AUSTRALIAN MUSEUM SCIENTIFIC PUBLICATIONS

Bergmans, W., 1978. Taxonomic revision of Recent Australian Nuculidae (Mollusca: Bivalvia) except *Ennucula* Iredale, 1931. *Records of the Australian Museum* 31(17): 673–736. [31 December 1978].

doi:10.3853/j.0067-1975.31.1978.218

ISSN 0067-1975

Published by the Australian Museum, Sydney

Taxonomic Revision of Recent Australian Nuculidae (Mollusca: Bivalvia) Except *Ennucula* Iredale, 1931

W. BERGMANS
Instituut voor Taxonomische Zoologie
(Zoologisch Museum)
Plantage Middenlaan 53, Amsterdam
The Netherlands

SUMMARY

Taxonomy and distribution of 14 Recent Australian species of the family Nuculidae Gray, 1824 are described and discussed. Available data on biology and ecology are added. Illustrations and distribution maps of all species are given.

The genera *Pronucula* Hedley, 1902, and *Deminucula* Iredale, 1931, are considered synonyms of *Nucula* Lamarck, 1799. *Rumptunucula* is proposed as a new genus for *Pronucula vincentiana* Cotton and Godfrey, 1938. Lectotypes are selected for *Nucula pusilla* Angas, 1877, *Nucula micans* Angas, 1878, *Nucula torresi* Smith, 1885, *Nucula dilecta* Smith, 1891, *Nucula hedleyi* Pritchard and Gatliff, 1904, *Deminucula praetenta* Iredale, 1924, *Pronucula mayi* Iredale, 1930, and *Pronucula saltator* Iredale, 1939. *Nucula micans* Angas, *Nucula hedleyi* Pritchard and Gatliff, and *Pronucula concentrica* Cotton, 1930 are considered synonyms of *Nucula pusilla* Angas. *Pronucula voorwindei* Bergmans, 1969 is synonymized with *Nucula torresi* Smith. *Nucula diaphana* Prashad, 1932 and *Pronucula flindersi* Cotton, 1930 are ranked as subspecies of *Nucula dilecta* Smith. The study also includes *Pronucula decorosa* Hedley, 1902, *Nucula beachportensis* Verco, 1907, and *Pronucula australiensis* Thiele, 1930, while four new species are described: *Nucula revei, Nucula covra, Nucula papuensis* and *Nucula brongersmai*. Notes on the zoogeography of the species involved are given.

INTRODUCTION

When, as a novice in the malacological field, I was first involved in the study of Australian species of the family Nuculidae Gray, 1824 my studies eventually resulted in two small publications (Bergmans, 1968; 1969). The first publication contained an account of six small nuculid species found in New South Wales, the second described a new species in the same category. The identifications in the first paper were mainly based on original descriptions and illustrations in literature, and the nomenclature used was taken from Hedley (1902), Iredale (1924), Cotton (1930) and Cotton and Godfrey (1938), with the assignation of all six species to the genus *Pronucula* Hedley, 1902. Both procedures, induced by the combination of the lack of comparative material and an uncritically high evaluation of earlier works, soon proved to be inadequate. Later opportunities to examine type material of these species and of others, and to study an extensive material of Australian Nuculidae in museum collections, revealed firstly that I had made — and published — several misidentifications, which needed correction, and moreover, that the taxonomy of the Australian Nuculidae required a general revision. My original intention to restrict my work to small New South Wales Nuculidae had been expanded already by the necessary study of type and other material from other Australian states.

Records of The Australian Museum, 1978, **Vol. 31 No. 17,** 000-000, Figures 1-74

The second limit I imposed was that of the genus *Pronucula*. An effort to clearly delimit this genus from other nuculid genera failed and posed the question of whether it could be maintained as a valid genus. As will appear in the following pages, it could not. An acceptable compromise was finally made by including all Australian Nuculidae with the exception of those species originally or subsequently assigned to the genus *Ennucula* Iredale, 1931. The selection thus made comprises all small species, i.e. with greatest valve length not exceeding 8 mm, with the exclusion of *Ennucula orekta* Iredale, 1939, and *Ennucula privigna* Iredale, 1939. A further restriction is the time scale considered. Although occasionally reference is made to fossils only Recent species are considered in detail. It must however be emphasized that in taxonomic or zoogeographical studies of recent material of geologically ancient and apparently slowly evolving taxa like the Nuculidae (Quenstedt, 1930; Dickins, 1963) it is of the utmost importance to be aware of the fossil evidence from the area concerned (compare Hedley, 1902: 287).

The following abbreviations of collections are used:
AM — Australian Museum, Sydney
BMNH — British Museum (Natural History), London
NMV — National Museum of Victoria, Melbourne
RMNH — Rijksmuseum van Natuurlijke Historie, Leiden
SAM — South Australian Museum, Adelaide
TAS — Tasmanian Museum, Hobart
WAM — Western Australian Museum, Perth
ZMA — Zoölogisch Museum, Amsterdam
ZMB — Zoologisches Museum, Berlin
ZSI — Zoological Survey of India, Calcutta

METHODS

Beside *Pronucula* Hedley two other genera fall within the scope of this paper: *Protonucula* Cotton, 1930, and *Deminucula* Iredale, 1931. Both are monotypic and, as with *Pronucula,* type material of their type species has been examined. To evaluate these genera correctly, the superspecific taxonomy of the Nuculidae, in so far as genera occurring in Australian waters are concerned, is discussed in the first pages of the taxonomic section. This is followed by the descriptions of the species considered, which have been standardized generally in accordance with the directives given by Mayr (1969), and by a key to adult specimens of these species. The descriptions are primarily based on type material, though details of slight and, in my opinion, taxonomically insignificant conchological variation is included. Whenever this variation reaches a degree of possible importance, it is dealt with in the species discussions.

Months in collecting dates are indicated with Roman numerals. Depths are given in metres (m), except in the bibliographic references if originally given in fathoms (1 fathom = 1.8285 m). Measurements are all given in millimeters (mm). In the listing of material examined single valves are listed as ½ (half) specimens. In the measurements *length* stands for greatest valve length, *height* for the height perpendicular to this length, *section* for the section (greatest depth) of a single valve, *embryonic shell length* (abbreviated e. s. l.) for the greatest length of the embryonic shell, and *interdissoconch length* (abbreviated i. d. l.) for the greatest length of the interdissoconch. Both embryonic shell and interdissoconch are best distinguishable in young specimens. The term interdissoconch (initial stage of the post-embryonic shell or dissoconch) is applied to the growth stage following the embryonic stage. This interdissoconch is characterised

by its sculpture (often lacking) and its often distinct margin. In describing shell morphology the term dissoconch has been used for the shell part beyond the embryonic shell plus the interdissoconch, although it could be argued that it does include the interdissoconch. (See also the discussion of *Nucula pusilla* Angas, in the taxonomic section.) The term *primary teeth* (*primary* in the sense of "earliest") is introduced for what possibly are provincular teeth: small vertical teeth or crenulations at either side of the chondrophore, which in some species persist in the adult shell. As opposed to these, the real hinge teeth are called *secondary teeth* (*secondary* in the sense of "coming in time after"). The geographic ranges are based on specimens identified by the author. The illustrations of specimens have been made with drawing attachment, by the author.

TAXONOMY

In 1799 Lamarck described the genus *Nucula*. The type of this genus is the European *Nucula nucleus* (Linnaeus, 1758), neotypes of which were designated, described and illustrated by Schenck (1935). In 1858 Adams and Adams proposed to separate from *Nucula* s. s., into a new subgenus *Acila*, those species with divaricate shell sculpture. The important monograph on *Acila* by Schenck (1936), who raised it to generic rank, provides excellent illustrations of the type species, *Acila divaricata* (Hinds, 1843). Apart from a doubtful taxon, the fossil *Deshayesii* Berge, 1855 (see Vokes, 1967) and the genus *Ptychostolis* Tullberg, 1881 from the Jurassic of the USSR (see Keen, 1969), neither of which needs to be considered here, the superspecific taxonomy of the Nuculidae remained uncomplicated until about the beginning of this century. It is true that before this time several workers have tried to establish two or more "groups" or "divisions" within *Nucula* (see Quenstedt, 1930, and the elaborate historical review by Schenck, 1934), but such categories were never formally proposed as systematic units.

In 1902 Hedley described a new nuculid species from off Port Kembla, New South Wales, which he made the type of the new genus *Pronucula*. It deserved distinction, in his opinion, because "this genus differs from *Nucula* by having the hinge line arched instead of angulated, the rows of teeth do not meet or overlap between the umbones, but are distant from the chondrophore, which is not oblique as in *Nucula*, but perpendicular. Briefly, the constituents of the hinge, which in *Nucula* are much compressed and perhaps slightly rotated, are here wide spread. The shell has not the trigonal contour of *Nucula*, is far thinner and the radial sculpture more pronounced than in that genus. Neither lunule nor escutcheon are present." The type species was named *Pronucula decorosa*, and as second species Hedley included in his new genus *Nucula minuta* Tenison Woods, 1877 the types of which he had examined. This inclusion must have confused a number of later authors with regard to the definition of *Pronucula*, which was obviously based on *Pronucula decorosa*. The apt criticism by Pritchard and Gatliff, as early as 1904, in which they stated that their shells of *Nucula minuta* Tenison Woods were "apparently indistinguishable from *Nucula*", unfortunately escaped the attention of later students. The matter has scarcely been discussed since and the concept of the genus *Pronucula* was widened further by the assignment to it of a variety of nuculid species of which the main decisive character not infrequently must have been their small size.

In 1915 Oliver described *Pronucula kermadecensis* from the Kermadec Islands, and figured it correctly (I studied some paratypes held in the Australian Museum collection) with a slightly angulate dorsal margin and a distinctly oblique chondrophore which is overlapped by the anterior teeth row. *Pronucula mesembrina* Hedley, 1916, from Macquarie Island, has, according to the original drawing, a chondrophore more oblique than perpendicular and there are no edentulous spaces between the teeth rows and the

chondrophore. In 1924 Iredale referred *Nucula pusilla* Angas, a species with an oblique chondrophore overlapped by anterior teeth, to *Pronucula*. *Pronucula tenuis* Powell, 1927, from South-West Otago, New Zealand, has a hinge with "a narrow central part," that is dorsal to the chondrophore, "with 6 minute, indistinct tubercles" (see the discussion of *Nucula covra,* n. sp., in this paper). In 1930 Thiele described *Pronucula australiensis,* from Cockburn Sound, southern Western Australia, a species with concentric sculpture only, and with a smooth inner margin. In 1930 Iredale added *Pronucula mayi* to the genus in so naming the shells taken off Pilot Station, south-east Tasmania that had been identified as *P. decorosa* Hedley by May (1915), a species possessing a much more compressed hinge and a much finer radial sculpture (Figs. 33-35). *Pronucula concentrica* Cotton, 1930, has an oblique chondrophore which is overlapped by the anterior teeth row (see Fig. 13 in this paper), and *Pronucula flindersi* Cotton, 1930, has no sculpture at all, and a smooth inner margin (see its redescription in this paper, and also Fig. 62). Without comment Cotton (1930) placed *Nucula micans* Angas in *Pronucula,* a rather smooth form with an oblique chondrophore (Figs. 6, 7). Marwick, 1931 described *Pronucula totangiensis* from Tertiary layers in the Gisborne District, New Zealand, a species with a distinctly angular dorsal margin, to judge from its original figure. *Pronucula maoria* Powell, 1937, from off Three Kings Islands, New Zealand, has what to me seem teeth rows that meet over the chondrophore, which itself can hardly be called perpendicular. Cotton and Godfrey, in 1938, published *Pronucula vincentiana* from Gulf St. Vincent, South Australia, failing to notice that its hinge configuration, instead of approaching that of *Pronucula,* is strikingly different from all known Nuculidae (see its redescription in this paper). In 1939 Iredale placed in this genus his new species *P. saltator* from Low Isle, Queensland, an almost smooth species without radial sculpture and with an oblique chondrophore. In 1947 Cotton remarked that the Miocene *Nucula morundiana* Tate, 1886, from the River Murray Cliffs, South Australia, possibly is a *Pronucula* species. Ludbrook (1955) lists it as such. In 1961 he also assigned to the genus *Pronucula* the species *Nucula tatei* Finlay, 1924, from the Upper Eocene of Blanche Point, South Australia, and *Nucula fenestralis* Tate, 1886, from the Oligocene of Table Cape, Tasmania. From the descriptions and figures in Ludbrook (1955, 1961) it appears that *Nucula morundiana* Tate has no real radial sculpture and is much more trigonal than typical *Nucula;* that *Nucula tatei* Finlay also lacks the pronounced radial sculpture of *Pronucula* and has an oblique chondrophore; and that *Nucula fenestralis* Tate has a "slightly oblique" chondrophore. In 1961 Clarke describes *Pronucula benguelana* from the South Atlantic Ocean, about 400 miles north-west of Cape Town in South Africa (depth 3100 m), with the chondrophore "close to the innermost taxodont teeth" and with "narrow" radial ribs. In 1968 Bergmans, following Hedley (1902), Iredale (1924), Cotton (1930) and Cotton and Godfrey (1938), lists six small nuculid species from New South Wales under *Pronucula,* stating that his material is too limited for studies of their relationships, and treating the species "in an order according to their more or less pronuculid hinge".

In 1969 Bergmans describes *Pronucula voorwindei,* dredged off Port Stephens, New South Wales, with a weak radial sculpture and an oblique chondrophore. (This species is presently synonymized with *Nucula torresi* Smith, 1885.)

I have examined the types of *Nucula minuta* Tenison Woods and found that they actually are rather young valves and belong, in my opinion, to *Nucula pusilla* Angas; see also the discussion of this species. Their somewhat quadrately ovate outline and the relatively spacious setting of their hinge teeth are mainly due to their age (see figs 9-11). Their chondrophores are distinctly oblique, and their anterior teeth rows do continue over the chondrophore, while exteriorly they do not show any pronounced radial or other sculpture. For these reasons I do agree with Pritchard & Gatliff (1904) that *Nucula minuta* Tenison Woods belongs in *Nucula* Lamarck.

From the foregoing necessarily concise account of species allocated to *Pronucula* by original or subsequent designation it is clear that none coincides with Hedley's description of this genus in all respects. All these species may possess one or more characters by which they should be judged as relatives of *Pronucula decorosa,* but there are, in every species, also characters by which they more closely fit into the genus *Nucula.* One could, for instance, describe the hinge of *Pronucula mayi* as pronuculid — although it is distinctly more compressed than in *P. decorosa.* However, its outline and its sculpture of delicate concentric riblets, crossed in the median part by equally weak radial riblets, do not indicate this relationship. Still, of the described species, *mayi* seems one of the closest relatives of *decorosa.*

In *Pronucula decorosa* itself it is not the hinge line, but the dorsal margin, that is arched. The two teeth rows enclose a distinct angle, and the difference with *Nucula* is only one of degree. The teeth rows in *Nucula,* writes Hedley, meet or overlap beneath the umbones. Indeed, Schenck (1935) figures the type of *Nucula nucleus* (L.) with an anterior teeth row that runs over the chondrophore and meets the posterior teeth row. A closely related species, *Nucula turgida* Leckenby & Marshall, 1875, well figured in Tebble (1966: 12), also has the anterior teeth row continuing over the chondrophore, but it does not meet the posterior row because this stops at some slight distance behind the chondrophore. A comparable situation is found in adult specimens of *Nucula pusilla* Angas (figs 3, 7 and 13). Edentulous spaces between teeth rows and chondrophore as in *Pronucula decorosa* are found, but to a lesser degree, in *P. mayi* and in *P. australiensis* (figs 34 and 55). Compared with the figures in a former article (Bergmans, 1968) the illustrations in this paper more clearly present a range of chondrophore form and orientation which demonstrates that the implicit direction is always toward the anterior or anteroventral shell side. This is even true for *Pronucula decorosa,* though admittedly exhibited only very weakly. Whenever a nuculid species has a somewhat longer chondrophore, this anteriorly-directed vector in its orientation becomes manifest. The teeth in *decorosa* are not different from those in *Nucula,* being V-shaped and with the tips curved slightly upwards (see for instance fig. 34). The outline of *decorosa* differs from that in typical *Nucula* but any intermediate outline exists in the Nuculidae. The same applies to the relatively moderate thickness of its shell. The radial ribs in *decorosa* are not so much "pronounced" (Hedley, 1902) as well broad, with broad interstices, but again differ from those in *Nucula* species only in a relative sense. (The neotype of *Nucula nucleus,* length 9.3 mm, has according to Schenck's figures (1935) about 5 to 6 radials per mm; the paratype of *Pronucula decorosa* here figured (fig. 39), length 2.45 mm, about 12 to 14 per mm.) Finally, Hedley states that *Pronucula* has neither lunule nor escutcheon. In typical *Nucula* the lunule, if present, is not well defined. The escutcheon however, is, and its absence in *Pronucula decorosa* connects this species with all other species here treated, and cannot be regarded as of taxonomic significance. Especially in a number of these species that are radially sculptured over the median part of the valve only, the anterior and posterior shell areas could easily be taken for lunule and escutcheon, respectively, though these areas are never really depressed.

As I hope to have demonstrated no species that has been regarded as belonging to the genus *Pronucula,* possesses a set of characters which would warrant its separation from *Nucula.* I therefore propose to sink *Pronucula* Hedley, 1902, into the synonymy of *Nucula* Lamarck, 1799, and to assign to that genus all the Australian species treated here except *Pronucula vincentiana* Cotton & Godfrey, for which a new genus is proposed. This synonymy follows that of Thiele (1934), who however did not present any arguments. Schenck (1934) lists *Pronucula* as a genus, but it appears that because of lack of specimens to examine he could do nothing else. Van de Poel (1955) recognizes only three genera in the Nuculidae, namely *Nucula* Lamarck, *Nuculoma* Cossmann, 1907, and *Acila* Adams &

Adams. He ranks *Pronucula,* because of its denticulated margin, as a subgenus of *Nucula*. He does not go into its differences from other taxa. Keen (1969) lists *Pronucula* as a genus, with *Austronucula* Powell, 1939, as a subgenus, though the reasons for this decision are not given.

In 1931 Iredale described the genus *Ennucula* to accommodate Australian species which, in his opinion, differed from typical *Nucula* in having "a notably oblique chondrophore, above which the teeth become much smaller", while the "angle of opposition of the two rows of teeth is scarcely marked", and the edge of the shell is "practically smooth". He proposed *Nucula obliqua* Lamarck, 1819, as type of this genus. A glance at a specimen of *Nucula nucleus* (or the illustrations in Schenck, 1934) is sufficient to decide that the differences between these genera are a matter of degree as far as chondrophore orientation and teeth arrangement are concerned. The angle of opposition of the two teeth rows in *Nucula obliqua* Lamarck (type figured in Schenck, 1934) is not much greater than in *N. nucleus* (L.) and the difference is certainly not of taxonomic importance. The remaining distinguishing character, a smooth inner valve margin, has been considered of crucial importance by all more recent authors on the classification of the Nuculidae: Quenstedt (1930), Thiele (1934), Schenck (1934) and Van de Poel (1955). It has been demonstrated more than once that a denticulated margin is directly related to a radial prismatic inner shell structure (Schmidt, 1922; Bøggild, 1930: Quenstedt, 1930; Wrigley, 1946; Taylor, Kennedy & Hall, 1969), which, according to some authors, smooth-margined species would not possess (Quenstedt, 1930; Van de Poel, 1955). However, Taylor, Kennedy & Hall (1969) claim such a structure also for the smooth-margined species involved in their shell structure studies, *Nucula laevigata* (Sowerby, 1818), *Acila castrensis* (Hinds, 1843) (cited as *Nucula),* and *Acila cobboldiae* (Sowerby, 1818) (erroneously cited as *Acila cobboldiana).*

As long as an examination of the shell structures of the individual, smooth-margined species *Nucula australiensis* (Thiele, 1930), *Nucula papuensis* n. sp., *Nucula brongersmai* n. sp., and *Nucula dilecta* Smith, 1891, treated in this paper, has not been carried out I prefer to assign them to *Nucula.* In the former three species this placement is supported by observed radial strieae, and in the latter by faint traces of a radial lining in the shells of some specimens.

An extensive discussion of the validity of the genus *Ennucula* can thus be omitted here, but it seems useful to remember that it has been synonymized with *Leionucula* Quenstedt, 1930, by Thiele (1934), who was followed in this — in spite of Iredale's defensive remarks (1939) — by Eames (1951), Macpherson & Gabriel (1962) and Keen (1969), while Van de Poel (1955) preliminary lists it as a subgenus of the first smooth-margined genus described, *Nuculoma* Cossmann, 1907 (described in: Thiéry & Cossmann, 1907).

In 1931 Iredale also proposed the new genus *Deminucula* for *Nucula praetenta* Iredale, 1924. In 1924 he wrote of this species that it was "a true *Nucula",* but in 1931 it is explained that he meant *Nucula* "in the broad sense". Since he had, in the same article, denied the existence of typical *Nucula* species in Australia, and referred Australian species that had been so classed to his new genus *Ennucula, Deminucula* is only compared with this genus, and not with *Nucula,* with which it nevertheless happens to share most of it's generic characters. *Deminucula* has "the surface radially rayed, the inner margin of the shell denticulate and the hinge line more angular than it is in *Ennucula,* the teeth more distant, the chondrophore small and scarcely exceeded by any teeth". With regard to *Pronucula* Iredale confines himself to the remark "I have noted that *Nucula praetenta* was not a *Pronucula* . . . ". In 1939 he describes an obviously

related species as *Pronucula saltator*. The characters that would distinguish *Deminucula* from *Nucula* Lamarck, are already sufficiently dealt with in my arguments for the synonymy of *Pronucula* Hedley with *Nucula*. Suffice it to state that I regard *Deminucula* Iredale, 1931, as a synonym of *Nucula* Lamarck, 1799. (In my discussion of *Deminucula praetenta* it will be explained that McAlester's opinion (1969), according to which *Deminucula* would belong in the family Malletiidae Adams & Adams, 1858, is based on incorrect illustrations in Schenck (1934).)

Finally, some remarks should be made on *Protonucula* Cotton, 1930, which as appears from the context, was described as a genus in the family Nuculidae. The type and only species, *Protonucula verconis* Cotton, 1930, because of its length of only 3.5 mm would fall within the scope of this paper. Schenck (1934) remarks that this genus would probably more correctly be allocated to *Tindaria* Bellardi, 1875, and thus to a family other than the Nuculidae, namely the Malletiidae Adams & Adams, 1858. Fleming (1948) supports this, saying that *Protonucula* "is apparently an Australian relative of *Tindaria*". I studied SAM samples D 1644, from 130 fathoms off Cape Jaffa, and D 1645, from 300 fathoms off Cape Jaffa (South Australia), both mentioned by Cotton in his description of *Protonucula verconis*, and which are thus to be regarded as paratypes (Mayr, 1969: 371). These shells are certainly not nuculids. Cotton's description and figures are incorrect. The valves are quadrately ovate, almost equilateral, thin, smooth, with no apparent radial structure. The hinge plate is interrupted in the middle, beneath the umbo. In one specimen there are 13 anterior and 11 posterior teeth, the rows being almost equal in length. The rather small teeth are V-shaped — with the leg of the V at the side of the valve margin longer than the other — and not very long or pointed. Beneath the hinge plate interruption there is a triangular thickening of the valve (a resilium?), visible when the inside of the umbo is examined. From old labels it appears that Verco had classified the species as *Nuculana Link*, 1807.

Nucula Lamarck, 1799

Nucula Lamarck, 1799: 87.

Pronucula Hedley, 1902: 290.

Deminucula Iredale, 1931: 202.

Nucula pusilla Angas

Figures 2-14

Nucula pusilla Angas, 1877: 177, pl. 26, fig. 26.

Nucula micans Angas, 1878: 864, pl. 54, fig. 16. New synonymy.

Nucula hedleyi Pritchard & Gatliff, 1904: 237 (new name for *Nucula minuta* Tenison Woods, 1877:156 *non* Owen, 1839; *nec* Fleming, 1813; *nec* Defrance, 1825); Bergmans, 1968: 76, pl. 12, figs 5a-f. New synonym.

Pronucula concentrica Cotton, 1930: 224, fig. 2. New synonymy.

LECTOTYPE: A right valve from shell sand, Port Jackson, New South Wales, collected by J. Brazier (BMNH 1877.5.12.61).

DIAGNOSIS: A moderately sized, ovately shaped *Nucula*, smooth or partly sculptured with concentric ribs, with a distinct radial structure in the median section of

the valve (appearing as radial "lines" or striae) and a correspondingly denticulated inner ventral margin, and with a short but oblique chondrophore. From its nearest relative, *Nucula beachportensis* Verco, it differs in being smaller, with a usually less truncated, relatively longer posterior area and a relatively shorter posterior margin, and a less oblique and more projecting chondrophore in adult specimens. The two species seem to differ also in habitat, *N. pusilla* preferring rather shallow waters while *N. beachportensis* is restricted to deeper waters.

DESCRIPTION: Valve moderately solid, quadrately ovate in outline, not very small. Dorsal margin slightly curved. Posterodorsal and posteroventral angulations only sharp in young specimens and usually more rounded in adult ones. Posterior side somewhat truncated, weakly rounded. Anterodorsal curve gradual, anterior side weakly rounded and with a broad curve extending to the evenly rounded ventral margin. Embryonic shell with a granular appearance on median exterior, and a smooth margin. Interdissoconch smooth but for growth lines. Rest of valve with concentric ribs on anterior and posterior areas, sometimes covering the median area also. Usually a few well developed concentric ribs near ventral margin. Beyond interdissoconch shell distinctly radially structured with narrow, prismatic elements (see Taylor, Kennedy and Hall, 1969). Periostracum greenish, sometimes brownish. Shell white. Hinge line arched, chondrophore short, pointing forwards. In lectotype (length 2.60 mm) 10 anterior and 4 posterior, V-shaped secondary teeth. In younger shells some small primary tooth-like projections may be present beneath the beak (Bergmans, 1968). Adductor muscle scars and pallial line usually indistinct. Inner margin finely denticulated by radial structure.

MEASUREMENTS: See Tables 1 and 2

GEOGRAPHIC RANGE: Along the coasts of southern New South Wales, Victoria, Tasmania, South Australia and southern and western Western Australia (fig. 69).

ECOLOGY AND BIOLOGY: *Nucula pusilla* has been collected alive from near beaches to depths of 36.8 m, and dead from beaches and offshore to a maximum depth of 366 m. It probably lives in rather shallow waters. A shell from South Australia (RMNH 16a), length 2.92 mm, contained at least 26 embryos, with embryonic shell lengths varying from 0.41 to 0.45 mm and heights from 0.34 to 0.37 mm. Another specimen from South Australia (BMNH 197115), with a length of 2.9 mm, contained 22 embryos, one of which measured 0.45 mm in length, 0.40 mm in height and 0.25 mm in section (whole specimen). It is clear that in *Nucula pusilla* brood protection exists. From the embryonic shell measurements taken from samples of full-grown individuals (table 2) it appears that the embryos in the two South Australian specimens were about to begin their independent existence.

Table 1. Measurements of Nucula pusilla.

locality	specimen	length	height	section	e.s.l.	i.d.l.
Port Jackson	Lectotype *Nucula pusilla*	2.60	2.15	0.70		
Blackmans Bay	Lectotype *Nucula hedleyi*	1.94	1.47	0.47		0.97
	Paralectotype *Nucula hedleyi*	1.98	1.59	0.46		0.86
Gulf St. Vincent	Holotype *Pronucula concentrica*	3.75	3.22	1.05	0.29	0.86
Brighton	Lectotype *Nucula micans*	2.45	2.08	0.60		
	Paralectotype *Nucula micans*	2.50	2.02	0.65		
Shark Bay		2.36	2.00	0.65	0.31	0.82

Table 2. Nucula pusilla: embronic shell lengths and interdissoconch lengths.

