterhouse, 1987, but is more elongately subpentagonal in shape, and has a much less costate fold, and somewhat less costate sulcus. As well plicae are finer, at least in the type species.



A

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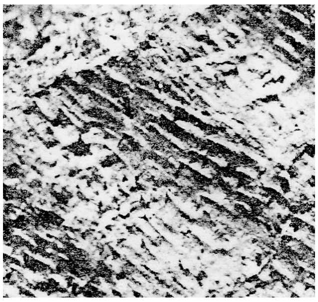

C

Fig. 38. *Sulcicosta pelicanensis* (Armstrong). A, ventral aspect of UQF 52879, x1. B, dorsal aspect of GSQF 10606, holotype, x1. C, micro-ornament on UQF 52879, x10. From *Isbellina pelicanensis* band, north Bowen Basin. (Armstrong 1970a).

The ventral valve figured as *Subansiria* sp. cf. ?*campbelli* Armstrong (1970a, pl. 4, fig. 10) from the Oxtrack Formation of the southeast Bowen Basin is similar in shape and plication to *pelicanensis.* Ribbing is not clearly visible in the sulcus, perhaps because it was worn, or the photography at fault, because otherwise the presence or absence of costae does not appear to vary.

Stratigraphy: The species is found in the upper *Echinalosia* (*Unicusia*) *minima* Zone, upper Blenheim Formation, north Bowen Basin.

Sulcicosta lata Waterhouse, 2022

Fig. 39 - 42

2022 *Sulcicosta lata* Waterhouse, p. 182, Fig. 40-43.

Diagnosis: Transverse small shells with eight or nine pairs of plicae, two to four sulcal costae, and four costae developed over the fold, two on each side of median channel. Connector plate, no syrellum.

Holotype: UQF 82652 from upper Blenheim Formation, figured by Waterhouse (2022, Fig. 40A-C, 41) and herein as Fig. 39A-C and Fig. 40 herein, OD.

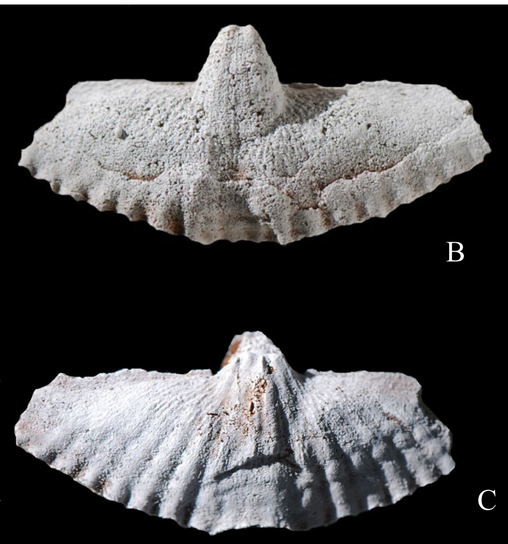

Fig. 39. *Sulcicosta lata* Waterhouse. A-C, dorsal aspect of external mould, and ventral and dorsal aspects of internal mould, UQF 82652, holotype, x1.5. Upper Blenheim Formation. (Waterhouse 2022). See Fig. 40.

Fig. 40. *Sulcicosta lata* Waterhouse, latex cast of ventral valve UQF 82652, x1.5, holotype. Upper Blenheim Formation, north Bowen Basin. (Waterhouse 2022).

Morphology: Specimens are transverse, with ventral umbo broad, angle estimated to be 110°, ventral sulcus comparatively shallow, with two low costae posteriorly, increasing to four well in front. The dorsal fold is low, and bears a well-defined median channel arising at umbo between two costae, joined close to anterior margin by a costa on each lateral slope. Plicae number eight or nine pairs, diminishing laterally in strength and with rounded crests of similar strength and profile on each valve. Micro-ornament consists of tiny dense pustules leading to pores, with grooves not discernible, and prominent growth laminae at intervals, especially close to the anterior margin of the holotype.

