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Wenlock (Early Silurian) Brachiopods from the Orane District of New South Wales

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Abstract
Two late Wenlock (Early Silurian) brachiopod species from the Ulah Formation near Orange, New South Wales, are closely associated with graptolite faunas. Visbyella cumnockensis occurs in the testis Biozone on Wallace Creek in the Four Mile Creek area, and Strophochonetes melbournensis is recorded from the ludensis Biozone on Spring Creek. Poorly preserved but similar Visbyella? and Strophochonetes? From the Prídolí Wallace Shale at Cheesemans Creek are also illustrated. These occurrences provide significant new stratigraphic and distributional data for the species.

Keywords
Brachiopods, New South Wales, Pøídolí, Silurian, Strophochonetes melbournensis, Ulah Formation, Visbyella cumnockensis, Wallace Shale, Wenlock, GeoQuest

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Wenlock (Early Silurian) Brachiopods from the Orange District of New South Wales

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Two late Wenlock (Early Silurian) brachiopod species from the Ulah Formation near Orange, New South Wales, are closely associated with graptolite faunas. *Visbyella cumnockensis* occurs in the *testis* Biozone on Wallace Creek in the Four Mile Creek area, and *Strophochonetes melbournensis* is recorded from the *ludensis* Biozone on Spring Creek. Poorly preserved but similar *Visbyella*? and *Strophochonetes*? From the Prídolí Wallace Shale at Cheesemans Creek are also illustrated. These occurrences provide significant new stratigraphic and distributional data for the species.

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KEYWORDS: Brachiopods, New South Wales, Pøídolí, Silurian, *Strophochonetes melbournensis*, Ulah Formation, *Visbyella cumnockensis,* Wallace Shale, Wenlock.

INTRODUCTION

The Silurian strata of the area west and southwest of Orange, NSW, in the valleys of Spring Creek and Four Mile Creek (Fig. 1), have yielded a diversity of fossils, but very few shelly fossils have ever been described, apart from corals described by authors including Etheridge and McLean (full references to these works can be found in Pickett 1982). The most abundant and important fossils in the region are graptolites, which have been known for more than 50 years and were reported by Packham and Stevens (1955) and Jenkins (1978, 1986).

Jenkins recorded (but did not describe) brachiopod faunas from limestones in the Four Mile Creek area, but few brachiopods have been reported from clastic strata common in the area. Rickards and Wright (1997) described two brachiopod species from late Wenlock strata (*ludensis* Biozone) in Cobblers Creek (Fig. 1), and in the section at 'Mirrabooka Park' brachiopods were noted in Wenlock strata during field work by L. Muir, R.B. Rickards, G.H. Packham and A.J. Wright. A diverse and abundant shelly fauna occurring with the late Wenlock graptolite *Testograptus testis* on the Cadia gold mine access road, several kilometres to the east of Four Mile Creek, was illustrated by Rickards et al. (2001).

The two species described here are recorded for the first time from the region near Orange. One, *Visbyella cumnockensis* Walmsley et al., 1968, was originally described from near Cumnock, 55 km northwest of Orange, where it occurs with *T. testis* (Walmsley et al. 1968:315). *Visbyella* has been reported also, but not illustrated, by Pickett (1982) and Pogson and Watkins (1998). The other species, *Strophochonetes melbournensis* (Chapman 1903), was previously known only from Wenlock and Ludlow strata in the Melbourne Trough, Victoria. Pickett's report was based on the record of *Visbyella* cf. *cumnockensis* by Sherwin (1971). Sherwin's locality is younger, and contains a sparse and poorly preserved fauna including also a chonetoide similar to *Strophochonetes? savagei* Strusz, 2000 from Cumnock. These taxa are illustrated but not described. Documented brachiopod occurrences in the Orange region are still insufficient, however, to permit any notion of a regional brachiopod zonation.