Locality	e.s.l.			i.d.l.		
	n	m	min-max	n	m	min-max
Port Phillip Bay	38	0.31	0.28-0.35	44	0.89	0.86-0.95
Port MacDonnell	5	0.44	0.41-0.45	6	0.83	0.76-0.86
Guichen Bay	16	0.38	0.28-0.41	17	0.88	0.82-0.93

DISCUSSION: The syntype series of *Nucula pusilla* Angas (BMNH, 1877. 5.12.61) consisted of one complete specimen and one loose valve, the latter with the hinge broken off. Unfortunately, during my studies, the left valve of the complete specimen, which I had chosen as lectotype, and the loose valve were accidentally destroyed. Consequently the remaining and undamaged right valve became lectotype of the species (Figs. 2-4). My studies of those species, which I now consider to be conspecific with *Nucula pusilla* Angas, namely *Nucula micans* Angas, *Nucula hedleyi* Pritchard and Gatliff and *Pronucula concentrica* Cotton, started with the examination of the type material. In the cases of *N. micans* and *N. hedleyi* no holotype specimens had been indicated by their original describers. Moreover, the original illustration of a *N. micans* syntype is very poor, while for *N. hedleyi* no syntype has ever been figured. Before concluding their synonymy with *N. pusilla* I selected lectotypes of both species and made drawings of them. In the case of *P. concentrica* the type specimen had been registrated as such, but again the original illustrations of this species are poor and in some respects even misleading. For these reasons it is figured here too (Figs. 6-12).

Typical *Nucula pusilla* have been collected from New South Wales (as far north as Port Stephens), Victoria, Tasmania, and eastern South Australia (Port MacDonnell and Robe). In larger samples there are almost always some specimens with thinner and smoother shells than in the typical form, and sometimes with an atypical, rather quadrate outline due to a more pronounced anterodorsal angulation. Intermediates between these and the typical form are equally encountered in the same samples, and I regard the observed variation as intraspecific.

In populations from off Lakes Entrance, Victoria, to Geraldton, Western Australia, and also around Tasmania, *pusilla* shells are more heavily built than typical ones, with relatively broader umbones and thicker valves. Moreover these shells sometimes feature bluntly truncated posterior sides and almost linear and quite sharply descending anterodorsal margins, resulting in a rather triangular valve outline. Again, intermediates between these and typical *pusilla* have been found as well, especially where the distribution areas overlap (e.g. Western Port Bay and Corio Bay in Victoria). From about the same regions, from off Lakes Entrance in Victoria to Careening Bay, Garden Island, Western Australia, shells have been collected with distinct concentric ribs covering the whole valve beyond the interdissoconch. This sculpture seems to be a constant character in some populations, but definitely not in all. From between Robe and Lakes Entrance I have seen samples containing both practically smooth and concentrically ribbed specimens. A sample from Port Phillip Bay, Victoria, collected alive (AM C. 100969), consisted of 18 typical and 28 ribbed specimens which otherwise were identical. In my opinion this concentric sculpture can not serve as a sufficient character to separate the ribbed specimens in an apart taxon.

In 1877 Tenison Woods described *Nucula minuta* from Blackmans Bay, Tasmania. Because this name was preoccupied Pritchard and Gatliff (1904) renamed the species as *Nucula hedleyi*. I studied the syntypes, three rather small valves (table 1) and compared them to typical *N. pusilla* of approximately the same size from the New South Wales localities: Collaroy Beach, Watsons Bay and Narrabeen. The series from Narrabeen has been described earlier (Bergmans, 1968). As already argued in my discussion on the validity of the genus *Pronucula* Hedley, I could in no way discriminate the *hedleyi* types from equally sized *pusilla*, and consider the former species as a synonym of the latter. I selected an undamaged left valve as lectotype of *Nucula hedleyi* (figs. 9-11; TAS. E. 18a/7359), which left as paralectotypes a right valve and a heavily damaged left valve (TAS. E. 18b/7359). Turner and Dartnall (1971) erroneously stated that the syntypes would comprise two right valves and one left valve.

In 1878 Angas described *Nucula micans* from Salt Creek and Glenelg, South Australia. He described *N. pusilla*, a year before, as "rather thin", and *N. micans* as "moderately solid", with "a different style of sculpture".
Angas observed "radiating hairlines" in *pusilla*, but failed to describe these for *micans*. In fact these hairlines (the expression of the radial structure) are as clearly visible in *N. micans* as in *N. pusilla*. Other differences in sculpture do not exist either. The syntypes of *micans* are merely representatives of the heavier South Australian *pusilla*, and undoubtedly conspecific, which conclusion reduces *micans* to the synonymy of *pusilla*. A right valve of *micans* was selected as lectotype (BMNH 1879.1.31.8/1) and figured (figs. 6-8), the three other valves becoming paralectotypes (BMNH 1879.1.31.8/2).

In 1930 Cotton described *Pronucula concentrica* from Gulf St. Vincent, South Australia. A study of the type specimen (SAM D.10115) learned that both original description and illustration were inaccurate. The specimen lacks the pointed umbo and rounded posterior side as figured by Cotton, and has an outline like that of *Nucula pusilla*. The concentric ribs do not extend on the interdissoconch and the radial structure visible in *pusilla* is also present in the type of *concentrica*. In fact, I could find no difference between typical *pusilla* and Cotton's *concentrica* other than the concentric sculpture being restricted in the former and not so in the latter. As I have pointed out before, this sculpture is not reliable as a taxonomic character. Smooth and ribbed specimens are found together, and in some cases intermediately sculptured shells have been collected. From Western Port Bay a well-preserved specimen (RMNH 16b), with a smooth median area where traces of concentric ribs are scarcely detectable, was taken together with distinctly ribbed specimens. A difference suggested by the measurements in table 1 is that in the size of adult specimens. The holotype of *Pronucula concentrica* measures 3.75 mm in length, whereas the sexually adult *Nucula pusilla* containing embryos measure only about 2.9 mm. This difference however could not be confirmed as a constant one, which would enable us to separate ribbed from more smooth forms. I therefore consider *Pronucula concentrica* as a synonym of *Nucula pusilla*.

(From beaches at some Western Australian localities — Dongara, Geraldton, Shark Bay, North West Cape, Monte Bello Island — a form has been collected that with some reservation is assigned here to *pusilla*. It differs from typical *pusilla* in being heavier, in featuring a much less distinct crenelation of the ventral margin and a more triangular outline, with the posterior margin slightly excavated by a shallow furrow running from the umbo and weakly defining an area. From other Western Australian *pusilla* it differs in the absence of concentric ribs. The best preserved valve representing this form, WAM 809-71, is from South Passage, Shark Bay; its measurements are given in table 1, and its outline as fig. 5.)

Considering the wide geographical distribution of the forms assigned here to *Nucula pusilla* the studied collections are still quite small. They certainly did not provide a basis for a definite concept of the taxonomy of the species. The classification used in the present study has merely been proposed to accommodate some undoubtedly very closely related forms that could not be separated on shell-morphological grounds. The nature of the observed morphological variation is probably at least partly genetically determined. It is not very likely, after all, that only environmental conditions would account for it. The regions to which certain forms are more or less restricted are far too large to allow the assumption of identical ecological conditions at all the involved localities (with a possible exception for temperature ranges).

The sculpture on the exterior of adult shells of *Nucula pusilla* can be divided into four zones:

1. The microscopically pitted surface of the median part of the embryonic shell.
2. The rather narrow smooth marginal zone of the embryonic shell.
3. The comparatively large interdissoconch, which is smooth but for some fine growth lines.
4. The valve beyond the interdissoconch, with concentric ribs covering anterior and posterior areas and not infrequently also the median area.

Ockelmann (1962), dealing with types of development in mainly northern Atlantic marine bivalves, summarizes what is known about some *Nucula* species from this region. *N. proxima* Say, *N. turgida* Leckenby and Marshall, and *N. nucleus* (L.) reproduce by means of lecitotrophic larvae (larvae reaching metamorphosis solely on nutrient matter from the egg). Free-swimming larvae of the latter two species were observed by Lebour (1938). The pelagic life of these species is very short, lasting from a few hours to a few days at most. According to Ockelmann's observations species with an embryonic shell with two differently sculptured zones of which the outer one is poorly developed, are most likely species with lecitotrophic development and a short pelagic life. This may very well apply to *Nucula pusilla,* although its embryonic shell is comparatively large. Ockelmann (1962) found a length of 0.135 to 0.230 mm, with a rather limited intraspecific variation, for zone 1 (or prodissoconch I, i.e. the inner or oldest embryonic shell zone) in species with this type of development. He did not give measurements for zone 2 (or prodissoconch II, i.e. the outer or youngest embryonic shell zone) but stated it to be absent or poorly developed. My measurements of the lengths of zones 1 and 2 together amount from 0.28 to 0.45 mm, in *N. pusilla*. As Ockelmann observed further, larger measurements of zone 1 and 2 occur in species with brood protection, but he did not mention the magnitude of this increase.

I have considered the smooth and distinctly aberrant stage following the embryonic shell and preceding the final shell stage as an interdissoconch, in *N. pusilla*. It is not certain, however, to what life period this stage corresponds. It seems rather large to be formed during the pelagic stage, assuming this stage would be short as in the northern Atlantic *Nucula* species mentioned above. According to Quenstedt (1930) the development of rib sculpture on the shell exterior in the Nuculidae would be an evolutional adaptation to digging habits, and from this point of view it would not be unlikely that the development of the final shell stage would be initiated by the settling of the specimen in the sandy bottom. The existence in the species of populations wholly or partly without ribbed dissoconchs either speaks strongly against such a direct relation, or points to another possible interpretation of the observed sculptural differences, namely differences in the nature of the substrata.

SPECIMENS EXAMINED: New South Wales: 7/2 from 44 m, off Port Stephens (6/2: AM C.87623; 1/2: RMNH 55084); 1 17/2 from shell sand, Narrabeen, 1961, coll. J. Voorwinde (RMNH 52694); 1/2 conform *Nucula pusilla,* from 146 m, 22 miles east of Narrabeen, 7-VI-1906, coll. H.M.C.S. "Miner," don. W. A. Haswell (AM C.26047); 2/2 from 10.6 m, from rocks below R.S.L. Club, Harbord, 14-VIII-1971, coll. P. Hutchings (AM C.88712); 1 10/2 from Collaroy Beach (AM C.83117); 16 from North Harbour (AM C.83108); 4 4/2 from 11 to 14.5 m, Chinamans Beach, Middle Harbour (AM C.83113 and RMNH 55096); 1/2 from Balmoral (AM C.87624); 1 1/2 from shell sand, Port Jackson (syntypes of *Nucula pusilla* Angas, BMNH 1877.5.12.61); 2/2 from 9 m, off Bottle and Glass Rocks, 1878, coll. J. Brazier (AM C.88711); 5 2/2 from Bottle-glass, Port Jackson (RMNH 55085); 4 from 14.6 m, off Old Man Hat Point, Inner North Head, Port Jackson, 1886, coll. J. Brazier (AM C.88710); 10 19/2, Watson's Bay (Collection Van der Slik); 1 4/2 from Quarantaine Bay, Port Jackson (RMNH 55086); 1 from 14.5 to 18.8 m, George River, Dolls Point, 1961-1962, coll. J. Voorwinde (RMNH 52695); 2 from Twofold Bay (AM C.83109). Victoria: 7/2 from 366 m, 30 miles south of Cape Everard, 22-X-1964, coll. "Endeavour" (AM C. 83128); 1/2 and 12 fragments from 152 m, off Lakes Entrance, 38°13′ S, 149°06′ E, 20-VI-1962, coll. C.S.I.R.O. Fisheries, H.M.A.S. "Gascoyne" (RMNH 55087); 1 10/2 from Western Port (AM C.28381, NMV F28111, SAM D.15062); 7 from Western Port Bay (RMNH 16b, ZMB 59760); 7 9/2 from 3.6 to 5.5 m, between Eagle and Crawfish Rock, Northwest Arm Western Port Bay, 15-II-1969, coll. W. F. Ponder and B. J. Smith (AM C.88105); 2/2 from Portsea (NMV F19170);46 from Port Phillip Bay, coll. Fisheries and Wildlife Department (AM C.100969); a series from Corio Bay (NMV F28112, RMNH 55088); 1/2 from Cowes (NMV F28121); 2 from San Remo (NMV F28115); 1 2/2 and a series from Victoria (NMV F28123 and F28118). Tasmania: 2 from Bass Strait, coll. J. H. Ponsonby (BMNH 93.3.210.11); 2/2 from Cape Portland, 15-V-1970, coll. G. Davis (TAS E7706); 1/2 from Spring Beach, 2-II-1970, coll. E. Turner (TAS E7533); 1/2 from shell sand, North Oyster Bay, Maria Island, IX-1967, coll. J. Thwaites (TAS E5670); 1 1/2 from Dunalley, 30-VI-1965, coll. L. Crofts and N. Pattison (TAS E4239); 6/2 from corraline algae on intertidal rocks, Pirate Bay, Eaglehawk Neck, III-1970, coll. W. F. Ponder (AM C.83124 and C.88704); 2/2 from White Beach, X-1967, coll. A. Dartnall (TAS E6247); 2/2 from 2 miles south of Tasman Head, Bruny Island (AM C.8323); 1/2 from Derwent Estuary, 11-XII-1916, coll. W. L. May (TAS E19/7360); a series from Derwent Estuary and a series from Derwent Estuary and Gordon Channel, both from the W. L. May Collection (SAM D.15085 and D.15084); 3/2 from Blackmans Bay (syntypes of *Nucula minuta* Tenison Woods, lectotype TAS E18a/7359, paralectotypes TAS E18b/7359); 3/2 from Blackmans Bay (NMV F811); 1/2 from Browns River (AM C.10892); 11/2 from Port Davey, Bond Bay, II-1968, coll. King family (TAS E6191); 1/2 from near Granville Harbour, 23-XI-1967, coll. A. Dartnall (TAS E6305); 20 1/2 from Tasmania (BMNH 197114, RMNH 52693, SAM D.15043, SAM D.15074, TAS E3705, ZMB 59761). South Australia: 6/2 from MacDonnell Bay, coll. J. Verco (SAM D.15061); a series from Port MacDonnell, coll. J. Verco (SAM D.15059); 11 4/2 from Port MacDonnell Beach, coll. J. Verco (SAM D.15060); 22/2 from 73, 201, 274 and 366 m, respectively, off Beachport (SAM D.15068, D.15069, D.15070 and D.15071); a series from Robe (AM C.83112, RMNH 55089, SAM D.15057); a series from Guichen Bay (SAM D.15052); 2/2 from 135 and 238 m, respectively, off Cape Jaffa (SAM D.15066 and D.15067); 2 7/2 from Kingston (SAM D.15053); 5/2 from Encounter Bay (RMNH 55090); 5/2 from Salt Creek, Edithburg, coll. J. Verco (SAM D.15064); 4/2 from Brighton (syntypes *Nucula micans* Angas, lectotype BMNH 1879.1.31. 8/1, paralectotypes BMNH 1879.1.31.8/2); 2/2 from Holdfast Bay (NMV F28110); 10/2 from Henley Beach, 1944, coll. S. Merton (SAM D.15082); 1 from 36.8 m, Gulf St. Vincent (holotype of *Pronucula concentrica* Cotton, SAM D.10115); a series from Gulf St. Vincent (SAM D.15042 and D.15046); 4 from a depth to 36.5 m, Gulf St. Vincent, coll. J. Verco (SAM D.15045); 3/2 from 110.5 m, off Cape Borda (SAM D.15065); 5 9/2 from Hardwicke Bay (AM C.13450 and C.66732); 1 4/2 from Wallaroo (SAM D.15083); 5 2/2 from

Port Elliston (SAM D.15074); a series from Venus Bay (SAM D.15078); 4 1/2 from Carawa, Streaky Bay (SAM D. 15063); 13/2 from St. Francis Island (SAM D.15050); 6 11/2 from St. Francis Island Beach (SAM D.15048); 3 8/2 from 11, 27.5 to 36.5, and 64 m respectively (SAM D.15049, D.15051 and 15058); a series from South Australia (BMNH 197115, RMNH 16a, SAM D.15044, D.15054, D.15055, D.15056 and D.15081). Western Australia: 2/2 from Hopetoun Beach (SAM D.15076); 6/2 from King George Sound Beach (SAM D.15072); 2/2 from King George Sound (SAM D.15073); 1 from 24.5 m, off Bunbury (SAM D.15077); 15 2/2 sieved from mud, 15 m, Skippy Rock, Careening Bay, Garden Island, 16-I-1965, coll. S. Slack-Smith (RMNH 55091, WAM N.4973); 2/2 from Dongara, 11-VIII-1943, coll. G. P. Whitley (AM C.83104); 1 2/2 from Geraldton, coll. Dr. Tott (SAM D.15075); 3 3/2 from South Passage, Shark Bay, mainlandshore, sieved from intertidal sand, 6-III-1966, coll. Wilson and Kendrick (3 1/2: WAM 809-71; 2/2 RMNH 55092); 6 2/2 from Yardie Beach, North West Cape, in tide wash — at low tide, 9-X-1969, coll. F. Plant (WAM 808-71); 1 7/2 from Monte Bello Islands, 18-IX-1945, coll. G. P. Whitley (AM C.100952). Localities unknown: 5 series (SAM D. 15039, D.15040, D.15041, D.15079 and D.15080).

Nucula beachportensis Verco
Figures 15-19

Nucula beachportensis Verco, 1907: 31, pl. 27, fig. 3.

HOLYTYPE. — A specimen from 73 m, off Beachport, South Australia, (SAM D. 11310).

PARATYPES. — See under "Discussion."

DIAGNOSIS: A *Nucula* of middling size, triangularly ovate in outline, with an almost straight posterior margin. Outer shell surface either smooth or with weakly developed, keeled concentric ribs which occasionally are notched by the radial shell structure. Of the known species *Nucula pusilla* Angas comes closest, but *N. beachportensis* is larger, less ventricose, with a very short posterior part, a relatively longer and almost straight posterior margin and, in adult specimens, a chondrophore that projects less beyond the hinge plate and that is more forwardly directed. *N. beachportensis* very probably lives at greater depth, and *pusilla* in rather shallow water.

DESCRIPTION: valve fairly solid, rather shallow, triangularly ovate in outline, posterior part somewhat depressed. Dorsal margin weakly curved, almost linear near the beak, passing into posterior margin either with a distinct angle or gradually. Posterior margin almost straight, descending vertically from the posterodorsal angulation, or when there is no such angulation, slanting backwards directly from beneath the umbo, or intermediate. Dorsal margin anteriorly shading off into anterior margin, which is nearly straight. Posteroventral angle not sharp, but yet distinct, ventral margin broadly rounded — though straighter posteriorly — and gradually extending into anterior margin. Exteriorly, embryonic shell with microscopic pits, interdissoconch smooth, dissoconch either smooth with some more or less pronounced growth lines on anterior, posterior and ventral areas, or with additional sculpture of weak, irregular, keeled concentric riblets. Radial shell structure distinct on median area, most conspicuous in concentrically ribbed specimens in which shell surface and even ribs may show faint radial lines. Shell colour whitish, sometimes with yellowish concentric zones (possibly an artefact). Periostracum light olive green. Hinge parts not very heavy, with up to about 15 anterior and 9 posterior V-shaped secondary teeth. Anterior teeth row extending over chondrophore, not reaching posterior teeth row. Chondrophore not very salient, oblique, strongly forwardly directed. Adductor muscle scars and pallial line often indistinct. Ventral margin minutely crenulated by radial structure.

MEASUREMENTS: The holotype (figs 15-17) has an embryonic shell length of about 0.22 mm, an interdissoconch length of about 0.75 mm, a valve length of 5.74 mm, a valve height of 4.97 mm and a valve section of 1.44 mm. (The measurements given by Verco (1907) and copied by Cotton and Godfrey (1938), i.e. length 4.9 mm and umbo-ventral distance 4.6 mm do not apply to the only specimen indicated as "Type" by Verco). The largest valve examined has a length of 6.16 mm.

RANGE: Off the coasts of southern New South Wales, Victoria, Tasmania, South Australia and Western Australia (fig. 70).

ECOLOGY: Complete specimens of *Nucula beachportensis,* with an unimpaired periostracum, have been dredged from depths between 146 and 183 m and from 366 m. Dead and mostly worn specimens came from depths between 73 and 570.5 m. Hedley (1911) gives 14°C as the bottom temperature near a collecting locality (4 miles south of Cape Wiles).

HORIZON: Ludbrook (1955) recorded the species from Pliocene layers near Adelaide, South Australia.

DISCUSSION: When describing *Nucula beachportensis* Verco had before him several samples other than the one he indicated as type. These can be referred to as paratypes (Mayr, 1969: 371). Verco (1907) lists his original specimens as follows: "Dredged off Beachport, 40 fathoms, 1 perfect (type), 2 valves; in 100 fathoms, 1; 150 fathoms, 2; 200 fathoms, 1; off Cape Jaffa in 130 fathoms, 1; 300 fathoms, 6; all dead." I think that we may assume that all specimens but the type were odd valves. The collection in the South Australian Museum, where Verco worked, holds the following lots from the cited localities: Dredged off Beachport, 40 fathoms, 1 specimen (holotype: SAM D. 11310); in 150 *and* 200 fathoms (put together), 4 valves (SAM D. 15037); in 200 fathoms, 9 valves (SAM D. 15034). Off Cape Jaffa in 130 fathoms, 1 valve (SAM D.15036) and 5 valves (SAM D.15089); in 300 fathoms, 9 valves (SAM D. 15035) and 3 valves (SAM D.15088).

Lot D.15037 contains a label written by Verco which says "COTYPE," but later another specimen has been added and we will probably never know which three out of the four valves are the paratypes. Lots D.15034, D.15036 and D.15088 contain Verco labels reading "*Nucula* 3," obviously written before *beachportensis* was described. Lot D.15089 is labelled by Verco "*Nucula beachportensis* Verco — Duplicates," in which the word "*Nucula*" was obviously written much earlier than the other words, from which it might be concluded that the sample was collected before and identified after the description (where only 1 valve from the concerned locality is mentioned).
If the other lots contain paratypes, which does not seem unlikely because of the labels with Verco's preliminary identifications, it will nevertheless be impossible to indicate the proper specimens (except in D.15036) because of the apparent mutations in the numbers of specimens after the time of Verco's description. The two paratype samples from 40 and 100 fathoms off Beachport have, at the time of this writing, not yet been located.

Apart from the typical form with a distinct posterodorsal "shoulder" (figs 15, 16) quite frequently another form was encountered in which this shoulder was less distinct or even completely reduced. The latter condition results in a posterior margin that seems to run from right beneath the beak. An example of this form, from 260 m, south of Rowley Shoals, Western Australia (WAM 800-71) has been figured (fig. 19). There is no clear geographical or other physical separation between the typical form and this more triangular and possibly slightly shorter form, although the tendency towards the atypical configuration is most marked in Western Australian examples, just like the trend to develop concentric sculpture. The picture is obscured by the occurrence of

intermediates between typical and atypical shells, and further by the fact that one sample may contain different forms.

An outline of a juvenile valve, from 366 m, 30 miles south of Cape Everard, Victoria, has been figured to show the outline change during growth (fig. 18).

SPECIMENS EXAMINED: New South Wales: 6/2 from 294-304 m, 25 miles east of Twofold Bay, 37°27′ S, 150°17′ E, 19-VI-1962, coll. C.S.I.R.O., H.M.A.S. "Gascoyne" (AM C.83135). Victoria: 1 15/2 from 366 m, 30 miles south of Cape Everard, 22-X-1964, coll. "Endeavour" (9/2: AM C.83128; 1 6/2 AM C.83129); 2/2 from off Ninety Mile Beach (NMV F.28122). Tasmania: 1 6/2 from 146 m, off Schontern Island (probably an error for Schouten Island), and 3 from 183 m, 7 miles east of Cape Pillar (put together; SAM D.15031); 1/2 from 570.5 m, 9.5 miles northeast of Tasman Island, 43°12′30″ S, 148°13′45″ E, 24-III-1970, coll. W. F. Ponder, F.R.V. "Penghana" (AM C.83122); 1/2 from Storm Bay (SAM D.15030); 2/2 from Tasmania (TAS E3704). South Australia: 1 from 73 m, off Beachport (holotype; SAM D.11310); 4/2 from 274 and 366 m, off Beachport (SAM D.15037); 9/2 from 366 m, off Beachport (SAM D.15034); 6/2 from 238 m, off Cape Jaffa (1/2: SAM D.15036; 5/2: SAM D.15089); 12/2 from 548 m, off Cape Jaffa (9/2: SAM D.15035; 3/2: SAM D.15088); 7/2 from 183 m, 40 miles south of Cape Wiles, pres. Fisheries Bureau (6/2: AM C.100954; 1/2: RMNH 55093), this sample, and the next, possibly being the ones referred to by Hedley (1911) as from 4 miles South of Cape Wiles; 8/2 from 183 m, 40 miles south of Cape Wiles (SAM D.15038). Western Australia: 1/2 from 132 m, 40 miles west of Eucla (SAM D.15032); 26/2 from 548 m, 120 miles west of Eucla (SAM D.15033); 3/2 from 156 m, west of Bunbury, 33°03′ S, 114°44′ E, 10-VIII-1962, coll. C.S.I.R.O., H.M.A.S. "Gascoyne" (AM C.83132); 7/2 from 260 m, south of Rowley Shoals, 20-XII-1969, coll. "Umataku Maru" (6/2: WAM 800-71; 1/2 RMNH 55094); 8/2 from 266 m, south of Rowley Shoals, about 17°20′ S, 119°15′ E, 20-XII-1969, coll. "Umataku Maru" (WAM 804-71); 2/2 from 250 m, north of Browse Island, 23-XII-1969, coll. "Umataku Maru" (WAM 1150-75).

Nucula torresi Smith
Figures 20-23

Nucula torresi Smith, 1885: 227, pl. 18, figs 9, 9a.

Pronucula voorwindei Bergmans, 1969: 61, figs 1a-c. New synonymy.

LECTOTYPE: A right valve from 247 m, east of Cape York, Queensland, 11°35′25″ S, 144°2′ E, collected 31-VIII-1874, by H.M.S. "Challenger" (BMNH 1887.2.9.2908/1).

PARALECTOTYPES: Two right valves and one left valve, collected together with the lectotype (BMNH 1887.2.9.2908/2).

DIAGNOSIS: A small, stout, rather equilateral *Nucula,* with a blunt umbo and usually with strong rounded concentric ribs and a very small chondrophore that does not project beyond the hinge plate. From *Nucula praetenta* (Iredale) it differs in its concentric ribs and possibly in its smaller size, and from *Nucula saltator* (Iredale) it differs in being shorter and more equilateral, in having a pronounced concentric sculpture over the whole valve beyond the interdissoconch and in the small non-projecting chondrophore.

DESCRIPTION: Valve stout, rather convex, triangular in outline, slightly longer than high. Umbo slightly opisthogyrate, bifid in juvenile valves. Anterior valve part relatively short. Dorsal margin rounded, passing without angulations into an almost straight posterior margin and a weakly curved anterior margin. Posteroventral angulation distinct but not sharp. Ventral margin but slightly curved posteriorly and more rounded

anteriorly. Anteroventral angulation weak, not well marked. Embryonic shell with microscopic pits that under certain light give the impression of tube-like structures just under the shell surface (Bergmans, 1969). Interdissoconch small and smooth. Rest of valve usually with relatively strong, rounded concentric ribs, about as broad as their interstices. Narrow radial riblets between the concentric ribs except on anterior and posterior areas. Periostracum lost in the specimens studied. Shells transparent and white or shining yellowish brown. Chondrophore very small, triangular and oblique, separating the teeth rows but not projecting beyond hinge line. Up to 9 anterior and 6 posterior V-shaped secondary teeth. Only inner boundaries of adductor muscle scars visible. Pallial line not visible. Inner ventral margin denticulated by radial structure, with about 65 denticles in the figured specimen.

