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GEOLOGICAL SURVEY BULLETIN 69

Hellyerian and Tamarian (Late Carboniferous – Lower Permian) invertebrate faunas from Tasmania

TASMANIA DEPARTMENT OF RESOURCES AND ENERGY
DIVISION OF MINES AND MINERAL RESOURCES

COVER PHOTOGRAPH

The fasciculate spiriferid *Trigonotreta stokesi* Koenig, 1825, the first described fossil taxon from Australia, which is an abundant and characteristic index marker for the Tamarian Stage.

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Hellyerian and Tamarian (Late Carboniferous – Lower Permian) invertebrate faunas from Tasmania

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Abstract

Hellyerian and Tamarian (Late Carboniferous–Lower Permian) faunas from Tasmania composed mainly of marine macro-invertebrates are described and figured. No new taxa are introduced but most elements of the molluscan faunas are described and figured from Tasmania for the first time. Palynological data are largely at a reconnaissance level, but they are consistent and allow a correlation with the eastern Australian scheme of palynological stages, and permit a calibration of those stages with subdivisions based on macro-invertebrate faunas. The stratigraphy of the more important developments at various locations is summarised and correlation with sequences outside Tasmania is discussed.

Introduction

Late Palaeozoic (Late Carboniferous–Permian) rocks and fossils are very widespread in eastern Australia. They occur in the Tasmania Basin in the south, through the Sydney Basin and parts of the New England Fold Belt in New South Wales, to the Bowen and Yarrol Basins in Queensland in the north. These rocks, like those of the other parts of the now fragmented Gondwana supercontinent (South America, South Africa, Peninsula India and Antarctica), display an unmistakable glacial imprint with markedly provincial faunas and floras. The sequences are almost everywhere subhorizontal or gently folded, and fossils are abundant and well preserved. It is not surprising, therefore, that Late Palaeozoic fossils are prominent amongst those first described from the Australian continent (G. B. Sowerby, 1844; Lonsdale and Morris, *in* Strzelecki, 1845; Dana, 1847; McCoy, 1847). Indeed, the characteristic fasciculate spiriferid *Trigonotreta stokesi* Koenig, 1825 from the Early Permian (Asselian) Swifts Jetty Sandstone at Middle Arm, Beaconsfield, Tasmania (Green, 1959) constitutes the first described fossil taxon from Australia.

In Tasmania Late Palaeozoic (Late Carboniferous-Permian) rocks are referred to as the Lower Parmeener Supergroup. They are subhorizontal and rest with pronounced landscape unconformity on a basement of older folded rocks intruded by granites which may be as young as Late Devonian–Early Carboniferous. Basement relief is of the order of 1000 m and its surface is often scoured, plucked and striated with *roches moutonnées* in rare instances (Banks, 1981). At their maximum development these rocks consist of poorly fossiliferous, thick basal glaciomixtite, tillite, and glaciolacustrine rhythmite claystone with subordinate till-derived pebbly mudstone, turbidite sandstone and outwash conglomerate (500 m), overlain by richly fossiliferous cold-water marine sequences (675–900 m) which contain much ice-rafted material, with one thin interval of coal measures and other related non-marine rocks (Mersey Coal Measures and correlative beds).

The physical stratigraphy, distribution and palaeogeographic setting of the Lower Parmeener Supergroup in Tasmania has been recently summarised (Clarke, *in* Burrett and Martin, 1989), and is not repeated herein. The detailed subdivision of the sequence is that formalised by Clarke and Farmer (1976) following the recognition of successive broad faunal associations of marine macro-invertebrate biotas by Clarke and Banks (1975). Calibration of the marine faunas with the eastern Australian palynological zonation (Kemp *et al.*, 1977) has been summarised by Truswell (1978) and Calver, Clarke and Truswell (1984), but remains essentially at a reconnaissance level (fig. 1–2).

Only fossils from the two lowest stages, the Hellyerian and Tamarian Stages, are described herein. Those from the Hellyerian Stage are very limited and include the plants *Botrychiopsis plantiana* (Carruthers) and *Aphlebia* sp. (Gould, 1975), the neosecopteran insect *Psychroptilus burrettae* Riek, 1976, and the trace fossils *Tasmanadia twelvetreesi* Chapman, 1929, and *Gyrochorte* sp. The recognition of the Hellyerian Stage is essentially based on the range of the impoverished Stage 1 *Potonieisporites* Microflora (Truswell, 1978). The significance of the Stage 1 *Potonieisporites* Microflora is currently under debate but everywhere it consistently underlies the first occurrences of the *Eurydesma* faunal and *Glossopteris* floral associations which have traditionally been used in Australia to mark the base of the Permian System. Hellyerian biotas are known only from the basal glacigene sequence (Wynyard Tillite and correlative beds). In contrast, biotas from the succeeding Tamarian Stage, which consist mainly of marine macro-invertebrates, are extraordinarily rich in numbers of individuals but taxonomic or biological diversity is very low. They occur in the upper part of thick basal glacigene sequences in two instances (Maydena and Frankford), and through about 250 m of strata which immediately follow the basal glacigene sequence (fig. 2). Lithologically these rocks fall into two broad facies or associations of approximately equal thickness. The lower half of the sequence (Quamby Formation, Woody Island Formation and correlative beds) consists of very uniform, dark, massive-bedded, pyritic, carbonaceous and glendonitic siltstone. An oil shale about 2 m thick composed of the probable green alga *Tasmanites* (Truswell, 1978) occurs near the base of the sequence in northern Tasmania and at Douglas River, eastern Tasmania. Glendonites are pseudomorphs composed of calcite after ikaite (a hexahydrate of calcium carbonate) which is currently forming at sub-zero temperatures within organic-rich muds on the present day Antarctic Shelf (Suess *et al.*, 1982) and elsewhere (Jansen *et al.*, 1987). They occur as single and twinned crystals and in rosettes. In most outcrops the calcite is leached out, but moulds of the crystals are readily identifiable. The upper half of the sequence (Golden Valley Group, Bundella Formation, Darlington Limestone and correlative beds) consists of more variable, richly fossiliferous siltstone, calcareous siltstone and sandstone, with subordinate limestone and conglomerate, all with abundant ice-rafted debris. At Beaconsfield, Frankford and Latrobe in northern Tasmania and at Point Hibbs, western Tasmania, the two facies interdigitate. The very low taxonomic diversity of the faunas together with the presence of glendonites and the abundance of ice-rafted debris, all indicate cold- to very cold-water conditions of deposition following the main glacial retreat.

The brachiopod taxa described herein include *Grumantia costellata* Clarke, *Strophalosia subcircularis* Clarke, *Strophalosia concentrica* Clarke, *Licharewiella apicallosa* (Clarke), *Trigonotreta stokesi* Koenig, *Sulciplica crassa* Clarke, *Sulciplica subglobosa* Clarke, *Tomiopsis elongata* (McClung and Armstrong), *Tomiopsis konincki* (Etheridge), *Tomiopsis* cf.

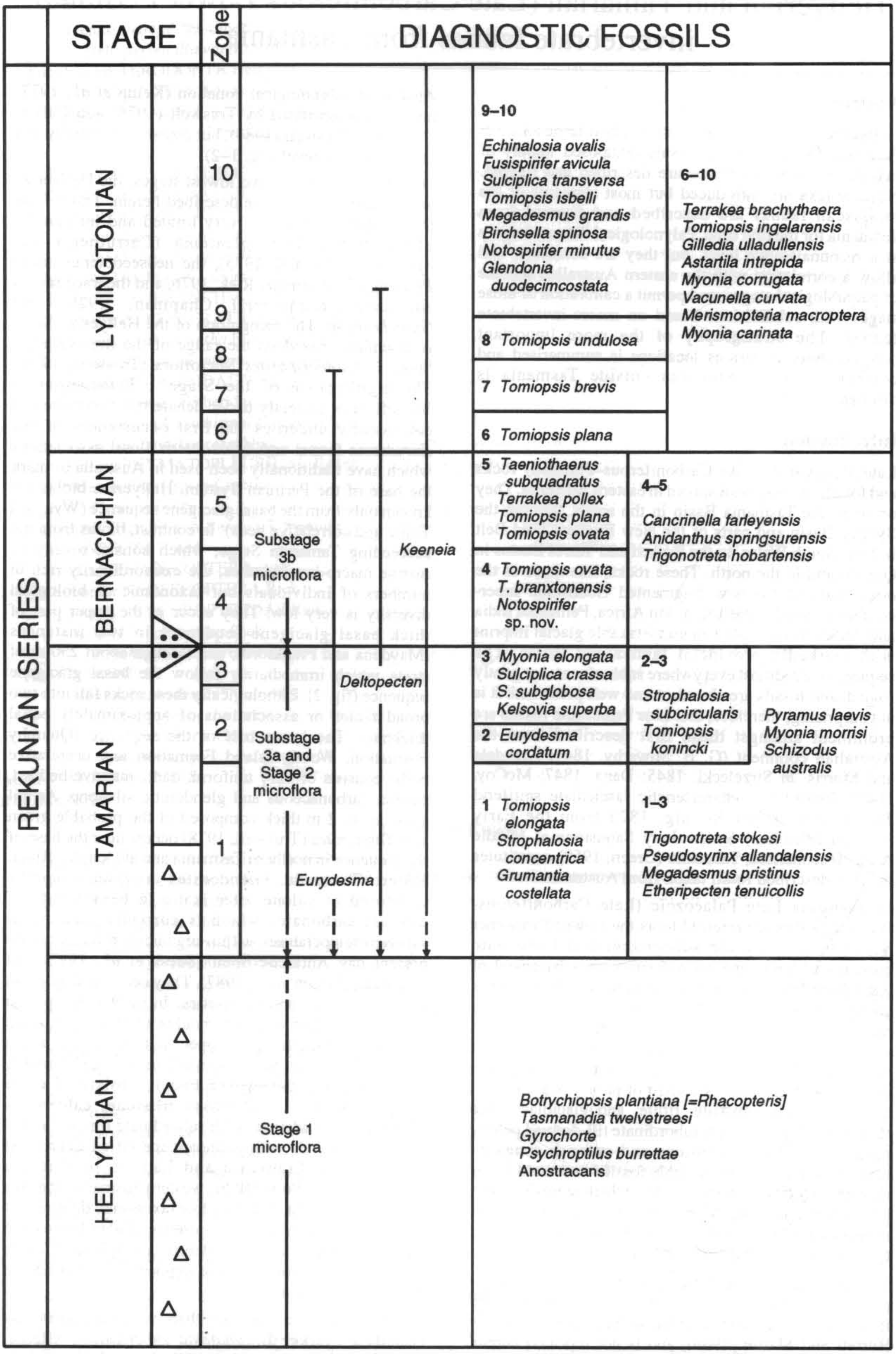

Figure 1. Stage subdivision of the Rekunian Series. In the generalised stratigraphic column the triangles represent glaciomixtite and other glacigene rocks, the dots represent coal measures and other freshwater rocks, and marine sequences with lonestones are left blank. (Modified and up-dated after Clarke and Farmer, 1976, and Truswell, 1978).

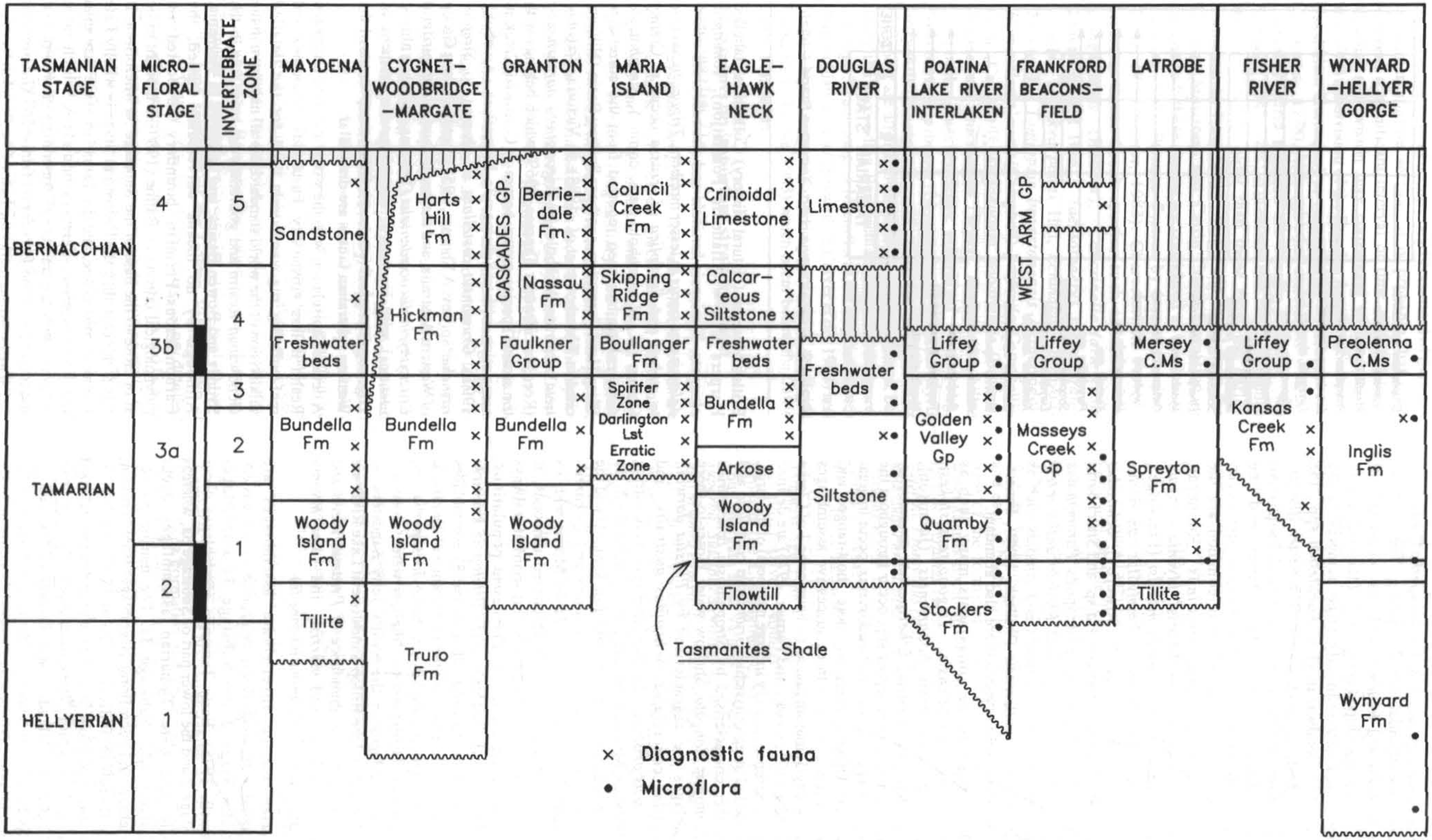

Figure 2. Correlation chart of some of the most important Hellyerian and Tamarian sequences as developed at various localities throughout Tasmania.

branxtonensis (Etheridge), *Kelsovia superba* Clarke, and *Pseudosyrinx allandalensis* Armstrong. The terebratuloids *Gilledia* and *Fletcherithyris* also occur but are rare. The non-brachiopod component of the fauna is also extensive and extraordinarily large numbers of the thick-shelled Gondwanan clam *Eurydesma* spp., the coarsely-ribbed, biconvex scallop *Deltopecten illawarensis* (Morris), and the more finely-ribbed, inequivalve scallop *Etheripecten tenuicollis* (Dana), and the gastropods *Keeneia* spp. and *Peruvispira* spp. occur. Also present, but relatively less common are the pelecypods *Megadesmus pristinus* Runnegar, *Merismopteria macroptera* (Morris), *Myonia elongata* Dana, *Myonia (Pachymyonia) morrisi* (Etheridge), *Phestia darwini* (de Koninck), *Promytilus cancellatus* Maxwell, *Pyramus laevis* (J. Sowerby), *Schizodus australis* (Runnegar), *Streblopteria* sp. and *Stutchburia farleyensis* Etheridge, the gastropods *Paromphalus ammonitiformis* Etheridge and *Rhabdocantha intermedia* Fletcher, rare conulariids and crinoids such as *Neocamptocrinus millerensis* (Willink, 1980). Fenestellid and stenoporid bryozoans are also abundant.

Of these invertebrate components many such as *Pseudosyrinx allandalensis, Trigonotreta stokesi, Eurydesma hobartensis hobartensis* (Johnston), *Deltopecten illawarensis, Etheripecten tenuicollis, Keeneia* spp. and *Peruvispira* spp. occur throughout the Tamarian Stage, and all but *Pseudosyrinx*, occur in great abundance. Other species are more short-ranged and allow the recognition of three successive assemblages (fig. 3). Early Tamarian faunas (= Faunizone 1 of Clarke and Banks, 1975; Clarke and Farmer, 1976) are defined by the occurrence (usually in large numbers) of the large, thick-shelled streptorhynchid *Grumantia costellata* and are further characterised by *Strophalosia concentrica* and *Tomiopsis elongata*. Shallow-water, closer-to-shore assemblages are characterised by *Phestia darwini, Promytilus cancellatus, Schizodus australis* and *Megadesmus pristinus*, the two latter species occurring in abundance. Middle Tamarian faunas (Faunizone 2) are characterised by the entry of *Tomiopsis konincki* and the presence of *Strophalosia subcircularis* and *Licharewiella apicallosa. Eurydesma cordatum* Morris with its high, pointed and massively thickened umbones, is apparently confined to the Middle Tamarian but is always a minor component of *Eurydesma* populations. *Strophalosia subcircularis* and *Tomiopsis konincki* persist into Late Tamarian (Faunizone 3) assemblages which are characterised by the appearance of *Sulciplica crassa, Sulciplica subglobosa, Kelsovia superba* and *Tomiopsis* cf. *branxtonensis*. Shallow-water, closer-to-shore assemblages in the Swifts Jetty Sandstone at Beaconsfield and the Billop Sandstone at Lake River are characterised by an abundance of *Pyramus laevis* and *Myonia (Pachymyonia) morrisi*, and rarer *Myonia elongata* and *Rhabdocantha intermedia*.

Tamarian marine invertebrate assemblages are associated with microfloras referrable to the eastern Australia Stage 2 and Substage 3a assemblages (Truswell, 1978). Early Tamarian assemblages occur with Stage 2 and the lower part of Substage 3a, whereas Middle and Late Tamarian assemblages occur exclusively with Substage 3a. The marine macroinvertebrate and microfloral assemblages from Tamarian rocks therefore indicate a good biochronological correlation with those from the lower part of the Dalwood Group in New South Wales, more especially those from the Lochinvar, Allandale and Rutherford Formations. The Sydney Basin faunas are molluscan-dominated but the brachiopods *Trigonotreta stokesi* (specimens in the

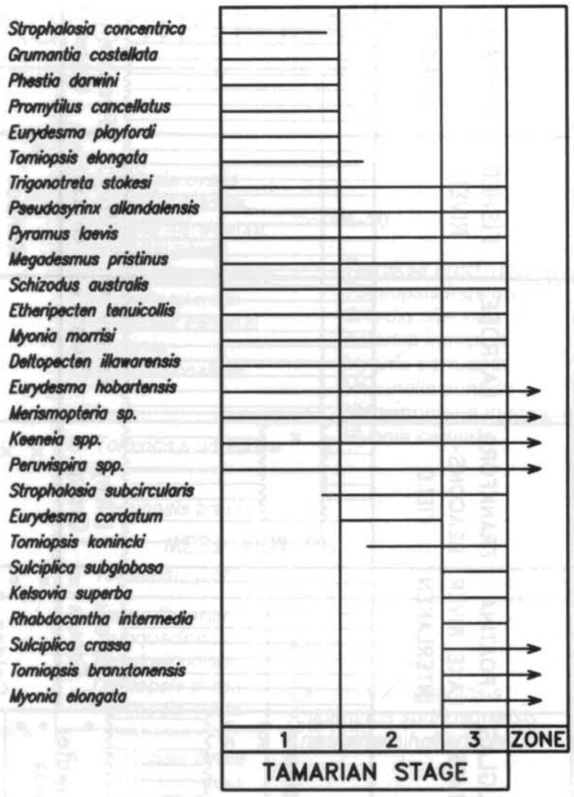

Figure 3. Species range chart, Tamarian Stage.

British Museum (Natural History) Collections labelled Harpers Hill = Allandale Formation), *Tomiopsis elongata, Tomiopsis konincki* and *Pseudosyrinx allandalensis* also occur in lesser numbers. *Trigonotreta* close to *stokesi* and *Sulciplica* cf. *crassa* occur at Cranky Corner (N. W. Archbold pers. comm.). *Strophalosia subcircularis* has been reported from the correlative Wasp Head Formation, southern Sydney Basin (Nillsen, cited *in* Waterhouse *et al.*, 1983). In Victoria, *Trigonotreta victoriae* Archbold (= *Trigonotreta narsarhensis* (Reed) *occidentalis* Thomas, 1969) which belongs with the *stokesi* species group, occurs at Coimadai Creek in association with a Substage 3a Microflora (Archbold, 1991). *Grumantia costellata* is closest to *Streptorhynchus* sp. nov. A Thomas, 1958 from the Lyons Group of Western Australia, and the small, fasciculate spiriferid *Brachythyrinella occidentalis* (Thomas, 1971), is almost identical with immature, unthickened specimens of *Trigonotreta stokesi* (see later). Other components of the Western Australian faunas are dissimilar.

A detailed correlation with the world standard Laurasian Realm is less satisfactory. Fusulinids, conodonts and reef-building rugosan corals used for the detailed subdivision of the world standard, are all unknown in the Gondwanan Realm and goniatites are very rare in the Sydney and Bowen Basins, and unknown in Tasmania. Although by no means universally agreed, the Carboniferous–Permian boundary advocated on palynological criteria by Balme (1980) is thought to lie at or close to the base of the Substage 3a Microflora. If this is the case then the Hellyerian Stage is wholly Late Carboniferous in age, and the Tamarian Stage may span the Carboniferous–Permian boundary, which is at variance with the traditional Australian viewpoint that the incoming of the *Eurydesma* faunal and *Glossopteris* floral associations marks the base of the Permian System.

Since Tamarian rocks occupy nearly one third of the total Tasmanian marine section, it is probable that they represent a significant interval of time, and that their tripartite subdivision may correspond with a similar three-fold subdivision of the Russian Asselian (Surenan, Uskalikian, Kurmaian) as suggested by Waterhouse (*in* Cohee *et al.*, 1978). Although other correlations with the Laurasian world standard are equally plausible (see Archbold, 1982; 1986), it is evident that Tamarian faunas are significantly older than those from the Farley Formation in New South Wales, and those from the Tiverton Subgroup and Cattle Creek Formation in Queensland; these faunas are considered to be close to the base of the Permian System by some authorities (Dear, 1972; Foster, 1983). Characteristic Farley–Tiverton–Cattle Creek species such as *Anidanthus springsurensis* (Booker), *Cancrinella farleyensis* (Etheridge and Dun), *Taeniothaerus subquadratus* (Morris), *Terrakea pollex* Hill, *Echinalosia preovalis* (Maxwell), *Tomiopsis branxtonensis* (Etheridge), *'Homevalaria' ovata* (Campbell)–*profunda* (Campbell)–*plana* (Campbell), *Trigonotreta hobartensis* (Brown), *Trigonotreta cracovensis* (Wass), *Notospirifer hillae* Campbell, *Punctospirifer etheridgei* Armstrong, *Pseudosyrinx procera* (Armstrong), *Fletcherithyris farleyensis* Campbell and *Gilledia homevalensis* Campbell, are all unknown from the Tamarian Stage, but typify the succeeding Bernacchian Stage. Furthermore, Substage 3b and Stage 4 Microfloras are associated with Bernacchian faunas (Truswell, *in* Calver *et al.*, 1984) and Stage 4 Microfloras enter in the upper part of the Reids Dome Beds (Foster, 1983) which occur below the Cattle Creek Formation.

Comments on important stratigraphical sections (fig. 2)

*1. **Maydena*** (Jago, 1972). The basal glacigene beds are 225 m thick and include glaciomixtite, rhythmite claystone and conglomerate, and rest on an uneven basement surface. Fragmentary and indeterminate marine fossils including fenestellids, stenoporids, spiriferids and crinoid debris occur in one of the higher glaciomixtites, and *Pyramus, Eurydesma* and *Deltopecten illawarensis* (Runnegar, 1969) occur in conglomerate near the top of the sequence. These faunas clearly indicate that part, if not all, of the basal glacigene sequence at Maydena was deposited below sea-level by wet-base ice (Carey and Ahmad, 1961). They also indicate that the upper part of the basal glacial sequence is of Tamarian age. The lower part of the sequence may be of Hellyerian age but no palynological work has been carried out. The so-called Quamby Group of Jago (1972) is re-allocated. The lower and essentially unfossiliferous, massive-bedded, pyritic and glendonitic siltstone is ascribed to the Woody Island Formation as originally defined on Woody Island (Banks *et al.*, 1955). The various richly fossiliferous units above are assigned to an undivided Bundella Formation as in south-eastern Tasmania in general. Following the drilling and revision of the type sequence of the Golden Valley Group at Golden Valley (Clarke, 1968) there is no detailed lithological similarity between the Maydena and Golden Valley developments, nor are there any grounds for placing the Darlington Limestone (as developed on north Maria Island) at the base of the Golden Valley Group. Rocks of Early and Middle Tamarian age with *Grumantia costellata* and *Eurydesma cordatum* respectively are certainly present within the Maydena sequence. Late Tamarian rocks may also be present but are not proved.

*2. **Cygnet–Woodbridge–Margate*** (Farmer 1981; 1985). Nowhere within the Kingborough Map Sheet is the basal unconformity exposed. However, the basal Truro Tillite was proved to be 450 m thick and rest on black lustrous Precambrian phyllite in the Woodbridge Borehole (Farmer and Clarke, 1985). Most of the sequence is massive glaciomixtite but minor laminated rhythmite siltstone also occurs. The overlying Woody Island Formation (120 m) consists of very uniform, massive-bedded, pyritic and glendonitic siltstone and is essentially unfossiliferous except for the uppermost few metres of beds. *Megadesmus pristinus* occurs at Wheatleys Bay. The Bundella Formation (80–120 m) is lithologically more varied and richly fossiliferous. At Cygnet the reduced thickness of the Bundella Formation is due to pre-Lymingtonian erosion and only rocks of Early and Middle Tamarian age are present. At Green Point, Wheatleys Bay and between Shag Point and Drip Beach, *Grumantia costellata, Tomiopsis elongata* and *Strophalosia concentrica* occur in profusion in the basal 5–6 m of the Bundella Formation. At Tobys Hill, Margate and east of Nicholls Rivulet, rather sandier beds at the base of the formation yield more restricted, shallow-water faunas dominated by molluscan elements which include *Pyramus laevis, Megadesmus pristinus, Phestia darwini, Promytilus cancellatus, Schizodus australis* and abundant *Peruvispira. Grumantia costellata* and *Phestia darwini* occur in siltstone and sandstone on Satellite Island (Banks *et al.*, 1955, p. 225). All these assemblages are of Early Tamarian age. Faunas from the main part of the Bundella Formation are very rich and are of Middle Tamarian age. Late Tamarian rocks are absent at Cygnet but progressively younger rocks occur northwards beneath the Lymingtonian overstep, so that in the Snug-Margate area, various species including *Kelsovia superba, Sulciplica crassa, Tomiopsis* cf. *branxtonensis* and *Myonia elongata* indicate a definitive Late Tamarian age. All palynological residues from the Cygnet–Woodbridge area are wholly carbonised (probably as a result of Cretaceous syenite intrusions). Inferentially the lower and middle parts of thick developments of the Truro Tillite are of Hellyerian age but proof is lacking.

*3. **Hobart–Granton (Mt Nassau)*** (Banks and Hale, 1957). The oldest rocks exposed in the well known reference section at Mt Nassau, a few kilometres west of Granton (Banks and Hale, 1957), are fossiliferous siltstone and sandstone of the Bundella Formation in its type development. Lower stratigraphic horizons of characteristic massive-bedded, pyritic and glendonitic Woody Island Formation are exposed in the Collinsvale district (Sutherland, 1964) but the area is much faulted and stratigraphic details can only be inferred. The most complete records of the sequence are offered by two fully cored boreholes, one at Chapel Street, Glenorchy (Everard, *in* Leaman, 1976) and the other at Mt Nassau itself (Clarke and Farmer, 1982). The Chapel Street Borehole was collared in the Bundella Formation and proved a complete and substantially thickened Woody Island Formation (208 m) resting directly on a basement of altered intermediate to basic volcanic rocks of inferred Cambrian age. The Mt Nassau Borehole was collared in the Malbina Formation and, *inter alia*, encountered the Bundella Formation in its entirety (118 m) consisting of richly fossiliferous siltstone, sandstone and thin, subordinate limestone, and an even thicker development of the massive-bedded, pyritic and glendonitic Woody Island Formation (255 m) with base unseen. *Grumantia costellata* has not been observed in any of the Hobart developments and all known faunal assemblages are of Middle Tamarian age. This may indicate that the base of the Bundella Formation in the Hobart area is younger than at Cygnet. The basal Truro Tillite and the Woody Island Formation vary in thickness sympathetically between Cygnet and Granton. This may suggest that the lower part of the abnormally thick developments of the Woody Island Formation at Glenorchy and Granton may represent the lateral fine fractions and time equivalents of the upper part of the thick mixtite developments to the south. However, total carbonisation of the palynological residues prevents proof of this hypothesis. Late Tamarian horizons may be represented within the poorly fossiliferous upper part of the Bundella Formation at Mt Nassau, but again proof is lacking.

*4. **Maria Island*** (Clarke, *in* Clarke and Baillie, 1981; 1984). Exposures of Permian rocks at the Fossil Cliffs near Darlington, north Maria Island are the most spectacular anywhere in Tasmania. However, the lower part of the section is less complete than many developments elsewhere in that the Hellyerian and Early Tamarian Stages are wholly absent. The lowest beds exposed, the so-called 'Erratic Zone', which show many large boulders of granite and quartzite (some of which disrupt and crumple the bedding as well as large bilaminar *Stenopora* colonies parallel to the bedding) are overlain by the Darlington Limestone (Banks, 1957) which consists essentially of *Eurydesma* and spiriferid calcirudite. Several of the individual units are sublensoid and there is at least one channelled surface within the Darlington Limestone. These high energy, sublittoral deposits are of Middle Tamarian age. The succeeding '*Spirifer* Zone' consists mainly of quiet-water siltstone rich in the spiriferids *Kelsovia superba, Sulciplica crassa* and *Sulciplica subglobosa* (listed as *Notospirifer* sp.nov. and *Sulciplica* spp.nov. respectively *in* Clarke and Baillie, 1984) which indicate a Late Tamarian age. A bed close to the summit of the sequence shows large, sponge-bored specimens of *Eurydesma hobartensis konincki* (Johnston) in growth position. On south Maria Island the Late Tamarian is represented by a lens of impure, cross-bedded limestone with much clastic detritus, within coarse arkosic sandstone and conglomerate.

