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SYSTEMATIC DESCRIPTION OF PERMIAN BRACHIOPODS, BIVALVES AND GASTROPODS BELOW WALL SANDSTONE MEMBER, NORTHERN BOWEN BASIN

by **J.B. Waterhouse**

ABSTRACT. A fauna of brachiopods, bivalves and gastropods is described from beds below the Wall Sandstone, variously assigned to the basal Gebbie Formation or upper Tiverton Formation, and regarded as typifying Fauna IIIa of Dickins in Malone *et al.* (1966). The fauna is shown to be closer to Fauna II than Fauna III, and matches the fauna of the Sirius Formation and upper Cattle Creek Formation of the southwest Bowen Basin, and the *Notostrophia zealandicus* and *N. homeri* zones in the Takitimu Group of New Zealand. No other faunas of east Australia are known to be similar. New taxa are described as *Aperispirifer crassiocostatus* n. sp., *Glyptoleda javesi* n. sp.; *Calcicanicularia glabra* n. gen., n. sp. (Limidae) and *Platyteichum ornatum* n. sp. The age is late Early Permian, probably Aktastinian, though possibly slightly younger.

INTRODUCTION

This paper describes brachiopod and molluscan species collected from a site east of the Bowen River in the north Bowen Basin at locality UQL 3725, by J.S. Jell and the writer in 1980, added to material collected from the same place in 1972 by I.R. Javes in his study of the area for an honours thesis (Javes 1972). The locality is that regarded by Runnegar (1969) as typifying Fauna IIIa of Dickins (in Malone *et al.* 1966), but up to now its fossils have received little attention in systematic studies, other than the record of an ammonoid (Armstrong *et al.* 1967). Indeed Dickins (in Malone *et al.* 1964) listed only two brachiopod genera, with species not determined; and Dear (1972) listed one species *Terrakea dickinsi* from the locality, and four species overall from beds considered to belong to Fauna IIIa. Our collections contain some eight species of brachiopods. More bivalve species have been listed, but present systematic examination suggests that few species were identified accurately. This paper sets out as briefly as possible the specific descriptions, with illustrations, in order to provide a summary of the fauna, that may be assessed in future studies on correlation and sequence for Permian rocks and faunas within and beyond the Bowen Basin.

Stratigraphy and location

The locality UQL 3725 is found as extensive erosion scars about 150 m long and 75 m across, some 50 m east of the scarp formed by the Wall Sandstone Member, north of the boundary fence between Exmoor and Blenheim properties, and 5.5 km southeast of Exmoor Homestead. The grid reference is FS 21297989 on Urannah 1:100,000 topographic sheet PC 8556, and appears to be the same as the locality MC 420 collected by the Bureau of Mineral Resources, Geology and Geophysics, Canberra (see Dickins in Malone *et al.* 1964). The location is in fine sandstone, with layers of coarse sandstone and dense black siltstone generally mapped as belonging to the basal Gebbie

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Formation (see Malone *et al.* 1964; 1966; McClung 1981). However Javes (1972) argued convincingly that the contact between the Gebbie Formation and the underlying Tiverton Formation as drawn by Malone *et al.* and other workers is so poorly exposed that it is not mappable, and he proposed that the boundary be transferred to the base of the Wall Sandstone Member, which would transfer the fossil locality from the basal Gebbie to the upper Tiverton Formation. Runnegar (in Hill *et al.* 1972, p. 32) followed this suggestion, and certainly, for all practical purposes, the boundary is best drawn at the base of the Wall Sandstone Member. The question is more fully discussed by Waterhouse & Jell (in press).

Registration and storage of material

The material is housed at the Department of Geology, University of Queensland, and figured specimens are registered serially by number with the prefix UQF.

SYSTEMATIC DESCRIPTIONS

Phylum Brachiopoda

Family Strophalosiidae Schuchert, 1913

Genus *Echinalosia* Waterhouse, 1967

Echinalosia cf. *preovalis* (Maxwell,1954)

Pl. 1, figs 1,2

Description. Only a few dorsal valves are available, not sufficient to define the species. They are subrounded in outline with deeply concave visceral disc and high subgeniculate trail, and fine dense spines. The interarea seems to have been low, but is not well preserved. A small specimen has well rounded anterior adductor scars and poorly differentiated posterior elements, and a mature poorly preserved internal mould shows a high marginal ridge across the ears.
Resemblances. The concave disc grading into a high trail suggests that the specimens might belong to *Echinalosia preovalis* (Maxwell 1954), originally described from the Cattle Creek Shale, because the other species from east Australia and New Zealand, *E. prideri* (Coleman,1957), *E. maxwelli* (Waterhouse, 1964) and *E. ovalis* (Maxwell, 1954) have a subgeniculate trail, as summarized in Waterhouse (1982a). However ventral valves are needed to allow the species to be identified with certainty.

Family Aulostegidae Muir-Wood & Cooper, 1960

Genus *Taeniothaerus* Whitehouse, 1928

?*Taeniothaerus* sp.

Pl. 1, figs 4,6

A large dorsal valve more than 70 mm wide belongs to this or an allied genus, but is poorly preserved, with the ventral valve not known, and external ornament and posterior hinge destroyed. The disc is gently convex, and the trail short and subgeniculate. A dorsal interior of another specimen some 45 mm wide is gently concave, with a high cardinal process, short ridge in front, and low broad median ridge extending in front of mid-length. Large dendritic adductor scars are present.

Family Linoproductidae Stehli, 1954

Genus *Cancrinella* Frederiks, 1928

Cancrinella sp.

A fragment of a ventral valve is present.

Genus *Terrakea* Booker, 1930

Terrakea dickinsi Dear, 1971

Pl. 1, fig. 3

1971 *Terrakea dickinsi* Dear, p. 15, pl. 4, figs 2-9.
Holotype. F 11710, Geological Survey of Queensland, (Dear 1971, pl. 4, fig. 2), by original designation.
Diagnosis. Moderately large incurved subelongate *Terrakea* with numerous ear spines and fine costellae.
Description. The present suite has already been identified as *Terrakea dickinsi* (see Dear 1972). The species has been well described. Dear reported that costellae numbered 15 to 18 in 10 mm at about 25 mm from the ventral umbo, and 32-40 costellae in 10 mm at 15 mm from the dorsal umbo, as in present specimens. Ventral spine bases are up to 3 mm long and 1.5 mm wide, and have 2-3 costellae commencing in front.

Dear (1971, p. 16) drew attention to rather similar specimens in what he called the Sirius Mudstone Member of the Cattle Creek Formation which are close, but larger and broader and not as strongly geniculate. Similar specimens were described from New Zealand by Waterhouse (1982a, p. 47, pl. 11a-d; i; see also Waterhouse 1964, pl. 10, fig. 1-5) as *T. pollex aurispina* Waterhouse. Although the New Zealand specimens have slightly coarser costellae, they are very close, and are probably identical with the Cattle Creek material. A few specimens from the present collection have a broad gently rounded visceral disc, as in *aurispina*.

Family Spiriferidae King, 1846

Genus *Aperispirifer* Waterhouse, 1968

Discussion. This genus was proposed for Trigonotretine shells that lacked a delthyrial plate, and has been further discussed by Termier *et al.* (1974) and

Plodowski (1970) in recognising species in Afghanistan. Clarke (1979) has proposed synonymising *Aperispirifer* with *Trigonotreta* Koenig, 1825, but the type and other species of this genus have a rounded outline and few costae, with high prominent plicae. Rather, I suggest that *Brachythyrinella* Waterhouse & Gupta (1978), type species *Spirifer narsarhensis* Reed, 1928, is indeed very close to *Trigonotreta,* apart from small size and thin shell, for we have now found short adminicula in the ventral valve, as recorded by Thomas (1971, p. 110, pl. 19, fig. 8). The overall appearance of *Aperispirifer* is completely different from *Trigonotreta,* and *Brachythyrinella,* though the three genera are probably related at subfamily level, with similar delthyrial callosity and no delthyrial plate.

Aperispirifer crassicostatus n. sp.

Pl. 1, figs 5,7-10; pl. 2, figs 1,4

1964 *Neospirifer hardmani* ? not Foord Waterhouse, p. 122, pl. 22, figs 4-8; pl. 23, figs 1-3, text-fig. 55-58.
1968 *Aperispirifer* A Waterhouse, p. 36, pl. 3, fig. 11; text-fig. 6C.
Holotype. BR 546, figured by Waterhouse (1964, pl. 22, figs 4-8; pl. 23, figs 1-3), kept at New Zealand Geological Survey.
Diagnosis. Moderately large shells, transverse, subrectangular outline, broad rounded plicae and broad costae; muscle field large in both valves.
Description. Present specimens include a well preserved internal cast that has the subrectangular shape typical of the New Zealand specimens, with moderately prominent umbo, wide hinge, and especially, the arched anterior lateral margins. The sulcus is broad, with a sinal angle close to 25°, and the concave floor has a median costa. Plicae number only three pair, with a faint fourth on the ventral valve, and the innermost pair is especially broad, and subdivided within the sulcus. Costae are low anteriorly, up to 1.5 mm wide, and may split in front, with well rounded crests, but are high over the umbo and have narrow angular crests.