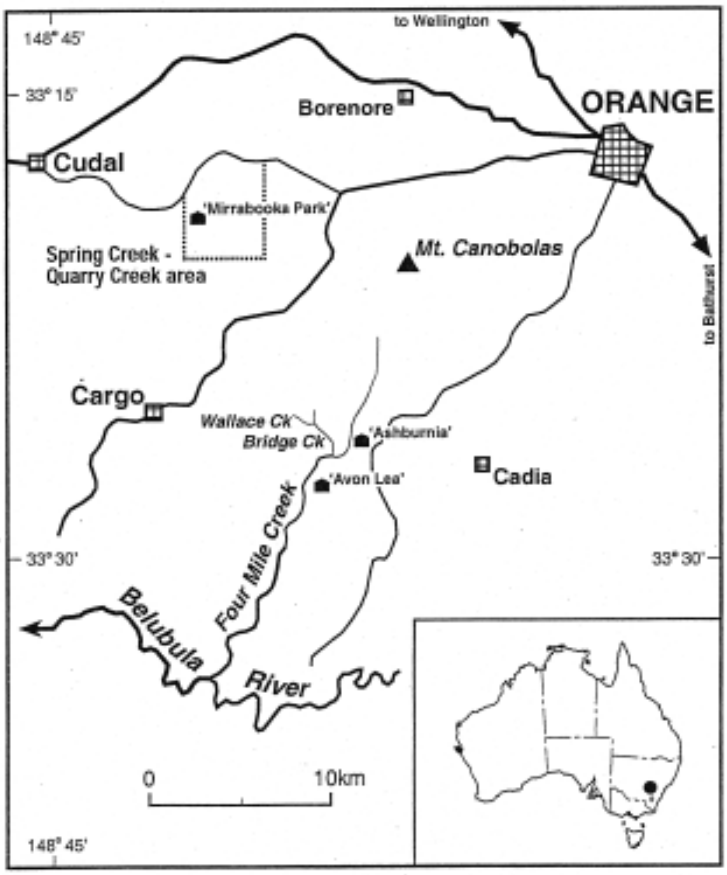

Figure 1. Map of the area southwest to west of Orange, central New South Wales, showing the geographic context of the two localities, LM3 on Wallace Creek east of Cargo and W940 near 'Mirrabooka Park' east-southeast of Cudal. Inset: the location of Orange within Australia.

LOCALITIES

LM3.

Visbyella cumnockensis was collected from Wallace Creek in the Four Mile Creek area, in grey-brown siltstones assigned by Jenkins (1978) to the Wenlock-Ludlow Ulah Formation. These beds have also yielded the graptolites *Cyrtograptus* and a new species of *Monograptus* (L. Muir, pers. comm.), and overlie beds containing *T. testis*. The brachiopod specimens are moulds of a single pedicle and a single brachial valve on the same bedding surface, which could represent the disarticulated valves of a single shell. No other macrofossils have been found at this locality. In contrast, the type material of *V. cumnockensis* is entirely of specimens in the 'butterfly' position, with the shell opened so that the conjoined valves lie on the bedding surface. The age assigned to the Ulah Formation by Chapman et al. (2003) is late Wenlock to Prídolí; the age of the strata at this locality is late Wenlock.

W940.

The somewhat more abundant specimens of *Strophochonetes melbournensis* were collected from dark siltstones of the Ulah Formation on the southern side of Spring Creek at 'Mirrabooka Park', directly opposite One Tree Hill. There are also occasional poorly preserved brachiopods, including pentamerides, in beds at about the same level on One Tree Hill itself. The shells at W940 occur with a graptolite fauna that includes *Monograptus ludensis* (R.B. Rickards, pers. comm.). Only disarticulated valves are known at this locality; small phosphatic brachiopods are quite common, and there are rare specimens of other brachiopods including strophomenides and atrypides. Most specimens of *Strophochonetes melbournensis* at this locality retain shelly material and the spines on the pedicle valve hinge line are often preserved. The environment was most probably a low-energy one.

MO/I/27.

A few poorly preserved orthide and chonetoide specimens have been collected from this outcrop of fine thin-bedded siltstone low in the Wallace Shale, about 600 m east of 'Mirrabooka' homestead. The fauna also includes occasional trilobites. The locality lies within the *Monograptus transgrediens* Biozone.

