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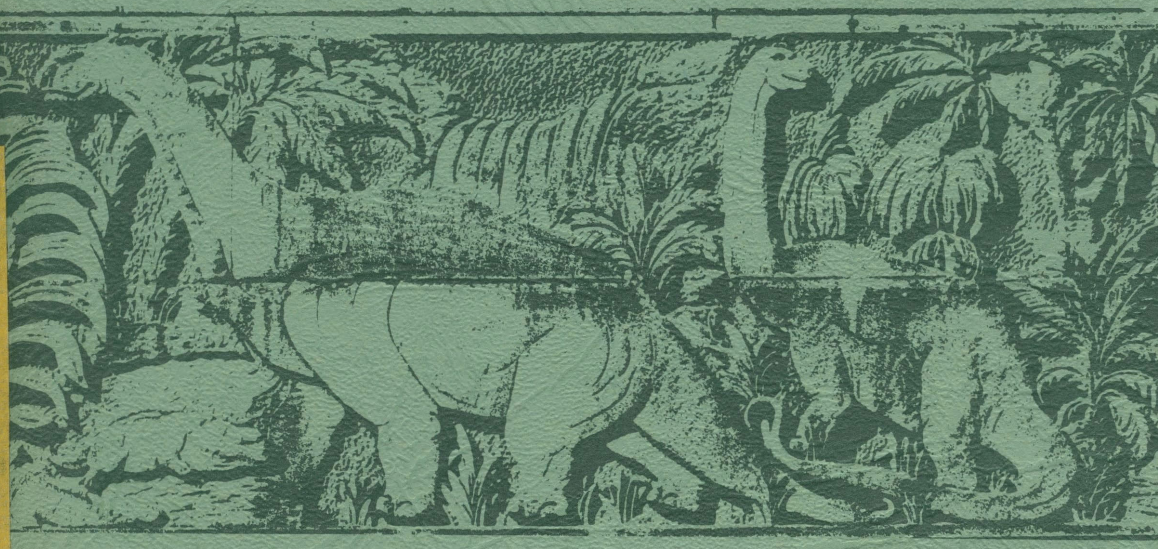

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REVISION OF THE BIVALVED MOLLUSCA DESCRIBED BY JAMES DWIGHT DANA 1847-1849 FROM THE PERMIAN OF EASTERN AUSTRALIA

by **J.B. Waterhouse**

ABSTRACT. The Permian Bivalvia collected and described by J.D. Dana (1847, 1849) from the Sydney Basin, New South Wales, Australia are revised and illustrated from the collections at the Smithsonian Institution, Washington, D.C. The morphology of some genera erected by Dana (1847) is clarified, and some of the obscure species, such as *Pecten mitis, Astarte gemma,* and *Pholadomya glendonensis* are redescribed. Statistical summaries are presented for some of the species with controversial limits, such as *Pyramus myiformis* Dana, *Notomya securiformis* M'Coy, and various species of *Astartila.* Newly proposed names are *Polidevcia cryptica* for *Nucula concinna* Dana, 1847 not *Nucula concinna* Sowerby, 1836; and *Astartila runnegari* for *Pachydomus ovalis* M'Coy, November 1847, not *Pachydomus ovalis* Sowerby, February 1847, the latter new name a subjective synonym of *Astartila intrepida* Dana.

INTRODUCTION

The Dana collection of Permian marine invertebrates from New South Wales was made in the years 1839–1840 by J.D. Dana on the Wilkes expedition. It was described in Dana (1847, 1849), and is housed largely at the U.S. National Museum of Natural History, Smithsonian Institution, Washington D.C., with some specimens at Peabody Museum, Yale University.

James Dwight Dana was born at Utica, New York State, in 1813, and graduated from Yale University in 1833, where he became Silliman Professor in Geology in 1850. He was an astonishingly gifted and productive man, producing the famous System of Mineralogy, tomes on corals, anemones, and hydroids, Crustacea, manuals and text books on geology, and works on volcanoes, and coral islands.

What contributed considerably to Dana's great range of interests was his participation in the United States Navy Exploring Expedition from 1838 to 1842. This expedition was charged with enquiring into possibilities of trade, and charting regions of the Atlantic and especially the Pacific Oceans, and investigating Antarctica, in all a very grandly conceived scheme of scientific and commercial exploration and diplomacy. According to Brixby (1966), the very scope of the plan invited political interference. Command of the expedition was given to a Lieutenant Charles Wilkes. Exactly how or why is no longer clear, but President Martin van Buren or his advisors were to change their minds about his suitability, and at the last moment refused to promote Wilkes to Captain, as they had promised (Brixby, 1966). A mere Lieutenant was to command an expedition of six vessels. Wilkes decided he could not lose face in visiting so many foreign ports, and therefore masqueraded as a Captain for the length of the expedition. There was the usual graft and stealing by contractors supplying the expedition. The deplorable food provided in the United States had to be replaced in South America, most of the ships were in bad repair, and Dana's vessel, the Peacock, built only a few years before, was unseaworthy, not only with

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her masts and rigging unsafe with dry rot, but the interior bilges and pumps rusted away. One ship, the Sea Gull, vanished without trace after leaving Orange Harbour in the Straits of Magellan.

Nonetheless, the expedition worked its way south, and then west, and late one evening in December, 1838, the flagship Vincennes and the Peacock made their own way into Sydney Harbour, to be joined later by other vessels. Here Wilkes came to appreciate more profoundly the lack of real preparation for Antarctic conditions: no ice saws, no special strengthening of the hulls. With good advice freely provided, Wilkes managed to take more precautions against the Antarctic conditions,, and also managed to conceal from the Australians the embarassing disrepair and poor state of some of his ships.

Four ships sailed south from Sydney just after Christmas; within a week, the Flying Fish was forced to limp back crippled to New Zealand, and the Peacock had to return early to Sydney.

The scientists were left at Sydney. Dana and his colleagues spent some three months in New South Wales, before sailing on to New Zealand, and Dana collected extensively from the Permian in the Sydney Basin, in the Hunter Valley and along the south coast, as recorded in Chapter 9 of Dana (1849), entitled "Geological Observations on New South Wales," with a map of New South Wales, and a more detailed map of the south coast from Bulli to Shoalhaven River. Fossil shells were collected from Wollongong Point, Black Head, Rocky Cove and three miles south of Kiama, and Shoalhaven along the south coast, and from beds regarded as roughly correlative in the Hunter Valley, at Glendon, and Harper's Hill.

Home by June, 1842, Dana accepted a government contract to prepare reports on his material collected during the expedition. Lieutenant Wilkes was now in charge of editing the reports, and this made difficulties. According to Fenton and Fenton (1945, p.219) Wilkes made copious and unacknowledged use of the notes and journals of his scientific colleagues, and forbade Dana to use previously published names for his corals, on the grounds that such were not "discoveries." Wilkes had his own troubles, and his misunderstandings should not be condemned. He was court-martialled on his return by a government highly incensed at his temerity in protesting about the dishonesty of contractors, and was mocked by his colleagues in the navy because the Ross expedition from Britain sailed their ships where he had reported mountains. It seems he did not triangulate his peaks, and misestimated distance. The fact that he won more honour overseas, and was awarded the gold medal of the English Royal Geographic Society could hardly compensate for troubles at home. He had neither the power nor the backing to fully exploit the discoveries of the expedition. The publications were seriously mishandled. The edition on the corals, anemones, and hydroids was limited to 100 copies, to be presented to foreign rulers and few institutions — they were to be regarded as a display piece or vanity item. The publishers were permitted to issue a further 75 to 100 copies — but Dana himself received not a copy, and was subjected to furious protest in arranging to buy some copies for colleagues.

Dana's work on Permian fossils appeared as two publications. The first, in July, 1847, narrowly preceded descriptions by F. M'Coy, (September, 1847) and the complete and illustrated descriptions appeared as part of the expedition reports in 1849. The illustrations, in a separate folio, are of chief value, and are extremely rare,

though it is possible now to acquire good photographic copies.

The collection has always been a significant one, one of the first to be made from extensive Permian outcrops or "sandstone strata below the coal" (Dana, 1849, p.484) in Australia, with new bivalve genera that have since been discovered widely in Gondwanaland, and also in Arctic Siberia. First-hand examination of the collections have been made by only a few workers, including Newell (1956) and Muir-Wood and Cooper (1960). Australian palaeontologists have been forced to rely on rare copies of the Dana text, or examine plaster duplicates of the type material (usually only the figured specimens), kept at the Australian Museum, Sydney, and the Bureau of Mineral Resources, Canberra. These moulds, generously and well prepared by the Smithsonian Institution, are no substitute for actual material. It therefore appears timely to re-examine Dana's material, especially the Bivalvia which make up most of his taxa. In this way unfigured material may be examined also, and the rare illustrations of Dana may be reinforced by photographs of type and other material; certain misconceptions based on interpretation of plaster duplicates may be clarified, and special attention paid to providing measurements, as a basis for population studies now needed to delimit the diversity and range of bivalve species in the Australian Permian. This study, it must be stressed, has narrow limits: it is concerned with a few specimens collected from somewhat uncertain horizons, so that in some cases it is only possible to frame questions that need to be answered from further work on the Australian Permian bivalves.

SUBSEQUENT STUDIES

Dana was almost first to study the Permian bivalves which are so abundant in Permian rocks of New South Wales, narrowly following limited studies by Sowerby (1838) and Morris (1845). He was certainly the most professional of geologists to make early collections from the Permian faunas. This shows in the quality of his material. His fossils came from a wider range of rocks, and are better preserved on the whole than the otherwise excellent collection studied by F. M'Coy (1847), who had the bad luck to have several of his names pre-empted in the earlier study by Dana. Dana's genera and species have been in constant use ever since his publications. Significant contributions on *Eurydesma* and the Permian Pectinina were made by Etheridge and Dun (1906, 1910) and on *Stutchbuha* and *Merismopteria* by Etheridge (1900, 1892, 1919). A number of the bivalves were widely and well revised by H.O. Fletcher (1929a,b, 1932, 1945) when curator at the Australian Museum, Sydney, in a series of monographs on the Sydney Basin, using plaster moulds of Dana's material for reference. His work deserves much praise and provided continuity between Dana and the present, with the provision of well curated substantial collections and careful descriptions. More recently, *Eurydesma* and members of the Anomalodesmata have been extensively summarised in Runnegar (1967, 1970). Waterhouse (1969b, 1982) published two monographs and other papers principally on occurrences of Dana's taxa in New Zealand, with some revision of the types, and a monograph on the bivalves in the Permian faunas of the south-east Bowen Basin in Queensland (Waterhouse, 1987).

In addition, a substantial number of papers have listed fossil species for Permian faunas of eastern Australia, and frequently include Dana's species and

genera. But these lists have proved to be of very limited value in the absence of systematic study, and are better ignored.

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I am also grateful to Mr. H.O. Fletcher and Dr. A. Ritchie, for making it possible to examine and borrow material from the Australian Museum, Sydney, to Dr. C.O. Forbes, for enabling me to examine and borrow material described by M'Coy (1847) at the Sedgwick Museum, Cambridge; to Dr. N.J. Morris and Mr. S. Ware for granting facilities to examine material described by Sowerby (1838) and Morris (1845) at the British Museum (Natural History), London; and to Drs. C. McClintock and A.L. McAlester for permission to examine Dana's material at the Peabody Museum, Yale University, New Haven. Photographs are by Mr. B. O'Donovan, and text figures by Mr. F. Jurgenheit, Department of Geology, University of Toronto. Expenses for this research have been provided by the National Research Council of Canada and a grant from the Australian Research Grants Scheme as part of the study on the Late Palaeozoic rocks and faunas of the Bowen Basin.

Registration of Specimens

Specimens at the U.S. National Museum of Natural History are registered, serially, by number with the prefix USNM. The place of storage of other registered specimens is provided when mentioned in the text.

SYSTEMATIC DESCRIPTIONS

Subclass Palaeotaxodonta Korobokov, 1954

Order Nuculoida Dall, 1889

Superfamily Nuculanacea H. Adams and A. Adams, 1858

Family Nuculanidae H. Adams and A. Adams, 1858

Subfamily Phestiinae Kumpera *et al.*, 1960

Genus *Polidevcia* Chernyshev, 1951

Discussion. The name *Polidevcia* was proposed by Chernyshev (1943, p.35) without a type species, and validated in 1951 (p.25) by designation of a type species *Leda karagandensis* Chernyshev (1941, p. 119, pl.29, figs. 7a, b). Lintz (1958) protested at the diagnoses of *Polidevcia* and *Phestia,* and erected another genus *Cidunana* for a better known North American species, *Leda bellislriata* Stevens, 1858, which on the whole seemed closely allied to *PLestia.* No lectotype was designated because Stevens' specimens are lost, and in revising Lintz's genus, McAlester (1968, p.25) did not designate a neotype on the grounds that the "species can be recognised with

reasonable certainty from Stevens' original description." But there must be type material if there is to be adherence to the rules of Zoological Nomenclature and "Specimen B" figured by Hall (1858, p.717, pl.29, fig. 6C; refigured by McAlester, 1968, pl.34, figs. 9, 10, 11) is here selected as neotype. It is registered as 8370/lb from the Upper Carboniferous "Lower Coal Measures" from an unknown locality in Illinois, and is kept at the American Museum of Natural History, New York. It clearly comes very close to *Phestia*, and *Culunana* is here regarded as a junior synonym of that name, even though Ciriacks (1963, p.41) and Amerom *et al.* (1970) referred *bellistriata* to *Polidevcia.*

Dickins (1963), followed by Logan (1967) and Puri in Cox et al. (1969), synonymised *Polidevcia* with *Phestia.* This view was not accepted by Waterhouse (1965b) who considered that differences of the escutcheon alone according to the original definition warranted generic separation. These differences are amply brought out in the illustrations by McAlester (1968, pl.34), which confirm the view of Chernyshev (1951) that two genera are present. McAlester himself offered simply a description of type material, with no assessment of validity. Schldmer (1967) and Amerom *et al.* (1970, p.43) emphasized the presence in *Polidevcia* of the inner umbonal ridge, but this is also present and longer in *Phestia.*

Dana's material is decorticated, and does not show the cardinal region well, so that generic position is not clear.

Polidevcia? cryplica nom. nov.

Pl. 1, figs. 1, 2, 5

not *Nucula concinna* Sowerby, 1836.
?Nucula Dana, 1847, p.l57.
Nucula concinna Dana, 1849, p.699, pl. 7, fig. 4.
Nuculana concinna Dana, Fletcher, 1945, p.3O5, pl. 22, fig. 3, not 4, 5.

Holotype. USNM 3635, sole specimen figured and described by Dana (1849), and refigured by Fletcher (1945, pl. 22, fig. 3), by monotypy, from Allandale Formation of Harper's Hill, "Illawarra" (really Hunter Valley), New South Wales.

Diagnosis. Small *Polidevcia?* with well rounded ventral margin and low umbones. Species poorly known.

Dimensions in mm of *Polidevcia?. cryptica* nom. nov.

Specimen	Length	Height	Width	Length of anterior	Umbonal angle
USNM 3635	+ 22	+ 14.3	7.5	9	7120°

Description. The specimen is very poorly preserved with a little shell left along the hinge. It has low umbones, and well rounded anterior and ventral margin. There is no well defined lunule, and the escutcheon appears to be large, with two sub-median ridges faintly and not definitely indicated. It is slightly elevated along the mid-line by a ridge each side of the commissure. Comarginal costae are fine, 2 per millimetre, and parallel to the margin where preserved on an anterior fragment of shell. Fletcher (1945, p.3O5) estimated that the umbonal angle was close to 135°.

Faintly impressed anterior and posterior adductors are visible on the right valve, with suggestions of an entire pallial line. A pedal scar possibly lies behind the anterior adductor, and another possibly at the umbonal tip, but there are no well defined scars on the umbonal flanks.

Resemblances. The specimen assigned to this species by Fletcher (1945, pl. 22, figs. 4-5) from Abermain No. 3 shaft near Cessnock, New South Wales, 200 ft. above the base of the Branxton Formation is moderately similar in shape, but has coarse costae (3-4 in 5mm posteriorly). It is distinguished from Dana's specimen by having a beaded escutcheon ridge, and was referred to a new species *Polidevcia nodulosa* Waterhouse (1956, p.641).

Polidevcia! abrupta (Dana, 1847)

Pl. 1, fig. 3

Nucula abrupta Dana, 1847, p. 157.
Nucula abrupta Dana, 1849, p. 698, pl. 7, figs. 3, 3a.
Nuculana abrupta Dana, Fletcher, 1945, p. 303, pl. 21, figs. 4-6.
Holotype. USNM 3640, specimen figured by Dana (1849, pl. 7, figs. 3, 3a) and refigured by Fletcher (1945, pl. 21, fig. 4), by monotypy from Gerringong Volcanics, Flagstaff Point, "Wollongong, Illawarra", New South Wales.
Diagnosis. Medium-sized shells with low costae and well formed pedal scar on lateral flanks.
Dimensions in mm of *Pl abrupta* (Dana).

Specimen	Length	Height	Width	Length of anterior	Umbonal angle
USNM 3640	+ 32	+ 27.7	5.4	12	100°

Discussion. The poor preservation of the dorsal region makes identification difficulty, but adductor scars and integripalliate pallia! line are well displayed on the holotype. The specimen figured by Fletcher (1945, pl. 21, fig. 6) appears to have an inner escutcheon ridge as in *Polidevcia.*

Subclass Pteriomorphia Beurlen, 1944
Order Ptcrioida Newell, 1965
Superfamily Pteriacea Gray, 1847
Family Pterineidac Miller, 1877
Genus *Merismopteria* Etheridge, 1892
Merismopteria imbricaia (Dana, 1847)
Pl. 1, figs. 4, 6-9, 11

Modiolopsis imbricatu Dana, 1847, p. 159.
Modiolopsis arcodes Dana, 1847, p. 159.
Modiolu crassissima M'Coy, 1847, p. 302, pl. 15, figs. 2, 3.
Cypricardiu arcodes Dana, Dana, 1849, p. 702, pl. 8, figs. 8a, b, 9?
Cyrpricardia imbricala, Dana, Dana, 1849, p. 702, pl. 8, figs. 5, 6, 7.
Merismopteria arcodes Dana, Etheridge, 1919, p. 192.
Merismopteria imbricala Dana, Etheridge, 1919, p. 192.
Types. Lectotype of AY. *imbricala* USNM 3641, figured by Dana (1849, pl. 8, fig. 5), here designated, from Allandale Formation of Harper's Hill, Hunter Valley, New South Wales. See pl. 1, fig. 4, herein. Holotype of *M. arcodes* Dana, USNM 3646, sole specimen described and figured by Dana (1849, pl. 8, figs. 8a, b) by monotypy from Allandale Formation, Harper's Hill, Hunter Valley, New South Wales. Sec pl. 1, figs. 8, 9, herein. Lectotype of *Modiola crassissima* M'Coy 1847, p. 302, pl.

15, fig. 2, here designated, from Harper's Hill, New South Wales.

Diagnosis. Medium-sized highly oblique shells with imbricate growth-lines and small anterior portion. Prismatic shell thick.

Dimensions in mm of *Merismopteria imbricata* (Dana)

Specimen USNM	Length	Height	Width	Umbonal angle	Anterior length	Hinge length
			M. arcodes (Dana)			
3646	38	?30	17.5	120°	10	25.5
			M. imbricata (Dana)			
3641	40		?20	110°	?3.5	28
3641	51	30	17	120°	9	?31

Synonymy. Dana (1847) distinguished *M. arcodes* from *M. imbricata* by its greater width, shorter hinge, especially behind the beaks, thicker umbones, and more carinate posterior umbonal ridge. Etheridge (1919, p. 192) agreed, stressing the robust shape and wide clavicle. Some of these differences such as width and wide clavicle may be due to advanced maturity, and shortness of hinge and posterior wing are probably due to breakage. It is not easy to compare a shelled specimen (type of *imbricata)* with an internal mould (holotype, *arcodes),* and my synonymy is provisional, pending study of more material.

Taxonomy. Dana (1849, p. 702) referred to a figure in pl. 8, fig. 5a, but this is not provided in the plate. Two other figured specimens (Dana, 1849, pl. 8, figs. 6, 7) were not mentioned, though identified as *imbricata* in 1847. They, together with another poorly preserved valve, make up a suite of specimens, compared with one specimen representing *arcodes.* A specimen figured at pl. 9, fig. 8, was mentioned as allied, but this is *Etheripecten mitis,* probably the specimen of pl. 8, fig. 9 was intended. If the two species named by Dana are conspecific, it appears preferable to nominate *imbricata* as the senior species and to place *arcodes* in subjective synonymy. Both species were published on the same page, but *imbricata* was mentioned first in both the original proposal of the species (Dana, 1847, p. 59) and in the first major revision by Etheridge (1919, p. 192).

Specimens from Harper's Hill described as *Modiola crassissima* M'Coy (1847, p. 302, pl. 15, figs. 2, 3) come from the same locality and appear to be similar in shape.

Merismopteria macroptera (Morris, 1845)

Pl. 1, fig. 10; Pl. 2, figs. 1, 3

Pterinea macroptera Morris, 1845, p. 276 pl. 13, figs. 2, 3.
Pterinea macroptera Morris, Dana, 1847, p. 160.
Modiolopsis acutifrons Dana, 1847, p. 159.
Cypricardia acutifrons (Dana), Dana, 1849, p. 702, pl. 8, figs. 4a, b.
Pterinea macroptera Morris, Dana, 1849, p. 704.
lAvicula sublunulata de Koninck, p. 307, pl. 26, fig. 4.
Merismopteria macroptera (Morris), Waterhouse and Jell, 1983, p. 248, pl. 3, figs. 25, 28. See for synonymy and typology.

Diagnosis. Very large prosocline shells with swollen anterior lobes, and variably developed growth lines.

Dimensions in mm of type of *"Modiolopsis" acutifrons* Dana = *macroptera*

Specimen	Length	Height	Width single valve	Anterior length
USNM 3642	90	52	24.5	19

Discussion. Etheridge (1919, p. 192) stated that Dana's form *Merismopteria imbricata* was distinguished by "its transverse obliquity, extended cardinal margins, and gently insinuated ventral margin." De Koninck (1877; 1898, p. 241) on the other hand stated that the two were probably conspecific. The specimen described as *Avicula sublunulata* de Koninck (1877, pl. 16, fig. 4) from Muree (Muree Sandstone Member, middle Maitland Group) is probably conspecific also. It was destroyed in the Garden Palace fire.

Gen. indet. *praerupta* Dana, 1847

Pl. 2, fig. 2

Modiolopsis praerupta Dana, 1847, p. 159.
Cypricardia praerupta Dana, 1849, p. 703, pl. 8, fig. 10.
Stutchburia praerupta Etheridge, 1919, p. 190.

Holotype. USNM 3667, sole specimen figured and described by Dana (1849, pl. 8, fig. 10), by monotypy, from "Carboniferous, lllawarra. New South Wales."

Diagnosis. Elongate moderately inflated shell with modest anterior lobe and no definite radial ornament.