In the ventral valve the adminicula and dental plates are largely buried in secondary thickening, and the dental plates are triangular in shape, and the teeth broad and short. The muscle field is large and long, with growth marks and longitudinal striae over adductors and diductor impressions. The dorsal cardinal process is distinct with transverse markings across the vertical laminae, and a subrectangular crural plate each side. The median septum arises a little in front of the process and extends well beyond midlength as a distinct ridge. Adductor scars are large and long with longitudinal striae, and transverse striae converging outward to a position close to mid-length of the scars. Vascular patterns are present on both valves.
Resemblances. These specimens have the shape, ornament and large muscle fields of *Aperispirifer crassicostatus,* proposed for New Zealand specimens from the Takitimu Group in the *Notostrophia zealandicus* and *N. homeri* Zones. Originally the New Zealand specimens were compared to *Spirifer hardmani* Foord (1890, pl. 7, fig. 1, 1A) from the Lyons Group and

Callytharra Formation of the Carnarvon Basin, Western Australia, of Asselian and Sakmarian age. The resemblance is close, but the west Australian shells have higher plicae and some have much finer costae, and the sulcus has a much wider angle. Its generic relationships are not certain, but may lie with *Neospirifer.*

Family Reticulariidae Waagen, 1883

Genus *Tomiopsis* Benedictova, 1956

Tomiopsis plica (Campbell,1960)

Pl. 2, figs 2,3, 5-9

1960 *Ingelarella plica* Campbell, p. 1114, pl. 136, figs 8-13.
1968 *Ambikella plica* Waterhouse, p. 58, pl. 10, figs 1-6, 8.
Holotype. UQF 25725 figured by Campbell (1960, pl. 136, fig. 12), kept at University of Queensland.
Diagnosis. Oval shells with well formed but not high plicae, wide sulcus bearing two subplicae prominent anteriorly; dorsal fold sulcate; surface grooves short and dense; ventral adminicula usually short and close-set; myophragm high; dorsal tabellae short, bow-shaped in maturity.
Discussion. A large suite of this characteristic species is available. Most specimens conform well with the types, though it may be noted that micro-ornament is poorly preserved. A few individuals 65 mm in width or more show that the subplicae within the sulcus and groove within the dorsal fold become faint or disappear anteriorly in some large individuals. During ontogeny the adminicula become somewhat longer and more subparallel than in the specimens previously described, and the ventral muscle field is rimmed in front by high ridges. The dorsal tabellae also become slightly longer. However the specimens clearly are conspecific with others that are identical with *T. plica* as described by Campbell.

Tomiopsis plana (Campbell, 1960)

Pl. 2, fig. 10; pl. 3, figs 1-4

1960 *Ingelarella plana* Campbell, p. 1112, pl. 136, figs 1-7.
Holotype. UQF 15686, figured by Campbell (1960, pl. 136, figs 6a-c), kept at University of Queensland.
Diagnosis. Large shells with broad sulcus and moderately high dorsal fold with sloping sides and faint median groove on some but not all specimens; adminicula well spaced and diverge forward at low angle, not long; tabellae short, diverge forward at low angle, extending forward for .2 to .25 length of valve.
Discussion. Tomiopsis plana (Campbell) is a distinctive species, up to now described only from the Cattle Creek Formation at Cattle Creek, and also from the Sirius Formation in Staircase Creek, and reported but not described from older beds. A few specimens are figured here to widen the range of variation

recorded by Campbell (1960). Two dorsal valves carry a shallow groove along the fold, whereas others like the suite of type specimens have a rounder crest, and another specimen has a slightly broader shallower groove, so that this feature must vary in individuals. One fragmentary external mould suggests fine surface grooves over 5 mm long anteriorly, but otherwise micro-ornament is poorly known for the species.

Genus *Notospirifer* Harrington, 1955

Notospirifer extensus tweedalei Campbell, 1961

Pl. 3, figs 5-8

1961 *Notospirifer extensus tweedalei* Campbell, p. 188, pl. 28, figs 5-8.
Holotype. UQF 24061, figured by Campbell (1961, pl. 28, figs 5a, b), kept at University of Queensland.
Diagnosis. Small transverse shells with fold well rounded or slightly flattened on top and two to four (usually three) pairs of ventral plicae.
Discussion. The number of plicae vary, some specimens having only two pairs, rather than the three or rarely four allowed by Campbell (1961). The species was originally described from near Homevale in a fauna matching the present one in age.

Family Dielasmatidae King, 1846

Genus *Fletcherithyris* Campbell, 1965

Fletcherithyris reidi Campbell, 1965

Pl. 3, fig. 9

1956 *Fletcherithyris reidi* Campbell, p. 36, pl. 2, figs 1-13.
Holotype. ANU 11981, figured by Campbell (1965, pl. 2, figs 7-10), kept at Australian National University.
Diagnosis. Small shells with flatly convex dorsal valve and anterior if any sulcus on ventral valve; dorsal septum short, septalium raised well above floor, even posteriorly, concave anterior outline; posterior shell thick, and umbonal shoulders massive, so that shoulders of interior mould diverge widely from umbo.
Discussion. A single internal mould is characterised by massive posterior shoulders on the ventral valve, like the internal mould figured for *Fletcherithyris reidi* by Campbell (1965, pl. 2, figs 9, 12), and different from other Permian species described from east Australia by Campbell (1965) or from New Zealand by Waterhouse (1982a). Unlike the types, the ventral posterior is extended well beyond the hinge.

Family Heterelasminidae Likharev, 1956

Genus *Gilledia* Stehli, 1961

?*Gilledia* sp. indet.

Obscure fragments of a species up to 45 mm long have the size and concave ventral valve seen in *Gilledia.* Traces of external grooves, and small foramen suggest that they might belong to *Gilledia oakiensis* Campbell (1965, pl. 8, figs 32-41; text-figs 30-32), but material is not adequately preserved to allow even an accurate generic determination. *G. oakiensis* was first described from near Homevale in a fauna of the same age as the present fauna.

Phylum Mollusca

Class Bivalvia

Family Nuculanidae H. Adams & A. Adams, 1858

Genus *Glyptoleda* Fletcher, 1945

Glyptoleda javesi n. sp.

Pl. 3, figs 10-12; pl. 4, figs 1-6; Text-fig. 1

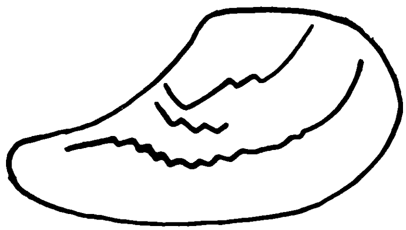
Named after I.R. Javes, former student at the University of Queensland, who did an excellent study of the geology of the Exmoor area.

Holotype. UQF 70065, figured herein as pl. 4 fig. 4, from L 3725, Exmoor area.

Diagnosis. Glyptoleda with subrounded extended anterior shell, moderately attenuated behind umbones, with posterior dorsal outline only slightly concave, and ventral outline well rounded. Costae in characteristic pattern, forming broad posteriorly sited V.

Description. The shells are equivalved, umbones anteriorly placed, orthogyrous, touching, with an umbonal angle between 110° and 120°. The anterior outline is ovally subquadrate, as in related species, and the dorsal margin only gently concave, the ventral margin well rounded, and the posterior shell is slightly attenuated, with a small posterior gape. Shells are moderately inflated, with no vestige of any lateral sulcus. The commissure is raised along the mid-line dorsally and no lunule is defined, except very weakly on a few specimens. The escutcheon is very well divided by a ridge lying inside the posterior umbonal ridges, but there is no clear outer escutcheon ridge as reported by Waterhouse (1965) in other species. Ornament consists of fine costae, with sharply edged crests and wider flatly concave interspaces, describing a course as shown in Text-fig. 1.

A resilifer pit lies under the umbo of each valve, between about 10-11 anterior chevron teeth, and some 16 posterior teeth. Anterior and posterior adductor scars are present, subrounded and moderately impressed, but the pallial line and umbonal muscle scars are not clearly defined.