SYSTEMATIC PALAEONTOLOGY

Suprageneric taxonomy follows that in Kaesler (2000); references to authorship of suprageneric taxa are therefore not repeated here. Specific diagnoses have been rephrased to accord with currently accepted terminology (Kaesler 1997). Details of localities are given in the descriptive section below.

Abbreviations.

Ls - shell length
Ld - dorsal valve length.
Ws - shell width
Wh - hinge line width

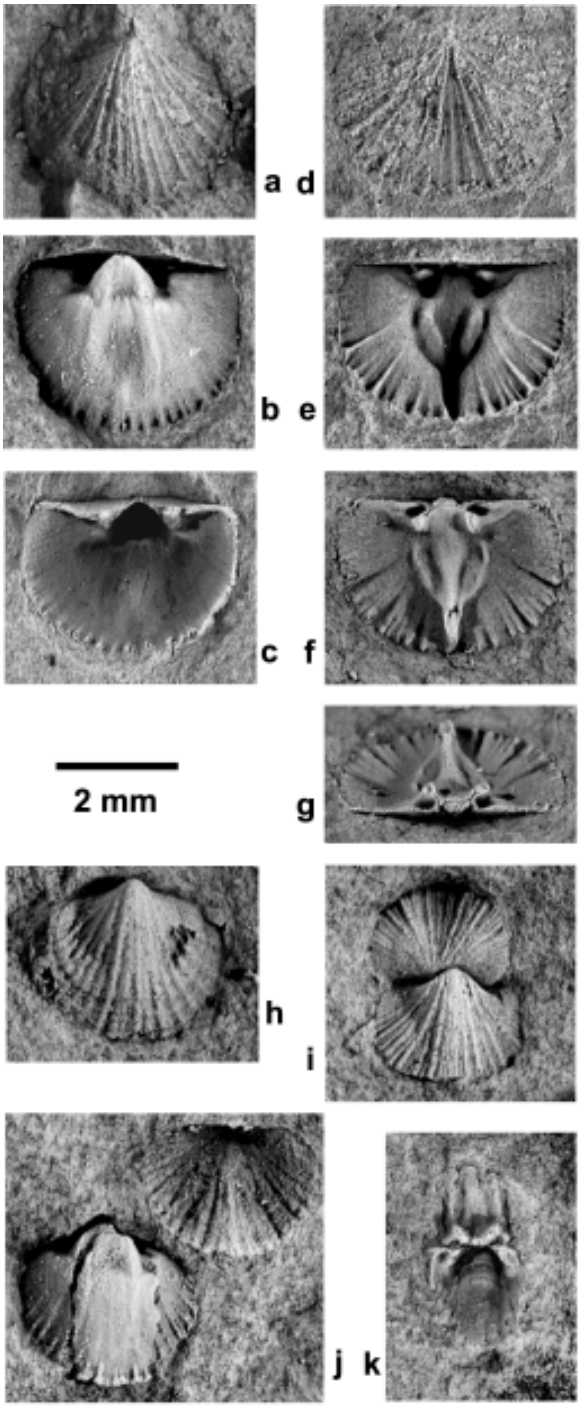

Figure 2. a-g, *Visbyella cumnockensis* Walmsley et al., 1968. a-c, ventral valve counterparts; a, latex cast of exterior, AM F124331. b-c, internal mould and latex cast, AM F124332. d-g, dorsal valve counterparts; d, latex cast of exterior, AM F124333. e-g, internal mould and latex cast (in ventral and postero-ventral views), AM F124334. h-k, cf. *Visbyella cumnockensis*, Prídolí, Wallace Shale. h, latex cast of ventral valve, MM F37431. i, latex cast of shell in 'butterfly' position, MM F21132. j, external mould of dorsal valve plus internal mould of ventral valve, MM F21125. k, latex cast of incomplete interior of shell in 'butterfly' position, MM F37428. Scale bar 2 mm.