Dimensions in mm of Gen. indet., *praerupta* Dana

Specimen	Length	Height	Width	Anterior length
USNM 3667	34 +	16.5	5.8	1.7

Discussion. Dana (1847) at first grouped this species with *simplex* (now *Stutchburia}, siliqua* (now lost), *imbricata (Merismopteria}, arcodes (Merismopteria},* and *acutifrons (Merismopteria},* as members of the genus *Modiolopsis.* In 1849 Dana transferred most of these species *simplex, praerupta, acutifrons, imbricata,* and *arcodes* to *Cypricardia,* and added *veneris.* These species were subdivided by Etheridge (1889, 1892, 1919) between the genera *Merismopteria* and *Stutchburia* and *praerupta* was included in the latter genus "in the absence of any negative characters" (1919, p. 190). Certainly the species *praerupta* can be readily distinguished from *Merismopteria,* because it has no posterior wing, although it does have an anterior lobe and prismatic shell as in this genus.

Stutchburia is closer in overall shape, but lacks a prismatic shell, and as a rule the anterior lobe. The genus may be related to *Modiolopsis* or *Promytilus,* though the shell is usually less prismatic in these forms and is more oblique in outline. The poorly exposed hinge and musculature make its generic position very obscure.

Suborder Pectinina Waller, 1978
Superfamily Aviculopectinacea Newell, 1938
Family Aviculopectinidae Newell, 1938
Subfamily Etheripectininae Waterhouse, 1982
Genus *Etheripecten* Waterhouse, 1963
Etheripecten ienuicollis Dana, 1847

Pl. 2, fig. 5

Pecten tenuicollis Dana, 1847, p. 160.
Pecten tenuicollis Dana, Dana, 1849, p. 705, pl. 9, figs. 7-7a.
Etheripecten tenuicollis (Dana), Waterhouse, 1982, p. 161, pl. Ig; 2a-g; 3a, d. (See for synonymy).

Holotype. Specimen USNM 3658, figured by Dana (1849, pl. 9, figs. 7, 7a) by monotypy, from Allandale Formation at Harper's Hill, Hunter Valley, New South Wales.

Discussion. This is a small specimen, with ornament worn, and the exterior of the ears poorly preserved. The hinge is not exposed. It comes from the same locality as *Etheripecten subquinquelineatus* (M'Coy, 1847) and somewhat resembles the type of that species in inflation, but is smaller, and has a more curved anterior umbonal slope, and slightly denser higher costae. The species has been discussed by Waterhouse (1982, 1983).

Etheripecten leniusculus (Dana, 1847)

Pl. 2, fig. 6; Pl. 3, figs. 1, 2

Pecten leniusculus Dana, 1847, p. 160.
Pecten leniusculus Dana, Dana, 1849, p. 704, pl. 9, figs. 6a, b.
Pecten mitis Dana, 1849, p. 705, pl. 9, fig. 8.
Etheripecten leniusculus (Dana), Waterhouse, 1982, p. 20, pl. 5a-f; 6a, b, e; 9e. (See for synonymy and diagnosis).
Etheripecten leniusculus (Dana), Waterhouse and Jell, 1983, p. 249, pl. 4, fig. 9.

Types. Lectotype of *Pecten leniusculus* — USNM 3644, figured by Dana (1849, pl. 9, figs. 6a, b), designated by Waterhouse (1982). From Illawarra (locality not specified), New South Wales. See pl. 3, fig. 1, 2 herein. Holotype of *Pecten mitis* Dana, USNM 4758, figured by Dana (1849, pl. 9, figs. 8, 8a), by monotypy, from Glendon, Hunter Valley. See pl. 2, fig. 6 herein.

Dimensions in mm of *E. leniusculus* (Dana)

Specimen USNM	Length	Height	Width both	Width left	Width right	Length anterior in front of umbo	Umbonal angle
3644	+ 94	?92	28.5	15.5	+ 7	+ 51	90°
lectotype	+ 99	95	37	?28	?13	43	70°
3644	+ 102	113	+ 37		16	+ 50	80°

Resemblances. Various specimens of early Middle Permian age in eastern Australia appear to belong to this species.

According to Fletcher (1929a, p. 25) specimens figured as *Deltopecten farleyensis* Etheridge and Dun (1906, pl. 6, fig. 2; pl. 13, fig. 5; pl. 16, fig. 4) from Drake, Boorook, and Pokolbin, New South Wales, really belong to *leniusculus*, but this may not be correct.

The Glendon species *Pecten mitis* Dana (1849, pl. 9, figs. 8a, b) is very badly preserved and distorted with a chondrophore in each valve. Growth lines arch strongly between the primary costae, and costae found in three orders seem to be less dense, at 11 in 10 mm at the anterior margin, compared with 16 in 10 mm at 35 mm

from the umbo in *E. leniusculus* types described by Dana (1849). Etheridge and Dun described Dana's specimen as an indeterminable fragment, and ignored the name.

Deltopecten clarkei Fletcher (1929a, pl. 14, figs. 1, 2; fig. 6), from Sussex Inlet, Gerringong, New South Wales, is allied. According to Fletcher *clarkei* includes *D. limaeformis* of Etheridge and Dun (1906, pl. 10, fig. 3) from Bombaderry, New South Wales, with a chondrophore. Auricles and growth lines are not known. The left valve of a non-cited specimen F 19525 at the Australian Museum, has costae of many orders, the primary being low, and the specimens appear to belong to the *Etheripecten leniusculus* superspecies. Ribs on the right valve are slightly coarser than on the left valve.

Etheripecten leniusculus appears to be close to *Pecten subquinquelineatus* M'Coy (1847, p. 298, pl. 17, fig. 1), from the Allandale Formation at Harper's Hill, Hunter Valley, New South Wales. The shape is very similar, except for a deeper notch in the posterior auricle, more inflated left valve, and the anterior umbonal slope less inclined from the hinge in *leniusculus.* The primary costae are more close-set on the type of *subquinquelineatus* at 4.5 mm compared with primaries 6.5 mm apart in *leniusculus,* but a Gerringong specimen F 19407 of *leniusculus* kept at the Australian Museum and figured by Etheridge and Dun (1906, pl. 3, fig. 1) has strong costae only 4 mm apart, much as in M'Coy's species, though primaries are more close-set posteriorly in this specimen.

Deltopecten depressus Fletcher (1929a, pl. 10, fig. 2) from Kioloa, south coast of New South Wales is another ally, seemingly distinguished only by its larger size — the low inflation being possibly due to slight flattening (F 19485, Australian Museum).

Deltopecten rientsii Mitchell (1927, pl. 2, figs. 1, 2) from the lllawarra District was referred to this species by Fletcher (1929) and Branson (1948) but seems to have fewer costae on the right valve and more primaries with fewer secondaries on the left valve.

Genus *Eletcheripecten* Waterhouse, 1982

Eletcheripecten lalicoslatus Waterhouse, 1982

PI. 2, fig 4

not *Pecten comptus* M'Coy, 1844, p. 90, pl. 15, fig. 14.
Pecten comptus Dana, 1847, p. 160.
Pecten comptus Dana, Dana, 1849, p. 704, pl. 9, fig. 5.
not *Deltopecten comptus* Dana, Fletcher, 1929a, p. 23, pl. 13, figs. 1-4.
Eletcheripecten lalicoslatus Waterhouse, 1982, p. 25, pl. 10b.

Holotype. USNM ' 3652, figured by Dana (1849, pl. 9, fig. 5), designated by Waterhouse (1982) from Allandale Formation of Harper's Hill, "lllawarra" (= Hunter Valley), New South Wales.

Diagnosis. Medium sized shells with numerous broad primary subplicac.

Discussion. Only one specimen was described by Dana (1847). Although referred to *E. subquinquelineatus* M'Coy (a species which in fact was named later than *comptus^)* by Etheridge (1892) and Etheridge and Dun (1906), *comptus* Dana is readily distinguished by the broad primary subplicac. Hosking (1931) referred shells from Western Australia to *Deltopecten subquinquelineatus comptus,* but these are not conspecific.

Fletcher (1929a, p. 23) recorded specimens of *Deltopecten comptus* (Dana) from

Tianjarra, Wandrawandrian Creek, and Lake Tullawulla, St. George's Basin, the latter mentioned as exposing Conjola Formation or Yadboro Conglomerate (early Permian) by McElroy (1969, p. 356). These specimens are not conspecific with *comptus,* having narrower primary ribs, as also discussed by Runnegar and Ferguson (1969).

Probably *Deltopecten wingenensis* Etheridge and Dun (1906) is allied, but has fewer ribs.

Family Deltopectinidae Dickins, 1957

GenusDettopecten Etheridge, 1892

Deltopectenillawarrensis (Morris, 1845)

Pecten illawarensis Morris, 1845, p. 277, pl. 14, fig. 3.
Pecten illawarrensis Morris, Dana, 1849, p. 705, pl. 9, fig. 9.
Deltopecten illawarrensis (Morris), Newell in Cox *et. al.,* 1969, p. N 341.
Deltopecten illawarrensis (Morris), Waterhouse, 1987, p. 154, pl. 6, fig. 6, 9. (See for synonymy).

Holotype. Specimen figured by Morris (1845, pl. 14, fig. 3); PL 3688, British Museum (Natural History), London, by monotypy. See Newell (1938, p. 63).

Dimensions in mm of *Deltopecten illawarrensis* (Morris), right valve

Specimen	Length	Height	Width	Width left valve
USNM3657	89	98	15	26

Resemblances. Deltopecten illawarrensis is found chiefly in the Allandale faunas and equivalents of eastern Australia, especially New South Wales and Tasmania, in beds of late Asselian or Kurmaian age. From Kashmir the Early Permian has yielded allied specimens described by Bion (1928) and Reed (1932). The superspecies arose in the late Carboniferous, with specimens in the Fairyland and Dresden Formations of Bowen Basin (Waterhouse, 1987), and no members are known in the Middle or Late Permian.

Taxonomy. Morris (1845, p. 277) named *"Pecten illawarensis"* from the **"**Illawara district**"**, leaving out the second **"**r**"**. In the caption to the plate the name is spelled *Illavarensis,* (p. xviii) and in the map it is spelled Illawarra L.

The label on the type states it came from Illawara (Bairstow in Newell, 1938, p. 64). Dana (1847, p. 160; 1849, p. 705) emended the spelling to *illawarrensis* from **"**Harper's Hill, Hunter (inserted), Illawarra**"**. Etheridge and Dun (1906, p. 25) when referring to Morris' work spelled the name as *"illawarensis"* with inverted commas but otherwise emended the spelling to *illawarrensis* and were followed by Fletcher (1929a), but not by Newell (1938, p. 63) who retained the original spelling.

From my reading of the rules of Zoological Nomenclature, Article 33a, *illawarrensis* is to be regarded as a justifiable emendation by Dana (1847) and Etheridge and Dun (1906) of the incorrect original spelling *illawarensis* by Morris (1845).

Superfamily Buchiacea Waller, 1978

Family Eurydesmatidae Reed, 1932

Genus *Eurydesma* Morris, 1845

Type species. Eurydesma cordatum Morris, 1845.

Discussion. Newell in Cox *el al.* (1969) referred *Eurydesma* to the Myalinidae, but

there is little similarity. Waterhouse (1980b) favoured a relationship with the Buchiidae, which have a more inflated left valve, as in *Eurydesma,* better developed right anterior ear, and ligamental notch. A genus related to *Eurydesma, Glendella* Runnegar 1970, is significant in this respect, as it is markedly inequivalve with a small flat right valve.

Eurydesma cordatum Morris, 1845

Pl. 4, figs. 1-5; Pl. 5, fig. 1

Isocardia sp. Sowerby, 1838, p. 15, pl. 2, figs. 1, 2.
Eurydesma cordata Morris, 1845, p. 276, pl. 12, fig, 1, upper figure, not 2, 3.
E. globosa Dana, 1847, p. 158.
E. elliptica Dana, 1847, p. 158.
E. cordata Morris, M'Coy, 1847, p. 299.
Pachydomus sacculus M'Coy, 1847, p. 301, pl. 14, fig. 5.
E. elliptica Dana, 1849, p. 700, pl. 7, figs. 6a-d.
E. cordata Dana, 1849, p. 700, pl. 8, figs. 1, la.
E. globosa Dana, Dana, 1849, p. 700, pl. 7, figs. 7, 7a.
E. sacculus M'Coy, Dana, 1849, p. 700, pl. 7, figs. 8-8a.
E. globosum Dana, Koken, 1904, p. 97, text fig. 1-3.
Eurydesma cordatum Morris, Etheridge and Dun, 1910, p. 71, pl. 17, figs. 1-2; pl. 18, fig. 1; pl. 19, figs. 3-5; pl. 20, figs. 2-5; pl. 22, figs. 3-5; pl. 23, figs. 3-4; pl. 25, fig. 3; pl. 26, fig. 4. not pl. 23, figs. 12 = *hobartense.*
Eurydesma cordatum Morris var. *sacculum* Etheridge and Dun, 1910, p. 74, pl. 19, figs. 1-2; pl. 20, fig. 1; pl. 24, figs. 1-2.
Eurydesma cordatum Morris, Runnegar, 1969b, p. 279, pl. 18, fig. 9; pl. 19, figs. 5-7.
Eurydesma cordatum Morris, Runnegar, 1970, p. 92, pl. 13, figs. 2-10; pl. 14, figs. 3-6; not pl. 13, fig. 1; pl. 14, fig. 1; pl. 14, fig. 2; indet. pl. 16, fig. 7; not pl. 17, fig. 1-4.

Types. Lectotypes are designated or summarized by Runnegar (1970).

Dimensions in mm of *Eurydesma cordatum* in Dana collection with Dana figure reference

Length	Height	Width left	Width right	Width both	Anterior length	Umbonal angle
E. cordatum USNM 3664 Harper's Hill, Illawarra, pl. 8, figs. 1, la						
120	+7120	36	34.5	81	44	80°
E. sacculus M'Coy USNM 3602, Harper's Hill, Illawarra, pl. 7, figs. 8a, b						
88?	92		744		31	?60°
E. ellipticum Dana USNM 3601, Harper's Hill, Illawarra, pl. *1,* figs. 6a-d						
67	60	17	19	36	27	88°
E. ellipticum Dana USNM 3655 (reregistered 25647) Illawarra, pl. *1,* fig. 6? Wollongong Point						
75	+80	25	29	59	20	
E. globosum Dana USNM 3600						
39.5	45		15		11	790°

USNM 3566						
40	38			29	17	85°
Eurydesma sp. USNM 25647 "Carboniferous", New South Wales						
22.2		8	8.3	15	7.7	90°
18.8	17		6		5.9	65°
39	?39	13	13	26	12.5	95°
45.5		14	14.5	33.3	8.5	85°
84	?82	+ 26	28	+ 56	29.5	80°

Discussion. Specimens of *Eurydesma* from "Harper's Hill, Illawarra" (really Hunter Valley), New South Wales, were assigned by Dana (1849) to several species, but all probably belong to one species, as in Branson (1948, p. 608) and Runnegar (1970). No attempt to demonstrate this statistically is made, because measurements are unreliable, what with distortion, decortication and breakage.

Resemblances. All specimens are much less oblique with longer anterior portions than in the Pakistan specimens from the "Olive beds", Salt Range, Pakistan, identified as *E. globosum* and *E. ellipticum* by Waagen (1891).

Subclass Heterodonta Neumayr, 1884
Order Veneroida H. Adams and A. Adams, 1856
Superfamily Carditacea Fleming, 1820
Family Permophoridae Dall, 1895
Subfamily Myochonchinae Newell, 1957
Genus *Stutchburia* Etheridge, 1900
Stutchburia simplex (Dana, 1847)
Pl. 5, fig. 2

Modiolopsis simplex Dana, 1847, p. 159.
Cypricardia simplex (Dana), Dana, 1849, p. 703, pl. 9, fig. 2.
Stutchburia simplex (Dana), Etheridge, 1900, p. 182.

Holotype. USNM 3632, sole specimen described and figured by Dana (1849, pl. 9, fig. 2), by monotypy, from "Carboniferous of New South Wales", probably from Allandale Formation of Harper's Hill, Hunter Valley, to judge from coarse gritty green matrix.

Dimensions in mm of *Stutchburia simplex* (Dana)

Specimen	Length	Height	Width	Hinge length	Length of anterior	Umbonal angle
			single valve			
USNM 3632	37	17.5	3.7	?16.5	5.3	140°

Description. The specimen is small with valves conjoined, resting in a concretion that contains the displaced external mould. The shell is crossed by concentric growth-lines, with no trace of radial ornament apart from faint striae posteriorly. The anterior adductor is impressed, and has a small pedal scar above, but other internal details are obscure. The hinge is thickened by a ridge, but dentition and ligament details are not preserved. The shell completely lacks the ventral sulcus and swollen anterior

protuberance seen in *Stutchburia ornata* (Morris).

Stutchburial recta (Dana, 1847)

Pl. 5, fig. 3

Cardinia recta Dana, 1847, p. 156.
Cardinia recta Dana, Dana 1849, p. 691, pl. 4, figs. 5a, 5b.
Stutchburia recta (Dana), Etheridge, 1919, p. 189, pl. 30, fig. 7.
Lectotype. USNM 3648, figured by Dana (1849, pl. 4, figs. 5a, b) and Etheridge (1919, pl. 30, fig. 7), here designated, from "Carboniferous, District of lllawarra. New South Wales", in greenish sandstone reminiscent of Allandale Formation.
Diagnosis. Moderately elongated, little inflated shells with umbones not well forward, lateral sulcus large, costae numerous, crossing sulcus.
Dimensions in mm of *Stutchburial recta* (Dana)

Specimen	Length	Height	Width	Length anterior	Hinge length
USNM 3648	49?	23	?5	9	?28

Description. The lectotype is a left valve, preserved chiefly as an internal mould, with the hinge. The other figured specimen (Dana, 1849, pl. 4, figs. 5a, b) has not been found. The shell is elongated with a prosogyrous non-incurved umbo, of which the umbonal cavity measures 130°. The dorsal anterior margin slopes at 135° from the hinge with a slightly concave outline and well rounded anterior extremity with maximum extension near mid height. The ventral margin converges posteriorly on the dorsal margin by 15-18°, unlike *Stutchburia costata,* in which the two margins are subparallel. The posterior end is destroyed, and was probably well rounded and most extended below mid-height, to judge from growth lines. The sulcus is opisthocline and broad but shallow. There are at least 15 costae over the sulcus and posterior part of the shell.

The shell is laminated and not obviously prismatic where preserved at the hinge in front of the umbo.

The hinge is obscure. Although described as edentulous by Etheridge (1919, p. 190) it has a large posterior groove and two oblique anterior ones behind the beak, separated by a ridge (?3b). The anterior adductor is large and extended postero-dorsally towards the hinge, and a discrete large oval pedal scar lies close to the commissure, within the umbonal slope. There is no scar on the thickened buttress behind the adductor. A small pit lies on the posterior umbonal ridge just behind the umbo. The posterior adductor is not clearly defined.
Resemblances. The shell is distinguished by its subcuneiform shape, reminiscent of *Cardinia cuneata* Dana, and by numerous costae which cover the sulcus as well as posterior dorsal face.

Stutchburia costata (Morris, 1845)

Pl. 5, figs. 4-7

Orthonotal costata Morris, 1845, p. 274, pl. 11, figs. 1, 2.
Cardinial costata Morris, Dana, 1849, p. 692, pl. 4, figs. 8a-8c.
Stutchburia costata Morris, Waterhouse, 1980a, p. 113, figs. 4.1, 3, 4; fig. 5, fig. 6. (See for synonymy and typology).
Dimensions in mm of *Stutchburia costata* (Morris)

PAPERS
Department of Geology
University of Queensland

Corrigenda Volume 11, Number 3:
Pagination

p. 84 follows p. 82
p. 83 follows p. 84
p. 85 follows p. 83

the correct sequence is pp. 82, 84, 83, 85

insert
p. 67

Specimen USNM	Length	Height	Width		Anterior length	Number of costae
188140	66	32.6	10.5	(single)	14	+4?
188161	+78	34	28	(both)	10	?6
3630	96.5	35	28	(both)	10.3	?6

Description. Three specimens are available in the Dana collection from the "Carboniferous of Illawarra, New South Wales". They are typical of the species, with only about 6 costae and show virtually nothing of the hinge line. Adductors are visible, and the small specimen (pl. 5, fig. 5) seems to have two pedal pits in front of the umbonal tip along the umbonal ridge. The specimens may have come from Black Head, New South Wales.

Synonymy. As pointed out by Etheridge (1900, p. 181), the fragment figured as *Cypricardia* (*Avicula*?) *veneris* Dana (1849, pl. 9, figs. 3a, b) might belong to *S. costata*, but it has costae in the sulcus as in *S. recta* (Dana). This specimen could not be found at the Smithsonian Institution (Waterhouse, 1980a, p. 116).

Stutchburia? *cuneata* (Dana, 1847)

Pl. 6, figs. 1–12

Cardinia cuneata Dana, 1847, p. 156.
Cardinia ?*exilis* M'Coy, 1847, p. 302, pl. 15, fig. 1.
C. cuneata Dana, Dana, 1849, p. 692, pl. 4, figs. 6, 6a–6e.
[*Cardinia*?] *cuneata* (Dana), Etheridge, 1919, p. 190, pl. 30, figs. 3–6.

Lectotype. Specimen USNM 3672 figured by Dana (1849, pl. 4, figs. 6, 6b–d), here designated, from Gerringong Volcanics, Wollongong Point, New South Wales. See pl. 6, figs. 1–3 herein. Lectotype of *Cardinia exilis* M'Coy, specimen figured by M'Coy (1847, p. 15, fig. 1), here designated.

Diagnosis. Small cuneiform moderately well inflated shells with broad escutcheon.

Dimensions in mm of *Stutchburia*? *cuneata* (Dana)

Specimen	Length	Height	Width	Anterior length
	internal moulds, valves conjoined			
USNM 188143	36	20.5	11	5
USNM 188142	37.2	20.5	9.2	7.2
USNM 3672	40	20.3	12.8	7.4
F 7910	?54	26	21	10

Description. the shells, represented by three specimens with valves conjoined and a single valve, are cuneiform in shape, with low prosogyrous umbones, moderately rounded anterior portion, extended below mid-height, and long tapering posterior portion, most extended close to the ventral margin. A low posteriorly sloping sulcus crosses the flanks from the umbo. There is no lunule, but the shell next to the posterior hinge is flattened or gently concave, and sharply distinguished from the rest of the shell by an umbonal ridge passing back from the umbo. A short narrow calcified ligament extends from the umbones for half of the length of the hinge. There is a narrow posterior gape.

Dentition is very poorly preserved. The commissure under the beaks possibly has a cardinal tooth in the right valve and broad socket in the left. A slender groove passes back inside the commissure. The anterior adductor is large and deeply impressed, with a posteriorly crenulate margin, and a small protractor is attached to

its posterior dorsal edge. A large discrete anterior retractor is present, and a tiny pit lies behind the tip of the umbonal cavity in the lectotype, suggestive of an umbonal pedal retractor scar. The posterior adductor is elongated, and the posterior retractor short, attached to the anterior dorsal edge of the adductor. The pallial line is well defined, and posteriorly curves sharply forward to pass along the ventral edge of the adductor, and form a very shallow sinus or back-curve. The shell lacks the anterior ventral swelling seen in *Stutchburia ornata*.