Text-fig. 1. Sketch of *Glyptoleda javesi* n. sp., showing course of costae.

Resemblances. These specimens are characterised by their outline and ornament. Of two species described from the Ingelara Formation of the south-west Bowen Basin by Fletcher (1945), *G. glomerata* Fletcher (1945, pl. 20, figs 1-3) is distinguished by its less attenuated posterior shell, and by its costae which described a large simple V. *G. reidi* Fletcher (1945, pl. 19, figs 1-5; Hill *et al.* 1972, pl. PX, fig. 2: ?Waterhouse 1980b, figs 1,5,6) is a more elongated shell, with zig-zagged costae of different outline. *G. coleyi* Fletcher (1945, p. 301, pl. 19, figs 7-9) from the Baigendzinian Cundlego 'Series' of the Carnarvon Basin, Western Australia, also has ornament forming a simple V, and a less quadrate anterior outline. Of the species described by Waterhouse (1965) from the *Terrakea brachythaera* Zone in the upper Mangarewa Formation in New Zealand, of upper Kazanian age, *Glyptoleda intricata* Waterhouse (1965a, pl. 98, figs 1-5) has a very complex pattern of costae with numerous zig-zags, and *G. simplicata* Waterhouse (1965a, pl. 98, figs 13-15) has a simple well formed V. The closest species is *G. flexuosa* Waterhouse (1965, pl. 98, figs 6-12) which has a somewhat similar outline with well rounded ventral margin, but the dorsal posterior margin is more concave in outline, and the posterior portion slightly less extended. The rib pattern is only moderately close, with more anterior zig-zags, and lacks the posterior set of inclined ribs (Text-fig. 1).

Family Inoceramidae Giebel, 1852

Genus *Aphanaia* de Koninck, 1877

?*Aphanaia* sp.

A prosocline left valve, shaped like *A. tivertonensis* Waterhouse, 1979 from the Tiverton Group is present, but does not show the internal features and is poorly preserved.

Family Pterineidae Miller, 1877

Genus *Merismopteria* Etheridge, 1892

Merismopteria sp.

A left valve.

Family Aviculopectinidae Meek & Hayden, 1864

Genus *Etheripecten* Waterhouse, 1963

?*Etheripecten* sp. A

Pl. 4, fig. 9

An internal mould of a left valve shows a well developed chondrophore and small muscle scars. Lack of plicae suggests the fragment might belong to *Etheripecten,* but the external ornament and the auricles are lost.

Etheripecten sp. B

Pl. 4, fig. 8

A small left valve 9 mm long has strong upstanding narrow primary costae very like *Etheripecten dawsonensis* (Runnegar & Ferguson 1969) from the Flat Top Formation of the southeast Bowen Basin.

Etheripecten tenuicollis (Dana, 1847)

Pl. 4, figs 7, 11, 12

1847 *Pecten tenuicollis* Dana, p. 160.
1849 *Pecten tenuicollis* Dana, p. 705, pl. 9, figs 7-7a.
1887 *Aviculopecten sprenti* Johnston, p. 9.
1888 *Aviculopecten sprenti* Johnston, p. 127, pl. 14, fig. 11 (fig. 8 in error).
1906 *Aviculopecten tenuicollis* Etheridge & Dun, p. 13, pl. 13, figs 10-12; pl. 14, fig. 5.
1906 *Aviculopecten sprenti* Etheridge & Dun, p. 15, pl. 2, figs 6,7; pl. 13, fig. 9; pl. 16, figs 5,6, not pl. 12, fig. 1.
1907 *Aviculopecten sprenti* Etheridge, p. 32, pl. 7, figs 5,6.
?1957 *Aviculopecten tenuicollis* Dickins, p. 45, pl. 6, figs 7, 8, not 9?
?1963 *Aviculopecten tenuicollis* Dickins, p. 82, pl. 11, fig. 5; pl. 13, figs 12-16, not 17?; pl. 14, fig. 1.
1982b *Etheripecten tenuicollis* Waterhouse, p. 16, pls lg, 2a-g, 3a,d.
not 1929 *Aviculopecten sprenti* Fletcher, p. 9, pl. 3, figs 1-6, text-fig. 1. (=*E. leniusculus*).

Holotype. Sole specimen figured by Dana (1849, pl. 9, figs 7, 7a), by monotypy.
Diagnosis. Medium sized shells with little inflated left valve, anterior umbonal slope inclined from hinge by 30° to 40°, ornament well differentiated in three or four orders, variable in spacing. Concentric lamellae well defined, subspinose over costae, arching dorsally over crests. Costae differentiated over left auricles.
Description. The left valve is small, and gently convex, with a narrow umbo and low but steep anterior and posterior umbonal walls diverging at 70-80°, anterior wall concave forward in outline. The anterior auricle is large and gently convex, with arched anterior outline, and the posterior auricle is concave to almost flat, and has an alate cardinal extremity and posterior concave outline.

Ornament consists of about 8 primary costae with other intervening costae arising very close to the umbo, and two further orders, with rounded crests, rarely broad, and separated by almost flat, broad interspaces. Growth lamellae are scalariform over the valve, arching hingewards between major costae. The anterior auricle has close-set costae in two orders, and the posterior auricle has more and finer ribs. The right valve is slightly less convex than the left, and has low umbonal walls, and a large anterior auricle with rounded anterior margin and deep byssal notch. The posterior ear is concave and matches that of the left valve. Ornament on the right valve consists of fine costae less differentiated than those of the left valve, and wide flat interspaces, with faint growth lamellae. The costae on the right anterior ear are strong, and on the right posterior ear are numerous and fine.
Resemblances. These specimens come close to *Etheripecten tenuicollis* (Dana) from the Allandale Formation at Harper's Hill, though the type of Dana's species is a little more inflated, and the specimen is not very well preserved. Dickins (1957, 1963) referred Johnston's species *Aviculopecten sprenti* to synonymy. The species has been widely reported in the Early Permian faunas of east Australia, and occurs in the *Notostrophia homeri* Zone of the Takitimu Group in New Zealand. It is reviewed by Dickins (1963) and Waterhouse (1982b).

Family Oxytomidae Ichikawa, 1958

Genus *Cyrtorostra* Branson, 1930

?*Cyrtorostra* sp.

A left valve.

Family Limidae Rafinesque, 1815

Genus *Calcicanicularia* n. gen.

Type species. Calcicanicularia glabra n. sp.
Diagnosis. Small Limid shells with almost smooth exterior and simple channel-form ligament lacking chondrophore or pit, no hinge teeth.
Discussion. It appears that genera not in any way closely related developed a channel-form ligament during the late Palaeozoic Era. The Atomodesminae closely related to the Inoceramidae, offer the best known example. Posidoniidae are similar. *Eurydesma* Morris had a channel form ligament, and the somewhat similar genus *Glendella* Runnegar which Waterhouse (1980a) has suggested is a primitive member of the Buchiidae, is another example. *Dolponella* Waterhouse from the late Permian faunas of Nepal appears to be related to yet another different stock, the Oxytomiidae. *Manticula* Waterhouse of Triassic age has been classed in the Treatise with the Pergamidiidae. The present genus is allied to none of these genera, for it is Limid in external appearance and shape, though readily distinguished by its lack of ligament pit, and by its smooth shell. The genus is only known at present from the fauna here described

though costate limid shells are common in the Permian faunas of the Bowen Basin. They have not yet been described, and the nature of the hinge is not known.

Calcicanicularia glabra n. gen., n. sp.

Pl. 4, figs 10, 13-15; pl. 5, figs 1,2

Holotype. UQF 70073 figured in pl. 4, fig. 14; pl. 5, fig. 2, kept at University of Queensland.
Diagnosis. Opisthocline shells with almost smooth shell and short hinge with bearing short ears.
Description. The shells are equivalved, and higher than long, with subcentrally placed umbones lying just behind mid-length, and an angle close to 110°. The anterior umbonal wall is steep and high and extends well forward to below mid-height, with slight forward concavity in outline. The posterior wall is shorter and more convex in profile and slightly rounded in outline, rounding evenly into the posterior edge of the shell which is most extended near mid-height. Both valves are moderately convex, and most inflated above mid-height. The hinge extends for about one fourth of the length of the shell, and has a small anterior ear or flattened portion, with abruptly terminated extremity measuring 100°, and a slightly larger flat posterior 'wing', that has a more obtuse angle. The surface of the shell is almost smooth apart from low growth wrinkles and fine growth lines, but does have traces of low radial ribs, 2 in 3 mm.

The hinge on both valves is elongate, and gently concave, 1.3 mm high in shell almost 30 mm high, and carries fine growth lines and grooves. There is no ligament pit, and there are no teeth. Muscle scars are not impressed.