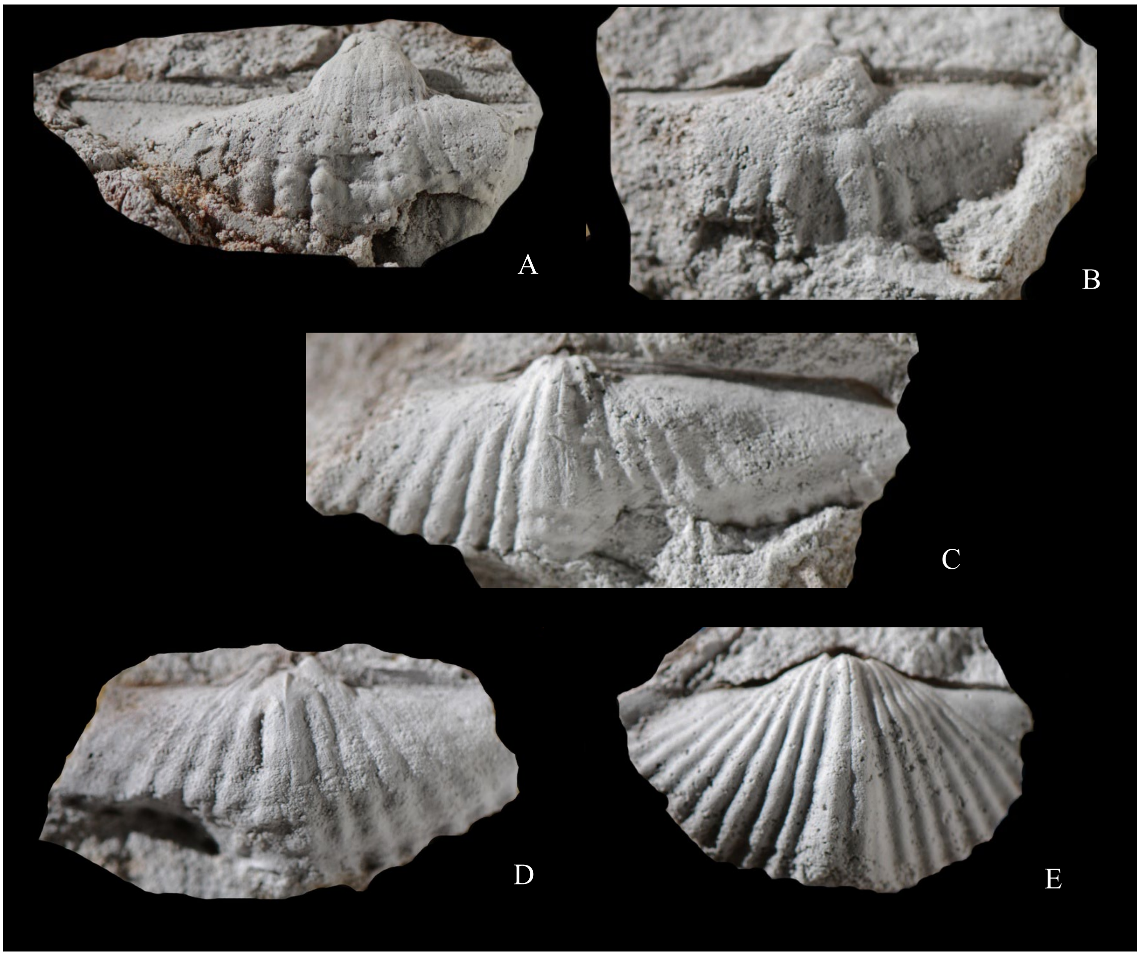

Fig. 41. *Sulcicosta lata* Waterhouse. A, ventral internal mould, UQF 82658, x1.5. B, ventral internal mould, UQF 82659, x2. C, dorsal internal mould UQF 82668, x2. D, dorsal internal mould UQF 82660, x2. E, dorsal internal mould UQF 82667, x2. [cf. Fig. 26D herein]. Specimens from lower *Echinalosia* (*Unicusia*) *minima* Zone, upper Blenheim Formation, north Bowen Basin. (Waterhouse 2022).

The subdelthyrial connector plate is highly convex dorsally. Dental plates are low, converging inwards whilst diverging forward, and supported by outwardly inclined and anteriorly divergent adminicula, which are well-spaced and allow a broad muscle field. Adductor scars are weakly impressed, divided by a low septum and bordered by wider diductor scars with longitudinal striae, and there is no syrellum. The hinge area is heavily thickened by secondary shell which on the surface is marked by pits and pustules. Crural plates are low and divergent, lying each side of a broad ctenophoridium with gently concave anterior face and bearing some sixteen vertical blades. Poorly preserved elongate adductor scars lie immediately in front, and there is no sign of any median septum.

Fig. 42. *Sulcicosta lata* Waterhouse, detail of dorsal external mould UQF 82705 from upper Blenheim Formation, x5. Upper Blenheim Formation, north Bowen Basin. (Waterhouse 2022).

This species is highly transverse and so recalls *Sulcicosta brevis* (Armstrong) from the underlying Scottville Member in the upper Blenheim Formation. Armstrong's species is represented by few specimens, and further enquiry is needed to consolidate the knowledge of the species, which has slightly fewer pairs, and its costae appear stronger over the dorsal fold, and secondary thickening along the ventral hinge in *brevis* is much less than in *lata,* and a syrellum may be present. *Sulcicosta plicatus* (Armstrong 1970a, p. 142, pl. 2, fig. 6-11) from Middle Permian of New South Wales is more elongate with better defined sulcal costae. The closest of other species appears to be *S*. *costata* Waterhouse (1987, p. 14, pl. 1, fig. 1, pl. 3, fig. 5) from the Dresden Limestone of the southeast Bowen Basin, but one of the specimens is more elongate, and the dorsal channel is better defined, and the sulcus and fold lack ribs.

Subfamily **ASYRINXIINAE** new subfamily

Diagnosis: Typified by absence of subdelthyrial connector plate. The type species is strongly transverse with smooth sulcus and fold and fine plicae. No delthyrial cover plate. Short adminicula and tabellae.

Name genus: *Asyrinxia* Campbell, 1957, based on *Spirifera alata* M'Coy, 1847 from Tournaisian of Sydney Basin, New South Wales, here designated.

Discussion: The definite absence of a connector plate is highly unusual for Syringothyroidea, but was closely addressed by Campbell in his study of the type species. In other respects the type species comes close to members of Permasyrinxiidae. *Primorewia* Licharew & Kotlyar (1978, p. 71) appears to belong to the group, with the figure in Licharew & Kotlyar (1978, pl. 11, fig. 3) strongly suggesting that no syrinx was developed. It is a transverse form with stronger plicae than developed in *Asyrinxia*, and unlike *Asyrinxia*, the genus has a syrellum.