Larger specimens from Wollongong kept at the Australian Museum probably belong to this species (pl. 6, figs. 9–12). Specimen F 7910 has broad low costae or plicae on the posterior flanks, three on the left valve, two on the right. It is more roundly inflated than Dana's specimens. An internal mould of a left valve F 8230 shows the hinge moderately well. There is a long slender posterior tooth P 11, a slender internal groove, perhaps for a ligament, and a very low anterior tooth, 4b.

Resemblances. Etheridge (1919, pl. 30, figs. 4–6) figured several specimens from Wollongong which agree in shape with *cuneata*, but have radial costae in two individuals. Costae are lacking from Dana's specimens except faintly in one shell and further study is needed to confirm if this is a variable feature as assumed here. Etheridge stated that *cuneata* can hardly be placed in *Stutchburia*, and his view may yet be sustained.

Cardinia ?exilis M'Coy (1847, p. 302, pl. 15, fig. 1) from Wollongong appears to be conspecific.

Subclass Anomalodesmata Dall, 1889

Order Pholadomyoida Newell, 1965

Superfamily Edmondiacea King, 1849

Family Vacunellidae Waterhouse, 1969

Subfamily Myoniinae Waterhouse, 1987

Genus *Myonia* Dana, 1847

Myonia elongata Dana 1847

Pl. 7, figs. 1, 2; Pl. 8, figs. 1, 2; Pl. 9, fig. 1

Pachydomus carinatus not Morris, Morris, 1845, pl. 11, fig. 4 (not fig. 3).
Myonia elongata Dana, 1847, p. 158.
Myonia valida Dana, p. 158.
Maeonia elongata Dana, Dana, 1849, p. 695, pl. 5, figs. 3a–c.
Maeonia valida Dana, Dana, 1849, p. 695, pl. 5, figs. 4, 4a, b.
Myonia elongata Dana, Waterhouse, 1980a, p. 125, fig. 9.4, 6. (See for synonymy and typology).

Limits of species. As a device for coping with the large collections of *Myonia*, and a plethora of already proposed specific names, Waterhouse (1969b) suggested using the superspecies or artenkreis concept (Rensch, 1959), for *Myonia elongata* and its allies. In this way closely associated and similar species can be associated in a framework of some possible zoological reality, without prematurely obscuring the work by earlier authorities. Waterhouse (1969b) thus recognised *M. elongata* (=*M. valida*), with *M. depressa* Fletcher and *M. accentuata* Fletcher in the same superspecies. Runnegar (1967) placed *Myonia depressa* in both *M. valida* (p. 50) and in *M. elongata* (p. 47) with little comment and no analyses. He allowed the validity of both *elongata* and

valida, whereas I believe they are conspecific.

Though included without question in *M. elongata* by Runnegar, the species *M. accentuata* Fletcher is an extraordinary one, well inflated with an apparent large posterior gape, as noted by Waterhouse (1969b, p. 65), possibly exaggerated by crushing. It thus approaches *Vacunella ?dawsonensis* Runnegar (1967, p. 73, pl. 11, figs. 1–8; pl. 13, figs. 1–4), from the Flat Top and Upper Barfield Formations of Queensland. The latter species was hesitantly referred to *Australomya* by Runnegar (1969, p. 285).

Additional material of *M. elongata* not figured by Dana (1849) includes a left valve USNM 188145 from Black Head, identified as *M. elongata*, which has a high posterior dorsal face as in *M. valida*, and a faint ridge along the posterior umbonal ridge. Another specimen from Black Head, marked (27) on the specimen and 188146 on label, has valves conjoined and is identified as *M. valida*. Its umbonal and anterior retractors are well defined, and the protractor forms a discrete rounded scar between the anterior retractor and adductor. Thus the *valida* shape was preponderant in Dana's material.

Myonia sinuosa (Dana, 1847) = *M. elongata* Dana, 1847?

Pl. 6, fig. 13; Pl. 14, fig. 5

Cypricardia sinuosa Dana, 1847, p. 157.
Cypricardia sinuosa Dana, Dana, 1849, p. 696.
Maeonia axinia Dana, 1849, pl. 5, fig. 5d.
Pyramus myiformis (Dana), Runnegar, 1967, p. 37.

Lectotype. USNM 3585, figured by Dana (1849, pl. 5, fig. 5d), refigured herein, designated subsequently by Dana (1849, p. 696), from Gerringong Volcanics, Wollongong Point, Wollongong, New South Wales, according to Runnegar (1967, p. 38), the label reading only "Illawarra, Australia".

Diagnosis. Moderately inflated shells with high and long anterior portion, umbones apparently placed near mid-length.

Dimensions in mm of *Myonia sinuosa* (Dana), from growth lines

Length L	Height H	Width W	Anterior A	H/L	W/L	A/L
			left valve			
42	23	?6	18	0.54	0.14	0.42
59	29.5	?10	24	0.50	0.17	0.40
?83	52	16.5	33	0.62	0.19	0.39
			right valve			
49.5	27		22	0.54		0.40
66	38		27	0.57		0.40
78	48	16.5	31.5	0.74	0.21	0.40

Anterior measures distance from anterior margin to umbonal tip.

Discussion. This specimen is close to *Pyramus securiformis* (Dana) in having a high anterior portion that tapers posteriorly, and was synonymised by Dana (1849) with *Maeonia axinia* Dana, a form identical with *Pyramus securiformis*. However the anterior portion is longer in *sinuosa*, and the umbo is placed at or behind 0.4 of the shell length, compared with 0.34 to 0.38 in *P. myiformis* and *securiformis*. Also the

shell tends to be slightly lower and less inflated. So few specimens have been measured that it is difficult to determine the importance of this difference — it may be an unusual representative of *P. securiformis*, as believed by Runnegar (1967). The lectotype of *sinuosa* USNM 3585 has few visible internal details, and even the margins are broken, so that the shape is incomplete, and gape uncertain. The adductors are partly visible, with a small pallial sinus. It is believed that the shape most closely agrees with that of *Myonia elongata*, to which it is here referred, in sulcus, and especially in its umbonal ridges which are only slightly less defined than in the lectotype.

Myonia undata (Dana, 1847)

Pl. 9, figs. 2, 3, 5

Pholadomya undata Dana, 1847, p. 153.
Pholadomya (*Platymya*) *undata* Dana, Dana, 1849, p. 687, pl. 2, figs. 11a, b.
Chaenomya undata (Dana), Laseron, 1910, p. 209 (part).
Myonia undata (Dana), Fletcher, 1932, p. 407, pl. 50, figs. 1, 2.
Myonia undata Dana, Waterhouse, 1964a, p. 74.
Pyramus? *undatus* (Dana), Runnegar, 1967, p. 44, pl. 4, fig. 2.
Myonia undata (Dana), Waterhouse, 1969b, p. 63, pl. 16, fig. 3.

Holotype. USNM 3639, sole specimen described and figured by Dana (1849, pl. 2, figs. 11a, b), refigured by Fletcher (1932, pl. 50, fig. 2), by monotypy, from Gerringong Volcanics, Wollongong, New South Wales.

Diagnosis. Small subrectangular *Myonia* with umbo near anterior fourth of the shell length, umbonal ridge low, sulcus broad.

Dimensions in mm of *M. undata* (Dana)

Specimen	Length	Height	Width (single valve)	Umbo from anterior	
USNM 3639	77	43	13.5	22.5	left valve
		44			right valve

Discussion. This is an interesting species, because it has been referred to three different genera. The reference by Dana (1847) to *Pholadomya* is reasonable, because the shell gapes posteriorly, and has no teeth. But it seems that the gape is due to breakage of the shell after death, with some of the posterior part of the left valve, and much more of the right valve lost. Growth lines appear to intersect the margin, not lie parallel to it, though such could have occurred by subsequent widening of the gape by resorbtion of shell.

Runnegar's proposal that the species belonged to *Pyramus* was based on "the lack ... (of) a well developed carina and ... relatively well pointed beaks on the internal moulds" (1967, p. 44). Of course many *Myonia*, including the type, lack a well developed carina, and as shown by Waterhouse (1980a), Runnegar (1967) misinterpreted *M. elongata*, referring to it several shells belonging in fact to *Myonia* (*Myomedia*) *carinata*. Musculature is vague over the umbones. The position of the umbonal retractor is not certain, but it seems to lie *below* the umbonal tips. In *Pyramus* the umbonal retractor lies at the umbonal tip; in *Myonia*, below the umbonal tip on the umbonal face (Waterhouse, 1965a; 1969b). The lack of a well defined tooth and socket, and the anterior pedal musculature would seem to rule against an affinity with *Pyramus*.

Reference to *Myonia*, first proposed by Fletcher (1932), is supported by overall shape, including the profile of the posterior umbonal ridge and face, the possible lack of posterior gape, lack of teeth and socket, and by the anterior pedal musculature, which is fused into a series of scars as in *Myonia valida*. In *Pyramus*, the anterior retractor is normally large and discrete. A very feebly visible pallial line appears to lack a sinus, but this is not certain. Overall it seems likely that this form should be placed in the superspecies of *Myonia elongata*. Shells illustrated as *Sanguinolites undatus* (Dana) by de Koninck (1877, pl. 17, fig. 1) and Johnston (1888, pl. 11, fig. 14) are not conspecific, having a different outline, and apparently no posterior umbonal ridge.

Subgenus *Myomedia* Waterhouse, 1969

Myonia (*Myomedia*) *carinata* (Morris, 1845)

Pl. 7, fig. 3; Pl. 15, fig. 6

Pachydomus carinatus Morris, 1845, p. 273, pl. 11, fig. 3, not fig. 4.
Cypricardia rugulosa Dana, 1847, p. 157.
Maeonia? *carinata* (Morris), Dana 1849, p. 696, pl. 6, figs. 1a–b.
?*Maeonia fragilis* Dana, 1849, p. 696, pl. 6, figs. 2, 3.
Maeonia carinata var. *minor* Etheridge Jnr. 1919, p. 187, pl. 29, figs. 5–8; pl. 30, fig. 9.
Myonia minor var. *etheridgei* Fletcher, 1932, p. 407.
Myonia carinata (Morris), Runnegar, 1967, p. 50, pl. 4, figs. ?8, 9, not 11–13, pl. 5, fig. 20, pl. 12, figs. 7, 14.
Myonia elongata not Dana, Runnegar, 1967, p. 48, pl. 5, figs. 12–14, 18, figs. 15, 19 indet., either *elongata* or *carinata*.
Myonia (*Myomedia*) *carinata* (Morris), Waterhouse, 1969b, p. 67, pl. 1, fig. 2. (See for synonymy).
Myonia (*Myomedia*) *carinata* (Morris), Waterhouse and Jell, 1981, p. 251, pl. 5, fig. 7.
Myonia (*Myomedia*) *carinata* (Morris). Waterhouse, 1987, p. 171, pl. 10, fig. 24.

Types. Citation of types is summarized in Runnegar (1967) and Waterhouse and Vella (1965).

Dimensions in mm of *Myonia carinata* (Morris)

Specimen	Length	Height	Width	Anterior length
(*Maeonia fragilis* type)				
USNM 4639	46	27.5	4	?16
(*Cypricardia rugulosa* type)				
USNM 25640	66.3	39.3	15.1	?17.5

Discussion. Runnegar (1967, p. 52) considered that *Myonia carinata* was distunguished specifically by its large size, and by the depth of its pedal and pallial muscle scars. Such features are likely to be characteristic of advanced ontogenetic stages in various species. It is here preferred to stress the shape and the strength of the carinate posterior umbonal ridge. Runnegar (1967, p. 52, pl. 4, figs. 11–13) assigned upper Sakmarian and lower Artinskian specimens to *M. carinata*, whilst noting that it was predominantly a younger, Kazanian species. His illustrations of supposed Sakmarian–Lower Artinskian specimens show specimens allied to

Pachymyonia cf. *etheridgei*, not *M. carinata*, and a specimen figured by Hill and Woods (1964, pl. 10, fig. 10) and refigured by Runnegar (1967, pl. 4, fig. 8) seems to lack the typical carina of *M. carinata*. Various individuals assigned to *M. elongata* by Runnegar are closer to typical *M. carinata*.

I

Family Megadesmidae Vokes, 1967

Subfamily Megadesminae Vokes, 1967

(nom. correct Newell, in Cox *et. al.* (1969, p. 823) from Megadesmatidae Vokes, 1967)

Genus *Megadesmus* Sowerby, 1838

Subgenus *Cleobis* Dana, 1847

Megadesmus (*Cleobis*) *grandis* (Dana, 1847)

Pl. 10, figs. 1, 2; Pl. 11, fig. 1; Pl. 12, figs. 1-3; Pl. 13, figs. 1-3, 5; Pl. 14, figs. 1, 4
Cleobis grandis Dana, 1847, p. 154.
Cleobis gracilis Dana, 1847, p. 154.
Pachydomus gigas M'Coy, 1847, p. 301, pl. 16, fig. 3.
Maeonia (*Cleobis*) *grandis* Dana, Dana, 1849, p. 697, pl. 6, figs. 7, 7a; 8, 8a.
Maeonia (*Cleobis*) *gracilis* Dana, Dana, 1849, p. 698, pl. 7, figs. 1a-c.
Maeonia gigas M'Coy, Dana, p. 697.
Megadesmus (*Cleobis*) *grandis* (Dana), Waterhouse and Jell, 1983, p. 251, pl. 5, fig. 2, 4. (See for synonymy and typology).

Dimensions in mm of *Megadesmus* (*Cleobis*) *grandis* (Dana), collected by Dana, with Dana figure references

Specimen	Length L	Height	Width	Umbo from anterior A	Ratio A/L
USNM 188150 *M. grandis*					
not fig.	83	72	26	14	
USNM 3638 *M. grandis*					
type	165	106	55.5	37	0.22
USNM 188151 *M. grandis*					
pl. 6, figs. 7, 7a	82.5	61.5	29.25	23.5	
fig. 8, 8a			25.0		
USNM 188149 *M. grandis*					
not fig	170	113	40	43.5	0.25
USNM 188152 *M. gigas*					
	193	140	62	40.5	0.21
USNM 26939 *M. gigas*					
	167	112	58	38	0.22
USNM 188154 *M. gracilis*					
pl. 7,	76	57	23.5	21.5	0.25
fig. 1b, c			(both)		
USNM 3637 *M. gracilis*					
type pl. 7, fig. 1a	70.5	54.4	19	22.5	0.31
Specimens described as *gigas*, kept at Sedgwick Museum					
E10758	143	102	39.5	45	0.31

E13432	163	109	51	41.5	0.39
E13430	167	113	39	43.5	0.36
E13431	192.5	105	65	48	0.24

Statistical summary of *Megadesmus (Cleobis) grandis* (Dana) including *gigas* M'Coy and *gracilis* Dana

	Length	Height	Width single	Anterior
n	12	12	12	12
$\bar{x}$	139.3	95.4	42.2	34.8
S	45.1	26.0	15.1	10.8
correlation coefficients	L/H 0.95	W/A 0.75		
V	32.4	27.3	35.8	31.0
$\delta\bar{x}$	13.0	7.5	4.3	3.1

coefficient of correlation $W/L = 6.33$

a H/L 0.57

n = number of sample
$\bar{x}$ = mean
S = standard deviation
V = coefficient of variation
$\delta\bar{x}$ = standard error of the mean
a = growth ratio with $(SX)/(SY)$

Discussion. This species is a huge form, with anteriorly placed umbones, a posterior gape in many individuals, and an apparent small tooth in the right valve. The large size has prevented the presentation of adequate photographs apart from Dana (1849) and Waterhouse (1969b, pls. 10, 11) and the opportunity is taken to figure further large specimens to provide a better appreciation of the species. It is probably second only to *Aphanaia gigantea* de Koninck in size and biomass amongst the Permian bivalves of Australia. The lectotype of *grandis* has a well rounded posterior umbonal ridge and faintly concave posterior dorsal face, and the suggestion of a narrow posterior gape to judge from growth-lines. Little of the musculature is visible, apart from parts of the anterior adductor and perhaps protractor. The large paratype (pl. 10, fig. 2) USNM 188149, not figured by Dana, has a gently rounded posterior dorsal face without a noticeable posterior umbonal ridge, and the small figured specimen (Dana, 1849, pl. 6, figs. 8, 8a) USNM 188151 is similar. Muscle scars are faintly impressed, and somewhat obscured by iron stains. The large rhomboid posterior adductor appears to be attached dorsally to a long posterior retractor. Other unfigured specimens registered as USNM 3638 and 188147 are poorly preserved and unusually high, with a gently concave posterior dorsal face. An obscure USNM 188148 is over 13 cm long.

Significant data on musculature is provided by two large internal moulds, USNM 25639 and 188152, ascribed by Dana (1849) to *Maeonia gigas* (M'Coy). These possess a small umbonal pedal scar placed below and in front of the umbonal apex, and a large anterior retractor more or less joined to a protractor scar, which in turn abuts the anterior adductor. Both specimens gape posteriorly, without obvious anterior (pedal) gape. On the left valve the protractor is large and subdivided, on the other side possibly faintly impressed and small. The adjoining anterior retractor is

large on the right valve, small on the left, and adductors of both are huge and subdivided. There are suggestions of a very small tooth in the right valve of the small figured specimen USNM 25639. Pallial line and posterior adductors are not well shown.

Several fine specimens E 10755–7 from Wollongong and identified as *Pachydomus globosus* by M'Coy (1847) are kept at the Sedgwick Museum, Cambridge. Other specimens are assigned to *Pachydomus gigas* M'Coy (1847) with the specimen figured by M'Coy (1847, pl. 16, fig. 3) the smallest of all. The two large specimens of M'Coy have more anterior umbones and rounder posterior dorsal face; and F 13432 has a gentle posterior umbonal ridge and posterior gape. The figured specimen has little or no gape. The small specimens identified as *Cleobis gracilis* by Dana have slight pedal and siphonal gape. They are close to *gigas* in the position of the umbo, but have a less concave posterior dorsal face.

As here understood, the species varies considerably in the position of the umbo with an approximate range from 0.2 to 0.3 of the length of the shell from the anterior margin. As a consequence, the anterior dorsal margin slopes steeply forward in some individuals, and gently forward in others. Runnegar (1967, p. 45) on the other hand considered that the variation was due to breakage in some individuals but this is difficult to sustain from inspection of the types. It would also appear that there is some variation in posterior gape, for it is negligible in the lectotype of *M. gigas* and greater in many of the other figured specimens. The lectotype of *M. gigas* also differs in the position of its lateral sulcus, which is sited near mid-length behind the umbones, instead of anteriorly.

Synonymy. Both the specimen USNM 3637, figured by Dana (1849, pl. 7, fig. 1a) as *Cleobis gracilis*, and the other figured *C. gracilis* (USNM 188154, Dana, 1849, pl. 7, figs. 1b, c) were chosen as lectotype of *gracilis* by Runnegar (1965). Only one specimen not two should be selected as lectotype, and Waterhouse (1965a, p. 851) had already selected the specimen figured by Dana (1849, pl. 7, fig. 1a). The two specimens, as here noted, match with the figures. Fig. 1a is larger than Figs. 1b and c and matrix lies between the beaks in 1a and not 1b.

Further work is needed on the identity of *Notomya trigonalis* Johnston (1887, 1888, pl. 14, fig. 2) from Deloraine, Tasmania. Although this species was synonymised with *Megadesmus nobilissimus* de Koninck by Runnegar (1965, p. 237), the type specimen looks very close to *Megadesmus* (*Cleobis*) *grandis* (Dana) in shape and size, as shown by Waterhouse (1969b).

Megadesmus (*Cleobis*) *recta* Dana, 1847 = *grandis* Dana?

Pl. 15, figs. 1, 3

Cleobis recta Dana, 1847, p. 154.

Maeonia recta Dana, 1849, p. 698, pl. 7, fig. 2.

Lectotype. USNM 3651, figured by Dana (1849, pl. 7, fig. 2), designated by Waterhouse (1969b, p. 80), from Gerringong Volcanics, Wollongong Point, Illawarra, New South Wales. See pl. 15, fig. 3 herein.

Diagnosis. Slender *Megadesmus* with smoothly rounded posterior umbonal slopes.

Dimensions in mm of *Megadesmus* (*Cleobis*) *recta* USNM 3651

Length	Height	Width one valve	Umbo from anterior	A/L
?77	55	?15	21.5	0.19

Discussion. The specimen USNM 3651 described by Dana (1847) as *Cleobis recta*, and then transferred to *Maeonia recta* (Dana, 1849, pl. 7, fig. 2) has escaped attention in recent years apart from a brief comment by Waterhouse (1969b, p. 80). The figured specimen lies over a second identical specimen, USNM 188155, more complete, but largely buried in matrix. Both specimens have very well rounded posterior dorsal faces, much as in *Megadesmus nobilissimus* (de Koninck), without the prominent ridge seen in associated specimens of *Megadesmus* (*Cleobis*) *grandis*, apart perhaps from the small topotype figured by Dana (1849, pl. 6, figs. 8, 8a) and herein as pl. 12, figs. 2, 3. Both specimens of *recta* show a little of the posterior adductor, and the paratype, a better preserved specimen, (pl. 15, fig. 1), has a faintly impressed pallial line that appears to be shallowly sinuate. Either the specimens represent unusual variants of *M.* (*Cleobis*) *grandis* or they represent a separate species or subspecies distinguished by their rounder posterior-dorsal face, in the same lineage as *Megadesmus robusta* (Laseron) and *M. nobilissimus* (de Koninck). *Cleobis robusta* Laseron 1910, with type designated by Waterhouse (1965c, November) and also by Runnegar (December, 1965, p. 243) may be intermediate between *nobilissimus* and *recta*.

Superficially there is some resemblance to a New Zealand species described as *Myonia ovata* Waterhouse (1969b), but the New Zealand shells have a faint posterior umbonal ridge and posterior face, and lack socket and tooth from the hinge.