*5. **Eaglehawk Neck*** (Gulline and Clarke, 1984). In this fully cored borehole the Bundella Formation (94.2 m) consists of richly fossiliferous, often bioturbated, siltstone, fenestellid siltstone, sandstone and granule conglomerate and subordinate coarse-grained, granite-derived arkose and granule conglomerate with minor dark siltstone. Numerous clasts, sometimes angular but mostly rounded, of Mathinna Beds-type quartzite and granite occur throughout. Below the Bundella Formation is an interval (53.1 m) composed of coarse-grained arkose and closed framework conglomerate. The larger clasts are predominantly Mathinna Beds-type quartzite and are mostly cobble-sized but reach boulder grade. Shell fragments occur, most particularly near the base. These beds are shallow-water, high energy, sublittoral, locally-derived deposits which reflect the proximity of a granite-Mathinna Beds basement. Monotonous, massive-bedded, dark grey, pyritic and glendonitic siltstone with rare patches of dispersed granule debris and rare, larger clasts, characteristic of the Woody Island Formation occupy a thickness of 45.5 m below the arkosic sequence. Fossils are rare but include *Trigonotreta stokesi, Stenopora* and crinoid debris. The basal beds (16.9 m) are unique. They represent sub-aqueous, possibly ponded, laminated light- and dark-coloured siltstone deposition with abundant load and de-watering structures, interrupted periodically by thin, irregular intervals of flowtill, which were deposited on a surface which had undergone *in situ* mass-wasting and is characterised by the development of intricate Neptunean dyke systems. Small patches of shell debris, *Stenopora, Strophalosia, Peruvispira* and crinoid debris indicate a marine environment. Overall this basal sequence may indicate that the Eaglehawk Neck area was peripheral to the main area of glaciation. Accessible sections of the Bundella Formation along the shores of Forestier Peninsula indicate that both Middle and Late Tamarian horizons are present. Large, coarsely-ribbed *Deltopecten illawarensis, Eurydesma cordatum, Eurydesma hobartensis konincki, Eurydesma hobartensis hobartensis, Trigonotreta stokesi* and *Sulciplica crassa* occur in profusion. Early Tamarian rocks are probably represented by the arkosic sequence (at least in part), by the Woody Island Formation and the basal beds, but confirmatory palynological studies have yet to be carried out. Similarly the *Tasmanites* Shale horizon may be represented towards the base of the Woody Island Formation, but isolated specimens of *Tasmanites* are not sufficiently common so as to be recognisable in hand specimen. Only detailed palynological analysis will prove the presence or absence of abnormally high, but dispersed concentrations as recorded in the lower part of the Masseys Creek Group at Beaconsfield (Truswell, 1978).

*6. **Douglas River*** (Calver, Clarke and Truswell, 1984). The Douglas River Borehole was drilled as one of a series to provide control for geophysical studies related to coal exploration in north-eastern Tasmania, and rather surprisingly, penetrated a fairly complete section of the Lower Parmeener Supergroup, including horizons as low as the *Tasmanites* Shale. The lowest beds (51.8 m) rest with abrupt unconformity on folded and cleaved, Siluro-Devonian quartzwacke turbidite Mathinna Beds. They consist of a few metres of basal arkosic conglomerate followed by poorly-sorted, dark grey and black siltstone and mudstone with sporadic sandy and granule horizons. Lonestones are present together with plant fragments and foraminiferans. *Tasmanites* Shale occurs in two seams near the base of the sequence. The uppermost four metres of the sequence is richly fossiliferous, calcareous siltstone with brachiopods, bryozoans and molluscans. Above this basal marine sequence, non-marine and marginal marine rocks occur (56 m). They consist of pebbly, quartz sandstone; sandy, carbonaceous mudstone; coarse-grained, cross-bedded, quartz sandstone; fine-grained, quartz sandstone with minor, thin, carbonaceous mudstone, thin coals and coal streaks; and bioturbated, fine-grained, quartz sandstone with rare plant fragments. The basal 21 m of beds (including the *Tasmanites* Shale) yield microfloras referrable to Stage 2 and are therefore of Early Tamarian age. The uppermost marine beds immediately below the non-marine interval yield microfloras referrable to Substage 3a and, *inter alia, Strophalosia subcircularis, Deltopecten illawarensis* and *Trigonotreta stokesi* which prove a Middle Tamarian age. An interesting feature of the palynological residues from this part of the sequence is that they yield both coeval Late Palaeozoic, and older, derived Early Palaeozoic spinose acritarchs (Truswell, *in* Calver *et al.*, 1984). The lower half of the overlying non-marine sequence also yields microfloras referrable to Substage 3a and is therefore of Late Tamarian age. The base of the non-marine sequence at Douglas River is therefore significantly older than the base of the non-marine Liffey Sandstone at Golden Valley (Truswell, 1978).

7. Poatina–Golden Valley–Lake River–Interlaken (McKellar, 1957; Wells, 1957; Clarke, 1968; Matthews in preparation; Forsyth, 1989). The terms Stockers Tillite, Quamby Mudstone, Golden Valley Limestone and Shale, and Liffey Sandstone refer to characteristic lithological associations as developed in the Golden Valley–Quamby Brook area, ten kilometres south of Deloraine (Wells, 1957), and similar sequences occur over much of the Central Plateau area. The nomenclature based on the Golden Valley–Quamby Brook sections was more or less concurrently applied to the Poatina section (then better known in detail from a number of fully cored Hydro Electric Commission boreholes) with a number of modifications (McKellar, 1957), which has led to some confusion. As originally defined (Wells, 1957) the Quamby Mudstone consists of very uniform, dark grey, massive-bedded, carbonaceous, pyritic and glendonitic siltstone and mudstone, essentially without macrofossils and with *Tasmanites* Shale near its base in some sections. Lonestones are uncommon and generally small. It is therefore generally similar to the Woody Island Formation in south-eastern Tasmania though most of the sequence is more fine-grained. The Golden Valley Limestone and Shale was characterised as a sequence of richly fossiliferous, erratic-rich siltstone, calcareous siltstone and conglomeratic sandstone with minor, impersistent limestone. At Poatina (McKellar, 1957) recognised a tripartite subdivision (Brumby, Billop and Macrae Formations) and raised the formation to group status. In doing so he made the unwarranted assumption that the Darlington Limestone, as developed on north Maria Island, occupied a position at the base of the Golden Valley Group thus necessitating the inclusion of richly fossiliferous, erratic-rich siltstone (below his Brumby Formation) within his Quamby Mudstone. Following drilling of the type section at Golden Valley which showed that impersistent limestone developments occurred much closer to the base of the Billop Sandstone than to the base of the Golden Valley Group as mapped by Wells, and that most of the Macrae Formation was faulted out of the section, Clarke (1968) accepted McKellar's tripartite subdivision of the Golden Valley Group but introduced the Glencoe Formation to include the Brumby Formation and the richly fossiliferous beds below (those referred to the upper Quamby Mudstone by McKellar) thus restoring the names Quamby Mudstone and Golden Valley Group to those characteristic lithological associations as originally conceived and mapped by Wells (1975).

The basal Stockers Tillite is very highly variable in its development. At Golden Valley it is thin (6.5 m) and consists mainly of massive mixtite with some evidence of crude sorting and layering in its upper part. More substantial developments are known in surface outcrop at Lake River (180 m), and in boreholes at Poatina (110 m minimum), Tunbridge (202 m), Ross (90 m) and The Quoin (58 m). Most deposits are predominantly massive mixtite, but rhythmite claystone is well developed at Lake River, outwash conglomerate occurs at Tunbridge and Ross, and laminated, pebbly siltstone is developed between massive mixtite at the Quoin.

The Quamby Mudstone varies in thickness from 30-210 m but most occurrences are 80–100 m thick. Everywhere it presents a monotonous sequence of massive-bedded, dark grey, carbonaceous, pyritic and glendonitic siltstone and mudstone with few lonestones. *Tasmanites* Shale occurs as a sublittoral accumulation close to a basement high at Quamby Brook. Ellipsoidal calcareous concretions in the upper part of the Quamby Formation at Lake River are moderately fossiliferous with definitive Early Tamarian faunas which include *Grumantia costellata, Phestia darwini* and *Schizodus australis.*

The Golden Valley Group is generally about 85 m thick and is richly fossiliferous for most part. The lowest few metres of the Glencoe Formation at Golden Valley, Poatina and Lake River yield *Grumantia costellata* which indicates an Early Tamarian age, but the greater part of the formation yields very rich faunas with *Strophalosia subcircularis, Tomiopsis konincki* and *Eurydesma cordatum* which indicate a Middle Tamarian age. The Billop Sandstone forms a prominent topographic marker horizon and yields faunas of Late Tamarian age with *Sulciplica crassa* and *Myonia elongata.* At Lake River it is rather more arkosic than usual and yields common *Myonia (Pachymyonia) morrisi, Tomiopsis* cf. *branxtonensis* and an almost complete specimen of the crinoid *Neocamptocrinus millerensis* (Willink, 1980).

Detailed palynological studies have been carried out on the Golden Valley Borehole (Helby, 1972; Truswell, 1978). The thin development of the Stockers Tillite and the lowest part of the Quamby Mudstone yield microfloras belonging to Stage 2, whereas the upper Quamby Mudstone and Golden Valley Group yield microfloras referrable to Substage 3a. *Granulitisporites trisinus* which marks the base of the Substage 3b Microflora (and the base of the Bernacchian Stage) occurs a few metres below the base of the Liffey Sandstone. The onset of non-marine conditions was therefore later than at Douglas River. Spot samples from the upper part of the Stockers Tillite at Lake River also yield microfloras referrable to Stage 2 (Truswell, 1978), and are therefore of Tamarian age. The lower part of basal mixtite sequences at Lake River and Tunbridge are probably of Hellyerian age but proof is lacking.

8. Beaconsfield–Frankford (Gee and Legge, 1974; Gulline, 1981). Important sections of pre-Liffey Sandstone rocks are well exposed at Middle Arm, West Arm–Andersons Creek–Masseys Creek and Port Sorell, and two fully cored boreholes were drilled at Andersons Creek. These developments were accorded the status of reference sections in the original definition of the Tamarian Stage (Clarke and Farmer, 1976). At Beaconsfield and Frankford these rocks are of the order of 290–350 m thick at their maximum, and they are referred to as the Masseys Creek Group. They present a varied, interdigitated sequence of mixtite, essentially unfossiliferous, massive-bedded, pyritic and glendonitic Quamby-type mudstone, and richly fossiliferous, erratic-rich siltstone, sandstone and subordinate limestone. Basement relief is considerable and rocks as young as the Liffey Sandstone may rest on basement. Facies variations are rapid, the more so close to basement highs. Characteristic localised sandstone developments such as the Swifts Jetty Sandstone at Middle Arm (Green, 1959) and the Winkleigh Sandstone at Winkleigh (Gulline, 1981) have been recognised, but otherwise there has been no formal subdivision of the Masseys Creek Group.

Rich Early Tamarian faunas with very large, thick-shelled *Grumantia costellata* and *Strophalosia concentrica* occur intermittently through an interval of at least 90 m in the lower middle part of the Andersons and Masseys Creek sections. Then follows a substantial thickness of essentially unfossiliferous beds overlain by 45–50 m of beds (up to and including a thin limestone immediately below the Swifts Jetty Sandstone) which yield faunas of Middle Tamarian age with *Eurydesma cordatum, Eurydesma hobartensis hobartensis,* *Deltopecten illawarensis, Trigonotreta stokesi, Strophalosia subcircularis* and *Merismopteria macroptera* in great abundance. The Swifts Jetty Sandstone, which consists of massive-bedded, conglomeratic and glauconitic sandstone, is also richly fossiliferous and yields a Late Tamarian fauna dominated by molluscan elements such as *Eurydesma hobartensis hobartensis, Deltopecten illawarensis, Etheripecten tenuicollis, Myonia (Pachymyonia) morrisi, Megadesmus pristinus, Pyramus laevis, Schizodus australis* and *Stutchburia farleyensis* (Etheridge), many of which are articulated, *Keeneia platyschismoides* and *Rhabdocantha intermedia*. Brachiopods are also common and although well preserved, are commonly disarticulated and somewhat abraded. They include *Trigonotreta stokesi, Sulciplica crassa, Kelsovia superba, Tomiopsis konincki, Tomiopsis* cf. *branxtonensis* and *Pseudosyrinx allandalensis*. The prominent cliff-like outcrop alongside Middle Arm Creek at DQ770255 is almost certainly the original collecting site of the type material of *Trigonotreta stokesi* (Koenig, 1825). Early and Middle Tamarian rocks at least, are well developed in the Port Sorell section. Notable occurrences include well preserved *Megadesmus pristinus, Deltopecten illawarensis, Eurydesma cordatum, Strophalosia concentrica* and exceptional specimens of *Trigonotreta stokesi* in growth position and with geopetal infillings (Clarke, 1972).

Palynological studies have been conducted on the Andersons Creek No. 1 Borehole (Helby *in* Clarke, 1974; revised by Truswell, 1978) which penetrated the lower part of the Masseys Creek Group through to Cambrian ultramafic basement rocks. The microfloras belong to Stage 2 and Substage 3a, and contain recycled Early Palaeozoic material as at Douglas River. Although the *Tasmanites* Shale is not present as a distinctive rock type recognisable in hand specimen samples, Truswell (1978) recorded abnormally rich concentrations of *Tasmanites* through an interval of 28 m near the bottom of the hole in a stratigraphic position consistent with other occurrences of the *Tasmanites* Shale.

9. Latrobe (Clarke, *in* Jennings, 1979). Beds below the Mersey Coal Measures in the Latrobe–Spreyton area are referred to an undivided Spreyton Formation. They are poorly exposed, but to judge from limited exposures and old borehole records, they consist of a variable sequence of mixtite, conglomerate, Quamby-type pyritic and glendonitic siltstone, *Tasmanites* Shale and richly fossiliferous, erratic-rich siltstone and sandstone. The best section is that at the Great Bend of the Mersey River immediately south of Latrobe which was temporarily extended by deep trenching at the time of pipeline installations by Associated Pulp and Paper Mills in 1969-70. The section consists of massive, unbedded basal mixtite which passes laterally into well rounded pebble and cobble conglomerate in the vicinity of a basement high of Precambrian quartzite (thickness 4.5 m, base not seen); dark grey, carbonaceous, pyritic and glendonitic, massive-bedded siltstone with few lonestones and without fossils (23 m); *Tasmanites* Shale (1.5 m); medium grey, thin- to medium-bedded siltstone (47 m); and ochreous and khaki-coloured, very pebbly, richly fossiliferous siltstone and sandstone (seen to 33.5 m). The top of this sequence is at least 45 m below the base of the Mersey Coal Measures assuming a thickness of 150 m for the Spreyton Formation at the Great Bend (Burns, 1964).

The *Tasmanites* Shale contains lonestones and glendonites as well as clasts of polymict and unsorted clastic debris which must have been frozen when they were shed from melting ice. In common with occurrences elsewhere, the *Tasmanites* Shale at Latrobe yields microfloras referrable to Stage 2. More importantly, the large amounts of material mined during the commercial exploitation of the shale has revealed the presence of a sparse but definitive marine faunal assemblage which indicates an Early Tamarian age. Important forms include *Grumantia costellata*, strophalosiid fragments, *Etheripecten tenuicollis, Eurydesma hobartensis hobartensis, Deltopecten* ex gr. *illawarensis, Megadesmus pristinus, Merismopteria* sp., *Promytilus cancellatus, Keeneia twelvetreesi, Peruvispira* sp., and foraminiferans (Crespin, 1958). Immediately above the *Tasmanites* Shale, *Trigonotreta stokesi* and *Schizodus australis* occur in addition to the previously listed forms. The ochreous siltstone and sandstone 47 m above the *Tasmanites* Shale is richly fossiliferous. The fauna, which is dominated by molluscans, includes *Trigonotreta stokesi, Pseudosyrinx allandalensis, Tomiopsis elongata, Strophalosia concentrica, Deltopecten illawarensis, Eurydesma hobartensis hobartensis, Etheripecten tenuicollis, Megadesmus pristinus, Pyramus laevis, Phestia darwini, Schizodus australis, Stutchburia* sp., *Keeneia twelvetreesi, Keeneia platyschismoides* and *Peruvispira* sp. also indicates an Early Tamarian age. The overlying Mersey Coal Measures yield microfloras referrable to Substage 3b (Truswell, 1978) and are of Early Bernacchian age. Whether rocks of Middle and Late Tamarian age are represented within the upper part of the Spreyton Formation is unknown.

10. Fisher River–Kansas Creek (Clarke and Farmer, 1973). In the Western Bluff–Fisher River area major excavations associated with the Fisher Tunnel by the Hydro Electric Commission provided a continuous but temporary section of the sequence below the Liffey Sandstone which complement the incomplete section exposed in Kansas Creek (Banks, *in* Ford, 1960). In the Fisher River area basal mixtite is nowhere developed. Basement relief is subdued but rocks as young as the Liffey Sandstone may rest on the folded basement. The pre-Liffey Sandstone sequence is referred to an undivided Kansas Creek Formation (Jennings, 1963) which has a maximum known thickness of approximately 90 m. The basal beds consist of a few metres of massive-bedded, quartzose conglomerate containing an abundance of well-rounded, tabular quartzite pebbles up to 100 mm in diameter, with subordinate clasts of schist, chert and felsic igneous rocks. The matrix is angular, quartzose and of coarse sand grade. Above this about 45 m of beds consist of richly fossiliferous siltstone, calcareous siltstone and impure limestone with abundant lonestones, underlain gradationally by more uniform, massive-bedded siltstone with few lonestones and fossils, and overlain by coarser-grained siltstone and sandstone with large clasts. The uppermost 40 m of beds consist of dark, uniform, massive-bedded, pyritic siltstone with rare small clasts and large ellipsoidal calcareous concretions. Fossils from the richly fossiliferous middle part of the Kansas Creek Formation indicate an Early Tamarian age, and include *Trigonotreta stokesi, Pseudosyrinx allandalensis, Tomiopsis elongata, Tomiopsis konincki, Grumantia costellata, Strophalosia concentrica, Deltopecten illawarensis, Etheripecten tenuicollis, Eurydesma hobartensis hobartensis, Megadesmus pristinus, Merismopteria* sp., *Myonia (Pachymyonia) morrisi, Keeneia platyschismoides* and *Peruvispira* sp. Spot samples from the uppermost Kansas Creek Formation and the Liffey Sandstone yield microfloras referrable to Substage 3a and Substage 3b respectively (Truswell, 1978). As at Latrobe, it is unknown whether rocks of Middle and Late Tamarian age are represented.

11. Wynyard–Hellyer Gorge. Thick basal sequences below the Preolenna Coal Measures occur extensively from Wynyard and southwards into the deeply dissected Hellyer Gorge and Arthur River areas. Spectacular shore platform exposures from Doctors Rocks in the east to Fossil Bluff in the west show a very uneven basement surface of Precambrian rocks, overlain by massive, unbedded, glaciomixtite, rhythmite claystone, fluvioglacial conglomerate, pebbly mudstone and minor ripple-marked and turbidite sandstone. There are at least nine mixtite and four rhythmite claystone units interbedded with conglomerate and other rock types. Four angular disconformities occur where glaciomixtite rests on rhythmite claystone or conglomerate, and clasts of mixtite and rhythmite claystone occur in some of the higher mixtite intervals. Surfaces below mixtite show striations which indicate ice movement to the NNW-NE. Thick sequences of glaciolacustrine rhythmite claystone are exceptionally well developed in the Hellyer Gorge area. This sequence (Wynyard Tillite) is the thickest known and exceeds 500 m. The presence of the spinose acritarch *Veryhachium* in palynological residues (Truswell, 1978) suggests that some occurrences are the product of wet-base ice discharging its debris at or below sea level as at Maydena, Frankford–Beaconsfield and elsewhere.

The transition into the overlying Inglis Formation is rapid with massive-bedded mixtite grading to stratified sandstone, siltstone and mudstone over an interval of about 5 m. A few boulders, cobbles and pebbles, often striated, occur scattered through the predominantly dark grey siltstone and mudstone which immediately overlies the basal mixtite sequence. Lenticular beds of *Tasmanites* Shale up to 0.6 m thick occur in silty mudstone from 6–20 m above the base of the formation. Abnormally high, but dispersed concentrations of orange-brown, flattened spheres of *Tasmanites* are recognisable in hand specimen over a few metres above and below the main seam in exposures in the Cam River near Oonah. The bulk of the sequence above this consists of massive-bedded, dark grey siltstone, although occasional resistant, indurated sandstone horizons occur which often form small waterfalls in creeks. Black micaceous mudstone with occasional pyrite nodules also occurs. Near the top of the formation fossils become abundant and crinoid stem fragments are plentiful. Dark, platy, pyritic siltstone with rich molluscan, brachiopod and bryozoan faunas occurs near the top of the formation which is approximately 130 m thick.

Foraminiferal faunas from the *Tasmanites* Shale and the lower part of the Inglis Formation are listed and described in Crespin (1958). They include *Ammodiscus oonahensis, Digitina recurvata, Hippocrepinella biaperta, Pelosina ampulla, Spiroplectammina carnarvonensis* and *Thuramminoides sphaeroidalis*, and are similar to those from the same stratigraphic level at Latrobe. Rich marine macro-invertebrate faunas occur towards the top of the Inglis Formation at Scolyers Hill. Forms present include *Trigonotreta stokesi, Pseudosyrinx allandalensis, Grumantia costellata, Tomiopsis elongata, Strophalosia concentrica, Deltopecten illawarensis, Eurydesma hobartensis hobartensis, Schizodus australis, Myonia (Pachymyonia) morrisi, Merismopteria macroptera* and *Keeneia* spp. This fauna is of Early Tamarian age, but the rarity of *Grumantia costellata* suggests that it may be close to the Early-Middle Tamarian boundary. Spot samples from this locality yield a Substage 3a Microflora (Truswell, 1978). The *Tasmanites* Shale yields a Stage 2 Microflora and samples from near the base and the middle of the Wynyard Tillite at Pine Point, Wynyard and the Hellyer Gorge respectively, yield Stage 1 (Hellyerian) *Potonieisporites* Microfloras. The trace fossil *Gyrochorte* and the spinose acritarch *Veryhachium* occur at Pine Point and suggest marine conditions. *Veryhachium* is absent at Hellyer Gorge where the plant *Botrychiopsis plantiana* and the neosecopteran insect *Psychroptilus burrettae* also occur in the main rhythmite interval. The arthropod track *Tasmanadia twelvetreesi* occurs in abundance in the lower part of the rhythmite sequence. Spot samples from near the base of the Preolenna Coal Measures at Relapse Creek yield microfloras referrable to Substage 3b and are of Early Bernacchian age (M. R. Banks, pers. comm.)

12. Other sections. Other developments of Hellyerian and Tamarian rocks which are generally less accessible and therefore less well-known in detail include Mt Sedgwick and the Pyramid Mountain area (Lyell), the Henty Plantation area and environs (Strahan), Point Hibbs (Point Hibbs), Cradle Mountain (Macintosh), Musselroe Bay (Eddystone) Castle Forbes Bay (Picton), Mt Anne–Mt Mueller–Mt Wedge (Pedder), the Hastings Caves–Lune River area and Precipitous Bluff (Adamson), and the Strickland Gorge (Ben Lomond). Considerable basement relief is present at most localities with an exhumed *roche moutonnée* and periglacial screes at Cradle Mountain (Gee and Burns, 1968; Banks, 1981). Variable sequences of thick or thin basal mixtite or basal conglomerate, followed by massive-bedded, pyritic and glendonitic siltstone of Woody Island–Quamby-type and richly fossiliferous Bundella Mudstone occur in most areas. Horizons as young as the Bundella Formation rest on basement rocks. The section at Point Hibbs (Banks and Ahmad, 1962) resembles those at Beaconsfield–Frankford–Latrobe in that unfossiliferous Quamby-type rocks interdigitate with more variable, richly fossiliferous sequences of Golden Valley–Bundella aspect. Early and Middle Tamarian horizons with abundant *Trigonotreta stokesi, Pseudosyrinx allandalensis, Grumantia costellata, Tomiopsis elongata, Tomiopsis konincki, Strophalosia concentrica, Strophalosia subcircularis, Deltopecten illawarensis, Eurydesma cordatum, Eurydesma hobartensis hobartensis, Etheripecten tenuicollis, Megadesmus pristinus, Merismopteria macroptera, Schizodus australis* and *Keeneia* spp. occur at most localities. In the Strickland Gorge section only Middle Tamarian horizons have been proved, and at Musselroe Bay much attenuated developments are wholly of Middle Tamarian age. Thick basal sequences of glaciomixtite and rhythmite claystone in the Strahan–Henty Plantation area have yielded the spinose acritarch *Veryhachium* and microfloras referrable to the Stage 1 (Hellyerian) *Potonieisporites* Microflora (Truswell, 1978). Rocks on Mt Dundas mapped as basal Zeehan Tillite (Blissett, 1961) are fossiliferous conglomerate and sandstone of Lymingtonian age thereby indicating substantial basement relief.

Synthesis

Hellyerian and Tamarian rocks are widely, yet variably developed over much of Tasmania. They consist of a basal sequence of glaciomixtite and associated glacigene rocks (Wynyard Tillite and correlative beds) followed by massive-bedded, poorly fossiliferous, pyritic and glendonitic siltstone, sometimes with the *Tasmanites*

Shale near the base (Woody Island Formation, Quamby Formation and correlative beds), and richly fossiliferous, erratic-rich siltstone, calcareous siltstone, sandstone with subordinate limestone and conglomerate (Golden Valley Group, Bundella Formation, Darlington Limestone and correlative beds). Non-marine sandstone is known definitively only at Douglas River.

Hellyerian biotas (including the Stage 1 *Potonieisporites* Microflora) are known only from the lower and middle parts of the Wynyard Tillite at Pine Point, Wynyard, the Hellyer Gorge and the Strahan–Henty Plantation area, but are inferentially present in many of the other thicker developments of basal mixtite and other glacigene rocks. Lack of sampling or complete carbonisation of palynological residues, however, preclude proof. They consistently occupy a stratigraphical position below the incoming of the Gondwanan *Eurydesma* faunal and *Glossopteris* floral associations which marks the base of the overlying Tamarian Stage.

Systematic palynological studies have been carried out only on the Golden Valley, Andersons Creek and Douglas River Boreholes, and these, together with spot samples from elsewhere, consistently indicate that Tamarian marine macro-invertebrate assemblages are associated with microfloras referrable to Stage 2 and Substage 3a. If the Permo–Carboniferous boundary is placed at or close to the base of the Substage 3a Microflora as advocated by Balme (1980), the Tamarian Stage spans the boundary and the *Eurydesma–Glossopteris* association is, in part, of Late Carboniferous age. This is at variance with traditional Australian practice. Tamarian marine faunas are exceedingly rich in numbers of individuals but taxonomic diversity is very low. Early and Middle Tamarian faunas are widespread, but Late Tamarian assemblages are definitely known only from the Central Plateau area (Poatina–Lake River–Golden Valley), Beaconsfield, Maria Island, Eaglehawk Neck and the Snug–Margate area south of Hobart. Inferentially, however, Late Tamarian faunas would be expected to occur through essentially unfossiliferous intervals immediately below non-marine Bernacchian rocks in many other sections. At Douglas River Late Tamarian rocks consist of non-marine sandstone and associated rock types, and in the Cygnet area they are absent through their removal by Lymingtonian overstep.

This bulletin follows the convention that fossils (like extant organisms) are named according to the Linnaean or binomial system of nomenclature. The first letter of the generic name is capitalised and is followed by a non-capitalised specific name. In the course of an ordinary sentence both are printed in different type from the rest of the sentence (normally, in a sentence of roman type they would be in italics). It is also standard practice to state the authorship and date of the original description of the taxon. Thus the characteristic Gondwanan clam *Eurydesma cordatum* Morris, 1845 was named as such in the original description of the species (Morris, *in* Strzelecki, 1845). Frequently, however, species are transferred to other genera by later workers. This can be indicated in one of two ways. Either the original genus is enclosed in square brackets viz. *Deltopecten* [*Pecten*] *illawarensis* Morris, 1845, a style commonly used in older literature citations, or preferably, since it is more concise, by enclosing the author's name in rounded brackets viz. *Deltopecten illawarensis* (Morris), which is modern practice. The first letter of a subgeneric name is also capitalised and enclosed in rounded brackets viz. *Myonia* (*Pachymyonia*) *morrisi*, whereas subspecific names are non-capitalised and non-bracketed viz. *Eurydesma hobartensis hobartensis*.

Most of the specimens figured herein are housed in the fossil collections of the Geological Survey of Tasmania (GST). Other repositories are indicated as necessary. All illustrations are at natural size unless stated otherwise.

SYSTEMATIC PALAEONTOLOGY

Phylum BRACHIOPODA Duméril, 1806
Class ARTICULATA Huxley, 1869
Order STROPHOMENIDA Öpik, 1934
Family STREPTORHYNCHIDAE Stehli, 1954

Genus **Grumantia** Ustritsky, *in* Ustritsky & Cernyak, 1963

TYPE SPECIES: *Streptorhynchus kempei* Andersson, *in* Wiman, 1914, by original designation.

Grumantia costellata Clarke
(fig. 4A-K)

1990 *Grumantia costellata* Clarke, p. 56, fig. 4A–M

HOLOTYPE: GST 8334A–B, complete articulated internal mould of both valves and counterpart external mould of dorsal valve and ventral interarea, from the basal Bundella Formation, shore platform, Green Point, Cygnet at EN076181.

MATERIAL AND LOCALITIES: GST 14101, ventral valve external mould from basal Bundella Formation, shore platform, Wheatleys Bay, Cygnet at EN018168. Paratypes GST 14102, ventral external mould and GST 14105–14107, dorsal internal moulds, from the type locality. GST 14103, ventral valve internal mould from the basal Bundella Formation, Langdons Hill, Cygnet at EN059182. GST 14108–14109, ventral and dorsal valve internal moulds from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175.

DESCRIPTION: Shell large (up to 60 mm wide, 70 mm long) subequally biconvex with the ventral valve rather more convex than the dorsal valve. The hingeline is equal to about three quarters of the maximum width which occurs at midlength. Shell substance is thick (1.5 mm) and pseudopunctate with rather coarse taleolae arranged in rows along the costellae. The ventral valve is irregularly conical with the umbo produced posteriorly well beyond the hingeline. The interarea is high, flat or slightly concave, and is usually asymmetrically twisted by growth distortion. The convex pseudodeltidium is broadly triangular and is about three eighths of the width of the interarea at its base. Both the interarea and pseudodeltidium are ornamented by fine transverse growth lines. The dorsal valve has a very low interarea and is more convex posteriorly. Both valves are ornamented by fine radial costellae, concentric growth lamellae and somewhat irregular and variably developed concentric rugae. The costellae are rounded and regular and occur in three or four cycles; they increase mainly by intercalation and are fine and thread-like at first but rapidly increase in strength so that all costellae are equal at the shell margins where they number 16–18 per 10 mm. Five or six rather irregular concentric rugae occur in most specimens. Concentric step-like growth lamellae are prominent near the shell margins.