MEASUREMENTS: See table 3.

Table 3. Nucula torresi: Measurements, number of teeth and approximate number of concentric ribs.

specimen	length	height	section	e.s.l.	i.d.l.	secondary teeth		concentric ribs
						ant.	post.	
Lectotype	2.86	2.66	1.03			9	6	$\geqslant 20$
Paralectotype	2.77	2.38	0.97			9	6	>14
Port Stephens	1.80	1.58	0.58			6	5	14
Roebuck Bay	1.84	1.60	0.58		$\pm$ 0.94	6	5	13
Roebuck Bay	1.64	1.44	0.52	$\pm$ 0.24		6	4	13

RANGE: Along the east coasts of Queensland and northern New South Wales, from Raine Island in the north to Port Stephens in the south, and in northern Western Australia (fig. 71).

ECOLOGY: The species has not been found in beach samples. The Port Stephens specimen was dredged in 44 m, the Roebuck Bay shells in 188 m and the syntypes in 247 m. The Port Stephens specimen is in a good, but not fresh condition, some of the Roebuck Bay valves are in a good condition, and the syntypes are much more worn. The stoutness of the shells might suggest rather rough environmental conditions, such as surf or a coarse-grained substratum, the latter condition extending to greater depths. The syntypes were found in coral sand, for instance (Smith, 1885).

DISCUSSION: Smith (1885) gives as type locality "Station 185" of the Great Barrier Reef Expedition, which position is described by the coordinates cited above. On the original label with the syntypes Raines Island is mentioned as type locality (Raine Island on recent maps), next to "Station 185." The Port Stephens specimen figured here (figs 20-22) agrees in every detail with the lectotype, except that it is in a better condition. Some of the types were locally damaged to the extent that part of the outer shell layer was lacking. This revealed that the radial riblets are the expression of a structure in the middle shell layer. The concentric ribs in the left valve contained in the paralectotype lot are only very weak. The specimens from Western Australia show a smooth median area: the first 5 or 6 ribs and the radial lines fade away here (fig. 23).

SPECIMENS EXAMINED: Queensland: 1/2 from 247 m, near Raine Island, 11°35'25" S, 144°2' E, 31-VIII-1874, coll. H.M.S. "Challenger" (lectotype; BMNH 1887.2.9.2908/1); 3/2 from the same lot (paralectotypes; BMNH 1887.2.9.2908/2). New South Wales: 1/2 from 44 m, Port Stephens (holotype of *Pronucula voorwindei* Bergmans; AM C.67030). Western Australia: 8/2 from 188 m, approximately 135 miles north-west of Roebuck Bay, 17°34' S, 120°22' E, coll. m.v. "Kos 2" (7/2: AM C.88702; 1/2 RMNH 55095).

Nucula praetenta Iredale
Figures 24-26

Nucula umbonata Smith, 1891: 443, pl. 35, fig. 24 (*non* Seguenza, 1877; *nec* Hall, 1883).

Nucula praetenta Iredale, 1924: 184 (*nom. nov.* for *Nucula umbonata* Smith, 1891).

Deminucula praetenta, Iredale, 1931:202.

Tindaria (Deminucula) praetenta, McAlester, 1969: N235, fig. A5-11.

LECTOTYPE: A specimen from 750 m, off Sydney, New South Wales, 34°13'0" S, 151°38'0" E, 13-VI-1874, coll. H.M.S. "Challenger" (Station 164B) (BMNH 89.2.13.12-13/1).

PARALECTOTYPE: A left valve, heavily damaged, from the same sample as the lectotype (BMNH 89.2.13.12-13/2).

DIAGNOSIS: A small, stout, short, triangular, smooth *Nucula,* with a very small but distinct chondrophore and a denticulated ventral margin. Differs from *Nucula torresi* Smith by its smoothness and possibly a larger adult size. Differs from *Nucula saltator* (Iredale) in being less inequilateral, and also by its lack of sculpture and perhaps by a larger adult size. Differs from both *torresi* and *saltator* in both geographical and vertical distribution, as far as the evidence goes.

DESCRIPTION: Valve solid, short, rounded triangular in outline, inflated, with a rather acuminate, incurved umbo. No distinct angles between rounded dorsal margin and weakly curved anterior and posterior margins. Ventral margin anteriorly broadly rounded, posteriorly less curved. Posteroventral angulation rather well marked, anteroventral angulation indistinct. Border and sculpture of embryonic shell obsolete, not distinct. Interdissoconch smooth. Dissoconch smooth, with few slightly pronounced growth lines. Radial structure lines visible in median dissoconch area, but not on anterior and posterior areas. Periostracum very light yellowish brown, thin, smooth. Hinge with 9 anterior and 6 posterior teeth, both teeth rows ending with an additional very small tooth near the umbo. Chondrophore small but distinct, triangular, directed towards anteroventral valve margin, slightly rounded ventrally, hardly projecting beyond hinge plate. Adductor muscle scars ovate, pallial line indistinct. Inner ventral margin finely denticulated by radial structure.

MEASUREMENTS: See table. 4.

RANGE: The only known locality seems to be that of the types, off Sydney, but as *praetenta* probably is a deep water species, an extended range can be expected (fig. 71).

ECOLOGY: The type specimens were dredged from green mud at 750 m. The lectotype is a complete specimen and still bears its periostracum, so it may have lived not far from where it was dredged.

Table 4. Nucula praetenta: measurements and number of teeth.

specimen	length	height	section	e.s.l.	i.d.l.	secondary teeth ant.	post.
lectotype	3.37	3.03	1.04	?0.18	?0.82	9	6
paralectotype	3.00	2.67	0.88				

DISCUSSION: *Nucula praetenta* was described from Station 164B of the "Challenger" Expedition. Due to an error, part of the material said to come from this Station would be from Atlantic origin (Smith, 1891). Apart from one doubtful record (Iredale, 1931) *N. praetenta* has never been collected since the expedition, which by some authors (e.g. Iredale and McMichael, 1962) is used as an argument to assume its Atlantic origin. (The discussions on the material from "Challenger" Station 164B are summarized in my account of *Nucula dilecta dilecta* Smith.) However, the strong affinities of *N. praetenta* with *N. torresi* Smith and *N. saltator* Iredale render Australian origin much more likely. The New Zealand species from shallow waters *Nucula certisina* Finlay, 1930, first figured by Dell (1956 pl. 1, figs 5, 7) is possibly also related.

In 1931 Iredale proposed a new genus, *Deminucula,* solely for *Nucula praetenta*. He based this proposal not on Smith's types, but on "specimens from 800 fathoms, 35 miles east of Sydney, identical with Smith's species", that had been compared with the types, as Iredale writes in a much later paper (1939:234). Surprisingly, in their reference list of marine molluscs of New South Wales, Iredale and McMichael (1962: 4) mention *Nucula umbonata* Smith as one of the assumed Atlantic species, ignoring both Iredale's new specific name *praetenta* – which certainly deserves recognition — and his genus *Deminucula*. Genus and species are simply omitted from the check list proper. The only explanation, apart from an error, is that Iredale's specimens from 800 fathoms (1463 m) had got lost in the meantime.

Regarding the taxonomic position of the genus *Deminucula,* Schenck (1934: 44, pl. 5, figs 3, 3a) caused quite some confusion by figuring and describing *Deminucula praetenta* as a species without a chondrophore. Unfortunately Schenck could not examine the types himself, but had to rely on the information of others (evidently not specialists), who assured him that they could find "no vestige of a chondrophore" in the types, and who provided him with drawings from which the exact hinge configuration is not clear. Hence, Schenck even doubted whether *Deminucula* should be assigned to the family Nuculidae. McAlester (1969: N235), content with Schenck's remarks and copying his misleading illustrations, went so far as to place *Deminucula* in the family Malletiidae Adams and Adams, 1858, as a subgenus of *Tindaria* Bellardi, 1875. In reality, there is no reason to question the placement of this species in the family Nuculidae Gray, as a distinct chondrophore is present (fig. 24).

SPECIMENS EXAMINED: None other than the type specimens.

Nucula saltator (Iredale)
Figures 27-29

Pronucula saltator Iredale, 1939: 231, pl. I, figs 10, 10a.

LECTOTYPE: A left valve from 16 to 22 m, Low Isle, Queensland, 1928-1929, coll. Great Barrier Reef Expedition (AM C.60256).

PARALECTOTYPE: A left valve from the type locality, from the same sample as the lectotype (AM C.78302).

DIAGNOSIS: A small, stout, almost smooth *Nucula,* with blunt umbones, convex valves, concentric sculpture on anterior area only, and a denticulated inner ventral margin. Nearest relatives are *Nucula praetenta* (Iredale) and *Nucula torresi* Smith, from which it differs in being relatively longer, in presence and distribution of concentric sculpture and in having a relatively larger chondrophore.

DESCRIPTION: Valve stout, triangular-ovate, convex. Umbo blunt. Dorsal margin arched, posterodorsal curve not angular, posterior side truncated, posteroventral angulation well marked. No anterodorsal angulation, anterior side slightly curved, anteroventral curve broad, ventral side evenly rounded, somewhat straight posteriorly. Embryonic shell with a pitted outer surface, umbo slightly bifid, interdissoconch smooth and with imperceptible border, rest of valve smooth except for 5 to 9 usually prominent ribs which sculpture the anteroventral area. In the median area a subsuperficial structure of radiating lines is visible, in the lectotype (figs 27-29) 73 near the margin, and not extending, apparently, to anterior and posterior areas. Periostracum lost in the specimens studied. Valve shining white exteriorly, silverish white interiorly. Hinge with up to 6 anterior and 5 posterior V-shaped secondary teeth. Teeth rows separated by a small chondrophore. Chondrophore almost vertical, hardly projecting beyond hinge line, rounded at ventral side. In the lectotype the ventral side of the chondrophore is slightly damaged (fig. 27). Anterior adductor muscle scar partly visible, posterior one and pallial line unapparent. Ventral margin finely denticulated internally by the radial structure.

MEASUREMENTS: See tabel 5.

RANGE: Along the northern part of Queensland's east coast (and possibly also in northern Western Australia) (fig. 72).

ECOLOGY: *Nucula saltator* is known from samples, collected at depths between 7 and 27.5 m. None of the known specimens was collected alive, but it seems not unlikely that the species lives not far offshore, in rather shallow waters. Its relative stoutness suggests exposition to either turbulent water movements (surf), or to a coarse-grained substratum ("coral sand").

DISCUSSION: When Iredale described the species, he must have had more specimens than the two syntypes that resulted from a search in the Australian Museum type collection by Dr W. F. Ponder in 1970. The figures illustrating Iredale's description are of a right valve, while the two syntypes are left valves. Moreover the description speaks of valves with 8 or 9 anterior teeth. On the other hand, the figured valve (Iredale, 1939) measures 1.5 mm in length and has 7 or 8 teeth, which seems an unlikely combination (see table 5). Iredale did not mention the concentric sculpture, though his figure does show it. This sculpture appears to be variable. In some specimens it is very prominent, in others less. In two of the examined specimens it is almost lacking, as it is in the smallest specimen. Partly this may be due to the growth stage of the shells concerned, because the concentric ribs develop only at a certain shell size. All specimens listed below are quite worn. A small valve in rather bad condition from a depth of 128 m at about 200 miles west of Roebuck Bay, Western Australia (AM C.100958), possibly belongs to *saltator,* but more material from that region is needed to check its identity.

Table 5. Nucula saltator: measurements, number of teeth and number of concentric ribs.

specimen	locality	length	height	section	secondary teeth		concentric ribs
					ant.	post.	
lectotype	Low Isle	1.73	1.45	0.56	6	5	5
paralectotype	Low Isle	± 1.73	1.50	0.56	6	5	
largest valve	Albany Passage	1.86	1.59	0.59		5	8-9
smallest valve	Albany Passage	± 1.47	1.18	0.42	6	4	

SPECIMENS EXAMINED: Queensland: 4/2 from 7 to 26 m, Albany Passage, coll. C. Hedley (AM C.36300); 15/2 from 7 to 26 m, Albany Passage, probably also collected by C. Hedley (13/2 AM C.78303; 2/2 RMNH 55097); 2/2 from 16 to 22 m, Low Isle, collected 1928-1929, by the Great Barrier Reef Expedition (lectotype AM C.60256, paralectotype AM C.78302); 4/2 from 27.5 m, Palm Islands, coll. C. Hedley (AM C.10323). (Western Australia: 1/2 from 128 m, approx. 200 miles west of Roebuck Bay, 18°33′ S, 119°08′ E, 7-X-1968, coll. "Espirito Santo"; AM C.100958; identification with reservations.)

Nucula mayi (Iredale)

Figures 33-35

Pronucula decorosa, May (*non* Hedley, 1902), 1915 : 81, pl. 8, figs. 42-42a; May, 1923 : 7, pl. 1, Fig. 1.

Pronucula mayi Iredale, 1930 : 384.

Pronucula cancellata Cotton, 1930 : 224; Bergmans, 1968 : 73-74, pl. 11, figs. 2a-c; Bergmans, 1969 : 62.

LECTOTYPE: A specimen from 16.5 m, Pilot Station, D'Entrecasteaux Channel, Tasmania (SAM D.10114).

PARALECTOTYPES: 5 1/2 from 18.3 m, off Pilot Station, D'Entrecasteaux Channel *and* Union Bay, Tasmania (SAM D.15021).

DIAGNOSIS: A small, delicate, yet relatively solid *Nucula,* sculptured on dissoconch with concentric riblets and in the median area with additional equally fine radial riblets, with a small but distinct chondrophore well separating the teeth rows, and a denticulated ventral margin. Differs from *Nucula covra* Bergmans by its greater size, its distinctly narrower radial riblets, and probably by a different vertical distribution.

DESCRIPTION: Valve small, rather solid, ventricose, truncately ovate in outline. Dorsal margin distinctly curved, posterodorsal angulation marked, posterior margin truncated. Anterior margin slightly curved, gradually passing into dorsal margin. Ventral margin in smaller specimens more evenly rounded, though somewhat straight posteriorly, and in larger shells also straight anteriorly and slightly angulated in the middle. Embryonic shell sculptured with microscopic pits. Interdissoconch smooth but for fine growth lines, dissoconch with fine concentric riblets and with additional radial riblets (about 25 per mm at the ventral margin in the illustrated paralectotype) in the median area. Concentric and radial riblets are of about equal width and so are concentric and radial interstices, resulting in a cancellated median area. Periostracum clearly light brown, thin, shining, smooth. Shell white, transparent. Hinge with a small series of primary teeth near the dorsal margin at either side of the chondrophore, only a few or

none persisting in adult shells. Up to 6 anterior and 4 posterior secondary V-shaped teeth, with tips curving towards the dorsal valve margin. Chondrophore small, hardly exceeding hinge line, directed towards middle of ventral margin, clearly separating the secondary teeth rows. Adductor muscle scars broadly ovate, pallial line indistinct. Ventral margin denticulated by radial shell structure.

MEASUREMENTS: See table 6.

RANGE: Along the coast of New South Wales, up to Port Stephens, and along the coasts of Victoria, east and south Tasmania and South Australia westward to Cape Borda (fig. 72).

ECOLOGY: I have seen specimens taken from beaches and down to a depth of 294-304 m. Perfect shells came from between 14.5 and 73 m, somewhat worn or obsolete shells from beaches and from 73 to 294-304 m. From these data it seems that *mayi* prefers relatively shallow waters.

DISCUSSION: May (1915) appreciated his first find of *Nucula mayi,* from "off Pilot Station in nine fathoms" as a variety of *Pronucula decorosa* Hedley with less pronounced radiating ribs. In 1923, in his index of Tasmanian shells, May still mentions only one locality, namely "off Pilot Station, Channel." The addition "Channel," standing for D'Entrecasteaux Channel (May, 1923 :4), is important, because it fixes May's "Pilot Station" (of which there are several in Tasmania: Miss A. Green *in lit.,* 14-V-1974) and therewith the type locality of *Nucula mayi.*

Coincidentally, in 1930 Cotton and Iredale each based a new species on this sample in the May collection. Iredale's paper was published on the 27th of June, and Cotton's on the 18th of July, so that Iredale's name *mayi* has priority over Cotton's *cancellata.* Iredale was content with May's original illustrations and concise remarks (1915) as a basis for his *Pronucula mayi,* and thus could not indicate a type specimen. He erroneously recorded "Pilot Bay" as type locality, but his reference to the specimens reported on by May (1915) is unequivocal. Cotton, who had May's shells before him, indicated a type specimen (SAM D.10114). I found this specimen to be conspecific — though not identical — with the illustrations by May (1915), and propose here to regard it as lectotype of *Nucula mayi* (Iredale). In the South Australian Museum collection a sample from the former May collection (now SAM D.15021) has been marked "*Pronucula cancellata* Cotton, CO-TYPES". However, these specimens are from "Pilot Station and Union Bay." One may wonder who put the specimens from these two localities together, May or someone after him. If it happened before Cotton studied and described them, the possibility exists that Cotton selected his type from this mixed sample, ignoring the double locality. In this case the type locality would become "Tasmania", or even "Australia", since "Union Bay" cannot be traced (Miss A. Green *in lit.,* 14-V-1974). For the present I must consider the cited type locality of *Nucula mayi* as correct, and leave a further analysis of the question to others.

Before 1930 two samples in the South Australian Museum collection, SAM D.15026 from Gulf St. Vincent and SAM D.15027 from 62 fathoms north-west of Cape Borda, had been labelled by Verco "*Pronucula cancellata* Verco," followed by "sp. n." in the latter sample. We can safely assume that Cotton knew these samples when he described his *cancellata,* and they can almost certainly be regarded as paratypes of *Pronucula cancellata* Cotton.

Table 6. Nucula mayi: measurements and number of teeth.

specimen	length	height	section	e.s.l.	i.d.l.	primary teeth ant.	primary teeth post.	secondary teeth ant.	secondary teeth post.
paratype (drawn spec.)	1.72	1.48	0.62					6	4
Narrabeen	1.60	1.25	0.40			2	1		
holotype	1.50	1.24	0.44	0.22	0.82	2	1	5	4
Off C. Borda	1.50	1.20	0.41		0.82			4	3
Narrabeen	1.44	1.15	0.38						
paratype	1.20	0.98	0.36					4	2

Typical *Nucula mayi* valves are relatively high. Some valves from Collaroy Beach, off Nelson Bay, and Dolls Point are relatively slightly longer and approach small *Nucula pusilla* Angas in their outline. Apart from sculptural differences *mayi* is at once separable from small *pusilla* by its almost symmetrically formed chondrophore.

SPECIMENS EXAMINED: New South Wales: 1/2 from 44 m, Port Stephens (Bergmans, 1969: 62); 2 from off The Old Man Hat Point, Inner North Head, Port Jackson, 1886, coll. J. Brazier (AM C.88709); 2 1/2 from 46-73 m, off Nelson Bay (AM C.100963); 5 from 14.5-18.3 m, Dolls Point, George River, 1961-1962, coll. J. Voorwinde (2 1/2: Collection Van der Slik; 2 1/2: RMNH 52691); 11/2 from 294-304 m, 25 miles east of Twofold Bay, 37°27′ S, 150°17′ E, 19-VI-1962, coll. H.M.A.S. "Gascoyne" (AM C.100957); 1/2 from 149 m, 20 miles south-east of Twofold Bay, 37°26′ S, 150°15′ E, 19-VI-1962, coll. H.M.A.S. "Gascoyne" (AM C.83134). Victoria: 1 dredged from Western Port (SAM D.15022); a series from Corio Bay (NMV F.28113 and RMNH 55098). Tasmania: 1/2 from 56 m, east of Babel Island, 18-I-1968, coll. "Umataka Maru" (TAS E7405); 3/2 from 50 m, east of Flinders Island, 18-I-1968, coll. "Umataka Maru" (TAS E9207); 1 from 16.5 m, Pilot Station (lectotype; SAM D.10114); 5 1/2 from off Pilot Station and Union Bay (paratypes of *Pronucula cancellata* Cotton; SAM D.15021). South Australia: 1/2 from 73 m, off Beachport (SAM D.15028); 6 13/2 from Gulf St. Vincent (SAM D.15026 and D.15029); 1 from 100.5 m, off Cape Borda (SAM D.15024); 1 from 113 m, north-west of Cape Borda (SAM D.15027); 2, and a series, from "South Australia" (SAM D.15023 and D.15025).

Nucula revei n. sp.
Figures 30-32

Pronucula vincentiana, Bergmans (*non* Cotton and Godfrey, 1938), 1968 : 74, pl. 11, figs. 3a-c; Bergmans, 1969 : 62.

HOLOTYPE: A specimen from shell sand, Narrabeen, New South Wales, 1961, coll. J. Voorwinde (RMNH 52697).

PARATYPES: 5/2 from the same sample as the holotype (RMNH 55099); 1/2 from North Head, New South Wales, coll. J. Voorwinde (AM C.83115); 1 from 11-14.6 m, Chinamans Beach, Middle Harbour, New South Wales, coll. J. Voorwinde (AM C.100962).

DIAGNOSIS: A very small species of *Nucula,* with minute radial striae on parts of interdissoconch, radial and concentric riblets on dissoconch, a small chondrophore, and a finely denticulated inner ventral margin. Differs from *Nucula mayi* (Iredale) and *Nucula covra* Bergmans by its radial interdissoconch striae, by the presence of radial riblets on anterior and posterior dissoconch parts and by the relatively small space between chondrophore and secondary teeth rows. From *N. covra* it differs moreover by the narrowness of the radial riblets.

DESCRIPTION: Valve small, relatively solid, somewhat inflated, squarish ovate in outline. Dorsal margin curved, with almost straight anterior and posterior parts. Anterodorsal and posterodorsal angulations marked. Posterior side short, truncated. Posteroventral angulation not sharp but distinct. Anterior side slightly bent, with broad curve passing into rather evenly rounded ventral side. Embryonic shell bifid, with microscopically pitted surface. Interdissoconch with very delicate radial striae, especially on anterior, posterior and ventral areas, and with fine growth lines. Dissoconch with narrow, evenly spaced radial riblets, definitely not corresponding with striae on interdissoconch. These riblets are about as broad as their interstices, extending on anterior and posterior areas, numbering over 70 near valve margin in holotype. The concentric riblets on the dissoconch are somewhat stronger, and less regularly arranged, than the radial riblets. Periostracum unknown, shell whitish. Hinge without distinct primary teeth, dorsal margin not thickened near chondrophore. Up to 6 anterior and 5 posterior secondary teeth, median ones rather crowded and very close to chondrophore. Adductor muscle scars ovate, pallial line indistinct. Inner ventral margin finely denticulated by radial dissoconch structure.

MEASUREMENTS: See table 7.

Table 7. Nucula revei, n. sp.: measurements and number of teeth.

specimen	length	height	section	e.s.l.	i.d.l.	secondary teeth	
						ant.	post.
holotype	1.04	0.90	0.32		0.66	6	4
paratype Narrabeen	±1.3			0.22	0.66		
paratype Chinamans Beach	1.04	0.88	0.32				

RANGE: The known range reaches only from Narrabeen to Middle Harbour, Port Jackson, New South Wales (fig. 71).

ECOLOGY: All known specimens came from beach samples or from depths to 14.6 m. Although, with the exception of the holotype, these specimens are rather worn, *Nucula revei* may well be a shallow water species.

DISCUSSION: When superficially examined specimens of *Nucula revei* are easily taken for representatives of *Nucula mayi* (Iredale). The latter species, however, differs in the distinct restriction of the radial dissoconch sculpture to the median area, a feature shared by a number of other specis dealt with in this paper. This, and the other distinguishing characters of *revei,* its very probable sympatry with *mayi,* and the absence of any intermediate form in the studied samples lead me to consider *revei* as an independent species.

SPECIMENS EXAMINED: Those of the type series detailed above.

Derivatio nominis: The species is dedicated to my friend the Dutch author Gerard Kornelis van het Reve who, during my first years as a student of biology at the Amsterdam University, generously supported my trips in the course of the present study to the Zoologisches Museum at Berlin and the British Museum (Natural History) in London, and who certainly is among the first artists to promote science in this way.

Nucula covra n. sp.
Figures 39-41

HOLOTYPE: A right valve from 183 m, 40 miles south of Cape Wiles, South Australia, VIII-1909, coll. "Endeavour" (AM C.88707).

PARATYPES: New South Wales: 5/2 from 294 to 304 m, 25 miles east of Twofold Bay, 37°27' S, 150°17' E, 19-VI-1962, coll. C.S.I.R.O. Fisheries, H.M.A.S. "Gascoyne", Cruise G2/62, Station 60 (AM C.100955). Victoria: 1/2 from 366 m, 30 miles south of Cape Everard, 22-X-1964, coll. "Endeavour" (AM C.100956). Tasmania: 1 from "off Pilot Station" (at D'Entrecasteaux Channel) or "Union Bay", possible collector W. L. May (SAM D.15020). South Australia: 2/2 from the same sample as the holotype (AM C.100959); 4/2 from 183 m, 40 miles south of Cape Wiles, coll. "Endeavour", possibly also from the same sample as the holotype (2/2 AM C.32040; 2/2 RMNH 55105).

DIAGNOSIS: A small *Nucula* species, with a convex shell, a radial shell structure which may form broad radial ribs on its exterior, and with two rows of distinct primary teeth persisting in adult shells. Secondary teeth few. Inner ventral margin denticulated. From *Nucula decorosa* (Hedley) it differs in being smaller, more convex, less equilateral, in the extension of its radial structure beyond the median area to the anterior and posterior areas, in the possession of well developed primary teeth, and in its relatively less projecting and smaller chondrophore. From *Nucula mayi* (Iredale) it differs in its relatively broader radial ribs, when these are present, its primary teeth configuration, and by greater distances between chondrophore and secondary teeth rows.

DESCRIPTION: Valve small, convex, quadrately ovate in outline. All margins rather rounded, passing into one another without sharp angulations. Posterior side somewhat truncated. Embryonic shell bifid and with granular surface. Interdissoconch smooth. Rest of valve with a very distinct radial prismatic structure, subsuperficial in solid shells but inducing radial ribs on the exterior of thinner shells (about 18 per mm at the ventral margin in the holotype). Thinner shells also tend towards featuring pronounced growth lines, which in combination with the radial ribs more or less cancellate the shell surface. Periostracum unknown, shells white. Chondrophore small, triangular, hardly projecting beyond hinge plate. Up to 5 anterior and 3 posterior V-shaped secondary teeth. Next to these two rows of very small, vertical primary teeth, one row at either side of the chondrophore. These primary teeth seem to arise from the inward turned outer dorsal valve margin rather than from the actual hinge plate, and are difficult to trace in worn specimens, where they may look like mere crenelations. There are up to 5 or 6 anterior and 4 posterior primary teeth. Adductor muscle scars and pallial line not obvious. Inner ventral margin and adjoining parts of anterior and posterior margins coarsely crenulated by the radial structure.

MEASUREMENTS: See table 8.

RANGE: From Twofold Bay in New South Wales along the coast of Victoria, including Tasmania, to Cape Wiles in South Australia (fig. 71).

ECOLOGY: Known collecting depths range from 183 to 366 m. None of the known specimens was collected alive or fresh, but as *Nucula covra* has never been encountered in beach samples or samples from lesser depth, the species probably lives in rather deep waters. The Tasmanian specimen (SAM D.15020) forms part of the "co-types" series of *Nucula mayi* (Iredale) (SAM D.15021). See for the uncertainty about its provenance the discussion of this species.