Family Permophoridae van der Poel, 1959

Genus *Stutchburia* Etheridge, 1900

Stutchburia sp.

Pl. 5, fig. 3

A few small specimens are available, none well preserved, so that the species is indeterminate. If at maturity, they resemble various small-shelled species discussed by Waterhouse (1980b, p. 118), such as *Stutchburia muderongensis* Dickins, *S. simplex* (Dana) and *S. biplex* (de Koninck), and come closest to the latter species, insofar as one specimen has two or three posterior costae. De Koninck's species came from the southern Sydney Basin near Woolloongong (de Koninck 1877).

Family Edmondiidae King, 1849

Genus *Pachymyonia* Dun, 1932

Pachymyonia sp.

A left valve belongs to this genus. It lacks the deep sulcus and very high posterior carina of the type species *Maeonia morrisi* (Etheridge, 1919), and is shaped somewhat like *P. triangulatus* Waterhouse, 1969 from the *Echinalosia ovalis* Zone in the middle Mangarewa Formation in New Zealand, of early Kazanian age. But material does not suffice to allow a specific determination.

Family Pholadomyiidae Gray, 1847

Genus *Vacunella* Waterhouse, 1965

Vacunella waterhousei (Dun, 1932)

Pl. 5, fig. 4

1932 *Myonia waterhousei* Dun, p. 412, pl. 52, fig. 3, not 2.
1967 *Vacunella*? *waterhousei* Runnegar, p. 69, pl. 10, fig. 1.
1967 *Vacunella* cf *waterhousei* Runnegar, p. 70, pl. 10, figs 2-13.
Lectotype. AMF 6589, figured by Dun (1932, pl. 52, fig. 3), kept at Australian Museum, Sydney, designated by Waterhouse (1965b, p. 850).
Diagnosis. Subelongate shells with rounded anterior portion and slightly upturned posterior portion, no marked lateral sulcus.
Discussion. Reinspection of the type shows that Dun's species undoubtedly belongs to *Vacunella,* and there is no need for the hesitancy expressed by Runnegar (1967) in his suggestion that the species be tentatively assigned to *Vacunella.* The Farley specimens that he compared to *waterhousei,* should, in my view, be regarded as fully conspecific.

The present suite contains one well preserved specimen, which has a short anterior portion in front of the umbo, like the specimens figured by Runnegar (1967, pl. 10, figs 5, 10). Many associated specimens have lost the posterior shell, and appear subquadrate or subrectangular in outline, like specimens figured by Runnegar (1967, pl. 9, figs 1-12, 14) as *Vacunella etheridgei* (de Koninck). This species is said to characterise Fauna III in the Bowen Basin. The species *V. etheridgei* is probably more prosocline than the present specimens, with a more anterior placed umbo, like the specimen figured by Runnegar (1967, pl. 9, fig. 13) as *V. etheridgei*? from the Branxton Formation of the northern Sydney Basin.

Class Gastropoda

Family Sinuitidae Dall, 1913

Genus *Warthia* Waagen, 1880

Warthia micromphala (Morris, 1845)

Pl. 5, fig. 5

1845 *Bellerophon micromphalus* Morris, p. 288, pl. 18, fig. 7.
1847 *Bellerophon undulatus* Dana, p. 150.

1849 *Bellerophon undulatus* Dana, p. 706, pl. 10, figs 4a, b.
?1877 *Goniatites micromphalus* de Koninck, p. 339, pl. 24, fig. 5.
?1888 *Goniatites micromphalus* Johnson, p. 128, pl. 21, figs 5a, b.
1958 *Warthia micromphala* Fletcher, p. 147, pl. 16, figs 4, 5.
1963 *Warthia micromphala* Waterhouse, p. 90, figs 4, 5, 34.

Holotype. Specimen figured by Morris (1845, pl. 18, fig. 7), kept at British Museum (Natural History).

Discussion. A number of specimens come close to this species, but are not very well preserved, and there are so few morphological features that discrimination of morphotypes is restricted. Its relationship to other species of *Warthia* in east Australia is discussed by Waterhouse (1963a).

Family Eotomariidae Wenz, 1938

Genus *Platyteichum* Campbell, 1953

Platyteichum ornatum n. sp.

Pl. 5, figs 6-13

Holotype. UQF 63664 figured in pl. 5, fig. 9, kept at University of Queensland.

Diagnosis. Small shells with whorls well rounded in spire, costae narrow and radial threads raised.

Description. Shells are small for the genus, though at maturity, with some five whorls, swollen in the spire, and the body whorl characterized by a flattened upper profile. The apical angle measures 90° for the spire and 80° for the body whorl. Sutures are adpressed, with a prominent shoulder in whorls of the spire, but not developed on the body whorl. The selenizone lies just above mid-height of each whorl, and is well exposed in the spire. It is concave and bordered by a high thin carina above and below, and the slit extends for just under a third of the circumference. The upper aperture is convex forward and sweeps back from the suture at about 60°, and rounds more into the slit, and the lower aperture sweeps convexly forward at about 150° from the slit to the lower third of the whorl, where the shell is at maximum width, and then curves back, with slight forward concavity across the base which is narrowly cryptomphalous. Spiral threads are fine, numbering 8-9 over the upper whorl which is 3.3 mm high, and are crossed by raised growth threads, numbering 2-3 in 1 mm, to form elongate nodules, especially prominent near the suture, and over the base.

Resemblances. Platyteichum costatum Campbell (1953, pl. 7, figs 11-14; Hill & Woods 1964, pl. PXII, fig. 17; Hill *et al.* 1972,pl. PXII, fig. 17) from the lower or restricted Ingelara Shale of the western Bowen Basin is a larger shell with stronger spiral costae, and its close ally, if not senior synyonym, *Platyteichum coniforme* (Etheridge 1892, pl. 41, fig. 5; Dickins 1961, pl. 17, figs 4-6) from the lower Flat Top Formation of the southeast Bowen Basin is similar. *P. spirolaxum* Waterhouse (1963, figs 33-36; 1980c, figs 2, 1, 4) from the *Spinomartinia adentata* Zone of the Takitimu Group is also a larger species with stronger spiral ornament, less conspicuous radial ornament, and higher spire. *P. loratum* Waterhouse (1963, figs 4, 37-50) from the *Terrakea brachythaera* Zone in the upper Mangarewa Formation of New Zealand has a broader spire, larger size, better defined sutural shoulder, and fewer spiral costae over the upper whorl. A poorly known species *P. waterhousei* (Etheridge 1898) from the Maitland Group, north Sydney Basin near West Maitland, has numerous spiral threads over the upper whorl, and is a larger species with wide umbilicus. Its generic position is not certain.

Platyteichum johnstonei Dickins (1961, pl. 17, figs 9-12) from Baigendzinian formations of the Byro Group in the Carnarvon Basin, Western Australia, has less globular whorls in the spire, and finer spiral threads below the selenizone which lies higher on the whorl. A specimen from the overlying Kungurian Coolkilya Formation differs in having a wide umbilicus (Dickins 1961, pl. 17, figs 1-3).

CORRELATION

Bowen Basin

The fauna here described is not found higher or lower in the stratigraphic succession of the north-east Bowen Basin. With correlative faunas, it belongs to a unique faunal zone characterized by *Terrakea dickinsi, Tomiopsis plana, T. plica* and other species. There are some similarities to underlying faunas of the Tiverton Formation, insofar as *Echinalosia preovalis* (Maxwell) has been recorded from the older Tiverton fauna at Homevale, though this report may require further study; and *Taeniothaerus* is common in the upper fauna of the Tiverton Formation near Homevale (Briggs & Waterhouse 1982). There are fewer similarities to younger faunas, apart from some specimens of *Vacunella* which approach *V. etheridgei* (de Koninck), and based on any count of species or genera in common, Fauna IIIa really looks like a late 'Fauna II'.

To the south in the Cracow region, which has recently been studied by Flood *et al.* (1981), there are no faunas that show any obvious match. Briggs & Waterhouse (1982) suggested that the fauna in the ?Pindari Formation, near Rose's Pride Mine is like that of the *Taeniothaerus* fauna in the Tiverton Formation near Homevale, and showed that the overlying Brae Formation has a different fauna, younger than that here described. The equivalents of the *Terrakea dickinsi-Tomiopsis plica* faunal interval must be represented in the Banana-Theodore-Cracow area by either non-fossiliferous sediment or more probably by non deposition.