Syringothyroid gen. & sp. indet. A

2001 Syringothyrididae gen. & sp. indet. A Waterhouse, p. 105, text-fig. 7g.

An obscure specimen OU 18300 comes from the Hilton Limestone at Wairaki Downs, southern New Zealand. The shell is punctate.

Syringothyroid gen. & sp. indet. B

2001 Syringothyrididae gen. & sp. indet. B Waterhouse, p. 105.

A fragmentary and punctate ventral valve with seven to nine plicae pairs comes from the Wairaki Breccia at Wairaki Downs, New Zealand.

Order SPIRIFERINIDA Ivanova, 1972

Ivanova (1972, p. 41) proposed Suborder Spiriferinidina, and excluded Syringothyroidea (Syringothyridoidea) Fredericks, 1926 but included Cyrtinioidea Fredericks, 1924. Cooper & Grant (1976, p. 2666) recognized Order Spiriferinida, and included only Retziidina Boucot, Johnson & Staton, 1964 and Spiriferinidina, the latter thought to be a new proposal, and made no mention of syringothyrids or cyrtinioids. On the other hand, Carter & Johnson *in* Carter et al. (1994) proposed to include Syringothyridoidea Fredericks, 1926 in Spiriferinida, and this step was consolidated by Carter (2006, p. 1897), and elaborated by Carter & Gouvennec (2006). Such an interpretation seems challengeable. The brachiopod record suggests that punctation arose independently in several brachiopod assemblages, as implied by Cooper & Grant (1976b) in recognizing Retziidina as a member of Spiriferinida. Suborder Retziidina is punctate, but treated as a member of Athyrida not Spiriferida or Spiriferidina by Alvarez & Rong (2006). Terebratulida are also finely punctate. In this study it is suggested that Spiriferinidina arose from amongst the oldest group of spiriferimorph brachiopods classed as Cyrtiidei, with close approach to members of Adolfioidea. Syringothyridina

Grunt, 2006, downscaled herein to Syringothyridei, now recognized for syringothyrids, on the other hand appears most closely related to members of Cyrtospiriferoidea Termier & Termier, 1949, a non-punctate group with strong allegiances to Spiriferidei in terms of shape and internal plates, to imply that Syringothyroidea arose independently of Spiriferinidina.

Suborder SPIRIFERINIDINA Ivanova, 1972

Spiriferinidina are characterized by ventral median septum and usually dense punctae. Adminicula are present, and tabellae are developed in a number of genera assigned to the principal superfamily Pennospiriferinoidea Dagys by Carter (2006) and though apparently absent from various if not most genera, short tabellae have been revealed by sectioning of the dorsal umbonal region for instance by Campbell (1959). The delthyrium appears to be open as a rule, without a subdelthyrial connector plate. The Upper Paleozoic members are biconvex and plicate, and ornamented as a rule by dense spines. In shape they are very like members of Adolfioidea, which also have somewhat spinose micro-ornament, open delthyrium, adminicula and often an apparent absence of tabellae, apart from *Eurekaspirifera* Johnson, 1966, which definitely has well-developed tabellae. Johnson claimed that crural plates were absent from this genus but they are clearly present in his excellent figures, as arrowed in Fig. 43 herein.

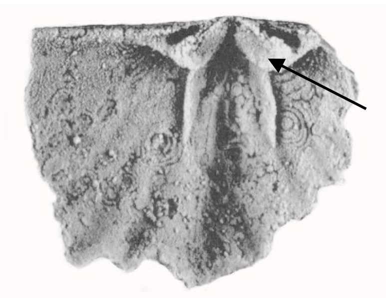

Fig. 43. *Eurekaspirifer pinyyonensis* (Meek), dorsal interior of USNM 16521 x3, showing crural plates supported by tabellae. Johnson (1966, 1970, 2006) called the tabellae "dorsal adminicula", and denied the presence of crural plates. Lower Devonian of Nevada. (Johnson 2006).

Although a connector plate is generally absent from members of Spiriferinida, the ventral umbonal region does display some modification in a few genera. Campbell (1959) recorded what he called callus at the tip of the umbo that united the crest of the median septum with the adminicula in type *Reticulariina* (Campbell 1959, p. 358, text-fig. 4.2,3,4) and a callus that does not protrude through the delthyrium (p. 361), and he figured a similar structure for *Spiriferellina* (Campbell 1959, text-fig. 5.2). Cooper & Grant (1976, p. 2711) wrote of the apical end of the ventral septum being braced by a short bridge between the dental plates (they did not recognize adminicula) in *Crenispirifer* and *Metriolepis,* with mention of a similar structure for several other spiriferinid genera and families,, including *Altiplecus, Reticulariina* and Paraspiriferidae. Some east Australian species of *Pustulospiriferina* have larger plates in the same position, very much approaching the connector plate of Spiriferida, perhaps as an outsize development of the bridge seen in Texan species as recorded by Cooper & Grant (1976), and marking an exceptional modification to the spiriferinidan architecture, in approaching that seen in Syringothyroidea and Spiriferida. So is this structure demonstrating links with Spiriferida, or a newly evolved feature?