Table 8. Nucula covra n. sp.: measurements and number of teeth.

specimen	length	height	section	e.s.l.	i.d.l.	primary teeth		secondary teeth	
						ant.	post.	ant.	post.
holotype	1.36	1.20	0.44	0.28	0.80	4-5	4	3	2
SAM D.15020	1.58	1.40	0.50	0.26	0.66			3	3
RMNH 55105	1.48	1.38	0.54	0.28	0.80			4	3
AM C.100956	1.26	1.16	0.44	0.26	0.64	4-5	⩾3	3	2
AM C.100955	1.12	0.96	0.34	0.26	+ 0.66			3	2

DISCUSSION: In the material of *Nucula covra* covered in this study two forms can be recognized that differ in some morphological aspects and in geographical distribution. The specimens from the type locality, 40 miles south of Cape Wiles, are relatively solid, have less pointed umbones, more rounded outlines, no real sculpture, embryonic shell lengths of 0.28 mm and interdissoconch lengths of 0.80 mm. The valves from off Twofold Bay, off Cape Everard and (probably) Tasmania are thinner, have more pointed umbones which are more distinctly bifid, more angular outlines, radial ribs on the dissoconch, pronounced growth lines which in combination with the radial ribs more or less cancellate the shell exterior, embryonal shell lengths of 0.26 mm and interdissoconch lengths of 0.66 mm. Moreover the primary teeth are more narrowly set. In short, the specimens from the southern coast of eastern Australia are more delicately built than the South Australian specimens.

The placement of the species in the genus *Nucula,* in spite of its seemingly aberrant hinge formation, seems justified by the observed presence of primary teeth-like structures in other small species of *Nucula,* e.g. *N. pusilla* Angas and *N. australiensis* (Thiele).

A closely related form from outside Australia seems to be the New Zealand species *Pronucula tenuis* Powell, 1927. This has been collected off Puysegur Point, south-west Otago, at Snares Island and off Leeward Islands, Antipodes, at depths ranging from 27.5 to 315 m (Powell, 1927; 1937; 1955). The holotype of this species, as described and figured by Powell, agrees in many respects with *Nucula covra* from southern east Australia. The main difference appears to be the form and position of the chondrophore, which in *Pronucula tenuis* is larger, not triangular and distinctly projecting beyond the hinge line, and situated nearer the exterior and the posterior side of the valve. I do not wholly

exclude the possibility that the results of future collecting and study will show that *Nucula covra* and *Pronucula tenuis* are actually conspecific. As, in my opinion, *Pronucula tenuis* Powell is clearly a *Nucula* species, th specific name would than be *Nucula covra, Nucula tenuis* being preoccupied (Montagu, 1808).

SPECIMENS EXAMINED: The type series as detailed above.

Derivatio nominis: The name *covra* is formed by the initials of the late Dr. C. O. van Regteren Altena, former Curator of the Mollusca Department of the Rijksmuseum van Natuurlijke Historie at Leiden, The Netherlands, and during his life leading Dutch malacologist. Dr. van Regteren Altena died on the 23rd of December, 1976, when this study had long been completed. His kind help in many ways has been an indispensable support to my debut in the malacological field.

Nucula decorosa (Hedley)
Figures 42-44

Pronucula decorosa Hedley,1902: 290, fig. 39; Bergmans, 1968: 73, pl. 11, fig. 1a-c.

HOLOTYPE: A specimen from 115-138 m, off Port Kembla, New South Wales, collected 18-III-1898, by the "Thetis" (AM C.12309).

PARATYPES: 5 single valves from the same sample as the holotype (AM C.12309).

DIAGNOSIS: *Nucula decorosa* is distinguished by its tendency towards an equilateral outline, its broad radial ribs and the spacial setting of the hinge components. Its nearest relative seems to be *Nucula covra* Bergmans, from which it differs by its larger measurements (to be checked with the interdissoconch lengths: tables 8 and 9), its peculiar periostracum (though the periostracum of *N. covra* is not known yet), its restricted radial sculpture and its chondrophore which projects further beyond the hinge line and is farther from the first posterior tooth.

DESCRIPTION: Valve moderately solid, not very convex, quadrately ovate in outline. Dorsal margin weakly and evenly curved, anterodorsal and posterodorsal angulations indistinct, posterior side short and somewhat truncated, anterior side almost straight. Ventral side broad and rounded, straighter posteriorly. Posteroventral curve gradual, anteroventral curve broad. Embryonic shell with a granularly structured median outer surface, and a narrow smooth border. Interdissoconch smooth but for some weak growth lines. Rest of valve with relatively broad radial ribs (about 45 in the figured paratype valve, length 2.45 mm) and concentric striae, possibly growth lines. Radial ribs restricted to median area, though an occasional indistinct rib may be observed on anterior or posterior area, concentric striae covering whole valve beyond interdissoconch. Shell white to transparent white, covered by a light brown periostracum, that features rows of tubiform projections on the radial ribs, which rows may continue on the interdissoconch. Hinge with subtriangular chondrophore, which distinctly projects beyond the hinge plate, and is separated from both secondary teeth rows by relatively large toothless hinge plate areas. Anterior teeth row with up to 7 teeth, posterior row with up to 5 teeth. Adductor muscle scars and pallial line indistinct. Ventral margin crenulated by the radial ribs.

MEASUREMENTS: See table 9.

RANGE: New South Wales, from Laurieton to Twofold Bay near the Victorian border; probably also in Victoria and perhaps Tasmania. Hedley (1911) recorded *N. decorosa* from south of Cape Wiles, South Australia. In Western Australia off Eucla (fig. 72). The specimens recorded as this species by Cotton (1930) from MacDonnell Bay, South Australia, are in fact *Rumptunucula vincentiana* (Cotton and Godfrey), discussed in the present paper. I have not seen his specimens from 120 miles west of Eucla, mentioned in the same paper, and cannot evaluate this identification.

Table 9. Nucula decorosa: measurements and number of teeth.

locality	length	height	section	e.s.l.	i.d.l.	secondary teeth	
						ant.	post.
off Port Kembla (figured paratype)	2.45	1.91	0.64			6	4
off Sydney	2.93	2.44	0.77	0.34	1.18	7	5
20 miles S.E. of Twofold Bay	2.47	2.06	0.67	0.31	1.22	7	5
off Nelson Bay	2.26	1.90	0.59	0.32	1.06		
	1.76	1.32	0.31			3	2
off Eucla	1.53	1.18	0.39	0.33	1.22	4	2

ECOLOGY: Live specimens have been collected at depths of 46 to 137 m, dead specimens not much beyond this range, as far as I have seen. The types were taken from a sample of "mud and pebbles," at a distance of 5 to 8 miles from the mainland coast. *Nucula decorosa* has not been found on or near beaches.

DISCUSSION: In damaged specimens the shell structure is sometimes revealed. The contact surface between outer and middle shell layers is comparable to that described for *Nucula placentina* (Lamarck) by Taylor, Kennedy and Hall (1969). The prismatic structure that causes tangential projections of the outer layer into the underlying middle layer seems also responsible for the radial ribs covering the exterior of the outer layer. The light breaking effect of the radial prismatic structure is distinct, and helps in determining where the radial rib sculpture exists and where not. It is not known whether this prismatic radial structure exists in those areas of the valve where radial ribs are lacking. According to Dr. J. D. Taylor, London (VII-1971, *in verbis*), it is very unlikely that it would not.

The characteristic periostracum is best studied when the shell is immersed in water. It seems to adhere to dead shells of this species longer than in some other *Nucula* species, and when present it obscures the borders between embryonic shell and interdissoconch and between the latter and the rest of the valve.

For this reason the measurements given in table 9 for embryonic shell length and interdissoconch length are possibly not exact.

SPECIMENS EXAMINED: New South Wales: 7 from 73 m, off Laurieton (RMNH 55100); a sample from 146 m, 22 miles east of Narrabeen, probably collected 7-VI-1906 by H.M.C.S. "Miner" (BMNH 1907.9.10.141); 1 from 46 to 73 m, off Sydney (RMNH 55101); 3 from 46 to 73 m, off Nelson Bay (RMNH 55102); 1/2 from 64 m, off Cronulla, 6-XI-1963, coll. C.S.I.R.O. Fisheries "Benthos" (RMNH 55103); 1/2 from 73 m, off Cronulla, coll. J. McIntyre (AM C.83121); 3/2 from 80 m, off Cronulla, 1966, coll. C.S.I.R.O. Fisheries (RMNH 52692); 3/2 from 115 to 138 m, off Port Kembla, 18-III-1898, coll. "Thetis" (paratypes, AM C.12309); 1/2 from Gerringong, coll. R. Etheridge (AM C.7202); 2/2 from 149 m, 20 miles southeast of Twofold Bay, 37°26′ S, 150°15′ E, 19-VI-1962, coll. C.S.I.R.O.

Fisheries, H.M.A.S. "Gascoyne", Cruise G2/59/62 (AM C.100953). Western Australia: 1 3/2 from off Eucla, 33°20' S, 128°45' E, 5-VII-1962, coll. C.S.I.R.O. Fisheries, H.M.A.S. "Gascoyne", Cruise G2/62, Station 96 (RMNH 55104)

Nucula australiensis (Thiele)
Figures 55-58

Pronucula australiensis Thiele, 1930: 589, pl. 4, fig. 69.

HOLOTYPE: A specimen from 14.5 to 18 m (mud and algae), Cockburn Sound, Western Australia, collected 30-IX-1905 by W. Michaelsen and R. Hartmeyer (ZMB 67669). Holotype by monotypy.

DIAGNOSIS: A small but quite solid *Nucula* species, trapezoid ovate in outline, with relatively broad concentric ribs and a smooth inner ventral margin. Differs from *Nucula papuensis* Bergmans by its much broader concentric ribs and from *Nucula brongersmai* Bergmans by its larger size and its concentric ribs and, in most specimens, by itslack of visible radial structure or sculpture. Differs from both these species by its known geographical range.

Table 10. Nucula australiensis: measurements and number of concentric ribs and secondary teeth, Holotype measurement from the original description (Thiele, 1930).

locality	length	height	section	approx. number of concentric ribs	e.s.l.	i.d.l.	secondary teeth	
							ant.	post.
Gulf St. Vincent ')	1.98	1.76	0.83	± 32	0.22	± 0.80	8	4
Monte Bello Island	1.88	1.61	0.51	21			8	5
Garden Island ')	1.61	1.41	0.50	16			6	4
Bandicoot Bay	1.53	1.33	0.44	19	0.23	0.78	7	3
Monte Bello Island	1.43	1.25	0.43		0.22	0.78	7	4
Cockburn Sound '')	1.4	1.1		17			7	4
Yardie Beach	1.25	1.06	0.39	14	0.22	0.78		
200 miles W of Roebuck Bay	1.10	0.94	0.33	16	0.21	0.75	5	3

') Figured valves.
'')Holotype.

DESCRIPTION: Valve quite solid, moderately convex, trapezoid ovate in outline. Dorsal margins weakly curved, posterodorsal angulation rounded but marked, anterodorsal curve gradual, although in some specimens more angular than in the figured valve from Careening Bay, Western Australia (figs 55-57). Posterior side truncated, ventral side evenly or less regularly rounded, anteroventral curve broad, anterior side almost straight. Embryonic shell weakly bifid (that is, with two slightly elevated umbonal areas), with surface of central part granularly structured, otherwise smooth. Interdissoconch smooth, rest of valve with relatively broad concentric ribs, running into one another on anterior and posterior areas of valve. Traces of a very

delicate radial structure or sculpture sometimes present on interdissoconch and rest of valve. Shell white, periostracum thin, smooth, transparently light brown to greenish. Hinge parts moderately solid. Secondary teeth V-shaped, 8 in anterior and 5 in posterior teeth row in largest specimen. One or two primary teeth at either side of chondrophore. Chondrophore projecting beyond hinge line, with rounded or more angular ventral side. Adductor muscle scars oval, visible in fresh specimens, mantle line not traceable. Inner ventral margin smooth.

MEASUREMENTS: See table 10.

RANGE: Gulf St. Vincent, probably along the South Australian and southern Western Australian coast, and from Cockburn Sound along the Western Australian coast northward to Roebuck Bay, including islands within the Continental Shelf boundary (fig. 73).

ECOLOGY: *Nucula australiensis* is possibly a sublittoral species. Most specimens were collected at or near beaches (0-18 m). Among these were fresh to fairly well preserved specimens. The only specimen from greater depth AM C. 88701 from 128 m, 200 miles west of Roebuck Bay, was not fresh when collected.

DISCUSSION: Thiele (1930) mentioned as type locality just Cockburn Sound. From the label with the type specimen I learned that it had been collected at Station 48 of the Expedition by Michaelsen and Hartmeyer, the position of which, as cited above, was published in the itinerary of this Expedition (Michaelsen and Hartmeyer, 1907).

The anterodorsal part of the right valve of the holotype was lacking. Altogether 37 specimens could be studied. In only two of these was the radial structure or sculpture, mentioned in the description, bserved (AM C. 88701 and SAM D.15090). The fact that not the holotype, but another specimen has been figured, is due to my short and unplanned stay in East-Berlin, where I only had time and equipment to make sketches and notes concerning the holotype specimen. All other specimens of *N. australiensis* listed below have been identified with the help of these.

One figured valve (figs 55-57) is from Careening Bay, Garden Island, which is not very far from the type locality. The other figured valve (fig. 58), the largest known specimen, is from Gulf St. Vincent. The locality suggests that it might represent a link between *N. australiensis* and the undoubtedly related *N. brongersmai,* described hereafter. Its well developed radiating lines on interdissoconch and adjacent anterior and posterior areas of the dissoconch support this idea. But considering both as conspecific would leave us with the inherent assumption that all known specimens of the very small *brongersmai* are juveniles. This is far from likely, since the collecting localities of *brongersmai* comprise some of the malacologically best known of Australia, and yet specimens approaching the size range of *australiensis* have never been collected. I therefore prefer the treatment as proposed here, and to await the results of future collecting before commenting on the actual relation between the two forms.

SPECIMENS EXAMINED: South Australia: 1 from Gulf St. Vincent (SAM D.15090); Western Australia: 1 from 14.5 to 18 m (mud and algae), Cockburn Sound, 30-IX-1905, coll. W. Michaelsen and R. Hartmeyer (holotype: ZMB 67669); 1 2/2 from base of Skippy Rock, Careening Bay, Garden Island, 16-I-1965, coll. S. Slack-Smith (WAM 1147-75; left valve of complete specimen figured); 4 2/2, from Yardie Beach, North West Cape, 9-X-1969, coll. F. Plant (WAM 1149-75); 1 2/2, found high up on sheltered intertidal sandflats, Bandicoot Bay, 20°52′ S, 115°19′ E, 31-VIII-1966, coll. U.S.N.M. "Barrow I", W.A. Exp. 1966 (WAM 807-71); 2 20/2 from Monte Bello Island, 18-IX-1945, coll. G. P. Whitley (2 18/2 AM C.83125; 2/2 RMNH 55106); 1/2 from 128 m, approximately 200 miles west of Roebuck Bay, 18°33′ S, 119°08′ E, 7-X-1968, coll. m.v. "Esperito Santo" (AM C. 88701).

Nucula papuensis n. sp.
Figures 52-54

HOLOTYPE: A single right valve from between 7 and 26 m (4-14 fathoms), Albany Passage, north-east Queensland, possibly collected by C. Hedley (AM C.100961).

PARATYPES: 8/2 from 9-18 m, Hope Island, Queensland (approx. 15°43′ S, 145°24′ E), presented (and probably collected; see Hedley, 1912: 131) by C. Hedley (AM C.29678); 9/2 from a seaweed dredge in 12.8 m, Amazon Bay, Milne Bay District, Papua, collected 13-IX-1948 by C.S.I.R.O. Fisheries (7/2: AM C.83101; 2/2: RMNH 55107).

DIAGNOSIS: A small species of *Nucula,* combining sculpture of fine concentric ribs (not on embryonic shell and interdissoconch) and a smooth inner ventral margin. Distinguished from its nearest relatives, *Nucula australiensis* (Thiele) and *Nucula brongersmai* Bergmans, by the narrowness and greater number of its ribs *(australiensis)* and by its proportions and concentric sculpture *(brongersmai)* and by its geographical range (both species).

DESCRIPTION: Valve not very convex, moderately solid, trapezoid ovate in outline. Dorsal margin weakly curved, posterior side truncated, anterior side only weakly rounded, ventral side evenly rounded but for an almost straight posterior section. Anterodorsal, posterodorsal and posteroventral angulations rather distinct. Embryonic shell distinctly bifid in some younger shells, with a pitted appearance of the surface in the central area. Interdissoconch smooth. Rest of valve covered by rather fine and closely set concentric ribs. A very delicate structure or sculpture of radiating lines is visible on anterior and posterior areas of both interdissoconch and rest of valve. The shell is white or with a very weak brownish tinge. The epidermis is abraded in all the types. Hinge plate relatively broad, with 7 anterior and 4 posterior, V-shaped secondary teeth in the largest specimen and one primary tooth at either side of the chondrophore. The chondrophore in the holotype is slightly damaged at its ventral margin, but in the paratypes it is relatively hardly larger, with a somewhat rounded ventral side, and projects beyond the hinge line. Adductor muscle scars and pallial line not visible. Inner ventral margin smooth.

MEASUREMENTS: See table 11.

RANGE: From the limited material collected thus far it may be concluded that *Nucula papuensis* occurs at either side of Torres Strait, and probably along or near the coasts of the islands in this strait. Hope Island is the southernmost locality along the eastern Queensland coast (fig. 73).

ECOLOGY: Although none of the known specimens was collected alive or freshly dead, the species probably does not live much beyond the depth range of 7 to 26 m from which it was dredged, because the depths around the collecting localities hardly surpass 26 m.

SPECIMENS EXAMINED: The type series as detailed above.

Nucula brongersmai n. sp.
Figures 59-61

Pronucula pusilla, Bergmans (*non* (Angas, 1877)), 1968: 76, pl. 12, figs 4a-c; Bergmans, 1969: 63.

HOLOTYPE: A single right valve, collected at Primrose Sands, Tasmania, 25-III-1967, by E. Aves (TAS E5373).

PARATYPES: New South Wales: 3 39/2 from shell sand, Narrabeen, 1961, coll. J. Voorwinde (RMNH 59696); 4/2 from shell sand, Narrabeen, coll. J. Voorwinde (Collection Van der Slik); 4/2 from 3.6 to 7.3 m, Fairlight, Port Jackson, coll. J. Voorwinde (AM C. 83119); 1 from 9 m, off Bottle and Glass Rocks, Port Jackson (AM C.100960); 2 from 3.6 m, east side Sow and Pigs Reef, Port Jackson (near the rocks, rocky bottom), 1865, coll. J. Brazier (AM C.100970); 1 from 11 to 14.6 m, Chinamans Beach, Middle Harbour, coll. J. Voorwinde (AM C.83114); 1 from algae, Balmoral, Sydney Harbour, 19-I-1969, coll. W. F. Ponder and J. Voorwinde (AM C.73217); 3/2 from Collaroy Beach, coll. J. Voorwinde (AM C.83118). Victoria: 1 2/2 from Corio Bay, ex-collection J. H. Gatliff (NMV F28114). Tasmania: 1/2 from Tinderbox, 12-IV-1967, coll. E. Aves (TAS E5469).

DIAGNOSIS: *Nucula brongersmai* is distinguished at once from sympatric *Nucula* species by the combination of its minute size, sculpture of peculiar radial striae (extended to interdissoconch) and smooth inner ventral margin. From its closest relatives, *N. australiensis* (Thiele) and *N. papuensis* Bergmans, *brongersmai* differs in being smaller, in the possession of a usually well developed sculpture of radial striae and by the absence of concentric riblets. It also has a different geographical range.

DESCRIPTION: Valve moderately convex, trapeziod ovate in outline. Dorsal margin weakly curved and in a number of specimens with a weak median angulation at the level of the chondrophore. Posterior side rather truncated, posterodorsal and posteroventral angulations rather distinct. Ventral side evenly rounded but for an almost straight posterior part. Anterior side almost vertical and only weakly curved, tending to be straight in the largest specimens.

Anteroventral and anterodorsal angulations indistinct. Valve moderately solid. Embryonic shell umbo bifid, surface with granular appearance. Rest of valve, including interdissoconch, with more or less elevated lines of growth and covered by numerous very delicate radiating striae. Interdissoconch border not distinguishable in most specimens. Shell transparent, whitish. Epidermis thin, light green to light greenish brown. Hinge with up to 7 anterior and 4 posterior V-shaped secondary teeth. A minute projection (primary tooth?) at either side of the chondrophore. Chondrophore triangular, with rounded ventral margin projecting beyond hinge line. Adductor muscle scars (visible in some specimens: Bergmans, 1968, fig. 4a) almost equal, ovate. Pallial line not visible. Inner ventral margin smooth.

MEASUREMENTS: See table 12. In one specimen from Fairlight, Port Jackson (AM C.83119) the interdissoconch length appeared to be about 0.66 mm, but this measurement should be considered with reservation. The specimen from Tinderbox (TAS E5469) is the largest known specimen.

RANGE: From Narrabeen in New South Wales southwards and westwards to Corio Bay in Victoria, and in south-eastern Tasmania (fig. 73).

ECOLOGY: Well preserved or fresh *Nucula brongersmai* have been collected on beaches and at a depth of 3.6 to 9 m. Worn specimens are known from beaches and from depths to 14.6 m. As the species was never found in deeper waters, its habitat is probably in shallow sublittoral waters.

DISCUSSION: The conchological variation is restricted to the outer shell sculpture. Growth lines may be rather pronounced in some specimens and hardly affecting the shell surface in others. They never tend to resemble riblets, however. The radial striae as a rule are most distinct on anterior and posterior areas; on the rest of the valve they can be as distinct as almost obscure, especially on the median area. The species bears a great likeness to both *australiensis* and *papuensis*, but as yet these species seem to be rather widely separated geographically, and reflections on possible closer relations between them and *brongersmai* would at present be mere speculations.

Table 11. Nucula papuensis, n. sp.: measurements and number of concentric ribs and secondary teeth; paratypes from Amazon Bay.

specimen	length	height	section	e.s.l.	i.d.l.	approx. number of concentric ribs	secondary teeth	
							ant.	post.
holotype	1.39	1.21	0.44		0.76	35	7	4
paratype	1.18	1.02	0.37		0.69	23	5	3
paratype	1.14	0.94	0.33	0.20	0.75	20	4	3
paratype	1.04	0.87	0.29	± 0.22	0.73	16	4	3

Table 12. Nucula brongersmai, n. sp.: measurements and number of teeth.

specimen	locality	length	height	section	e.s.l.	secondary teeth	
						ant.	post.
holotype	Primrose Sands	1.07	0.91	0.30	0.26	7	4
paratype	Fairlight, Pt. Jackson	0.96	0.81	0.28	0.20	5	4
paratype	Collaroy Beach	0.94	0.78	0.28	0.23	4	3
paratype	Tinderbox	1.23	1.05	0.35		7	4
paratype	Balmoral	1.03	0.85	0.30	0.20	4	3

Derivatio nominis: I dedicate this smallest of all known Australian *Nucula* species to professor Dr L. D. Brongersma, former director of the Rijksmuseum van Natuurlijke Historie, Leiden, who so often encouraged me during the initial stages of my biology studies.

Nucula dilecta dilecta Smith
Figure 66

Nucula dilecta Smith, 1891: 442-443, pl. 35, fig. 23.

LECTOTYPE: A specimen from 750 m, off Sydney, New South Wales, 34°13'0" S, 151°38'0" E, 13-VI-1874, coll. H.M.S. "Challenger" (Station 164B) (BMNH 89.2.13.22-30/1).

PARALECTOTYPES: 8 (or 7 2/2) specimens from the same sample as the lectotype (BMNH 89.2.13.22-30/2).

DIAGNOSIS: A medium sized, rather ventricose, oval-shaped, smooth species of *Nucula,* with a relatively long posterior area, a hardly oblique chondrophore and a smooth inner margin. It cannot be confused with any other sympatric *Nucula* species. Subspecific differences in outline and hinge configuration.

DESCRIPTION: Valve somewhat ventricose, with two very weak depressions radiating from umbo towards margins, one just above anteroventral and one just above posteroventral curve. Valve of medium thickness, truncately ovate in outline. Dorsal margin almost straight anteriorly, weakly curved posteriorly, with broad curves passing into short and rather straight anterior and posterior margins. Posteroventral angulation distinct. Ventral margin broadly and evenly curved. Anteroventral curve broad. Embryonic shell border not to be traced with certainty, surface microscopically pitted. Interdissoconch smooth, border not easily discernible. Dissoconch smooth but for some pronounced growth lines, especially on anterior and posterior (and occasionally extreme ventral) areas. Periostracum thin, shiny, yellowish to greyish olive green, covering inner valve margin, in larger specimens obsolete in umbonal region. Chondrophore not very oblique, with a rounded ventral margin. Secondary teeth rows starting lateral from chondrophore, with up to 9 anterior and 7 posterior, rather slender teeth. Adductor muscle scars and pallial line indistinct.

MEASUREMENTS: See table 13.

RANGE: The only known locality of the subspecies *dilecta* is the type locality, i.e. off Sydney (fig. 74), but as it is a true deep water species, with subspecies in South Australian and eastern Indonesian waters (and possibly also in New Zealand: see under "Discussion"), a more extended range may be expected. Cotton (1930: 225) reports on *Nucula dilecta* from a depth of 91-128 m, at Port Arthur, but the sample from this locality so named by him (SAM D.15092) does not contain this species, but another, obliquely chondrophored *Nucula,* not discussed in this paper.

Table 13. Nucula dilecta dilecta: measurements and number of teeth.

specimen	length	height	section	secondary teeth	
				ant.	post.
lectotype	5.67	4.50	1.50	9	7
paralectotype	5.08	3.83	1.33		
paralectotype	3.67	2.71	0.83	6	4
paralectotype	3.29	2.43	0.77	6	5

ECOLOGY: The type series was trawled from green mud (Smith, 1885: 15). The known depth range of the three subspecies recognized here runs from 250 to 959 m. Complete and fresh looking specimens came from depths of 550, 750 and 959 m.

DISCUSSION: The first of the three subspecies to be studied and drawn for this study happened to be *N. dilecta flindersi* (Cotton). Because of the great resemblance I later confined the illustration of *N. dilecta dilecta* to the outline and hinge.

Already in 1891 Smith (p.436) had remarked that a number of specimens said to originate from Station 164B of the "Challenger" Expedition were not Australian but "undoubtedly Atlantic forms", suggesting that some mistake had been made aboard the

"Challenger" in labelling an Atlantic sample as one from Station 164B. As appears from Hedley's first account of this problem (1901), Smith withdrew this opinion a few years later, convinced by Dr J. Murray of the "Challenger" Expedition that no mistake could possibly have been made. Hedley was not convinced, and in 1918 he even attributed the supposed mistake to Murray himself. Hedley and Petterd (1906) were the first to examine an extensive new collection from near this Station, and they could confirm the Australian origin of about half of the species that had been recorded from Station 164B. They decided to await further investigations before determining the origin of those species that had not yet been found again, among which were *Nucula dilecta* Smith and *Nucula umbonata* Smith, which is treated elsewhere in this paper (as *Nucula praetenta* Iredale). Not much later Hedley (1907: 362) believed he had rediscovered *Nucula dilecta:* "Of common occurrence in the vicinity of the type locality is a *Nucula* which coincides with the account of *Nucula dilecta* and which is accordingly identified as such. But this involves adding *N. dilecta* to the synonymy of *Nucula obliqua,* Lamarck . . . ". In his checklist of 1918 Hedley still sticks to this opinion. If Hedley had known the hinge of the *Nucula dilecta* types, he would not have made this error. I have not seen his *"dilecta"* specimens and thus have no opinion as to where they might belong, but they evidently do not belong to *N. dilecta.* (The holotype of *N. obliqua* Lamarck has been figured by Schenck, 1934, pl. III.) Iredale (1929: 158) disagrees with Hedley (1907), stating that *Nucula dilecta* Smith is easily separable (from *Nucula obliqua* Lamarck) on account of its shape and smaller size. Iredale, too, failed to discuss the obvious hinge differences, and I wonder whether he based his comments on specimens or on Smith's original description and figure. In 1931 Iredale (p. 102) writes of a "deep-water form of *dilecta* from 300 fathoms east of Sydney" (which would be more elongate than the typical form) but later Iredale and McMichael (1962: 4) eliminated *dilecta* from the faunal list of New South Wales, stating that it had not been found since Smith's description and that it "can be assumed to be from the Atlantic." This assumption is no more warranted than the supposition that *dilecta* is Australian, because its Atlantic distribution has never been verified either. Because of the discovery of *Nucula diaphana* Prashad from eastern Indonesia and Western Australia and *Pronucula flindersi* Cotton from South Australia, which in my opinion are only subspecifically distinct from *N. dilecta* sensu stricto, I do not doubt that *N. dilecta* is Australian, and that its types originate from "Challenger" Station 164B. The occurrence of yet another, closely related form, *Nucula strangeiformis* Dell (1956: 9, pl. 1, figs 2, 3), at depths of between 400 and 600 m at various localities in New Zealand waters, supports this conclusion. (In fact, type material of *N. strangeiformis* should be compared to that of *N. dilecta,* because neither the described characters nor the figures of *N. strangeiformis* warrant its recognition as specifically different from *N. dilecta* sensu lato. On the contrary, it strikingly agrees with the nominate form.)