In the western part of the Bowen Basin in the Springsure region, the upper Cattle Creek Formation, and equivalent Sirius Formation, show obvious similarities, sharing the brachiopod species *Tomiopsis plana, T. plica,* and *Fletcherithyris reidi,* and possibly *Echinalosia preovalis,* and what appears to be a variety of *Terrakea dickinsi.* Mollusca from the Cattle Creek Formation have not yet been monographed, so that their similarities and differences cannot yet be ascertained.

Sydney Basin

Etheripecten tenuicollis (Dana) has been widely reported from the Dalwood Group of the Sydney Basin, and *Vacunella waterhousei* (Dun) is restricted to the Farley Formation, which is correlative in part with the Tiverton Formation (Briggs & Waterhouse 1982). However no exact equivalent is apparent, and the species *Echinalosia preovalis, Terrakea dickinsi, Tomiopsis plana* and *T. plica* have not been reliably identified from the Sydney Basin.

Tasmania

No correlative fauna is apparent from scrutiny of the faunal lists for the Permian succession of Tasmania by Clarke & Banks (1975) or Clarke & Farmer (1977), but the faunas are yet to be monographed in modern terms. However it appears possible that the fauna is not present in Tasmania.

Western Australia

Dickins (1963, p. 82) has recorded specimens like *Etheripecten tenuicollis* from the Callytharra Formation of the Carnarvon Basin, the Nura Nura Member of the Poole Sandstone of the Canning Basin, and High Cliff Sandstone and Fossil Cliff Formation of the Perth Basin, all of Sakmarian age.

New Zealand

A related fauna occurs in the *Notostrophia zealandicus* and *N. homeri* Zones of the Takitimu Group in southern New Zealand (Waterhouse 1982a) with *Aperispirifer crassicostatus, Tomiopsis plica,* and *Etheripecten tenuicollis.* A close ally of *Echinalosia preovalis* is present, and *Terrakea pollex aurispina* is regarded as a close ally of *T. dickinsi,* identical with the form found in the Cattle Creek Formation (Sirius Formation equivalent).

CONCLUSIONS

The fauna here described appears to be correlative with the Sirius Formation and upper Cattle Creek Formation across the Bowen Basin, and with the *Notostrophia zealandicus* and/or *N. homeri* Zones of the Takitimu Group in New Zealand. The fauna is not a common one in east Australia, and appears to be missing from the south-east Bowen Basin, and the entire Sydney Basin and from Tasmania. However it does not represent a peculiar biofacies, correlative with other faunas and different faunas, because it is found in clear stratigraphic sequence in both the northeast and southwest Bowen Basin.

PREVIOUS CORRELATIONS

Since this work offers the first systematic study of Fauna IIIa from the upper Tiverton Formation (or previously lower Gebbie Formation), all previous proposals on faunal identifications and correlations have involved a degree of speculation. First to draw attention to the fauna and its significance was

Dickins in Malone *et al.* (1964), who discriminated it and correlative faunas along strike as Fauna III, distinct from the underlying Fauna II of the Tiverton Formation, and from overlying Fauna IV of the Blenheim Formation. He composed a faunal list (*op. cit.* 1964, pp. 60, 61) dominated by species shared with the Blenheim and correlative formations including *Glyptoleda* cf. *reidi* Fletcher, *Stutchburia* cf. *costata* (Morris) and *Mourlonia* (*Platyteichum*) cf. *costatum* Campbell, which he noted as being smaller than typical *P. costatum.* The only brachiopods were recorded as *Terrakea* and *Ingelarella.* Later Dickins in Malone *et al.* (1966) subdivided Fauna III into three and referred the present fauna to IIIa. He stated that Fauna III lacked most of the species found in Fauna II, and saw the introduction for the first time of *Glyptoleda,* and *Platyteichum,* and *Tomiopsis* (*Ingelarella*) of the *ingelarensis* type, and 'characteristic species' of *Schizodus, Megadesmus, Pachymyonia* and *Walnichollsia.* The exact horizon of these characteristic species was not specified, and they remain undescribed by Dickins. Some 17 species were tabulated, but have not been figured and described. They include several genera not encountered in the present study, mostly as bivalves, and the lack of brachiopods from the list is noteworthy. Later Dickins (in Mollan *et al.* 1969, p. 84) realised that *Glyptoleda* did range into older beds, at least in the Springsure area. He moreover pointed out that *Tomiopsis plana* and *plica* were shared with the upper Cattle Creek Formation, but also listed species *ingelarensis, ovata* and *profunda* for Fauna IIIa, to suggest a mixing of Fauna II and Fauna IV. I consider that his list involves misidentified species. To Dickins, the absence of *Cancrinella farleyensis, Anidanthus springsurensis, Strophalosia preovalis* and '*Neospirifer* (*Grantonia*) cf. *hobartensis*' from Fauna IIIa ruled out any correlation with the Sirius Formation. The present study however suggests that *Echinalosia preovalis* is present in Fauna IIIa, and *Cancrinella* might be – it is too poorly preserved to judge. No adequate study of the '*Neospirifer*' from the Sirius Formation has ever been published. This leaves the absence of *Anidanthus* as a difference between faunas of the Sirius Formation and upper Tiverton Formation, a difference presumably due to facies, in view of the presence of several other shared species with proven short ranges.

Dear (1972) described *Terrakea dickinsi* from the lower Gebbie Formation, and this was the only brachiopod known to him from the area near Exmoor that has yielded the present fauna (Dear 1972). Further south near Homevale he reported that *Terrakea dickinsi* occurred with a few more brachiopod species, *Ingelarella* cf. *ingelarensis* Campbell, *Notospirifer extensus tweedalei* Campbell, and *Gilledia oakiensis* Campbell. The fauna was correlated with the lower Aldebaran Sandstone of the southwest Bowen Basin, and shown as younger than the Sirius Formation. Dear (1972, p. 8) did note the presence of *Taeniothaerus* in the upper Cattle Creek and Sirius formations, and stressed that *Tomiopsis plica* was 'possibly a short-range species diagnostic of the upper Cattle Creek fauna'.

In adopting Dickins' scheme for subdividing the Permian faunas of the Bowen Basin, Runnegar (1967, p. 89) suggested that the reference section for Fauna III should be the Gebbie Formation near Exmoor Homestead, which would include the present fauna and locality as examplar of Fauna IIIa. But no discussion of the subdivisions within Fauna III was offered. In Hill *et al.* (1972), Runnegar (p. 32) showed the Wall Sandstone as marking the base of the Gebbie Formation, and correlated the upper Tiverton Formation, which would include Fauna IIIa, with the upper Cattle Creek Formation. No reasons were given, but the correlation agrees with the present faunal analysis. Runnegar & McClung (1975) recognised a *plana* Zone which also included the species *Tomiopsis plica,* and *Terrakea dickinsi,* and the possible reference section was suggested as that south of Exmoor Homestead, with the fauna described here. Other species were listed, but are difficult to interpret without systematic description and illustration, and no correlation table was offered. McClung (1978, fig. 1, p. 19) showed the *plana* Zone as incorporating the lower Gebbie Formation and upper Tiverton Formation, and ranging in the southwest Bowen Basin from the Riverstone Sandstone to the Sirius Mudstone. But G. McClung (pers. comm.) has stated that, from his work in the Springsure area, *plana* is restricted to the upper Cattle Creek Formation in Reids Dome and the uppermost Staircase Sandstone and Sirius Formation near Springsure. Ingelarellid species in the older Riverstone Sandstone are distinct from *plana.* In all surface localities known to Dr McClung, *plana* and *plica* have similar ranges. McClung (1981, fig. 7, p. 26) showed Fauna IIIa in the lower Gebbie Group, correlative with the upper Cattle Creek Formation.

In summary, the systematic analysis supports Runnegar & McClung (1975), in their correlation of Fauna IIIa with the Sirius Formation, rather than with the lower Aldebaran Sandstone favoured by Dickins (e.g. 1970) or Dear (1972).