Spiriferinida include Cyrtinoidea Fredericks (Lower Devonian to Early Carboniferous), Suessioidea Waagen (Early Carboniferous to Lower Jurassic) and Spondylospiroidea Hoover (Middle Triassic - Upper Triassic), all linked by the presence of punctation, ventral median septum and common presence of a spondylium. Tabellae are apparently absent. These are grouped as Suborder Cyrtinidina Carter & Johnson in Carter et al. 1994.

Superfamily PENNOSPIRIFERINOIDEA Dagys, 1972

Family SPIRIFERELLINIDAE Ivanova, 1972

[Spiriferellinidae Ivanova, 1972, p. 41].

Diagnosis: Transverse subelliptical to subtrigonal shells with comparatively narrow sulcus and fold and several well-defined plicae pairs bearing fine and crowded spinules, short adminicula, dental plates and crural plates, short bridge over posterior ventral septum under the umbo in the type species. Tabellae are not obvious, but they are represented by very small plates in the dorsal umbonal region of the type species of *Spiriferellina*, as shown by Campbell (1959, text-fig. 5), and Campbell showed similarly reduced tabellae for the type species of *Reticulariina* Fredericks and *Punctospirifer* North. Longer tabellae are present in various species and genera described from the Glass Mountains of Texas by Cooper & Grant (1976). In east Australian specimens, the tabellae are represented by very short nicks in internal moulds, which might either be truncated tabellae as seems probable, though they could be left by leaching of the bases of the crura. Strong ventral medium septum.

Type genus: *Spiriferellina* Fredericks, 1924 from Wuchiapingian Zechstein of Germany, OD.

Genus ***Spiriferellina*** Fredericks, 1924

Diagnosis: Plicae high, round-crested, finely and densely spinose, sulcus concave or flat-bottomed, rarely with weak median rib. Subdelthyrial plate short, ventral median septum high.

Type species: *Terebratulites cristatus* Schlotheim, 1816 from Zechstein of Germany.

Discussion: Campbell (1959) provided a fine review of the type species.

Spiriferellina disparata Waterhouse, 1987

Fig. 44

1987 *Spiriferellina*? *disparata* Waterhouse, p. 43, pl. 12, fig. 10-16.

Diagnosis: Ventral interarea very high, fine pustular ornament, four or five pairs of plicae,

Holotype: UQF 12626 from Fairyland Formation, figured in Waterhouse (1987, pl. 12, fig. 10, 11) and herein as Fig. 44A, C, OD.

Morphology: The dorsal valve is transverse and not nearly as long as the ventral valve.

Stratigraphy: Up to now the species has been found only in the Fairyland Formation of the southeast Bowen Basin, Queensland.

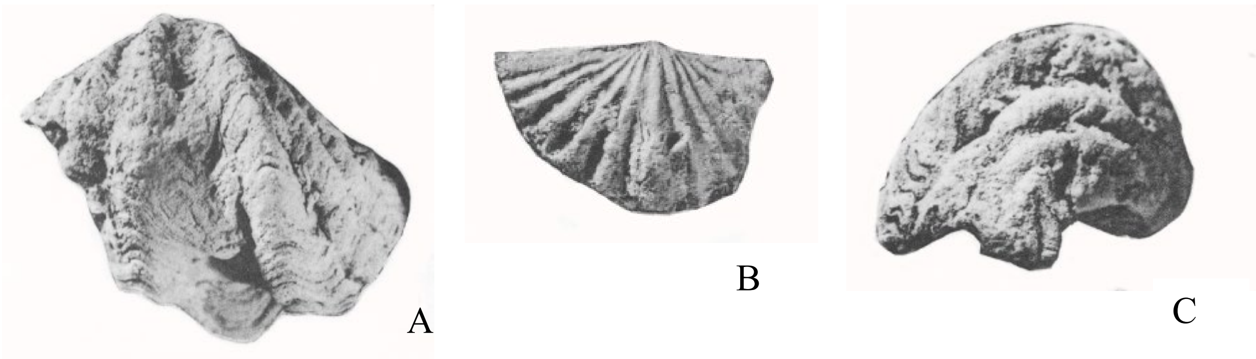

Fig. 44. *Spiriferellina disparata* Waterhouse. A, C, ventral and lateral aspects of ventral valve holotype, UQF 12626. B, dorsal valve UQF 27563. D, posterior part of ventral valve showing part of interior, UQF 74245. Specimens x2 from Fairyland Formation, southeast Bowen Basin. (Waterhouse 1987).

Spiriferellina anguliplica Waterhouse, 1987

Fig. 45

1987 *Spiriferellina anguliplica* Waterhouse, p. 43, pl. 12, fig. 17-21.

Diagnosis: Plicae high and angular, interspaces deep, spinules fine. Tabellae not apparent.

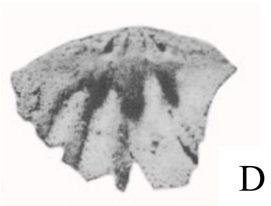

Fig. 45. *Spiriferellina anguliplica* Waterhouse. A, B, ventral exterior and interior aspects, UQF 74240 holotype, x4, x6. C, ventral valve from dorsal aspect, UQF 74243, x4. D, dorsal interior, UQF 74244, x4. Dresden Limestone, southeast Bowen Basin. (Waterhouse 1987).

Holotype: UQF 74240 from Dresden Limestone, figured by Waterhouse (1987, pl. 12, fig. 17, 19) and herein as Fig. 45A, B, OD.