In his original description Smith states about *dilecta* "pagina interna . . . radiatim minute substriata . . . ". Indeed, faint radiating lines (structure?) may be observed in the valve interior. I found traces of what is likely to represent radial structure on the exterior of the holotype of *Nucula dilecta flindersi* (Cotton) (fig. 62). (Undoubtedly Dell (1956) refers to similar observations in *Nucula strangeiformis* when he somewhat ambiguously describes its interior as "smooth, polished, sculptured with fine radials".)

SPECIMENS EXAMINED: None other than the type specimens.

Nucula dilecta flindersi (Cotton)
Figures 62-64, 68

Pronucula flindersi Cotton, 1930: 225, fig. 3.

HOLOTYPE: A specimen from 550 m, 120 miles west of Eucla, Western Australia, date and collector unknown (SAM D.10116). Holotype by monotypy.

PARATYPES: 6/2 and 4 fragments from the type locality, date and collector unknown (SAM D.1587); 7/2 from 550 m, 120 miles east of Eucla, South Australia, date and collector unknown (SAM D.15086).

DIAGNOSIS: At specific level as for *Nucula dilecta dilecta* Smith. The characters in which it differs from the nominate form and from *Nucula dilecta diaphana* Prashad are described below.

DESCRIPTION: Agrees in most details with nominate form. Differs in that the posterior area is shorter, dorsal margin less curved, anterodorsal and posterodorsal angulations sharper and more distinct, posterior margin more vertical, posterior teeth row shorter, anterior teeth more numerous, hinge plate immediately anterior of chondrophore narrower. From *Nucula dilecta diaphana* Prashad it differs in its longer dorsal margin, its much more vertical posterior margin and its less numerous, less lamelliform anterior teeth. For relation valve length/anterior teeth number in *Nucula dilecta* subspecies see fig. 1. In some specimens of *flindersi* embryonic shell and first stage of interdissoconch opaquely white. Weak traces of radial lines — probably shell structure — on lower posterior side of valve exterior. Periostracum thin, greyish green. In the holotype there are two very small projecting folds on anterior valve side, probably deformations. Up to 10 anterior and 5 posterior teeth.

MEASUREMENTS: See table 14.

RANGE: From 120 miles west of Eucla, Western Australia, eastwards into South Australian waters, 120 miles east of Eucla (see under "Discussion", however) (fig. 74).

Cotton and Godfrey (1938) mention Neptune Islands as the eastern limit of distribution, but I have not seen the sample on which this was based, and cite this locality with strong reservations.

Table 14. Nucula dilecta flindersi: measurements and number of teeth.

specimen	collection	length	height	section	approx. e.s.l.	approx. i.d.l.	secondary teeth	
							ant.	post.
holotype	SAM D.10116	4.04	3.29	1.07	0.27	0.65	10	5
paratype	SAM D.1587	4.07	3.10	1.03			9	5
paratype	SAM D.1587	3.66	2.76	0.83			8	5
paratype	SAM D.1587	2.97	2.28	0.69			7	4

ECOLOGY: The types are all from the same depth, 550 m. The holotype and one series of paratypes (SAM D. 15086) are in excellent condition and probably lived at or not much beyond this depth.

DISCUSSION: Verco wrote the original labels accompanying the three type samples (W. Zeidler *in lit.*, 3-V-1974). He recognized the shells as representatives of a new species and even named them "*Pronucula flindersi* Verco" on the labels, but did not publish his findings. The original holotype label reads "D.10116 TYPE *Pronucula flindersi* 120 miles W. of Eucla 300 fms." Verco's labels with the paratype series read "D.1587 *Pronucula*

flindersi Verco 300 fms. 120 miles W. of Eucla" and "D. 15086 *Nucula* 3 300 fms 120 miles E. of Eucla." (The registration numbers have been added later.) Cotton was the only person to handle the Nuculidae of the South Australian Museum collections after Verco and before the present author (Mrs H. M. Laws *in lit.*, 1-III-1972). When describing the species he overlooked the remarkable difference between the localities of the two paratype series and put both in one bigger tube, adding one general label reading "SA.Mus. D.1587 *Pronucula flindersi* Cotton Cotypes 120 m. W. of Eucla 300 fms.". In the course of the present study the paratype sample from 120 miles east of Eucla has been separated again and registered as SAM D.15086.

Nucula dilecta flindersi does not show variation in shell morphology, as far as the known specimens are concerned. Younger specimens are just a bit more angular in outline, with the radial depressions more distinct, and the anterior valve margin straight (fig. 68). Cotton (1930) claims the species to have concentric ribs, but the few more or less pronounced growth lines can by no means stand as such, although they must be what Cotton referred to. In fact, the outer surface in *flindersi* is polished and smooth as in none of the other small nuculid species treated in this paper (apart from the other two *dilecta* subspecies). Cotton *(loc. cit.)* gave as the difference between *flindersi* and *Pronucula concentrica,* described by him in the same paper and here regarded as a synonym of *Nucula pusilla* Angas, that *flindersi* has concentric ribs over the ventral portion (of the valve), while *concentrica* has its whole valve covered with concentric ribs. It now appears that *flindersi* has no ribs at all, while *concentrica* has at least a smooth interdissoconch. Both Cotton's descriptions and illustrations of *flindersi* and *concentrica* are therefore misleading. The absence of a distinctly visible radial structure and of a denticulated inner ventral margin are better used to distinguish *flindersi* from *concentrica*. The hardly visible radiating lines on the posterior part of the valve exterior in *flindersi* seem to affect the surface, but very soon become worn in dead shells where they can not be traced. In fresh specimens they may even very slightly notch the inner valve margin, so that under a certain angle of light it appears to be somewhat undulating at the level of the radial lines.

Specimens examined: No specimens other than the types.

Nucula dilecta diaphana Prashad
Figures 65, 67

Nucula (Nucula) diaphana Prashad, 1932: 15, pl. I, figs. 3, 4.

SYNTYPES: Three specimens, one type and two paratypes, from 959 m, dredged between Sumba and Flores, Indonesia, 9°3'4" S, 119°56'7" E, 20-IV-1899, coll. "Siboga" (Station 52) (holotype and paratype: ZMA; paratype: ZSI M.13306/2).

DIAGNOSIS: At specific level as for *Nucula dilecta dilecta* Smith. The characters in which *diaphana* differs from the subspecies *dilecta* and *flindersi* are described below.

DESCRIPTION: *Nucula dilecta diaphana* agrees in most details with the nominate subspecies. It differs from this in form of posterior margin, which is less vertical, in number and form of anterior teeth, which are more numerous and more lamelliform, and perhaps by its greater size. From *Nucula dilecta flindersi* it differs by its less vertical posterior margin, its less distinct or even indistinct anterodorsal and posterodorsal angulations, its longer posterior teeth row and its more numerous anterior teeth. There is no real concentric sculpture of very fine, microscopic striae as Prashad (1932) states, these "striae" being merely lines of growth. Up to 16 anterior and 11 posterior teeth.

MEASUREMENTS: See table 15.

RANGE: From between Sumba and Flores, Indonesia, via Browse Island to south of Rowley Shoals, off northern Western Australia (fig. 74).

ECOLOGY: The types of *Nucula dilecta diaphana* were dredged in "Globigerina ooze" on 959 m. These are rather well preserved specimens and probably lived near that depth. The only recently collected Western Australian specimens are mostly rather worn or even obsolete and from lesser depth, 250 to 300 m.

DISCUSSION: Mr. N. V. Subba Rao of the Zoological Survey of India kindly informed me that in the collection of this institution there are two specimens of *Nucula diaphana* Prashad, labelled as paratypes in Prashad's hand (Subba Rao, 12-IX-1975, *in lit.*). As the holotype and one paratype are in the collection of the Zoologisch Museum in Amsterdam there appear to be four types instead of the three mentioned by Prashad in his description (1932). I can not think of a solution to this confusing matter. The Western Australian specimens (and the known representatives of the other two subspecies) are all smaller than the two *diaphana* types in the ZMA collection.

Table 15. Nucula dilecta diaphana: measurements and number of teeth.

specimen	length	height	section	secondary teeth ant.	post.
holotype (ZMA)	8.33	6.67	2.25	16	11
paratype (ZMA)	7.83	6.17	2.20	12	9
WAM 803-71	4.76	3.66	1.41	14	7
WAM 803-71	3.10	2.34	0.83	10	6

The number of anterior teeth in the specimens from Browse Island and Rowley Shoals is relatively larger than in the types. Considering all known representatives of *Nucula dilecta* sensu lato it is suggested that a negative ecological correlation exists between collecting depth and anterior teeth number, in the sense that shells from deeper water bear relatively fewer teeth. More material is needed to verify this phenomenon, which would interfere with the subspecific arrangement as here defined. It is not even unlikely that future collecting will also yield evidence that other differences here considered of taxonomic value are not really that important. After all we may expect a very extended distribution area for a deep water species like *dilecta,* already strongly suggested by the striking resemblance of Indonesian, Australian, and probably also New Zealand forms. We may then also expect an inherent variation of characters, when comparing material from different populations which are more or less isolated vertically and horizontally.

The hinge of the holotype, and outline and hinge of a worn Western Australian specimen (WAM 801-71) have been figured.

SPECIMENS EXAMINED: Western Australia: 1/2 from 260 m, south of Rowley Shoals, 20-XII-1969, coll. "Umataku Maru", UMD 6920 (WAM 801-71); 6/2 from 300 m, south of Rowley Shoals, 20-XII-1969, coll. "Umataku Maru", UMD 6921 (WAM 802-71 and 803-71); 7/2 from 266 m, south of Rowley Shoals, 20-XII-1969, coll. "Umataku Maru", UMD 6926 (6/2: WAM 805-71 and 1/2: RMNH 55108); 1/2 from 250 m, north of Browse Island, 23-XII-1969, coll. "Umataku Maru", UMD 6929 (WAM 806-71). Indonesia: 2 from 959 m, 9°3'4" S, 119°56'7" E, between Flores and Sumba, 20-IV-1899, coll. "Siboga" (holotype and paratype; ZMA).

Nucula species
Figures 36-38

Nucula micans, Bergmans (*non* Angas, 1878), 1968: 78; pl. 12, figs. 6a-c; 1969: 63.

It seems useful to draw attention to this small species which, to judge from its embryonic shell length (about 0.24 mm) and its comparatively high number of teeth, is probably adult or nearly so at a length of 1.18 mm as in the figured specimen. The type of *Nucula micans* Angas, now regarded as a junior synonym of *Nucula pusilla* Angas, possesses a distinct radial shell structure and a correspondingly crenulated inner ventral margin, whereas these specimens do not show any sign of radial structure and have a smooth ventral margin. Moreover, the tooth count is considerably larger than in *pusilla* of the same size (the *pusilla* valve of figs. 9-11 measures 1.94 mm and still has fewer teeth). As the available material is very scarce, and some of it rather worn, I refrain from attaching a specific name to it.

SPECIMENS EXAMINED: New South Wales: 1/2 from shell sand, Narrabeen, 1961, coll. J. Voorwinde (RMNH 54758); 2/2 from Northhead, Sydney Harbour, coll. J. Voorwinde (AM C.83116); 1/2 from 11-14.5 m, Chinamans Beach, Middle Harbour, coll. J. Voorwinde (AM C.83113).

Rumptunucula n. gen.

TYPE SPECIES: *Pronucula vincentiana* Cotton and Godfrey, 1938.

DIAGNOSIS: A genus of the family Nuculidae with the hinge plate interrupted beneath the beak, a sunken chondrophore, and one or more small primary teeth at either side of the resilium between anterior and posterior hinge plate parts. Hinge plate and chondrophore configuration distinguish this genus from all other genera in the family.

DESCRIPTION: Valves longer than high, with a triangularly or squarish ovate outline. Embryonic shell and interdissoconch marked. Shell with radial prismatic structure which may affect the outer dissoconch surface to the extent of radial riblets. Hinge plate interrupted in the middle. Relatively many teeth on anterior hinge plate part, which ends in front to the umbo, and few teeth on posterior hinge plate part, which ends posterior of the umbo. Small primary teeth project from the inner dorsal margin in the hinge plate gap, one or a few at either side of the ligament. Chondrophore sunken into the valve, projecting from the inner valve surface distal of the hinge plate gap and supported by ridges which radiate from the chondrophore over the inner valve surface. Adductor muscle scars ovate, rather long.

Species included: Only the type species.

DISCUSSION: Superficially the only known representative of the new genus here proposed bears much resemblance to *Nucula decorosa* (Hedley), though a better look at the hinge structure at once reveals its position as distant from this and other species of *Nucula*. Traces of a periostracum, preserved in one of the three known specimens, suggest that this might have borne projections similar to those on the periostracum in *decorosa,* while valve outline and style of sculpture also remind one strongly of this species. No really close relatives of *Nucula decorosa* are known, and the same is true for *Rumptunucula vincentiana*. Both species are possibly relatively young, and within the scope of our present knowledge of genera and species of the Nuculidae it seems permissible to envisage a close origin of both taxa. *Nucula decorosa* remained within the limits of the genus *Nucula* Lamarck, 1799, and the off-shoot that eventually gave rise to

Rumptunucula vincentiana crossed these limits. In my opinion *Rumptunucula* is of special interest, since it shows a possible way in which evolution may interfere with so stable a character as the typical *Nucula* hinge configuration.

Derivatio nominis: The prefix *Rumptu* is derived from the Latin verb *rumpere,* meaning to break, or to split, and applies to the broken up hinge plate.

Rumptunucula vincentiana (Cotton and Godfrey)
Figures 48-51

Pronucula vincentiana Cotton and Godfrey, 1938: 38, fig. 7.

HOLOTYPE: A specimen from Gulf St. Vincent, South Australia, date and collector unknown (SAM D.13151).

DIAGNOSIS: A trapezoid ovate, small shell, with relatively broad radial ribs on median area of dissoconch, an anterior hinge plate which tapers towards the umbo, a rather large oblique chondrophore, a broad posterior hinge plate, and a crenulated inner ventral margin.

DESCRIPTION: Valve small, rather inflated, trapezoid ovate in outline, with the greatest height in the anterior part; delicate but not very thin. Dorsal margin slightly and evenly curved, angulations between dorsal and anterior and posterior margins marked but not sharp. Posterior margin short and slightly rounded. Anterior margin long and weakly curved. Ventral margin broadly rounded but for an almost straight posterior part, with broad curvings passing into anterior and posterior margins. Embryonic shell with microscopically pitted outer surface, interdissoconch smooth but for fine growth lines. Dissoconch with some pronounced growth lines (that do not take the shape of riblets), and with radial ribs on its median area; interstices between the ribs rather broad. Radial ribs extending farther on anterior and posterior areas than in *Nucula decorosa* (Hedley). Growth lines most prominent on anterior and posterior extremities. Periostracum light brown. Anterior hinge plate rather long, narrowing posteriorly, extending over chondrophore and ending just before umbo. Anterior secondary teeth up to 9, narrowing with hinge plate, with somewhat curved tips. Posterior hinge plate relatively short and broad, only narrowing between its first secondary tooth and umbo and ending posterior of umbo. Up to 3 posterior secondary teeth. Chondrophore solid, rectangular, obliquely projecting into the valve towards anterior part of ventral margin and supported by 4 or 5 ridges on the valve interior. Posterior supporting ridge strongest, running from posterior side of chondrophore towards posterior hinge plate. Posterior primary teeth consist of one rather strong tooth in right valve, opposed by two teeth in left valve. Anterior primary teeth consist of a distinct and an obtuse tooth in the right valve, opposed by what seems a thickened dorsal margin in left valve. Pallial line entire and indistinct. Adductor muscle scars distinct and oblongly ovate. Inner ventral margin crenulated by radial shell structure.

Table 16. Rumptunucula vincentiana: measurements and number of teeth.

specimen	length	height	section	e.s.l.	i.d.l.	secondary teeth	
						ant.	post.
holotype	2.32	1.88	0.62	0.38	1.32	7	2 and 3
MacDonnell Bay	2.45	1.95	0.68		± 1.14	9	3
MacDonnell Bay	2.05	1.59	0.50	± 0.40	± 1.14	7	3

MEASUREMENTS: See table 16.

RANGE: Eastern South Australia (fig. 72).

DISCUSSION: The original description and figure of *Pronucula vincentiana* are poor and inaccurate. Cotton and Godfrey (1938) wrongly claimed the presence of concentric ribs, the extension of the radial ribs on anterior and posterior valve ends, a perpendicular chondrophore and in general a hinge configuration as in *Nucula decorosa* (Hedley).

Cotton and Godfrey (loc. cit.) give Gulf St. Vincent as type locality. The box holding the type had this locality written on its lid by Cotton, but inside there is a Verco label reading "*Pronucula cancellata* n. sp. 15-20 fms. St. Francis Is". In my account of *Nucula mayi* (Iredale) in the present paper I already explained that Verco had labelled two samples in the South Australian Museum collection as "*Pronucula cancellata* Verco" but that this species was eventually published by Cotton (1930) under the same name. Cotton in his description mentioned St. Francis Island — and also the depth of 15(-20) fathoms — as one of the localities of his *Pronucula cancellata,* but the sample of this species from St. Francis Island has not been found since. I am convinced that Verco would never have confused such different shells as *Nucula mayi* (Iredale), i.e. the valid name for *Pronucula cancellata* Cotton, and *Rumptunucula vincentiana.* Thus Verco would never have identified material of the latter species as conspecific with his "*cancellata*". A more plausible explanation for the label with that name in the box of the *vincentiana* type is that Cotton, when preparing the section on the Nuculidae for The Molluscs of South Australia (Cotton and Godfrey, 1938), confused or mixed two labels while comparing the type of *vincentiana* with samples of *Nucula mayi.* The St. Francis Island label could then belong to the Gulf St. Vincent sample of *mayi* that has a Verco label without an identification (SAM D.15029), while the latter label could belong to the *vincentiana* type. Presumably, Cotton checked the collecting depth of the type of *vincentiana* after the exchange of labels, and copied the depth mentioned on the St. Francis Island label without noticing his error. If this reconstruction is correct, Gulf St. Vincent would be the correct type locality of *Rumptunucula vincentiana,* and the cited depth of 15-20 fathoms would be based on an error.

Other localities mentioned in the original description of *Pronucula vincentiana* are "off Cape Borda, 55 fathoms" and "north-west of Cape Borda, 62 fathoms". The samples providing these data apparently served Cotton when describing *Pronucula vincentiana,* and could therefore be referred to as paratypes (Mayr, 1969: 371). I have studied both samples, which had been put together in one bigger tube (fortunately each still with its own label) with a Cotton label covering both samples "*Pronucula vincentiana* Cotton and Godfrey". Both lots consisted of shells of *Nucula mayi* (Iredale), however. The label with Cotton's identification has been left with one sample, SAM D.15024, while the other sample has been separated as SAM D.15027. Apart from the type specimen I have seen only two other specimens of *Rumptunucula vincentiana,* both loose right valves. These came from MacDonnell Bay, South Australia, and were identified and listed by Cotton and Godfrey (1938) as *Pronucula decorosa* Hedley. These MacDonnell Bay specimens were the first of *vincentiana* that I studied, hence the drawings of the whole valve (figs. 45-47) are from one of these specimens and not from the holotype which I saw and found to be conspecific much later. In the right valve of the holotype part of the ventral margin and of the dorsal margin just behind the umbo are lacking.

Some indication of the conchological variability within *Rumptunucula vincentiana* is shown in figures 46 and 48. The form of the chondrophore is more rectangular and the supporting ridges are in a different position in the type (fig. 48) than in the MacDonnell Bay specimen (fig. 46). The posterior hinge plate is narrower in the type, and the primary

teeth are more prominent (though this may be due to a greater degree of wear in the MacDonnell Bay specimen).

SPECIMENS EXAMINED: South Australia: 1 from Gulf St. Vincent (holotype, SAM D. 13151); 2/2 from MacDonnell Bay (1/2: SAM D. 11306; 1/2: RMNH 55109).

Key to adult specimens of recent Australian Nuculidae except Ennucula Iredale, 1931

1. Hinge plate not interrupted beneath the umbo (chondrophore forming part of the hinge plate and at about the same level) 2

   Hinge plate interrupted beneath the umbo (chondrophore detached from and sunken beneath the hinge plate) ..... *Rumptunucula vincentiana*

2. Inner ventral margin of valves distinctly denticulated or crenulated 3

   Inner ventral margin of valves smooth 11

3. Chondrophore distinctly oblique and projecting beyond hinge plate; resilifer longer than broad 4

   Chondrophore either hardly or not projecting beyond hinge plate (if somewhat projecting then almost vertical); resilifer short, not longer than broad 5

4. Posterior margin straight, running either from a distinct posterodorsal angulation situtated halfway of the posterior secondary teeth row, or from directly beneath the umbo; posteroventral angulation distinct; chondrophore scarcely diverging from anterior part of hinge plate ..... *Nucula beachportensis*

   Posterior margin rounded or only partly straight; posterodorsal angulation usually broad and if more or less sharp, at or beneath the level of the last posterior secondary tooth (counting from the chondrophore); posteroventral angulation usually not distinct; chondrophore diverging from both anterior and posterior hinge plate sections ..... *Nucula pusilla*

5. Valves either smooth and then always without primary teeth, or with relatively strong concentric ribs and/or weak or deciduous radial riblets 6

   Valves either smooth and then always with primary teeth, or with equally valid concentric and radial riblets, or with relatively strong radial ribs and concentric striae 8

6. Valves without sculpture ..... *Nucula praetenta*

   Valves at least partly sculptured 7

7. Usually prominent concentric ribs (5-9) on anteroventral area of valves; no radial sculpture ..... *Nucula saltator*

   Usually prominent concentric ribs beyond interdissoconch; fine radial riblets in interstices ..... *Nucula torresi*

8. Valves with sculpture of about equally valid, rather narrow concentric and radial riblets 9

   Valves smooth, or with sculpture of relatively strong, rather wide radial ribs and weak concentric striae (or merely pronounced growth lines) 10

9. Radial riblets not on anterior and posterior valve areas; interdissoconch smooth except for some delicate growth lines ..... *Nucula mayi*

   Radial riblets covering whole valve beyond interdissoconch; interdissoconch with very delicate radial striae, especially on anterior, posterior and ventral areas, and with fine growth lines ..... *Nucula revei*

10. Chondrophore scarcely projecting beyond hinge plate, producing only a very slight curve on the ventral hinge plate margin; distinct primary teeth at either side of chondrophore; valve smooth or radially ribbed ..... *Nucula covra*

    Chondrophore projecting beyond hinge plate, being substantially longer than the width of the adjacent hinge plate parts; no primary teeth visible; valve with radial ribs ..... *Nucula decorosa*

11. Valve either with concentric ribs on dissoconch, or with delicate radial striae on (parts of) interdissoconch and dissoconch; teeth never tending towards lamellar form 12

    Valve smooth; anterior teeth tending to become lamelliform ..... *Nucula dilecta*

12. Dissoconch concentrically ribbed 13
    Dissoconch without concentric ribs ..... *Nucula brongersmai*

13. About 20 concentric ribs per mm of height ..... *Nucula australiensis*
    About 40 concentric ribs per mm of height ..... *Nucula papuensis*

GENERAL DISCUSSION

In the section on taxonomy I have referred to the zoogeographical regions proposed by Hedley (1904) for the marine Australian fauna. These regions, with some later emendations summarized by Iredale (1939:220), have been introduced on the distribution maps (figs 69-74). I have drawn the border between Flindersian and Peronian/Maugean according to the position of the vanished Bassian isthmus as figured by Hedley *(loc. cit.),* from Wilsons Promontory in Victoria via the islands of the Furneaux Group to Cape Portland in north-east Tasmania. South of Tasmania it is thought to continue approximately in line with the South Tasmanian Ridge.

No attempt has been made to sketch a general outline of the zoogeography of the species of Nuculidae dealt with in this paper. Uneven collecting efforts made thus far would undoubtedly produce a biased concept. Moreover, it is felt that little justification exists for treating the species involved as a more or less natural group or unity. Such a group should at least comprise all Recent Australian Nuculidae. Apart from the new species which no doubt will be discovered, the known larger species of Australian Nuculidae strongly need a modern revision. For the present it seems wisest to leave the question of a general zoogeography to later workers. In the meantime the available data do allow some observations.

Most of the species (or species groups) that do occur in more than one zoogeographical region show a morphological variation which can be related to the zoogeographical compartimentation of their distribution areas. In general, *Nucula pusilla* Angas shells are typical in the Peronian region, possibly more frequently thinner in the Maugean, thicker and in part concentrically ribbed in the Flindersian and Dampierian, and in addition in northern populations in the latter region have a posterior marginal incurvation. *N. beachportensis* Verco seems more frequently typical in the

Peronian, Maugean and Flindersian, while the shells from the Dampierian region would more often represent the triangular, sculptured variety. *N. torresi* Smith occurs in Peronian, Solanderian and Dampierian regions, developing a different style of sculpture in the latter region. Typical shells of *N. covra* Bergmans, from the Flindersian region, are more solid, less angular and less sculptured than Peronian shells of this species. A variation at species level occurs in the closely related species of the *australiensis* group: *N. australiensis* (Thiele) in the Dampierian and Flindersian, N. *papuensis* Bergmans in the Solanderian, and *N. brongersmai* Bergmans in the Peronian, Maugean and eastern Flindersian regions. *N. dilecta* Smith, with the subspecies *dilecta* Smith in the Peronian, *flindersi* (Cotton) in the Flindersian, and *diaphana* Prashad in the Dampierian region, shows an early stage of such a differentiation.

The patterns of distribution of the involved Nuculidae suggest that the most important zoogeographical borders are those between the Solanderian (and probably Banksian) and Peronian regions, and between the Dampierian and Flindersian regions. It is also suggested that for the Nuculidae the latter border lies more to the north than it should according to Hedley (1904). In short, there seems to exist an obviously northern Australian nuculid fauna and likewise a southern one.

The marine mollusc fauna of the northern half of Australia is poorly represented in collections. This region roughly includes the shores and waters of the Kimberley region, Arnhem Land, the Gulf of Carpentaria and the mainland coast of Queensland. The supposed zoogeographical border here is that between the western Dampierian and the eastern Banksian/Solanderian. It is noteworthy that a form of *Nucula torresi* Smith, a species described from the Solanderian, has been collected in the centre of the Dampierian region, while the same may be true for *N. saltator* (Iredale). Moreover, I have seen specimens of the Solanderian *Ennucula privigna* Iredale, 1939, from south of Sweers Island in the southern Gulf of Carpentaria (AM C. 78223 and C. 75249). It would appear from these examples that the border between the two northern regions is of less concern to species which, like the Nuculidae, inhabit sandy or muddy substrates than to those which are exclusively inhabiting coral reef environments. The Great Barrier Reef Nuculidae (Iredale, 1939) may therefore be expected to occur at either side of the border between the mentioned regions. I equally doubt the value, for the Nuculidae, of the border between the Solanderian and Banksian regions.