Genus *Pyramus* Dana, 1847

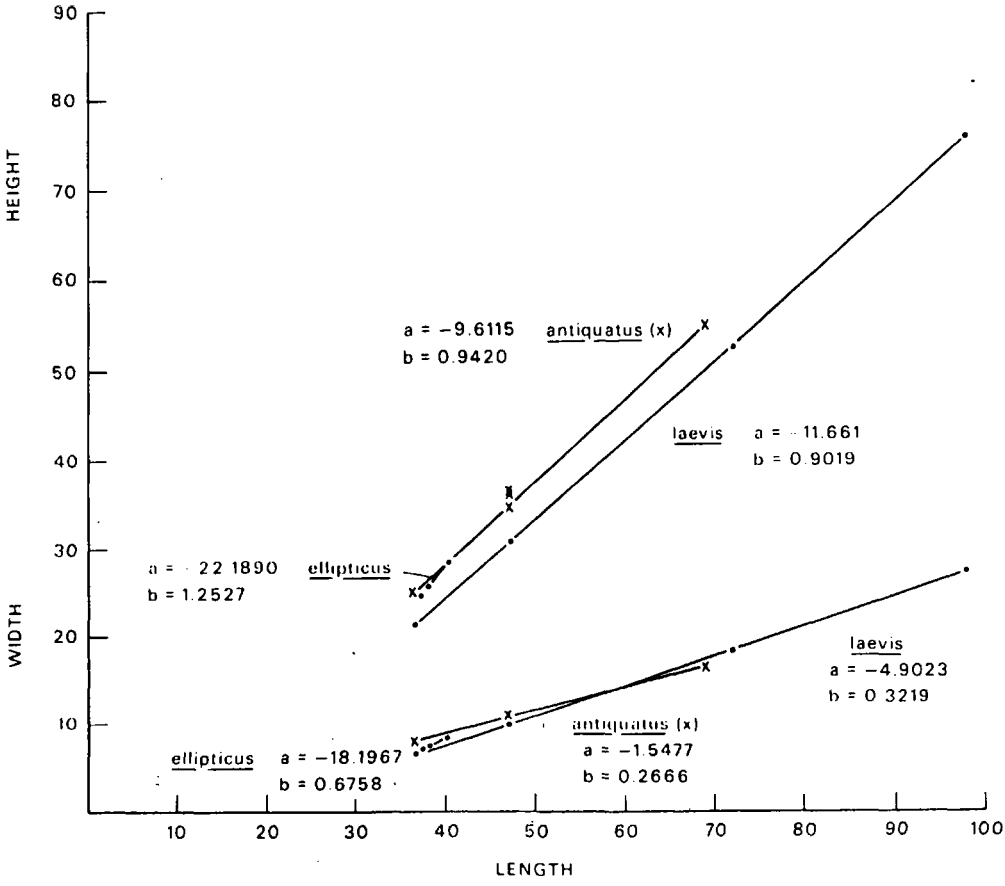
Subjective synonym. *Notomya* M'Coy, 1847.

Discussion. *Pyramus* is distinguished from *Megadesmus* chiefly by its elongated and less inflated outline and pedal musculature, as shown by Waterhouse (1965a, 1969a, b).

Pyramus laevis (Sowerby, 1838)

Pl. 9, fig. 6; Pl. 13, fig. 4; Pl. 14, figs. 2, 3; Pl. 15, figs. 2, 4, 5, 7, 8; Pl. 16, fig. 1; text-fig. 1.

Megadesmus laevis Sowerby, 1838, p. 15, pl. 3, fig. 1.
Megadesmus antiquatus Sowerby, 1838, p. 15, pl. 3, fig. 2.
Megadesmus cuneatus Sowerby, 1838, p. 15, pl. 3, fig. 3.
?*Pachydomus globosus* not Sowerby, Morris, 1845, pl. 10, figs, 3, 4?
?*Pyramus ellipticus* Dana, 1847, p. 157.
Pachydomus cuneatus (Sowerby), Dana, 1847, p. 160.
Pachydomus antiquatus (Sowerby), Dana, 1847, p. 160.
Astartila cyprina not Dana, Dana, 1849, p. 689 (part).
Pachydomus cuneatus (Sowerby), Dana, 1849, p. 693, pl. 5, figs. 1a–b.
Pachydomus antiquatus (Sowerby), Dana, 1849, p. 693, pl. 5, fig. 2.
Maeonia elliptica (Dana), Dana, 1849, p. 697, pl. 6, figs. 5a–c. not 6, 6a.
Pachydomus laevis (Sowerby), de Koninck, 1877, 1898, p. 214, pl. 20, fig. 1.
Notomya (*Megadesmus*) *cuneata* (Sowerby), David, 1907, pl. 34, fig. 2.
Pachydomus cuneatus (Sowerby), Newell, 1956, fig. 2A, B.
Pachydomus cuneatus (Sowerby), Müller, 1958, p. 523, fig. 639.
Pyramus laevis (Sowerby), Runnegar, 1966, p. 375, fig. 1.
Pyramus laevis (Sowerby), Runnegar, 1967, p. 34, pl. 1, figs. 1–12; pl. 2, figs. 1–10; text fig. 4.
Pyramus laevis (Sowerby), Runnegar, 1968, pl. 19, figs. 2–8; pl. 20, figs. 1, 7–9, 13.



Text-fig. 1: Regression analyses for variously named types of *Pyramus*, from the Allandale Formation, chiefly Harper's Hill, Hunter Valley, New South Wales.

Pyramus laevis (Sowerby), Runnegar, 1969b, p. 284, pl. 18, figs. 1–6.
Pyramus laevis (Sowerby), Waterhouse, 1969b, p. 48, pl. 9, fig. 3, text fig. 23.
Notomya elliptica (Dana), Waterhouse, 1969b, p. 52.
Notomya cuneata (Sowerby), Waterhouse, 1969b, p. 51, pl. 8, fig. 5; pl. 10, figs. 2, 4; text figs. 26, 27.

Types. Lectotypes have been designated by Runnegar (1967) and Waterhouse (1965c, p. 373).

Discussion. Several names are amalgamated under the heading *Pyramus laevis*, though there is room for some hesitation, as shown below.

Dimensions

types of *ellipticus, laevis* and *antiquatus* excluding uncertain specimens

	L	H	W	H/L	A/L
n	12	12	12	12	12
$\bar{x}$	50.4	36.1	11.6	0.69	0.37
S	18.5	16.2	5.8	0.05	0.04

Correlation coefficients L/H 0.99 L/W 0.98 H/L 0.31
a H/L 0.87 W/L 0.31
n = number in sample
$\bar{x}$ = mean
S = standard deviation
V = coefficient of variation
$\delta\bar{x}$ = standard error of the mean
a = growth ratio $(SY)/(SX)$

Discussion. The specimens described by Dana (1847, 1849) as *Pyramus ellipticus* are represented by a suite at the U.S. National Museum of three specimens with valves conjoined and a single valve from "Harper's Hill, valley of the Hunter, Wollongong, Illawarra", according to the label, a single larger valve from "Harper's Hill and Wollongong" 188159 (with redder matrix) (Pl. 17, fig. 1 herein) and two separated valves, USNM 188160, in greener matrix, from Illawarra, New South Wales (original label lost), figured by Dana (1849, pl. 6, figs. 6, 6a). See here pl. 16, fig. 6. This confusion of localities has been at least partly disentangled by Runnegar (1967), with the suggestion that the types came from Harper's Hill, and were probably conspecific with *Pyramus laevis* (Sowerby). He referred the single valve to *P. myiformis*, although I am not certain that this is correct, because the umbo is less anteriorly placed, and so more like that in *P. laevis*. The three specimens with valves conjoined are small and inflated with well defined musculature like that of *Notomya securiformis* M'Coy (Waterhouse, 1965a, 1969b), and slight or no posterior gape. They seem to agree well in these details with juvenile *Pyramus antiquatus*, but are consistently more elongated than *P. laevis*. There is no posterior gape, and two show virtually no pallial sinus although the line is high and inclined in one specimen and doubled under the adductor. The umbonal pedal pit is well developed, and the protractor scar is deep and ventrally placed in the largest shell.

The various single valves, much larger than the specimens with valves conjoined, are relatively little inflated, and seem moderately close to *P. laevis* in umbonal position. One of them has the musculature and pallial sinus typical of *Pyramus*.

Three specimens of intermediate size are relevant to the problem of *M. ellipticus*. One is labelled as this species (USNM 3583), and is a specimen with valves conjoined, found in a concretion, which is slightly weathered with reddish hue. It is labelled as coming from the Upper Marine at Illawarra, and features a prominent posterior gape. The other specimens are single valves, less weathered, but with a similar red hue, with the numbers 20182 and 20192 crossed out, labelled as coming from New South Wales — USNM 188162 and 188163. They are close to the other in shape, but less inflated and have a less pronounced posterior umbonal ridge. Both are close to the worn greenish specimen identified as *laevis*, but have a different anterior outline, the anterior margin being inclined from the hinge at 140°, compared with 110°. Thus the specimens agree with the large single valves of *ellipticus* USNM 188159 (3583a red), and are moderately close in this respect to the type of *Notomya securiformis* M'Coy. They were identified as "*Myonia*" sp.

Two specimens with valves conjoined from Harper's Hill, "Illawarra" (in fact the Hunter Valley) were described by Dana (1849) as *Pachydomus antiquatus* Sowerby, showing the typical thick shell and ragged growth-lines of this species, rather than the smooth shell seen in the type specimen of *laevis*. The figured specimen has a very narrow posterior gape, and shows a little of a discrete anterior retractor and part of the attached posterior retractor. The other shows a long attached anterior protractor and small discrete anterior retractor. The pallial sinus is poorly exposed and probably very shallow.

An unlocalised specimen USNM 3676, labelled *Pachydomus*, is probably conspecific. It has the same worn greenish coloured shell as the small specimen assigned to *ellipticus*.

Specimen USNM 188164 collected by Dana appears from shape and posterior gape and musculature to belong to *Pyramus laevis*. The valves are conjoined, set in greenish matrix, but slightly displaced, and of reddish colour. They show a shallow pallial sulcus and small attached posterior retractor scar. Locality details are vague, given as "Carboniferous, district of Illawarra", which would suggest a middle Permian age, but the locality might be wrong.

Pachydomus cuneatus (Sowerby) of Dana (1949, pl. 5, figs. 1a, b) is kept at the Peabody Museum, Yale University. It is a well preserved internal mould, showing a well developed protractor scar clearly attached to the anterior adductor muscle, as Waterhouse (1965a, 1969b) for *Pyramus*.

In the original collection of Sowerby's at the British Museum (Natural History), *Pyramus laevis*, specimen L 61060, has no posterior ridge or concave posterior dorsal face and a slight posterior dorsal gape. *Megadesmus cuneatus* Sowerby, PL 682, from Harper's Hill, has no pallial sinus, and a strong posterior dorsal ridge on the internal mould. The type of *antiquatus* PL 683 is a more battered specimen, much like *cuneatus* in shape, with a slightly concave posterior dorsal face.

Specimens identified with *Megadesmus antiquatus* Sowerby from Harper's Hill in M'Coy's collection at the Sedgwick Museum are somewhat like *Notomya securiformis* in shape but do not gape posteriorly. E 10947, similar in shape to *P. cuneatus* and *P. antiquatus*, has a shallow posterior dorsal concavity, and weak ridge. Well preserved specimens identified as *cuneatus*, E 10945 and 10946, have a shallow pallial sulcus and no posterior dorsal ridge or concavity. E 10944 is the same

with virtually no sulcus or gape, nor is posterior gape seen in the Australian Museum specimen F 44044 from Harper's Hill, Hunter Valley. Some Sedgwick Museum specimens from Harper's Hill, such as E 10949 and 10950 are juvenile shells very much like the type of *cuneata*. They also look like *Notomya securiformis*, with a large anterior retractor muscle scar as in the types of this form.

Statistically the types and other specimens of *Megadesmus antiquatus* Sowerby, and *M. cuneatus* Sowerby, and *Pyramus ellipticus* Dana are not quite identical in shape with the type of *M. laevis* Sowerby, and they differ in possessing much more ragged and far-spaced growth lines separated by much deeper interspaces. By contrast *M. laevis* is smooth with subdued close-set growth rugae, and differs slightly in shape. This difference is indicated by calculation of the straight line of regression (Text-fig. 1), or line of average relationship of height on length and width on length, in which constants a and b are first determined by the method of least squares, and the length treated as an independent variable, x plotted against the computed value of the dependent variable:

$$\text{as } y = a + bx$$

$$a = \frac{(y)(\Sigma x^2) - (\Sigma xy)(\Sigma x)}{n\Sigma x^2 - (\Sigma x)^2}$$

$$b = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{n\Sigma x^2 - (\Sigma x)^2}$$

Inspection of Fig. 1 reveals that *ellipticus* and *antiquatus* are virtually identical, and that *laevis* is distinctive. Computation of all three as one regression line gives what appears to be an unreal line, passing from the *ellipticus* valves to the large *laevis* shape.

Pyramus myiformis Dana, 1847

Pl. 9, fig. 4; Pl. 16, figs. 1–5, 7; Pl. 17, figs. 1?, 2, 7, 8; Pl. 20, figs. 3, 6, 7

Pyramus myiformis Dana, 1847, p. 157.

Notomya securiformis M'Coy, 1847, p. 304, pl. 15, figs. 5, 5a.

Notomya clavata M'Coy, 1847, p. 304, pl. 15, fig. 4.

Notomya ovalis M'Coy, 1847, p. 305.

Maeonia (*Maeonia*) *axinia* Dana, 1849, p. 696, pl. 5, figs. 5a–c, c[1] (?not d = *Myonia elongata*).

Maeonia myiformis Dana, 1849, p. 697, pl. 6, figs. 4a–c.

Maeonia (*Pyramia*) *elliptica*? Dana, 1849, p. 697, pl. 6, figs. 6, 6a.

Clarkia myiformis (Dana), de Koninck, 1877, 1898, p. 267, pl. 18, figs. 1, 1a–b.

?*Pleurophorus carinatus* (Morris), de Koninck, 1877, p. 285, pl. 19, fig. 8 fide Runnegar (1967).

Pyramus myiformis Dana, Newell, 1956, p. 7, figs. 4E–F.

Pyramus myiformis Dana, Termier and Termier, 1960, p. 181, fig. 1.

Pyramus myiformis Dana, Waterhouse, 1964a, p. 74.

?*Pyramus* (*Notomya*) *ovalis* M'Coy, Waterhouse, 1965b, p. 851.

Pyramus myiformis Runnegar, 1967, p. 37, pl. 2, figs. 11, 12, 13, 15, 16, 17, ?18; pl. 3, fig. 1.

Pyramus axina (sic) Dana, Runnegar, 1967, p. 38.

Pyramus myiformis Dana, Waterhouse, 1969b, p. 79, pl. 8, figs. 3, 4; pl. 20, figs. 6, 7, text figs. 7c, 8c, 22.
Notomya securiformis Waterhouse, 1969b, p. 49, pl. 3, fig. 1; pl. 8, fig. 2; pl. 12, figs. 2, 3.
Types. Types are summarized by Waterhouse (1969b).
Diagnosis. Slender elliptical shells with short anterior portion, subdued posterior umbonal ridge and shallow sulcus.
Dimensions in mm of *Pyramus myiformis* Dana and *Notomya securiformis* M'Coy

	Length	Height	Width single	Width both	H/L	A/L	W/L	Anterior°	Converge°
Pyramus myiformis Dana									
USNM 3587 type	52.7	29.5	7		0.47	0.38	0.13	23°	−50°
USNM 188165	47.4	28.5	7		0.60	0.34	0.14		
Black Head — large specimen USNM 188166	83	49	17		0.59	0.31	0.20	30°	18°
"*Maeonia axinia*" USNM 188169 (omitted from statistics)	53	32.5?	9.7	19.4	0.61	0.34	0.18	25°	18°
Notomya securiformis lectotype E 10776	55	38	13	26	0.69	0.34	0.23	50°	
N. clavata holotype E 10778	57	38	24.5		0.66	0.39	0.25	60°	25°
Black Head USNM 188167									
left valve	63	38	11.8	21	0.60	0.33	0.18	50°	20°
right valve	63	38	12	21.5	0.66	0.39	0.25	50°	25°
N. ovalis holotype E 10780 (omitted from statistics)	53	35	9.5		0.66	0.17	0.18		
"*Maeonia axinia*" Dana lectotype, USNM 188168	71	45	13	26	0.61	0.36	0.19	40°	35°

anterior° — angle from umbo to anterior extremity
converge° — angle of convergence of dorsal and ventral margins.

Statistical summary — *Pyramus myiformis* Dana

types (2 paratypes + topotype) of *P. myiformis*

	L	H	W	H/L	A/L	W/L
n	3	3	3	3	3	3
$\bar{x}$	61.0	35.6	10.3	0.6	0.3	0.15
S	15.6	9.4	4.7	0.01	0.03	0.03

Correlation coefficient L/H 0.99 L/W 0.99 H/L 0.00

a H/L 0.60 W/L 0.30

V	25.6	26.4	45.6	1.7	8.2	19.1

$\delta\bar{x}$	9.0	5.4	2.7	0.01	0.01	0.01

types of *securiformis, clavata, axinia* and Black Head USNM 188167

n	4	4	4	4	4	4
$\bar{x}$	61.5	39.7	13.1	0.64	0.35	0.21
S	6.2	3.03	0.95	0.03	0.02	0.02

correlation coefficient L/H 0.88 L/W −0.35 H/L 0.32 W/L 1.02

a H/L 0.48 W/L 0.15

V	10.1	7.6	7.3	5.6	6.3	13.3
$\delta\bar{x}$	3.1	1.5	0.47	0.02	0.01	0.01

P. myiformis including *securiformis, clavata* and *axinia*

n	7	7	7	7	7	7
$\bar{x}$	61.3	38	11.9	0.6	0.18	0.35
S	11.3	6.8	3.4	0.04	0.04	0.02

Correlation coefficient L/H 0.93 L/W 0.78 H/L 0.82 W/L 0.15

a H/L 0.61 W/L 0.31

V	18.4	18.1	29.9	6.2	21.2	6.9
$\delta\bar{x}$	4.2	2.6	1.3			

n = number in sample
$\bar{x}$ = mean
S = standard deviation
a = growth ratio *(SX)/(SY)*
V = coefficient of variation
$\delta\bar{x}$ = standard error of the mean

Comparisons of types of *myiformis* (3) with types of *clavata, securiformis* and *axinia*

	H/L	A/L	W/L
mean of difference of gain	0.06	−0.02	−0.06
variance of difference of gain	0.05	0.05	0.06
t score	−2.31	−0.66	−1.74

(V = 5, t 10 = 2.015)

Discussion. This species has been revised by Runnegar (1967) and Waterhouse (1969b). An internal mould of a small specimen with valves conjoined, labelled "*Maeonia axinia*", USNM 188169 from Illawarra, New South Wales, is very like the type *Pyramus myiformis* (see pl. 16, figs. 2, 7). It is more mature than the type, and has a narrow posterior gape and slightly wider posterior retractor. The lectotype of *M. axinia* has a well-defined groove along the inner side of the nymph, reminiscent of the groove in some *Edmondia* (e.g. Waterhouse, 1966, pl. 15, figs. 4, 5; 1969c), with a subdivided anterior adductor scar. The anterior retractor is large and deeply impressed, the protractor small and fused to the adductor, and discrete from the retractor. Runnegar (1967, p. 40) stated that the protractor is "commonly missing", and "frequently absent". I would not agree with this assessment. I believe that the protractor *is* present, fused to the adductor and leaving a tiny scar.

A large specimen identified as *ellipticus* by Dana in red matrix, USNM 188159

(Dana, 1849, pl. 6, figs. 6, 6a) has identical musculature, deep socket and deep groove inside the nymph. (See pl. 17, fig. 1). It was referred to *P. myiformis* by Runnegar (1967) but is high approaching *laevis*. In the right valve USNM 188160 of the two splayed shells identified as *ellipticus* by Dana (see pl. 16, fig. 6 herein) the anterior retractor is sited close to the protractor, and the identity is not certain, as its umbo is centrally placed, suggesting *laevis*. It also is more inflated than the other specimen.

Two very well preserved specimens add considerably to knowledge of the morphology. Both are identified as 188166, *Myonia axinia*, from Black Head, Illawarra, and reidentified on the labels as *Pyramus myiformis* by Dr. N.D. Newell. USNM 188166, a single valve (pl. 16, fig. 1; pl. 20, fig. 3 herein) is a large specimen, typical of *P. myiformis* in shape, with musculature as described by Waterhouse (1965a). The anterior segment is well rounded, the ventral and dorsal margins converge at a low angle, as far as can be seen (the rim is broken), and the posterior gape is slight but distinct. A shallow sulcus crosses the flank of the shell beneath the umbo and there is no posterior umbonal ridge. The anterior adductor is large, with a depressed linear posterior subdivision, and the posterior adductor is more elongated. The pallial line is thick, with oblique striations, and a very shallow sinus, below which the pallial line is considerably thickened. Pedal scars are also well defined. Three retractors lie (a) at the umbonal tip, (b) anteriorly above and discrete from the anterior adductor, and (c) posteriorly as a very slender scar attached to the dorsal edge of the posterior adductor. The protractor is possibly represented by a tiny scar attached to the posterior dorsal end of the anterior adductor, with its surface at right angles to this scar. It is much smaller than in *Pyramus cuneata* (= *P. laevis*) of Dana (1849) or *Notomya securiformis* M'Coy. The hinge is less clear, and seems to have two grooves, the anterior one of which is deeper under the umbo and probably formed the dental socket. The external umbo lies well in front of the interior umbonal cavity.

The second specimen identified as *Maeonia axinia* (See pl. 16, figs. 4, 5; pl. 20, figs. 6, 7 herein), also found in a concretion, consists of two splayed valves, as internal and external moulds — USNM 188167. The external moulds have ragged growth lamellae, a short high calcified ligament, and narrow posterior gape. An extremely faint sulcus is present and no posterior umbonal ridge. The internal moulds of the two valves differ in outline, the right looking like the type of *securiformis*, the left like the type of *myiformis*, because of slightly greater convergence of the dorsal and ventral margins in the right valve, due to slight distortion that has buckled the posterior part of the right valve, unless it was a growth phenomenon, or due to preservation of the ventral rim, though this seems unlikely. The two valves are almost identical in basic dimensions. Anterior musculature differs on the two valves. The anterior retractor is much larger on the left valve than on the right, and the protractor scar is conspicuous, forming a rounded scar attached to the adductor. On the right valve the anterior retractor is smaller, and the protractor obscure, possibly because of slight damage. Other markings occur on this valve, suggestive of another retractor closer to the hinge but less impressed. The umbonal retractors lie at the umbonal tip, well preserved only in the right valve, and the left valve shows the posterior adductor and attached pedal scar, which is relatively wider than in the preceding specimen. The pallial line has a shallow sulcus. The right tooth is

conspicuous, the left socket broad and shallow, the hinge behind rather flat without a well defined hollow.

Three New South Wales species assigned to *Notomya* by M'Coy are probably conspecific. They have been examined at the Sedgwick Museum, Cambridge. The lectotype of *N. ovalis* M'Coy, E 10780 from Loder's Creek, designated by Waterhouse (1965c, p. 851), is immature. The type of *N. securiformis*, from Wollongong, has a sizable posterior gape, high pedal scar, probable umbonal scar and shallow sulcus. The type of *N. clavata* M'Coy, E 10778, also from Wollongong, has a slightly higher anterior part than in *N. securiformis*, with a lower anterior pedal scar and deeply pitted umbonal retractor. There is little posterior gape, and the pallial line is feebly impressed. These differences are due to immaturity, and there is closer agreement with *ovalis*. An unfigured *clavata*, E 10779, has a very narrow posterior gape, umbonal retractor sited on the umbo, and a pallial sinus, and a large right tooth. (The tooth of the type specimen is obscured by shell left in the mould).