Internally the ventral valve displays dental ridges which are much thickened and terminate in large, rounded teeth; supporting plates are absent. Despite the thickness of the shell the muscle tracks are little impressed; they are large and flabellate with the outer diductor impressions enclosing a narrow, raised adductor platform. The radial costellae are impressed on the valve interior towards the shell margins. The dorsal interior shows a prominent but

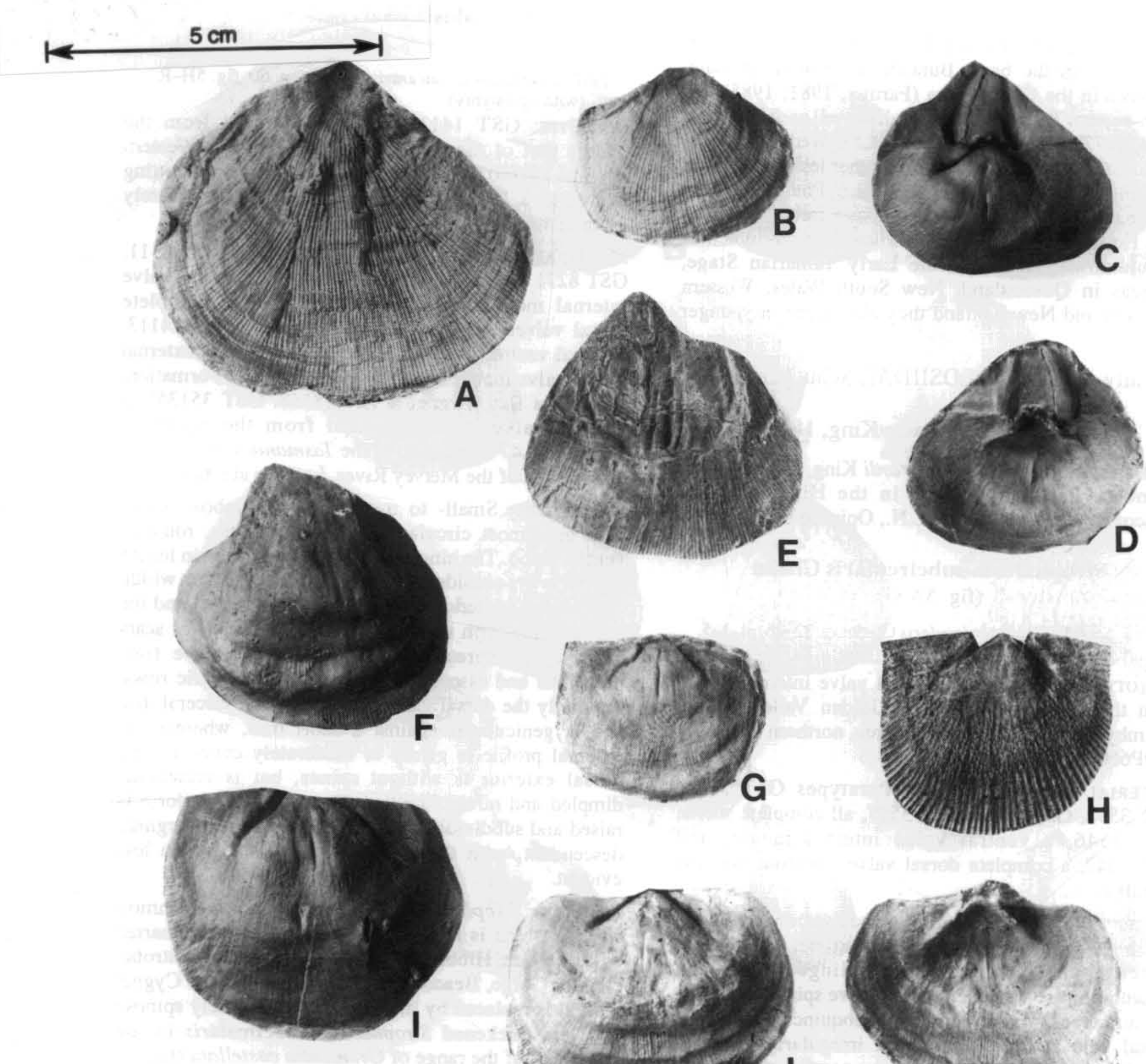

Figure 4. A–K, *Grumantia costellata* **Clarke. A, B,** latex casts of ventral valve exteriors GST 14101-2. **C, D,** dorsal view of complete holotype internal mould GST 8334A and latex cast of dorsal valve interior and ventral interarea showing thickened teeth ridges. **E, F,** ventral valve internal moulds GST 14108, GST 14103. **G, H, I,** dorsal valve internal moulds GST 14105, GST 14107, GST 14109. **J, K,** dorsal valve internal mould and latex cast of dorsal valve interior GST 14106. **A,** from the basal Bundella Formation, Wheatleys Bay, Cygnet. **E, H,** from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe. **F,** from the basal Bundella Formation, Langdons Hill, Cygnet. All other specimens are from the type locality and are paratypes. All illustrations × 1, except **H,** which is × 2.

low cardinal process. The process is bilobed with each lobe split into two tubes on the posterior face for the attachment of the diductor muscles. It is smooth on the anterior face. Erismata (socket plates) are high but short and terminate abruptly beyond the dentifers (socket ridges) so that the overall structures recurve towards the hingeline. The erismata enclose the posterior part of the adductor field which is sometimes weakly dendritic, and subdivided by a low and short myophragm or median septum.

REMARKS: Eastern Australian streptorhynchids have been traditionally referred to *Streptorhynchus* King, 1850 with *Terebratutites pelargonatus* Schlotheim, 1816 as type species. However, following Cooper and Grant (1974) *Streptorhynchus* is now restricted to small, thin-shelled Zechstein forms with long, divergent erismata. *Arctitreta* Whitfield, 1908 and *Grumantia* Ustritsky, 1963 are clearly distinguished from *Streptorhynchus* by their thick shells and short, recurved erismata. Although *Arctitreta* and *Grumantia* were synonymised by Cooper and Grant (1974), the former has well developed dental plates which extend to the floor of the valve and I therefore follow Waterhouse (1982) in using *Grumantia* for those forms which lack dental plates. *Grumantia costellata* is very close in external morphology to the considerably younger Queensland Bowen Basin species *Grumantia pelicanensis* (Fletcher), but has a much lower cardinal process and less thickened erismata. *Streptorhynchus* sp. nov. A of Thomas (1958) from the Lyons Group of Western Australia is also externally similar but the internal details of this species are poorly known.

Grumantia costellata serves as an easily recognised index species for the Early Tamarian Stage, and occurs abundantly in the basal Bundella Formation at many localities in the Cygnet area (Farmer, 1981; 1985) and south-eastern Tasmania in general, as well as at Maydena (Jago, 1972), Mt Anne, Mt Mueller, Mt Wedge, Latrobe, Beaconsfield and elsewhere. It is rather less abundant in the Central Plateau area (Western Bluff, Poatina, Golden Valley and Lake River), and it is very rare at Scolyers Hill, Hellyer Gorge area. In Tasmania streptorhynchids are unknown outside of the Early Tamarian Stage, whereas in Queensland, New South Wales, Western Australia and New Zealand they also occur in younger rocks.

Family STROPHALOSIIDAE Schuchert, 1913

Genus **Strophalosia** King, 1846

TYPE SPECIES: *Strophalosia gerardi* King, 1846 from an unknown Permian horizon in the Himalayas (by subsequent designation, I.C.Z.N., Opinion 625).

Strophalosia subcircularis Clarke
(fig. 5A-G)

1969 *Strophalosia subcircularis* Clarke, p. 22–36, pl. 1–5.
1990 *Strophalosia subcircularis* Clarke, p. 58, fig. 5A–G.

LECTOTYPE: GST 3545, a ventral valve internal mould from the Glencoe Formation, Golden Valley Group, Quamby Brook, Golden Valley area, northern Tasmania at DP660730.

MATERIAL AND LOCALITY: Paratypes GST 3544, GST 3592, GST 3595, GST 3597, all complete shells; GST 3546, a ventral valve internal mould; and GST 3547, a complete dorsal valve; all from the type locality.

DESCRIPTION: Medium-sized, concavo-convex shells which are generally subcircular in outline; the venter is flattened or weakly sulcate. Hinge width and geniculation are variable. Ventral valve spines are strong and numerous, and are arranged subquincuncially. The dorsal vale is non-spinose, but irregularly dimpled, lamellose and finely nodose, rarely with fine, discontinuous radial capillae. The ventral adductor platform is short or of medium length, of moderate height; the adductor scars are subdivided, unequal in development with smaller crescentic posterior elements partly enclosing larger, oval or pear-shaped anterior elements. The diductor scars are circular or oval, and are deeply impressed into the floor of the valve. The teeth are supported by callosities of moderate development. The dorsal valve is internally flat over the visceral disc and is geniculated against a short trail; externally it is concave. The brachial ridges are strongly descendent and strongly sigmoidal anteriorly. The cardinal process is typically strophalosiid and is supported by a robust median septum.

REMARKS: *Strophalosia subcircularis* occurs abundantly and usually in growth position at numerous localities throughout Tasmania. It characterises Middle and Late Tamarian rocks but overlaps the uppermost range of *Grumantia costellata* (fig. 3). Small umbonal attachment scars are present in some specimens. The period of attachment to pebbles and other substrate shell matter was probably restricted to early ontogeny. Mature shells broke away from the attachment and lived with the convex ventral valve lowermost, relying on the long ventral spines to provide anchorage and maintain the anterior shell margins above the essentially soft-sediment, quiet-water substrate (Clarke, 1969).

Strophalosia concentrica Clarke
(fig. 5H–R)

1990 *Strophalosia concentrica* Clarke, p. 60, fig. 5H–R (with synonymy)

HOLOTYPE: GST 14112, a complete shell from the middle part of the Kansas Creek Formation, Western Bluff at DP240780; the rocks are exposed in a cutting alongside a Forestry Commission track immediately north of where it crosses Kansas Creek.

MATERIAL AND LOCALITIES: Paratypes GST 14111, GST 8271 (complete shells), GST 14116, ventral valve internal moulds, GST 8272, GST 14117, complete dorsal valves, all from the type locality. GST 14113, external ventral valve mould, and GST 14118, external dorsal valve mould from the basal Bundella Formation, Wheatleys Bay, Cygnet at EN018168. GST 351350, a ventral valve internal mould from the Spreyton Formation, 47 metres above the *Tasmanites* Shale at the Great Bend of the Mersey River, Latrobe at DQ390175.

DESCRIPTION: Small- to medium-sized, globose shells with an almost circular outline and obtuse, rounded ventral umbo. The hingeline is short to medium in length and is always considerably less than the maximum width. The ventral posterior walls are much thickened and the adductor platform is short and high; the diductor scars are deeply impressed. The ventral spines are fine, numerous and essentially arranged in concentric rows. Internally the dorsal valve is flat over the visceral disc and is geniculated against a short trail, whereas the external profile is gently to moderately concave. The dorsal exterior is without spines, but is lamellose, dimpled and rarely capillate. The adductor platform is raised and subdivided; brachial ridges are submarginal, descendent, with the sigmoidal anterior portions less evident.

REMARKS: *Strophalosia concentrica* is a common species which is restricted to rocks of Early Tamarian age at Point Hibbs, the Fisher River area, Latrobe, Hellyer Gorge, Beaconsfield, Maydena and the Cygnet area. It is replaced by the larger, more coarsely spinose and less thickened *Strophalosia subcircularis* in the upper part of the range of *Grumantia costellata* (fig. 3).

Genus **Licharewiella** Ustritsky, *in* Ustritsky *et al.*, 1960

1966 *Costalosia* Waterhouse and Shah, p. 230

TYPE SPECIES: *Strophalosia costata* Waagen, 1884, from the Lower Productus Limestone, Salt Range, West Pakistan (by original designation). *Costalosia* Waterhouse and Shah, 1966 is a junior objective synonym of *Licharewiella* since both genera share *Strophalosia costata* Waagen, 1884 as type species.

Licharewiella apicallosa (Clarke)
(fig. 6A-G)

1969 *Costalosia apicallosa* Clarke, p.37, pl.6, fig.9–11; pl.7, fig.1–8.
1990 *Licharewiella apicallosa* Clarke, p. 61, fig. 6A–H.

LECTOTYPE: GST 3554, a complete shell partly etched to show ventral muscle platform, from the Glencoe Formation, Golden Valley Group, Quamby Brook, northern Tasmania at DP660730.

MATERIALS AND LOCALITY: GST 35117, an incomplete ventral valve, GST 3557–3558, GST 35113, ventral valve internal moulds, GST 3555, a complete dorsal valve, all from the type locality (paratypes).

DESCRIPTION: The shell is concavo-convex and non-sinuate; the dorsal valve geniculate and with a short trail.

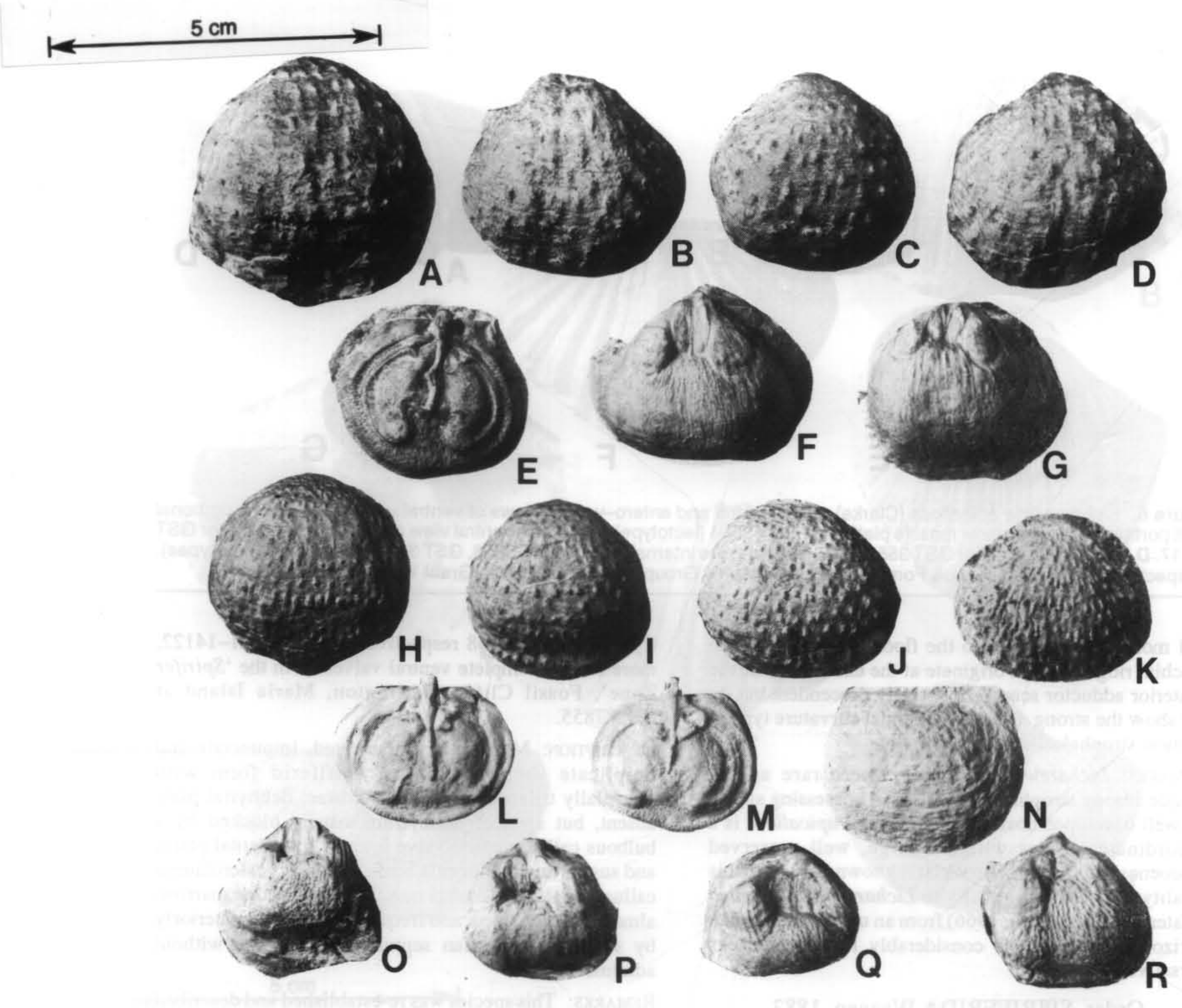

Figure 5. A–G, *Strophalosia subcircularis* Clarke. **A–D,** ventral valve exteriors GST 3544, GST 3592, GST 3597, GST 3595. **E,** dorsal valve interior GST 3547. **F, G,** ventral valve internal moulds GST 3545-6. GST 3545 is the lectotype and all other specimens are paratypes. All specimens are from the Glencoe Formation, Golden Valley Group at Quamby Brook, Great Western Tiers. **H–R,** *Strophalosia concentrica* Clarke. **H–J,** ventral valve exteriors GST 14112, GST 14111, GST 8271. **K,** latex cast of ventral valve exterior GST 14113. **L, M,** dorsal valve interiors GST 8272, GST 14117. N, dorsal valve external mould GST 14118. **O–R,** ventral valve internal moulds GST 351350, GST 14114, GST 14116, GST 14115. GST 14112 is the holotype and I, J, L, M and P–R are paratypes; all specimens from the Kansas Creek Formation, Kansas Creek, Western Bluff, Great Western Tiers. K, N, from the basal Bundella Formation, Wheatleys Bay, Cygnet. O, from the Spreyton Formation, Great Bend of the Mersey River, Latrobe.

In outline the valves are subcircular but generally wider than long. The hingeline is about two thirds of the maximum width which occurs at midlength. The vental umbo is slightly incurved and sometimes deformed by a small attachment scar. The ventral interarea lies almost parallel with the plane of the shell, but the dorsal interarea is lower and slopes backwards at about 30°. Details of the interareas are normal for the Strophalosiidae. Concentric growth lamellae and stronger wrinkles are common more particularly on the anterolateral portions of the dorsal valve. Spines are abundant on the ventral but absent on the dorsal valve. The ventral spines show a crude quincuncial arrangement posteriorly but over the anterior two thirds they are developed on low, broad and rounded intercalated costae. The dorsal valve is wedge-shaped due to the differences in external and internal profiles. In the ventral valve the teeth lie close together and are supported by small, plate-like callosities. The adductor platform is situated close to the posterior wall and slightly raised. The muscle scars are well defined, of moderate length and generally longer than wide. Each muscle scar is usually subdivided; and anterior elements are pear-shaped and several times larger than the posterior elements which are rather more impressed into the floor of the valve. The diductor scars occupy depressed areas, are clearly defined and longitudinally striated. They are crescentic in shape with the posterior margins of the muscle attachments much shortened by posterolateral callus. The dorsal valve shows typical strophalosiid characters. The cardinal process is supported by a thick septum. The adductor scars are deeply sunk into the floor of the valve and slope backwards at about 30° with respect to the plane of the visceral disc. The scars are subdivided into anterior and posterior elements; the anterior elements are pear-shaped whereas the posterior elements are narrow and elongate

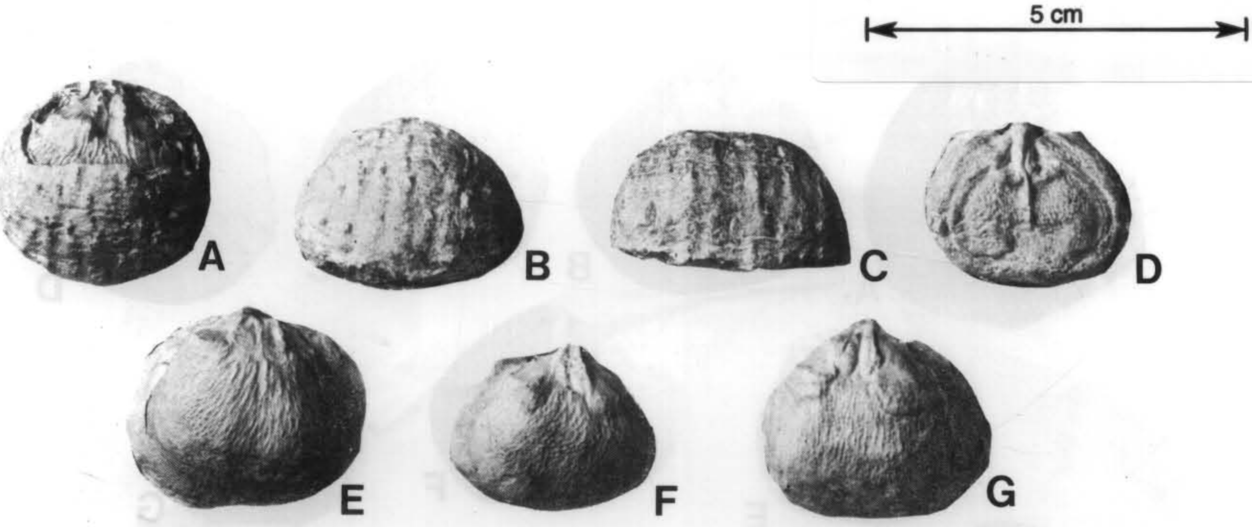

Figure 6. *Licharewiella apicallosa* (Clarke). **A, B,** ventral and antero–ventral views of ventral valve exterior with umbonal shell portions etched to show muscle platforms, GST 3554 (lectotype). **C,** antero–ventral view of ventral valve exterior GST 35117. **D,** dorsal valve interior GST 3555. **E–G,** ventral valve internal moulds GST 3558, GST 3557, GST 35113 (paratypes). All specimens from the Glencoe Formation, Golden Valley Group at Quamby Brook, Great Western Tiers.

and more deeply sunk into the floor of the valve. The brachial ridges, which originate at the extremities of the posterior adductor scars, are strongly descendent but do not show the strong anterior sigmoidal curvature typical of most strophalosiids.

REMARKS: *Licharewiella* is everywhere rare and is unique among strophalosiid genera in possessing spines on well developed costae. *Licharewiella apicallosa* is a subordinate species within a large, well preserved biocoenosis at Quamby Brook. It is known only from this locality. It is close externally to *Licharewiella argentea* (Waterhouse and Shah, 1966) from an unknown Permian horizon in Iran, but is considerably larger and lacks dorsal valve spines.

Order SPIRIFERIDA Waagen, 1883
Family SPIRIFERIDAE King, 1846

Genus **Trigonotreta** Koenig, 1825

TYPE SPECIES:. *Trigonotreta stokesi* Koenig, 1825 (by the subsequent designation of Buckman, 1908), from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, northern Tasmania at DQ770255.

Trigonotreta stokesi Koenig
(fig. 7A–H)

1979 *Trigonotreta stokesi* Koenig; Clarke, p. 199, pl. 1, fig. 1–9; pl. 2, fig. 1–9 (with synonymy).

1990 *Trigonotreta stokesi* Koenig; Clarke, p. 62, fig. 7A–H.

LECTOTYPE: British Museum (Natural History) B4798, a cast of a dorsal valve exterior and ventral umbo taken from an external mould in sandstone, almost certainly from the Swifts Jetty Sandstone, Masseys Creek Group at Middle Arm, near Beaconsfield, Tamar Valley, northern Tasmania (Clarke, 1979; Banks, 1991).

MATERIAL AND LOCALITIES: GST 368401–368402, complete shell and complete ventral valve respectively from the Glencoe Formation, Quamby Brook, Golden Valley area, Great Western Tiers at DP660730; fibreglass casts of GST 361116, a dorsal valve external mould and GST 368405, a ventral valve internal mould (topotypes); GST 14119–14120, ventral valve internal moulds from the Inglis Formation, Scolyers Hill, Hellyer Gorge at CQ640235, and the Bundella Formation, Wheatleys Bay, Cygnet at EN018168 respectively; GST 14121–14122, more or less complete ventral valves from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island at EN887855.

DESCRIPTION: Medium- to large-sized, impunctate and uniplicate shells of typical spiriferid form with essentially trifurcate fasciculate costae; delthyrial plate absent, but apex of delthyrium usually blocked by a bulbous callist; ventral valve interior with dental plates and supporting adminicula buried in thick posterolateral callus at maturity; ventral muscle platform long, narrow, almost parallel-sided, and frequently notched posteriorly by small blunt median septum; dorsal valve without adminicula.

REMARKS: This species was re-established and described in detail by Clarke (1979). It occurs in profusion throughout the Tamarian Stage. It is a distinctive yet variable species. Large populations which are available from most Tasmanian localities contain more equidimensional forms which are sometimes more finely fasciculate (fig. 7E) or more coarsely fasciculate (fig. 7F). These morphologies grade continuously with the more transverse modal form and never comprise more than about 5% of a population. *Trigonotreta hobartensis* (Brown, 1953) from the younger Berriedale Limestone is readily distinguished by its coarser fasciculations, more pronounced fastigium and sulcus and its short and wide ventral muscle platform. *Brachythyrinella* cf. *narsarhensis* (Reed) of Waterhouse and Gupta, 1978, pl. 4, fig. 5 from the Bijni Tectonic Unit, Garhwal Himalaya, with its massive posterolateral ventral thickening and narrow, elongate muscle field is typical *Trigonotreta stokesi*. *Trigonotreta narsarhensis* (Reed) *occidentalis* Thomas, 1971, which is referred to *Brachythyrinella occidentalis* (Thomas) by Archbold (1982), is identical with small, less thickened growth stages of Tasmanian populations of *Trigonotreta stokesi*, but the name may serve to distinguish small populations of ?immature individuals. Archbold (1991) now considers this species to be synonymous with *stokesi*. *Trigonotreta narsarhensis* (Reed) *occidentalis* Thomas, 1969, from Coimadai Creek in Victoria which is generally close to *stokesi*, is referred to the new species *Trigonotreta victoriae* (Archbold, 1991).

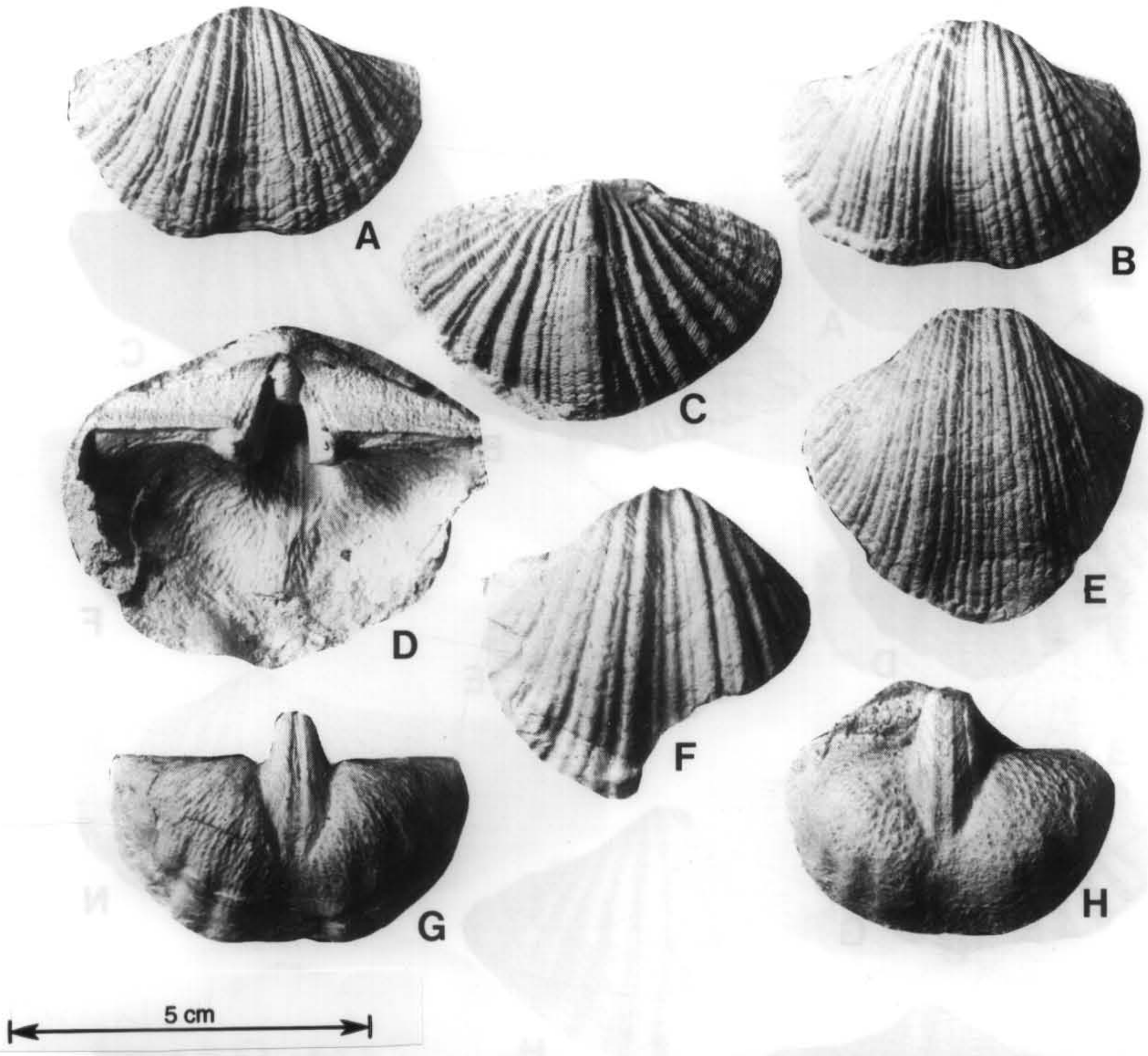

Figure 7. *Trigonotreta stokesi* Koenig. **A, B, E, F,** ventral valve exteriors GST 368401, GST 368402, GST 14122, GST 14121. **C,** latex cast of dorsal valve exterior GST 361116. **D,** latex cast of ventral valve interior showing the bulbous delthyrial callist GST 368405. **G, H,** ventral valve internal moulds GST 14119, GST 14120. **A, B,** from the Glencoe Formation, Golden Valley Group at Quamby Brook, Great Western Tiers. **C, D,** from the Swifts Jetty Sandstone, Masseys Creek Group at Middle Arm, Beaconsfield (topotypes). **E, F,** from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island. **D,** from the Inglis Formation, Scolyers Hill, Hellyer Gorge area. **H,** from the basal Bundella Formation, Wheatleys Bay, Cygnet.

Genus **Sulciplica** Waterhouse, 1968

TYPE SPECIES: *Sulciplica transversa* Waterhouse, 1968 [= *Spirifer vespertilio* Dana, 1849 non G. B. Sowerby, 1844, from the Gerringong Volcanics, Black Head, Gerroa, New South Wales (by original designation).

Sulciplica crassa Clarke
(fig. 8A–N)

1990 *Sulciplica crassa* Clarke, p. 64, fig. 8A–N

HOLOTYPE: GST 14127, a more or less complete ventral valve from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island at EN887855.

MATERIAL AND LOCALITY: GST 14123–14126, GST 14128–141233, more or less complete ventral valves; GST 14134–14135, conjoined but incomplete valves; GST 14136, incomplete ventral valve showing internal features. All paratypes, from the type locality.

DESCRIPTION: Medium-sized, moderately transverse shells of typical spiriferid form with multiplicate fastigia and sulci; six or seven coarse, simple plications on each flank of both valves; cardinal lateral margins typically subrounded, rarely produced; concentric growth lamellae prominent and crossed by fine radial lirae; posterolateral regions of ventral valve, on either side of narrow, elongate muscle platform, very heavily thickened by callus; delthyrial plate absent but apex of delthyrium with a large bulbous callist; shell substance impunctate.