The Nuculidae of the southern half of Australia are comparatively well known. It is evident that not too much value should be attached to the border between the Peronian and Maugean regions. Of the five species of smaller Nuculidae found in both regions only *Nucula pusilla* Angas shows a very slight morphological distinction. A more important border is that between Peronian and Flindersian though a large transition area can be recognized. Shallow water species from the Peronian region and from the Great Australian Bight probably meet a barrier of some importance in the Bass Strait area, with its distinctly lower temperatures (Hydrographic Office, U.S. Navy, 1954). Deep water species may meet a barrier in the shallow Bassian isthmus.

In general we may expect a more restricted distribution for shallow water species than for those living at greater depths, where environmental conditions remain practically constant over much larger areas. A good example of the latter category is *Nucula dilecta* Smith. This species is known from depths of 250 to 959 m, and its subspecies are not only found in the Dampierian, Flindersian and Peronian regions, but also in Indonesian waters and probably — via the South Tasmanian Ridge and the Southwest Auckland Rise? — in New Zealand.

ACKNOWLEDGEMENTS

The financial support to visit the Zoologisches Museum in Berlin, in 1970, and the British Museum (Natural History) in London, in 1971, received from Mr. G. K. van het Reve, France, is gratefully acknowledged. For the visit to London I also received a grant from the Linnaeus Fonds, Amsterdam. During the years that — on and off — I worked on this study, the help of the following persons has been indispensable: Mr. R. Burns, Miss J. E. Cave, Dr. W. O. Cernohorsky, Mr. Ph. H. Colman, Dr. H. E. Coomans, Mr. A. J. Dartnall, Dr. J. Gaillard, Miss A. Green, Dr. E. Gittenberger, Miss J. A. Hartman, Dr. R. Kilias, Mrs. H. M. King, Dr. H. M. Laws, Mrs. L. M. Marsh, Dr. P. Mather, Dr. D. F. McMichael, Miss B. J. Nielsen, Miss J. Olijslagers, Mr. J. Paul, Mrs. Drs. F. F. J. M. Peeters-Pieters, Dr. W. F. Ponder, Dr. C. O. van Regteren Altena, Mrs. J. E. Richardson, Mrs. S. M. Slack-Smith, Mr. L. van der Slik, Dr. B. J. Smith, Mr. N. V. Subba Rao, Dr. J. D. Taylor, Mr. J. Voorwinde, Miss K. Way, Dr. B. R. Wilson, and Dr. W. Zeidler.

Special thanks are due to Miss H. E. Loor, who very carefully typed the manuscript.

REFERENCES

Adams, H., and A. Adams, 1858. The genera of recent Mollusca, arranged according to their organization. II (4a): 541-572. John van Voorst, London.

Angas, G. F.,1877. Descriptions of 1 Genus and 25 Species of Marine Shells from New South Wales. *Proc. zool. Soc. Lond.* 1877: 171-177, pl. 26.

——— 1878. A List of Additional Species of Marine Mollusca of Southern Australia. *Proc. zool. Soc. Lond.* 1878: 864-871, pl. 54.

Bergmans, W., 1968. A survey of the species of the genus *Pronucula* in New South Wales. *J. malac. Soc. Aust.* 11: 71-78.

——— 1969. Description of a new species of *Pronucula* (Bivalvia, Nuculidae) from New South Wales and additional notes on some other species of the same genus. *J. malac. Soc. Aust.* 12: 61-63.

Böggild, O. B., 1930. The shell structure of the Mollusks. *K. dansk. Vidensk. Selsk. Skr.* IX, 2 (2): 233-325, pls. 1-15.

Clarke jr., A. H., 1961. Abyssal mollusks from the South Atlantic Ocean. *Bull. Mus comp. Zool. Harv.* 125 (12): 345-387, pls. 1-4.

Cotton, B. C., 1930. Pelecypoda of the "Flindersian" region, Southern Australia. No. 1. *Rec. S. Aust. Mus.* 4 (2): 223-240.

——— 1947. Some Tertiary fossil molluscs from the Adelaidean stage (Pliocene) of South Australia. *Rec. S. Aust. Mus.* 8 (4): 653-670, pls. 20-22.

Cotton, B. C., and F. K. Godfrey, 1938. The Molluscs of South Australia. Part I. The Pelecypoda. *Handbk Flora Fauna S. Aust.*: 1-314.

Dell, R. K., 1956. The archibenthal Mollusca of New Zealand. *Dom. Mus. Bull.* 18: 1-235.

Dickins, J. M., 1963. Permian pelecypods and gastropods from Western Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 63: 1-203.

Eames, F. E., 1951. A contribution to the study of the Eocene in western Pakistan and western India. The description of the Lamellibranchia from standard sections in the Rakhi Nala and Zinda Pir areas of the western Punjab and in the Kohat district. *Philos. Trans. R. Soc.* 235 B: 311-482.

Fleming, C. A., 1948. New species and genera of marine mollusca from the Southland Fiords. *Trans. R. Soc. N.Z.* 77 (1): 72-92, pls. 4-8.

Hedley, C., 1901. Studies on Australian Mollusca. Part IV. *Proc. Linn. Soc. N.S.W.* 26: 16-25, pl. 2.

——— 1902. Scientific Results of the trawling expedition of H.M.C.S. "Thetis" off the Coast of New South Wales in February and March, 1898. Mollusca. Part I. Brachiopoda and Pelecypoda. *Mem. Aust. Mus.* 4 (5): 287-324.

——— 1904. The effect of the Bassian isthmus upon the existing marine fauna: a study in ancient geography. *Proc. Linn. Soc. N.S.W.* 38 (4): 876-883.

——— 1907. The Results of Deep Sea Investigations in the Tasman Sea. II. The Expedition of the "Woy Woy". 2. Mollusca from Eight Hundred Fathoms, Thirty-five Miles East of Sydney. *Rec. Aust. Mus.* 6 (5): 356-364, pls. 62-63.

——— 1911. Report on the Mollusca obtained by the F.I.S. "Endeavour", chiefly off Cape Wiles, South Australia. Part I: 90-114, pls. 17-20. Dept. of Trade and Customs, Sydney.

——— 1912. Descriptions of some new or noteworthy shells in the Australian Museum. *Rec. Aust. Mus.* 8: 131-160, pls. 40-45.

——— 1916. Australasian Antarctic Expedition 1911-1914 under the leadership of Sir Douglas Mawson, D.Sc., B.E. Mollusca. *Scient. Rep. Australas. antarct. Exped.,* Ser. C, 4 (1): 1-80, pls. 1-9.

——— 1918. A checklist of the marine fauna of New South Wales. *J. Proc. R. Soc. N.S.W.* 51 (suppl.): M 1-M 120.

Hedley, C., and W. F. Petterd, 1906. Mollusca from three hundred fathoms, off Sydney. *Rec. Aust. Mus.* 6 (3): 211-225, 2 pls.

Hydrographic Office U.S. Navy, 1954. World Atlas of Sea Surface Temperatures. (reprint sec. ed. 1944). H. O. Publ. 225: Preface + 48 maps.

Iredale, T., 1924. Results from Roy Bell's molluscan collections. *Proc. Linn. Soc. N.S.Wales* 49: 179-278, pls. 33-36.

——— 1929. Mollusca from the continental shelf of Eastern Australia. *Rec. Aust. Mus.,* 17: 157-189, pls. 38-41.

——— 1930. More notes on the marine mollusca of New South Wales. *Rec. Aust. Mus.* 17 (9): 384-407.

——— 1931. Australian Molluscan Notes. No. 1. *Rec. Aust. Mus.* 18 (4): 201-235, pls. 22-25.

——— 1939. Mollusca. Part I. *Scient. Rep. Gt. Barrier Reef Exp.* 5 (6): 209-245, pls. 1-7.

Iredale, T., and D. F. McMichael, 1962. A Reference List of the Marine Mollusca of New South Wales. *Mem. Aust. Mus.* 11: 1-109.

Keen, A. M., 1969. Family NUCULIDAE Gray, 1824. (In: Treatise on Invertebrate Palaeontology. Part N. 1. Mollusca 6, Bivalvia: N 230-N 231. R. C. Moore & C. Teichert eds.). Geol. Soc. Am., Inc. and Univ. of Kansas, Kansas.

Lamarck, J. B. de, 1799. Prodrome d'une nouvelle classification des coquilles. *Mem. Soc. Hist. nat. Paris,* Priairial VII: 63-91.

Lebour, M. V., 1938. Notes on the breeding of some lamellibranchs from Plymouth and their larvae. *J. mar. biol. Ass. U.K.* 26: 381-389.

Ludbrook, N. H., 1955. The Molluscan Fauna of the Pliocene Strata Underlying the Adelaide Plains. Part II — Pelecypoda. *Trans. R. Soc. S. Aust.* 78: 18-87, pls. 1-6.

——— 1961. Revision of the Tate Molluscan Types: Pelecypoda — Nuculidae and Nuculanidae. *Trans. R. Soc. S. Aust.* 85: 55-65, pls. 1-3.

Macpherson, J. H., and C. J. Gabriel, 1962. Marine Molluscs of Victoria: I-XV, 1-475. Melbourne University Press, Melbourne.

Marwick, J., 1931. The tertiary mollusca of the Gisborn District. *Palaeont. Bull. Wellington* 13: 1-177, pls. 1-18.

May, W. L., 1915. Additions to the Tasmanian Marine Mollusca, with descriptions of New Species. *Pap. Proc. R. Soc. Tasm.*1915: 75-99, pls. 1-8.

——— 1923. An Illustrated Index of Tasmanian Shells: 1-100. Govt Printer, Tasmania.

Mayr, E., 1969. Principles of Systematic Zoology: i-xiv, 1-428. McGraw-Hill, New York etc.

McAlester, A. L., 1969. Family MALLETIIDAE Adams & Adams, 1858. (In: Treatise on Invertebrate Palaeontology. Part N. 1. Mollusca 6, Bivalvia: N 231-N 235. R. C. Moore & C. Teichert eds.) Geol. Soc. Am., Inc. and Univ. of Kansas, Kansas.

Michaelsen, W., and R. Hartmeyer, 1907. Reisebericht. *Fauna Südwest-Aust.* 1 (1): 1-116, + 1 map.

Ockelman, K. W., 1965. Developmental types in marine bivalves and their distribution along the Atlantic Coast of Europe. *Proc. first Eur. malac. Congr. Lond.* (1962): 23-35.

Oliver, W. R. B., 1915. The Mollusca of th Kermadec Islands. *Trans. Proc. N.Z. Inst.* 47 (1914): 509-568, pls. 9-12.

Powell, A. W. B., 1927. Deepwater Mollusca from South-West Otago, with descriptions of 2 new genera and 22 new species. *Rec. Canterbury Mus.* 3 (2): 113-124, pls. 21-23.

——— 1937. New species of Marine Mollusca from New Zealand. *"Discovery" Rep.* 15: 153-222, pls. 45-56.

——— 1955. Mollusca of the southern islands of New Zealand. *Cape Exped. Ser. Bull.* 15: 1-151, pls. 1-5.

Prashad, B., 1932. The Lamellibranchia of the Siboga Expedition. Systematic Part. II. Pelecypoda (Exclusive of the Pectinidae). *Siboga Exped.* 53 (118): 1-353, pls. 1-9, map.

Pritchard, G. B., and J. H. Gatliff, 1904. Catalogue of the Marine Shells of Victoria. Part VIII. *Proc. R. Soc. Vict.* 17 (n.s.): 220-266.

Quenstedt, W., 1930. Die Anpassung an die grabende Lebensweise in der Geschichte der Solenomyiden und Nuculaceen. *Geol. palaeont. Abh.* (n.s.) 18 (1): 1-120, pls. 1-3.

Schenck, H. G., 1934. Classification of nuculid pelecypods. *Bull. Mus. r. Hist. nat. Belg.* 10 (20): 1-78.

——— 1935. Neotypes of *Nucula nucleus* (L.) *Proc. malac. Soc. Lond.* 21 (4): 258-261.

——— 1936. Nuculid bivalves of the genus *Acila*. *Spec. Pap. geol. Soc. Am.* 4: 1-149, pls. 1-18.

Schmidt, W. J., 1922. Ueber den Aufbau der schale von *Nucula*. *Arch. mikrosk. Anat.* 96: 171-181.

Smith, E. A., 1885. Report on the Lamellibranchiata collected by H.M.S. Challenger during the years 1873-1876. *Rep. scient. Results Voy. Challenger,* Zool. 13: 1-341, pls. 1-25.

——— 1891. Descriptions of new Species of Shells from the "Challenger" Expedition. *Proc. zool. Soc. Lond.* 1891: 436-445, pls. 34-35.

Taylor, J. D., W. J. Kennedy, and A. Hall, 1969. The shell structure and mineralogy of the Bivalvia. Introduction. Nuculacea-Trigonacea. *Bull. Br. Mus. nat. Hist.* Zool. Suppl. 3: 1-125, pls. 1-29.

Tebble, N., 1966. British Bivalve Seashells: I-IV, 1-212, pls. 1-12. Trust. Brit. Mus. (Nat. Hist.), London.

Tenison Woods, J. E., 1877. On some new Tasmanian Shells, and a new reversed Tasmanian *Helix*. *Pap. Proc. R. Soc. Tasm.* 1876: 3-34.

Thiele, J., 1930. Gastropoda und Bivalvia. *Fauna Südwest-Aust.* 5 (8): 561-596, pl. 4.

——— 1934. Handbuch der Systematischen Weichtierkunde. 3: 779-1022. G. Fischer, Jena.

Thiery, P. & M. Cossmann, 1907. Note sur le Callovien de la Haute-Marne et specialement sur un

gisement situe dans la commune de Bricon. *Bull. Soc. Agric. Lett. Sci. Arts, Haute-Saone* 1907: 69-147.

Turner, E., and A. J. Dartnall, 1971. Types of Mollusca. A list of type specimens of molluscs held in the Tasmanian Museum, Hobart, Tasmania: 2 (unnumbered) + 1-96. Tasmanian Museum, Hobart.

Van de Poel, L., 1955. Structure du test et classification des Nucules. *Bull. Inst. r. Sci. nat. Belg.* 31 (3): 1-11.

Verco, J. C., 1907. Notes on South Australian Marine Mollusca, with Descriptions of New Species. — Part VI. *Trans. R. Soc. S. Aust.* 31: 213-230, pls. 27-28.

Vokes, H. E., 1967. Genera of the Bivalvia: A systematic and bibliographic Catalogue. *Bull. Am Paleont.* 51 (232): 103-394.

Wrigley, A., 1946. Observations on the Structure of Lamellibranch Shells. *Proc. malac. Soc. Lond.* 27 (1): 7-19.

Manuscript accepted for publication 26th May, 1977

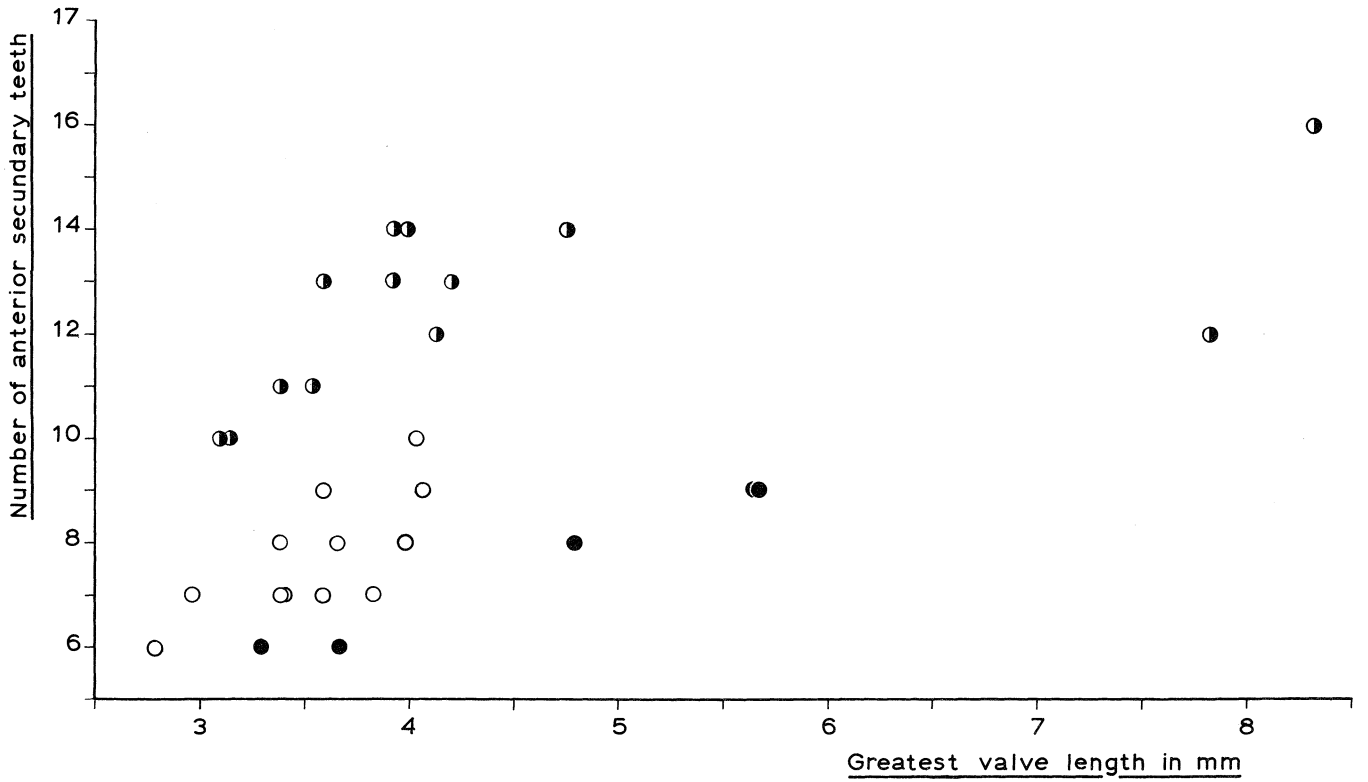
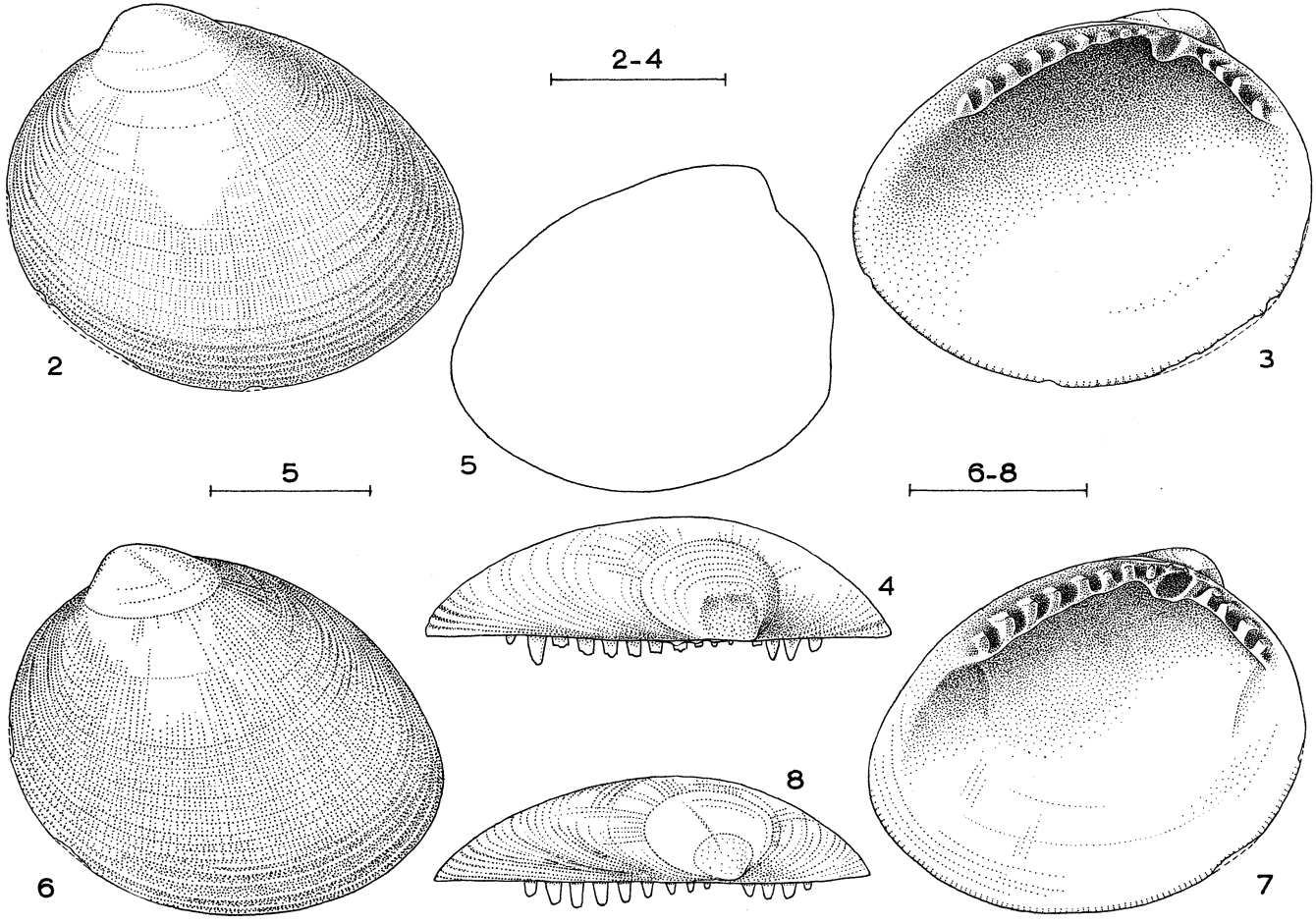
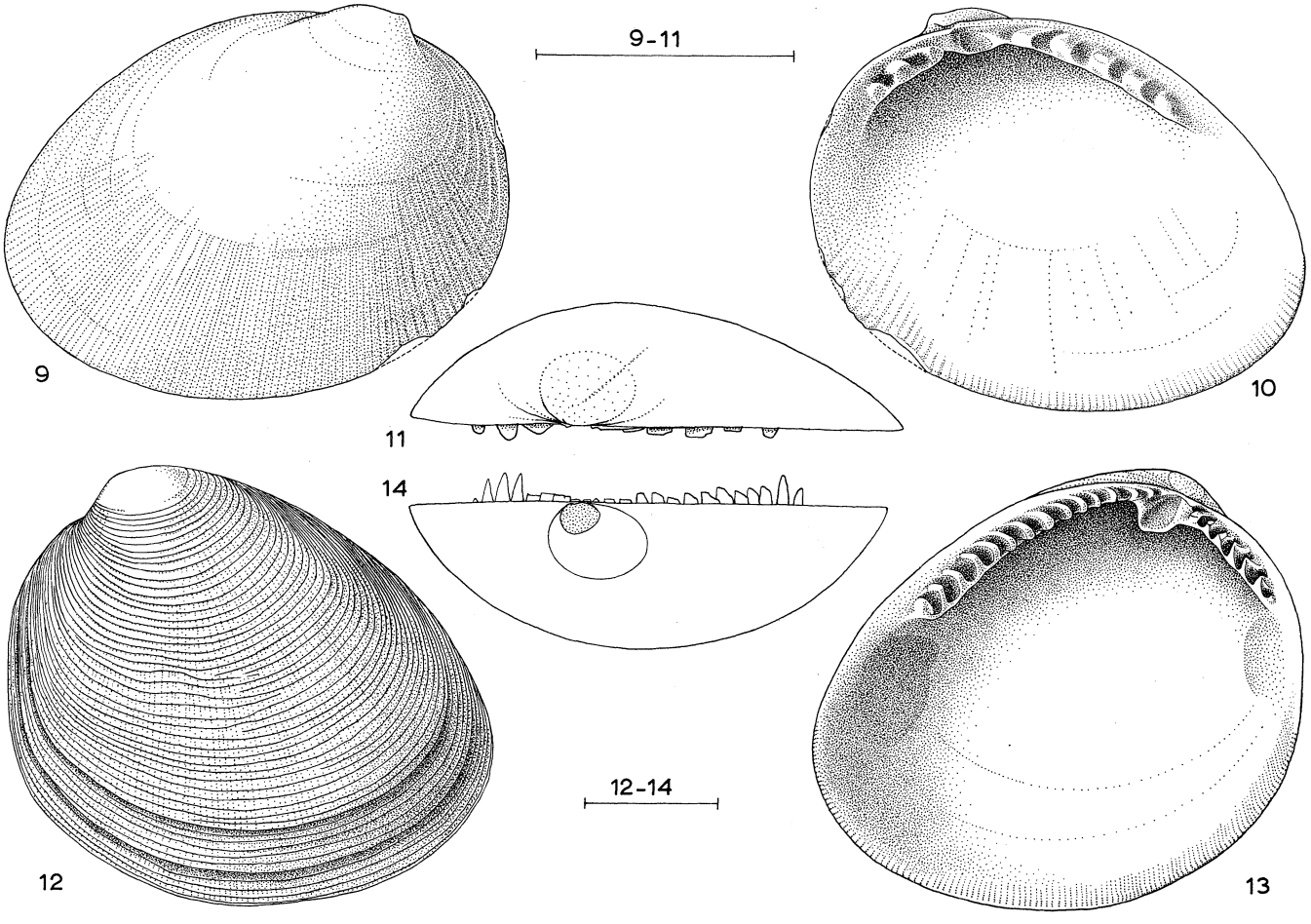


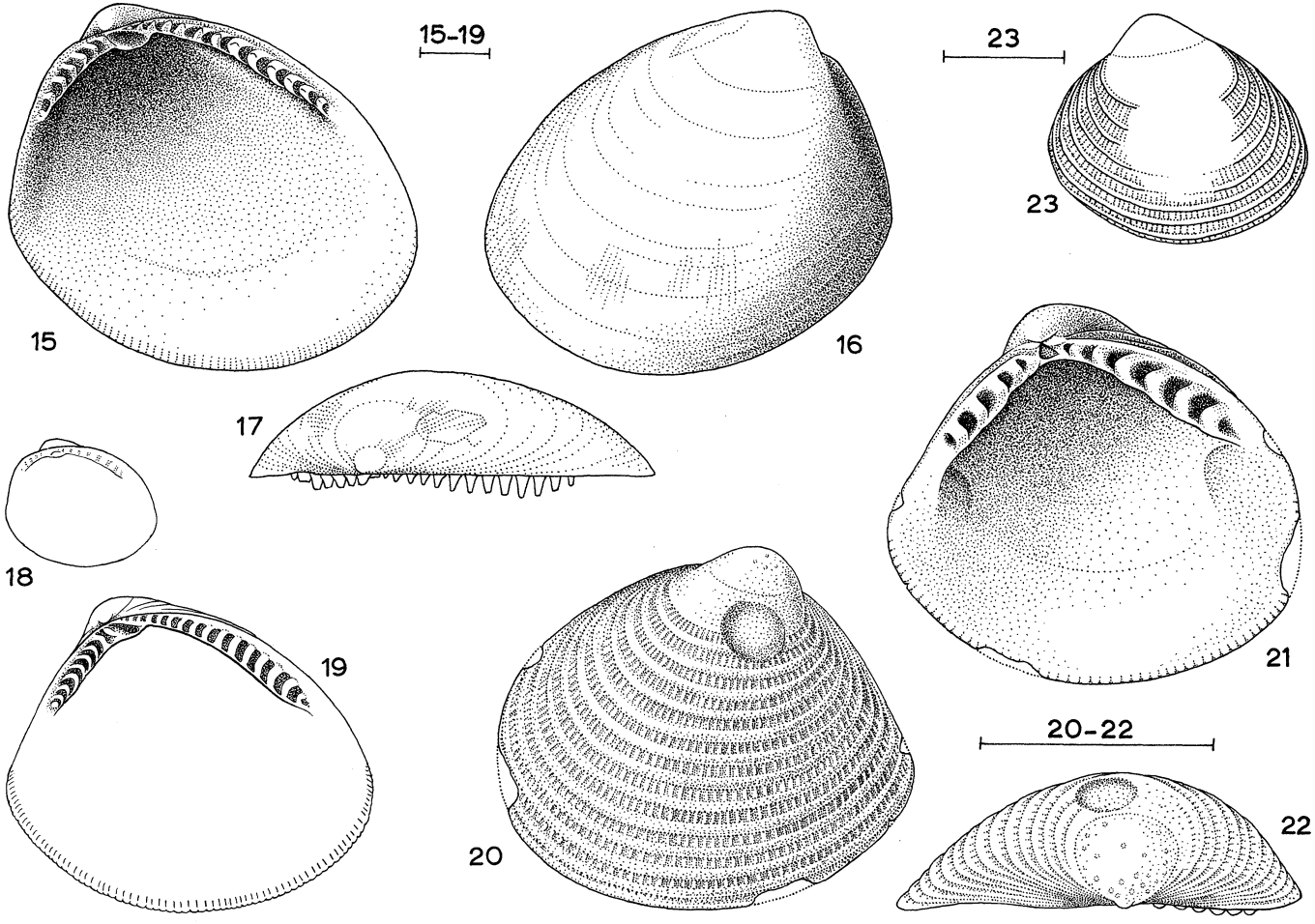
Fig. 1. *Nucula dilecta* Smith: the number of anterior secondary teeth as a function of the greatest valve length in mm. Black dots: *Nucula dilecta dilecta* Smith; open circles: *Nucula dilecta flindersi* Cotton; black-and-white dots: *Nucula dilecta diaphana* Prashad.