AM - Australian Museum
MM – Mining Museum Collection, Geological Survey of NSW
CPC - Commonwealth Palaeontological Collection
NMV - Museum of Victoria
SU - Sydney University (Geology Department)

Suborder DALMANELLIDINA Moore 1952
Superfamily DALMANELLOIDEA Schuchert 1913
Family DALMANELLIDAE Schuchert 1913
Subfamily RESSERELLINAE Walmsley and Boucot 1971
Genus VISBYELLA Walmsley, Boucot, Harper and Savage 1968

Type species

Orthis visbyensis Lindström 1861, by original designation; late Llandovery, Gotland.

Diagnosis

Subcircular, small valves with apical deltidium and hypercline dorsal interarea; ventral interior with recessive dental plates and cordate muscle scar; dorsal interior with trilobed, dorsally-facing cardinal process and median septum (Harper p. 797 in Kaesler 2000).

Visbyella cumnockensis Walmsley, Boucot, Harper and Savage 1968
Fig. 2 (a-g)

Synonymy

1968 *Visbyella cumnockensis* sp. nov.; Walmsley et al., pp. 313-315, pl. 61 figs 6-12.

Type material

Holotype AM F67781; paratypes AM F67782-67788 (formerly SU P19511, 19512-19518; all renumbered when collections were transferred from the University of Sydney to the Australian Museum).

New material

External and internal moulds of a ventral valve (AM F124331, F124332) and a dorsal valve (AM

F124333, F124334) from one bedding plane at locality LM3 (Grid reference 782 988, Cudal 8631 II and III 50 000 topographic sheet, Wallace Creek, Four Mile Creek area south of Orange, N.S.W.); Ulah Formation, *Testograptus testis* Biozone; late Wenlock (Early Silurian).

Diagnosis

Relatively small, weakly sulcate, coarsely multicostellate *Visbyella* with semicircular outline. Dorsal median ridge broad and low posteriorly, becoming narrower and higher to form an anterior median septum (after Walmsley et al. 1968)

Description

Shell small, almost plano-convex. Ventral valve broadly naviculate, with low suberect beak; dorsal valve weakly convex with shallow but distinct sulcus. Outline suboval, moderately transverse, with straight hinge, obtuse slightly rounded cardinal angles; greatest width at about 0.4Ls. Ventral interarea strongly apsacline, almost flat, apical angle about 120°; delthyrium open, apical angle about 70°, rimmed by narrow crescentic deltidium. Dorsal interarea low, concave, catacline, apical angle about 150°; notothyrium filled by cardinal process, apical angle about 80°. Ribs rather angular, stronger medially than laterally, increasing by bifurcation on the ventral valve, intercalation on the dorsal valve; about 30 counted at ventral valve margin.

Ventral interior with prominent subtriangular muscle field, impressed posteriorly but slightly raised anteriorly, length 1/3Ls and width 1/4Ws. Diductor scars elongate oval, divergent, depressed a little below slightly shorter flat adductor field. Raised anterior margin to adductor field distinctly denticulate, extends forward to about 3/4Ls as low ridge. Vascula media flank this ridge as broad, shallow furrows extending from the diductor scars. Muscle field flanked by stout dental plates, divergent forward at about 100° and slightly divergent ventrally, not extending beyond muscle field. Teeth strong, wide, triangular, with distinct crural fossettes on antero-median faces. Valve floor faintly radially furrowed, marginally strongly crenulated.

Dorsal interior with prominent oval muscle field extending to 2/3Ld, width 1/3Ws, defined by strong ridges arising just in front of brachiophores and increasingly raised anteriorly, which converge to abut on median septum. Diductor scars impressed, elongate oval, subequal, posterior scars subparallel, anterior scars convergent forward; scars separated by tapering ridge from which rises the stout median septum. Septum highest a little in front of muscle field, and extends to valve margin. Cardinal process large, directed posterodorsally, continuous with well developed notothyrial platform; no shaft. Brachiophores stout, blade-like, divergent ventrally, supported by low, thick plates. Sockets oval, diverging from valve axis at about 75°, deeply excavated into thick triangular socket pads. Valve floor radially grooved, marginally strongly crenulated.

Dimensions

	AM F124332	AM F124334
valve	ventral	dorsal
Ls, Ld	est 2.85	2.59
Ws	3.90*	3.73
Wh	3.60*	3.32
Ls/Ws	est. 0.73	0.69
Wh/Ws	est. 0.92	0.89

* values obtained by doubling exposed half-width, assuming a symmetrical shell.