INTERNATIONAL CORRELATION

Dickins (in Malone *et al.* 1964, p. 60) reported an ammonoid compared by B.F. Glenister to *Neocrimites fredericksi* (Emeliancev), and this was assigned without reservation to the species by Armstrong *et al.* (1967, p. 94, pl. 6, fig. 13). However preservation is poor, and only one specimen is known. Armstrong *et al.* pointed out at the depressed whorls were characteristic of both *fredericksi,* and a species recorded by Glenister & Furnish (1961) from the Coyrie Formation in the basal Byro Group of the Carnarvon Basin, Western Australia, and a Baigendzinian age was preferred. On the other hand Armstrong *et al.* (1967) also pointed out that *Neocrimites* appeared to occur with older faunas in east Australia, and it seems difficult to avoid the implication that *Neocrimites,* if correctly identified, entered the Australian Permian sequences before it appeared in the Urals. Even in the Urals there is some ambiguity, for Ruzencev (1952) stressed that *Neocrimites* was one of the key genera of the Artinskian Stage, as distinct from the Sakmarian Stage, yet he later (1956) stressed that *Neocrimites* characterised the upper Artinskian, or Baigendzinian, faunas, – in other words he appears to have distinguished the Sakmarian ammonoids from Artinskian ammonoids on the basis of genera that in fact are restricted to the upper Artinskian, leaving the lower Artinskian or Aktastinian in a somewhat nebulous position with reduced fauna. On the basis of an assessment of world faunas, including Brachiopoda and Fusulinacea as well as Ammonoidea, Waterhouse (1976) suggested that the *Notostrophia* zones of New Zealand, and what is now shown to be their correlatives in the upper Cattle Creek Formation and uppermost (extended) Tiverton Formation are Aktastinian, rather than Baigendzinian. The age of the underlying *Taeniothaerus – Tomiopsis ovata* fauna of Homevale and elsewhere, is Sterlitamakian (see Briggs & Waterhouse 1982), and the Baigendzinian age of overlying faunas in New Zealand would support an Aktastinian age. Discovery of further *Neocrimites* and study of the specimens now known might be valuable in elucidating this discrepancy in correlation, which are a substage apart.

Faunas from the Eight Mile and Tunnel blocks, south of Warwick, Queensland

Since preparation of the preceding text, a paper by Dickins (1981) has appeared, to propose correlation between so-called Fauna IIIa and faunas from the Eight Mile and Tunnel blocks. The fauna includes 18 species, and does not very much resemble the fauna described here, nor the faunas from the upper Cattle Creek Formation or from the *Notostrophia zealandicus* or *N. homeri* Zones in the Takitimu Group of New Zealand. Three brachiopod species as named by Dickins (1981) do suggest correlation – *Echinalosia preovalis, Terrakea* cf. *dickinsi,* and *Notospirifer extensus tweedalei,* but the first two species, very important for age determination, are poorly preserved, and do not appear to permit specific identification. For example the exteriors of the ventral ears of *T. dickinsi* seem to have been lost – or at least ears are not described or figured, and the figured ventral valves, decorticated or worn, show few specific attributes. Information about the *Echinalosia* species is meagre, and the specimens might, for example, prove to be closer to *E. maxwelli,* though this is not certain because the height of the interarea, the nature of the ventral and dorsal spines, and other criteria, are not described. The species of *Notospirifer* has well defined plicae and dorsal fold, and looks more like *N. microstriatus* Waterhouse than *tweedalei,* and Dickins (1981, p. 31) noted that four pairs of plicae were present, and that the plicae were high. A fourth critical species was determined as *Martiniopsis* (*Ambikella*) *ingelarensis* (Campbell). Dickins (1981) suggested that the species *ingelarensis* embraced *Ingelarella plana* Campbell and *I. undulosa* Campbell but the tabellae in the specimens from south of Warwick are longer than in typical *plana,* and do come moderately close to those of *ingelarensis. Etheripecten tenuicollis* (Dana) was also recorded by Dickins (1961), but his specimens appear to be poorly preserved, and the specific identity difficult to sustain.

The fauna probably needs close examination for an exact age to be determined. I consider that the overall composition, and the possible affinities of *Echinalosia, Tomiopsis, Notospirifer* and *Astartella* suggest correlation with the Ulladulla Mudstone, and perhaps Fenestella Shale of the Sydney Basin, as also proposed by Dickins (1981, p. 25). These beds and faunas are younger than so-called Fauna IIIa of the Bowen Basin, as may be illustrated from the sequence in New Zealand, where the *Notostrophia zealandicus* Zone, equivalent to fauna IIIa, is overlain in clear stratigraphic sequence by the *Spinomartinia adentata* Zone, the *Echinalosia prideri* Zone, a possible faunal gap, and then the *Terrakea concava* Zone, the upper part of which is correlated with the Ulladulla fauna and Fenestella Shale. No faunal evidence that is known to me would support correlation between the Ulladulla Mudstone or Fenestella Shale of the Sydney Basin with Fauna IIIa of the Bowen Basin. Dickins' own study appears to reinforce such a view.

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Table 1. Faunal list and number of specimens described from UQL 3275.

Species	Ventral valves	Dorsal valves	Both valves
Echinalosia cf preovalis		3	
Taeniothaerus sp.		2	
Cancrinella sp.	1		
Terrakea dickinsi Dear	48	10	9
Aperispirifer crassicostatus n. sp.	15	6	2
Tomiopsis plica Campbell	39	20	51
T. plana Campbell	23	15	5
Notospirifer extensus tweedalei Campbell	2	3	3
Fletcherithyris reidi Campbell	1		1
Gilledia sp. indet.	2		1
	Left valves	Right valves	Both valves
Glyptoleda javesi n. sp.	26	27	53
?Aphanaia sp.	1		
Merismopteria sp.	1		
?Etheripecten sp. A	1		
Etheripecten sp. B	1		
E. tenuicollis (Dana)	3	2	
?Cyrtorostra sp.	1		
Calcicanicularia glabra n. gen. n. sp.	6	13	3
Stutchburia sp.	1	2	2
Pachymyonia sp.	2		2
Vacunella waterhousei (Dun)		?3	?9,1
	Total No.		
Warthia micromphala (Dana)	36		
Platyteichum ornatum n. sp.	271		

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PLATE EXPLANATIONS

Plate 1

Figs 1, 2 — *Echinalosia* cf. *preovalis* (Maxwell) internal and external mould of dorsal valve, UQF 70037, x 2.

Fig. 3 — *Terrakea dickinsi* Dear, external mould of dorsal valve and umbonal part of ventral valve attached, UQF 70038, x 1.

Figs 4, 6 — ?*Taeniothaerus* sp. x 1. 4, decorticated interior shell UQF 70039. 6, dorsal internal mould of dorsal valve, UQF 70040.

Figs 5, 7-10 — *Aperispirifer crassicostatus* n. sp. x 1. 5, 8, internal mould and latex cast of exterior, dorsal valve UQF 70041. 7, 10, posterior and dorsal aspects of internal mould of specimen with both valves conjoined, UQF 70042, ventral valve on top in fig. 7. 9, latex cast of broken ventral exterior, UQF 70043.

Plate 2

Figs 1, 4 — *Aperispirifer crassicostatus* n. sp. x 1. 1, ventral aspect of UQF 70042 (see pl. 1, figs 7, 10). 4, worn exterior of ventral valve UQF 70044.

Figs 2, 3, 5-9 — *Tomiopsis plica* (Campbell) x 1. 2, 3 ventral and dorsal aspects of shell with valves conjoined, UQF 70045. 5, 7, ventral and dorsal aspects of shell with valves conjoined, UQF 70046. 6, dorsal exterior UQF 70047. 8, internal mould of ventral valve UQF 70048. 9, dorsal aspect of specimen with valves conjoined, UQF 70049.

Fig. 10 — *Tomiopsis plana* (Campbell), x 1, ventral internal mould UQF 70050.

Plate 3

Figs 1-4 — *Tomiopsis plana* (Campbell) x 1. 1, ventral valve UQF 70051. 2, 3, internal mould and latex cast of dorsal valve UQF 70052. 4, dorsal exterior, UQF 70053.

Figs 5-8 — *Notospirifer extensus tweedalei* Campbell. 5, dorsal aspect of internal mould with valves conjoined, UQF 70054, x 2.6, latex cast of dorsal exterior, UQF 70055, x 2. 7, dorsal internal mould UQF 70056, x 2. 8, ventral internal mould UQF 70057, x 1.

Fig. 9 — *Fletcherithyris reidi* Campbell, x 1, dorsal aspect of UQF 70058.

Figs 10-12 — *Glyptoleda javesi* n. sp. x 2. 10, latex cast of exterior of right valve UQF 70059. 11, left aspect of internal mould with valves conjoined, UQF 70060. 12, latex cast of broken left valve, UQF 70061.

Plate 4

Figs 1-6 *Glyptoleda javesi* n. sp. x 2. 1, 5, latex cast and internal mould of left valve UQF 70062. 2, latex cast of left valve interior, UQF 70063. 3, dorsal aspect of internal mould with valves conjoined, UQF 70064. 4, dorsal aspect of latex exterior of specimen with valves conjoined, UQF 70065. 6, latex cast of exterior, right valve UQF 70066.

Figs 7, 11, 12 *Etheripecten tenuicollis* (Dana) 7, 11, mould (x 2) and latex cast (x 3) of left valve exterior UQF 70067. 12, external mould of right valve UQF 70068, x 2.