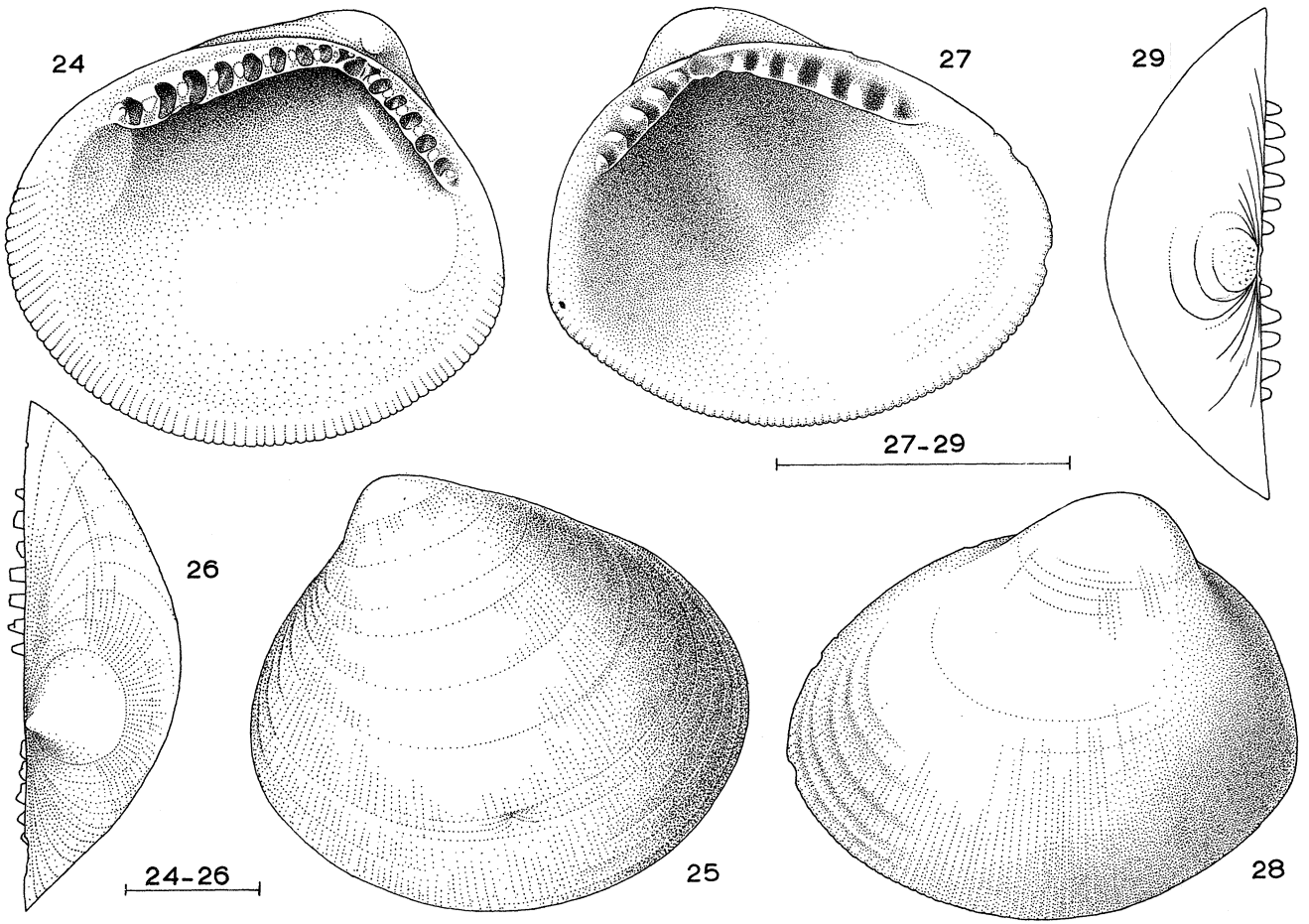
Figs 2-4. Lectotype of *Nucula pusilla* Angas, Port Jackson, New South Wales (BMNH 1877.5.12.61), scale 1 mm. Fig. 5. *Nucula pusilla* Angas, Shark Bay, Western Australia (WAM809-71), scale 1 mm. Figs 6-8. *Nucula pusilla* Angas, Brighton, South Australia (lectotype of *Nucula micans* Angas: MMNH 1879.1.31.8/2), scale 1 mm.



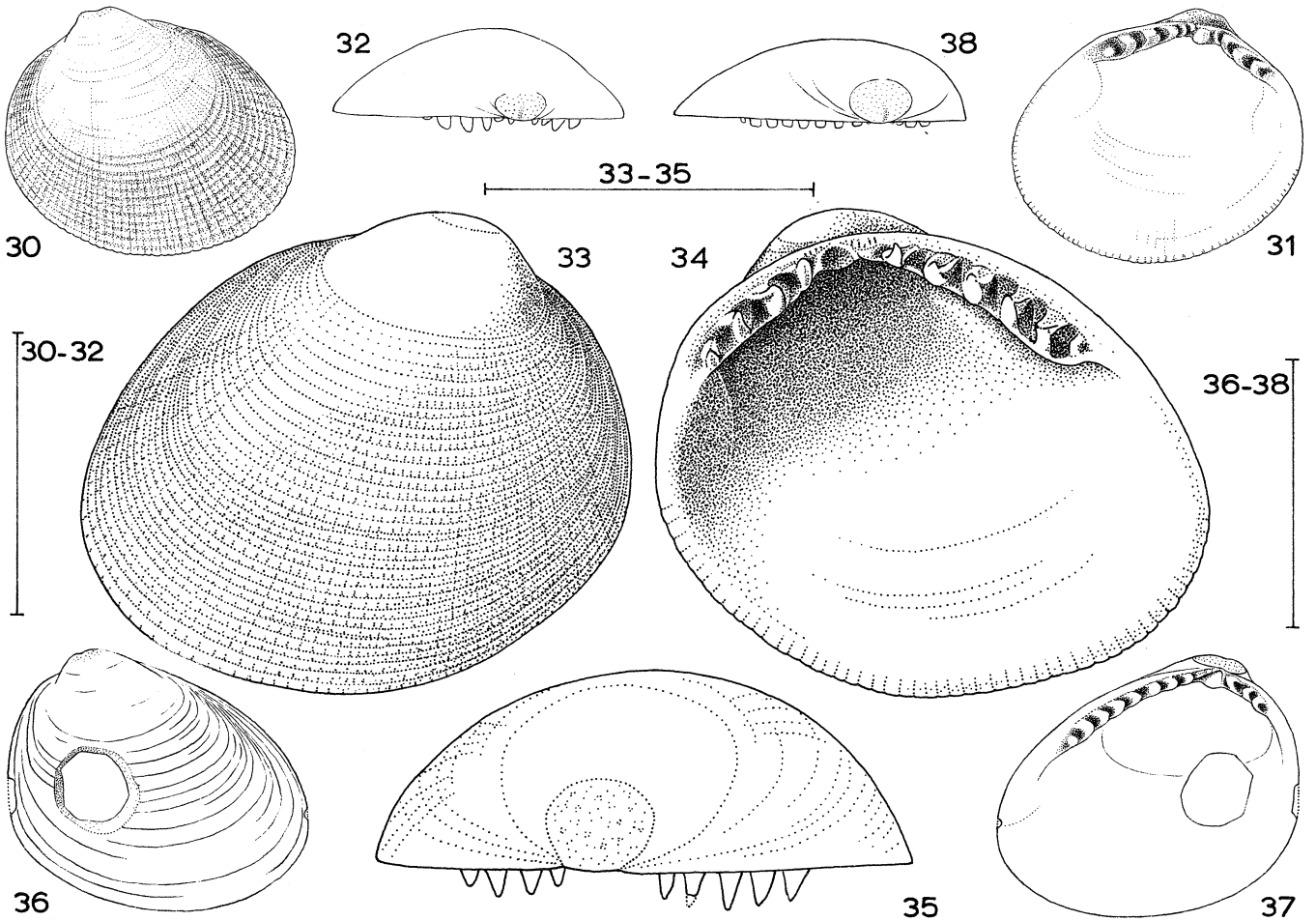
Figs 9-11. *Nucula pusilla* Angas, Blackmans Bay. Tasmania (lectotype of *Nucula hedleyi* Pritchard and Gatliff; TAS E18e/7359), scale 1 mm. Figs 12-14. *Nucula pusilla* Angas, Gulf St. Vincent, South Australia (holotype of *Pronucula concentrica* Cotton; SAM D.10115), scale 1 mm.



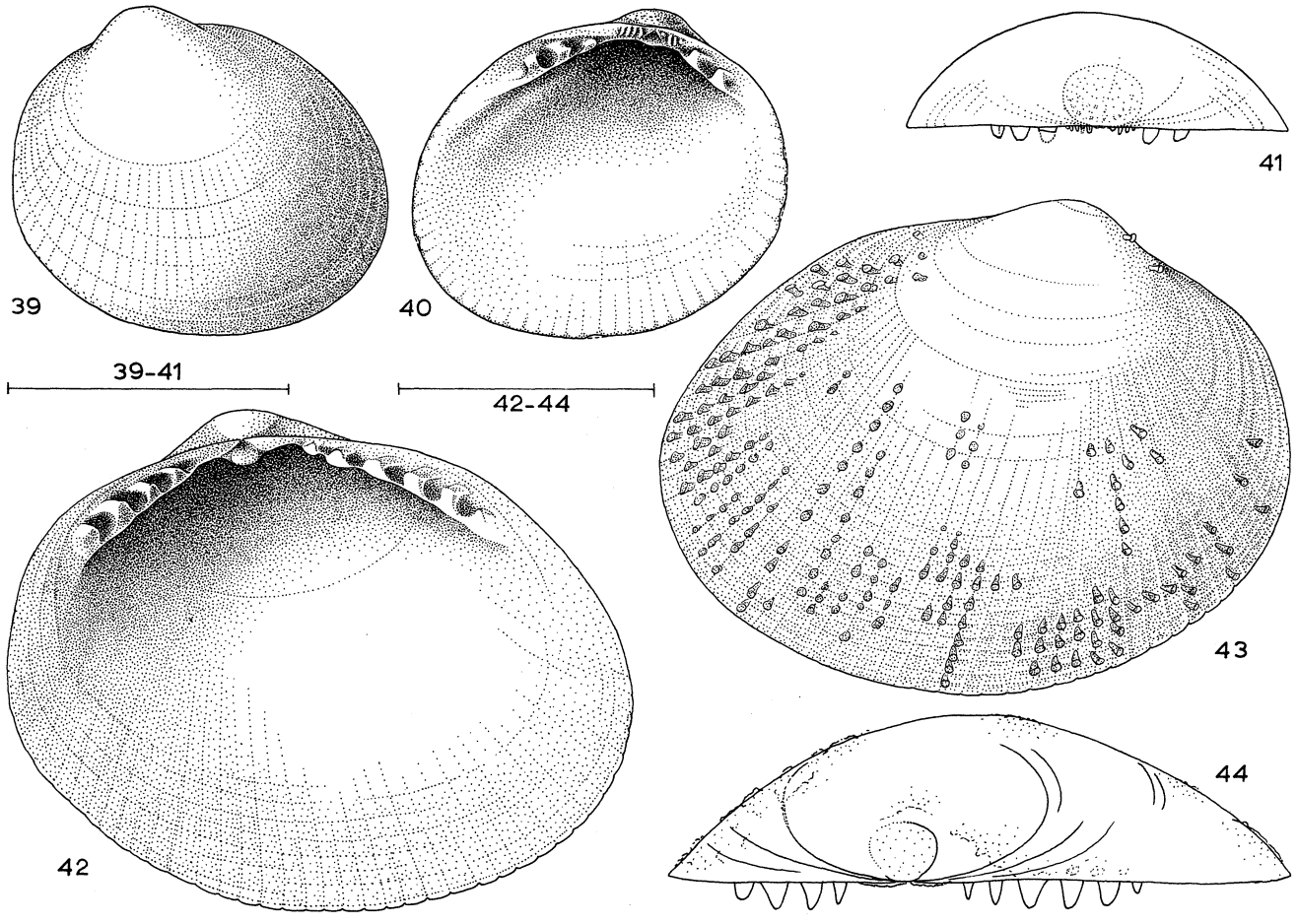
Figs 15-17. Holotype of *Nucula beachportensis* Verco, off Beachport, South Australia (SAM D.11310). Fig. 18. *Nucula beachportensis* Verco, 30 miles south of Cape Everard, Victoria (AM C.83128. Fig. 19. *Nucula beachportensis* Verco, south of Rowley Shoals, off Western Australia (WAM 800-71); scale 1 mm. Figs 20-22. *Nucula torresi* Smith, Port Stephens, New South Wales (holotype of *Pronucula voorwindei* Bergmans; AM C.67030), scale 1mm. Fig. 23. *Nucula torresi* Smith, approximately 135 miles north-west of Roebuck Bay, Western Australia (AM C.88702), scale 1mm.



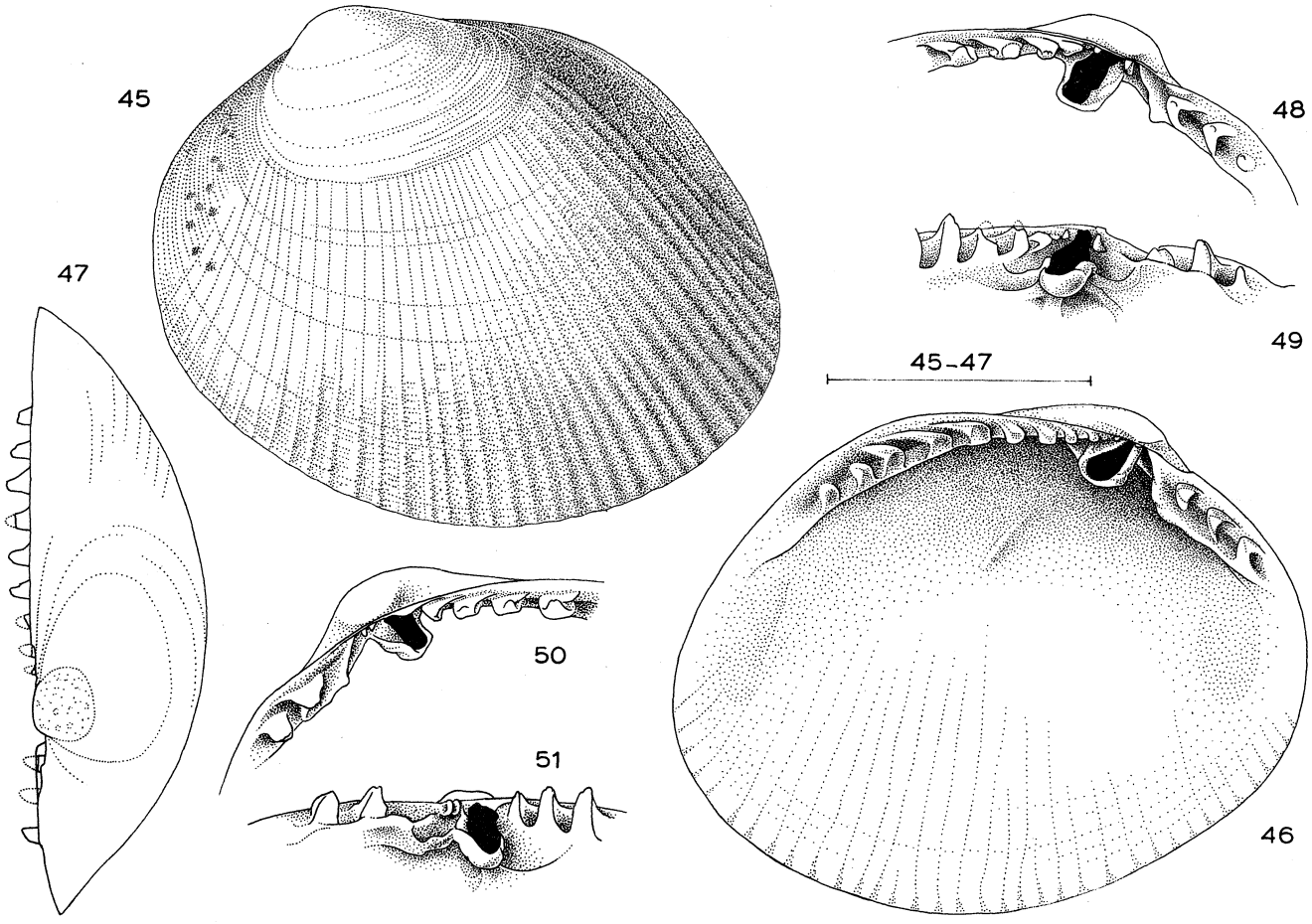
Figs 24-26. Lectotype of *Nucula praetenta* Iredale, off Sydney, New South Wales (BMNH 89.2.13.12-13/1), scale 1 mm. Figs 27-29. Lectotype of *Nucula saltator* (Iredale), Low Isle, Queensland (AM C.60256), scale 1 mm.



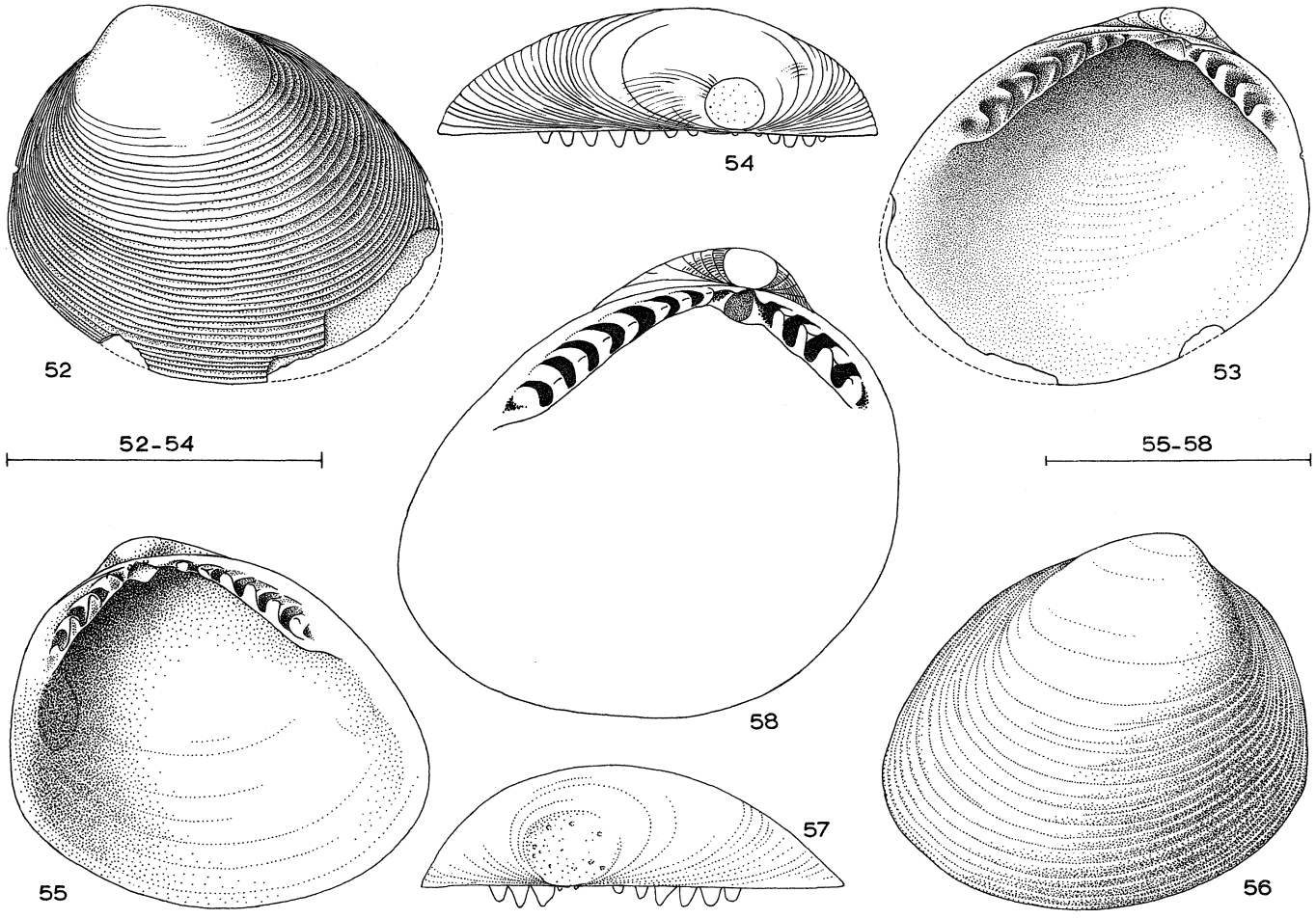
Figs 30-32. Holotype of *Nucula revei,* new species, Narrabeen, New South Wales (RMNH 52697), scale 1 mm. Figs 33-35. *Nucula mayi* (Iredale), Pilot Station, D'Entrecasteaux Channel, or Union Bay, Tasmania (SAM D. 15021), scale 1 mm. Figs 36-38. *Nucula* species, Narrabeen, New South Wales *(Pronucula micans,* Bergmans, (not (Angas, 1878)) 1968, *J. malac, Soc. Aust.* 11: 78, pl. 12, figs 6a-c), scale 1 mm.



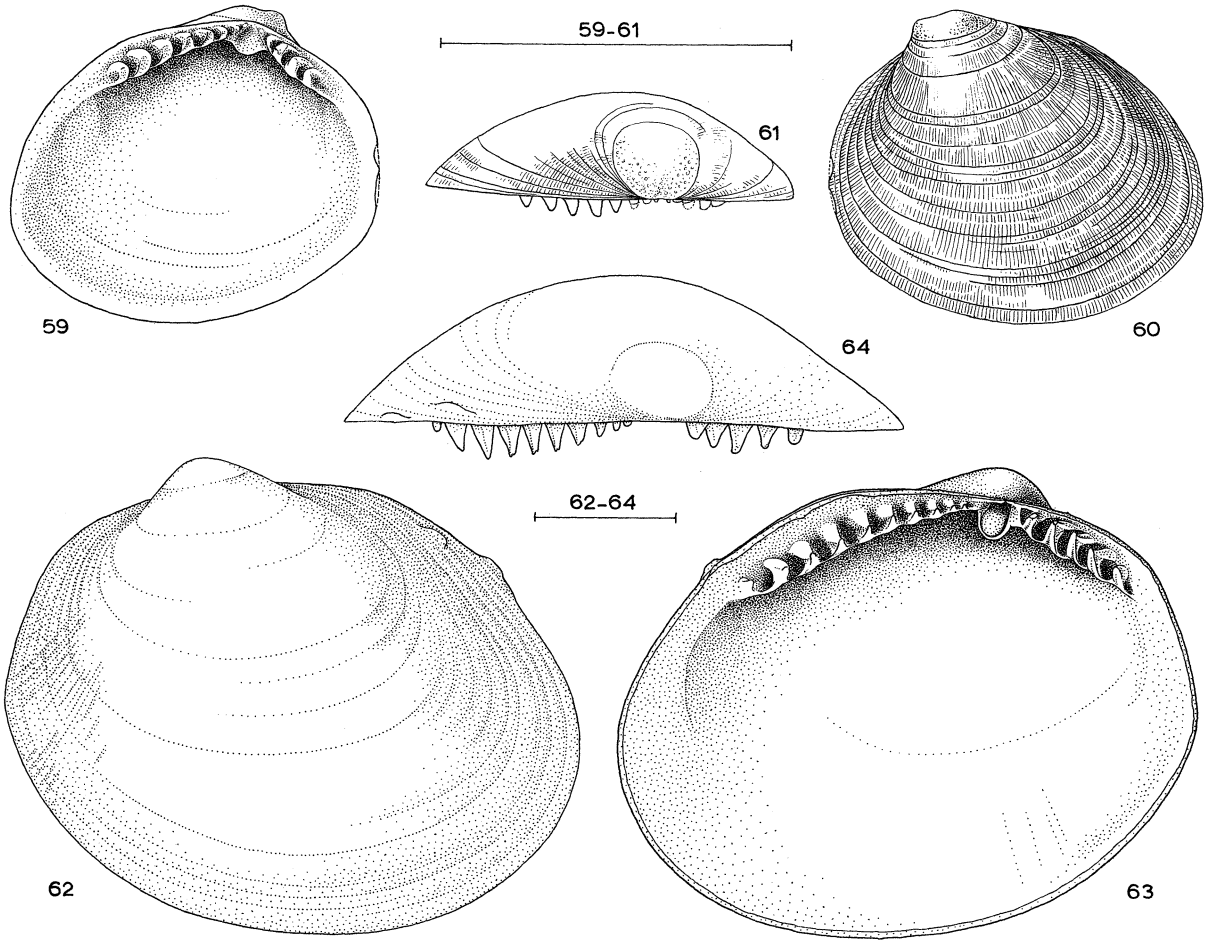
Figs 39-41. Holotype of *Nucula covra,* new species, 40 miles south of Cape Wiles, South Australia (AM C.88707), scale 1 mm. Figs 42-44. Paratype of *Nucula decorosa* (Hedley), off Port Kembla, New South Wales (AM C.12309), scale 1 mm.



Figs 45-51. *Rumptunucula vincentiana* (Cotton & Godfrey), MacDonnell Bay, South Australia (SAM D.11306), scale 1 mm. Figs 48-51. Holotype of *Rumptunucula vincentiana* (Cotton & Godfrey), Gulf St. Vincent or St. Francis Island, South Australia (SAM D.13151); fig. 48: hinge of right valve; fig. 49: ventral view of right valve hinge; fig. 50: hinge of left valve; fig. 51: ventral view of left valve hinge; scale figs 48-51 somewhat larger than that of figs 45-47. Remnants of ligament shown in black.



Figs 52-54. Holotype *Nucula papuensis,* new species, Albany Passge, Queensland (AM C.100961), scale 1 mm. Figs 55-57. *Nucula australiensis* (Thiele), Skippy Rock, Careening Bay, Garden Island, Western Australia (WAM 1147-75), scale 1 mm. Fig. 58. *Nucula australiensis* (Thiele), Gulf St. Vincent, South Australia (SAM D.15090), scale 1 mm.