Pyramus myiformis Dana and *Notomya securiformis* M'Coy came from the same locality at Wollongong Point, Wollongong, and provide a fascinating question whether they represent one or two species. The type of *N. securiformis* is distinctly more inflated than the type of *P. myiformis*, and is a slightly higher shell, with the anterior dorsal margin more steeply inclined from the hinge. *P. myiformis* has subparallel dorsal and ventral margins whereas those of *securiformis* converge posteriorly, because the anterior portion is very high. But the degree of variation in shape between two individual specimens may not justify specific separation. To what extent do these differences remain consistent? Dana's paratype of *myiformis*, and another more developed specimen which he apparently referred to *Maeonia axinia*, agree well with the type of *myformis*. M'Coy's type of *Notomya clavata*, synonymised with *securiformis* by Waterhouse (1969b), stands with *securiformis* in shape and inflation. The lectotype of *Maeonia axinia* Dana, USNM 188168 is close to *N. securiformis* in shape, but is decidedly less inflated, standing midway between *securiformis* and *myiformis*, with musculature as in *N. securiformis*. It is a large specimen, raising the possibility that inflation decreased with increase in size and of course could have had a very thick shell (pl. 17, figs. 2, 7, 8). Yet another large specimen, originally described as *Cypricardia sinuosa* Dana (1847) and later transferred to *M. axinia* by Dana (1849, pl. 5, fig. 5d) is not highly inflated, and does not have a thick shall but it may belong to *Myonia elongata*. Several single valves referred to *Maeonia elliptica* by Dana eg. (1849, pl. 6, figs. 6, 6a) were transferred by Runnegar (1967) to *P. myiformis*. These are comparatively large and little inflated specimens. Although as high as *securiformis*, this appears to be because of an increase in relative height late in ontogeny, and the shells are little inflated, with an outline much like that of the *myiformis* types. On the assumption that all of the preceding forms belong to one species, they form two peaks, one of a cluster of individuals relatively inflated when immature, with a high anterior portion and clavate shape, and more differentiated protractor scar, the other of more eliptical shells, persistently little inflated, and increasing in height at later maturity with a tiny or no visible protractor scar. If two species are present, they appear to have differed consistently in shape, but to have converged in relative inflation and height with increase in size.

myiformis	*securiformis*
myiformis pl. 16, fig. 3	
'axinia' pl. 16, fig. 2, 7.	*'axinia'* pl. 16, fig. 4, 5.
'axinia' pl. 16, fig. 1.	*'axinia'* pl. 17, fig. 2, 7, 8
'elliptica' pl. 17, fig. 1.	

Using regression analyses, as explained for *Pyramus laevis*, *securiformis* specimens are fairly distinct from *myiformis* (Text-fig. 2). The test for comparing dimensions of the two shapes suggests that width and the length of the anterior position are similar within 95% confidence, but that the height/length values differ. The various angles differ significantly, but these are difficult to measure accurately. There are also inherent problems of ontogeny and growth changes with size that are not taken into account. However, as fine suites of *myiformis* and *securiformis* from Wollongong are now available in Australian collections, it should be possible to undertake various multivariate analyses and detailed documented studies of musculature to reinforce some of the recently published views.

Subfamily Astartilinae Waterhouse, 1969

Genus *Astartila* Dana, 1847

Astartila intrepida Dana, 1847

Pl. 7, fig. 4; Pl. 17, figs. 3–6, 9; Pl. 18, figs. 1–11; Pl. 19, figs. 1–12, 15; Pl. 20, fig. 1

Pachydomus globosa not Sowerby or young *P. laevis* not Sowerby, Morris, 1845, pp.xvii, 272, pl. 10, fig. 4 (part?).

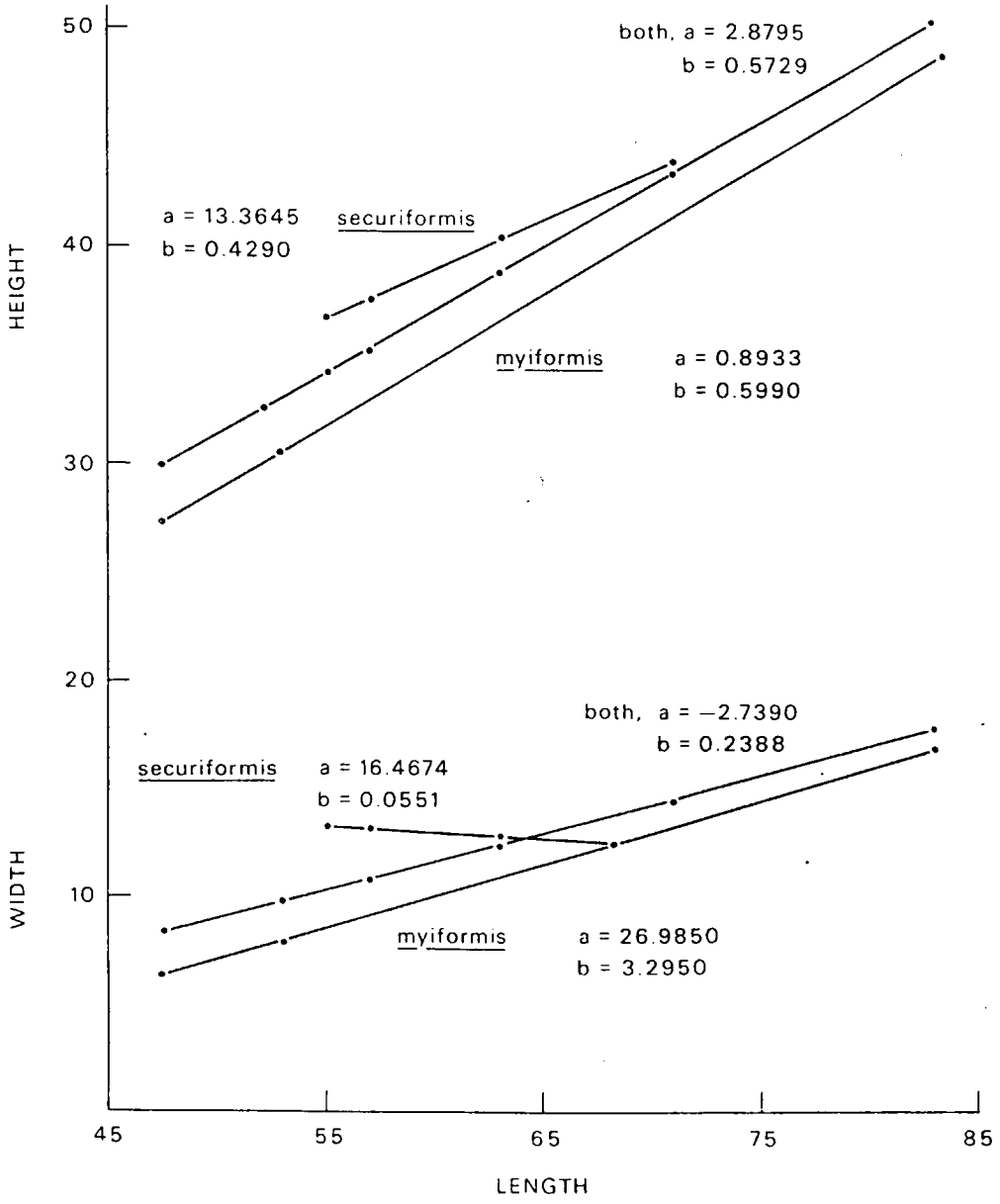
Astartila intrepida Dana, 1847, p. 155.

Astartila intrepida Dana, Waterhouse, 1987, p. 167, pl. 10, figs. 22, 23. (See for synonymy, typology and individual descriptions).

Diagnosis. Suboval to elongate shells, large for genus.

Dimensions in mm of *Astartila*

USNM	Length	Height	Width both	Width single	Anterior length	Umbonal angle
A. intrepida Wollongong						
3594	42.6	35.5	22.7	11.35	?8	
A. transversa Wollongong Point						
3598	36	26.5	31.7	10.8	7.5	120°
188172	32	27		10	5.4	110°
188171	42	31.5		14.8	6	?90°
A. cyprina Wollongong Point						
188174	+40	?35	26.7		9.1	125°
188175	42.9	35.4	22.8	11.4	7.5	110°
188176	43.3	37.5	28.2	14.1	8.4	130°
188177	?39.5	32.5	23.3	11.7	8.5	115°
3588	50	37.1		13.7	9.2	121°
3677	52	42.5	30	15	8.1	120°
A. cytherea Wollongong Point						
188170	26.3	20.9	17	8.5	?6.7	83°
3586	37.3	31.5	25.5	12.8	5.9	70°



Text-fig. 2: Regression analyses for specimens of *Pyramus myiformis* and *Notomya securiformis* from Gerringong Volcanics, Wollongong, New South Wales.

A. cyclas Wollongong Point						
3593	32.4	25.5	14.3	7.15	10.6	127°
A. corpulenta Illawarra						
3591	35	26.3	20.2	10.1	9.3	100°
A. polita Black Head, Illawarra						
3589	32.6	27.2	18.1		8.5	100°
188173	39.2	29.7		10.3	8.5	100°
A. pusilla (M'Coy), type and topotype specimens, Sedgwick Museum.						
E10770	23.0	21.7		8.2	6.1	95°
E10769*	18.0	18.5		8.3	4.8	?70°
E10771*	+29.5	+28.0		?9.5		
E10774	+20.0	18.3		8.3	?5	?70°
E10773	11.1	10.9		4.9	3.5	95°
E10772	8.0	7.6		3.8	1.5	

* Internal moulds

Astartila — specimens from Wollongong, not *pusilla*

	Length	Height	Width single	Anterior length
n	12	12	12	12
$\bar{x}$	39.6	31.9	11.7	7.6
S	7.1	5.8	2.3	1.4
correlation coefficients		L/H 0.95	L/W 0.82	L/A 0.29
a	0.8		0.3	
$\delta\bar{x}$	2.0	1.6	9.6	0.4
V	17.9	18.3	19.9	18.6

A. pusilla M'Coy

	Length	Height	Width single	Anterior
n	6	6	6	5
$\bar{x}$	18.2	17.5	7.1	4.1
S	7.1	6.7	2.1	1.5
correlation coefficient		L/H 0.99	L/W 0.9	L/A 0.9
$\delta\bar{x}$	2.9	2.7	0.8	0.7
V	39.2	38.4	28.7	37.6
a	H/L 0.93	W/L 0.3		

n = number in sample
$\bar{x}$ = mean
S = standard deviation
a = growth ratio *(SY)/(SX)*
V = coefficient of variation
$\delta\bar{x}$ = standard error of the mean

T test between *pusilla* and *intrepida*

Length	Height	Width	Umbonal angle	Length anterior
5.6	4.4	3.8	4.1	2.4

Description. The species has been described recently by Waterhouse (1987). Runnegar compared various specimens to *A. cytherea*, *A. polita*, and *A. transversa*. In my opinion there is no support at all for so many species, and the specimens from Wollongong belong to one species, except perhaps for *A. corpulenta*. Most of the specimens described from neighbouring regions also appear to be close, apart from some of the species named by Fletcher (1929b). As noted by Runnegar, the species *delicatula* Fletcher and *subcarinata* Fletcher belong to *Schizodus*, and *A. parkesi* is probably *Vacunella*.

Astartila runnegari nom.nov.

Pachydomus ovalis M'Coy, 1847, not Sowerby, p. 302, pl. 14, fig. 4.

Lectotype. E 10762, Sedgwick Museum figured by M'Coy (1847, pl. 14, fig. 4).

Paratypes. E 10764 - 10767. The unfigured E 10763 has a posterior ridge and concave posterior dorsal face as in *Megadesmus*, with a discrete pedal scar on the left valve.

Taxonomy. In February 1847, Sowerby, in Jukes, p. 242, used the name *Pachydomus ovalis* for shells from Wollongong and for specimens ascribed to *Pachydomus globosus* (Sowerby) by Morris (1845, pl. 10, figs. 2–4). Runnegar (1967, p. 45) tentatively referred Sowerby's species to *M. globosus*, but noted a possible identity with *M. nobilissimus* (de Koninck).

In November, 1847, M'Coy described a different species as *Pachydomus ovalis* M'Coy (1847, p. 302, pl. 14, fig. 4). This was synonymized with *Astartila intrepida* Dana, 1847 by Fletcher (1929, p. 68) and Waterhouse (1969b, p. 83), Waterhouse also providing dimensions. Thus both species named *Pachydomus ovalis* are subjective junior synonyms, and the junior homonym must be renamed (Stoll, *et. al.* 1961), even if it is to remain in synonymy. I therefore propose to replace the specific name *ovalis* M'Coy not Sowerby with *runnegari*, named in honour of Prof. B. Runnegar, Department of Geology, University of New England, Armidale, New South Wales. It is a subjective synonym of *A. intrepida* Dana.

I

Genus *Pleurikodonta* Runnegar, 1965

(Proposed as a subgenus of *Astartila*, treated as a full genus by Wass and Gould, 1968)

Pleurikodonta gemma (Dana, 1847)

Pl. 19, figs. 16–19

Astarte gemma Dana, 1847, p. 154.

Venus? *gregaria* M'Coy, 1847, p. 305, pl. 16, fig. 5.

Astarte gemma Dana, Dana, 1849, p. 688, pl. 3, figs. 4, 4a, 4b.

?*Astartila subgemma* Fletcher, p. 74, pl. 29, figs. 13–15.

Types. Holotype of *Astarte gemma* Dana, USNM 3593, figured by Dana 1849, pl. 3, figs. 4a, 4b), by monotypy, from Gerringong Volcanics, recorded by Dana (1847, 1849) from "Illawarra" and probably from Wollongong. See pl. 19, figs. 16, 18 herein. Lectotype of *Venus? gregaria* M'Coy, specimen E 10784, Sedgwick Museum, figured by M'Coy (1847, pl. 16, fig. 5), here designated, from Gerringong Volcanics, Wollongong, New South Wales. See pl. 19, fig. 19 herein.

Dimensions in mm of *Astarte gemma* Dana

Specimen	Length	Height	Width	Anterior from umbo	Valve
USNM 3593	15	12	+3	4.9	right
Venus? gregaria M'Coy					
E10784	10	8.7	2.5	3.6	left

Description. The shell is small and equivalve. The umbo is anteriorly placed and prosogyrous, with a narrow angle close to 80°, widening rapidly. The lunule is short, and apparently well formed, the escutcheon less clearly marked. Ornament consists of distinct ragged growth lamellae, about two per millimetre. The rim of the shell is crenulate. The holotype, a right valve, appears to have teeth 3 b and 5 b, and sockets for left teeth 2 and 4 b. The full dentition is not clear, but there is a low anterior tooth ridge and posterior ridge. The anterior adductor scar is prominent and the posterior adductor scar faintly impressed. A small pedal scar lies close to the hinge above the adductor, and the pallial line is entire.

Discussion. Fletcher (1920b, p. 74, pl. 29, figs. 13, 14, 15) recorded *Astartila subgemma* Fletcher from Gerringong with a crenulate margin. Fletcher stated that the hinge was edentulous in some specimens and had teeth in others. The specimens are so close to *Astarte gemma* in size and shape that it seems likely they will be conspecific, but confirmation is needed from examination of the type material.

This species is very close to *Astartila* (*Pleurikodonta*) *elegans* Runnegar, 1965 from the Flat Top and younger Blenheim faunas of the Bowen Basin (Waterhouse, 1987). The northerly specimens may be distinguished by their low ribs around the ventral margin, but this might well prove to be of only subspecific importance. Runnegar (1965) overlooked the similarity of his specimens to Dana's species.

I

Family Pholadomyidae Gray, 1847

Subfamily Chaenomyinae Waterhouse, 1969b

Genus *Vacunella* Waterhouse, 1965a

Discussion. The poorly known Carboniferous genus *Exochorhynchus* Meek and Hayden, 1865, with type species *Allorisma*? *altistriata* Meek and Hayden, 1858, has terminal beaks and a prosocline outline, moderately close apparently to *Vacunella curvatus*. Newell in Cox *et. al.* (1969, p. N 831) compared the genus to *Wilkingia*, implying that it has a lunule, unlike *Vacunella*. Its internal musculature and pallial line are poorly known. A specimen of Pennsylvanian age from Brazil (pl. 20, fig. 5) that is like *Exochorhynchus* in shape does not seem to have a well defined lunule, but it is not well preserved.

Vacunella curvata (Morris, 1845)

Pl. 19, figs. 13, 14; Pl. 20, fig. 4

Allorisma curvatum Morris, 1845, p. 270, pl. 10, fig. 1.
Allorisma curvata Morris, Dana, 1847, p. 160.
Allorisma audax Dana, 1847, p. 153.
Allorisma audax Dana, 1849, p. 687, pl. 3, figs. 1, 1b, 1c.
Pholadomya (*Homomya*) *curvatus* (Morris), Dana, 1849, p. 686, pl. 3, figs. 2a-b.
Pholadomya (*Homomya*) *glendonensis* Dana, 1849, p. 687, pl. 2, fig. 12.
Vacunella curvata (Morris), Waterhouse and Jell, 1983, p. 252, pl. 5, fig. 10. (See for synonymy).

Vacunella curvata (Morris), Waterhouse, 1987, p. 173, pl. 11, fig. 14; pl. 14, fig. 7.
Types. See Runnegar (1967, p. 64) and Waterhouse (1965a, p. 377).
Dimensions in mm of *Vacunella curvata* (Morris)

Specimen	Length	Height	Width	Length anterior
glendonensis type	64.4	33	25.5	?20.3
audax USNM 3643	118	85	68	36
curvata USNM 3673	96	66	54	28

Discussion. The lectotype of ?*Pholadomya* (*Homomya*) *glendonensis* Dana was said to have been misplaced by Runnegar (1967, p. 64), but it is intact at the U.S. National Museum. It is squashed and shows little internal detail. It is somewhat crescentic in shape as in "*Australomya*" but does have a narrow posterior dorsal gape.

Runnegar (1967, p. 66) noted that *V. curvata* was common in the Mulbring Formation, which crops out near or at the type locality of Dana's species *glendonensis*, and Waterhouse (1969b, p. 72) considered the form to be at best a subspecies. New Zealand material described as *glendonensis* by Waterhouse (1969b, p. 72) appears to be a little more distinctive, with more elongated outline and more anterior umbones. But the New Zealand specimens are distorted, and also approach a deformed Hunter River specimen of *V. curvata* illustrated by Runnegar (1967, pl. 9, fig. 15).

Phylum Brachiopoda

Family Linoproductidae Stehli, 1954

Subfamily Linoproductinae Stehli, 1954

Genus *Terrakea* Booker, 1930

Terrakea brachythaera (Morris, 1845)

Pl. 14, fig. 6

Productus brachythaerus not Sowerby, Morris 1845.
?*Avicula* sp. Dana, 1847, p. 160.
Avicula volgensis not de Verneuil, Dana, 1849, p. 704, pl. 9, fig. 4. (See Waterhouse, 1964b, Waterhouse and Briggs, 1986 for synonymy).
Discussion. The specimen USNM 3660 identified from Wollongong, New South Wales, identified with *Avicula volgensis* de Verneuil by Dana (1849) is part of the inside of a ventral valve of *Terrakea brachythaera* (Morris), showing radial costae and elongated spine bases typical of the genus.

Incerte sedis

Dana (1847, 1849) referred two obscure specimens to *Solecurtus* (Order Veneroida), and they have some attributes of this order, but may be Estherian. Etheridge (1919, p. 190) considered that, if the illustrations were accurate, the specimens were "meaningless" and "featureless" impressions.

Solecurtus? *planulatus* Dana, 1847

Pl. 8, fig. 3

Solen (*Solecurtus*?) *planulatus* Dana, 1847, p. 153.
Solecurtus planulatus Dana, Dana, 1849, pl. 2, fig. 10.
This specimen, USNM 3631, is a poorly preserved fragmentary external mould from

Harper's Hill, Hunter Valley, New South Wales.

Solecurtus? ellipticus Dana, 1847

Pl. 8, fig. 4

Solen (Solecurtus?) ellipticus Dana, 1847, p. 153.
Solecurtus? ellipticus Dana, Dana 1849, p. 686, pl. 2, fig. 9.
This specimen, USNM 3654, is an almost smooth ferruginised internal mould, with a median short blade, but no teeth or hinge preserved. The external mould has very fine growth lines. It comes from Wollongong Point, Illawarra, New South Wales, from a concretion.

A number of species have not been observed, including the following forms:
Nucula glendonensis Dana (1849, p. 699, pl. 7, fig. 5) from Glendon, probably belonging to *Nuculopsis* Girty.
Cardium australe (M'Coy, 1847), figured by Dana (1849, p. 701, pl. 8, fig. 2), from Glendon, belonging to *Bransonia*.
Cardium ferox Dana (1849, p. 701, pl. 8, figs. 3, 3a, b) from Wollongong. This species has never been reassessed since Dana's original description.
Modiolopsis siliqua Dana (1847, p. 159) = *Cypricardia siliqua* Dana (1849, p. 703, pl. 9, figs. 1a, b), assigned to *Stutchburia* by Etheridge (1919).
Cypricardia (Avicula?) veneris Dana (1849, p. 704, pl. 9, figs. 3a, b) from Glendon, considered to belong to *Stutchburia* by Etheridge (1919).
Gen. indet. perhaps *Avicula* sp. in Dana (1849, pl. 9, fig. 10) from Illawarra.

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TABLE 1: List of bivalve species recorded by Dana (1847, 1849).

Dana, 1847, following his original order of appearance	Dana, 1849	herein
Solen (Solecurtus?) ellipticus	*Solecurtus ellipticus*	incerte sedis
Solen (Solecurtus?) planulatus	*Solecurtus planulatus*	incerte sedis
Pholadomya undata	*P. (Platymya) undata*	*Myonia undata*
Allorisma audax	*P. (Homomya) audax*	*Vacunella curvata*
Cleobis grandis	*Maeonia grandis*	*Megadesmus (Cleobis) grandis*
Cleobis gracilis	*Maeonia gracilis*	*M. (Cleobis) grandis*
Cleobis? recta	*M.? recta*	*M. (Cleobis) recta = grandis?*
Astarte gemma	*A. gemma*	*Pleurikodonta gemma*
Astartila intrepida	*A. intrepida*	*Astartila intrepida*
Astartila cyprina	*A. cyprina*	*A. intrepida*
Astartila cytherea	*A. cytherea*	*A. intrepida*
Astartila polita	*A. polita*	*A. intrepida*
Astartila cyclas	*A. cyclas*	*A. intrepida*
Astartila transversa	*A. transversa*	*A. intrepida*
Cardinia recta	*Cardinia recta*	*Stutchburia? recta*
Cardinia cuneata	*C. cuneata*	*S? cuneata*
Pyramus ellipticus	*Maeonia elliptica*	*Pyramus laevis*
Pyramus myiformis	*Maeonia myiformis*	*P. myiformis*
Nucula abrupta	*N. abrupta*	*Polidevicia? abrupta*
Nucula ----?	*N. concinna*	*P? cryptica*
Cypricardia rugulosa	*Maeonia carinata*	*Myonia (Myomedia) carinata*
Cypricardia sinuosa	†*Maeonia axinia*	*Myonia elongata*
Myonia elongata	*Maeonia elongata*	*Myonia elongata*
Myonia valida	*Maeonia valida*	*M. elongata*
Eurydesma elliptica	*E. elliptica*	*E. cordatum*
Eurydesma globosa	*E. globosum*	*E. cordatum*
Modiolopsis simplex	*Cypricardia simplex*	*Stutchburia simplex*
Modiolopsis siliqua	*C. siliqua*	(lost)
Modiolopsis praerupta	*Cypricardia imbricata*	Gen. indet. *praerupta*
Modiolopsis imbricata	*Cypricardia imbricata*	*Merismopteria imbricata*
Modiolopsis arcodes	*C. arcodes*	*M. imbricata*
Modiolopsis acutifrons	*C. acutifrons*	*M. macroptera*
Avicula ----?	*?A. volgensis* Verneuil	**Terrakea brachythaera*
Pecten comptus	*P. comptus*	*Fletcheripecten laticostatus*
Pecten tenuicollis	*P. tenuicollis*	*Etheripecten tenuicollis*
Pecten leniusculus	*P. leniusculus*	*E. leniusculus*
Eurydesma cordata	*E. cordata*	*E. cordatum*
Pecten illawarrensis	*P. illawarrensis*	*Deltopecten illawarrensis*
Pachydomus antiquatus	*P. antiquatus*	*Pyramus laevis*
Pachydomus cuneatus	*P. cuneatus*	*P. laevis*
Allorisma curvatum	*P. (Homomya) curvata*	*Vacunella curvata*
Orthonota (Cardinia) costata	*?Cardinia costata*	*Stutchburia costata*
Pterinea macroptera (Morris)	*P. macroptera*	*Merismopteria macroptera*
	Additional species	
	Pholadomya (Homomya) glendonensis	*Vacunella curvata*
	Maeonia gigas M'Coy	*Megadesmus grandis*
	Astartila corpulenta	*Astatila intrepida*
	Maeonia fragilis	*Myonia carinata*
	Nucula glendonensis	†*Nuculopsis glendonensis*
	Eurydesma sacculus	*E. cordatum*
	Cardium ferox	lost
	C. australe	*Bransonia australe*
	Pecten squamuliferus	?lost
	Cypricardium (Avicula) veneris	lost
	Avicula sp.	lost
Pachydomus laevis	†*Pachydomus laevis*	

* brachiopod

† specimens not seen, presumably lost.