REMARKS: *Sulciplica crassa* occurs in profusion at the type locality. It also occurs at correlative horizons such as the Billop Sandstone, Golden Valley Group at Golden Valley, Poatina and Lake River, in the Swifts Jetty Sandstone, Masseys Creek Group at Beaconsfield, at Forestier Peninsula, and in the upper Bundella Formation in the Snug–Margate area, south-eastern Tasmania. All these occurrences are in rocks of Late Tamarian age, but the species also occurs in younger Bernacchian rocks. It is readily distinguished from *Sulciplica transversa* by its smaller size and less transverse outline. *Sulciplica stutchburii* auctt. is more equidimensional and has stronger and few lateral plications. *Sulciplica tasmaniensis* (Morris, 1845) is less transverse, has

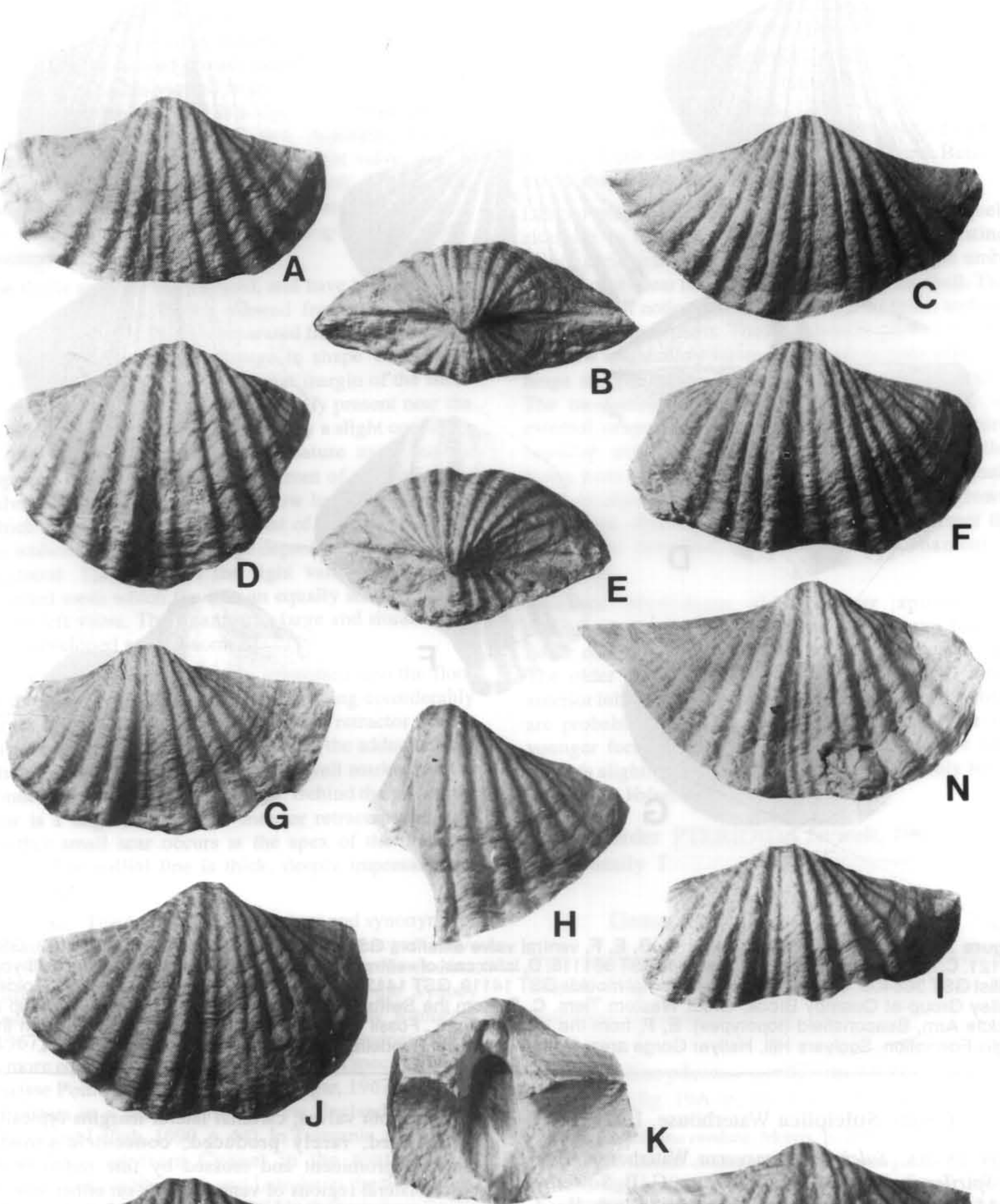

Figure 8. *Sulciplica crassa* Clarke. **A, C, D, F–J, L–N,** ventral valve exteriors GST 14127 (holotype), GST 14123, GST 14125, GST 14124, GST 14128, GST 14132, GST 14131, GST 14130, GST 14133 GST 14129, GST 14126. **B, E,** posterior views of more or less complete conjoined valves GST 14134-5. **K,** interior of ventral valve showing bulbous delthyrial callist GST 14136 (paratypes). All specimens from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island.

5 cm

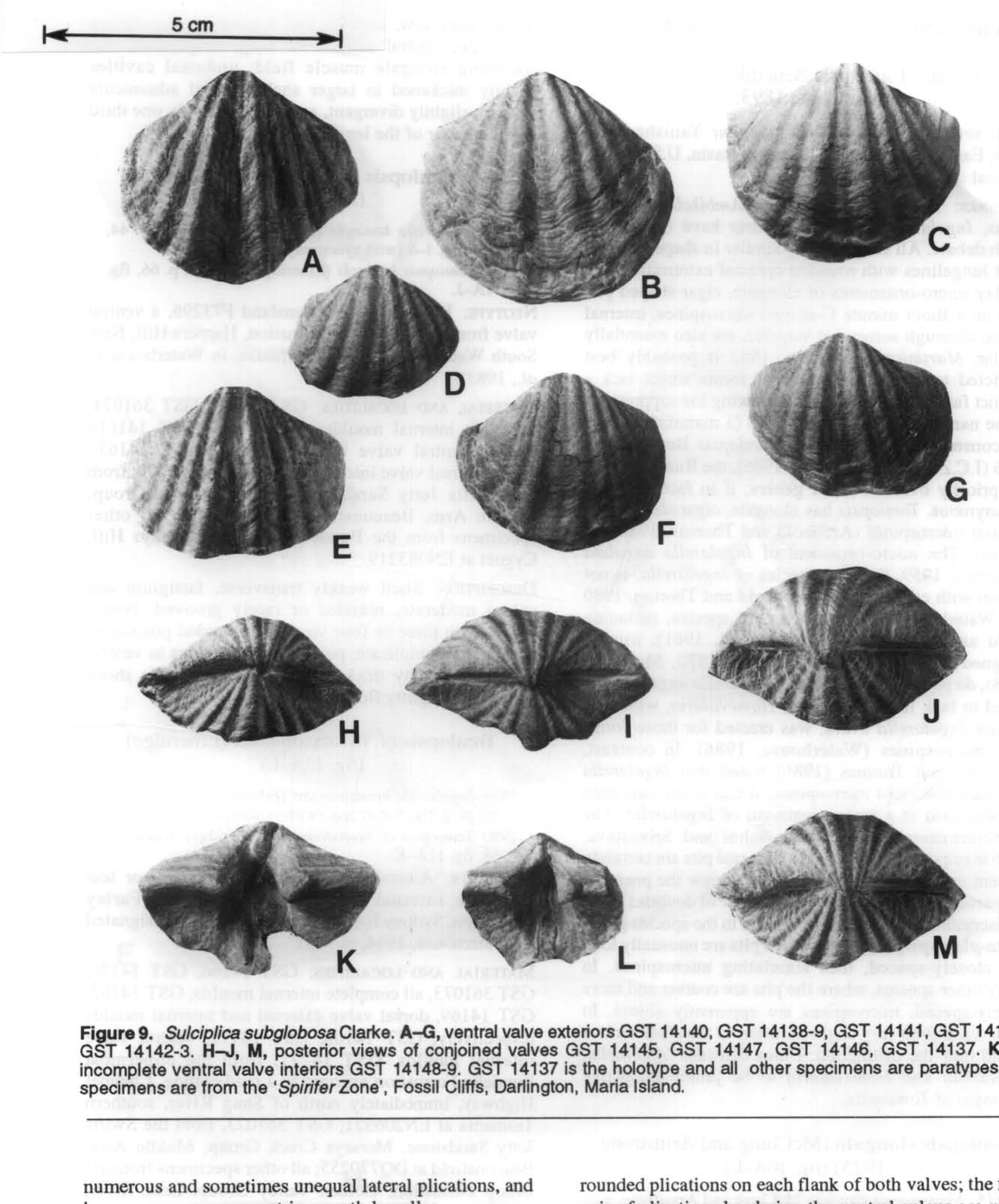

Figure 9. *Sulciplica subglobosa* Clarke. A–G, ventral valve exteriors GST 14140, GST 14138-9, GST 14141, GST 14144, GST 14142-3. H–J, M, posterior views of conjoined valves GST 14145, GST 14147, GST 14146, GST 14137. K, L, incomplete ventral valve interiors GST 14148-9. GST 14137 is the holotype and all other specimens are paratypes. All specimens are from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island.

numerous and sometimes unequal lateral plications, and has very coarse, concentric growth lamellae.

Sulciplica subglobosa Clarke
(fig. 9A–M)

1990 *Sulciplica subglobosa* Clarke, p. 64, fig. 9A–M.

HOLOTYPE: GST 14137, a more or less complete shell from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island at EN887855.

MATERIAL AND LOCALITY: GST 14138–14144, ventral valves; GST 14145–14147, more or less complete conjoined shells; GST 14148–14149, incomplete ventral valves showing delthyrial characters. All paratypes, from the type locality.

DESCRIPTION: Small- to medium-sized, equidimensional, subglobose shells with four or five prominent, rounded plications on each flank of both valves; the first pair of plications bordering the ventral sulcus are more prominent than the remainder; sulcus with a weak median plication, fastigium bold; concentric growth lamellae well developed, but radial lirae not observed; posterolateral regions of ventral valve heavily thickened by callus on either side of short muscle platform; delthyrial plate absent, but apex of delthyrium with bulbous callist; shell substance impunctate.

REMARKS: This characteristic species is only known from the type locality. *Sulciplica stutchburii* auctt. is similar in shape, but has much more angular lateral plications and a multiplicate fastigium and sulcus. *Sulciplica subglobosa* is superficially brachythyrid in morphology, but the hingeline is the widest part of the shell and the ventral valve is heavily thickened as in other species of *Sulciplica*.

Family INGELARELLIDAE Campbell, 1959

Genus **Tomiopsis** Benediktova, 1956 non Cope, 1893.

TYPE SPECIES: *Brachythyris kumpani* Yanishevskiy, 1935, Early Carboniferous, Kuznetz Basin, U.S.S.R (by original designation).

REMARKS: The genera *Tomiopsis, Ambikella, Martiniopsis, Ingelarella* and *Homevalaria* have occasioned much debate. All are generally similar in shape, possess short hingelines with rounded cardinal extremities, and display micro-ornaments of elongate, cigar-shaped pits with or without minute C-shaped microspines; internal plates, although somewhat variable, are also essentially similar. *Martiniopsis* Waagen, 1883 is probably best restricted to smaller, warm-water forms which lack a distinct fastigium and sulcus. Following the suppression of the name *Tomiopsis* Cope, 1893 (a mammalian) and the conservation of the name *Tomiopsis* Benediktova, 1956 (I.C.Z.N. Opinion, 1395, 1986), the Russian genus has priority over the other genera, if in fact, they are synonymous. *Tomiopsis* has elongate, cigar-shaped pits without microspines (Archbold and Thomas, 1986 and herein). The micro-ornament of *Ingelarella angulata* Campbell, 1959, the type species of *Ingelarella*, is not known with certainty (see Archbold and Thomas, 1986 and Waterhouse, 1986), but several species, including *ovata* and *profunda* (both Campbell, 1961), usually assigned to *Ingelarella* (Armstrong, 1970; McClung, 1978), do possess microspines. *Ingelarella angulata* was stated to lack microspines and *Homevalaria*, with type species *Ingelarella ovata*, was erected for those forms with microspines (Waterhouse, 1986). In contrast, Archbold and Thomas (1986) stated that *Ingelarella angulata* possesses microspines; if this is the case then *Homevalaria* is a junior synonym of *Ingelarella*. The micro-ornament of *Ambikella* Sahni and Srivastava, 1956 is imperfectly known but elongate pits are certainly present as in the other genera. In my view the presence or absence of microspines is a character of doubtful value in discriminating the various genera. In the species group *ovata-plana-profunda* the surface pits are unusually long and closely-spaced, thus simulating microspines. In many other species, where the pits are coarser and more widely-spaced, microspines are apparently absent. In either case even very slight abrasion of the shell surface would blur the distinction. I thus consider *Ambikella, Ingelarella* and *Homevalaria* to be junior subjective synonym of *Tomiopsis.*

Tomiopsis elongata (McClung and Armstrong, 1975) (fig. 10A–L)

1975 Martiniopsis elongata McClung and Armstrong, p. 231–232, fig. 1a–j.

1978 *Ingelarella elongata* (McClung and Armstrong); McClung, p. 46, pl. 2, fig. 1–2; pl. 3, fig. 7–11.

1990 *Tomiopsis elongata* (McClung and Armstrong); Clarke, p. 64, fig. 10A–L.

HOLOTYPE: University of New England, Armidale F13017, a complete internal mould from the Beckers Formation, Cranky Corner Basin, New South Wales.

MATERIAL AND LOCALITIES: GST 14150–14153, more or less complete internal moulds from the basal Bundella Formation, Wheatleys Bay, Cygnet at EN018168; GST 14154–14158, ventral valve internal moulds from the Inglis Formation, Scolyers Hill, Hellyer Gorge at CQ640235.

DESCRIPTION: Small- to medium-sized, generally smooth species with a weakly transverse outline; fastigium and sulcus very low, smooth and rounded, commissure uniplicate; ventral adminicula long, subparallel, and enclosing elongate muscle field; umbonal cavities slightly thickened in larger shells; dorsal adminicula straight, slightly divergent, and approximately one third to one quarter of the length of the valve.

Tomiopsis konincki (Etheridge) (fig. 11A–J)

1978 *Ingelarella konincki* (Etheridge); McClung, p. 44, pl. 3, fig. 1–6 (with synonymy)

1990 *Tomiopsis konincki* (Etheridge); Clarke, p. 66, fig. 11A–J.

NEOTYPE: University of Queensland F73296, a ventral valve from the Allandale Formation, Harpers Hill, New South Wales (chosen by Waterhouse, *in* Waterhouse *et al.*, 1983).

MATERIAL AND LOCALITIES: GST 14160. GST 361074, complete internal moulds; GST 14159, GST 14161–14162, ventral valve internal moulds; GST 14163–14165, dorsal valve internal moulds. GST 361074, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield at DQ770255; all other specimens from the Bundella Formation, Tobys Hill, Cygnet at EN083219.

DESCRIPTION: Shell weakly transverse, fastigium and sulcus moderate, rounded or rarely grooved; lateral slopes with three or four very low, rounded plications; commissure uniplicate; posterolateral regions in ventral valve moderately thickened; dorsal adminicula short, sometimes slightly flexed.

Tomiopsis cf. **branxtonensis** (Etheridge) (fig. 12A–L)

1978 *Ingelarella branxtonensis* (Etheridge); McClung, p. 45, pl. 2, fig. 5–6 *et seq.* (with synonymy)

1990 *Tomiopsis* cf. *branxtonensis* (Etheridge); Clarke, p. 68, fig. 12A–K.

LECTOTYPE: Australian Museum F.22, a more or less complete internal mould from the lower Farley Formation, Sydney Basin, New South Wales (designated by Waterhouse, 1964, p. 165).

MATERIAL AND LOCALITIES: GST 14166, GST 14170, GST 361073, all complete internal moulds; GST 14167, GST 14169, dorsal valve external and internal moulds respectively; GST 14168, GST 14171, ventral valve internal moulds. GST 14171, from the uppermost Bundella Formation exposed in a road cutting, Channel Highway, immediately north of Snug River, southern Tasmania at EN206321; GST 361073, from the Swifts Jetty Sandstone, Merseys Creek Group, Middle Arm, Beaconsfield at DQ770255; all other specimens from the Billop Formation, Golden Valley Group, Lake River, Great Western Tiers at EP168585.

DESCRIPTION: Shell small- to medium-sized, moderately transverse, with a moderately high and rounded fastigium and sulcus; three to five rounded lateral plications on each flank of both valves; commissure uniplicate or weakly parasulcate; ventral valve interior generally similar to that of *Tomiopsis konincki* but usually more thickened posteriorly; dorsal adminicula short, usually straight and divergent, rarely flexed; low myophragm occupies posterior half of valve.

REMARKS: As documented by McClung (1978) the *Tomiopsis elongata–konincki–branxtonensis* species group forms a continuous evolutionary sequence of morphological change in which the principal trends are towards stronger lateral plications, increased inflation of the valves with an associated increase in the height of

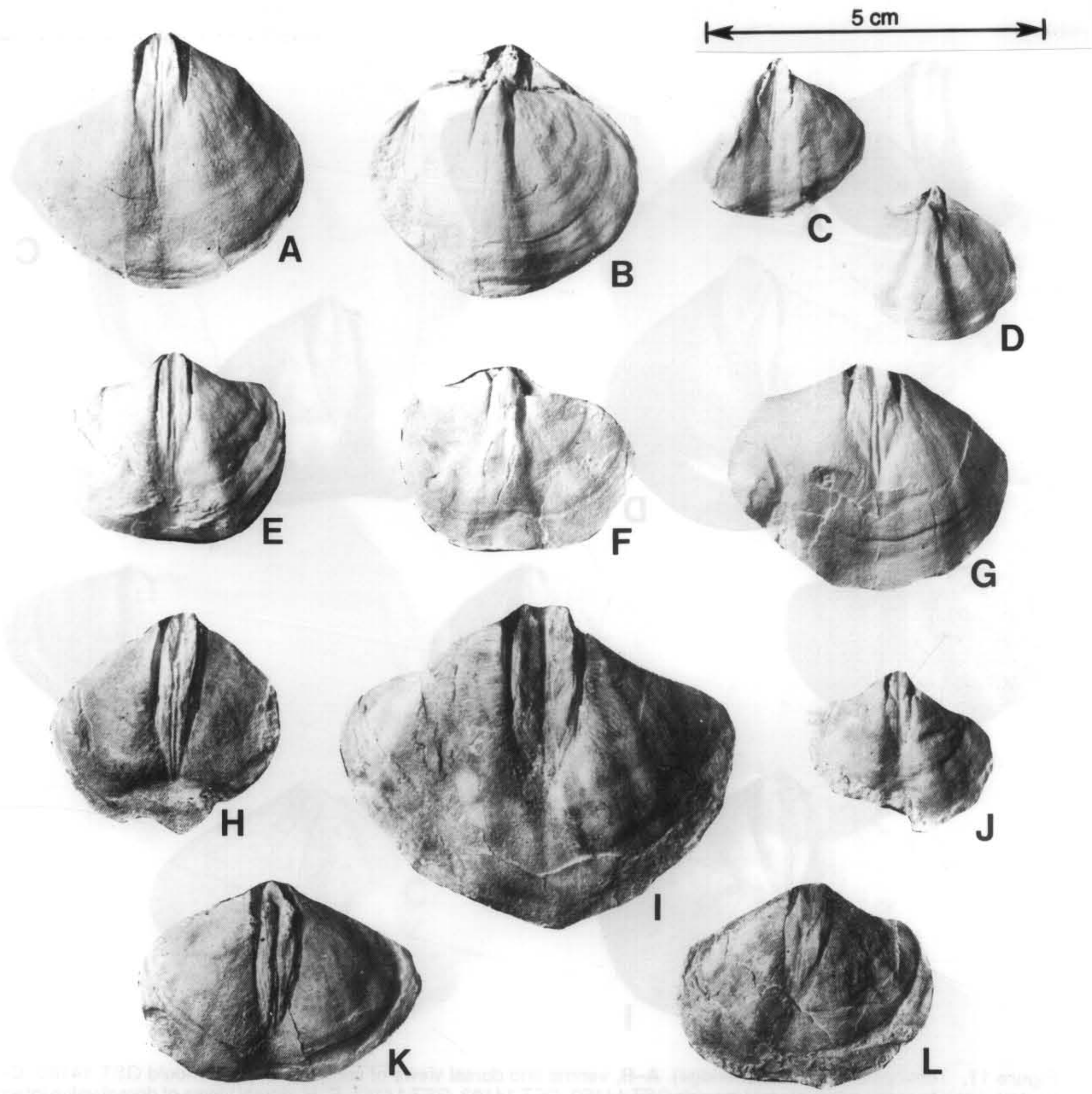

Figure 10. *Tomiopsis elongata* (McClung and Armstrong). **A–B, C–D, E–F,** ventral and dorsal views of complete internal moulds GST 14151, GST 14150, GST 14153. **G,** ventral view of complete internal mould GST 14152. **H–L,** ventral views of ventral valve internal moulds GST 14154-8. **A–G,** from the basal Bundella Formation, Wheatleys Bay, Cygnet. **H–L,** from the Inglis Formation, Scolyers Hill, Hellyer Gorge area.

the fastigium and sulcus, increased posterolateral thickening in the ventral valve, a less elongate ventral muscle field and shorter dorsal adminicula. Intermediate forms occur but identification is usually possible if sufficiently large collections are available. Microornament within the species group is consistently of narrow, elongate, cigar-shaped pits without spines (fig. 12L) and as illustrated for the Western Australian species figured by Archbold and Thomas (1986). The pits in *branxtonensis* are rather more elongate than those in *elongata* and *konincki.*

Tomiopsis elongata characterises rocks of Early Tamarian age but ranges above the last recorded occurrences of *Grumantia costellata* in most sections, and is replaced by *Tomiopsis konincki* which ranges throughout most of the Middle and Late Tamarian. In rocks of Late Tamarian age *Tomiopsis* cf. *branxtonensis* makes its first appearance, but it is always subordinate in numbers; *branxtonensis* s.s. characterises rocks of earliest Bernacchian age in association with *Cancrinella farleyensis* (Etheridge and Dun) and others.

Specimens from the Tiverton Subgroup in Queensland assigned to *elongata* and *konincki* (Waterhouse, *in* Waterhouse *et al.*, 1983) are misidentified; the former most closely resemble *branxtonensis*, and the latter is probably *Notospirifer* or a related genus.

Genus **Kelsovia** Clarke, 1990

TYPE SPECIES: *Kelsovia superba* Clarke, 1990, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, Tamar Valley at DQ770255.

Kelsovia superba Clarke
(fig. 13A-N)

1990 *Kelsovia superba* Clarke, p. 70, fig. 13A–N.

HOLOTYPE: GST 361234, GST 361168, counterpart external and internal moulds of a dorsal valve from the

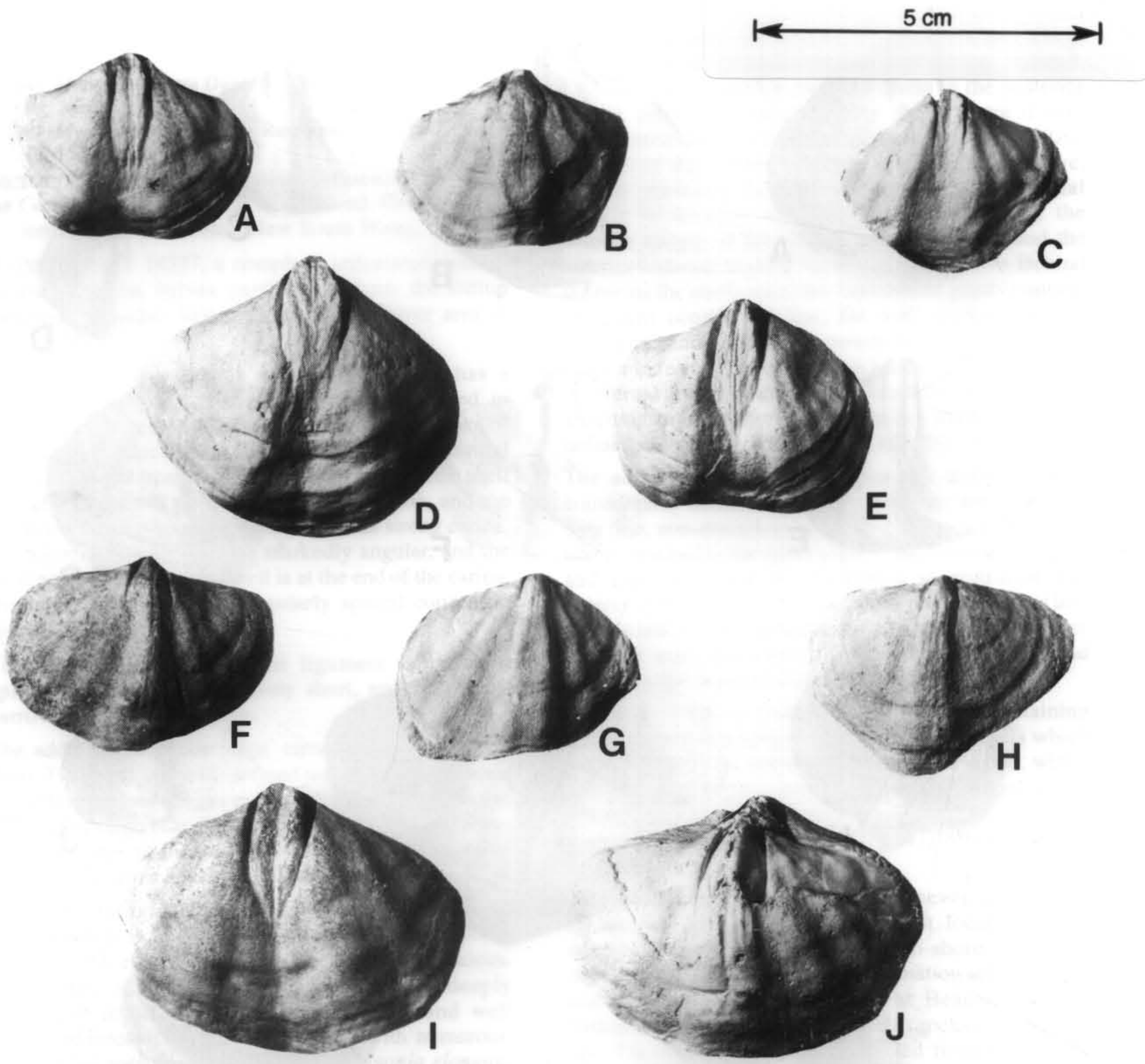

Figure 11. *Tomiopsis konincki* (Etheridge). **A–B,** ventral and dorsal views of complete internal mould GST 14160. **C–E,** ventral view of ventral valve internal moulds GST 14159, GST 14162, GST 14161. **F–H,** dorsal views of dorsal valve internal moulds GST 14165, GST 14163-4. **I–J,** ventral and dorsal views of complete internal mould GST 361074. **I–J,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield; all other specimens from the Bundella Formation, Tobys Hill, Cygnet.

Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, northern Tasmania.

MATERIAL AND LOCALITIES: GST 361239, GST 361236, counterpart external and internal moulds of a dorsal valve; GST 361090, GST 361085, complete internal moulds (all paratypes from the type locality). GST 14173, a more or less complete ventral valve; GST 14172, a complete internal mould; GST 14174 and GST 14175, complete internal ventral and dorsal valve moulds respectively, from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island at EN887855.

DESCRIPTION: Small- to medium-sized shells of typically notospiriferid form; fastigium and sulcus well developed, smooth, flattened or very weakly grooved, flaring anteriorly; lateral slopes with three or four well developed, evenly round plications on each flank; ventral interior with well developed dental plates and supporting adminicula, little or no posterolateral thickening in most specimens; dorsal interior with short, flexed adminicula which commence outside the first lateral plications but curve back anteriorly to finish within the first lateral interspaces; cardinal process striate with about fifteen lamellae, and a low median myophragm occupies the posterior half of the valve; micro-ornament of elongate, barchan-shaped microspines behind shallow, elongate grooves.

REMARKS: *Kelsovia* is morphologically close to both *Notospirifer* Harrington, 1955, and *Birchsella* Clarke, 1987. It differs from *Notospirifer* in possessing dorsal adminicula and lacks the deep, globose surface pits of that genus. *Birchsella* lacks dorsal adminicula, has very heavy posterolateral thickening in the ventral valve, and its microspines are shorter and more upright (Clarke, 1991). *Kelsovia* and *Glendonia* McClung and Armstrong, 1978 possess almost identical micro-ornaments, but *Glendonia* has much stronger and more angular lateral plications, and possesses a well marked median plication in both the fastigium and sulcus.

Kelsovia superba is never a common species and is known only from the type locality at Beaconsfield, and from Maria Island and the Snug–Margate area, south-eastern Tasmania, in rocks of Late Tamarian age.

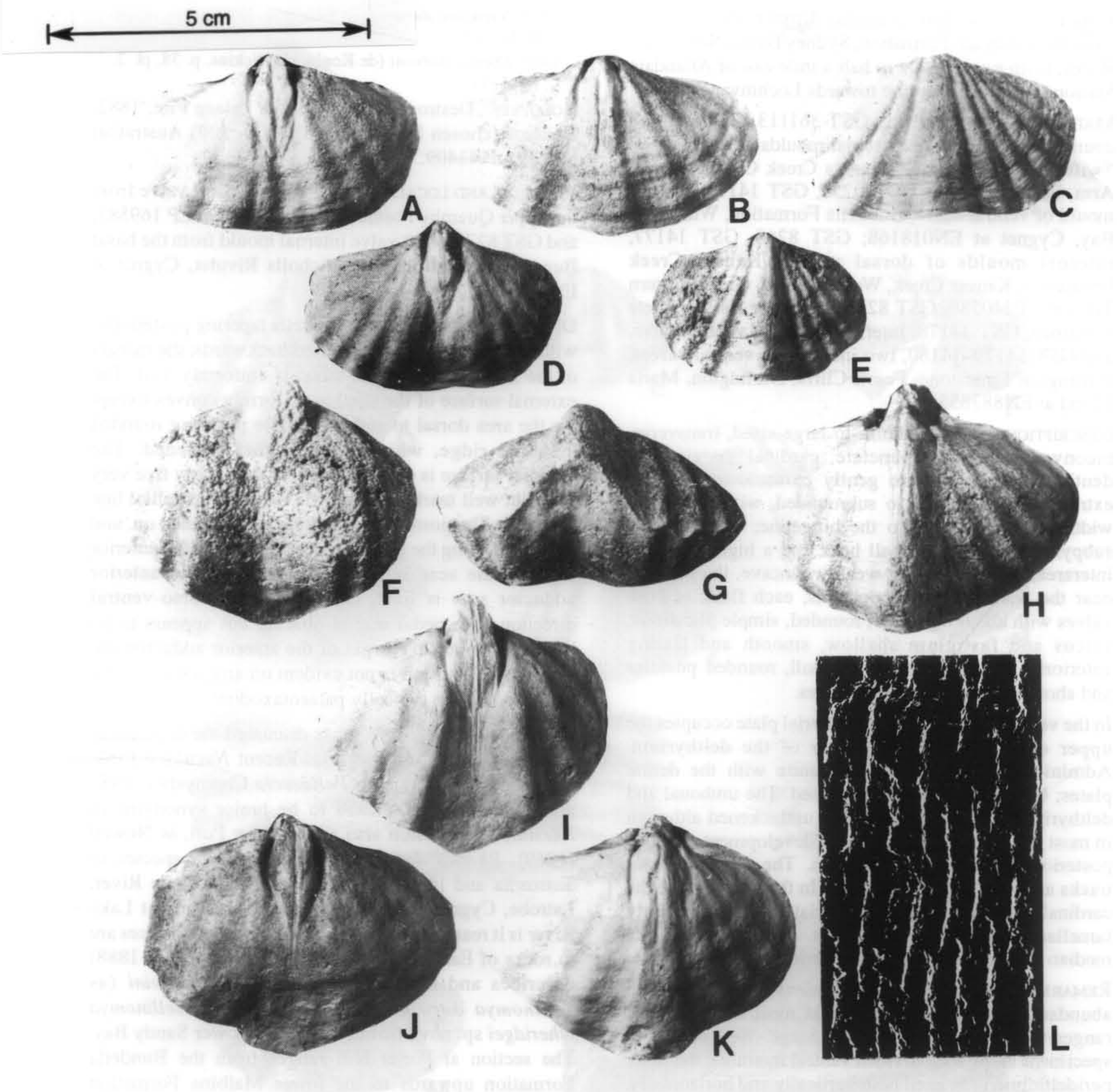

Figure 12. *Tomiopsis* cf. *branxtonensis* (Etheridge). **A–B,** ventral and dorsal views of complete internal mould GST 14166. **C,** latex cast of dorsal valve exterior GST 14167. **D,** ventral view of ventral internal mould GST 14168. **E,** dorsal view of dorsal valve internal mould GST 14169. **F–H,** ventral, anterior and dorsal views of complete internal mould GST 14170. **I,** ventral view of ventral valve internal mould GST 14171. **J–K,** ventral and dorsal views of complete internal mould GST 361073. **L,** scanning electron micrograph of micro-ornament of GST 14167 × 50. **I,** from the uppermost Bundella Formation, road cutting, Channel Highway immediately north of Snug River. **J, K,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. All other specimens from the Billop Formation, Golden Valley Group, Lake River, Great Western Tiers.

It appears to be similarly rare throughout eastern Australia. A younger species *Notospirifer*? sp.nov. McClung and Armstrong, 1978, from the Cattle Creek Shale, Queensland belongs in *Kelsovia*, but is smaller, has fewer lateral plications, and shorter dorsal adminicula. *Notospirifer undulatus* Parfrey, 1986 from the Camboon Andesite is possibly related. This species is larger and carries more lateral plications. A confident generic assignment must await the discovery of material showing the details of the micro-ornament. Parfrey records the presence of fine, closely-spaced, shallow linear pits 'with some evidence of crescent-shaped spines behind them', but she makes no mention of the deep globose pits which are typical of true *Notospirifer*.