Fig. 8 *Etheripecten* sp. B, x 2, external mould of left valve UQF 70069.

Fig. 9 ?*Etheripecten* sp. A, x 1, internal mould of left valve UQF 70070.

Figs 10, 13-15 *Calcicanicularia glabra* n. gen., n. sp. x 1. 10, left valve UQF 70071. 13, latex cast of right valve exterior UQF 70072, showing ears well. 14, holotype, internal mould, right valve UQF 70073. 15, internal mould, left valve UQF 70074.

Plate 5

Figs 1, 2 *Calcicanicularia glabra* n. gen., n. sp. x 2. 1, upper part of internal mould of left valve, with umbo cleared back to show ligament, UQF 70075. 2, holotype, internal mould of right valve with umbo cleared back to show ligament, UQF 70073.

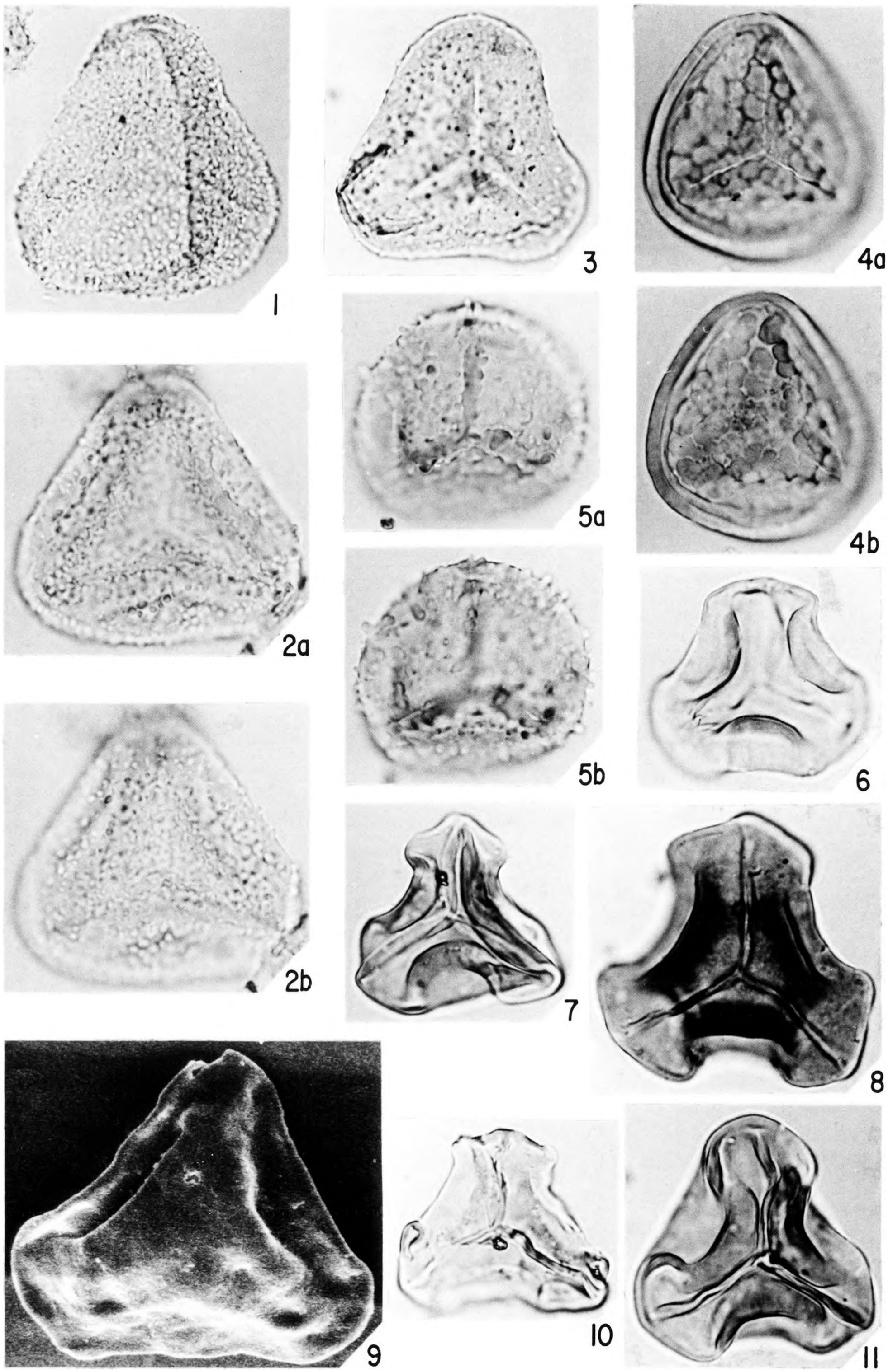
Fig. 3 *Stutchburia* sp. x 2, internal mould of right valve UQF 70076.

Fig. 4 *Vacunella waterhousei* (Dun) x 1, right aspect of specimen with valves conjoined, UQF 70077.

Fig. 5 *Warthia micromphala* (Dana), x 1, lateral aspect, broken aperture to top UQF 70078.

Figs 6-13 *Platyteichum ornatum* n. sp. latex casts, x 3. 6, spire of large specimen UQF 70079. 7, lateral aspect, UQF 70080. 8, lateral aspect, UQF 70081. 9, holotype, showing aperture and slit, UQF 63664. 10, lateral aspect UQF 70082. 11, tilted lateral aspect UQF 70083. 12, basal aspect, UQF 70085. 13, tilted basal aspect UQF 63662.

PLATE 1



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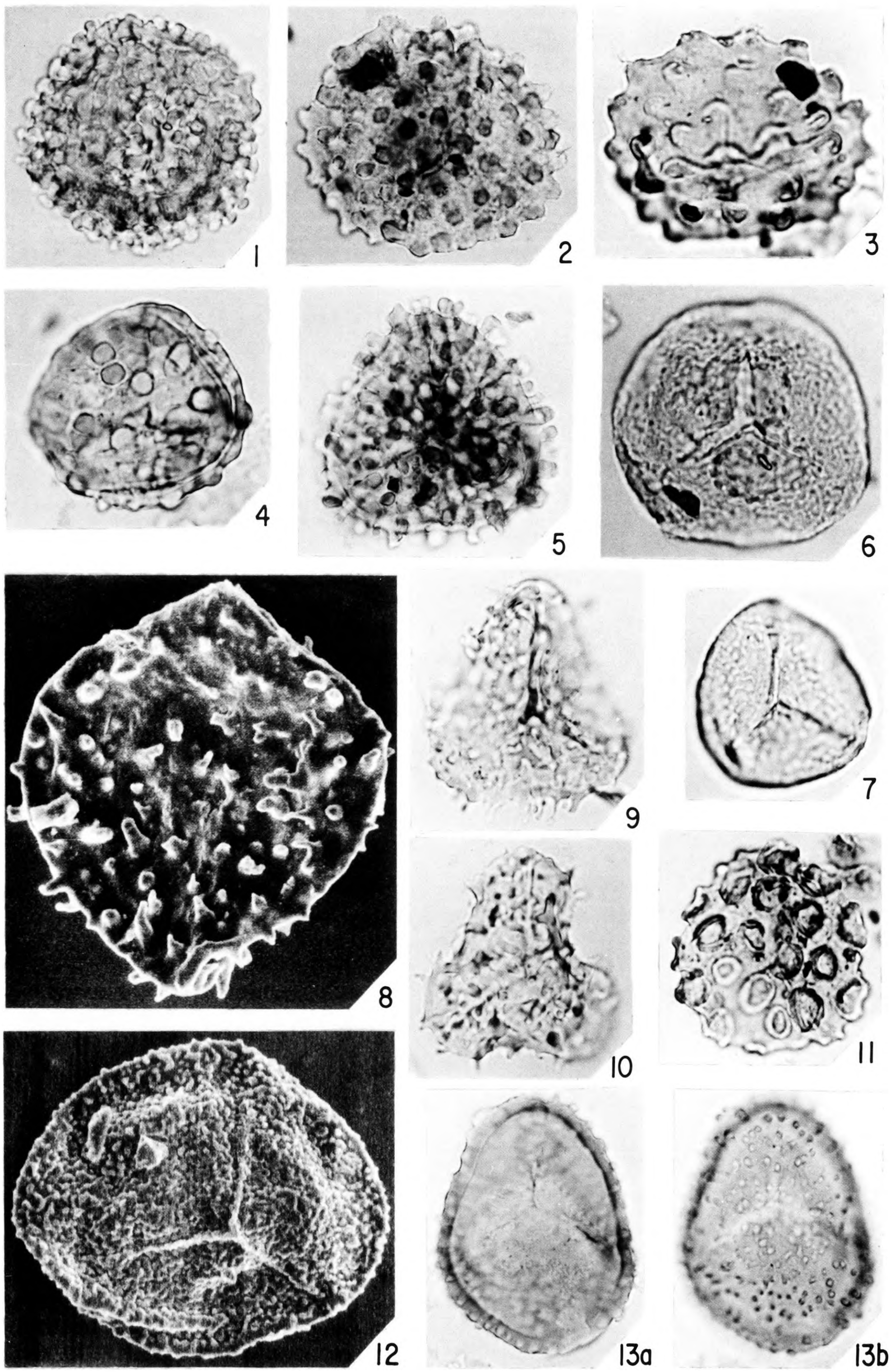