Remarks

The Wallace Creek occurrence of this species is almost exactly the same age as the original occurrence at Cumnock, and our admittedly limited new material corresponds closely in all specific characters to the type material. The specimens are slightly larger than shells of the type series (the maximum length and width of any specimens of the type series are 2.1 mm and 3.1 mm respectively), but the ratio Ls:Ws is close to the 2:3 cited for the type material; while the marginal crenulations in the ventral valve are less extensive. The internal moulds of the disarticulated valves are somewhat better than the types, and features of the hinge line can be seen more clearly.

The species was also tentatively recorded by Sherwin (1971, p. 223) from the Prídolí Wallace Shale at locality MO/I/27 in the Cheesemans Creek area north of Quarry Creek; his report was the basis for subsequent reports by Pickett (1982, pp. 154-155) and Pogson and Watkins (1998, p. 131). This occurrence is in significantly younger strata than the two other occurrences noted herein. Sherwin's report was based on several specimens from one locality; we were recently guided to this locality by Dr Sherwin, and collected a further seven specimens of the 'orthid' species, which is very rare at the locality (also collected were a few poor specimens of a chonetide, identified as *Strophochonetes*? cf. *savagei* Strusz, 2000, and illustrated in Fig. 4 for comparison with *Strophochonetes melbournensis*).

Unfortunately the only internal mould of a dorsal valve of the Wallace Shale orthide (Fig. 2k) is incomplete, and appears to lack a median septum, although its presence anteriorly cannot be completely ruled out. It was initially thought that the absence of a

septum would rule out the presence of *Visbyella*. However, one specimen (AM F125552) of *Visbyella cumnockensis* on one of the type slabs is close in size to the Wallace Shale material and, unlike all the other type specimens, lacks a median septum, so this is not an infallible character of this species. Other morphological features of the Wallace Shale material are not well preserved; there appear to be more than 30 costellae, and the internals of both valves, in so far as they are preserved, are similar to those of the Wallace Creek material (compare Figs 2h-i with Fig. 2a, and Fig. 2j with Fig. 2b).

Hence no conclusive argument can be presented to refute the presence of *Visbyella* at this locality, unlikely as it might seem. This opinion is slightly supported by the presence of a similar orthide (probably *Resserella*), but definitely lacking a median septum, in the late Ludlow Cardinal View Shale (Bauer 1994) at Bungonia, NSW. Unfortunately, our experience gives us no reason to expect more definitive material at this very unproductive Wallace Shale locality.

Suborder CHONETIDINA Muir-Wood 1955
Superfamily CHONETOIDEA Bronn 1862
Family STROPHOCHONETIDAE Muir-Wood 1962
Subfamily STROPHOCHONETINAE Muir-Wood 1962
Genus STROPHOCHONETES Muir-Wood 1962

Type species

Chonetes cingulatus Lindström 1861, by original designation; Wenlock, Gotland.

Diagnosis

Shell small, plano- to moderately concavo-convex; well developed median enlarged costa; long, symmetrically arranged high-angled spines varying from intraverse cyrtomorph proximally to orthomorph vertical distally; cardinal process strongly bilobed internally, anteriorly bounded by cardinal process pit; no median septum; anderidia long, narrow, anteriorly divergent at about 60° and isolated on valve floor; inner socket ridges short, thin, as two rounded ridges almost parallel to hinge (after Racheboeuf p. 369 in Kaesler 2000).

Strophochonetes melbournensis (Chapman 1903)
Fig. 3

Synonymy

1903 *Chonetes melbournensis* sp. nov.; Chapman, pp. 74-76, pl. XI, fig. 2 only.
1945 *Chonetes (Chonetes) melbournensis* Chapman; Gill, pp. 132-133.
1953 *Chonetes infantilis* n. sp.; Öpik; p. 15, pl. III, figs 19-22.
2000 *Strophochonetes melbournensis* (Chapman, 1903); Strusz, pp. 249-251, figs 2-3.