Family SYRINGOTHYRIDIDAE Fredericks, 1926

Genus **Pseudosyrinx** Weller, 1914

TYPE SPECIES: *Pseudosyrinx missouriensis* Weller, 1914, from the Mississippian of North America (by original designation).

Pseudosyrinx allandalensis Armstrong (fig. 14A–H)

1970 *Pseudosyrinx allandalensis* Armstrong, p. 140, pl. 1, fig. 1–7.

1990 *Pseudosyrinx allandalensis* Armstrong; Clarke, p. 72, fig. 14A–H.

HOLOTYPE: Australian National University F 17766, from the Allandale Formation, Sydney Basin, New South Wales, from a cutting about half a mile east of Allandale Station on the railway line towards Lochinvar Station.

MATERIAL AND LOCALITIES: GST 361113, GST 361084, counterpart external and internal moulds of both valves, Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield at DQ770255; GST 14176, internal mould of ventral valve, Bundella Formation, Wheatleys Bay, Cygnet at EN018168; GST 8268, GST 14177, internal moulds of dorsal valves, Kansas Creek Formation, Kansas Creek, Western Bluff, Great Western Tiers at DP240780; GST 8275, a more or less complete specimen, GST 14178, internal mould of ventral valve, and GST 14179–14180, two incomplete ventral valves, Darlington Limestone, Fossil Cliffs, Darlington, Maria Island at EN887855.

DESCRIPTION: Shell medium- to large-sized, transverse, biconvex and finely punctate; cardinal margins not denticulate; commissure gently parasulcate; cardinal extremities subangular to subrounded, with maximum width a little anterior to the hingeline; ventral valve subpyramidal, with a small beak and a high, catacline interarea; interarea flat or weakly concave, the more so near the beak in some specimens; each flank of both valves with about eight low, rounded, simple plications; sulcus and fastigium shallow, smooth and flaring anteriorly; micro-ornament of small, rounded pustules and short, radially elongate grooves.

In the ventral valve a curved delthyrial plate occupies the upper one third to one quarter of the delthyrium. Adminicula are divergent and unite with the dental plates; both are massively thickened. The umbonal and delthyrial cavities are essentially unthickened although in most specimens there is a small development of callus posterior to the muscle platform. The outer diductor tracks are often radially grooved. In the dorsal valve the cardinal process is wide and striate, with over thirty lamellae. Adminicula are absent. A thin, thread-like median septum occupies the posterior half of the valve.

REMARKS: *Pseudosyrinx allandalensis* is never an abundant species but it occurs at most localities and ranges throughout the Tamarian Stage. Well preserved specimens show a subdivided ventral interarea; the inner perideltidium is striated both vertically and horizontally, whereas the outer interarea has only horizontal striations.

Phylum MOLLUSCA Linné, 1758
Class BIVALVIA Linné, 1758
Subclass PALAEOTAXODONTA Korobkov, 1954
Order NUCULOIDA Dall, 1889
Family NUCULANIDAE Adams and Adams, 1856

Genus **Phestia** Chernyshev, 1951

TYPE SPECIES: *Leda inflatiformis* Chernyshev, 1939 (by original designation).

Phestia darwini (de Koninck)
(fig. 24J–K)

1877 *Tellinomya darwini* de Koninck, p. 147, pl. 16, fig. 9.

1887? *Tellinomya etheridgei* Johnston, p. 17, unfigured.

1888? *Tellinomya darwini* de Koninck; Johnston, pl. XV, fig. 12.

1888? *Tellinomya etheridgei* Johnston, pl. XV, fig. 14.

1945 *Nuculana darwini* (de Koninck); Fletcher, p. 306, pl. 21, fig. 1–2; pl. 22, fig. 1–2.

1957 *Nuculana darwini* (de Koninck); Dickins, p. 18, pl. II, fig. 1–6.

1963 *Phestia darwini* (de Koninck); Dickins, p. 38, pl. 2, fig. 4–11.

HOLOTYPE: Destroyed in the Garden Palace Fire, 1882. Neotype (chosen by Fletcher, 1945, p. 306) Australian Museum F 41409.

MATERIAL AND LOCALITIES: GST 8269, a left valve from the upper Quamby Formation, Lake River at EP 169587, and GST 8270, a left valve internal mould from the basal Bundella Formation, near Nicholls Rivulet, Cygnet at EN127196.

DESCRIPTION: Small elongate shells tapering posteriorly, with low, blunt umbones directed backwards; the margin of the shell in front of the umbo is uniformly oval. The external surface of the shell is uniformly convex except for the area dorsal to and behind the posterior rounded umbonal ridge, which is somewhat flattened. The external surface is covered by more than thirty five very fine, but well marked concentric ridges. The pallial line is simple. The posterior adductor scar is situated on, and elongated along the posterior umbonal ridge; the anterior edge of the scar is deeply impressed. The anterior adductor scar is oval, elongated in a dorso-ventral direction. The pedal scar is obscure but appears to lie between the dorsal margin of the anterior adductor and the umbo. Dentition is not evident on any specimen but is assumed to be typically palaeotaxodont.

REMARKS: Dickins (1963) has discussed the differences between *Phestia* and the Trias-Recent *Nuculana* Link, 1807, and considers both *Polidevcia* Chernyshev, 1951 and *Culunana* Lintz, 1958 to be junior synonyms of *Phestia*, a conclusion also accepted by Puri, *in* Newell (1969). *Phestia darwini* is usually a rare species in Tasmania and is known to me only from Lake River, Latrobe, Cygnet and Satellite Island; and only at Lake River is it reasonably common. All these occurrences are in rocks of Early Tamarian age. Johnston (1887; 1888) describes and figures probable *Phestia darwini* (as *Tellinomya darwini* de Koninck and *Tellinomya etheridgei* sp. nov.) from Porter Hill, Lower Sandy Bay. The section at Porter Hill ranges from the Bundella Formation upwards to the lower Malbina Formation (Clarke, 1985). The specimens may have come from the Nassau Formation but the material is lost. Both of Johnston's illustrations fall within the range of variation of *Phestia darwini* as figured by Dickins (1957), but *Tellinomya etheridgei* is closer to the more elongate specimens figured herein. *Phestia darwini* is known from the upper Lyons Group, Carnarvon Basin (Dickins, 1957) and from younger horizons in Western Australia (Dickins, 1963). It is also known from the Branxton Subgroup (Lymingtonian) in the Hunter Valley, Sydney Basin, New South Wales (Fletcher, 1945).

Subclass ANOMALODESMATA Dall, 1889
Order PHOLADOMYOIDA Newell, 1965
Family MEGADESMIDAE Vokes, 1967

Genus **Megadesmus** J. Sowerby, 1838

SYNONYMS: Objective synonym *Pachydomus* Morris, 1845. Subjective synonyms *Cleobis* Dana, 1847, and *Globicarina* Waterhouse, 1965.

TYPE SPECIES: *Megadesmus globosus* J. Sowerby, 1838 (subsequent designation of Woodward, 1854, p. 262).

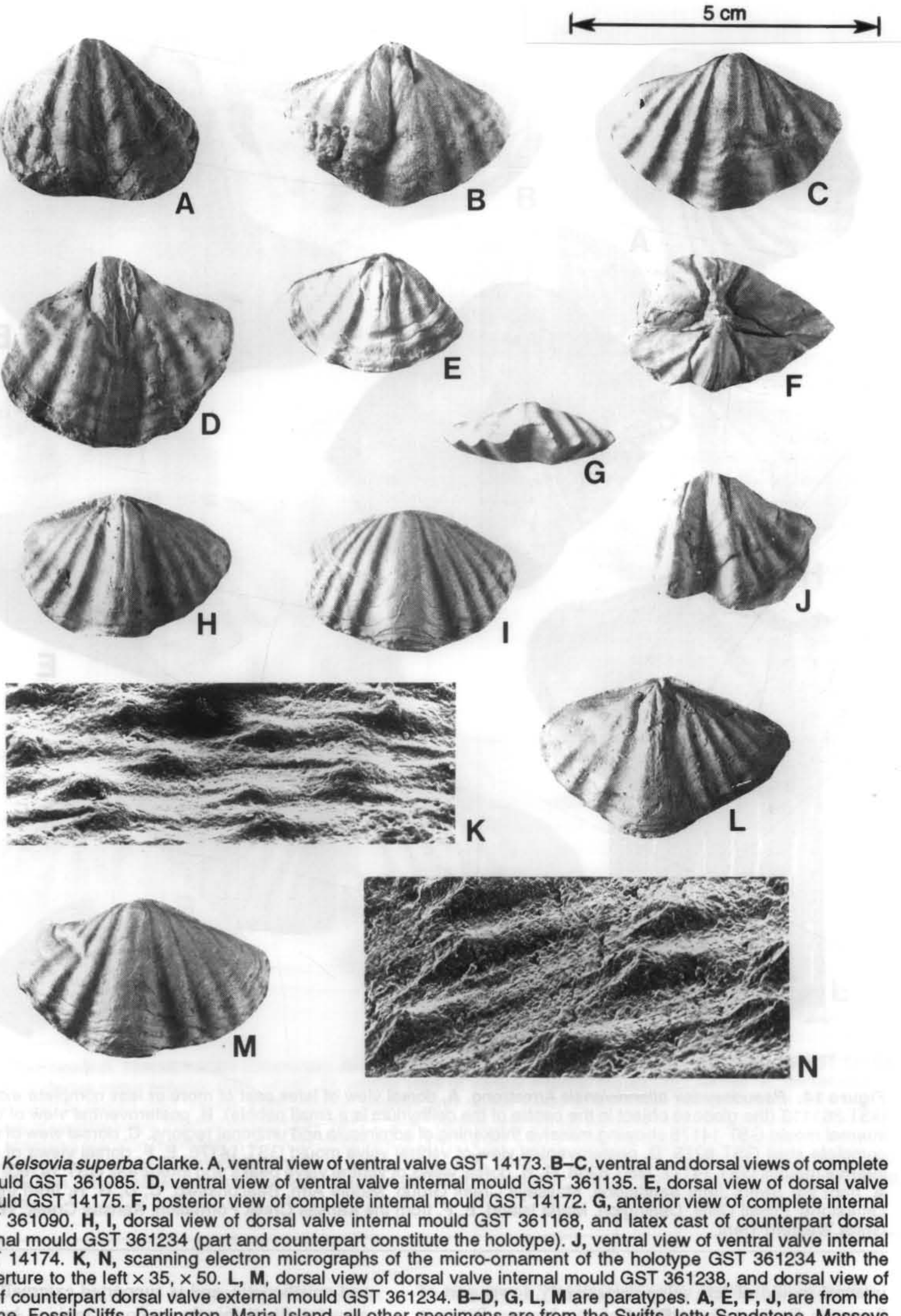

Figure 13. *Kelsovia superba* Clarke. A, ventral view of ventral valve GST 14173. **B–C**, ventral and dorsal views of complete internal mould GST 361085. **D**, ventral view of ventral valve internal mould GST 361135. **E**, dorsal view of dorsal valve internal mould GST 14175. **F**, posterior view of complete internal mould GST 14172. **G**, anterior view of complete internal mould GST 361090. **H, I**, dorsal view of dorsal valve internal mould GST 361168, and latex cast of counterpart dorsal valve external mould GST 361234 (part and counterpart constitute the holotype). **J**, ventral view of ventral valve internal mould GST 14174. **K, N**, scanning electron micrographs of the micro-ornament of the holotype GST 361234 with the anterior aperture to the left × 35, × 50. **L, M**, dorsal view of dorsal valve internal mould GST 361238, and dorsal view of latex cast of counterpart dorsal valve external mould GST 361234. **B–D, G, L, M** are paratypes. **A, E, F, J**, are from the '*Spirifer* Zone, Fossil Cliffs, Darlington, Maria Island, all other specimens are from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield.

Megadesmus pristinus Runnegar
(fig. 15A-F)

1972 *Megadesmus pristinus* Runnegar, p. 310, pl. 1, fig. 1–6.

HOLOTYPE: University of New England, Armidale F 12533, with paratypes University of New England F 12534–12536 and University of Queensland F 38609 and F 38612. The holotype and paratypes F 12534–121536 are from the top of the Seaham Formation in the Cranky Corner Syncline, north Sydney Basin; the other paratypes are from the Youlambie Conglomerate (Dear, 1968), Yarrol area, Queensland.

MATERIAL AND LOCALITIES: GST 14328, external mould of right valve from *Tasmanites* Shale, Great Bend of the Mersey River at DQ390175; GST 14329, external mould of right valve from Masseys Creek Group, Port Sorell at DQ650587; GST 441492, GST 441334 and GST 441496, two internal moulds of right valves and

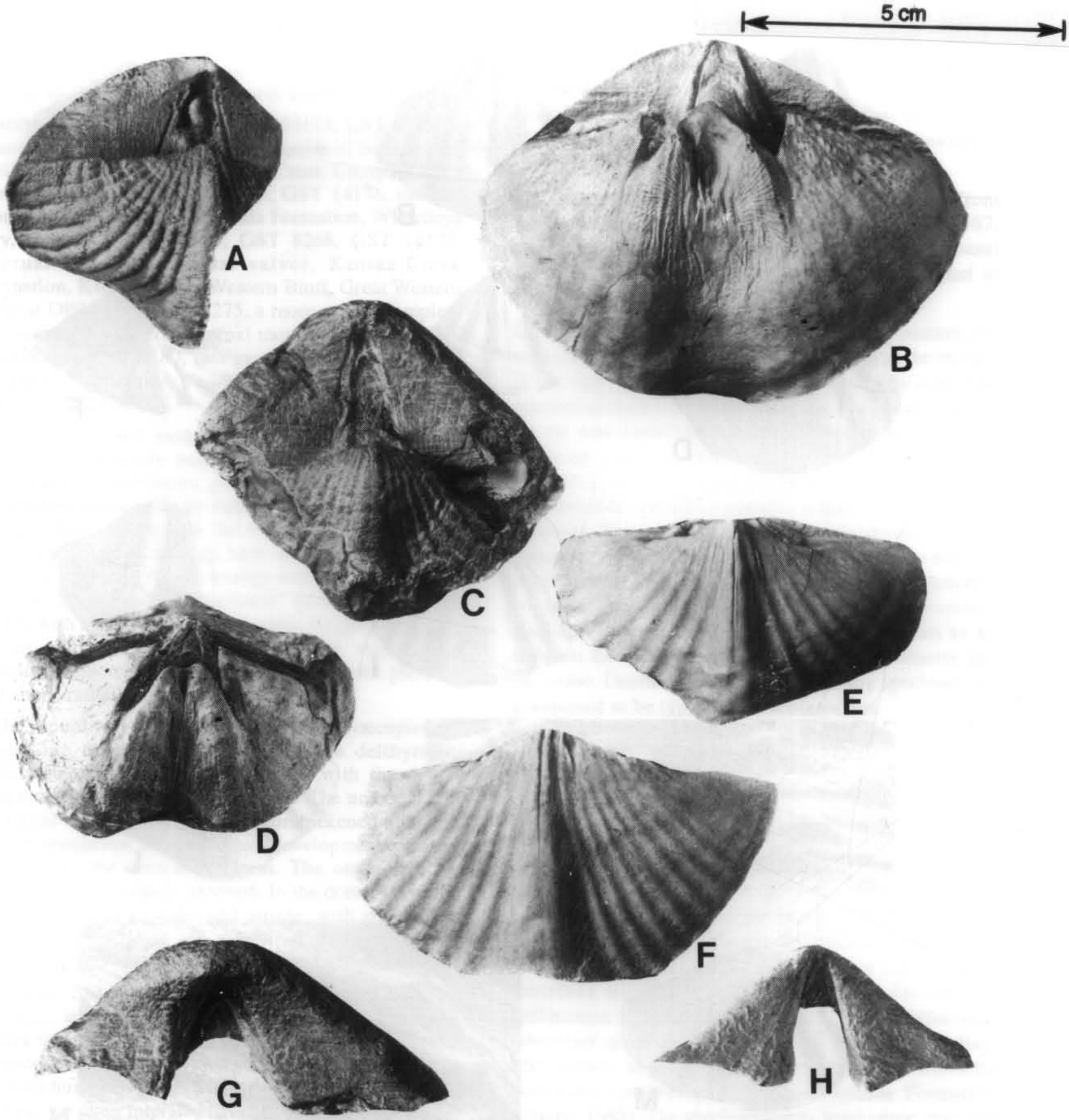

Figure 14. *Pseudosyrinx allandalensis* Armstrong. **A,** dorsal view of latex cast of more or less complete external mould GST 361113 (the globose object in the centre of the delthyrium is a small pebble). **B,** posteroventral view of ventral valve internal mould GST 14176 showing massive thickening of adminicula and umbonal regions. **C,** dorsal view of more or less complete shell GST 8275. **D,** posteroventral view of ventral valve mould GST 14178. **E, F,** dorsal views of dorsal valve internal moulds GST 14177, GST 8268. **G, H,** dorsal views of ventral valve beaks and interareas GST 14180, GST 14179. **A,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **C, D, G, H,** from the Darlington Limestone, Fossil Cliffs, Darlington, Maria Island. **E, F,** from the Kansas Creek Formation, Kansas Creek, Western Bluff, Great Western Tiers.

internal mould of left valve respectively, lower part of Spreyton Beds at Great Bend of the Mersey River at DQ390175; GST 441112, internal mould of right valve, Swifts Jetty Sandstone, Masseys Creek Group at Middle Arm, Beaconsfield at DQ770255.

DESCRIPTION: Shell medium- to large-sized, short, inflated with high pointed umbones; shell distinctly thickened ventrally so that internal moulds show an obvious concavity near the antero-ventral commissure. Musculature as in other species of *Megadesmus* with subequal adductor scars, four pedal muscle insertions, and an accessory muscle below the posterior adductor scar; the pallial line is non-sinuate. No shell gapes; hinge essentially edentulous. The ligament is strong, arcuate and opisthodetic, and is supported externally by strong nymphs. Shell thin in umbonal regions but thickened towards the ventral margins; ornamented by fine, but well marked concentric growth imbrications. Shell substance probably aragonitic (Runnegar, 1965, p. 234).

REMARKS: This species is intermediate in shape between *Megadesmus globosus* J. Sowerby and *Megadesmus gryphoides* (de Koninck). It is more equidimensional than *globosus* and lacks the very pronounced antero-ventral concavity of that species. *Megadesmus gryphoides* is generally similar in shape but has very high, massively in-rolled umbones. The specimen of *Cardiomorpha gryphoides* de Koninck from Latrobe figured by Johnston (1888, pl. XV, fig. 1) is probably

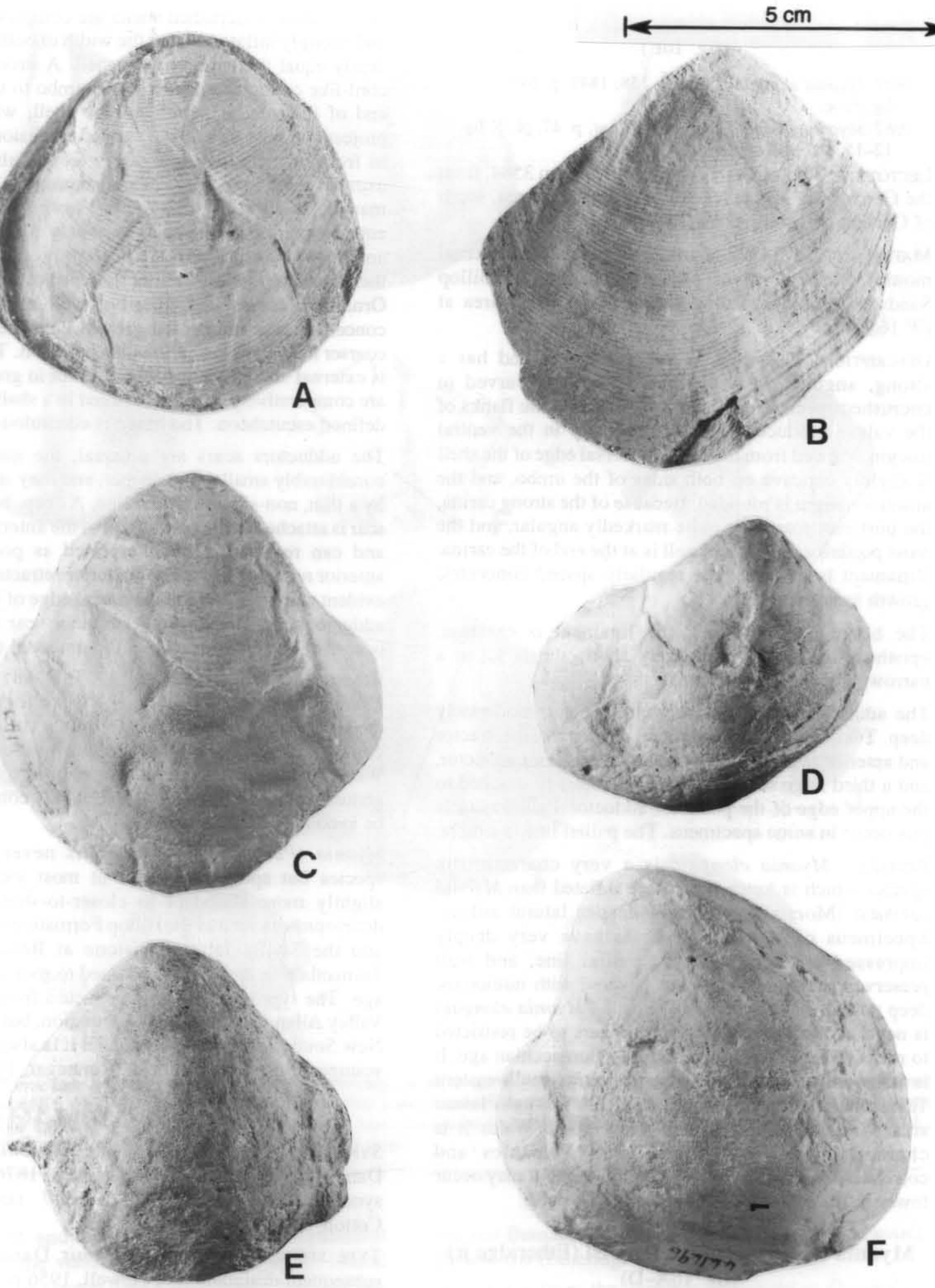

Figure 15. *Megadesmus pristinus* Runnegar. **A, B,** casts of right valve showing external ornament GST 14328-9. **C–E,** lateral views of right valve internal moulds GST 441492, GST 441334, GST 441112. **F,** lateral view of left valve internal mould GST 441496. **A,** from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe. **B,** from the lower part of the Masseys Creek Group, Port Sorell, northern Tasmania. **C, D, F,** from the Spreyton Formation, Great Bend of the Mersey River, Latrobe. **E,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield.

Megadesmus pristinus, although the specimen is extraordinarily flattened. *Megadesmus pristinus* is widely distributed and occurs throughout the Tamarian Stage. It is generally uncommon except in the lower part of the Spreyton Formation at Latrobe, where articulated specimens occur in some abundance. It also occurs at a similar stratigraphic horizon at Cranky Corner, New South Wales, and in the Youlambie Conglomerate, Queensland.

Genus **Myonia** Dana, 1847

SYNONYM: Objective synonym: *Maeonia* Dana, 1849 (variant spelling of *Myonia*)

HOMONYM: *Myonia* Walker, 1854 (Lepidopteran) and *Myonia* Adams, 1860 (gastropod).

TYPE SPECIES: *Myonia elongata* Dana, 1847 (by subsequent designation of Fletcher, 1932, p. 398).

Myonia elongata Dana
(fig. 16E)

1847 *Myonia elongata* Dana, p. 158; 1849, p. 695, pl. 5, fig. 3a–c.
1967 *Myonia elongata* Dana; Runnegar, p. 47, pl. 5, fig. 12–15, 18 (with synonymy)

LECTOTYPE: United States National Museum 3584, from the Gerringong Volcanics at Black Head, Gerroa, south of Gerringong, south coast, New South Wales.

MATERIAL. GST 14327, a complete, articulated internal mould with the valves partly ajar, from the Billop Sandstone, Golden Valley Group, Lake River area at EP 168585.

DESCRIPTION: The shell is very elongate, and has a strong, angular posterior carina which is curved in uncrushed specimens. A shallow sulcus on the flanks of the valves produces a gentle concavity in the ventral margin. Viewed from the side, the dorsal edge of the shell is slightly concave on both sides of the umbo, and the anterior margin is rounded. Because of the strong carina, the posterior margin is quite markedly angular, and the most posterior part of the shell is at the end of the carina. Ornament is of fine, low, regularly spaced concentric growth lamellae.

The hinge is edentulous; the ligament is external, opisthodetic, and comparatively short, and is set in a narrow, elongate escutcheon.

The adductor scars are large, circular and moderately deep. Two deep and well defined pedal scars (protractor and anterior retractor) occur above the anterior adductor, and a third large scar (posterior retractor) is attached to the upper edge of the posterior adductor. Pallial muscle pits occur in some specimens. The pallial line is simple.

REMARKS: *Myonia elongata* is a very characteristic species which is longer and more inflated than *Myonia carinata* (Morris), and has a deeper lateral sulcus. Specimens of the latter species have very deeply impressed muscle scars and pallial line, and well preserved internal moulds are covered with numerous, deep pallial muscle pits. In Tasmania, *Myonia elongata* is never a common species and appears to be restricted to rocks of Late Tamarian and Early Bernacchian age. It is known from the Snug-Margate area, south-eastern Tasmania, and several localities in the Central Plateau area, Great Western Tiers. In New South Wales it is characteristic of the Gerringong Volcanics and correlative horizons (Late Lymingtonian), but may occur lower in the sequence (Runnegar, 1967, p.49).

Myonia (Pachymyonia) morrisi (Etheridge jr)
(fig. 16A–D)

1919 *Maeonia morrisi* Etheridge jr, p. 186, pl. 28, fig. 78.
1967 *Myonia morrisi* (Etheridge jr); Runnegar, p. 53, pl. 4, fig. 3–5; pl. 5, fig. 1–11, 16–17; pl. 12, fig. 4. (with synonymy).

HOLOTYPE: Australian Museum F 16978, a complete, articulated internal mould from the Allandale Formation at Harpers Hill, one mile south-west of Lochinvar, Hunter Valley, New South Wales.

MATERIAL AND LOCALITIES: GST 14326, a left valve external mould from the Bundella Formation, Tobys HIll, Cygnet at EN083219. GST 44725, a right valve internal mould from the Inglis Formation, Ścolyers Hill, Hellyer Gorge area at CQ640235. GST 441169, a left valve internal mould, and GST 441075, a complete, articulated internal mould respectively, both from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield at DQ770255.

DESCRIPTION: Uncrushed shells are comparatively short and strongly inflated so that the width of both valves may nearly equal the length of the shell. A strong, rounded, cord-like carina extends from the umbo to the posterior end of the ventral margin of the shell, where it may project ventrally as a blunt rounded extension (fig. 22A). In front of the carina the valves are variably concave, usually markedly so, and consequently, the ventral margin is strongly indented. Viewed laterally, the anterior margin of the shell is evenly rounded and the anterior umbonal slope is flat or slightly concave. Behind the carina the shells are either flattened or gently convex. Ornament consists of fine, but well marked, regular concentric and imbricated growth lamellae, which are coarser in front of the carina than behind it. The ligament is external and opisthodetic, and is set in grooves which are comparatively short and lodged in a shallow but well defined escutcheon. The hinge is edentulous.

The adductors scars are unequal, the anterior being considerably smaller and deeper, and they are connected by a thin, non-sinuate pallial line. A deep, bilobed pedal scar is attached to the upper edge of the anterior adductor, and can reasonably be interpreted as protractor and anterior retractor scars. The posterior retractor scar is less evident and is attached to the dorsal edge of the posterior adductor scar. The umbonal retractor scar is small and occurs on the anterior side of the umbonal cavity.

REMARKS: I follow Dickins (1963, p. 48) in retaining *Pachymyonia* as a subgenus of *Myonia* for shells which are wide across the valves and strongly carinated, with a comparatively wide postero-ventral post-carinal slope. Waterhouse (1969) regarded *Pachymyonia* as a separate genus, whereas Runnegar (1967, p. 47) considered it to be synonymous with *Myonia*.

Myonia (Pachymyonia) morrisi is never a common species but specimens occur at most localities. It is slightly more abundant in closer-to-shore sandstone developments such as the Billop Formation at Lake River and the Swifts Jetty Sandstone at Beaconsfield. In Tasmania it is apparently confined to rocks of Tamarian age. The type material was collected from the Hunter Valley Allandale (Tamarian) Formation, but elsewhere in New South Wales and Queensland it is also known from younger (Bernacchian) rocks (Runnegar, 1967).

Genus **Pyramus** Dana, 1847

SYNONYMS: Objective synonyms: *Maeonia (Pyramia)* Dana, 1849; and *Clarkia* de Koninck, 1876. Subjective synonyms: *Notomya* McCoy, 1847 (not *Notomya* Cotton, 1931).

TYPE SPECIES: *Pyramus myiformis* Dana, 1847 (by subsequent designation of Newell, 1956 p. 7).

Pyramus laevis (J. Sowerby)
(fig. 17A–H; fig. 18A–B)

1838 *Megadesmus laevis* J. Sowerby, p.15, pl. 3, fig. 1
1967 *Pyramus laevis* (J. Sowerby); Runnegar, p. 34, pl. 1, fig. 1–12; pl.2, fig. 1–10.

LECTOTYPE: British Museum (Natural History) L 61050, from the Allandale Formation, Harpers Hill, one mile south-west of Lochinvar, Hunter Valley, News South Wales.