Morphology: Compared with *disparata*, the ventral valve is lower with lower interarea, and the dorsal valve is less small in size relative to that of the ventral valve.

Stratigraphy: The species comes from the Dresden Limestone of the southeast Bowen Basin of Queensland and is deemed to be of lower middle Sakmarian age.

Spiriferellina quadriplicata Waterhouse, 1987

Fig. 46

1953 *Spiriferellina* sp. nov. Campbell, p. 14, pl. 2, fig. 9-11.
1970a *Punctospirifer australis* [not Maxwell] – Armstrong, pl. 25, fig. 11.
1987 *Spiriferellina quadriplicata* Waterhouse, p. 44, pl. 22-25.
1988 *S. quadriplicata* – Parfrey, p. 19, pl. 4, fig. 2-8, 11.

Diagnosis: Wide little inflated shells with well-defined plicae of moderate height, curving out laterally. Micro-ornament of minute pustules.

Holotype: UQF 43590 from Barfield Formation, southeast Bowen Basin, figured by Waterhouse (1987, pl. 12, fig. 24) and herein as Fig. 46A, OD.

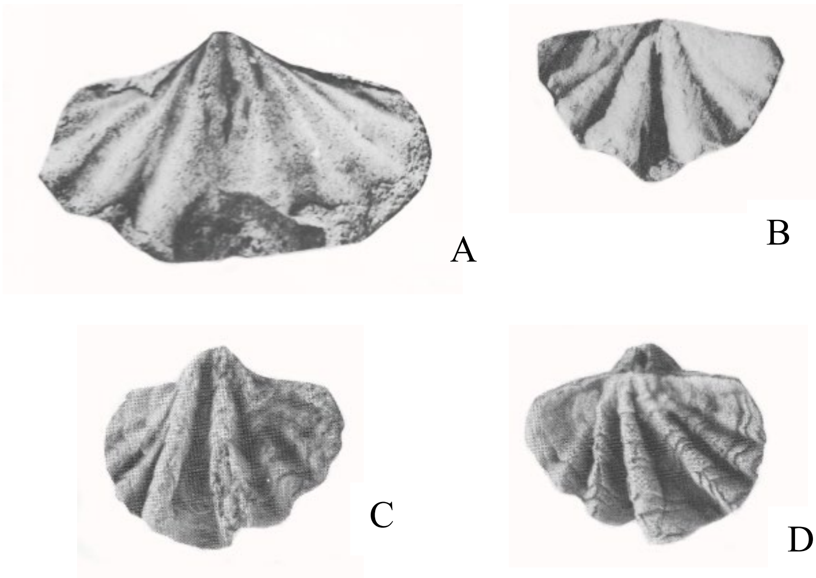

Fig. 46. *Spiriferellina quadriplicata* Waterhouse. A, ventral valve UQF 45390, holotype. B, immature ventral valve UQF 26468. (Waterhouse 1987). C, D, ventral and dorsal aspects of specimen at early maturity with valves conjoined, GSQF 13038. (Parfrey 1988). Specimens x2 from Barfield Formation, southeast Bowen Basin.

Stratigraphy: The species is found in the lower Peawaddy Formation of the southwest Bowen Basin and Barfield Formation in the southeast Bowen Basin in Queensland.

Family **PUNCTOSPIRIFERIDAE** Waterhouse, 1975

[Nom. correct. Carter *in* Carter et al. 1994 pro Punctospiriferinidae Waterhouse, 1987, p. 44 nom. transl. ex Punctospiriferinae Waterhouse, 1975, p. 17].

Diagnosis: Normally transverse shells with narrow sulcus, fold and plicae, short adminicula, long median septum, micro-ornament of radial capillae and prominent growth lamellae.

Type species: *Punctospirifer scabricosta* North, 1920 from Visean of England, OD.

Genus ***Pustulospiriferina*** Waterhouse, 1983

Diagnosis: Small shells with narrow sulcus and fold, slender plicae, characterized by having fine low granular-like spines as well as radial capillae and prominent commarginal growth lamellae.

Type species: *Punctospirifer etheridgei* Armstrong, 1970c, p. 317 from Tiverton Formation, north Bowen Basin, Queensland, OD.

Pustulospiriferina australis (Maxwell, 1964)

Fig. 47

1964 S*piriferellina australis* (Maxwell), p. 25, pl. 5, fig. 6-12.
1970c *Punctospirifer australis* – Armstrong, p. 317.

Diagnosis: Weakly transverse with strong commarginal laminae and three or four pairs of plicae, as well as fine granular spines that tend to be radially aligned. Strong ventral median septum.

Holotype: UQF 42868 from lower Burnett Formation, figured by Maxwell (1964, pl. 5, fig. 7) and herein as Fig. 47A, OD.

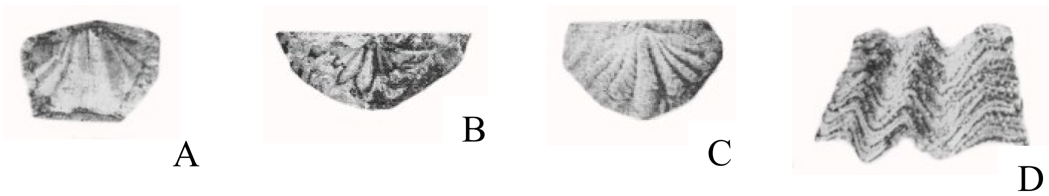

Fig. 47. *Pustulospiriferina australis* (Maxwell). A, ventral valve UQF 42868, holotype. B, dorsal internal mould, UQF 42874. C, latex cast of dorsal exterior, UQF 42873. D, part of exterior of ventral valve, UQF 42871, x3. Lower Burnett Formation, Yarrol Basin, Queensland. (Maxwell 1964).