Figs 59-61. Holotype of *Nucula brongersmai,* new species, Primrose Sands, Tasmania (TAS E5373), scale 1 mm. Figs 62-64. Holotype of *Nucula dilecta flindersi* (Cotton), 120 miles west of Eucla, Western Australia (SAM D.10116), scale 1 mm.

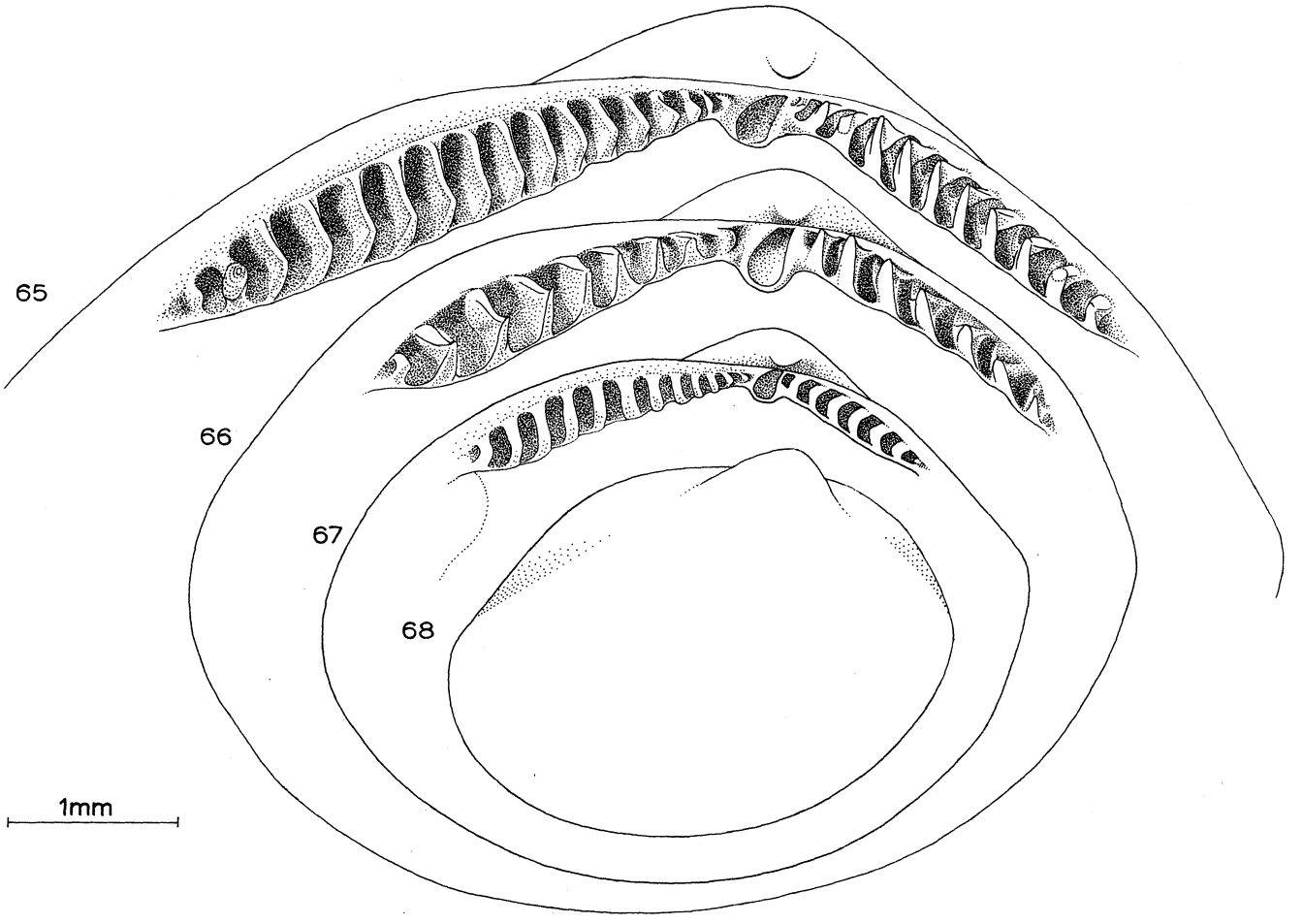


Fig. 65. Holotype of *Nucula dilecta diaphana* Prashad, between Sumba and Flores, Indonesia (ZMA), hinge of right valve. Fig. 66. Lectotype of *Nucula dilecta dilecta* Smith, off Sydney, New South Wales (BMNH 89.2.13.22-30/1). Fig. 67. *Nucula dilecta diaphana* Prashad, south of Rowley Shoals, off Western Australia (WAM 801-71). Fig. 68. Paratype of *Nucula dilecta flindersi* (Cotton), 120 miles west of Eucla, Western Australia (SAM D.1587). Scales applies to all figures.

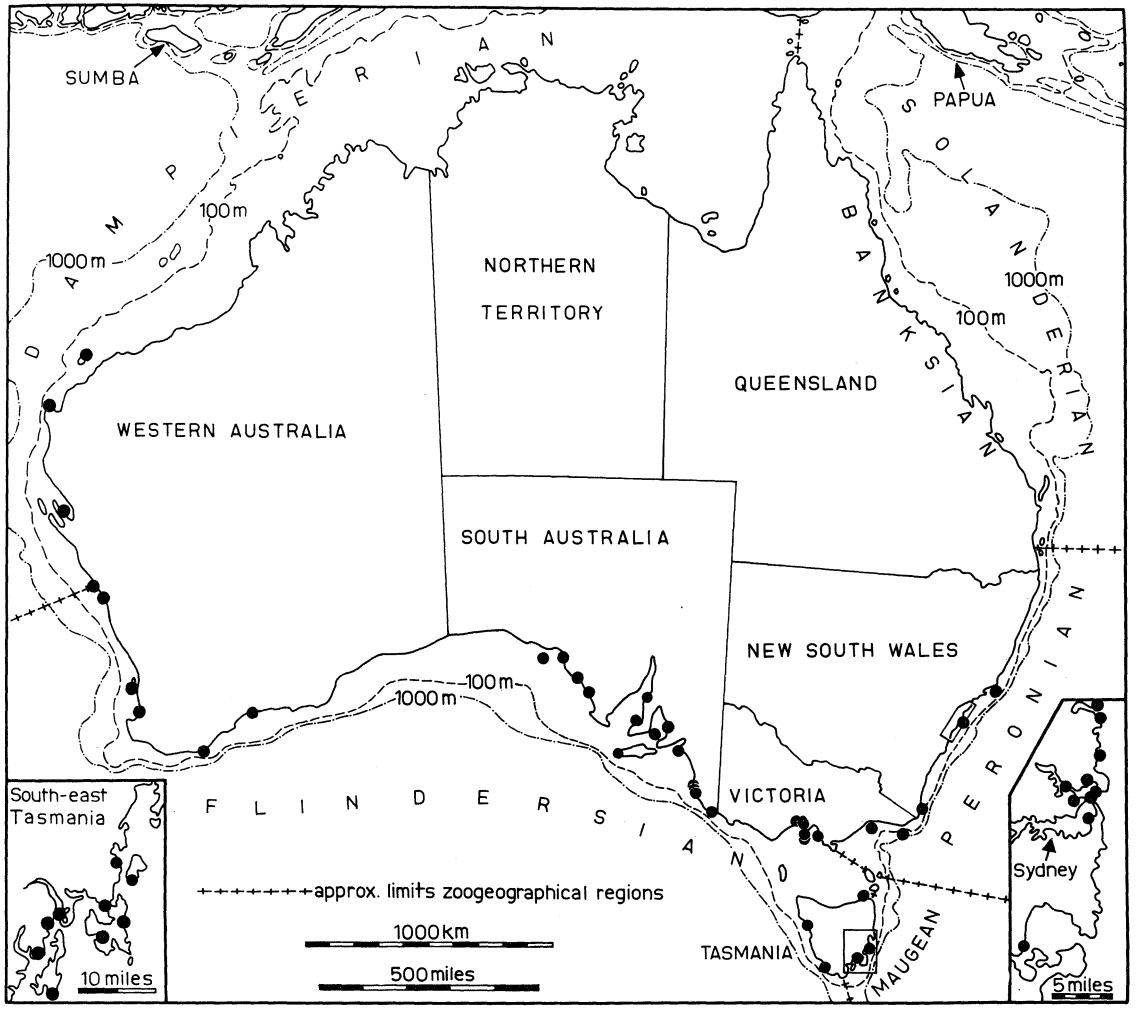


Fig. 69. Collecting localities of *Nucula pusilla* Angas (black dots).

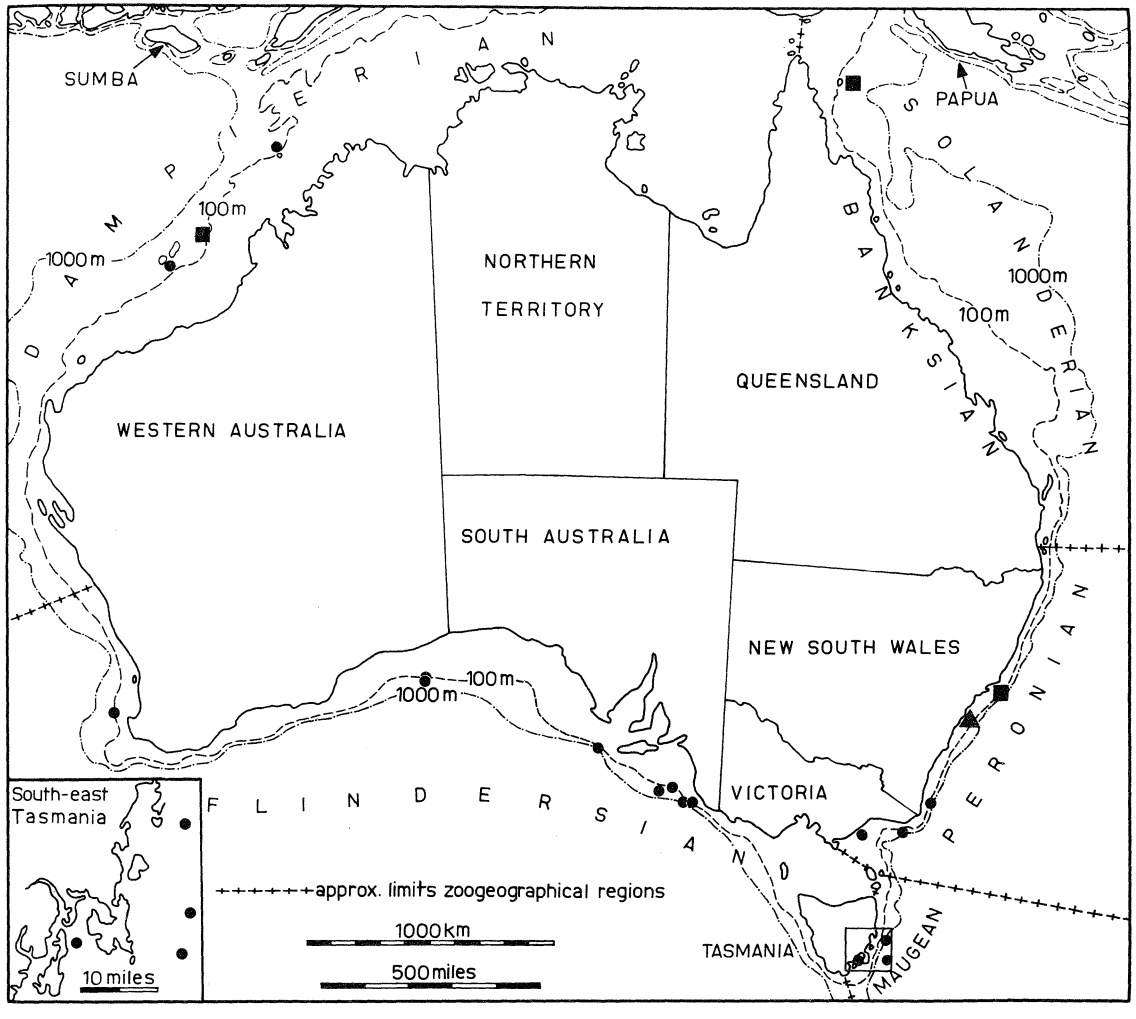


Fig. 70. Collecting localities of *Nucula beachportensis* Verco (black dots), *Nucula torresi* Smith (black squares), and *Nucula praetenta* (Iredale) (black triangle).

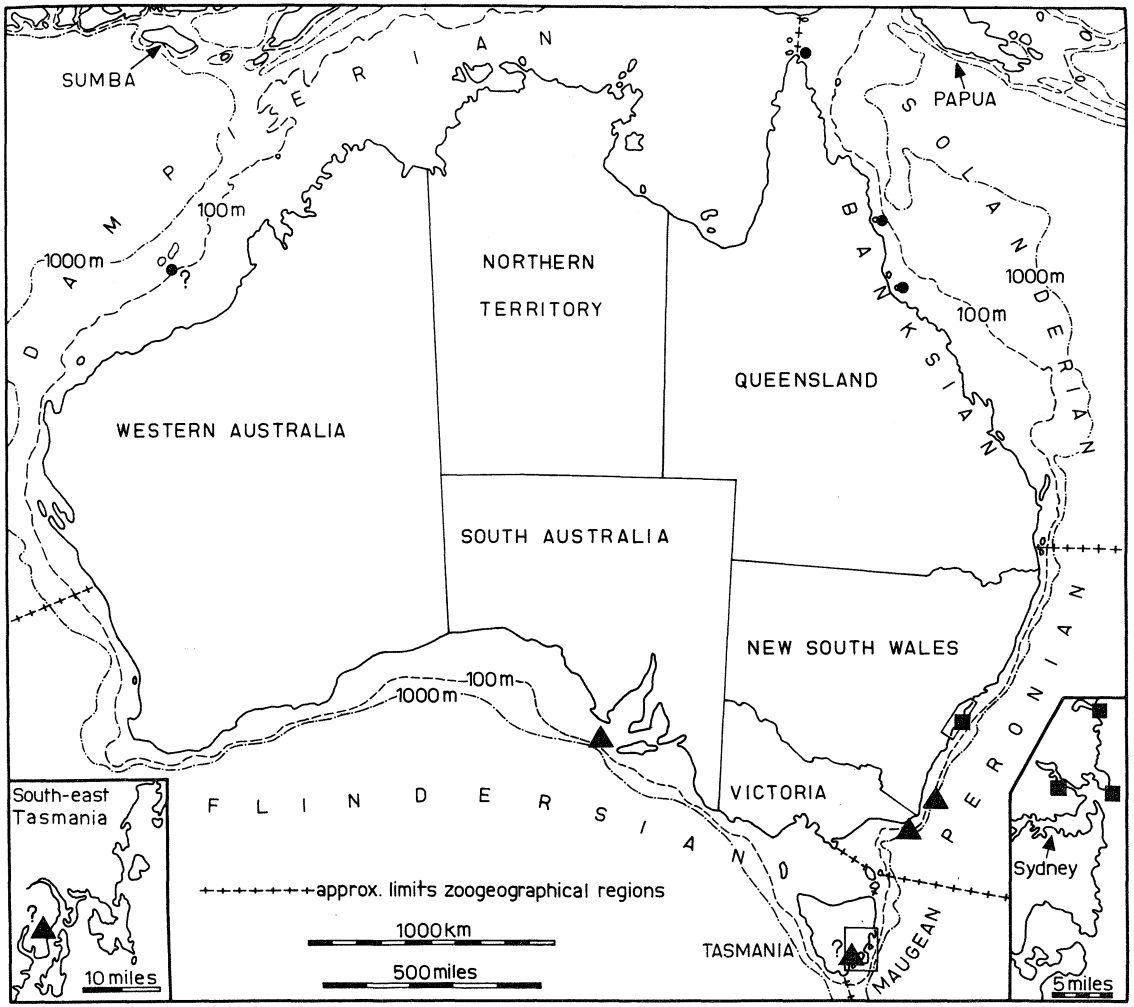


Fig. 71. Collecting localities of *Nucula saltator* (Iredale) (black dots), *Nucula covra* Bergmans (black triangles) and *Nucula revei* Bergmans (black squares).

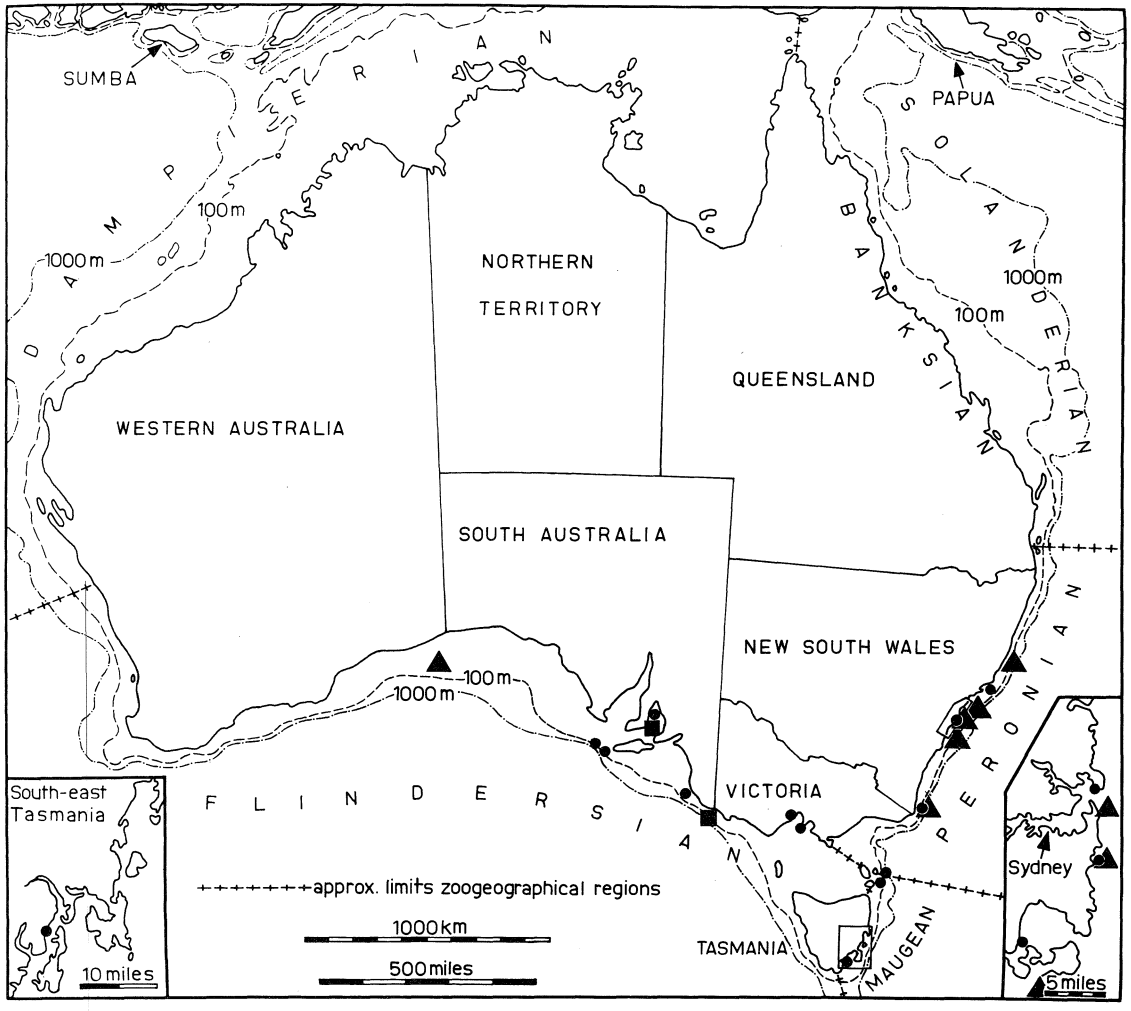


Fig. 72. Collecting localities of *Nucula mayi* (Iredale) (black dots), *Nucula decorosa* (Hedley) (black triangles), and *Rumptunucula vincentiana* (Cotton & Godfrey) (black squares).

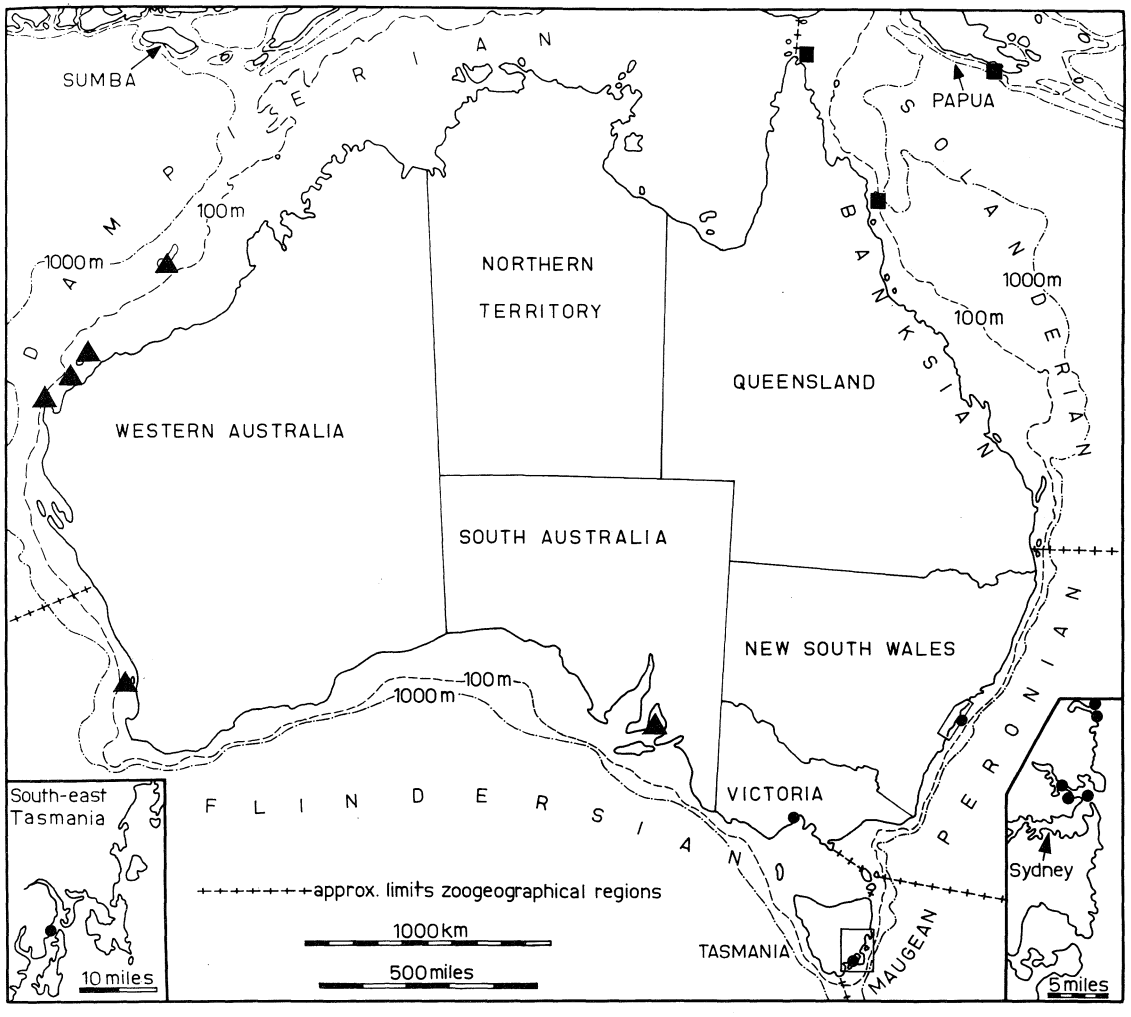


Fig. 73. Collecting localities of *Nucula australiensis* (Thiele) (black triangles), *Nucula brongersmai* Bergmans (black dots), and *Nucula papuensis* Bergmans (black squares).

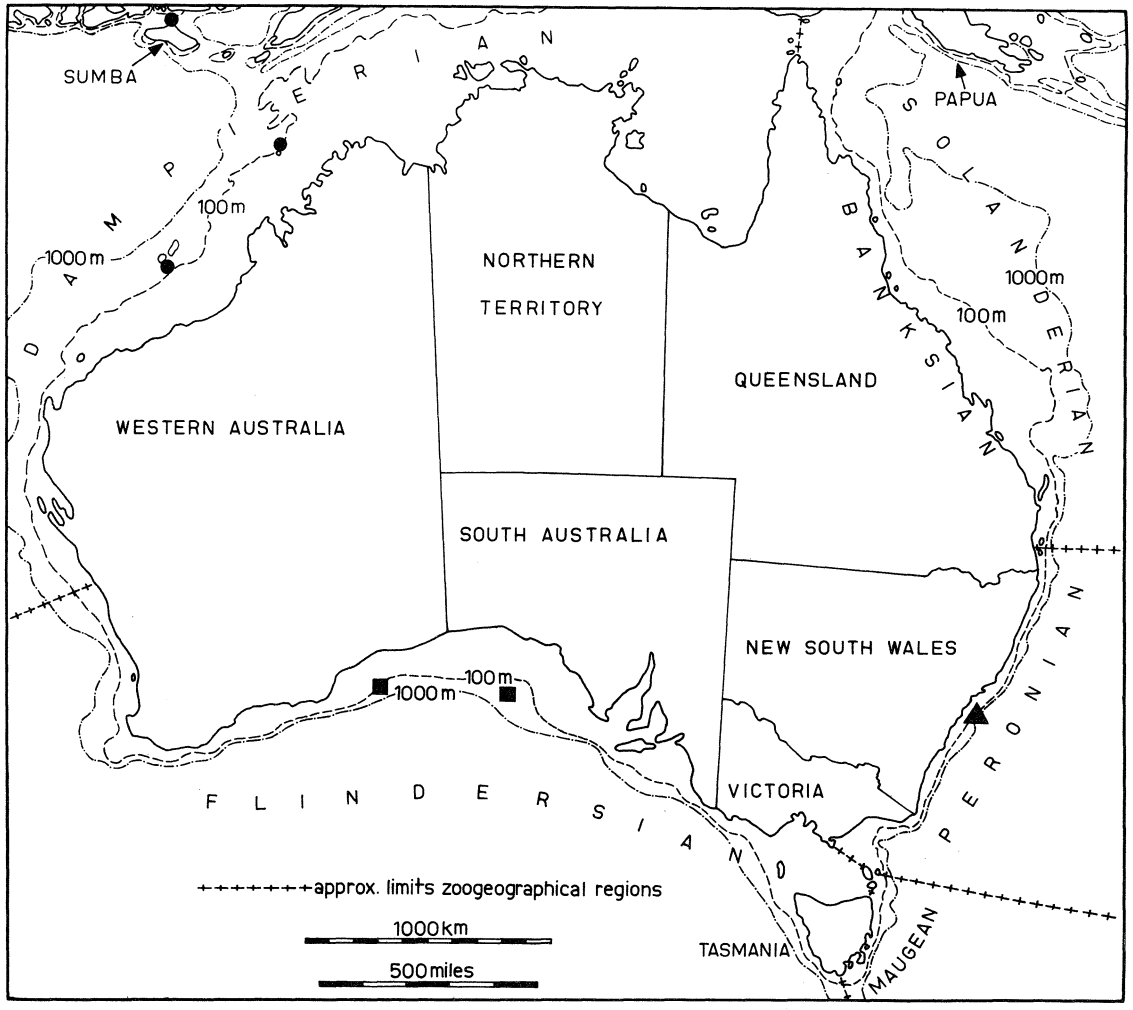


Fig. 74. Collecting localities of *Nucula dilecta dilecta* Smith (black triangle), *Nucula dilecta diaphana* Prashad (black dots), and *Nucula dilecta flindersi* (Cotton) (black squares).