MATERIAL AND LOCALITIES: GST 441182, GST 441181, GST 441017, GST 441078, GST 441080, GST 441079, all complete internal moulds of both valves from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield at DQ770255. GST 14300, an articulated specimen with right valve as an internal mould and the left valve with adherent silicified shell

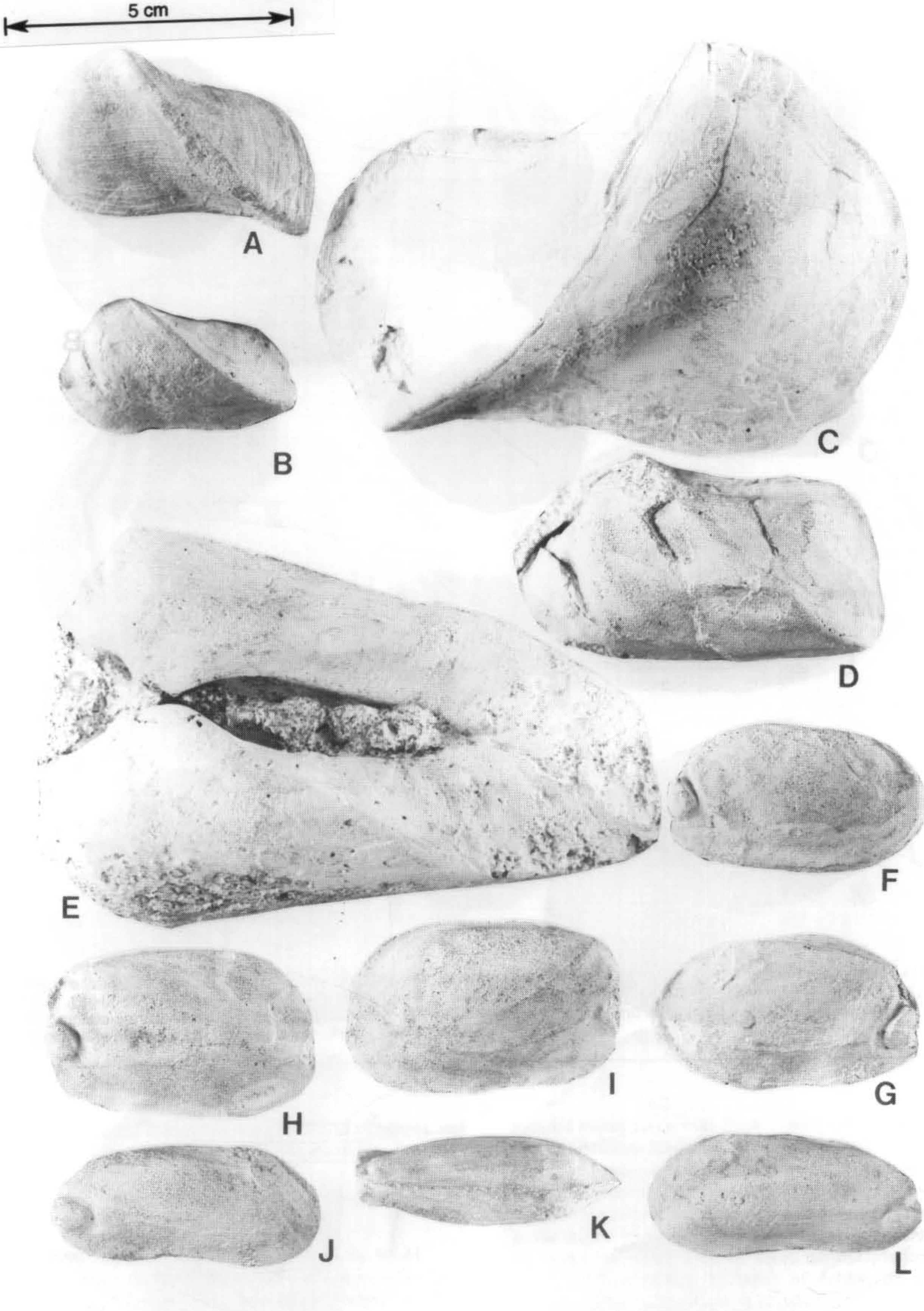

Figure 16. A–D. *Myonia (Pachymyonia) morrisi* (Etheridge). **A,** latex cast of left valve external mould showing the external ornament GST 14326. **B, D,** lateral views of left valve internal moulds GST 441169, GST 441075. **D,** lateral view of right valve internal mould GST 44725. **A,** from the Bundella Formation, Tobys Hill, Cygnet. **B, D,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **C,** from the Inglis Formation, Scolyers Hill, Hellyer Gorge area. *Myonia elongata* Dana. **E,** dorsal view of complete internal mould with valves partly ajar GST 14327, from the Billop Sandstone, Golden Valley Group, Lake River. **F–L,** *Stutchburia farleyensis* Etheridge. **F–G,** lateral left and right views of complete internal mould GST 441082. **H–I,** lateral left and right views of complete internal mould GST 441221. **J–L,** lateral left, dorsal, and lateral right views of complete internal mould GST 441222. All specimens from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield.

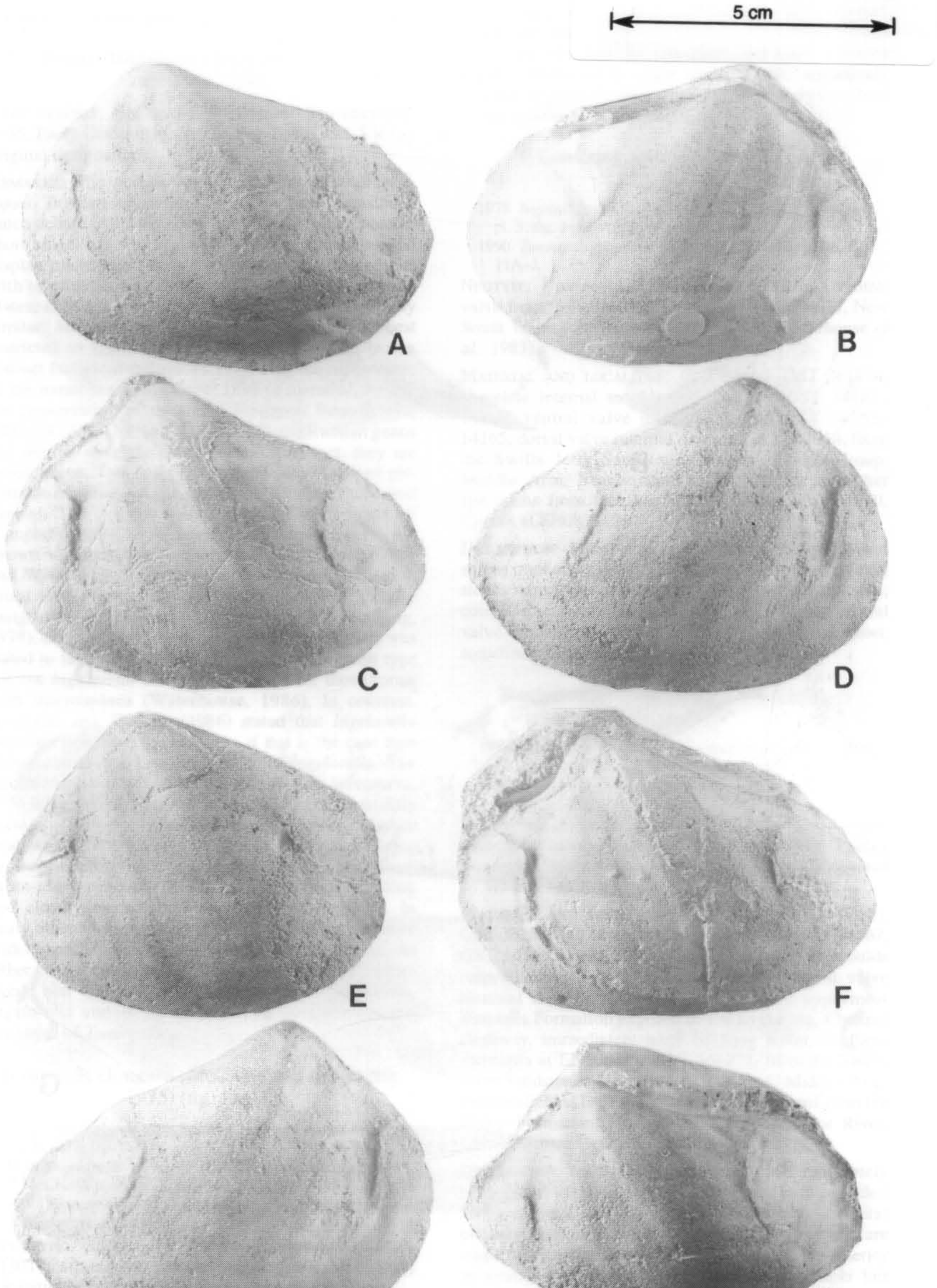

Figure 17. *Pyramus laevis* (Sowerby). **A–B, C–D,** left and right views of complete internal moulds GST 441182, GST 441181. **E, F, H,** left views of complete internal moulds GST 441017, GST 441078, GST 441080. **G,** right view of complete internal mould GST 441181. All specimens from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield.

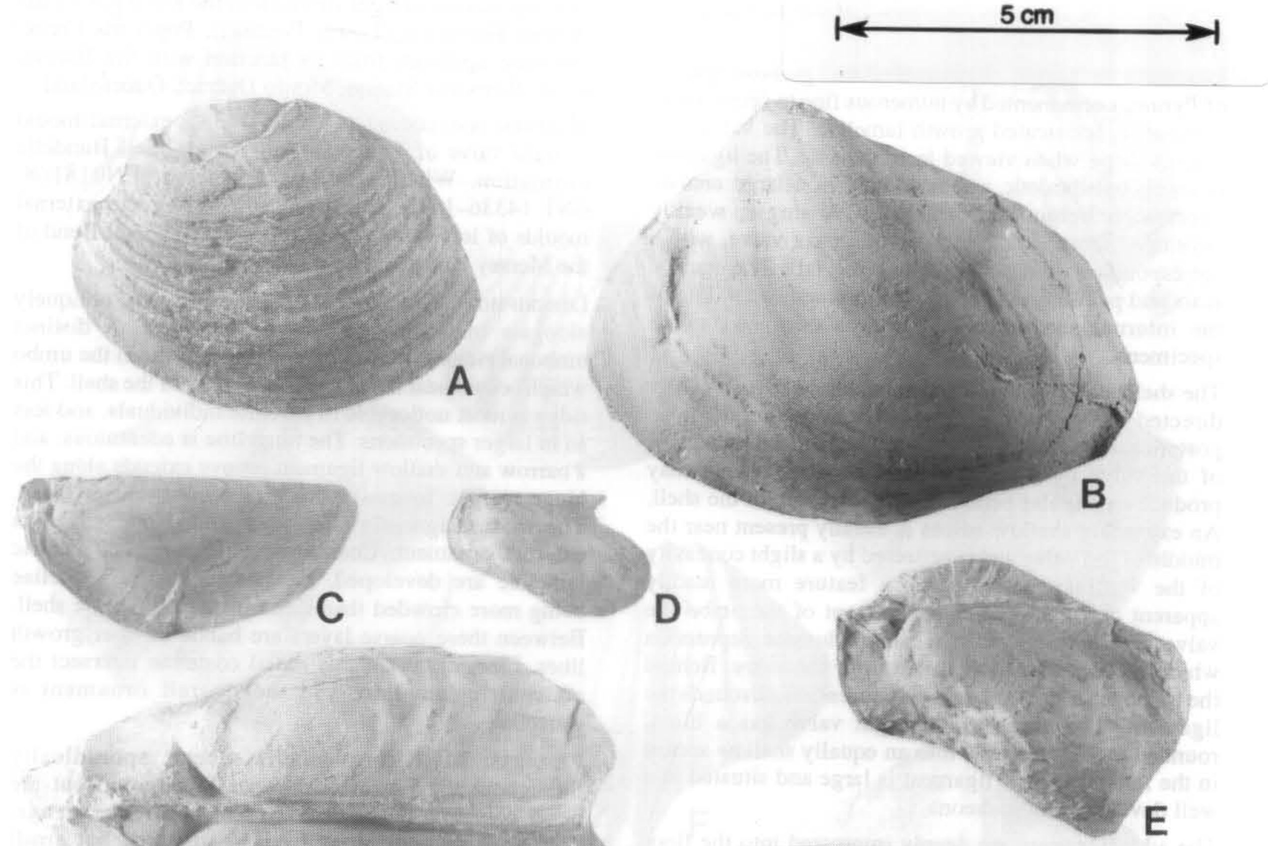

Figure 18. A, B. *Pyramus laevis* (Sowerby). **A,** lateral view of left valve of complete specimen showing the external ornament GST 14300. **B,** lateral view of left valve of complete internal mould GST 441079. **A,** from the Bundella Formation, Langdons Hill, Cygnet; **B,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **C–I,** *Merismopteria macroptera* (Morris). **C, D,** internal moulds of left valves GST 14301, GST 14302. **E,** lateral view of left valve of complete internal moulds GST 14304, GST 14306. **G,** lateral view of latex cast from external mould GST 14305 showing the external ornament. **I,** lateral view of right valve of complete internal mould GST 8320. **C, G,** from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe. **D,** from unnamed sandstone exposed in road cutting alongside the Marlborough Highway two miles north of Bronte Park. **E, F, H, I,** from near the top of the Abels Bay Formation, shore platform, Yellow Point, Birchs Bay.

attached, from the basal Bundella Formation, Langdons Hill, Cygnet at EN059182.

DESCRIPTION: Large, thick-shelled and globose species of *Pyramus* ornamented by numerous fine to very coarse, concentric, imbricated growth lamellae. The valves are oval in shape when viewed from the side. The ligament is short, opisthodetic and is lodged in a large arcuate depression behind the umbones. A single, weakly developed tooth is developed in the right valve, with a corresponding shallow socket in the left. The muscle scars and pallial line are deeply impressed and pitting of the internal surface of the valves occurs in some specimens.

The shells are oval and inflated, and have low, inwardly directed umbones. When viewed from the side, the posterior umbonal slope is separated from the remainder of the valve by a slight change in shape which may produce an angular bend in the rear margin of the shell. An extremely shallow sulcus is usually present near the middle of the valve and is reflected by a slight concavity of the ventral valve margin, a feature more readily apparent on internal moulds. In front of the umbo the valve is flattened to form a narrow lunular depression which extends almost to the front of the valve. Behind the umbones a similar but large depression surrounds the ligament. The hinge of the right valve has a blunt, rounded tooth which fits into an equally shallow socket in the left valve. The ligament is large and situated in a well developed escutcheon.

The adductor scars are deeply impressed into the floor of the valve, with the posterior scar being considerably larger than the anterior. The posterior retractor scar is large and is joined to the dorsal edge of the adductor scar. The protractor scar is smaller but is well marked, and is connected to the anterior adductor. Behind the protractor scar is a larger, deep, oval anterior retractor scar, and another small scar occurs at the apex of the umbonal cavity. The pallial line is thick, deeply impressed and non-sinuate.

REMARKS: The complex nomenclature and synonymy of *Pyramus laevis* is discussed in detail by Runnegar (1967, pp. 32–34) and is not repeated herein. The Tasmanian material compares very favourably with the Sydney Basin species as described and figured by Runnegar (1967) from the Hunter Valley and south Sydney Basin. A more equidimensional form similar to a specimen from Turisse Point, Batemans Bay (Runnegar, 1967, pl. 2, fig. 6) occurs in a fauna from the New England Fold Belt (Allan and Leitch, 1990, p. 44). In Tasmania, the species is widespread from Cygnet in the south-east to Beaconsfield in the north and Latrobe in the north-west. It is common only at Beaconsfield in the nearshore Swifts Jetty Sandstone. All known occurrences are from rocks of Tamarian age.

Subclass PTERIOMORPHIA Beurlen, 1944
Order MYTILOIDA Férussac, 1822
Family MYTILIDAE Rafinesque, 1815

Genus **Promytilus** Newell, 1942

TYPE SPECIES: *Promytilus annosus* Newell, 1942 (by original designation).

Promytilus cancellatus Maxwell
(fig. 24G–I)

1964 *Promytilus cancellatus* Maxwell, p. 16, pl. 3, fig. 4-6.

HOLOTYPE: Geology Department, University of Queensland F 42896a-b, counterpart internal and external moulds of right valve, from the lower part of the Burnett Formation (Lower Permian), Poperima Creek, one mile upstream from its junction with the Burnett River, Baywulla Station, Monto District, Queensland.

MATERIAL AND LOCALITIES: GST 14335, external mould of right valve of a juvenile individual, basal Bundella Formation, Wheatleys Bay, Cygnet at EN018168; GST 14336–14337, complete and incomplete external moulds of left valves, *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175.

DESCRIPTION: The shell is of moderate size, obliquely elongate in outline and evenly biconvex. A distinct umbonal ridge extends postero-ventrally from the umbo which occurs near the anterior extremity of the shell. This ridge is most noticeable in juvenile individuals, and less so in larger specimens. The hingeline is edentulous, and a narrow and shallow ligament groove extends along the hinge margin. Internal details have not been observed. The most diagnostic character of this species is its external ornament. Coarse, widely spaced, concentric lamellae are developed, the postero-ventral lamellae being more crowded than those of the rest of the shell. Between these coarse layers are bands of finer growth lines. Fine, discontinuous radial costellae intersect the concentric lamellae, and the overall ornament is cancellate.

REMARKS: Mytiliform shells occur sporadically throughout the Lower Parmeener Supergroup but are never common, the more so in rocks of Tamarian age. The older forms which possess a distinct, but small anterior lobe, which is separated from the rest of the shell, are probably best referred to *Promytilus*, whereas the younger forms lack this feature and the anterior lobe extends slightly in front of the umbo, are possibly better referred to *Volsellina* Newell, 1942.

Order PTERIOIDA Newell, 1965
Family EURYDESMIDAE Reed, 1932

Genus **Eurydesma** Morris, 1845

TYPE SPECIES: *Eurydesma cordatum* Morris, 1845 (by original designation).

SYNONYM: *Leiomyalina* Frech, 1891.

Eurydesma cordatum Morris
(fig. 19A–B; fig. 20D; fig. 21A)

1845 *Eurydesma cordata* Morris, p. 276, pl. 12, fig. 1.

1970 *Eurydesma cordatum* Morris; Runnegar, p. 92, pl. 13, fig. 1–10; pl. 14, fig. 1–6; pl. 16, fig. 7 (with synonymy).

LECTOTYPE: British Museum (Natural History) PL 3267, said to have come from the Illawara District of New South Wales but in fact probably from the Allandale Formation at Harpers Hill in the Hunter Valley (by subsequent designation of Dickins, 1961, p. 143).

MATERIAL AND LOCALITIES: GST 14312, a large partly decorticated left valve, Masseys Creek Group, Port Sorell, northern Tasmania at DQ650587; GST 14313, partly decorticated right valve, Darlington Limestone, Fossil Cliffs, near Darlington, Maria Island at EN887855; GST 14318, partly decorticated conjoined valves, Point Hibbs, western Tasmania at CN586804; GST 14319, internal mould of right valve, Bundella Formation, Tobys Hill, Cygnet at EN083219.

DIAGNOSIS: Large inflated species of *Eurydesma* with a relatively small byssal notch and high pointed, strongly inrolled and markedly thickened umbones.

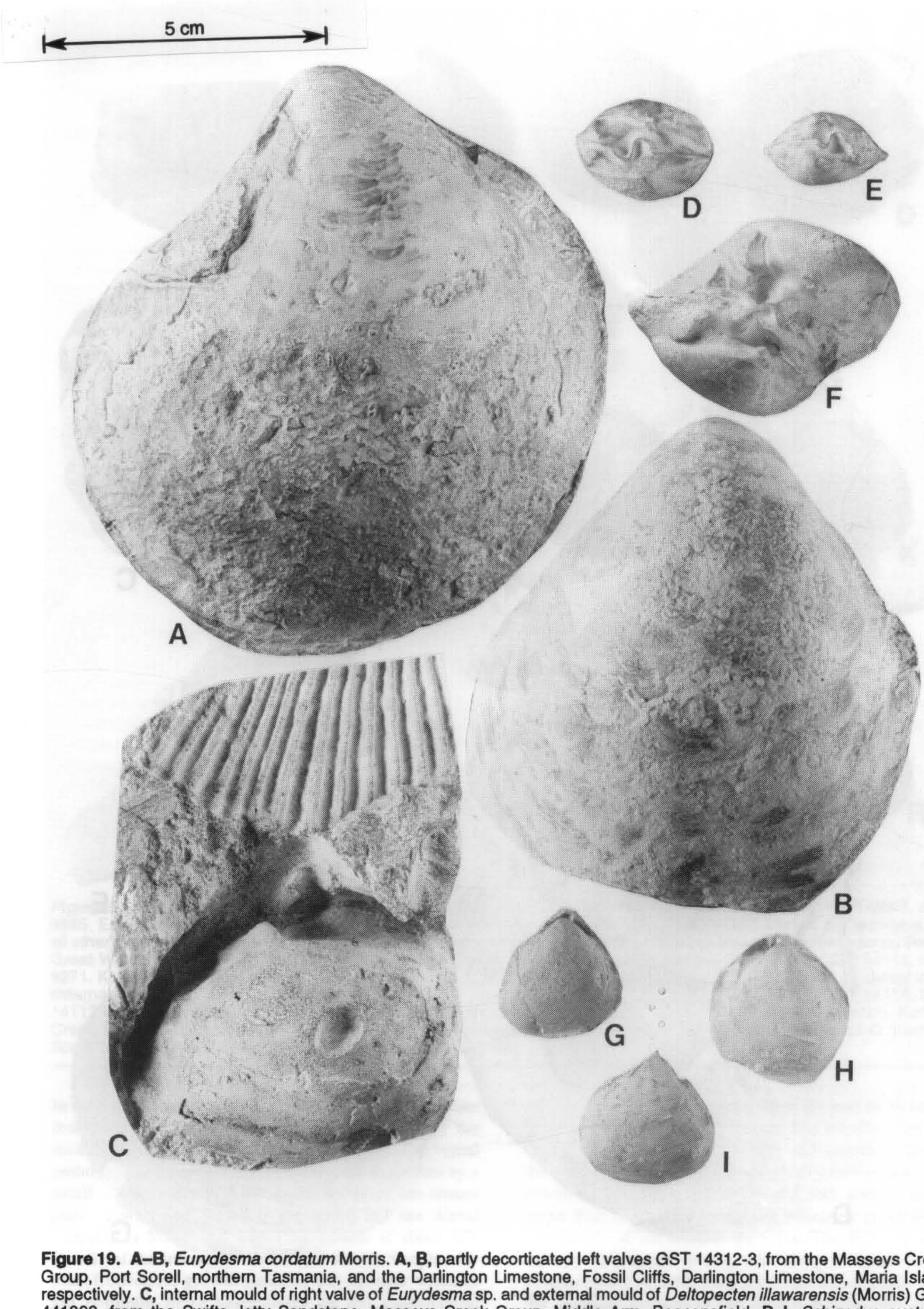

Figure 19. A–B, *Eurydesma cordatum* Morris. **A, B,** partly decorticated left valves GST 14312-3, from the Masseys Creek Group, Port Sorell, northern Tasmania, and the Darlington Limestone, Fossil Cliffs, Darlington Limestone, Maria Island respectively. **C,** internal mould of right valve of *Eurydesma* sp. and external mould of *Deltopecten illawarensis* (Morris) GST 441093, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **D–I,** *Schizodus australis* (Runnegar). **D–F,** dorsal views of complete internal moulds GST 441369, GST 441367, GST 441366, all × 2. **G,** lateral view of right valve internal mould GST 441170. **H,** lateral view of left valve internal mould GST 441372 2. **I,** left lateral view of complete internal mould GST 14314. **D–F, H,** from the Spreyton Formation, Great Bend of the Mersey River, Latrobe. **G,** from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **I,** from the Inglis Formation, Scolyers Hill, Hellyer Gorge area.

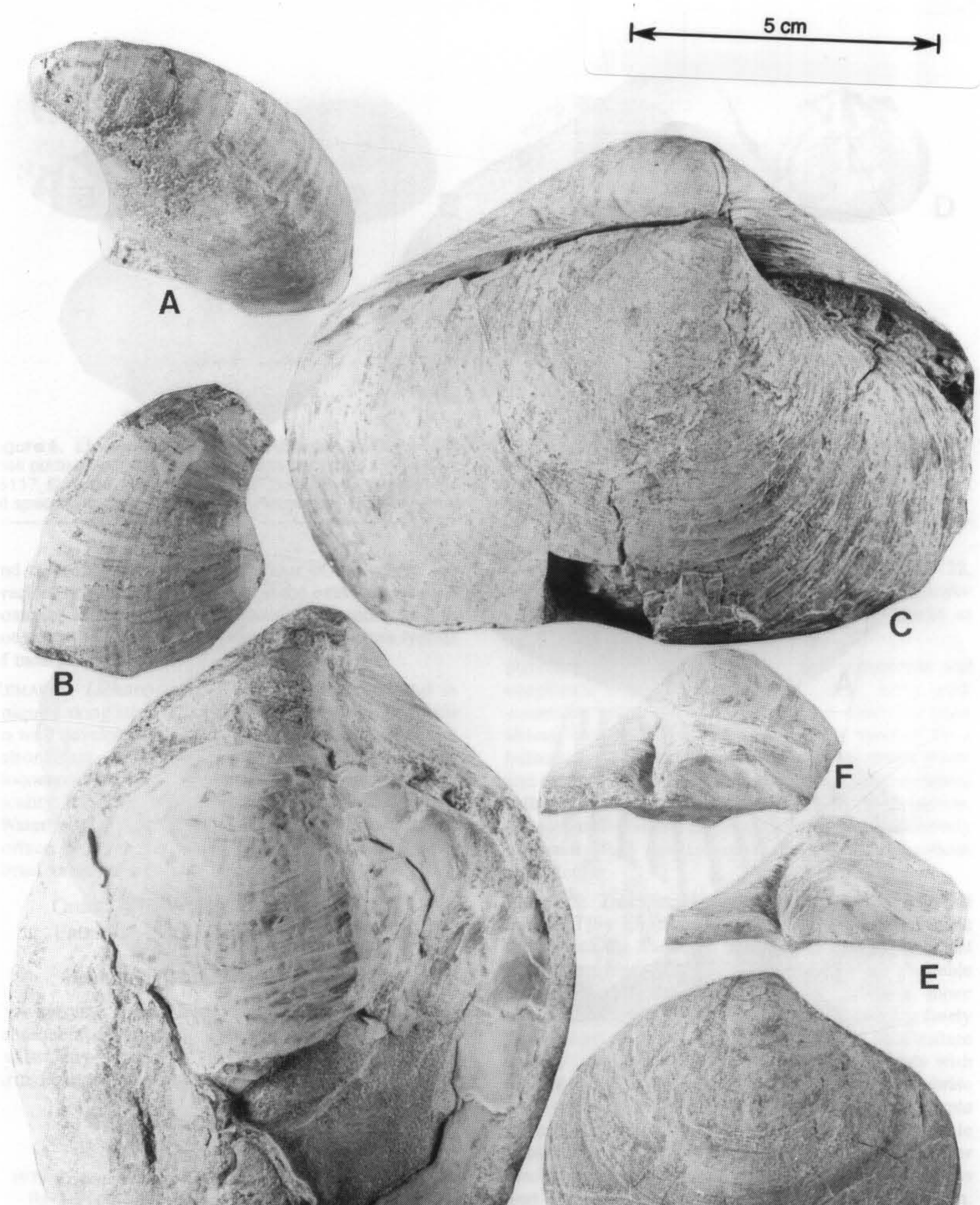

Figure 20. **A, B.** *Rhabdocantha intermedia* Fletcher. Lateral views of internal moulds GST 421110-1, × 2, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. **C, F, E.** *Eurydesma hobartensis konincki* (Johnston). **C,** lateral view of conjoined valves GST 14315. **F, E,** umbonal hinge fragments showing pronounced byssal notch in right valve GST 14316-7. All specimens from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island. **D.** *Eurydesma cordatum* Morris. **D,** lateral view of large conjoined valves GST 14318; tall (dorso-ventrally) specimens like this could be placed in *Eurydesma playfordi* Dickins. From Point Hibbs, western Tasmania. **G.** *Eurydesma hobartensis hobartensis* (Johnston). **G,** complete right valve GST 8274, from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe.

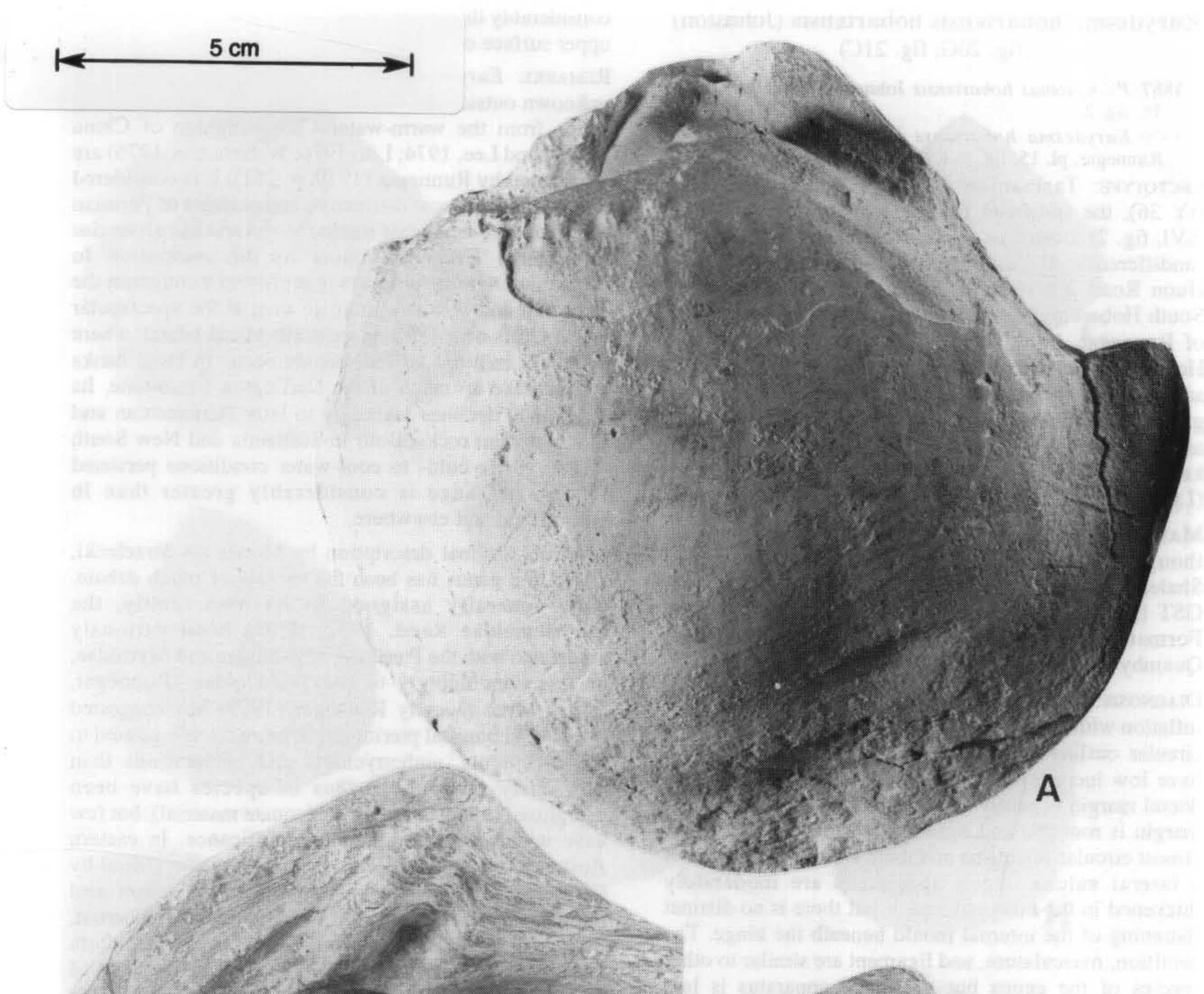

Figure 21. A. ***Eurydesma cordatum*** **Morris. A, lateral view of right valve internal mould GST 14319, from the Bundella Formation, Tobys Hill, Cygnet. B.** ***Eurydesma*** **sp. Umbonal hinge fragment of left valve showing the tooth-like process, GST 14320, from the Darlington Limestone, Fossil Cliffs, Darlington, Maria Island. C.** ***Eurydesma hobartensis hobartensis*** **(Johnston). Partly decorticated right valve, GST 14321, from the Glencoe Formation, Golden Valley Group, Quamby Brook, Great Western Tiers. D–G.** ***Peruvispira*** **sp. Latex casts of external moulds, GST 14322-5, × 4, from the basal Hickman Formation, Harts Hill, southern Tasmania.**

Eurydesma hobartensis hobartensis (Johnston)
(fig. 20G; fig. 21C)

1887 *Pachydomus hobartensis* Johnston, p.16; 1888, pl. 16, fig. 2.

1970 *Eurydesma hobartense hobartense* (Johnston); Runnegar, pl. 15, fig. 1–4, 6–11 (with synonymy).

LECTOTYPE: Tasmanian Museum Z 955 (formerly BY 36), the specimen figured by Johnston (1888, pl. XVI, fig. 2) located as 'Huon Road' and probably from 'undifferentiated Cascades Group' which crops out on Huon Road just beyond Turnip Fields Road between South Hobart and Fern Tree (by subsequent designation of Runnegar, 1970, p. 95). The Permian rocks of the Hobart area require revision in the light of the significant advances in the understanding of the detailed stratigraphy of sequences in the neighbouring Kingborough area (Farmer, 1981; 1985). The locality cited is now known to belong to the Deep Bay Formation (Lymingtonian) as defined by Farmer (1985).

MATERIAL AND LOCALITIES: GST 8274, a complete, though somewhat flattened right valve, *Tasmanites* Shale, Great Bend of the Mersey River at DQ390175; GST 14321, a slightly decorticated right valve, Glencoe Formation, Golden Valley Group, Quamby Brook, Quamby Bluff area at DP660730.