Morphology: The specimens need to be re-examined, particularly to ascertain details of micro-ornament, but one of Maxwell's figures shows the strong commarginal laminae typical of the genus, with crowded and minute granules (see Fig. 47D). There are no visible tabellae.

Stratigraphy: The species comes from the lower Burnett Formation of the Yarrol Basin, below the linoproductoid *Bandoproductus*, and suggestive of an early Asselian age.

Pustulospiriferina etheridgei (Armstrong, 1970c)

Fig. 48 - 51

1970c *Punctospirifer etheridgei* Armstrong, p. 317, pl. 25, fig, 6-10, 12-19, 21, 22.
1983 *Pustulospiriferina etheridgei* – Waterhouse, p. 303.
1987 *P. etheridgei* – Waterhouse, p. 45, pl. 12, fig. 26-28, cf. 29.
2006 *P. etheridgei* – Carter, p. 1912, Fig. 1272a-c.
2015a *P. etheridgei* – Waterhouse, p. 217, Fig. 171-173.

Diagnosis: Shells with narrow fold and sulcus, plicae usually in five pairs, varying between four and six pairs.

Holotype: UQF 54612 from Tiverton Formation, figured by Armstrong (1970c, pl. 25, fig. 19) and Carter (2006b, Fig. 1272a), OD.

Morphology: Specimens are weakly transverse with obtuse cardinal extremities, and have a high ventral interarea, with angle of 25-30^{o} for delthyrium. A small outwardly convex plate that tapers forward each side into a low ridge is placed between the junction of the adminicula and dental plates, at the umbonal end of the median septum, and large ventral valves have a weakly convex plate, arched towards the umbo, with two growth rugae, closing the delthyrium and bearing a median recession. Laterally, the plate tapers forward [each side] into a low ridge placed close to mid-height of the dental supports [ie. adminicula and dental plates]. Such a plate seems to match the "bridge" reported by Cooper & Grant (1976) in Texan spiriferinidans, and the "callus" reported by Campbell (1959) in type spiriferinid genera, but the plate is larger in this Australian species. Sulcus and fold narrow, as a rule five pairs of subangular plicae. Nicks at the hinge in the dorsal internal mould might represent either short tabellae or prominent bases of the crura. Two long ridges lie each side of the dorsal muscle scars (Fig. 48D), to represent myosepta.

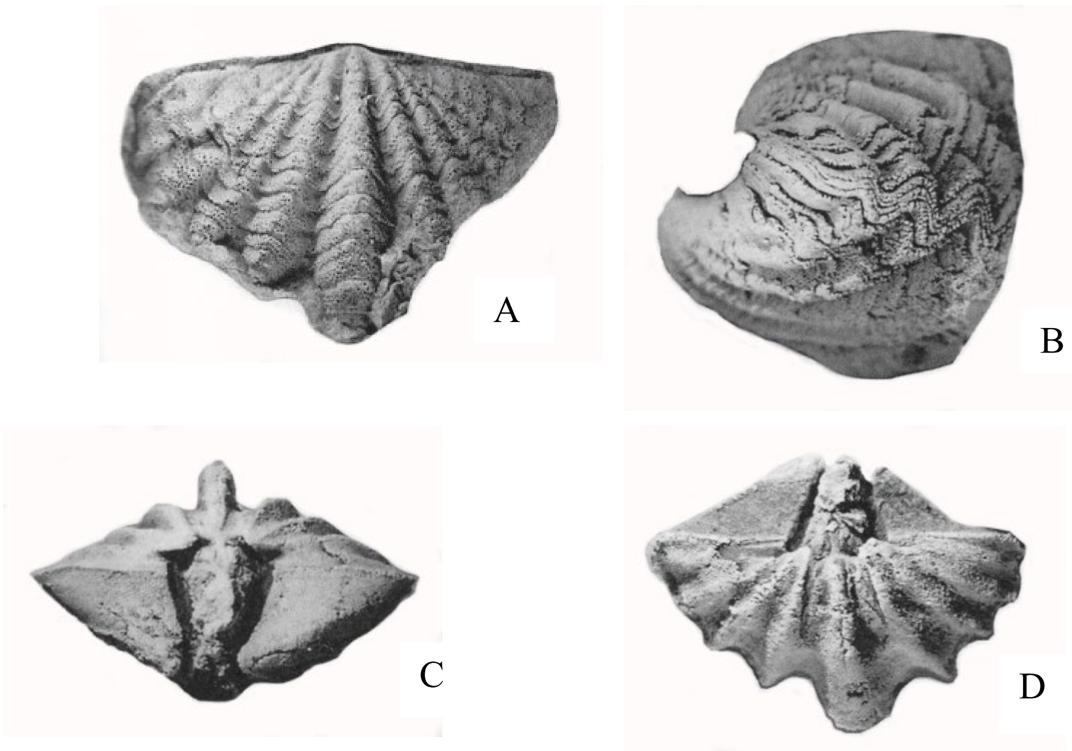

Fig. 48. *Pustulospiriferina etheridgei* (Armstrong). A, latex cast of dorsal exterior, UQF 81398, x 2. B, lateral aspect of specimen with valves conjoined, dorsal valve on top, UQF 81399, x2, x3**.** C, D, posterior and dorsal aspects of internal mould with valves conjoined with dorsal myosepta, dorsal valve on top, UQF 81400, x 3.5. Upper middle Tiverton Formation. (Waterhouse 2015a).