Type material

Lectotype NMV P1419, paralectotypes NMV P615-6, 619, 623, 625-7, 630-633, 637-43 designated by Strusz (2000); Melbourne Formation, Melbourne and South Yarra, Victoria; Ludlow (Late Silurian). Type material of *Chonetes infantilis* Öpik, 1953: holotype CPC 661, paratypes CPC 662-663, *Illaenus* Band, Wapentake Formation, Heathcote, Victoria; late Wenlock (Early Silurian).

New material

AM F124306 - 124330, locality W940 (grid reference 743 123, Cudal 8631-II and III 50 000 topographic sheet; south bank of Spring Creek, 'Mirrabooka Park', southwest of Orange, central N.S.W.); Ulah Formation, with *Monograptus ludensis*; Late Wenlock (Early Silurian).

Diagnosis

Small, weakly concavo-convex, subquadrate *Strophochonetes* with up to 5 pairs of gently intraverse-cyrtomorph hinge spines, and finely multicostellate ornament with median rib on ventral valve usually strongly enlarged. Valve floors heavily papillose, ventral muscle field distinct, anderidia short and diverging at 60-80° (after Strusz 2000).

Description

Shell small, plano-convex, ventral valve of very low convexity. Outline subquadrate, lateral margins gently sigmoid, with shallow re-entrants in front of small triangular ears; hinge width usually slightly less than greatest width (mean Wh/Ws 0.93). Ventral protegulum posteromedially furrowed, variably raised above remaining shell surface; distinct protegular lobe, weaker lateral lobes on dorsal valve. Maximum observed width 9.8 mm, length 6.5 mm, most specimens being much smaller; mean Ls/Ws 0.75, ratio decreasing with increasing shell size. Interareas mostly obscure; ventral interarea apparently low, apsacline, flat, delthyrium wide, beak very low; pseudodeltidium not seen; dorsal interarea linear, attitude unclear. Myophore small, projecting posteroventrally, bifid, each lobe less strongly bifid, flanked by small but distinct cardinal crests. Chilidium obscure, might be present as very narrow ridge wrapped around base of myophore. Hinge spines fine, relatively long, upright