EXPLANATION FOR PLATE 1

Figs. 1,2,5. *Polidevcia*? *cryptica* nom. nov. for *Nucula concinna* Dana, 1847 not Sowerby 1836, USNM 3635, figured by Dana (1849, pl. 7, fig. 4), right view, left view and dorsal aspects. From "Harper's Hill, Illawarra" (= Hunter Valley). × 1.

Fig. 3. *Polidevcia*? *abrupta* (Dana), USNM 3640, holotype, figured as *Nucula abrupta* Dana (1849, pl. 7, figs. 3, 3a). Fragment of *Pyramus* lies at lower left. "Flagstaff Point, Wollongong". × 1.

Figs. 4,6–9,11. *Merismopteria imbricata* (Dana), 1847.

Fig. 4. Specimen USNM 3641, lectotype figured as *Cypricardia imbricata* by Dana (1849, pl. 8, fig. 5).

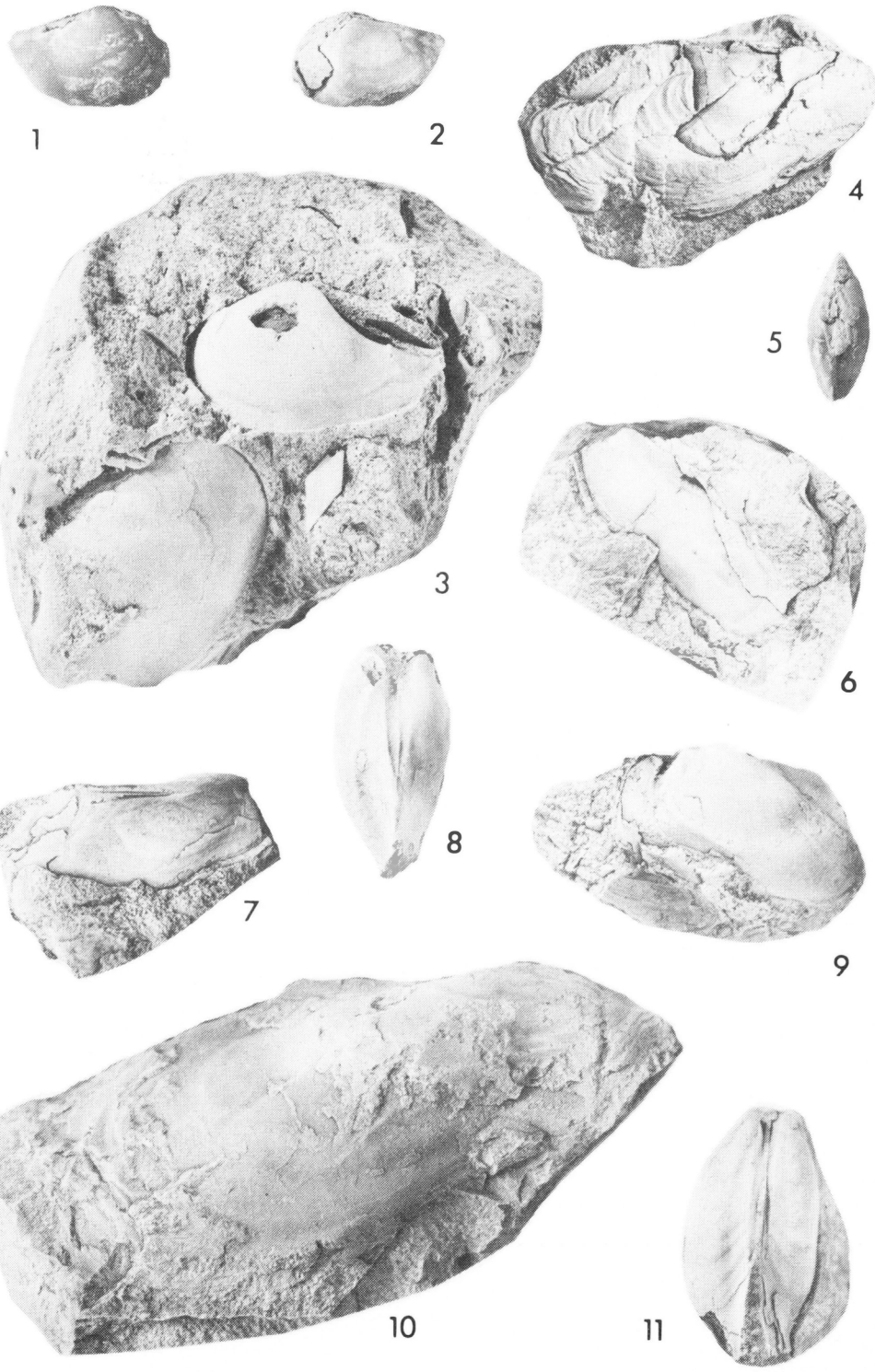
Fig. 6. USNM 188128 showing thick prismatic shell at left side, see Dana (1849, pl. 8, fig. 7).

Figs. 7,11. Lateral and dorsal aspects, USNM 188129, see Dana (1849, pl. 8, fig. 6). From "Harper's Hill". × 1.

Figs. 8–9. Dorsal and lateral aspects of USNM 3646, holotype of *Cypricardia arcodes* Dana (1849, pl. 8, figs. 8a, 8b). From "Harper's Hill, Illawarra" (= Hunter Valley). × 1.

Fig. 10. *Merismopteria macroptera* (Morris). Lateral view of USNM 3642, lectotype of *Cypricardium acutifrons* Dana (1847, 1849, pl. 8, figs. 4a, 4b). From Illawarra. × 1.

PLATE 1



EXPLANATION FOR PLATE 2

Figs. 1,3. *Merismopteria macroptera* (Morris). Lateral and dorsal views of USNM 3642, lectotype of *Modiolopsis acutifrons* Dana (1847, 1849, pl. 8, figs. 4a, 4b). From Illawarra. × 1.

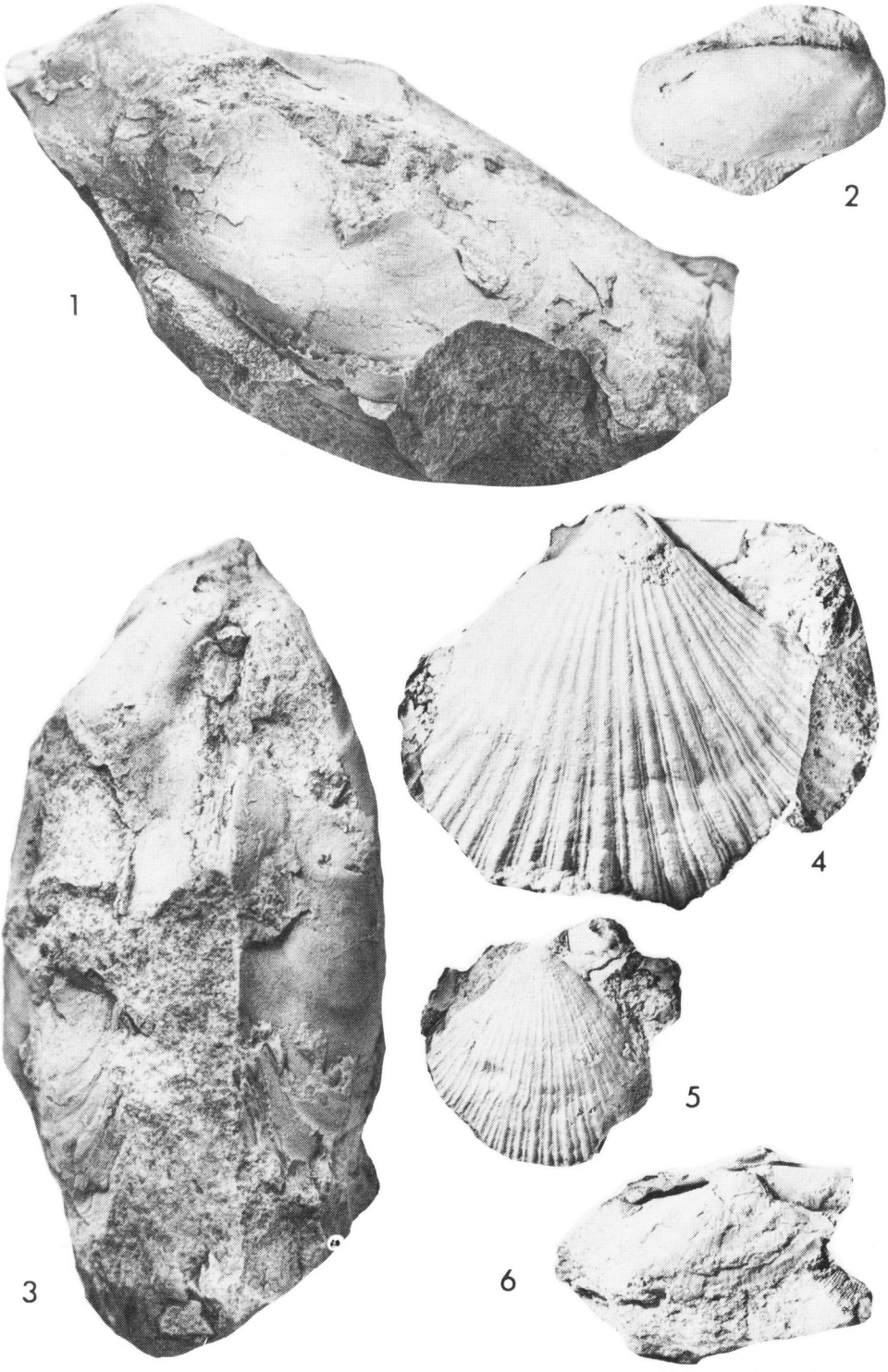
Fig. 2. Gen. indet. *praerupta* (Dana) USNM 3667, holotype, figured by Dana (1849, pl. 8, fig. 10). From Illawarra, New South Wales. × 1

Fig. 4. *Fletcheripecten laticostatus* Waterhouse (= *Pecten comptus* (Dana), 1847, not *Pecten comptus* Sowerby, 1836, USNM 3652, holotype, figured by Dana (1849, pl. 9, fig. 5). From "Harper's Hill, Illawarra, on the Hunter, New South Wales". × 1.

Fig. 5. *Etheripecten tenuicollis* (Dana), USNM 3658, holotype figured by Dana (1849, pl. 9, figs. 7, 7a). From Harper's Hill, "Illawarra", (i.e. Hunter Valley). × 1.

Fig. 6. *Etheripecten leniusculus* (Dana), USNM 4758, holotype of *Pecten mitis* Dana (1849, pl. 9, figs. 8a, 8b). View of right valve and left umbo, showing chondrophore. From "Glendon on the Hunter". × 1.

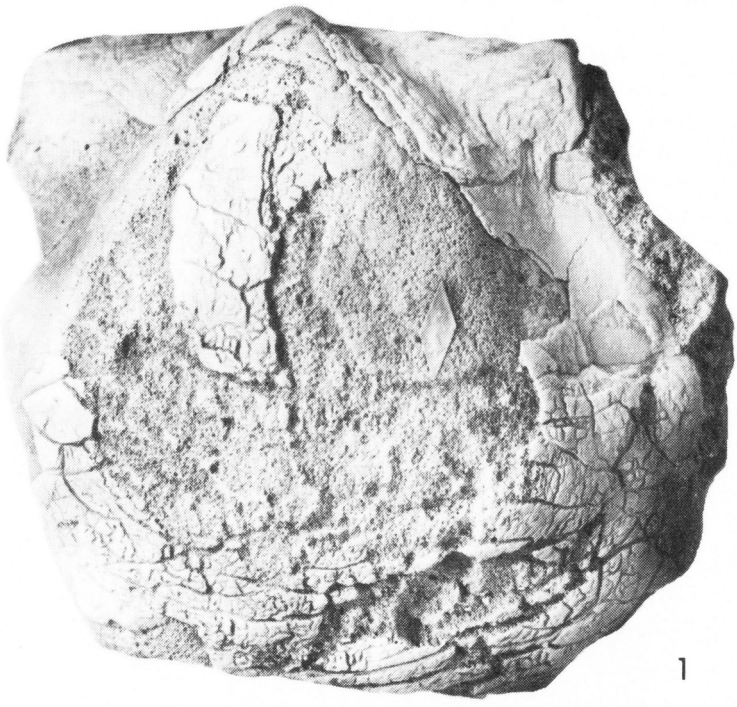
PLATE 2



EXPLANATION FOR PLATE 3

Figs. 1,2. *Etheripecten lenuisculus* (Dana), left and right valves of USNM 3644, lectotype, figured by Dana (1849, pl. 9, figs. 6a, 6b). From "Illawarra, New South Wales". × 1.

PLATE 3



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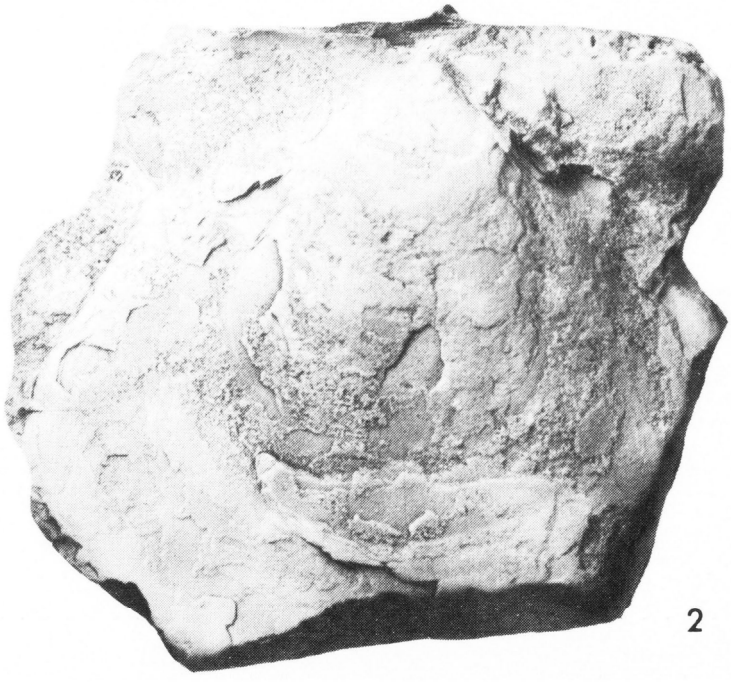


2

EXPLANATION FOR PLATE 4

Figs. 1–5. *Eurydesma cordatum* Morris. × 1.

Fig. 1. Anterior view of USNM 3664, figured as *E. cordata* Morris by Dana (1849, pl. 8, figs. 1, 1a). From "Harper's Hill, Illawarra", (i.e. Hunter Valley).

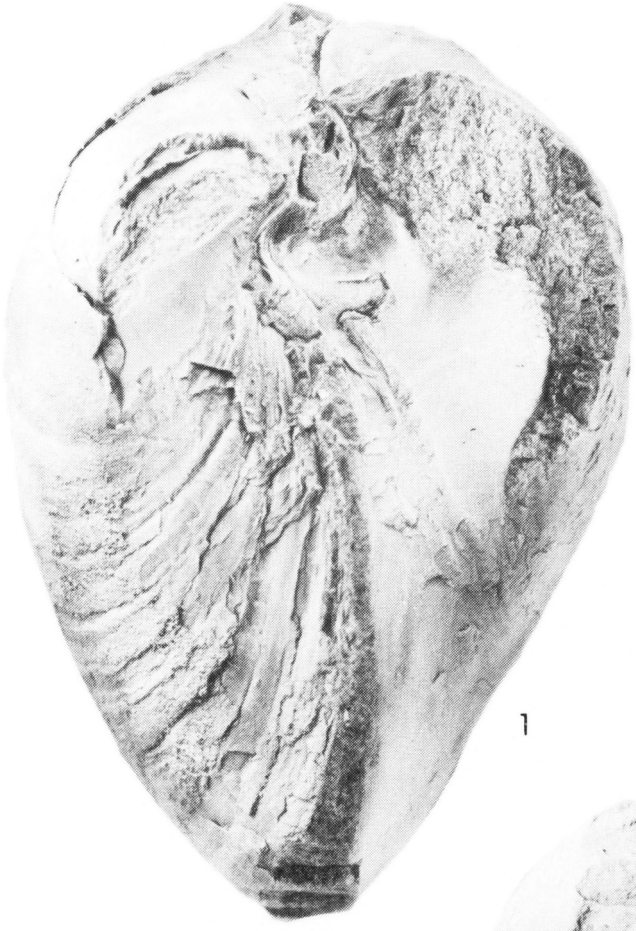
Fig. 2. Right valve USNM 188134, specimen of *E. globosum*, not figured. From "Illawarra", (i.e. Hunter Valley).

Fig. 3. USNM 3600, lectotype of *E. globosum* Dana, figured by Dana (1849, pl. 7, figs. 7, 7a). From "Illawarra", (i.e. Harper's Hill, Hunter Valley).

Fig. 4. Anterior view of USNM 3601, lectotype of *E. ellipticum* Dana (1849, pl. 7, fig. 6a–d — see 6c). From "Harper's Hill, Illawarra", (i.e. Hunter Valley).

Fig. 5. Right valve USNM 3602, figured as *E. sacculus* (M'Coy) by Dana (1849, pl. 7, figs. 8a–8c). From "Harper's Hill, Illawarra", (i.e. Hunter Valley).

PLATE 4



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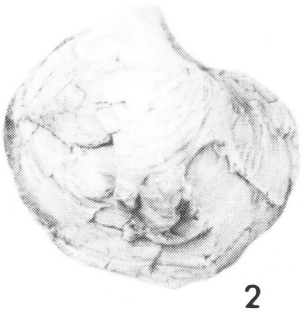

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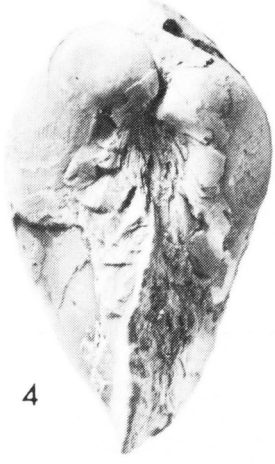

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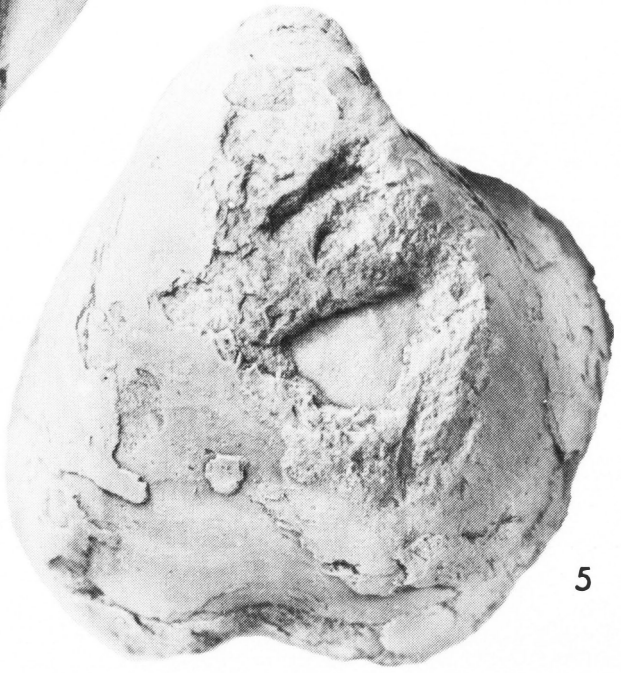


5

EXPLANATION FOR PLATE 5

Fig. 1. *Eurydesma cordatum* Morris, left valve of USNM 3601, lectotype of *E. ellipticum* Dana (1849, pl. 7, figs. 6a-d — see Fig. 6a). From "Harper's Hill, Illawarra" (i.e. Hunter Valley). × 1. See pl. 4, fig. 4.

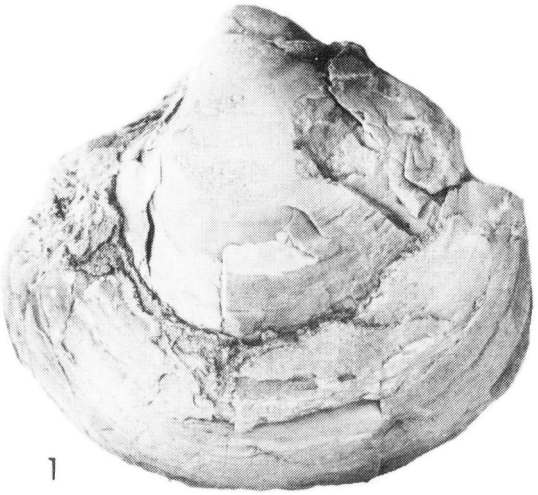
Fig. 2. *Stutchburia simplex* (Dana), USNM 3632, figured by Dana (1849, pl. 9, fig. 2). From "Carboniferous, New South Wales". × 1.

Fig. 3. *S.? recta* (Dana), USNM 3648, lectotype figured by Dana (1849, pl. 4, fig. 5). From "District of Illawarra, New South Wales". × 1.

Figs. 4,6,7. *Stutchburia costata* (Morris), right, left and dorsal views of USNM 3630, figured by Dana (1849, pl. 4, figs. 8a-c). From "Illawarra". × 1.

Fig. 5. *Stutchburia costata* (Morris), USNM 188140, not figured by Dana. From "Illawarra". × 1.