The species is distinguished from *Pustulospiriferina lirata* Waterhouse (1987, pl. 13, fig. 3-10) from the Elvinia and Roses Pride Formations of the southeast Bowen Basin by having more plicae pairs and denser pustules. These specimens show a high ridge bordering the outer edge of the dorsal muscle field (Waterhouse 1987, pl. 13, fig. 10). From the lower Elvinia Formation or Boughyard Member in the same region, poorly preserved specimens show some approach to *etheridgei* (Waterhouse 1987, p. 45, pl. 12, fig. 26-28) but a dorsal valve from the Roses Pride Formation has fewer plicae (Waterhouse 1987, pl. 12, fig. 29), although the plicae are high like those of *etheridgei*. Micro-ornament is not known for this specimen.

Fig. 49. *Pustulospiriferina etheridgei* (Armstrong), ventral internal mould showing posterior structure under umbo, UQF 74252, x2. Boughyard Member, Elvinia Formation. (Waterhouse 1987).

Fig. 50. *Pustulospiriferina etheridgei* (Armstrong), ventral internal mould UQF 81405, x3. Upper middle Tiverton Formation. (Waterhouse 2015a).

Nomenclature: Armstrong spelled the species name *etheridgi* in the heading for the description, but this is believed to be a lapse or printing error, because in the text and plate caption, the name was rendered *etheridgei*, so that is how it was spelled in Waterhouse (1987).

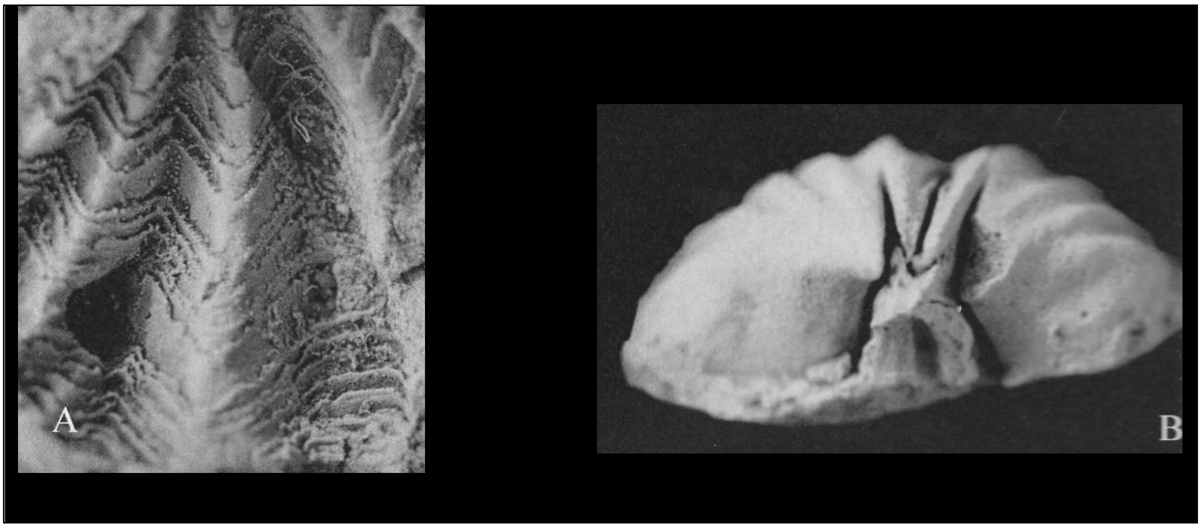

Fig. 51. *Pustulospiriferina etheridgei* (Armstrong). A, external mould of dorsal valve UQF 81357, x4. B, posterior aspect of ventral internal mould UQF 81404 x3. Upper middle Tiverton Formation. (Waterhouse 2015a).

Stratigraphy: Upper middle Tiverton Formation, in the *Svalbardia armstrongi* Subzone and *Taeniothaerus subquadratus* Zone of the north Bowen Basin, and possibly in the Boughyard Member at the base of the Elvinia Formation in the southeast Bowen Basin.

Pustulospiriferina lirata Waterhouse, 1987

Fig. 52

1987 *Pustulospiriferina lirata* Waterhouse, p. 44, pl. 13, fig. 3-10**.**

Diagnosis: Small shells with deep sulcus and high fold, three to four pairs of subangular plicae, few pustules. Ventral septum strong and long, connector plate, tabellae long.

Holotype: UQF 74254 from Roses Pride Formation, southeast Bowen Basin, figured in Waterhouse (1987, pl. 13, fig. 7) and herein as Fig. 52B, OD.

Morphology: The present species is close to *Pustulospirina australis* (Maxwell) but Maxwell's form has a prominent ventral median septum and the tabellae are either reduced or not developed. Specimens of *P. etheridgei* are larger and have more plicae pairs and tabellae are smaller.