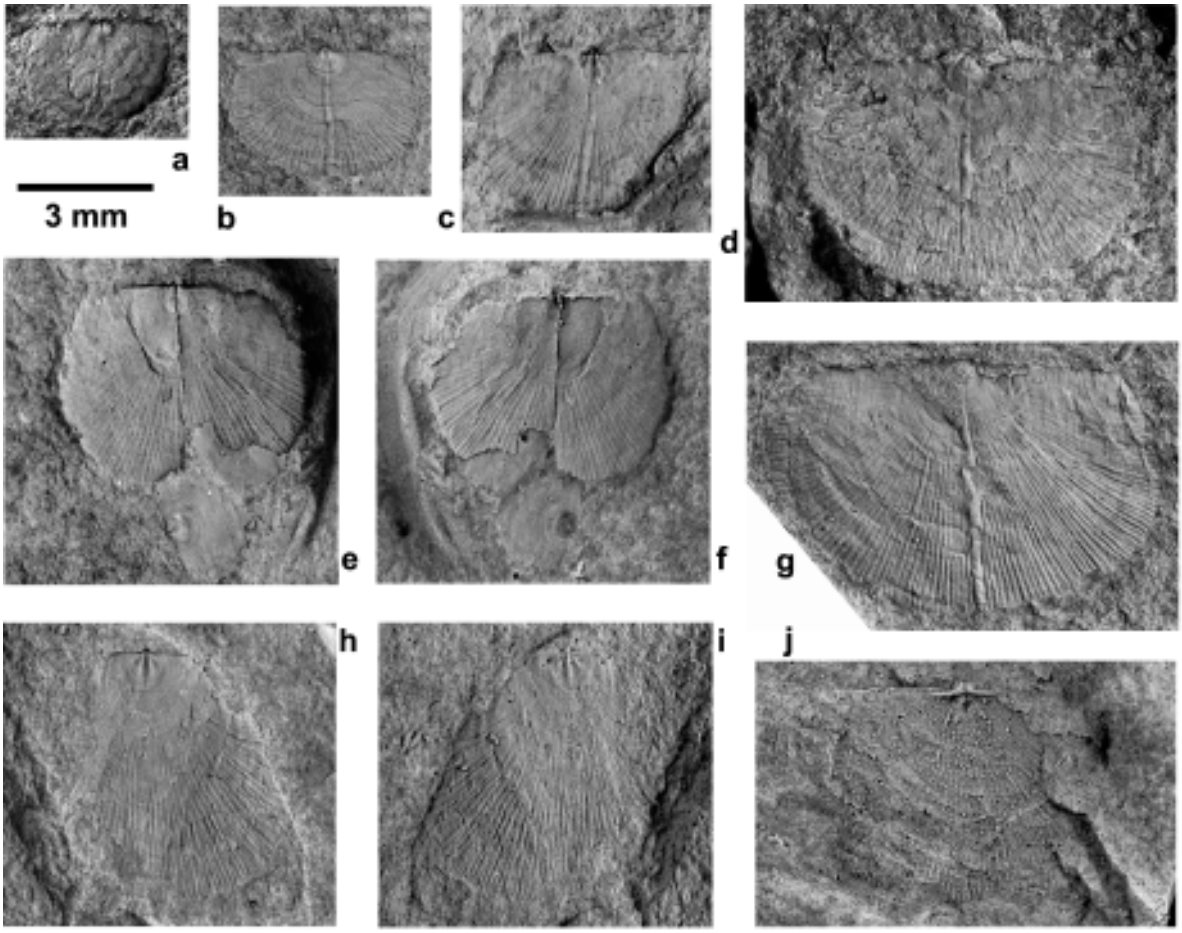

Figure 3. ***Strophochonetes melbournensis*** **(Chapman, 1903). a-g, ventral valves; some hinge spines are visible in b-e, only spine bases in f-g. a, juvenile valve AM F124320. b, juvenile with particularly prominent protegulum, AM F124317. c, juvenile AM F124322. d, AM F124324. e-f, internal mould and latex cast, AM F124312. g, AM F124326. h-j, dorsal valves; h-i, incomplete external mould and latex cast showing well developed protegular and lateral nodes, AM F124318. j, latex cast of incomplete interior, AM F124307. Scale bar 3 mm.**

or nearly so (initial angle with hinge line about 60-80°), straight (particularly in small specimens) to gently cyrtomorph intraverse, symmetrically placed; up to 4 each side of beak (AM F124324). Ornament of fine, rounded radial ribs, 29-34 counted in 5 mm at 5 mm radius, separated by narrower furrows; increase is by bifurcation only. Median rib on ventral valve prominent, arises within protegulum; remaining ribs arise at or in front of margins of concentrically wrinkled protegular regions.

Ventral interior with low, narrow median septum, reaching forward to about 0.2Ls; septum posteriorly raised and slightly widened. Teeth small, widely divergent. Muscle field generally obscure other than for weak or absent endospines; in one specimen (AM F124312) the field is weakly impressed, with small, elongate subtriangular, slightly divergent adductor scars further impressed posteriorly. Remainder of valve floor densely covered by fine endospines radially arranged beneath ribs, weakest towards cardinal margin and ears.

Dorsal interior still not well known. Cardinal process small, internally bifid, fused to short but strong inner socket ridges which are curved parallel to hinge margin. Short, shallow furrow in front of cardinal process, but no median ridge developed. Anderidia visible in only one specimen (AM F124307); they are short (0.2Ld), fine, low, diverging at about 60°. Muscle field obscure. Distal two-thirds of valve floor with numerous small radially arrayed endospines, as in ventral valve.

Dimensions

		valve	Ls, Ld	Ws	Wh	Ls/Ws	Wh/Ws
AM	F124307	dorsal	4.9	–	8.7*	–	–
	F124312	ventral	est. 4.8	5.6*	5.4*	est. 0.86	0.96
	F124318	dorsal	5.5	–	–	–	–
	F124322	ventral	3.6	4.7	4.4	0.77	0.94
	F124324	ventral	5.3	7.2	7.2	0.74	1.00
	F124326	ventral	5.6	8.4	7.2	0.67	0.86

* values obtained by doubling exposed half-width, assuming a symmetrical shell.