DIAGNOSIS: Medium- to large-sized shells of low inflation with low inconspicuous umbones and an almost circular outline. The valves are narrowly inflated and have low inconspicuous umbones so that the posterior dorsal margin is gently and evenly convex. The anterior margin is rounded and expanded so that the valves are almost circular in outline and there is little or no trace of a lateral sulcus. Adult specimens are moderately thickened in the umbonal region but there is no distinct flattening of the internal mould beneath the hinge. The dentition, musculature, and ligament are similar to other species of the genus but the hinge apparatus is less massive because of the narrower shell.

Eurydesma hobartensis konincki
(Johnston) (fig. 20C; fig. 21B)

1887 *Pachydomus konincki* Johnston, 1887, p. 15; 1880, pl. XVIII, fig. 2.

1970 *Eurydesma hobartense konincki* (Johnston); Run negar, p. 97, pl. 13, fig. 11; pl. 15, fig. 5; pl. 16, fig. 2–6, 8–9; pl. 17, fig. 5–13. (with synonymy).

NEOTYPE: Geology Department, University of Queensland F 51940, from the Darlington Limestone, Fossil Cliffs, near Darlington, Maria Island (chosen by Runnegar, 1970, p. 97).

MATERIAL AND LOCALITIES: GST 14315, a completed articulated specimen with ventral regions crushed, '*Spirifer* Zone', Fossil Cliffs, near Darlington, Maria Island; GST 14320, umbonal and hinge regions of a left valve, Darlington Limestone, Fossil Cliffs, Maria Island at EN887855.

DIAGNOSIS: Medium-sized to very large, strongly inflated shells, markedly thickened in the umbonal region, and having low, inconspicuous umbones; sometimes with more or less well marked lateral sulcus developed towards the ventral shell margins. The valves are moderately to considerably inflated, but the umbones are low and inconspicuous so that the posterior dorsal margin is evenly rounded. As in *Eurydesma hobartensis hobartensis* the anterior margin is expanded so that the shell outline is almost circular. The lateral sulcus is generally weakly developed, but it may be pronounced in some individuals (e.g. so-called *Notomya gouldi* Johnston, 1880, pl. XVII, fig. 1). Adult specimens are considerably thickened in the umbonal region so that the upper surface of internal moulds tends to be quite flat.

REMARKS: *Eurydesma* is a remarkable genus which is unknown outside the Gondwanan Realm (reports of the genus from the warm-water Changsinghian of China (Sheng and Lee, 1974; Liu, 1976; Waterhouse, 1976) are discounted by Runnegar (1979, p. 261). It is considered to be one of the most distinctive components of Permian southern cool-temperate marine biotas and has given rise to the term '*Eurydesma* fauna' for this association. In Tasmania *Eurydesma* occurs in profusion throughout the Tamarian and nowhere more so than at the spectacular Fossil Cliffs near Darlington, north Maria Island, where countless millions of individuals occur in shell banks which make up much of the Darlington Limestone. Its abundance declines markedly in later Bernacchian and Lymingtonian rocks. Both in Tasmania and New South Wales, where cold- to cool-water conditions persisted longer, its range is considerably greater than in Queensland and elsewhere.

Since its original description by Morris (*in* Strzelecki, 1845), the genus has been the subject of much debate. Now generally assigned to its own family, the Eurydesmidae Reed, 1932, it has been variously associated with the Pteriidae, Myalinidae and Mytilidae, or less convincingly to the Tridacnidae (Runnegar, 1970). More recently Runnegar (1979) has suggested that it is an unusual pteriomorph, more closely related to the cyrtodonts, ambonychiids and inoceramids than previously thought. Dozens of species have been recognised (many based on inadequate material), but few have widespread stratigraphic significance. In eastern Australia two major species groups were recognised by Runnegar (1970) namely, *Eurydesma cordatum* and *Eurydesma hobartensis*, and I follow this usage herein. Both occur together in the Darlington Limestone, Maria Island, but the former appears to be confined to rocks of Middle Tamarian age and correlative horizons in the Sydney Basin, whereas the latter ranges from the Early Tamarian through to the youngest known Middle Lymingtonian occurrences of the genus.

The palaeoecology of *Eurydesma* has been discussed at length by Runnegar (1979). He concluded that it lived upside down in an analogous way to modern giant clams. The byssal notch in the right valve is well developed in small, juvenile specimens, but less so in larger, more mature individuals with massively thickened umbones. This suggests that a functional byssal attachment existed in early growth stages at least. Specimens from near the top of the '*Spirifer* Zone' on Maria Island occur in the growth position advocated by Runnegar. They contain geopetal infillings, have abraded umbones, and the valves are sponge-bored almost to the umbones. These factors indicate that the shells were not buried to any extent within the substrate, and that the adult shells may have broken from the initial byssal attachment. The massive umbonal thickening in both valves would have maintained the shells in an upright position in a high energy, sublittoral environment.

Family PTERINEIDAE Miller, 1877

Genus **Merismopteria** Etheridge, 1892

TYPE SPECIES: *Pterinea macroptera* Morris (*in* Strzelecki, 1845) by original designation.

Merismopteria macroptera (Morris)
(fig. 18C–I; fig. 22A–F; fig. 23)

1845 *Pterinea macroptera* Morris, *in* Strzelecki, p. 276, pl. XIII, fig. 2–3.

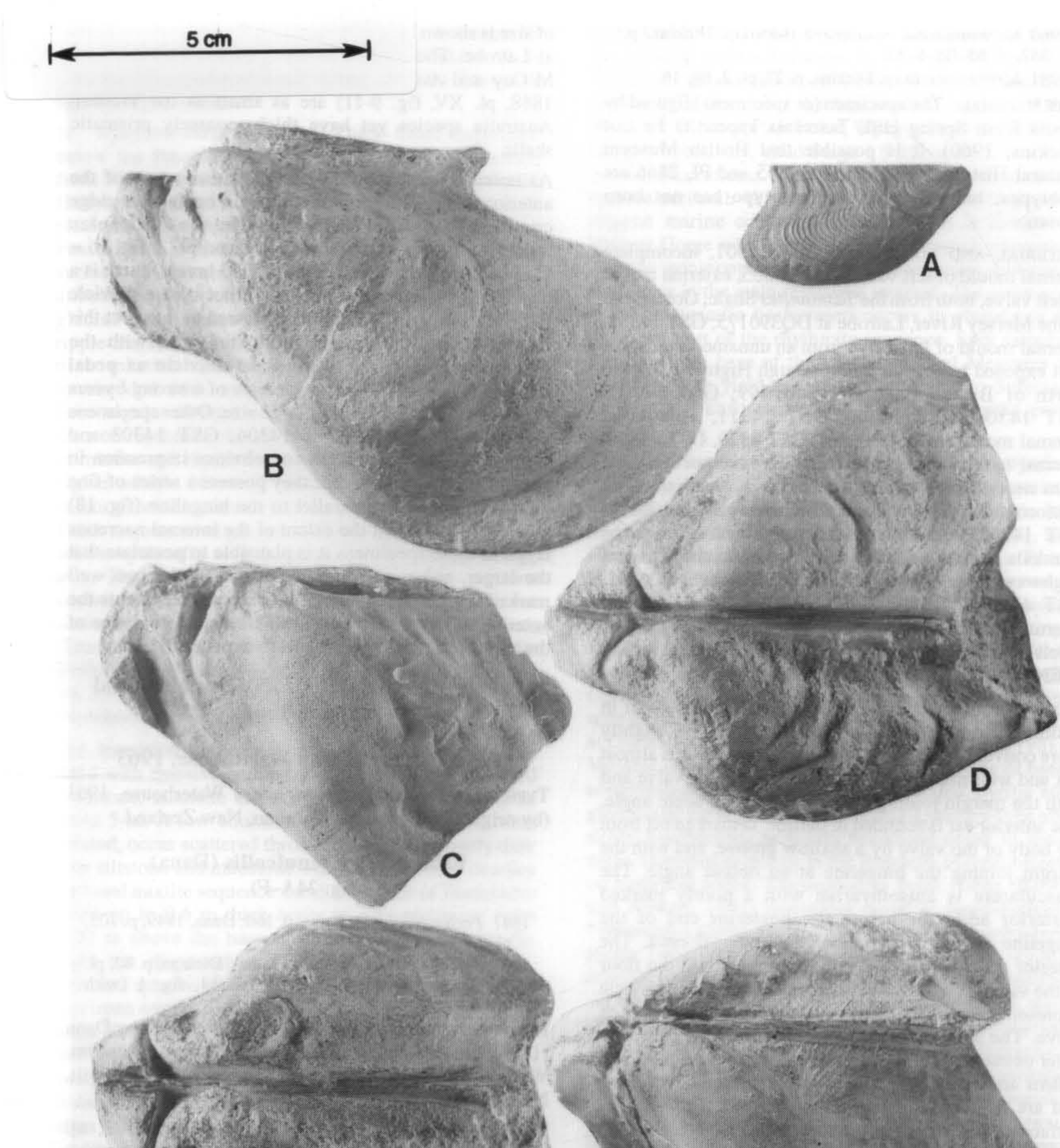

Figure 22. ***Merismopteria macroptera*** **(Morris). A, lateral view of latex cast of right valve showing the external ornament GST 14307. B, C, lateral views of left valve internal moulds GST 442011, GST 14308. D–F, dorsal views of complete articulated internal moulds GST 14309-11. A, from the uppermost Bundella Formation exposed alongside Channel Highway, immediately north of Snug River. B, D, E, from near the top of the Abels Bay Formation, Flowerpot Point, Blackmans Bay. C, F, from near the top of the Abels Bay Formation, shore platform, near Yellow Point, Birchs Bay.**

1960 *Merismopteria macroptera* (Morris); Dickins, p. 387, pl. 63, fig. 6–12.

1981 *Merismopteria* sp. Dickins, p. 27, pl. 2, fig. 16.

TYPE MATERIAL: The specimen (or specimens) figured by Morris from Spring Hill, Tasmania appear to be lost (Dickins, 1960). It is possible that British Museum (Natural History) specimens PL 2865 and PL 2866 are topotypes, but a neotype or lectotype has not been chosen.

MATERIAL AND LOCALITIES: GST 14301, incomplete internal mould of left valve, GST 14305, external mould of left valve, both from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175; GST 14302, internal mould of left valve from an unnamed sandstone unit exposed beside the Marlborough Highway, 3.2 km north of Bronte Park at DP401599; GST 14303, GST 14304, GST 14306, GST 14311, articulated internal moulds of both valves, GST 8320, GST 14308, internal moulds of right and left valves respectively, all from near the top of the Abels Bay Formation, shore platform, near Yellow Point, Birchs Bay at EN196187; GST 14307, external mould of right valve from the Bundella Formation, road cutting beside the Channel Highway immediately north of Snug River at EN206321; GST 442011, GST 14309, GST 14310, articulated internal moulds of both valves from near the top of the Abels Bay Formation, Flowerpot Point, Blackmans Bay at EN267381.

DESCRIPTION: Shell large, oblique, typically pterioid in outline, markedly inequilateral with left valve slightly more convex than right valve. The posterior ear is almost flat and well marked off from the body of the valve and with the margin joining the hingeline at an acute angle. The anterior ear is rounded in outline, is marked off from the body of the valve by a shallow groove, and with the margin joining the hingeline at an obtuse angle. The musculature is anisomyarian with a poorly marked posterior adductor below the posterior end of the hingeline on the back part of the umbonal crest. The anterior scars are more deeply impressed into the floor of the valve. A massive vertical buttress ridge or clavicle is present below the anterior end of the umbones in each valve. The shell is thick, up to 2 mm, with a prismatic outer ostracum and a thin, nacreous inner ostracum. The prisms are set at right angles to the surface of the shell and are readily visible to the naked eye. The external surface of the valves is ornamented by fine concentric lamellae which follow the contours of the valves. The ligament in both valves is lodged in a narrow, elongated external amphidetic ligament area, which is broadest under the umbones and narrows gradually behind the umbones and rapidly in front. The umbones are prosogyre and project only slightly above the hingeline. The hinge is essentially edentulous although a well marked, elongated posterolateral tooth is present in a few specimens (e.g. GST 14310).

REMARKS: *Merismopteria* occurs throughout the Tasmanian sequence and tends to occur in closely-packed clusters. Large, articulated specimens are associated with blocks of coalified wood near the top of the Abels Bay Formation at Flowerpot Point, Blackmans Bay and several other localities. Specimens lower in the sequence tend to be of smaller size, but do not otherwise appear to be significantly different. Although most specimens are preserved as moulds, when shell substance has been observed it is always thick and coarsely prismatic. In this respect the Tasmanian species differs from the Western Australian *Merismopteria carrandibbiensis* (Dickins) which is thin-shelled and finely prismatic (Dickins, 1957). That this feature is not simply a function of size is shown by specimens from the *Tasmanites* Shale at Latrobe. These specimens (figured as *Pterinea lata* M'Coy and *Avicula tasmanica* Johnston by Johnston, 1888, pl. XV, fig. 9-11) are as small as the Western Australia species yet have thick, coarsely prismatic shells.

As noted by Dickins (1981, p. 27), the nature of the anterior musculature and the clavicle or buttress ridge continue to present difficulties. In the Tasmanian specimen figured by Dickins (fig. 1 and pl. 2, fig. 16 = GST 442011), and GST 14308 (fig. 23 herein) there is a distinct triangular impression in front of the clavicle (labelled x in fig. 18). Dickins preferred to interpret this impression as the anterior adductor scar, with the prominent impressions behind the clavicle as pedal muscles consistent with the presence of a strong byssus necessary to anchor shells of large size. Other specimens including GST 8320, GST 14306, GST 14303 and GST 14311, do not possess any obvious impression in front of the clavicle. Rather they possess a series of fine grooves more or less parallel to the hingeline (fig. 18) which may represent the extent of the internal nacreous layer. In these specimens it is plausible to postulate that the larger, and more ventrally placed of the two well marked muscle scars behind the clavicle, represents the anterior adductor scar. But in this case the presence of the massive clavicle is difficult to explain.

Family AVICULOPECTINIDAE Meek and Hayden, 1864

Genus **Etheripecten** Waterhouse, 1963

TYPE SPECIES *Etheripecten striatura* Waterhouse, 1963 (by original designation), Permian, New Zealand.

Etheripecten tenuicollis (Dana)

(fig. 24A–F)

1847 *Pecten tenuicollis* Dana, p. 160; Dana, 1849, p. 705, pl. 9, fig. 7–7a.

1963 *Aviculopecten tenuicollis* (Dana); Dickins, p. 82, pl. 11, fig. 5; pl. 13, fig. 12-17; pl. 14, fig. 1 (with synonymy)

HOLOTYPE: That specimen USNM 3658 figured by Dana (1849) and kept in the United States National Museum, Washington, from the Allandale Formation, Harpers Hill, New South Wales.

MATERIAL AND LOCALITIES: GST 14330–144333, all essentially internal moulds of left valves with small amounts of adherent shell material, from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175; GST 441167, internal mould of left valve, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield at DQ770255; GST 14334, internal mould of left valve, from the Bundella Formation, Tobys Hill, Cygnet at EN083219.

DESCRIPTION: Small- to medium-sized aviculopectinids with left valve convex and right valve almost flat. The posterior auricles are almost as large as the anterior auricles, the latter being distinctly separated from the body of the valve by a groove. Ligament amphidetic with shallow, but distinct, central triangular resilifer pit or chondrophore in each valve. The hingeline is edentulous. The auricles and bodies of both valves are ornamented by radial ribs; those on the auricles are less distinct. On the bodies of both valves the ribs increase by intercalation in ranks viz. near the umbones secondary ribs appear between the primaries, and about one third to one half of the distance from the umbones to the ventral margin, thread-like tertiary ribs appear, one between each primary and secondary. In a few specimens

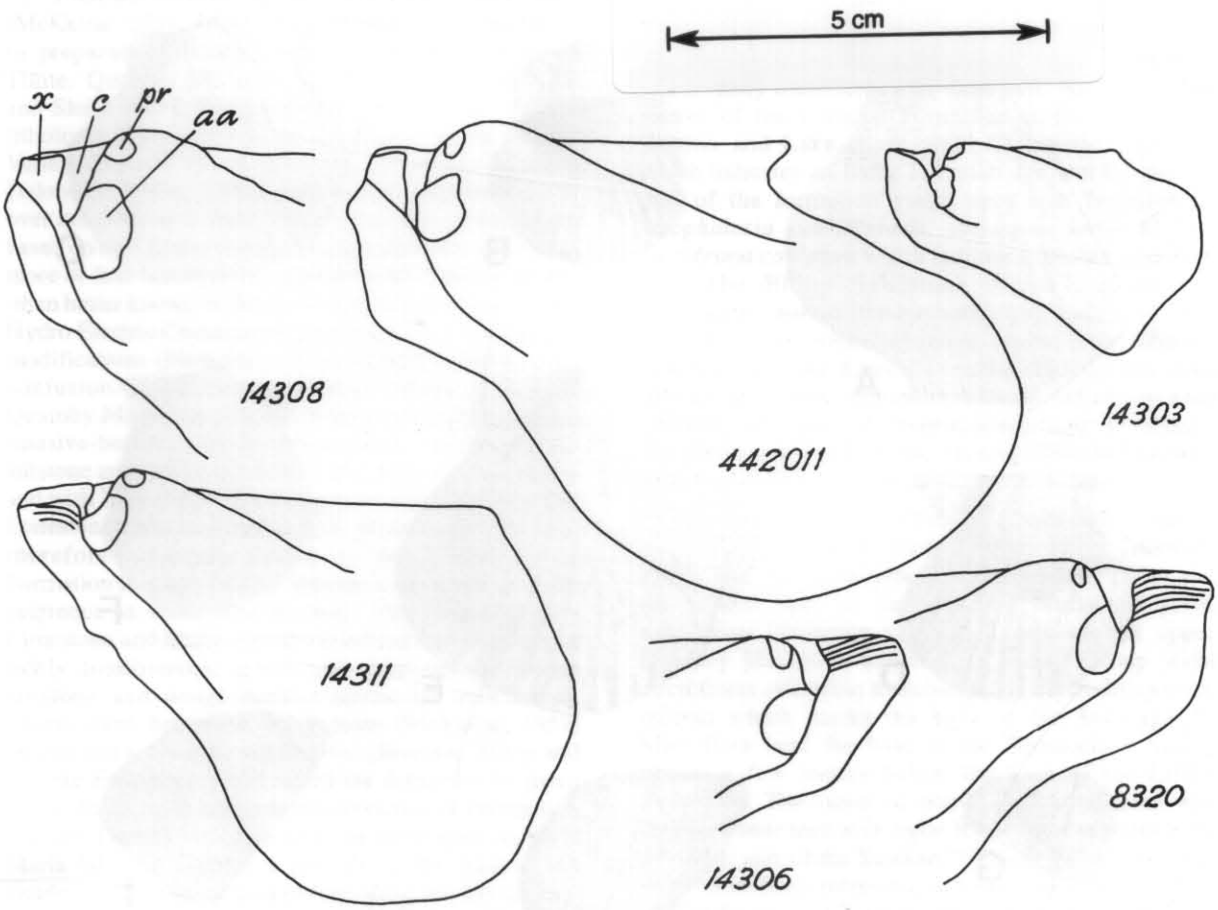

Figure 23. *Merismopteria macroptera* (Morris), showing internal structures. *x*, anterior adductor scar (as interpreted by Dickins, 1981); *aa*, anterior adductor scar?; *pr*, pedal retractor scar?; *c*, massive buttress ridge or clavicle.

very fine fourth order ribs are present near the ventral margin.

REMARKS: *Etheripecten tenuicollis* is never abundant but specimens occur at most localities. *Aviculopecten sprenti* Johnston, recorded from Latrobe (Dun, 1913, p. 6), is generally considered to be a synonym of *Etheripecten tenuicollis* (Dickins, 1957, p. 45; Waterhouse, 1982, p.16). *Aviculopecten latrobensis* Johnston was also recorded from Latrobe (Johnston, 1887; 1888) but this species has never been figured and the type material is lost.

Family DELTOPECTINIDAE Dickins, 1957

Genus **Deltopecten** Etheridge jr, 1892

TYPE SPECIES: *Pecten illawarensis* Morris (*in* Strzelecki, 1845, p. 277, pl. XIV, fig. 3) by original designation.

Deltopecten illawarensis (Morris)

(fig. 25A–I; fig. 26A–F)

TYPE MATERIAL: The specimen figured by Morris (*in* Strzelecki, 1845) is in the Sedgwick Museum, Cambridge. It was stated to have been collected from Illawarra by Morris. This is probably a mistake since the species is unknown at Illawarra; it is abundant in the Allandale Formation at Harpers Hill, Hunter Valley (where Strzelecki collected the type material of *Eurydesma cordatum*) and this is more likely to be the type locality (Dana, 1849; Etheridge and Dun, 1906; Dickins, 1957).

MATERIAL AND LOCALITIES: GST 14338, GST 14349, external moulds of right valves, GST 14341–14342, GST 14348, internal moulds of right valves, GST 14343, internal mould of left valve, all from an unnamed siltstone unit, Musselroe Bay, north-eastern Tasmania at EQ920803; GST 14340, GST 14352, internal moulds of left valves, GST 14347, internal mould of right valve, from the Bundella Formation, Tobys Hill, Cygnet at EN083219; GST 14339, external mould of right valve, Glencoe Formation, Golden Valley Group, Quamby Brook at DQ660730; GST 14344, incomplete right valve showing hinge structure, '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island at EN887855; GST 14345, internal mould of left valve, Bundella Formation, shore platform, Wheatleys Bay, Cygnet at EN018168; GST 14346, poorly preserved internal mould, *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175; GST 14350, internal mould of right valve, Bundella Formation, shore platform, Green Point, Cygnet at EN076181; GST 14351, external mould, Masseys Creek Group, Port Sorell, northern Tasmania at DQ650587.

DESCRIPTION: Large, thick-shelled, biconvex, coarsely-ribbed, calcitic pectinoid shells, with the left valve rather more convex than the right. The ligament area in both valves is bow-shaped and extends the full length of the

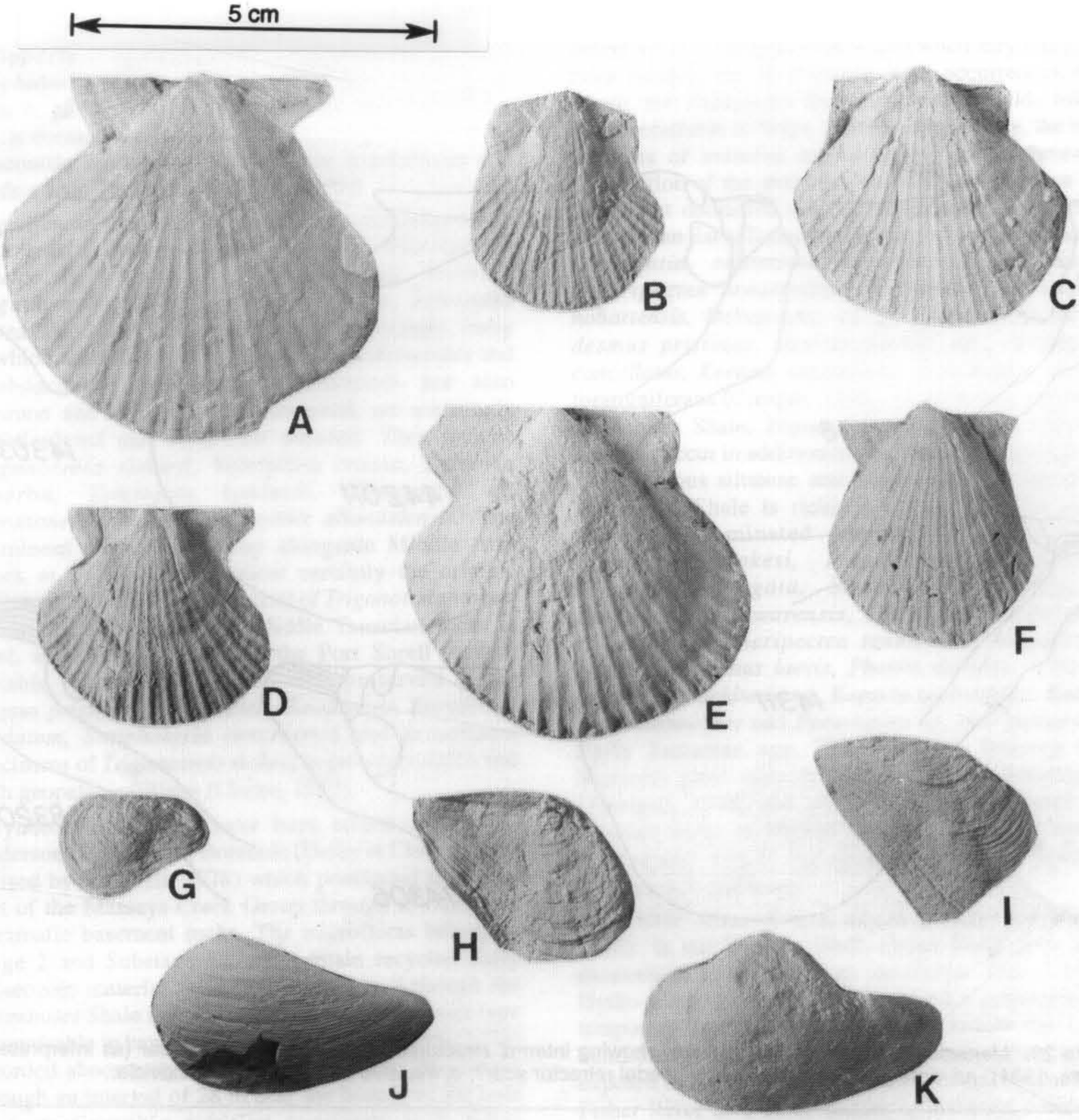

Figure 24. A–F. ***Etheripecten tenuicollis*** **(Dana). A–D, lateral views of left valve internal moulds, GST 14330-3; all specimens have small areas of adherent shell material. E, F, lateral views of left valve internal moulds, GST 441167, GST 14334. A–D, from the** ***Tasmanites*** **Shale, Great Bend of the Mersey River, Latrobe. E, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield. F, from the Bundella Formation, Tobys Hill, Cygnet. G–I.** ***Promytilus cancellatus*** **Maxwell. G, internal mould of right valve, GST 14335, from the basal Bundella Formation, Nicholls Rivulet, Cygnet. H–I, latex casts of left valve external moulds, GST 14336-7, from the** ***Tasmanites*** **Shale, Great Bend of the Mersey River, Latrobe. J, K.** ***Phestia darwini*** **(de Koninck). J, slightly decorticated left valve, GST 8269, from the upper Quamby Formation, Lake River. K, internal mould of left valve, GST 8270, from the basal Bundella Formation, Tobys Hill, Cygnet.**

hinge. There is no chondrophore or distinct resilifer pit, although rare specimens show a poorly marked central area with slightly radiating vertical grooves (fig. 25G). In the right valve the anterior auricle is much larger than the posterior, and is separated from the body of the valve by a groove and a pronounced byssal sinus. It is ornamented by several simple radiating ribs and concentric growth filae. Nodes are formed where the filae cross the ribs. The posterior auricle is flat and separated from the body of the valve by a shallow sulcus, and is similarly ornamented. In the left valve the anterior auricle is larger than the posterior auricle, but lacks the pronounced byssal sinus of the right valve. Both valves are ornamented by 16–26 coarse, rounded, radiating simple ribs crossed by fairly coarse, concentric growth filae. The shell is thick, reaching 5 mm in some specimens. Occasionally secondary shell material obscures the trace of the ribbing on internal moulds. This thickening affects the median shell regions only, and towards the ventral margins the ribs become more pronounced on the inside of the valves, so that in life the two valves were fully interlocking (fig. 26B). Muscle impressions have not been observed. A zigzag pattern in the interlocking lamellae of the shell reported in Western Australia *Deltopecten* (Dickins, 1963, p. 79) is also present in some specimens from Musselroe Bay (fig. 25F) and Cygnet (fig. 26D). Zig-zag patterns have also been recorded in *Indopecten* from the Triassic of the Middle East (Hudson and Jefferies, 1961). Whether these patterns are based on a similar structure is unknown, but several species of *Indopecten* resemble *Deltopecten* in being biconvex and having strong primary ribs that interlock around the shell margins.

REMARKS: When first proposed the name *Deltopecten* was clearly intended to embrace forms which possess a large, triangular or delta-shaped chondrophore such as

Pecten leniusculus Dana, 1847 (Etheridge and Dun, 1906, p. 22, pl. VII, fig. 2), in the mistaken belief that *Aviculopecten* McCoy, 1851 lacked such a structure. However, the nominate type species, *Pecten illawarensis* Morris, 1845, and associated forms of the same basic morphology, do not possess a chondrophore. Thus, paradoxically, most of the species assigned to *Deltopecten* by Etheridge and Dun (1906) are now assigned to *Etheripecten* Waterhouse, 1963 [= *Aviculopecten* M'Coy; Etheridge and Dun, not *Aviculopecten* M'Coy, 1851] and vice versa. Despite this confusion, *Deltopecten* is a valid name which defines a characteristic group of biconvex, coarsely-ribbed, calcitic shells which occur widely throughout Australia and Peninsula India. In Tasmania the genus occurs in considerable abundance until its disappearance in rocks of late Middle Lymingtonian age. In Tamarian rocks the only form present is the very coarsely-ribbed species *Deltopecten illawarensis*; enormous numbers of specimens are present in the so-called 'Erratic Zone' below the Darlington Limestone, north Maria Island. It is followed in younger rocks by a series of species which exhibit finer, more numerous and more complicated ribbing patterns. *Pecten mitchelli* Etheridge and Dun, 1906 is generally considered to be a junior synonym of *Deltopecten illawarensis* (Dickins, 1963). Despite their large size and thick shells there is no reason to believe that species of *Deltopecten* were unable to follow a free-swimming mode of life typical of most pectinoids, although individual travel spans may have been quite short.

Subclass HETERODONTA Neumayr, 1884
Order VENEROIDA Adams and Adams, 1856
Family PERMOPHORIDAE Van de Poel, 1955

Genus **Stutchburia** Etheridge jr, 1900

TYPE SPECIES: *Orthonota* ? *costata* Morris (*in* Strzelecki, 1845, p. 273, pl. XI, fig. 1) by original designation.

Stutchburia farleyensis Etheridge jr
(fig. 16F–L)

1900 *Stutchburia farleyensis* Etheridge jr, p. 183, pl. 32, fig. 3-6.

TYPE MATERIAL: The whereabouts of the type specimen is unknown to me. However, Dickins (1981, pl. 3, fig. 1-11) figures a number of topotypes from the Farley Formation, Hunter Valley, New South Wales. These specimens are in the collections of the Australian Museum, Sydney, numbered F 6596, F 35430, F 38301, F 38303 and F 38295.

MATERIAL AND LOCALITY: GST 441082, GST 441221–44222, three complete articulated internal moulds, from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, northern Tasmania at DQ770255.

DESCRIPTION. Shell more or less modioliform and with a distinct lunule and escutcheon. Ligament opisthodetic, contained in a deep groove which is marginal rather than external. The umbones are subterminal and do not project above the hingeline. Adductor scars subequal, deeply impressed. The anterior adductor is situated close to the anteroventral margin and is bounded behind by a stout buttress. The posterior adductor is situated close to the posterodorsal margin. A small, but well marked pedal scar occurs between the anterior adductor scar and the umbo. The hinge is apparently edentulous. Pallial line is well marked and entire. A broad, shallow sulcus is developed midway along the ventral margin of the valves in two of the specimens. The greatest thickness of the shells is about two thirds the distance to the posterior. The external ornament consists of fine, concentric growth lines and four or five faintly developed radial ribs over the posterodorsal regions of the valves.