Stratigraphy: *Pustulospiriferina lirata* is found in the Roses Pride Formation, and similar material comes from the slightly older Elvinia Formation in the southeast Bowen Basin, judged to be closer to *lirata* than to *etheridgei* because of the number of plicae pairs.

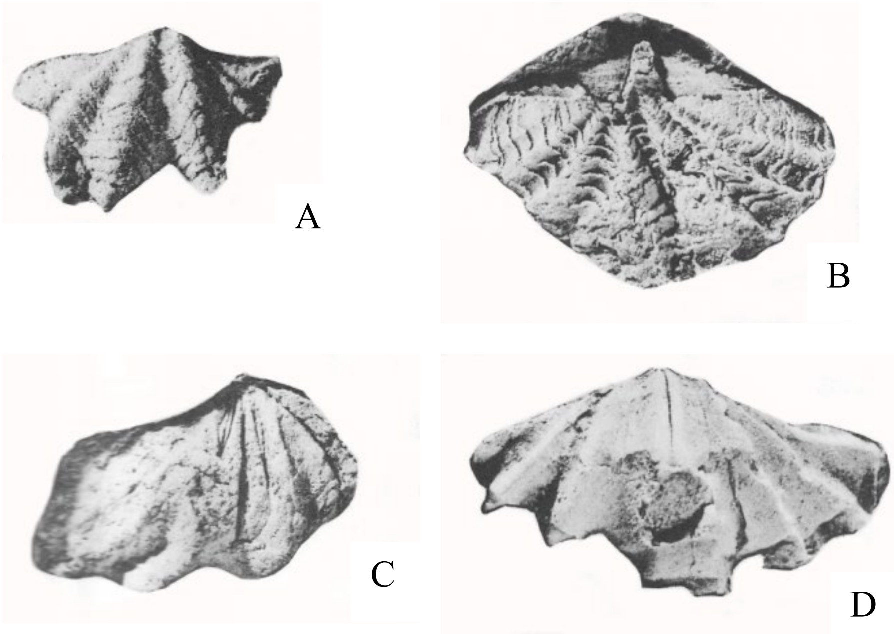

Fig. 52. *Pustulospiriferina lirata* Waterhouse. A, latex cast of ventral valve UQF 74246. B, dorsal view of external mould of specimen with valves conjoined, UQF 74254, holotype. C, ventral internal mould, UQF 74267. D, dorsal internal mould, UQF 74257. Specimens x2. A-C from Roses Pride Formation, D from Elvinia Formation. Southeast Bowen Basin, Queensland. (Waterhouse 1987).

Stratigraphy: *Pustulospiriferina lirata* is found in the Roses Pride Formation, and similar material comes from the slightly older Elvinia Formation and above the basal Boughyard Member in the southeast Bowen Basin, judged to be closer to *lirata* than *etheridgei* because of the number of plicae pairs.

Pustulospiriferina sp.

Fig. 53

2023 *Pustulospiriferina* cf. *australis* [not Maxwell] – Lee *in* Lee et al., p. 34, Fig. 16M-Q, 17.

Four fragmentary specimens from the Snapper Point Formation in the south Sydney Basin were compared with Maxwell's specimens from the early Permian Burnett Formation of the Yarrol Basin in Queensland, but Lee cautioned that the paucity of ventral valves and lack of information about the micro-ornament rendered comparison inconclusive. Other students will note the disparity in age, and the difference in number of plicae pairs between *australis* and the Snapper Point material.

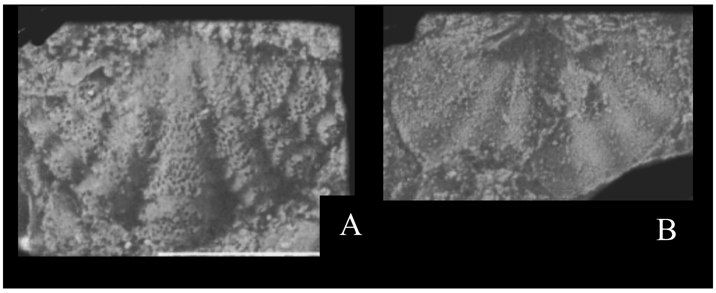

Fig. 53. *Pustulospiriferina* sp. A, latex cast, dorsal valve AMF 159083, space bar 5mm. B, dorsal interior, AMF 159086, latex cast, x 2.5 approx. Snapper Point Formation. (Lee et al. 2023).

CONCLUSIONS

Syringothyridei are prolific in the Permian of east Australiia, whereas Spiriferidinida are relatively few in terms of genera and species, and restricted so far it would appear to Queensland, apart from a species of *Pustulospiriferina* reported by Lee *in* Lee et al. (2023). Numbers are even less in New Zealand, with a few fragments belong to Syringothyridei, though the Permian of Gympie that once formed the northerly extension of that island arc complex has yielded more specimens.

A number of species are ascribed to Permasyrinxinae, but the stratigraphic range for some is uncertain and further investigation of larger faunas is required. The relationship between *Subansiria* and *Permasyrinx* needs to be clarified, and the matter of whether the dorsal fold can vary from rounded or channelled needs to be consolidated, and that will possibly affect the validity or otherwise of *Syrella* Archbold, 1996.

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INDEX

Abbreviated index for genera and species described in the text