Discussion

Although preservation is not particularly good, the Wenlock specimens from Spring Creek conform in all important aspects (very low ventral convexity, rib increase only by bifurcation, and less prominent protegular and lateral lobes on the dorsal valve) with *S. melbournensis* rather than *S. kemezysi* Strusz, 2000. Some of the minor differences could be related to the small size of most of the specimens (several are clearly juvenile, none approaches the maximum size recorded for the Victorian material). Some could be of age significance, but without better and more abundant material from older levels in Victoria this remains unclear. Thus no ventral valves show the anterior sulcus seen in some Victorian Late Silurian shells, and no more than 4 spines have been seen to either side of the ventral beak. The NSW specimens tend also to be more elongate (Ls/Ws very variable, mean 0.76; for Victorian specimens the mean is 0.61). Internally, the ventral muscle field is less obvious, and there are no coarser endospines near the hinge. In this last respect, and in a greater tendency for spines on small specimens to be straight, the Late Wenlock Spring Creek specimens are more like the few poor specimens from the Early Wenlock of Heathcote than the Ludlow material from Melbourne. Dorsal interiors, while still few and inadequate, do add some information, particularly the form of the cardinal process and its flanking cardinal crests. The presence internally of a weak posteromedian dorsal furrow instead of a low ridge places these specimens closer to typical *Strophochonetes* than are the type specimens.

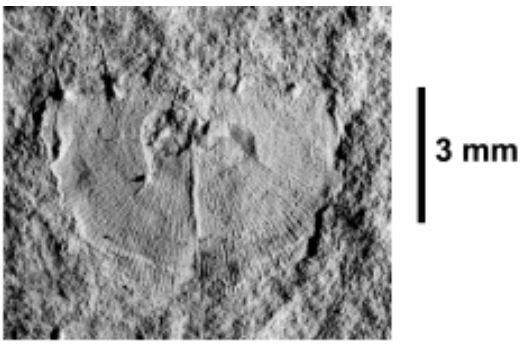

Figure 4. *Strophochonetes*? cf. *savagei* Strusz, 2000. Latex cast of ventral valve, MM F21133. Scale bar 3 mm.

Three similar chonetoide specimens (MM F21133, 37435, 37436) are available from the Wallace Shale locality - the best of them is figured (Fig. 4). All are small and weakly convex. In the absence of internal data, particularly of the dorsal valve, generic identity must remain uncertain. The long more or less upright hinge spines, low ventral valve convexity, fine ribbing and accentuated median rib all indicate *Strophochonetes*, however, and of the Australian taxa described by Strusz (2000) the closest is undoubtedly *S? savagei* from the Early Lochkovian of Manildra, northwest of Orange. *S. melbournensis* and *S. kemezysi* Strusz, 2000, while superficially similar, are both larger and more coarsely ribbed; the latter has very prominent protegulae. In only one respect these specimens appear unlike typical *Strophochonetes*, and that is in the alternating pattern of hinge spine insertion described for instance by Strusz (2000, p. 259) for the strongly convex and fairly coarsely ribbed Australian species of *Johnsonetes* Racheboeuf, 1987 (all of which lack spine 1'). However it is not clear that spine 1' is undeveloped in the Wallace Shale specimens. Moreover, the Manildra species show considerable variation in spine form, and some asymmetry cannot be ruled out.

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We gratefully acknowledge access graciously made available by Ian Street to 'Mirrabooka Park' and Ken Williams to 'Ashburnia', and thank Dr L. Sherwin for drawing our attention to the report of *Visbyella* cf. *cumnockensis* from the Wallace Shale and subsequently guiding us to the locality. Prof. Barrie Rickards and Dr Lucy Muir kindly allowed us to cite identifications of the graptolites. Robert Jones readily made the type material of *Visbyella cumnockensis* available for study. Strusz wishes to thank Dr Patrick DeDeckker for providing facilities at the

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