REMARKS: Specimens referrable to *Stutchburia* occur in reasonable abundance throughout the Tasmanian sequence. Considerable intraspecific variation about a simple basic morphology makes the recognition of species difficult. The only two readily recognisable species, the very large and coarsely costate *Stutchburia costata* (Morris), 1845 and the wedge-shaped *Stutchburia cuneata* (Dana), 1847, both characterise rocks of Lymingtonian age. The present material is close to *Stutchburia farleyensis* Etheridge as figured by Dickins (1981) from the Farley Formation, New South Wales. Newell (1957) suggests that *Stutchburia* and related forms were byssate, by analogy with the mytilids, in which there is a strong correlation between attachment and reduction of the anterior part of the body.

Subclass PALAEOHETERODONTA Newell, 1965
Order TRIGONIOIDA Dall, 1889
Family MYOPHORIIDAE Bronn, 1849

Genus **Schizodus** de Verneuil and Murchison, 1844

TYPE SPECIES: *Axinus obscurus* J. De C. Sowerby (19821, p.12, pl. 314) by the subsequent designation of de Verneuil, 1845, p. 308.

Schizodus australis (Runnegar)
(fig. 19D–I)

1969 *Neoschizodus australis* Runnegar, p. 280, pl. 19, fig. 8-13.

HOLOTYPE: University of Queensland F 49665, from approximately 50 m above the base of the Conjola Formation, Turisse Point, north of Durras Village, south Sydney Basin, New South Wales.

MATERIAL AND LOCALITIES: GST 441369, GST 441366–441367, complete articulated internal moulds of both valves, GST 441372, internal mould of left valve, all from the lower part of the Spreyton Formation, Great Bend of the Mersey River, Latrobe at DQ390175; GST 441170, internal mould of right valve from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, northern Tasmania at DQ770255; GST 14314, a complete articulated internal mould from the Inglis Formation, Scolyers Hill, Hellyer Gorge area at CQ640235.

DESCRIPTION: Small, triangular shells with orthogyrous umbones and rounded anterior and posterior margins. Both adductor scars well defined, with the anterior scars supported by a thick buttress. There are three pedal scars in each valve; an anterior retractor scar attached to the upper edge of the anterior adductor scar, a posterior retractor scar on the lower edge of the hinge plate above the posterior adductor, and an umbonal retractor scar at the apex of the umbonal cavity. The pallial line is thin and entire. Exterior of valves smooth except for very fine, concentric growth lamellae. The dentition consists of two teeth in the right valve (3a and 3b) and three in the left valve (4b, 2, and 4a); 3a and 2 are large and when articulated 3a is in front of 2; a large depression in front of 3a receives 4b which fits between 3a and the anterior dorsal margin of the valve. The ligament is external and opisthodetic and is set in well defined grooves behind the umbones.

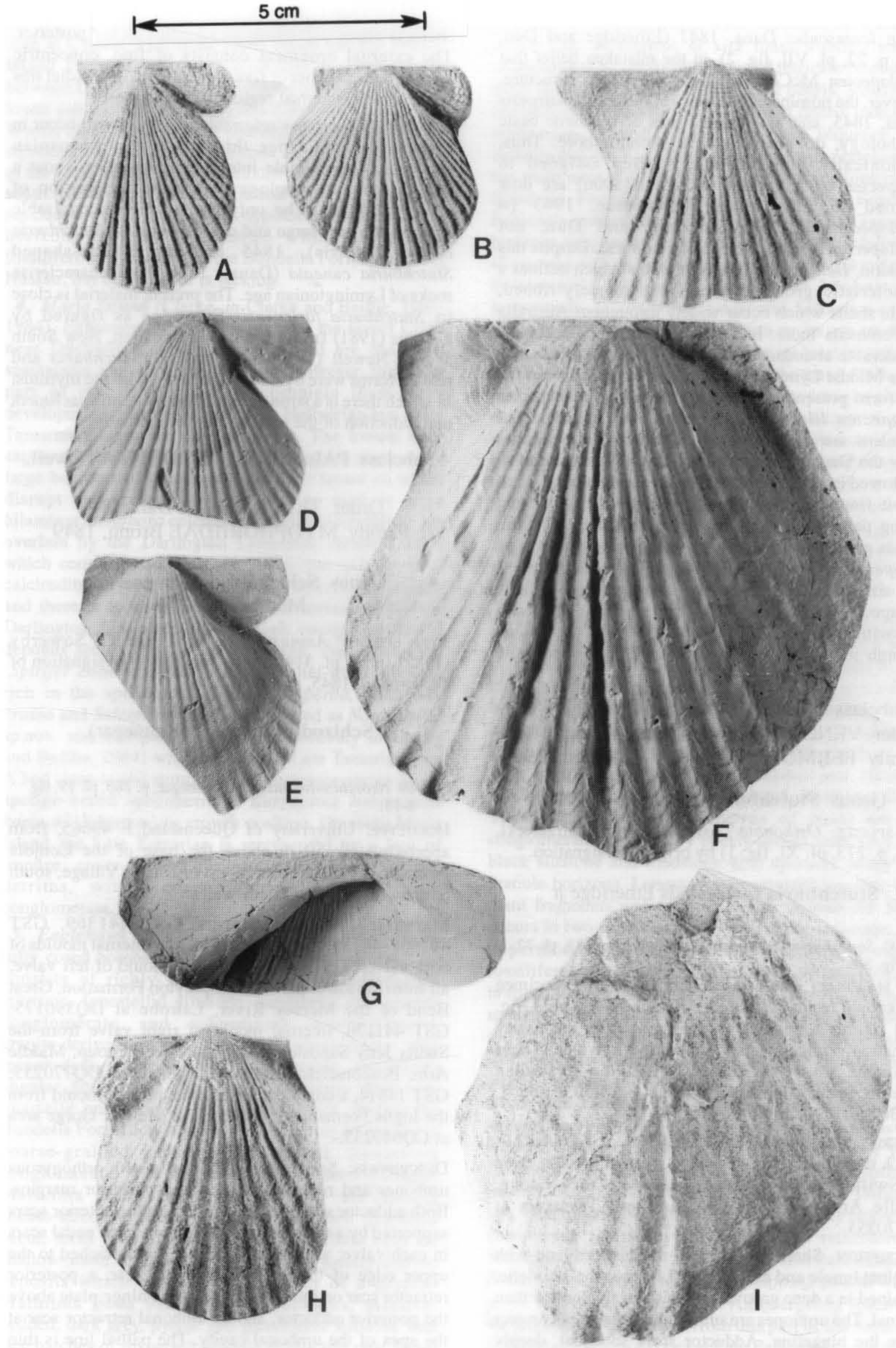

Figure 25. *Deltopecten illawarensis* (Morris). **A, B,** latex casts of right valve external moulds GST 14338-9. **D, E,** right valve internal moulds GST 14341-2. **C, F, H,** internal moulds of left valves GST 14340, GST 14343, GST 14345. **G,** interior of right valve showing the ligament area: note the obscure, narrowly radiating grooves in the centre of the area, GST 14344. **I,** fragmentary internal mould. **A, D, F,** from the basal beds, Musselroe Bay, north-eastern Tasmania. **B,** from the Glencoe Formation, Golden Valley Group, Quamby Brook, Great Western Tiers. **C,** from the Bundella Formation, Tobys Hill, Cygnet. **E, H,** from the Bundella Formation, Wheatleys Bay, Cygnet. **G,** from the '*Spirifer* Zone', Fossil Cliffs, Darlington, Maria Island. **I,** from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe.

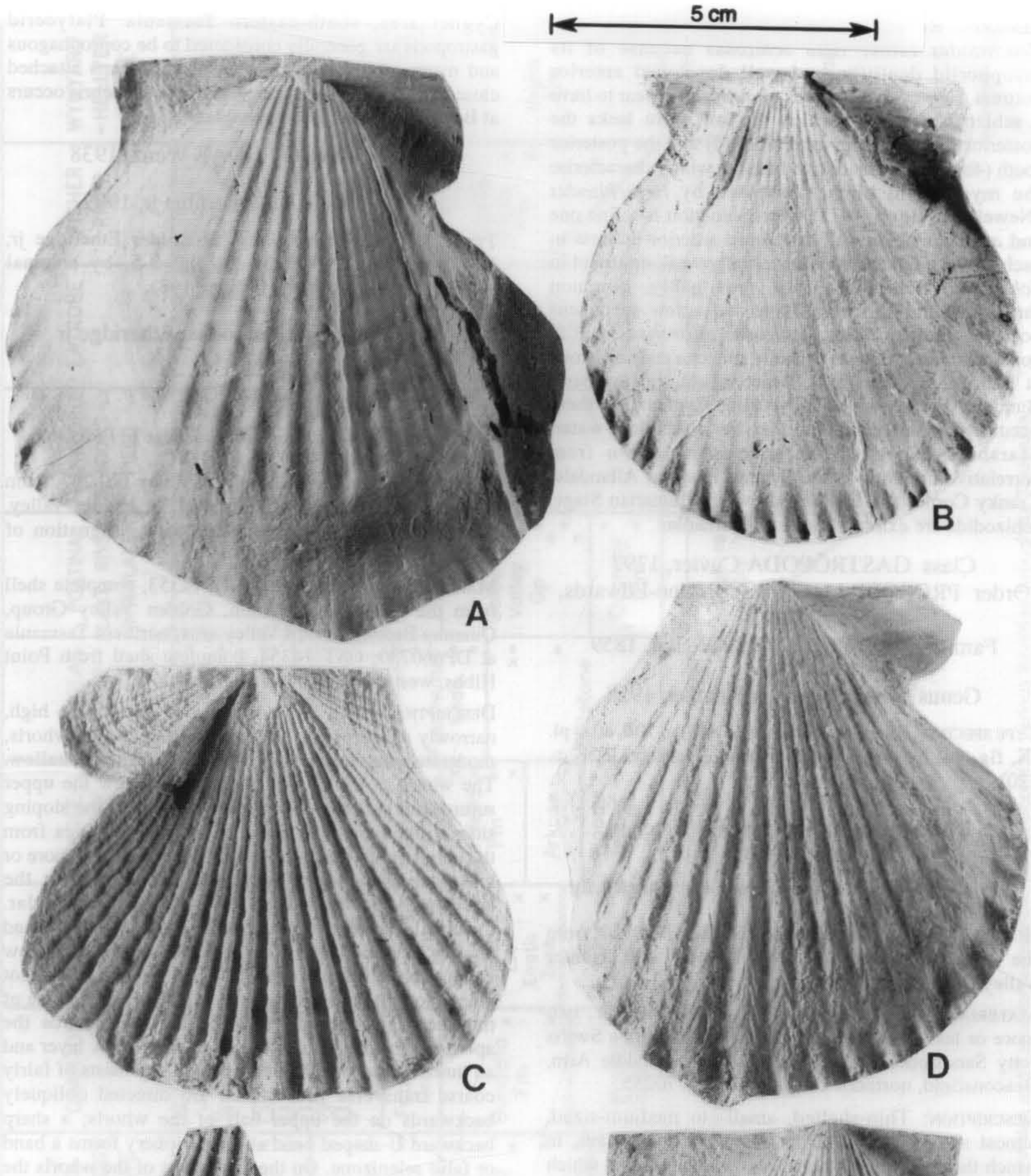

Figure 26. *Deltopecten illawarensis* (Morris). **A, F,** internal moulds of right and left valves GST 14347, GST 14352. **B, C,** internal and external moulds of right valves GST 14348-9. **D,** internal mould of right valve GST 14350. **E,** external mould GST 14351. **A, F,** from the Bundella Formation, Tobys Hill, Cygnet. **B, C,** from the basal beds, Musselroe Bay, north-eastern Tasmania. **D,** from the Bundella Formation, Green Point, Cygnet. **E,** from the Masseys Creek Group, Port Sorell, northern Tasmania.

REMARKS: Runnegar (1969) referred this species to *Neochizodus* rather than *Schizodus* because of its myophoriid dentition and well developed anterior buttress. However, the valves of *australis* appear to have a schizodid hinge in which the left valve lacks the posterior limb of the pivotal tooth (2) and the posterior tooth (4b) is very small, two features which characterise the myophoriid hinge possessed by *Neoschizodus* (Newell and Boyd, 1975). The distinction is a fine one and *australis* has a well developed anterior buttress in each valve, a feature which is usually weak or absent in *Schizodus*. Schizodids are reasonably common throughout the Tamarian Stage and a few specimens occur at most localities. *Schizodus australis* occurs in considerable abundance in sandy siltstone and sandstone at Latrobe, Scolyers Hill, Beaconsfield and the basal Bundella Formation at Tobys Hill, Cygnet. All these occurrences are considered to be in shallow-water, nearshore deposits. The species is known from correlative horizons in the Sydney Basin at Allandale, Cranky Corner and Durras. Above the Tamarian Stage, schizodids are extremely rare in Tasmania.

Class GASTROPODA Cuvier, 1797
Order PROSOBRANCHIATA Milne-Edwards, 1848
Family PLATYCERATIDAE Hall, 1859

Genus **Rhabdocantha** Fletcher, 1958

TYPE SPECIES: *Pileopsis alta* Dana, 1849, p. 706, atlas pl. IX, fig. 14, by original designation (Fletcher, 1958, p. 120).

Rhabdocantha intermedia Fletcher
(fig. 20A-B)

1958 *Rhabdocantha intermedia* Fletcher, p. 124, pl. 7, fig. 10–11

HOLOTYPE: Australian Museum, Sydney F 26950, from the Allandale Formation, near Harpers Hill, Hunter Valley, New South Wales.

MATERIAL AND LOCALITY: GST 421110–421111, two more or less complete internal moulds from the Swifts Jetty Sandstone, Masseys Creek Group, Middle Arm, Beaconsfield, northern Tasmania at DQ770255.

DESCRIPTION: Thin-shelled, small- to medium-sized, almost symmetrically conical to arcuate univalves, in which the shell rapidly narrows towards the apex which is slightly twisted to one side and never in contact with earlier parts of the whorl. The valve is oval to elliptical in cross-section. The apertural margin is not thickened, and is regular and non sinuate. The ornament consists of numerous fine, transverse growth and longitudinal lirae. The shell is elongate, conical; gently arcuate and expanding rapidly from the apex and attaining maximum inflation at the aperture. The apex is obtuse and does not project beyond the apertural margin, is not incurved and is slightly twisted to one side. The dorsal margin of the shell is broadly and evenly convex, and the ventral margin slopes concavely in a curve from the aperture to the apex. The aperture is elongatedly oval with regular and straight margins. The internal moulds are marked by numerous transverse growth undulations and lesser, finer longitudinal grooves. The shell substance is thin.

REMARKS: The present material compares very closely with the type material from the Allandale Formation, New South Wales. Platycerids are very rare in Tasmanian Late Palaeozoic rocks and the only other specimens known to me are a few partly flattened and incomplete internal moulds from the Bundella Formation in the Cygnet area, south-eastern Tasmania. Platycerid gastropods are generally considered to be coprophagous and many examples are known of specimens attached close to the anal tube of crinoids. Crinoidal debris occurs at Beaconsfield but is not abundant.

Family SINUOPEIDAE Wenz, 1938

Genus **Keeneia** Etheridge jr, 1902

TYPE SPECIES: *Keeneia platyschismoides* Etheridge jr, 1902, p. 199, pl. 32, pl. 33, fig. 3-5, by original designation (Etheridge jr, 1902, p. 198).

Keeneia platyschismoides Etheridge jr
(fig. 27D-G)

1902 *Keeneia platyschismoides* Etheridge jr, p. 198, pl. 32, pl. 33, fig. 3–5.

1958 *Keeneia platyschismoides* Etheridge jr; Fletcher, p. 132, pl. 14, fig. 1–2, pl. 15, fig. 1-2.

HOLOTYPE: Australian Museum, Sydney FY 257, from the Allandale Formation, Harpers Hill, Hunter Valley, New South Wales (by the subsequent designation of Brookes Knight (1941, p. 163).

MATERIAL AND LOCALITIES: GST 14353, complete shell from the Glencoe Formation, Golden Valley Group, Quamby Brook, Golden Valley area, northern Tasmania at DP660730; GST 14354, complete shell from Point Hibbs, western Tasmania at CN586804.

DESCRIPTION: Shell large, trochiform, wider than high, narrowly phaneromphalus; spire of four or five whorls, moderately depressed; body whorl large, sutures shallow. The whorl profile is well shouldered below the upper suture, and is flattened to gently convex on the sloping sides to the periphery; flattened to gently convex from the periphery to the umbilicus. The periphery is more or less sharply angular, becoming sub-angular at the aperture. Aperture large, obliquely quadrangular. Columella lip almost straight, thickened and reflected slightly over the umbilicus. The outer lip with a narrow insinuation developed at the periphery of the whorl, not a notch or slit, culminating in a selenizone. The base of the shell is flattened becoming arched towards the aperture. The shell is thick with an outer thick layer and an inner thin layer. The ornamentation consists of fairly coarse transverse lirae which are directed obliquely backwards on the upper half of the whorls; a sharp backward U-shaped bend at the periphery forms a band or false selenizone. On the lower part of the whorls the lirae extend forwards in a shallow sigmoidal curve and are gathered together as they enter the umbilicus.

REMARKS: This species is common throughout Tasmania. It is commonest in the Tamarian Stage where large individuals are sometimes 100 mm or more in diameter. It is one of the characteristic components of faunas of the Gondwanan Realm and, like *Eurydesma* and *Deltopecten*, it is much longer ranging in Tasmania than in Queensland, with the corollary that cold-water conditions persisted longer in the south than in the north.

Keeneia twelvetreesi Dun
(fig. 27A-C)

1913 *Keeneia twelvetreesi* Dun, p. 8, pl. II

HOLOTYPE: Queen Victoria Museum, Launceston 1957:38:342, from the *Tasmanites* Shale, Great Bend of the Mersey River, Latrobe at DQ390175.

MATERIAL AND LOCALITY: GST 8297, a complete specimen from the Glencoe Formation, Golden Valley Group, Quamby Brook, Golden Valley area at DP660730.

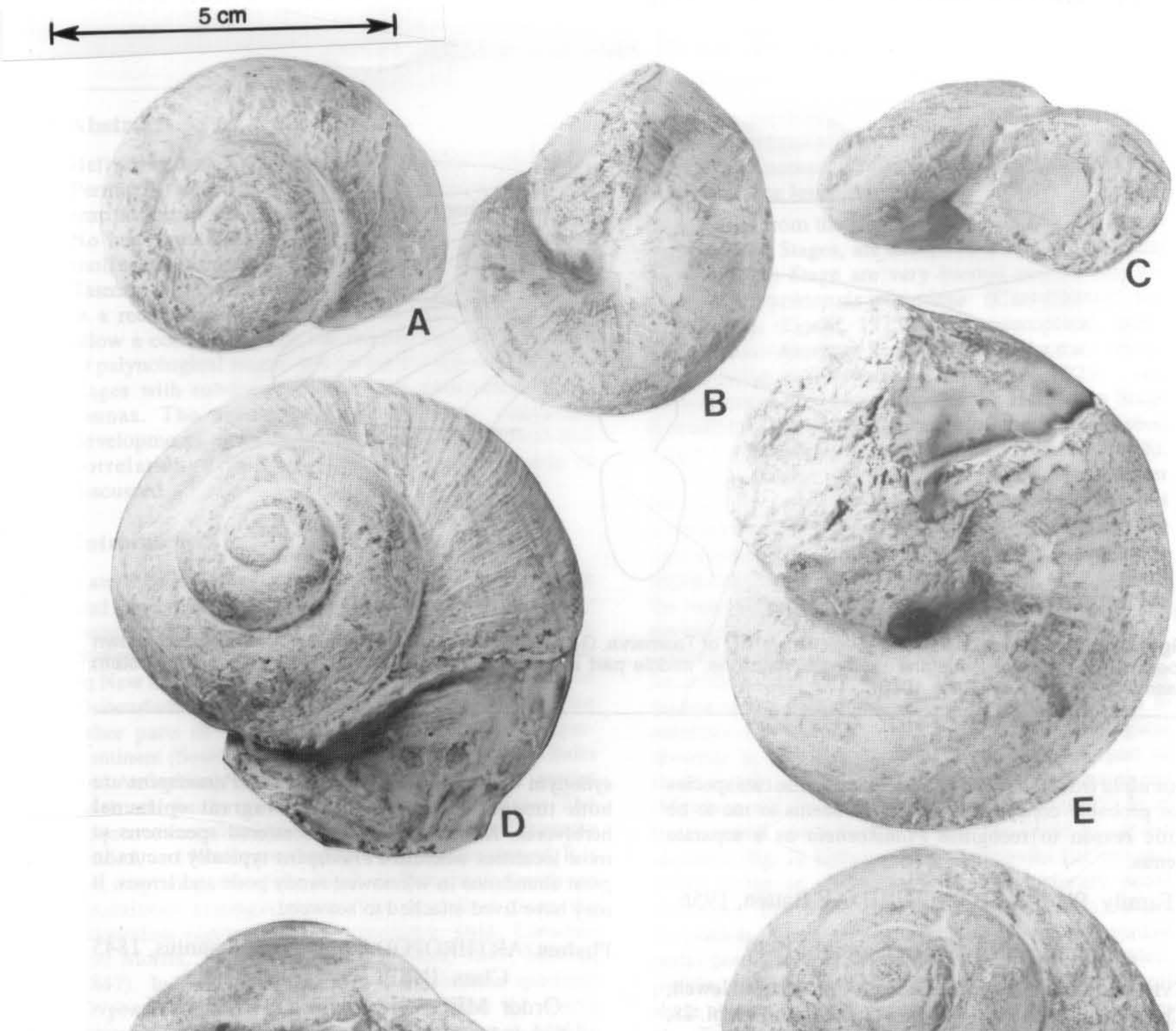

Figure 27. *Keeneia twelvetreesi* Dun. A–C, apical, basal and apertural views of GST 8297, from the Glencoe Formation, Golden Valley Group, Quamby Brook, Great Western Tiers. D–G, *Keeneia platyschismoides* Etheridge. D–E, apical and basal views of GST 14353, from the Glencoe Formation, Golden Valley Group, Quamby Brook, Great Western Tiers. F–G, apertural and apical views of GST 14354, from Point Hibbs, western Tasmania. All specimens × 2.

DESCRIPTION: Small- to medium-sized shells, subturbinate to almost heliciform in shape; the spire is very low and blunt, and consists of four whorls which taper rapidly. The body whorl is almost circular in cross-section and forms more than half the height of the shell. The base is strongly phaneromphalus. The aperture is almost circular; outer lip is thin with no trace of a sinus, inner lip callosed. The ornamentation consists of rounded growth ridges which are strongly inflected at the centre of the body whorl, and form a slightly raised band without lateral ridges or depressions. The band is sub-sutural on the preceding whorls.

REMARKS: This species is readily distinguished from *Keeneia platyschismoides* by its smaller size, lower spire and more rounded whorl cross-section. It is less widely distributed than *platyschismoides* both geographically and stratigraphically, and is known to me only from rocks of Tamarian age at Latrobe and the Central Plateau area. Fletcher (1958) in his major revision of *Keeneia* and related forms from New South Wales, created the new genus *Planikeeneia* for those forms with low, depressed spires and rounded whorl profiles. he was unable to locate the type material of Dun's species, but noted the close similarity between it and his species *Planikeeneia*

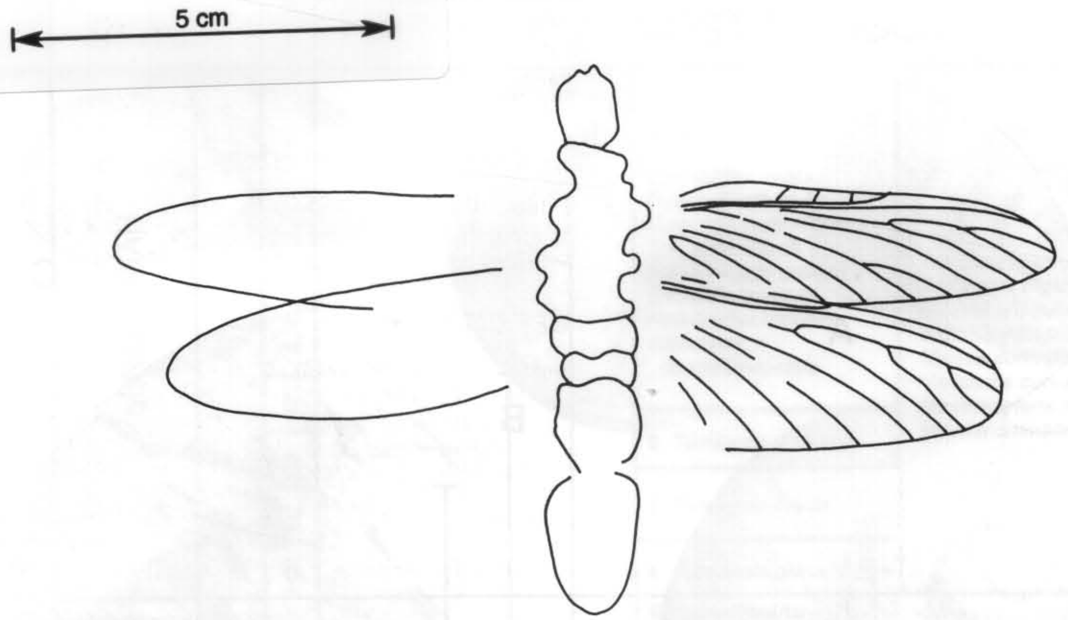

Figure 28. *Psychroptilus burrettae* Riek. University of Tasmania, Geology Department F 94563, holotype and only known specimen. From glacilacustrine rhythmite claystone, middle part of the Wynyard Tillite, Hellyer Gorge, north-western Tasmania. × 2.5 (After Riek, 1976).

insculpta from the Allandale Formation. The two species are probable conspecific, and there seems to me to be little reason to recognise *Planikeeneia* as a separate genus.

Family PHYMATOPLEURIDAE Batten, 1956

Genus **Peruvispira** Chronic, 1949

TYPE SPECIES: *Peruvispira delicata* Chronic (*in* Newell, Chronic and Roberts, 1949, p. 147; 1953, p. 139, pl. 28, fig. 9–12) by the original designation of Chronic.

Peruvispira sp.
(fig. 21D–G)

MATERIAL AND LOCALITY: GST 14322–14325, more or less complete external moulds from the Hickman Formation, Harts Hill, near Margate at EN203342.

DESCRIPTION: Small to very small, high-spired shells with a prominent selenizone or slit-band bordered by strong carinae above and below, and a third underlying carina which defines a strong peribasal concave band. The ornament consists of pronounced growth-lines which after leaving the base of the selenizone, swing forward across the concave area and then back across the revolving carina and over the base of the whorl.

REMARKS: Small ptychomphalinids occur abundantly throughout the Tasmanian sequence. Forms which lack the pronounced concave area below the slit-band are generally referred to *Ptychomphalina* Fischer, 1885. Whether this is a valid criterion for separation is debatable as the development of the concave area is highly variable. Sometimes it is narrower than the slit-band (fig. 21D, F), sometimes it is wider than the slit-band (fig. 21E), and in others it is poorly marked (fig. 21G). Similarly the angularity or roundedness of the whorl profiles show considerable variation. All four specimens illustrated herein occur in the same small piece of rock and it is difficult to believe that they belong to different species or genera. The genus *Pleurocinctosa* Fletcher, 1958 is generally considered to be a junior synonym of *Peruvispira*. *Keeneia* and *Peruvispira* are both thought to be benthonic, vagrant epifaunal herbivores. *Keeneia* occurs as scattered specimens at most localities whereas *Peruvispira* typically occurs in great abundance in winnowed sandy pods and lenses. It may have lived attached to seaweed.

Phylum ARTHROPODA Siebold & Stannius, 1845
Class INSECTA Linné, 1758
Order MEGASECOPTERA Riek, 1976
Suborder NEOSECOPTERA Riek, 1976
Family PSYCHROPTILIDAE Riek, 1976

Genus **Psychroptilus** Riek, 1976

TYPE SPECIES: *Psychroptilus burrettae* 1976, p. 230, fig. 2, by original designation.

Psychroptilus burrettae Riek
(fig. 28)

1976 *Psychroptilus burrettae* Riek, p. 230, fig. 2.

HOLOTYPE: University of Tasmania, Geology Department F 94563, from rhythmite claystone near the middle of the Wynyard Tillite, Hellyer Gorge, north-western Tasmania at CQ780338.

REMARKS: This species is known only from the type specimen and was fully described by Riek (1976) who assigned it to a new suborder of insects, the Neosecoptera. It is quite dissimilar to other insects recorded from glacigene rocks of a similar age in Antarctica and Zimbabwe (Tasch and Riek, 1969; Riek, 1974). It is illustrated herein for the sake of completeness.

TRACE FOSSILS

Genus **Tasmanadia** Twelvetrees, 1929

TYPE SPECIES: *Tasmanadia twelvetreesi* Chapman, 1929, p. 5, by monotypy.

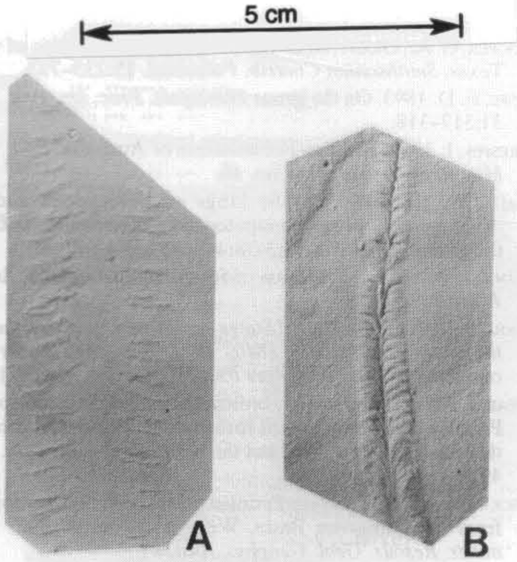

Figure 29. A, *Tasmanadia twelvetreesi* Chapman. University of Tasmania Geology Department F 59257, holotype specimen from rhythmite claystone, middle Wynyard Tillite, Hellyer Gorge. **B,** *Gyrochorte* sp. University of Tasmania, Geology Department F 94000, from rhythmite claystone, basal Wynyard Tillite, shore platform, Pine Point, Wynyard. × 2.

Tasmanadia twelvetreesi Chapman
(fig. 29A)

1929 *Tasmanadia twelvetreesi* Chapman, p. 5, pl. 1.

HOLOTYPE: University of Tasmania, Geology Department F 59257, from rhythmite claystone, Wynyard Tillite, Kirkups Quarry, Arthur River, north- western Tasmania.

REMARKS: *Tasmanadia*, originally described as a polychaete worm and assigned a Cambrian age (Chapman, 1929), consists of a double row of very sharp transverse imprints which are mostly single, but some are joined internally, or rarely externally, to form bifid impressions. Conclusively proved to be arthropod trails by Glaessner (1957), larger specimens show both straight and curved portions, as well as examples where individual trails are superimposed. The original Cambrian age assignment (Chapman, 1929) was presumably based on the erroneous identification of the host rock as slate (Gulline, 1967). *Tasmanadia* occurs in great abundance in the lower part of the main rhythmite claystone interval which occurs near the middle of the Wynyard Tillite in the Hellyer-Arthur River area, north-western Tasmania.

Genus Gyrochorte Heer, 1865

TYPE SPECIES: *Gyrochorte comosa* Heer, 1865, by subsequent designation by Häntzschel, 1962, p. W196.

Gyrochorte sp.
(fig. 29B)

MATERIAL AND LOCALITY: University of Tasmania, Geology Department F 94000, from rhythmite claystone, Wynyard Tillite exposed on the foreshore at Pine Point, Wynyard.

REMARKS: *Gyrochorte* consists of ridges on bedding-planes with biserially arranged, obliquely directed transverse pads, the two series separated by a median furrow. The causative organism is unknown. Samples from Pine Point processed for palynological residues yielded a Stage 1 *Potonieisporites* Microflora and the spinose acritarch *Veryhachium* (Truswell, 1978), which suggests marine conditions of deposition. Only a single specimen is known from Tasmania, but the morphology has been recorded from rocks of Cambrian to Tertiary age elsewhere.

ACKNOWLEDGEMENTS

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