PLATE 5



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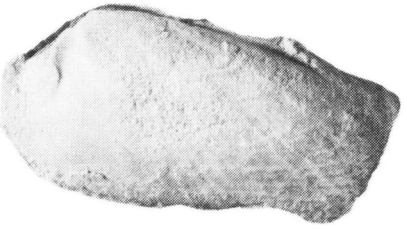

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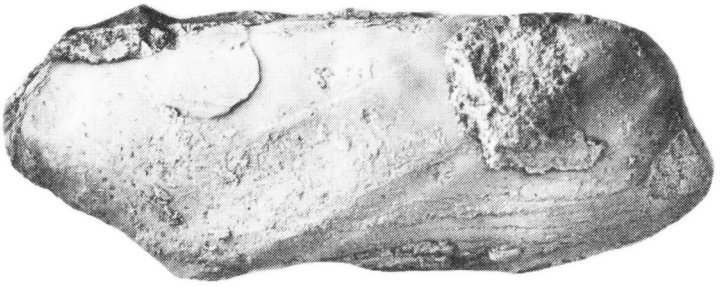

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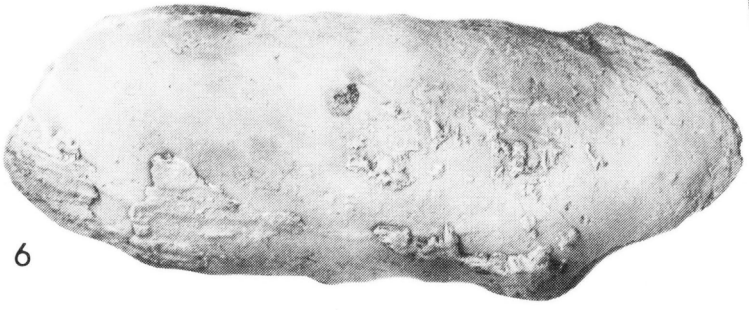


6

EXPLANATION FOR PLATE 6

Figs. 1–12. *Stutchburia*? *cuneata* (Dana) from Wollongong, Flagstaff Point?, New South Wales. × 1.

Figs. 1,2,3. Dorsal, anterior and lateral views of USNM 3672, lectotype, figured by Dana (1849, pl. 4, figs. 6, 6b, 6c, 6d = external mould?).

Figs. 4,5,6. Dorsal, lateral and anterior views of paratopotype USNM 188143, figured by Dana (1849, pl. 4, figs. 6a, 6e).

Fig. 7. Lateral view of unfigured specimen, USNM 188142.

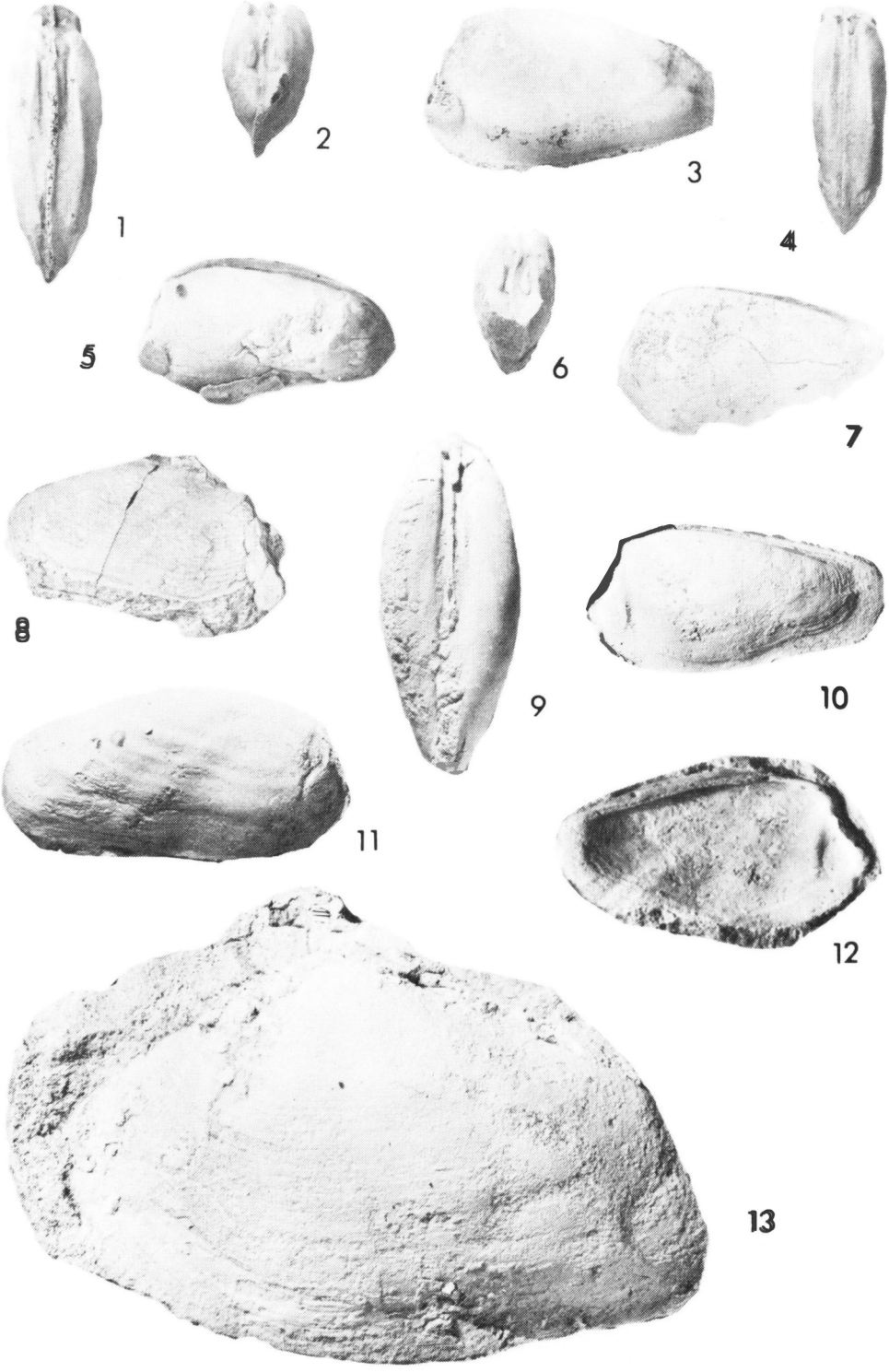
Fig. 8. Lateral view of unfigured, unlabelled specimen USNM 188144.

Figs. 9,11. Dorsal and lateral views, internal mould of F 7910, kept at Australian Museum, Sydney. From Gerringong Volcanics, Wollongong.

Figs. 10,12. Internal mould and latex cast of left valve F 8230, Australian Museum. From same locality.

Fig. 13. *Myonia elongata* Dana, USNM 3585, holotype of *Cypricardia sinuosa* Dana 1847, figured as *Maeonia axinia* by Dana (1849, pl. 5, fig. 5d). From Illawarra, New South Wales. × 1. See pl. 14, fig. 5.

PLATE 6



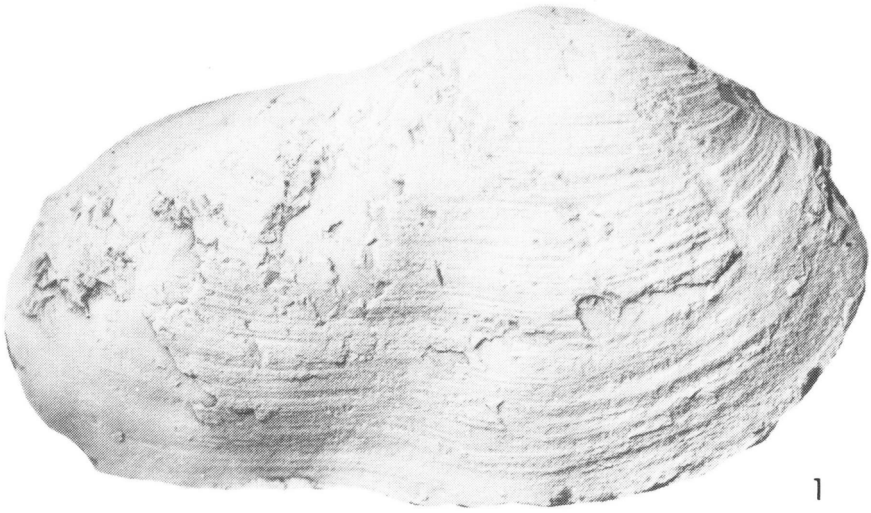
EXPLANATION FOR PLATE 7

Figs. 1,2. *Myonia elongata* Dana, lateral and dorsal views of lectotype, USNM 3584, figured by Dana (1849, pl. 5, figs. 3a-3c). From Black Head. × 0.9.

Fig. 3. *Myonia* (*Myomedia*) *carinata* (Morris), USNM 25640, figured by Dana (1849, pl. 6, figs. 1a, 1b), lectotype of *Cypricardia rugulosa* Dana, 1847. From Wollongong. × 1.

Fig. 4. *Astartila intrepida* Dana, left valve of specimen USNM 188171 not previously figured, right valve buried in concretion. Identified by Dana as *Astartila transversa* Dana. From Wollongong Point. × 1.

PLATE 77



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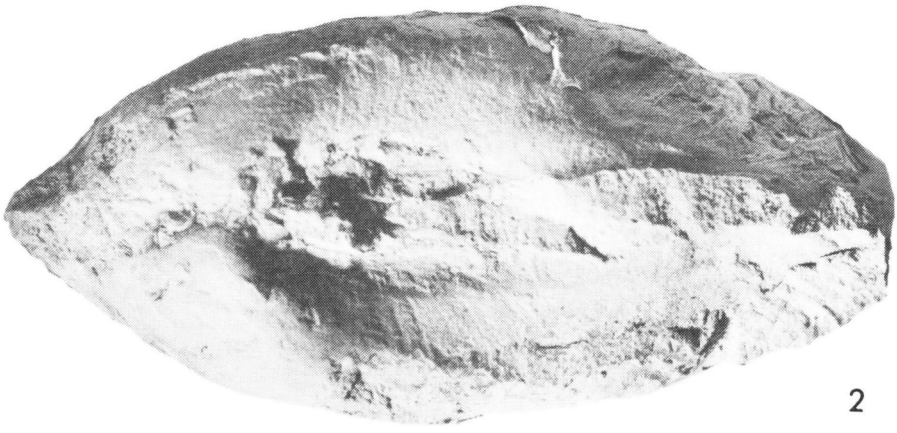

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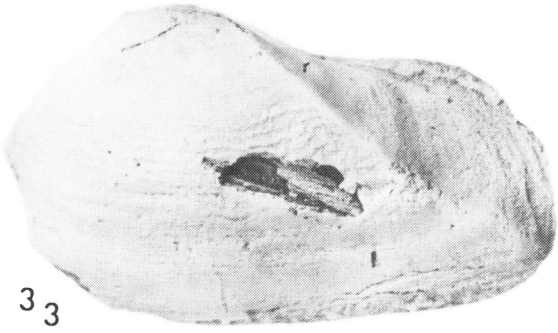

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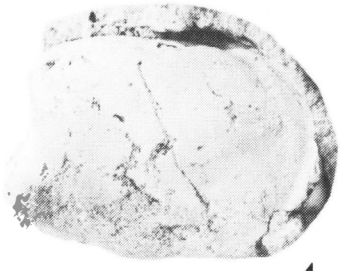

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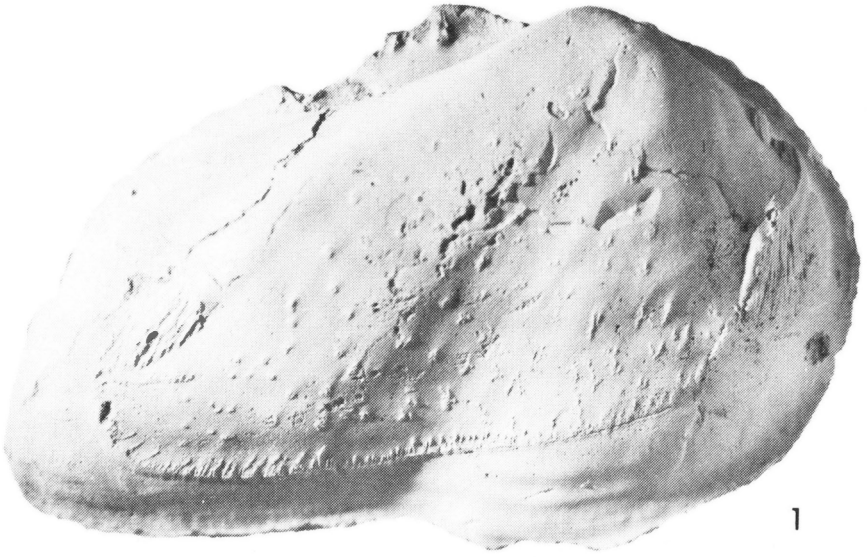
EXPLATION FOR PLATE 8

Figs. 1,2. *Myonia elongata* Data, lateral and dorsal views of lectotype of *M. valida* Dana, USNM 3665, figured by Dana (1849, pl. 5, figs. 4, 4a, 4b), and Fletcher (1932, pl. 48, fig. 2). From Black Head, south coast, New South Wales. × 0.75. See pl. 9, fig. 1.

Fig. 3. *Solecurtus*? *planulatus* Dana, incerte sedis, possibly conchostracan, holotype, USNM 3631, figured by Dana (1849, pl. 2, fig. 10), from "Harper's Hill", New South Wales. × 1.

Fig. 4. *Solecurtus*? *ellipticus* Dana, incerte sedit, possibly conchostracan, USNM 3654, figured by Dana (1849, pl. 2, fig. 9), from "Wollongong Point", New South Wales. × 1.

PLATE 8



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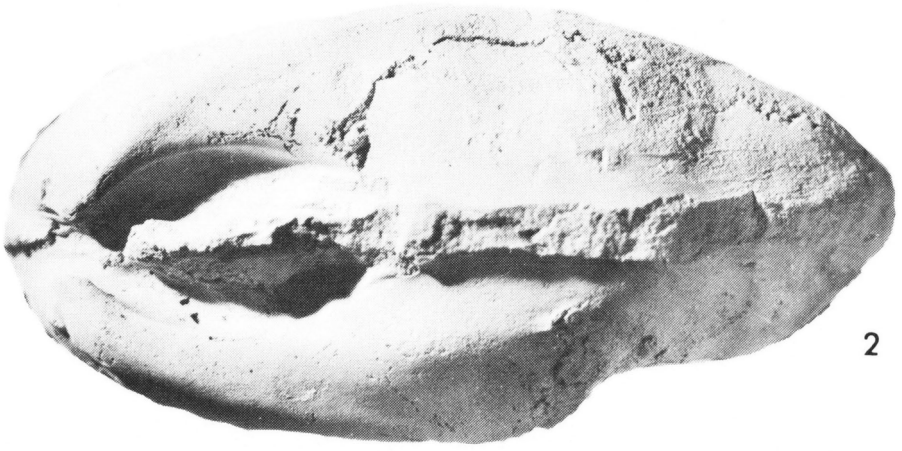

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EXPLANATION FOR PLATE 9

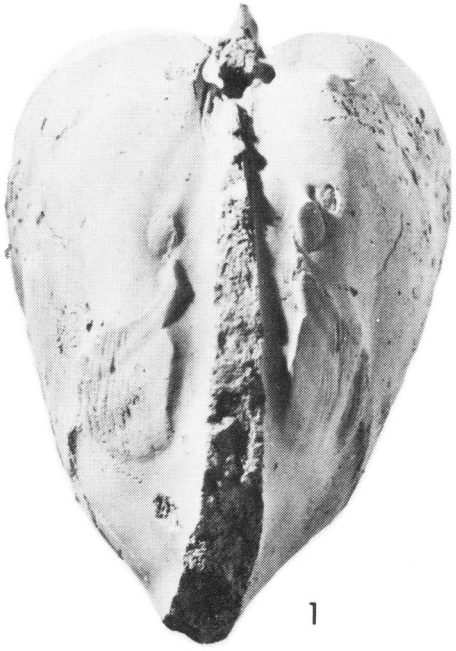
Fig. 1. *Myonia elongata* Dana, anterior view of USNM 3665, lectotype of *M. valida* Dana, figured by Dana (1849, pl. 5, figs. 4a–4b). From Black Head. × 0.75.

Figs. 2,3,5. *Myonia undata* (Dana), dorsal and lateral views of holotype, USNM 3639, figured by Dana (1849, pl. 2, figs. 11a, b), and Fletcher (1932, pl. 50, fig. 2). From Wollongong, New South Wales. × 1.

Fig. 4. *Pyramus myiformis* Dana, USNM 188168, lectotype of *Pyramus axinia* Dana, figured as *Maeonia axinia* by Dana (1849, pl. 5, figs. 5a–5c). From "Illawarra, Australia".

Fig. 6. *Pyramus laevis* (Sowerby), USNM 188156, identified as *Maeonia elliptica* by Dana, from "Harper's Hill, Valley of the Hunter, Wollongong, Illawarra". (Really from Harper's Hill). × 3.

PLATE 9



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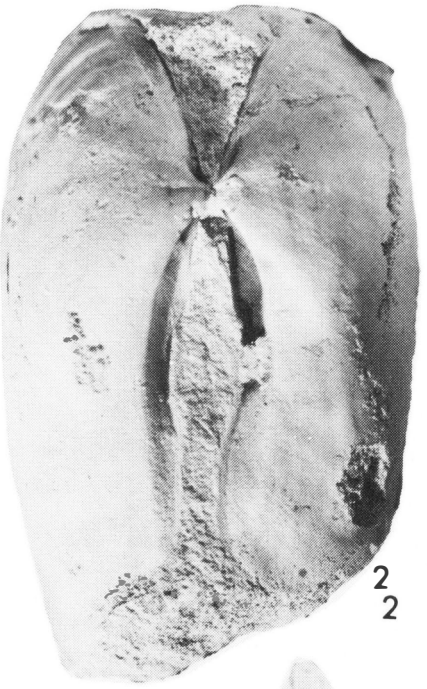

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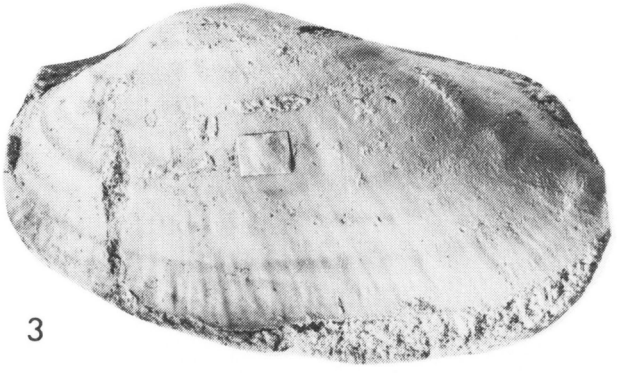

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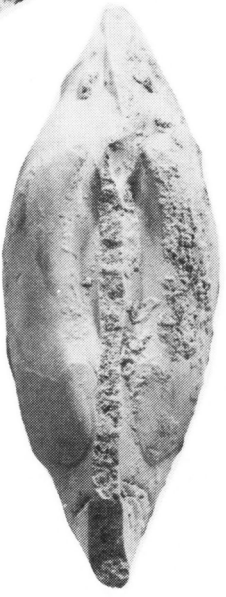

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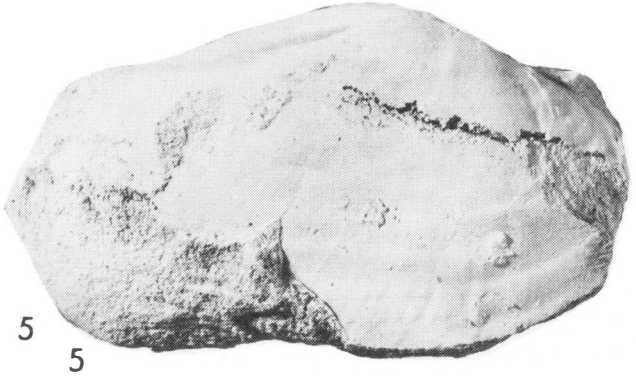

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EXPLANATION FOR PLATE 10

Fig. 1. *Megadesmus* (*Cleobis*) *grandis* (Dana), lateral view of lectotype, USNM 3638, figured as *Maeonia* (*Cleobis*) *grandis* by Dana (1849, pl. 6, figs. 7, 7a). From Wollongong Point, Illawarra, New South Wales. × 0.75.

Fig. 2. Lateral view of unfigured paratype, USNM 188149. From same locality. × 0.75.

PLATE 10

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EXPLANATION FOR PLATE 11

Megadesmus (*Cleobis*) *grandis* (Dana), dorsal aspect of internal mould of mature specimen USNM 25639, described as *Maeonia* (*Cleobis*) *gigas* M'Coy by Dana (1849, p. 697). From "District of Illawarra, New South Wales". × 1.

PLATE 11

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EXPLANATION FOR PLATE 12

Fig. 1. *Megadesmus* (*Cleobis*) *grandis* (Dana). Anterior view of large USNM 25639, described as *Maeonia* (*Cleobis*) *gigas* M'Coy by Dana (1849). From "District of Illawarra, New South Wales". × 1.

Figs. 2,3. Lateral, and anterior views of small specimen USNM 188151, figured as *Maeonia* (*Cleobis*) *grandis* by Dana (1849, pl. 6, figs. 8, 8a). From "Wollongong Point, Illawarra". × 1.

PLATE 12

EXPLANATION FOR PLATE 13

Figs. 1–3,5. *Megadesmus* (*Cleobis*) *grandis* (Dana).

Figs. 1,2. Lateral and dorsal views of juvenile specimen USNM 188154, figured as *Maeonia* (*Cleobis*) *gracilis* by Dana (1849, pl. 7, figs. 1b, 1c) and Runnegar (1965, pl. 15, fig. 2). From "Wollongong Point, Illawarra". × 1.

Figs. 3,5. Lateral and posterior views of juvenile specimen USNM 3637, lectotype of *Maeonia* (*Cleobis*) *gracilis* Dana, figured by Dana (1849, pl. 7, fig. 1a). From "Wollongong Point, Illawarra". × 1.

Fig. 4. *Pyramus laevis* (Sowerby), USNM 3590, figured as *Pachydomus antiquatus* (Sowerby) by Dana (1849, pl. 5, fig. 2). From "Harper's Hill, Illawarra". × 1. See pl. 15, figs. 2, 7.

PLATE 13

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EXPLANATION FOR PLATE 14

Figs. 1,4. *Megadesmus* (*Cleobis*) *grandis* (Dana). Posterior and tilted anterior of USNM 3638, lectotype, figured as *Maeonia* (*Cleobis*) *grandis* by Dana (1849, pl. 6, figs. 7, 7a). From Wollongong Point, Illawarra. × 0.75.

Figs. 2,3. *Pyramus laevis* (Sowerby), dorsal and lateral views of USNM 188178, identified by Dana (1849) as *Astartila cyprina* Dana. "From Wollongong", (i.e. Harper's Hill). × 1.

Fig. 5. *Myonia elongata* Dana, right valve of USNM 3585, lectotype of *Cypricardia sinuosa* Dana, 1847, figured by Dana (1849, pl. 5, fig. 5d). From "Illawarra, Australia". × 1. See pl. 6, fig. 13.

Fig. 6. *Terrakea brachythaera* (Morris), USNM 3660, figured as *Avicula volgensis* by Dana (1849, pl. 9, fig. 4). × 1.