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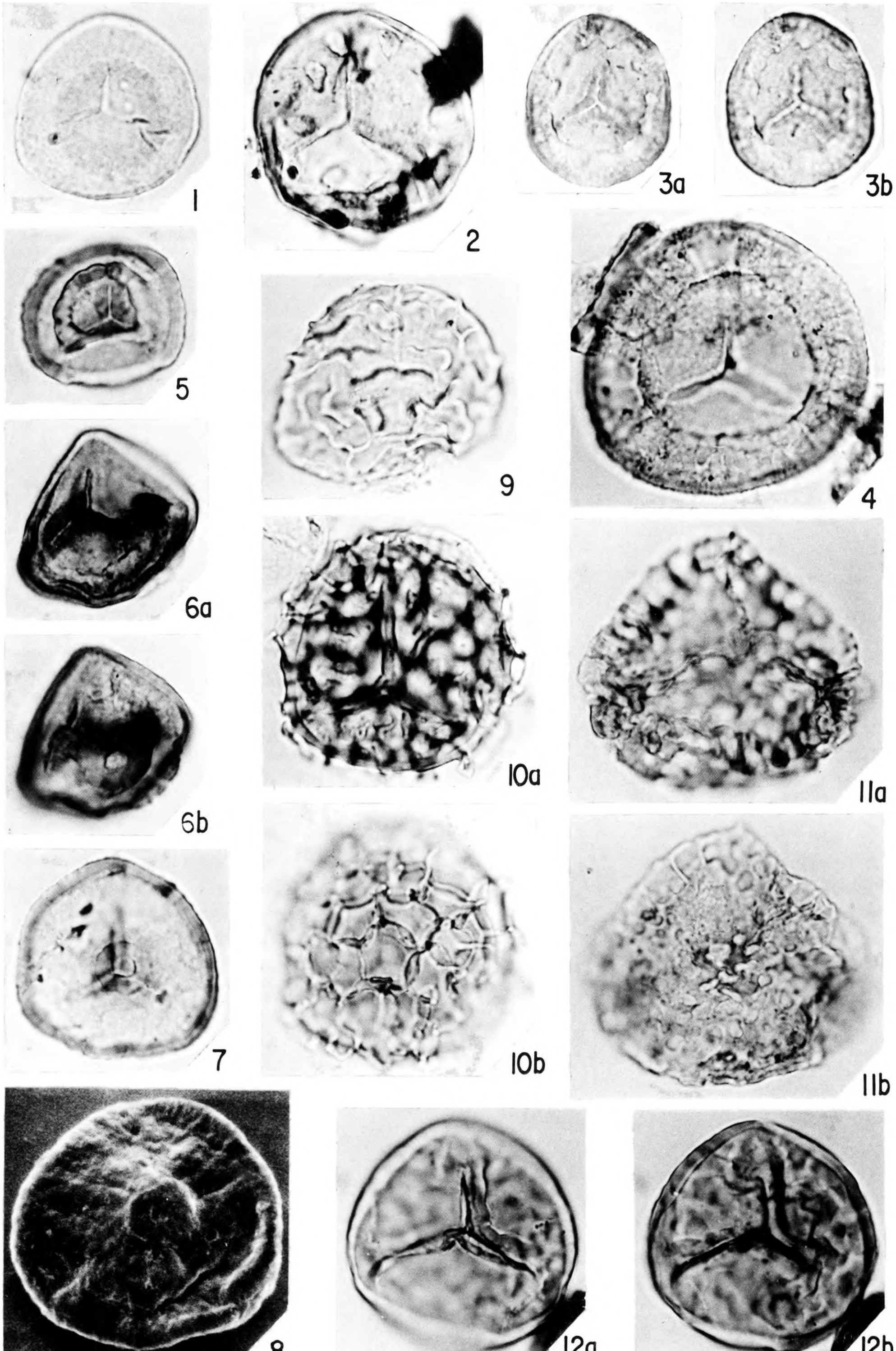

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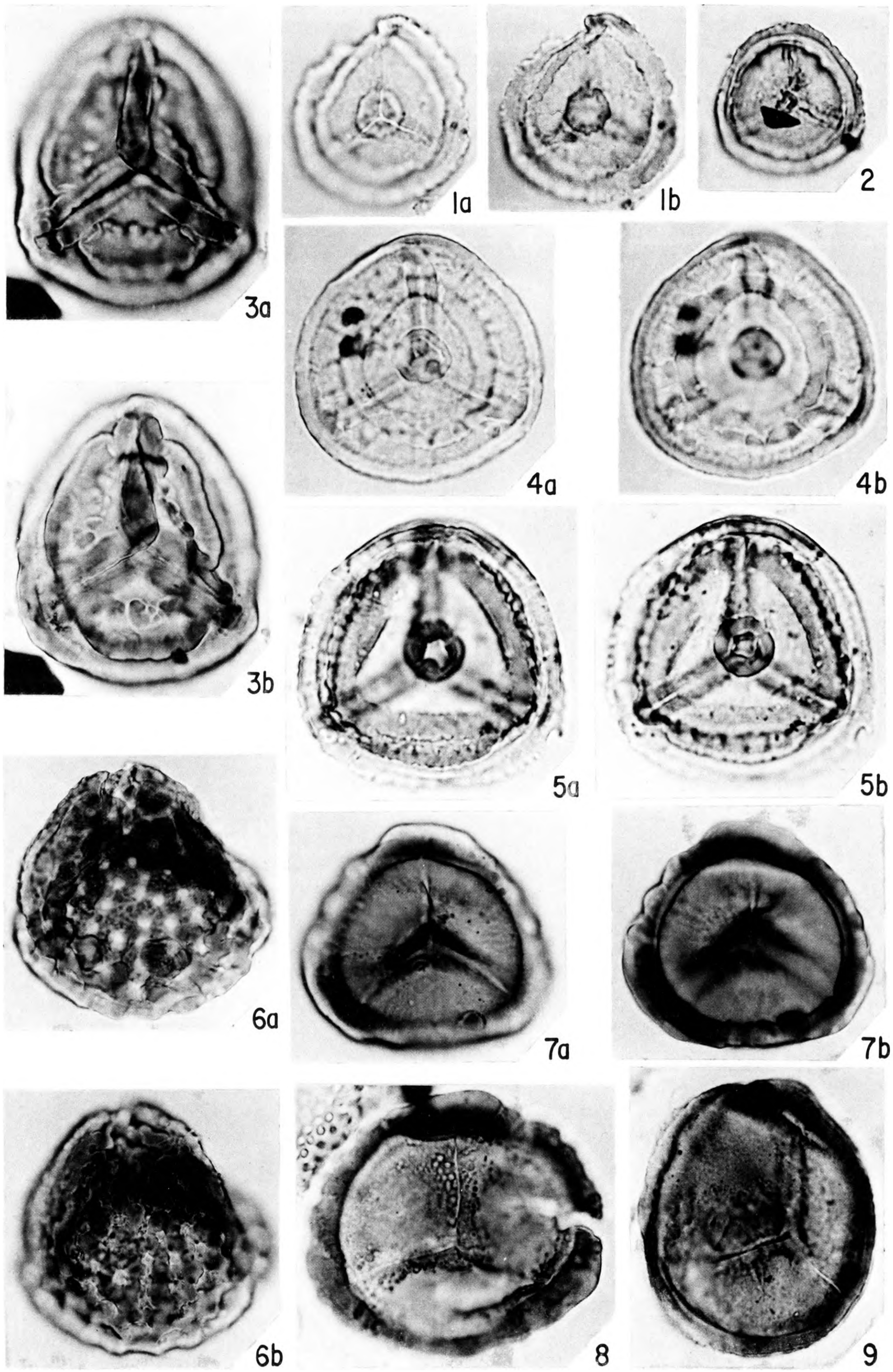

PLATE 5