PLATE 14

EXPLANATION FOR PLATE 15

Figs. 1,3. *Megadesmus* (*Cleobis*) *recta* Dana = *grandis* Dana?

Fig. 1. Specimen USNM 188155 buried in matrix below USNM 3651 of Fig. 3, showing pallial line and posterior adductor scar. "From Wollongong Point, Illawarra". × 1.

Fig. 3. USNM 3651, lectotype of *Cleobis recta* Dana 1847, figured as *Maeonia recta* by Dana (1849, pl. 7, fig. 2). × 1.

Figs. 2,4,5,7,8. *Pyramus laevis* (Sowerby, 1838).

Figs. 2,7. Posterior dorsal and lateral views of USNM 3590, figured as *Pachydomus antiquatus* (Sowerby) by Dana (1849, pl. 5, fig. 2). From Harper's Hill. × 1.

Figs. 4,8. Dorsal and lateral views of USNM 3583, lectotype of *Pyramus ellipticus* Dana 1847, figured as *Maeonia elliptica* by Dana (1849, pl. 6, figs. 5a–c — 5a, b here). From "Harper's Hill, Valley of the Hunter, Wollongong, Illawarra", (i.e. from Harper's Hill). × 1.25.

Fig. 5. Dorsal view of unfigured internal mould USNM 188156, paratype of *P. ellipticus*, from same locality as above. × 1.25. See pl. 9, fig. 6.

Fig. 6. *Myonia* (*Myomedia*) *carinata* (Morris), USNM 4639, lectotype of *Maeonia fragilis* Dana figured by Dana (1849, pl. 6, fig. 3). From "Glendon, Valley of the Hunter, New South Wales". × 1.

PLATE 15

EXPLANATION FOR PLATE 16

Figs. 1-5,7. *Pyramus myiformis* Dana 1847.

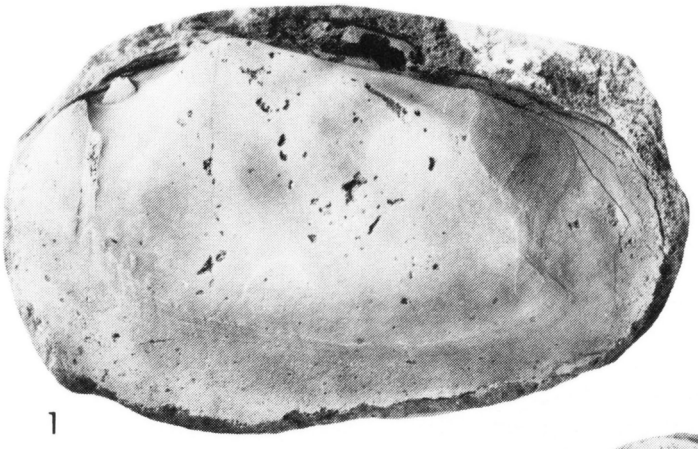
Fig. 1. USNM 188166. Old label reads *Myonia axinia* Dana. From Black Head. × 1.

Fig. 2,7. Lateral and dorsal views of internal mould of specimen with valves conjoined, regarded as typical of the species, USNM 188169, in box with, and previously numbered the same as *Maeonia axinia* Dana. From "Illawarra, Australia". × 1.

Fig. 3. Specimen from concretion like type *myiformis*, labelled USNM 188158, *Pyramus ellipticus* Dana, from "Harper's Hill, Valley of the Hunter, Wollongong, Illawarra", possibly from Wollongong. × 0.9.

Figs. 4,5. Lateral and dorsal view of USNM 188167, identified as *Maeonia axinia* Dana. From "Black Head" = Flagstaff Point, Wollongong. Also figured by Newell (1956, fig. 4A, B, D). × 1. See pl. 20, figs. 6, 7.

Fig. 6. *Pyramus laevis*? (Dana). One of two valves splayed apart, in green matrix, USNM 188160, *Maeonia* (*Pyramia*) *elliptica* Dana 1847, with no original label. Supposedly from Illawarra. × 1.



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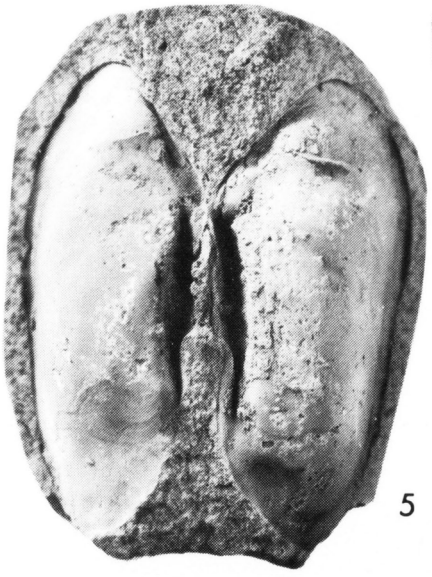

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EXPLANATION FOR PLATE 17

Figs. 1?,2,7,8 *Pyramus myiformis* Dana.

Fig. 1? Left valve USNM 188159, figured as *Maeonia elliptica* Dana by Dana (1849, p. 697, pl. 6, figs. 6, 6a), from "Harper's Hill and Wollongong, New South Wales", presumably the latter. × 1. Referred to *P. myiformis* by Runnegar (1967).

Figs. 2,7,8. Lateral and dorsal anterior views of USNM 188168, lectotype of *Pyramus axinia* Dana, 1847, Figured as *Maeonia axinia* by Dana (1849, pl. 5, figs. 5a–5c, c^1 — see figs. 5b, 5c). "Illawarra, Australia" (i.e. Wollongong). × 1. See pl. 9, fig. 4.

Figs. 3–6,9. *Astartila intrepida* Dana.

Figs. 3,4,9. Lateral and posterior aspects of USNM 3594, lectotype of *A. intrepida* Dana figured by Dana (1849, pl. 3, figs. 5, 5a, 5b, 5c = muscles) also figured by Fletcher (1929b, pl. 26, fig. 6). From Wollongong Point, Illawarra, New South Wales. × 1.

Figs. 5,6. *A. cytherea* Dana USNM 188170, Wollongong Point. Left valve and posterior view of the smaller of the two "cotypes" not figured by Dana, showing calcified ligament and strongly marked posterior adductor scar. From Wollongong. × 1.

PLATE 177

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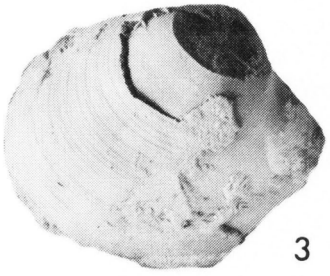

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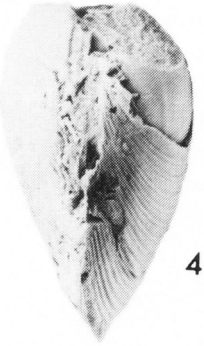

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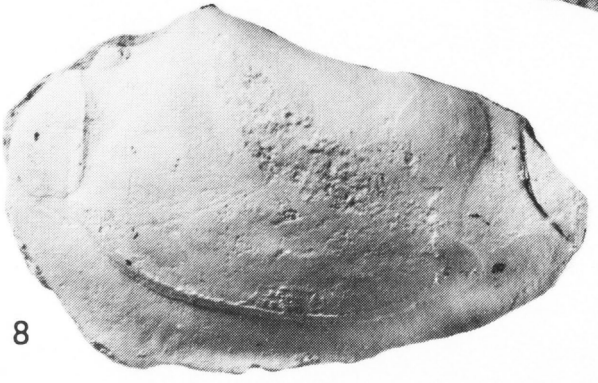

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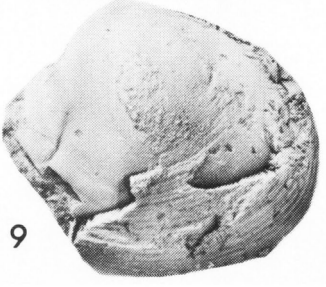

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EXPLANATION FOR PLATE 18

Figs. 1–11. *Astartila intrepida* Dana.

Figs. 1,2,4,6. Lateral, anterior and dorsal views, and latex mould of interior, left valve to right, anterior above, of USNM 3588, lectotype of *Astartila cyprina* Dana 1847, figured by Dana (1849, pl. 3, figs. 6?. 6a, b–f = muscle scars), and Fletcher (1929b, pl. 28, fig. 1). From "Wollongong Point, New South Wales". × 1 and × 2.

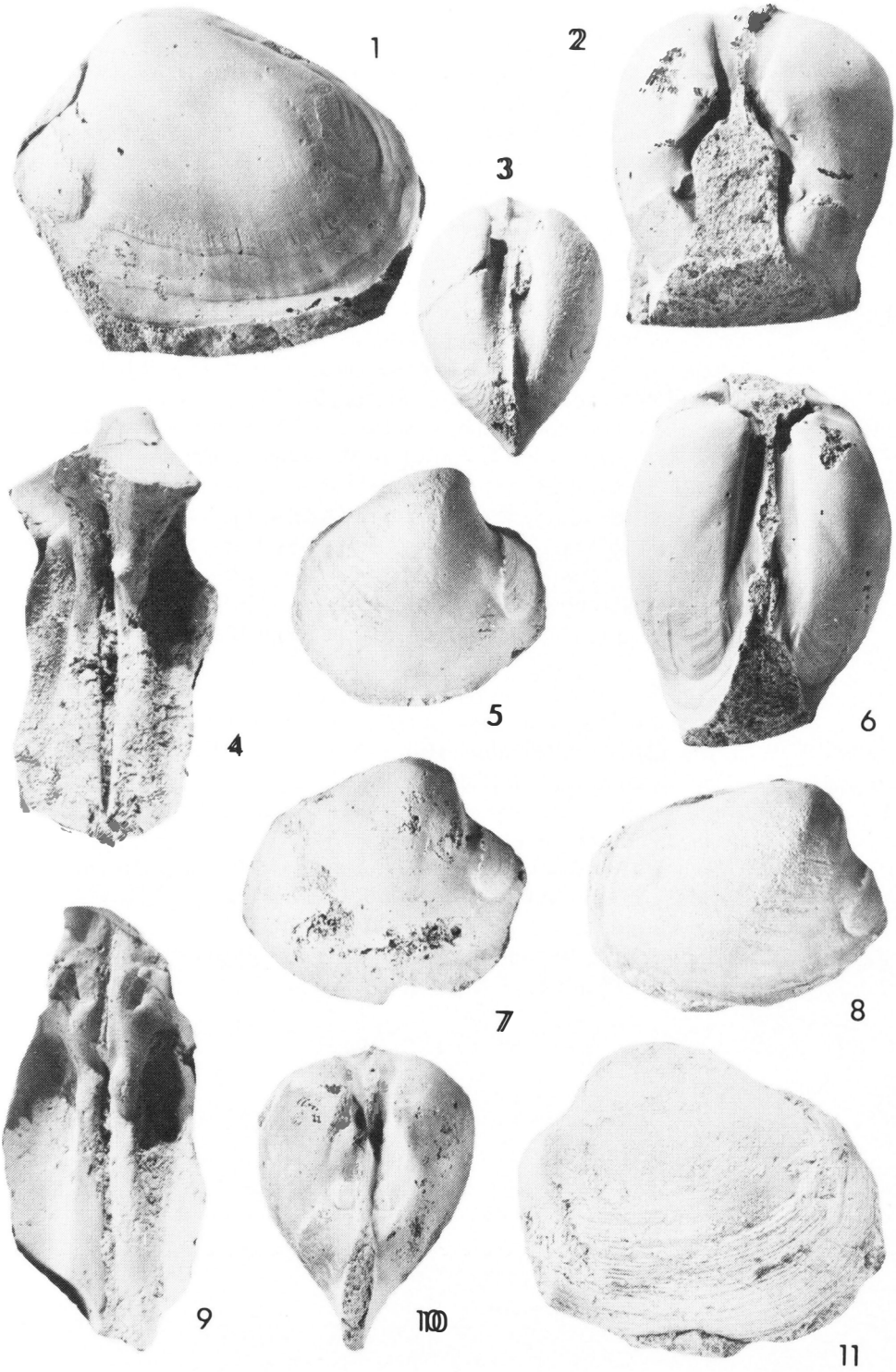
Figs. 3,5,9. Dorsal and lateral views and latex mould of interior, left valve to right, of USNM 3586, lectotype identified as *A. cytherea* Dana (1849, pl. 4, figs. 1b–1g), and Fletcher (1929b, pl. 28, fig. 12). From Wollongong. × 1, × 2. See pl. 19, fig. 2.

Figs. 7,10. Lateral and anterior views of USNM 188175, *A. cyprina* Dana. × 1 and × 1.2. See pl. 19, fig. 1.

Fig. 8. Lateral view of USNM 3598, lectotype of *Astartila transversa* Dana figured by Dana (1849, pl. 4, figs. 4, 4a–4d), and Fletcher (1929b, pl. 26, fig. 14), from Wollongong Point. × 1.2.

Fig. 11. USNM 3677, figured as *A. cyprina* by Dana (1849, pl. 3, figs. 7a, 7b), much restored in figures. From Wollongong Point, Illawarra, New South Wales. × 1.

PLATE 18



EXPLANATION FOR PLATE 19

Figs. 1–12,15. *Astartila intrepida* Dana.

Fig. 1. USNM 188175, labelled as *Astartila cyprina* Dana (1849). From Wollongong. × 1. See pl. 18, figs. 7, 10.

Fig. 2. Anterior view of USNM 3586, lectotype figured as *Astartila cytherea* by Dana (1849, pl. 4, figs. 1b–1g – 1, 1a = exterior). From Wollongong Point. × 1.

Figs. 3,4. USNM 3598, lectotype of *Astartila transversa* Dana figured by Dana (1849, pl. 4, figs. 4, 4a–4d). From Wollongong. × 1.2. See Pl. 18, fig. 8.

Figs. 5,6,9. Lateral and anterior views of USNM 3592, *Astartila cyclas* Dana, holotype figured by Dana (1849, pl. 4, figs. 3, 3a–3e), and Fletcher (1929, pl. 25, fig. 1, 2). From Wollongong. × 1. Fig. 9 Latex mould of hinge, left valve to right, × 2. See pl. 20, fig. 1.

Fig. 7. Single valve in concretion, USNM 188172, identified by Dana (1847, 1849) as *A. transversa* Dana. From Wollongong Point. × 1.

Figs. 8,10. Lateral and dorsal views of USNM 3591, *Astartila corpulenta* Dana, lectotype, figured by Dana (1849, pl. 3, figs. 3a–3c). × 1.

Fig. 11. USNM 188173, *A. polita* Dana, figured by Dana (1849, pl. 4, fig. 2a). From Black Head, Illawarra. × 1.

Figs. 12,15. Lateral and anterior views of USNM 3589, lectotype figured as *A. polita* Dana (1849, pl. 4, figs. 2b, 2c). From Black Head, Illawarra. × 1.

Figs. 13,14. *Vacunella curvata* (Morris). Lateral and anterior views of holotype USNM 25643 of *Pholadomya* (*Homomya*) *glendonensis* Dana (1849, pl. 2, fig. 12). From Glendon, Hunter Valley. × 1. See pl. 20, fig. 4.

Figs. 16–19. *Pleurikodonta gemma* (Dana).

Fig. 16. Right valve of holotype USNM 3593 figured by Dana (1849, pl. 3, fig. 4, 4a, b). From "Illawarra". × 2.

Fig. 17. Obscure right valve E 10786a, Sedwick Museum, in collection of *Venus? gregaria* M'Coy 1847. From Glendon. × 2.

Fig. 18. External mould of holotype USNM 3593. × 2.

Fig. 19. Right valve E 10787a, lectotype of *Venus? gregaria* M'Coy figured by M'Coy (1847, pl. 15, fig. 5). × 2.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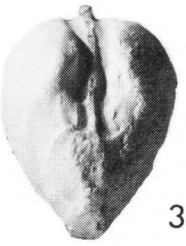
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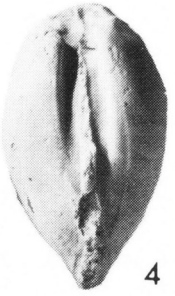
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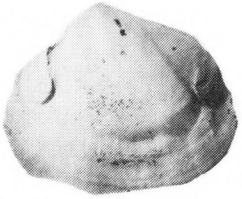
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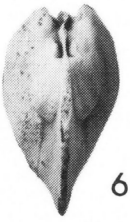
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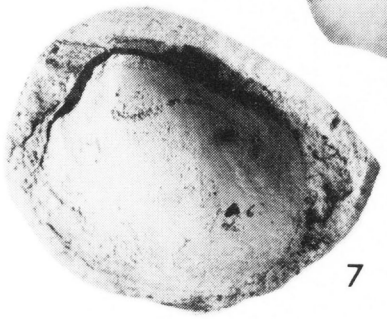
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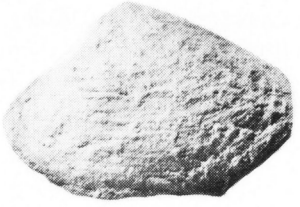
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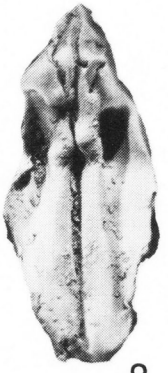
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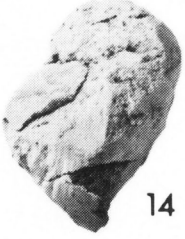
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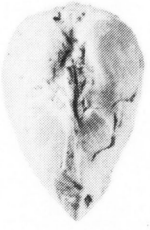
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EXPLANATION FOR PLATE 20

Fig. 1. *Astartila intrepida* Dana, latex mould of USNM 3592, holotype of *A. cyclas* Dana, figured by Dana (1849, pl. 4, fig. 3), and Fletcher (1924, pl. 25, fig. 1, 2). From Wollongong, New South Wales. × 2.

Fig. 2. *Megadesmus gryphoides* (de Koninck), latex mould of interior, right valve to left, for comparison with *Astartila* hinge. Geological Survey of Queensland F 9583, Tiverton Formation, Queensland. Courtesy of Dr. B. Runnegar. × 1.

Figs. 3,6,7. *Pyramus myiformis* Dana.

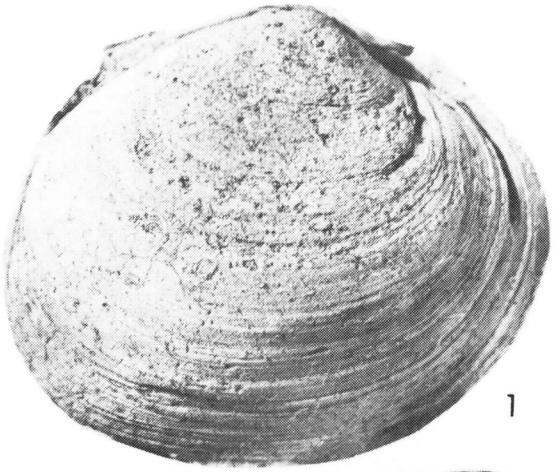
Fig. 3. USNM 188166, rubber latex mould of large left valve, × 1. Unlabelled, probably *M. axinia* from Black Head or Wollongong. × 1. See pl. 16, fig. 1.

Figs. 6,7. Rubber latex mould of exterior and interior of USNM 188167, "*Maeonia axinia*" Dana, from Flagstaff Hill, "Black Head" (= Flagstaff Hill, Wollongong). × 1. See pl. 16, figs. 4, 5.

Fig. 4. *Vacunella curvata* (Morris), left side of USNM 25643, holotype of *Pholadomya* (*Homomya*) *glendonensis* Dana (1849, pl. 2, fig. 12). From Glendon, Hunter Valley. × 1. See pl. 19, figs. 13, 14.

Fig. 5. ?*Exochorhynchus* from Pennsylvanian of Brazil, collection USNM 23686, *Heteropecten* bed at Boa Vista, 1.4km NE of Oswaldo Hotel, Taio Mun Rio do Sul. Coll. Dr. M. Gordon, Jnr, 1946. × 1.

PLATE 20



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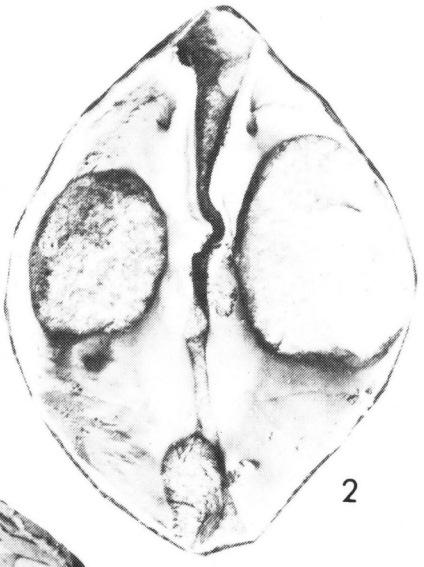

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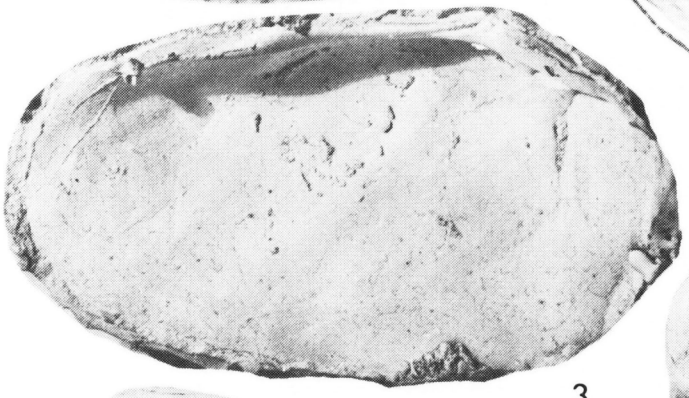

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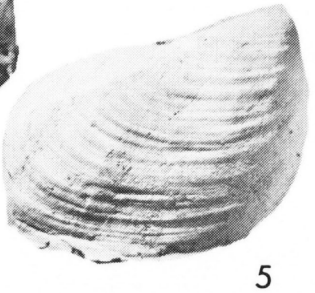

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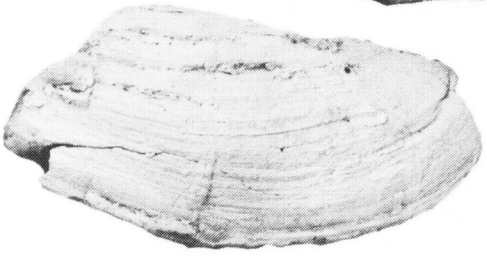

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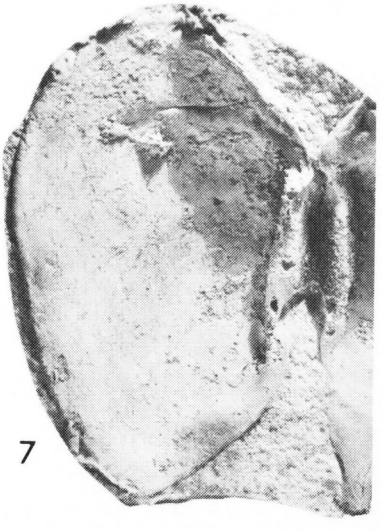

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